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The Effectiveness of ISCO Injection Methods for Remediation of Groundwater

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TABLE OF CONTENTS

ABSTRACT

In-Situ Chemical Oxidation (ISCO) injections were performed at Petro Stopping Centers # 10 (Petro) in December 2013 and June 2015. The methodology was direct injection of a heavy oxidizer, RegenOx®, followed by a time-release oxygen compound, ORC Advanced®, into a plume of gasoline sitting on top of the water in the aquifer in hope that this remediate the aquifer. Both chemicals are registered trademarks of the Regenesis® Company.

The levels of contaminates have dropped considerably. However, Petro has not achieved closure criteria according to RECAP standards. The site is classified as a GW-1B, subject to the most stringent of remediation standards, due to its ability to be used as a drinking water source. The analytical results show undulating contaminate levels, dropping to below detectable levels then resurging to levels above acceptable RECAP standards. Levels show steady decline in all the monitoring wells including downgradient monitoring wells. The undulating phenomenon can be explained by desorption of COCs, incidental spilling of gasoline, or the clay's affinity for organics. Further investigation into the clay will provide a better idea of which hypothesis is closer to the truth. During a sampling event, 3/19/15, levels were below detectable concentrations in all samples. Lab error offers a possible explanation for this event, the site still has contamination on it, if that sampling event produced clean samples is highly suspect.

The injections were successful at bringing gasoline contaminate concentrations down directly after an injection period. The method is effective and easy to apply. The resurgence of contaminates at this site is up for discussion and further study but, the method of remediation used at Petro is an effective tool in remediating a gasoline contaminated aquifer. Suggestions for improving the effectiveness of this method with the use of other injection materials in conjunction with the chemicals used in this project are mentioned in the discussion and conclusion sections of this thesis. Data referenced in this thesis is publicly available at the Louisiana Department of Environmental Quality document search website EDMS under the Agency Interest(AI) number 5962.

INTRODUCTION

Soil and groundwater contamination due to petroleum products is a common problem throughout the world. This issue is a result of man's widespread use of petroleum based products in day to day activities. Gasoline and diesel spills comprise the majority of soil and groundwater contamination events.

When the public thinks of a gasoline or diesel spill they think of the over turned big rig on the highway. Although highway accidents happen, it is not the most common way petroleum is released. Underground storage tanks (USTs), such as those at a gasoline station, are the most frequent routes for gasoline or diesel to contaminate soil and groundwater. USTs begin to leak for a variety of reasons, and because of their location can do so for extended periods of time, allowing large amounts of petroleum constituents to be released.

Some USTs can leak for months or years without being noticed. An example of this common UST scenario would be the spill at the Petro Stopping Centers #10 (Petro) in Hammond, Louisiana. The fuel lines running from the USTs to the fuel dispensers were discovered to have cracked and were leaking for an extended length of time which resulted in the soil and groundwater became severely impacted.

Contamination of soil and groundwater by gasoline is cause for concern because of the hazardous chemical composition of gasoline. Benzene, Toluene, Ethylbenzene, and Xylenes, collectively known as BTEX, are the most harmful components in gasoline. The combined components of BTEX are believed to work synergistically, producing even greater harm to the environment and exposed individuals. Gasoline also contained Methyl Tertiary Butyl Ether (MTBE), a harmful additive that must also be remediated

To remove BTEX and MTBE from the soil and groundwater, Eagle Environmental Services Inc. (Eagle), along with the Louisiana Department of Environmental Quality (LDEQ), designed a plan of action. A few methodological approaches were considered. In the interests of remediating in the most cost effective and least laborious manor, the In-Situ Chemical Oxidation (ISCO) injection method was chosen. ISCO entails the injection of a chemical oxidizer into the contamination plume with the use of direct-push technology. The chemical oxidation is designed to break down the constituents of concern (COC's), BTEX and MTBE.

This thesis is focused on evaluating the effectiveness of the ISCO injection method on remediating groundwater contamination. Specifically, reduction in the concentration of COCs at Petro.

BACKGROUND & LITERATURE REVIEW

REGULATION

Soil and groundwater contamination by petroleum has been an environmental issue for most of the last century and the costs of remediating sites lead to state and federal regulations. The US Congress created the Leaking Underground Storage Tank (LUST) Trust Fund in 1986 by amending Subtitle I of the Solid Waste Disposal Act to address the problem of soil and groundwater contamination by gasoline and diesel leakage from federally USTs (https://www.epa.gov/ust/leaking-underground-storage-tank-lust-trust-fund). "The LUST Trust Fund provides money to: Oversee cleanups of petroleum releases by responsible parties; Enforce cleanups by recalcitrant parties; Pay for cleanups at sites where the owner or operator is unknown, unwilling, or unable to respond, or which require emergency action; and Conduct inspections and other release prevention activities." (https://www.epa.gov/ust/leaking-underground-storage-tank-lust-trust-fund). This trust fund allows for the present site of interest, Petro, to receive money through the state from the federal government to clean its released materials and remediate the site. The full list of regulation on USTs can be found in U.S. Code, Title 42, Chapter 82, Subchapter IX.

The main state regulation that governs this project is the Louisiana Department of Environmental Quality (LDEQ) Risk Evaluation/Corrective Action Program (RECAP) (LDEQ,2003), which addresses risks to human health and the environment from release of chemicals to the environment. RECAP requires that risk to human health and the environment be evaluated in the remedial decision-making process. "RECAP uses risk evaluation to: (1) determine if corrective action is necessary for the protection of human health and the environment, and (2) identify constituent levels in impacted media that do not pose unacceptable risks to human health or the environment, i.e.,

RECAP standards "(http://www.deq.louisiana.gov/portal/Portals/0/remediation/RemediationServices/RECAPfinal.pdf).

SITE GEOLOGY

The geology of a contaminated site is an important aspect when considering the type of remediation one wishes to perform on an area. The remediation options can be considerably limited by the composition of the ground soil layers and the transport of contaminants to groundwater and deeper aquifers.

"The upper Ponchatoula aquifer consists of extensive deposits of sand and gravel and typically is 200 to 300 ft thick, but thins southward. The upper Ponchatoula is thickest in the vicinity of Tickfaw and Hammond, La., and thins to about 200 ft at Ponchatoula, LA." (Rapp, 1994). Petro sits on top of Pleistocene terrace formations of southeast Louisiana, and thus composed of deposits of clay, silt, and gravel according to the Soil Survey of Tangipahoa Parish, (McDaniel, 1990). The region of the present location of interest is the Hammond area, which contains poorly drained silts and clays with slow infiltration and permeability rates and high runoff potential, especially due to a thick clay layer or claypan at or near the surface, as classified by the Louisiana Geological Survey (LGS). As such this area is considered a low recharge potential area to deeper drinking water aquifers (LGS, 1988). The United States Department of Agriculture (USDA) Soil Survey of Tangipahoa Parish describes the Hammond area as being in pine flats consisting of extensive broad, flat, poorly drained areas that rise gently to the north (McDaniel, 1990). The groundwater at Petro is contained in a silty sand, gravelly sand layer starting at 10-12 feet below ground surface (ft bgs).

HYDROLOGY

The surface hydrology of Petro comes into play now because of the aforementioned poorly drained soils. Many small rivers and streams, the largest of which are the Tangipahoa River in the eastern part of the parish and the Natalbany River in the western part of the parish, bisect Tangipahoa Parish. The numerous smaller streams and creeks in the parish empty into these two main rivers. Ponchatoula Creek is located about 0.3 miles south-southwest of Petro. This creek empties into the Natalbany River. The Natalbany River empties in to the Tickfaw River, which empties into Lake Maurepas. Lake Maurepas flows to Lake Ponchartrain through North Pass and eventually empties to the Gulf of Mexico (http://www.mytopo.com/maps/index.cfm).

Surface contamination at this site is also a problem; customers can spill gas while fueling their vehicles. However, most surface contamination to hit this site will have a tough time making it past the clay layer and will be carried off via surface runoff and sheetflow, during normal rainfall events, to the Ponchatoula Creek.

HYDROGEOLOGY

The fresh-water aquifers in Tangipahoa parish include the Miocene aged aquifers known collectively as the Jasper equivalent system (USGS, 2007). This aquifer system was deposited as "an off-lapping sequence of continental, deltaic, and marine sediments along the north flank of the Gulf Coast geosynclines" (USGS, 2007). A review of registered water wells within a one-mile radius of Petro shows two public supply wells screened in the Hammond aquifer at approximately 2,600 ft bgs, and one screened in the much shallower Gonzales/New Orleans aquifer at approximately 100 ft bgs. Most of the registered domestic wells within one-mile of Petro are screened in the shallower Gonzales/New Orleans aquifer. A map showing the location of registered domestic and public supply wells within a one-mile radius of Petro is provided in Appendix 2. The nearest registered well, #137, is located up-gradient of Petro. The nearest down-gradient well is well #830, a public supply well that is screened at a depth of 2,665 ft bgs. The nearest down-gradient domestic well is located over one-half mile away, well #136, and is screened in the Gonzales/New Orleans aquifer at approximately 100 ft bgs.

TOXICOLOGY

The primary constituents of concern from gasoline are BTEX and MTBE. The Chemicals involved in BTEX may work synergistically and their effect as a whole is well documented. The constituents of BTEX and MTBE are listed among the Priority Pollutants by the U.S.EPA (Zhang, et al., 2013). Benzene is a common solvent used in industry from factory work to medicine, resulting in high potential exposure of the workforce. Exposure to the general public occurs through routes as simple as smoking a cigarette or buying gasoline (Khan, 2007). Although rare, acute doses of benzene are known to produce aplastic anemia, a lethal condition where the bone marrow stops producing new blood cells (ATSDR 2007, 2015) Benzene is a known human carcinogen, a leukemogen and a lymphomogen (producing leukemia and lymphomas) (Group I classification, IARC 2016) (http://monographs.iarc.fr/ENG/Classification/latest_classif.php). Chronic exposure to benzene at

low doses produces leukemia and non-Hodgkin lymphomas. Acute Myeloid Leukemia (AML) is considered a 'signature disease' from benzene exposure (ATSDR 2007, 2015). The exposure time to benzene for petroleum distribution workers was found to coincide with a significant risk for leukemia (Khan 2007).

The toxic mechanism of action of benzene is still poorly understood, but it is thought that the hydroquinone and benzoquinone metabolites are the ultimate agents damaging cellular macromolecules, including DNA that leads to leukemia or lymphoma. (Liu et al. 2015; ATSDR 2007, 2015). Thus the damage done to an organism persist long after the parent compound, benzene, has been metabolized and eliminated.

Although Toluene is not classified as a carcinogen (Group III, IARC 2016), it is a known neurotoxin (Liu et al., 2015). This chemical is known to cause neurodegenerative effects. Toluene is produced primarily as a solvent and considered safer than benzene, as a component of gasoline, and in production of benzene and many chemicals and consumer goods. It is generally agreed that toluene does not have the hemotoxic properties of benzene. The narcotic and neurotoxic properties of toluene are considered to be the main health hazards for humans (Fishbein, 1985).

Once absorbed, Toluene is primarily biotransformed by liver cytochrome P450 enzymes, resulting mainly in benzoic acid that is subsequently conjugated with glycine to form hippuric-acid and excreted in urine (Fishbein, 1985). Due to its high lipid solubility, toluene readily crosses membrane and physiological barriers including the blood brain barrier and the placental barrier. Infiltration of the CNS by toluene is obvious from its neurological impacts, but infiltration of the fetus leads to teratogenic effects. Toluene has been linked birth defects and is a known teratogen (Callan et al., 2016). The Callan et al. (2016) study looked at the birth weight of children whose mothers were toluene exposed through the work environment or through substance abuse, and identified physical and behavioral effects that fall under the category of Fetal Solvent Syndrome (Callen et al. 2016).

Ethylbenzene is an IARC suspected carcinogen (Group IIB, IARC 2016). Acute high doses of Ethylbenzene also result in eye and throat irritation, dizziness and vertigo. In a chronic low dose situation, such as prolonged exposure from a BTEX contaminated site, may result in irreversible inner ear damage as well as kidney failure (Taylor, 2010).As a natural product present in crude oil, large amounts of ethylbenzene

are produced in the United States and utilized mostly in the production of various plastics but also in fuels and solvents (Taylor, 2010). Unfortunately, Ethylbenzene seems to be ubiquitous in the environment, with low level concentrations present in all three medias: land, water, and air. This is particularly true in groundwater near current or former landfills, hazardous sites, or gas stations (Taylor, 2010).

Xylenes comprise the fourth component of BTEX. Three different isomers of xylene exist where the methyl group changes positions on the benzene ring meta-xylene, ortho-xylene, and para-xylene (ATSDR Toxicological Profile for Xylene, 2007). Xylenes fall into the classification of IARC suspect carcinogens (Group III, IARC 2016). Xylene is one of the top 30 most produced compounds in the United States and is also naturally occurring in petroleum and coal products (ATSDR Toxicological Profile for Xylene, 2007).

A known neurotoxin, xylene is rapidly absorbed through the lungs with 50% to 75% of the amount present in each inhaled breath being retained in the body (ATSDR Toxicological Profile for Xylene, 2007). Symptoms of exposure to 100 parts per million (ppm) of xylene in the air include headache, dizziness, nausea and vomiting as well as the CNS depression (Kandyala et al., 2010). Chronic exposure to xylene results in depression, insomnia, agitation, extreme fatigue, tremors, diminished short-term memory and impaired ability to concentrate. These symptoms have been referred to as ‘organic solvent syndrome’ (Kandyala et al., 2010).

BTEX DEGRADATION

The ISCO injection method chosen for Petro has two modes of degradation for the BTEX constituents. The first mode is direct chemical oxidation of the constituents, and the second is aerobic degradation performed by the existing microbes in the aquifer. The main chemical injected during this ISCO remediation was RegenOx which is a direct chemical oxidizer, making direct oxidation the main mode of oxidation for the injections. However, ORC Advanced was injected for the last few days of the injection period in order to sustain the already elevated dissolved oxygen levels in the aquifer as an effort to boost the aerobic degradation of the BTEX constituents long after injections were complete.

The constituents of BTEX are highly receptive to aerobic biodegradation under aerobic conditions. Two enzyme families are responsible, dioxygenases and monooxygenases. These enzyme pathways are referred to as the “tod” and “tol” pathways respectively. Enzymes from the Monooxygenase family attack the

methyl and ethyl group substituents on aromatic rings, this includes toluene, ethylbenzene, and xylenes. They are converted via enzyme catalyzed oxidation reactions to substituted pyrocatechols or phenyl glyoxal. This is referred to as the ‘tol” pathway (El-Naas et al., 2014). The “tod” pathway involves the dioxygenase family of enzymes. These enzymes attack the aromatic ring itself this includes all the BTEX constituents including Benzene. The breaking of the ring leads to the formation of 2-hydroxy-substituated compounds. The benzene oxidation is kicked off with a hydroxylation catalyzed by a dioxygenase (El-Naas et al. 2014). When the aromatic ring is substituted the enzymatic oxidation degradation can be catalyzed by both path ways, and according to El-Naas et al. toluene is the most readily degraded of the BTEX constituents.

The direct oxidation of BTEX, in the case of Petro, is the use of RegenOx reacting with its IRON chelating agent to create a free hydroxide radical (˙OH). This free radical attacks the organic constituents readily and quickly breaking bonds and stopping rotation inside aromatic rings. This reaction occurs on the order of 10^{9}-$10^{10}m^{-1}s^{-1}$(Kang and Hua, 2005).

THE CHEMICALS AND ISCO

To remove BTEX and MTBE from the soil and groundwater, Eagle Environmental Services Inc. (Eagle), along with the Louisiana Department of Environmental Quality (LDEQ), Developed a Corrective Action Plan (CAP) using RECAP standards as a guideline. In the interests of remediating in the most cost effective and least laborious manor, the In-Situ ISCO injection method was chosen. ISCO entails the injection of a chemical oxidizer into the contamination plume with the use of direct-push technology. The chemicals chosen for the remediation task were RegenOx and ORC Advanced. The Safety Data Sheets (SDS) for both of these chemicals are included in appendix 3.

RegenOx is a trade name for Sodium Percarbonate, activated with Chelated-Fe (II). The mode of action of RegenOx is oxidation of the COC’s. According to Crimi and Taylor (2007), benzene is often the limiting factor for achieving the designation of “clean” at a contaminated site. The maximum contaminate level for Benzene in groundwater has been set at .005 milligrams per liter (mg/l) by the Safe Drinking Water Act (Fu et al. 2015). At Petro this means all monitoring wells must measure below this level because of the aquifers classification at Groundwater Classification 1 B (GW1B). The use of a chelating agent in our case Iron (Fe

(II)), is because the Fenton like reaction, oxidation, performed by sodium percarbonate performs best done in the pH 2-4 range (Fu et al., 2015). Most ground water is near neutral or slightly basic, so the Iron is used as a catalyst material to overcome the hurdle of the sub-optimal pH conditions (Fu et al., 2015). According to Fu et al. (2015) this practice of using a chelating agent has been reported to significantly enhance the degradation of organic contaminates at neutral pH.

ORC Advanced is the trade name for a chemical mixture of Calcium Hydroxide Oxide and Calcium Hydroxide it was designed by the Regenesis Company. ORC Advanced contains what Regenesis calls Controlled Release Technology (CRT). According to their website ORC Advanced releases oxygen, 17% by weight, at a controlled rate over a period of up to 12 months. This is designed to boost the aerobic biodegradation of COCs in the ground water. It is used in conjunction with RegenOx at contaminated sites to continue remediation long after work has been completed. ORC Advanced can treat a wide variety of chemicals but its effects have been best observed aiding the biodegradation of BTEX and MTBE.

The LDEQ and Eagle both settled on RegenOx for a reason. Over years of experience in these remediation processes, the application of the Fenton reaction produces a powerful and non-selective oxidative decomposition of hydrocarbon contaminants (Fu et al. 2015). This approach has gained in popularity due to its effectiveness and low harmful impact to the environment. According to Fu and group (2015), the classic Fenton reaction involves the use of strong oxidizing ‘liquid H_2O_2’ without the use of a chelating agent. The Fenton alternative, Sodium percarbonate, RegenOx, performs as well as the Fenton’s reagent and there is a greater ease of use because RegenOx is a dry granule type material that in the event of a spill can be simply swept up and disposed of. Also the use of the Iron Chelating agent makes this RegenOx very powerful in normal soil conditions, whereas traditionally the liquid H_2O_2 needs soils in the acidic range to perform at optimum. The RegenOx reagent therefore was concluded to be better suited for Petro, with a near neutral pH and busy high traffic working area, than using the liquid Fenton’s reagent or other remediation methods.

ALTERNATIVE METHODS

There are alternatives to the ISCO chemicals chosen for this project. Permanganate and activated and inactivated persulfate were used in the remediation of a chalky aquifer in France by the Lemaire group

(Lemaire et al., 2011). This method, chosen by Lemaire was very similar to the method chosen for Petro. Lemaire and group chose this method after experimenting with the use of different oxidizers.

Bioremediation is always a popular idea because it uses microbes to destroy contaminates and is generally seen as man using mother nature to clean up the mess. This natural process is not the only aspect that makes this method attractive, it is also relatively easily done and cost effective, Gersberg and group (1995) performed a three-year study on the nitrate enrichment of ground water of a contaminated aquifer to encourage bacterial denitrification. Denitrification has been shown to support biodegradation of small hydrocarbons such as BTEX (Gersberg et al., 1995). Denitrification is an anaerobic process where nitrate becomes the alternative electron acceptor to oxygen so it would be preferred in low oxygen conditions such as a groundwater aquifer (Gersberg et al., 1995). This was a successful experiment as it brought BTEX levels down by 81% and 99% in the observed groundwater (Gersberg et al., 1995).

The bioremediation approach was taken a step further recently by the Zhang and group (2013). They used activated carbon as a bed for activated sludge with the idea that BTEX type chemicals would bind to the activated carbon and the microbial flora in the sludge would degrade these organic constituents (Zhang et.al, 2013). Though it was conducted on a small scale, this system was very successful. Results show low dissolved oxygen consumption, and the carbon binds the COC's acting like a filter while the microbes devoured them. Over the course of this 70-day study little breakthrough of organics was observed (Zhang et al., 2013).

Bentonite is a clay type mixture commonly referred to as drilling mud. Saeid Gitipour and his team used a modified bentonite to immobilize organic constituents in contaminated soils (Gitipour et al., 1997). "Absorption of organics by clays indicates that quaternary ammonium cations such as hexadecyltrimethylammonium (HDTMA) interact with clays and replace the exchangeable inorganic cations on their surfaces, forming a stationary phase in the clay particles" (Gitipour et al., 1997). In their experiment a chemical named Dimethyl di(hydrogenated) tallow was used to modify the bentonite clay mixture. Southern Clay Products (SCP) performed this modification (Gitipour et al., 1997). The experiment was successful in binding the organics with the modified bentonite, immobilizing 87% on average. Leaching was measured by conducting a standard, Toxicity Characteristics Leaching Procedure (TCLP) (Gitipour et al., 1997).

MATERIALS AND METHODS

The contamination at Petro is predominantly in the First 20 feet below the ground surface. Gasoline has a density less than 1 gram per cubic centimeter. "Gasoline weighs 0.749 grams per cubic centimeter" (http://www.aqua-calc.com/page/density-table/substance/gasoline), this property will make it float on top of the groundwater below ground surface. "The shallow aquifer consists of sand and gravel deposits underlying the upland terraces and flood plain deposits of major streams. Locally, the shallow aquifer can contain a large percentage of silt and clay, resulting in widely varying well yields." (Rapp, 1994). Petro sits on top of Pleistocene terrace formations of southeast Louisiana, the deposits from this period consist of clay, silt, and gravel according to the Soil Survey of Tangipahoa Parish. Upon investigation of Petro in particular it was found that the site had ground water in a silty and gravelly sand layer starting at 10-12 feet below ground surface, this can be observed cross section A-A' in Figures 1 and 2. The first 10-12 ft bgs consist of a silty clay, clay material. In the Hammond area these deposits are classified by the LGS (1988) as "poorly drained silts and clays with slow to very slow infiltration and permeability rates and high runoff potential. They include shallow soils over nearly impervious materials and soils with a claypan or a thick clay layer at or near the surface." As such this area is considered a low recharge potential area to deeper drinking water aquifers (LGS, 1988). Likewise, the USDA (1990) Soil Survey of Tangipahoa Parish describes the Hammond area as being in pine flats consisting of extensive broad, flat, poorly drained areas that rise gently to the north (USDA, 1990). Groundwater flow at Petro is in a northeast to southwest direction as seen in Figure 3.

During the RECAP investigation, the aquifer at Petro was classified as GW1B in accordance with RECAP standards "Groundwater within an aquifer that could potentially supply drinking water to a public water supply. The aquifer should be sufficiently permeable to transmit water to a well at a maximum sustainable yield of greater than or equal to 4,800 gallons per day (gpd) (6 households x 4 persons per household x 100 gpd x peaking factor of 2); and groundwater quality is such that it has a Total Dissolved Solids (TDS) concentration less than or equal to 1,000 milligrams per liter (mg/l)" (LDEQ RECAP 2003). GW1B designation forces Petro into RECAP's most stringent standards for declaring this site clean "An

aquifer meeting the Groundwater Classification 1 criteria is considered an underground source of drinking water and shall be protected or restored to its maximum beneficial use" (LDEQ RECAP 2003).

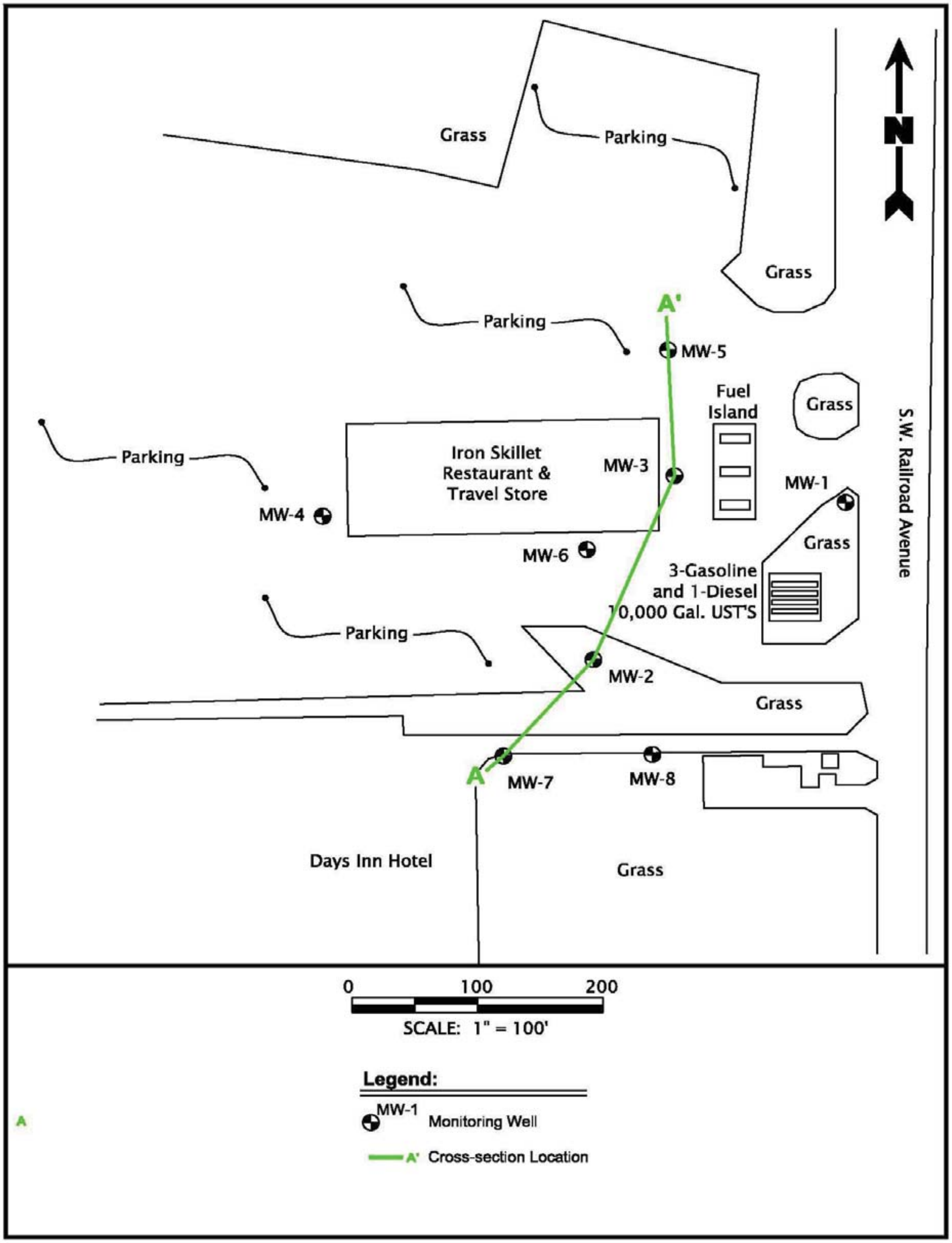


Figure 1-Cross section A-A' Location

This figure gives an over view of the cross sections location

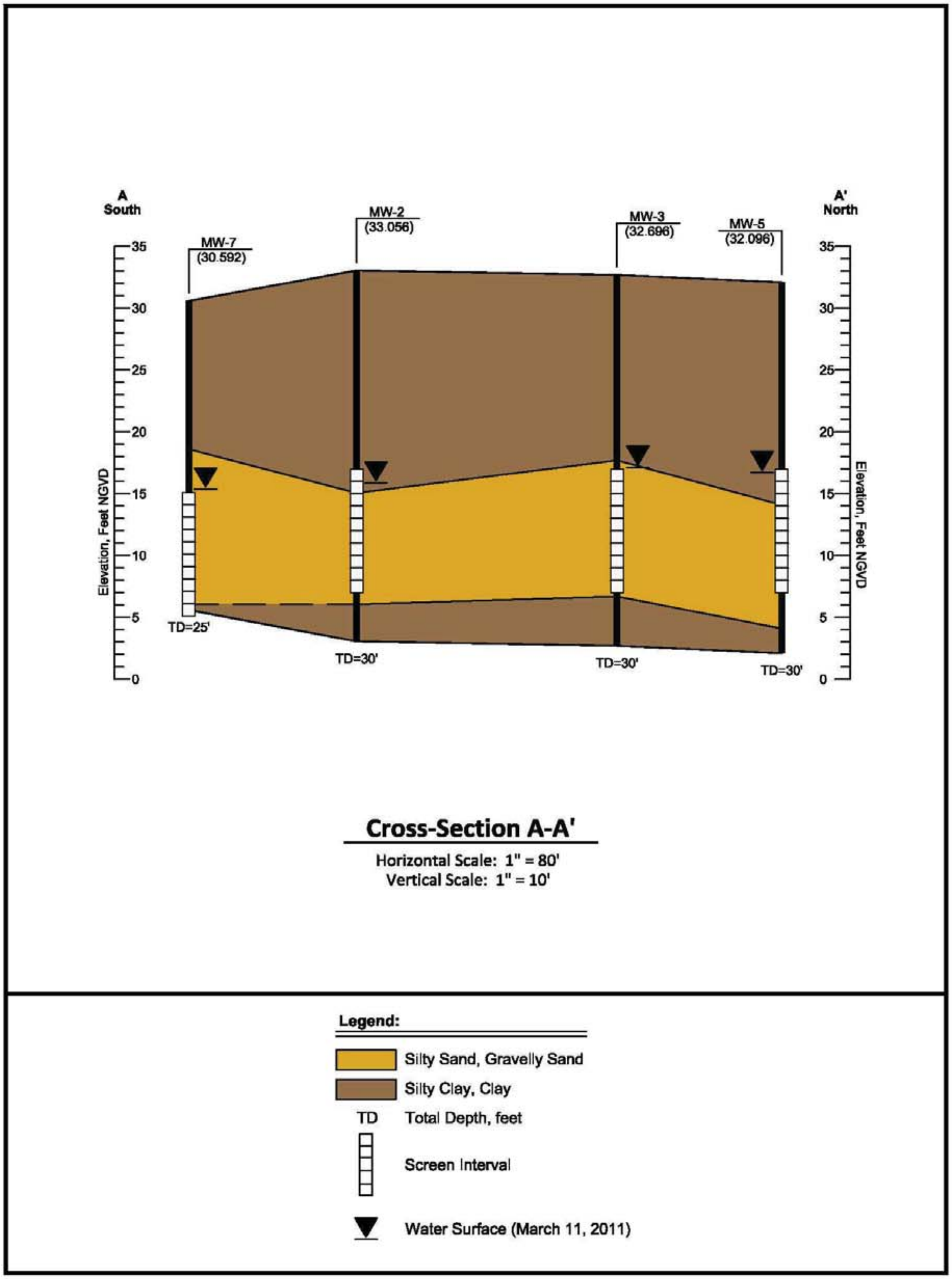


Figure 2-Cross section A-A':

This figure gives a view of the Clay layer that Petro sits on top of as well as the water bearing sands beneath them.

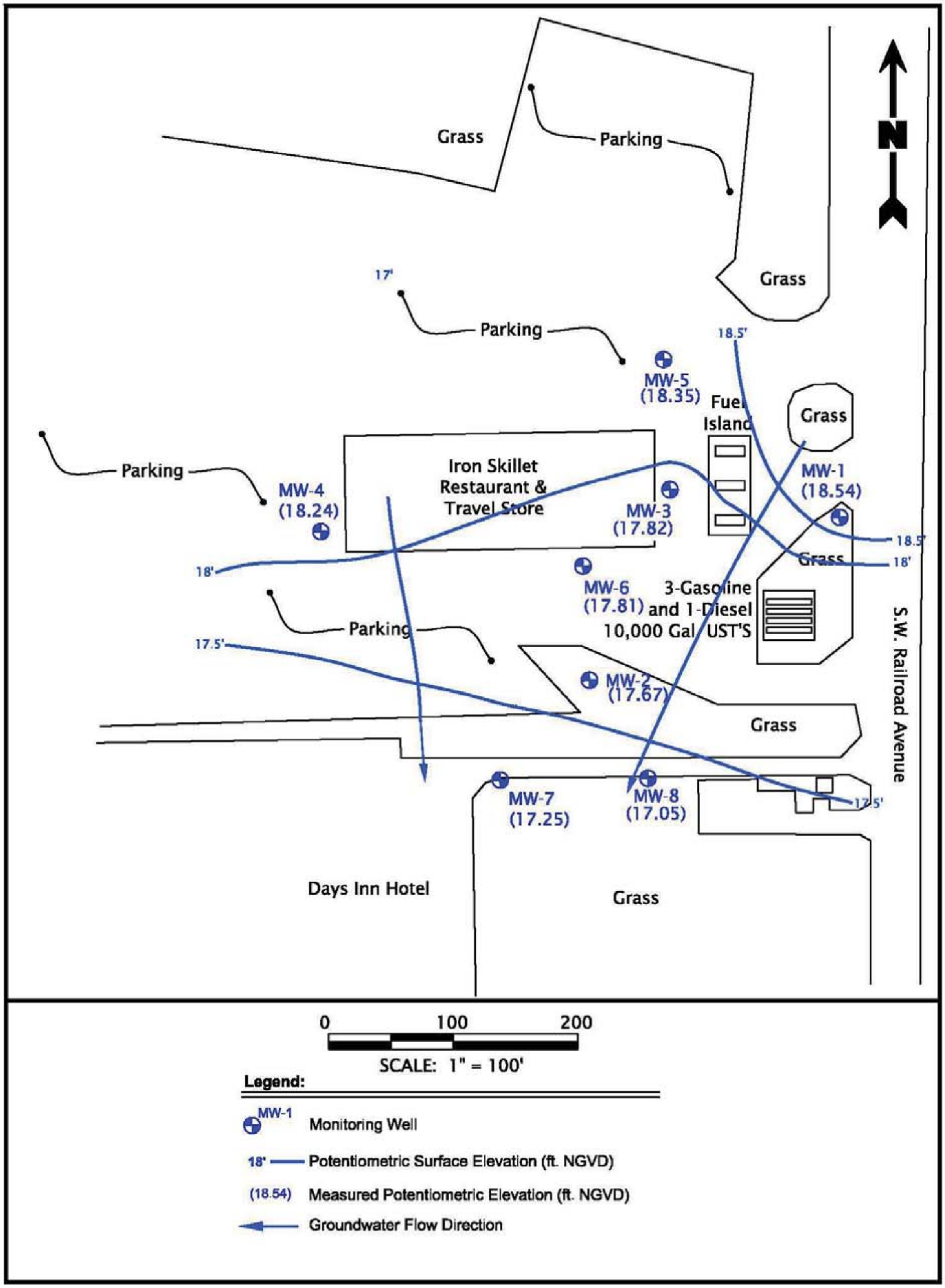


Figure 3-Potentiometric Map:

This figure gives a view of the flow of groundwater at Petro.

Point of Exposure (POE) for a GW1B Aquifer is assumed to be throughout the aquifer, and the Point of Compliance (POC) used to measure the concentration of COCs is supposed to be placed as close to the source of contamination without causing adverse effects (LDEQ RECAP 2003).

The RECAP standards for compliance can be found on the LDEQ website as table 3. The acceptable levels for each constituent analyzed in this remediation are as follows: benzene 0.005 mg/l, toluene 1.0 mg/l, ethylbenzene 0.7 mg/l, xylenes1.0 mg/l, MTBE 0.02 mg/l, C8-10 aromatics 0.34 mg/l, C6-8 aliphatics 3.2 mg/l, and C8-10 aliphatics 1.3 mg/l (LDEQ RECAP, 2003). A full list of RECAP standards is included in Appendix 1 of this document. The full document for aquifer and soil survey information can be found in Appendix 2.

The week the injection period was permitted to start, Eagle arrived onsite and began to prep the site for injection. Eagle introduced themselves to the Petro managers and made the manager familiar with what would be taking place over the next month. After the meeting with the manager the drilling crew arrived onsite. Eagle and the drill crew did a site walk around and marked out each injection point. After finishing marking prospective injection points, Eagle began testing the points for underground obstructions. This process consisted of a 3-inch Diameter Hammer drill bit to break through the asphalt and soil cement of the parking lot. A 2-inch hand auguring was also required to dig the rest of the clay to reach a four-foot depth. Four feet is the required depth to test for underground lines or piping. During the course of testing Louisiana One Call arrived onsite and marked the location of underground lines around prospective down gradient injection points. Not all injection points needed the hammer drill, as those in the grass could be checked with the hand auger alone. This site check took a day. The next day Eagle mobilized all equipment onsite so work could at 7:00 am the following morning. The equipment brought onsite included an 18-foot white cargo trailer to hold all chemicals, RegenOx Parts A and B, ORC Advanced, miscellaneous tools and small pieces of equipment such as all the injection hoses, a 2” Honda trash pump, and caution barrier fencing. The Drilling and pumping equipment was also stored onsite, which included a Geo Probe 6620 and a ChemGrout double hopper pump.

ISCO treatment of the shallow soil and groundwater at Petro was conducted between Wednesday June 3, 2015 and Thursday July 2, 2015. In accordance with the LDEQ approved Corrective Action Plan (CAP),

impacted areas of the property were treated by injecting ORC Advanced and RegenOx. The ISCO treatment was injected into the soil and groundwater utilizing direct-push technology. A GeoProbe 6620 was used to reach the desired injection depth. Injections were generally conducted between 15 and 25 feet bgs. The Oxidation chemicals were pumped down with a ChemGrout Double Hopper Pump.

During injection of ISCO access points, the drill and injection crew would move to another access point if the oxidation chemicals began to resurface, otherwise they would not move off of an access point until about 300 pounds was pumped into the ground. Sometimes the reaction was so violent that the gasses from the reaction would resurface vigorously long before any liquid began to resurface.

Following completion of injection activities at each ISCO Access Point, each resulting soil borehole was plugged and abandoned in accordance with the LDEQ and Louisiana Department of Transportation and Development (LDOTD) “Construction of Geotechnical Boreholes and Groundwater Monitoring Systems Handbook,” 2000. Each ISCO Access Point was grouted from the bottom of the borehole to the land surface. Additionally, each location was properly plugged and abandoned within 30 days of initiation of injection activities as required by the injection permit waver.

Photo 1: View of Crew mixing and injecting RegenOx, also a view of the GeoProbe and ChemGrout mixer
http://216.104.174.26/protech/content/project-3

<u>Photo 2</u>: View of Injection well head with pressure indicator and relief valve

http://216.104.174.26/protech/content/project-3

Petro has been sampled since 2006 initially with five groundwater monitoring wells, and subsequently the number was raised to eight wells after 2008. The eight groundwater monitoring wells are flush mounted to the areas where they were placed. Special hand tools were required to open and close the monitoring wells. Three bolts fasten the well cover to its anchor point on the ground and all three must be removed by ratchet in order for the well to be accessed. Once access to the well was obtained, the cap was removed and a water level taken. After this, the well was purged. To purge the wells, 4-foot long dedicated polyethylene hand bailers on a string were used. Hand bailers were chosen because of the low detection limits of BTEX, cross contamination is hard to eliminate with low detection limits if a pump is used to purge the wells. The bailer was dropped down the well and allowed to fill with water, then pulled from the well dumped into a bucket. The well was purged until three volumes were removed from the well. The wells all have a 2" diameter inside, the equation for the volume of water is:

Volume of Water in a 2" well = (0.17 (total Depth-Depth to water))
0.17 = Volume per foot of saturation (πr^2)
Amount to Purge = Volume of Water x 3

After purging was complete, the well was considered ready to be sampled. The samples were labeled with date, time, and location then brought to a certified lab for analysis. The samples were accompanied with appropriate Quality Assurance/Quality Control samples such as a daily field blank and a trip blank for reference.

RESULTS

The second ISCO treatment of the shallow soil and groundwater at Petro was conducted between June 3, 2015 and July 2, 2015. In accordance with the LDEQ approved CAP, the impacted areas of the property were treated by injecting ORC Advanced and RegenOx. The ISCO treatment was injected into the soil and groundwater utilizing direct push equipment, GeoProbe 6620, to reach the desired injection depth. Injections were generally conducted between 10 and 25 feet below ground surface. The Oxidation chemicals were pumped down with the ChemGrout Double Hopper Pump. The treatment was split into two areas. Area 1 consisted of the vicinity of MW-3, and Area 2 consisted of the vicinity of MW-2 and MW-7 (see Figures 4 – 7). Figure 1 is a site location map of the facility, and Figures 2, 3, and 4 provide the -locations of the ISCO Access Points.

Area 1 consisted of 17 ISCO Access Points used for the injection of RegenOx and ORC Advanced. The injection points were treated three separate times between June 3, 2015 and June 30, 2015 in which a total of 7,385 pounds of RegenOx was injected at area one. A fourth injection event at each point occurred between July 1, 2015 and July 2, 2015 in which a total of 1,920 pounds of ORC Advanced was injected. Table 1 includes a summary of volumes of RegenOx and ORC Advanced injected into the ISCO Access Points in Area 1.

Area 2 consisted of 38 ISCO Access Points used for the injection of ORC Advanced. One injection event was conducted at each location between June 17, 2015 and June 23, 2015. 1,840 pounds of ORC Advanced was injected in these locations. Table 2 includes a summary of ORC Advanced volumes injected into the ISCO Access Points in Area 2.

CHARTING DATA

An ongoing analysis of the quality of the groundwater at Petro has taken place since 2006. In December of 2005, wells MW-1 through MW-5 were installed onsite. The plume was observed growing or moving down stream in the aquifer. In June 2008, wells MW-6 through MW-8 were installed to measure expansion of the plume and down-gradient groundwater quality. A total of 40 sampling events have been

completed at wells MW-1 through MW-5 and 32 sampling events have been completed at wells MW-6 throughMW-8.

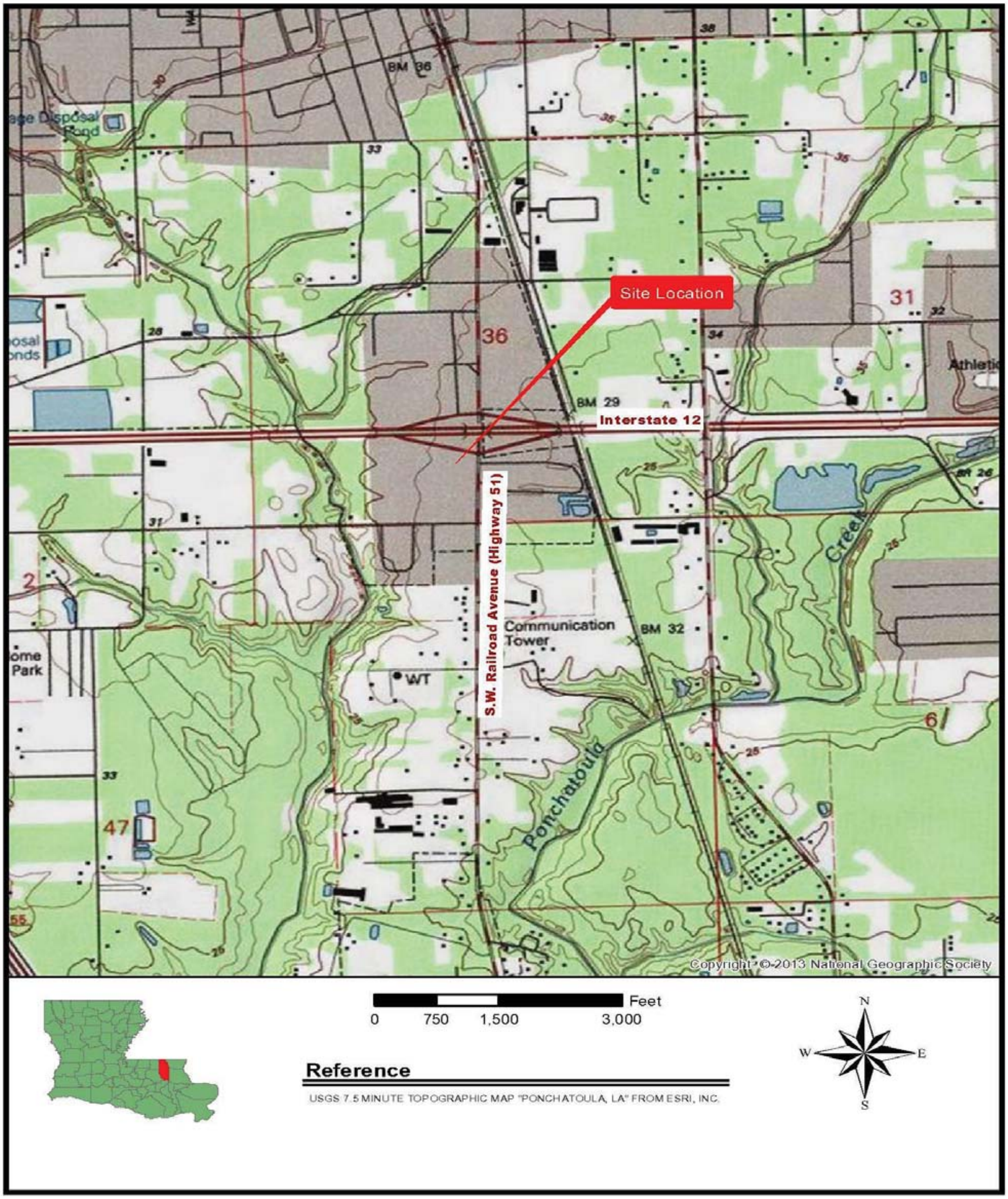


Figure 4- Site Location Map:

This demonstrates the location of Petro in Hammond, Louisiana also a reference to the location of Tangipahoa parish is given in the bottom left corner of the figure.

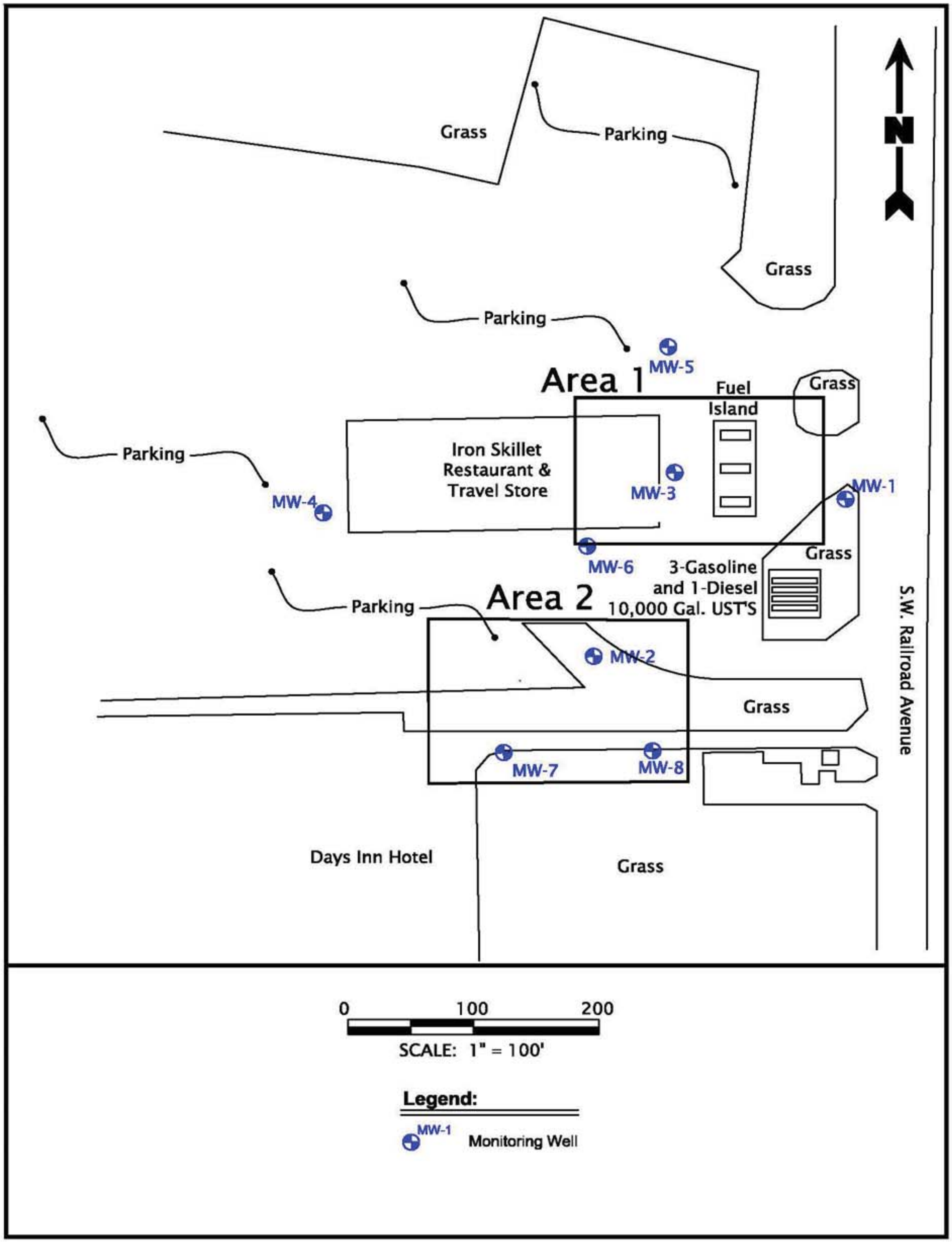


Figure 5- Injection Overview:

This Figure displays the two areas of injection at Petro

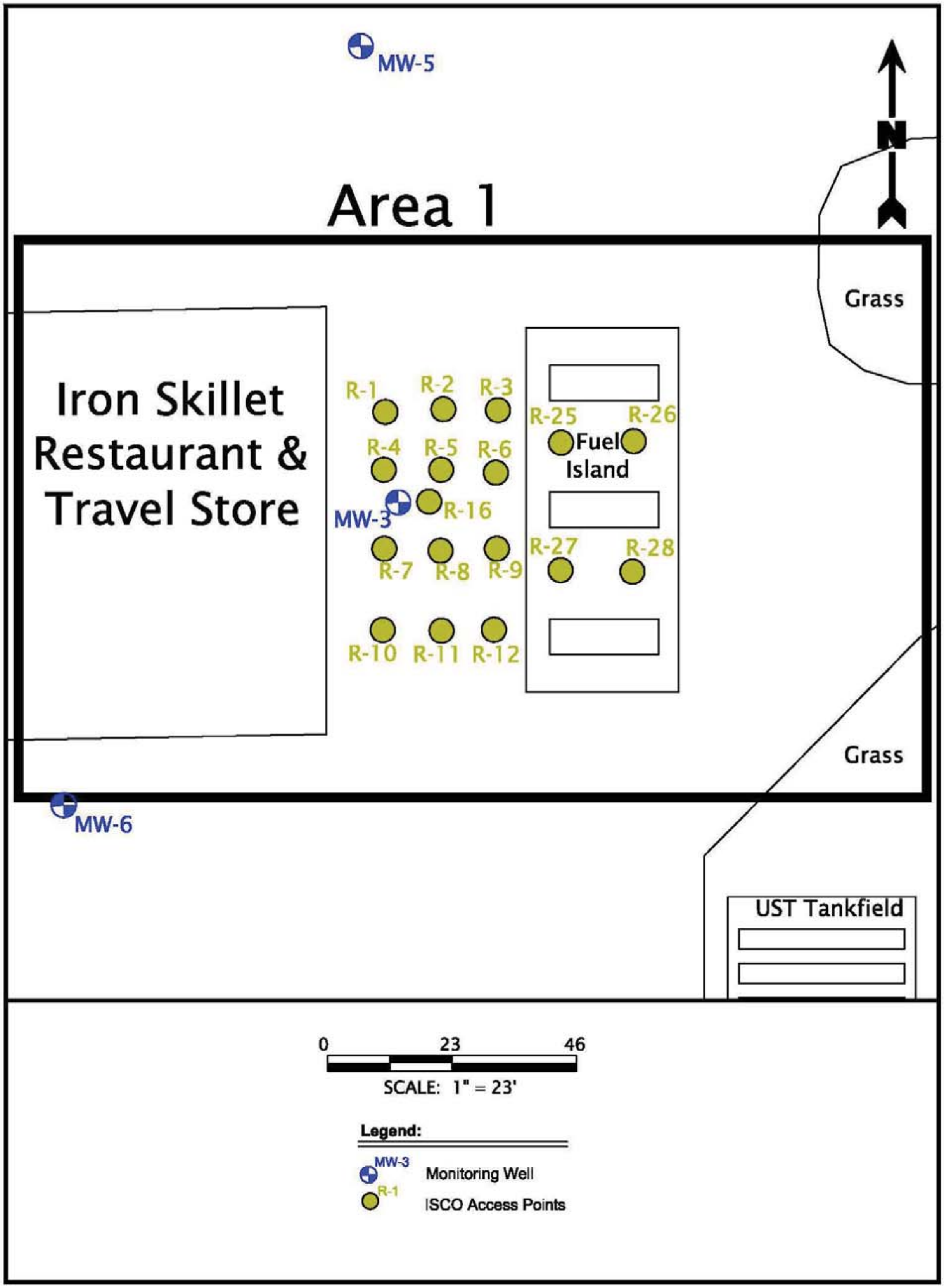


Figure 6- Injection Area 1:

Here is a close view of Injection area 1 all of the injection points are visible here as well.

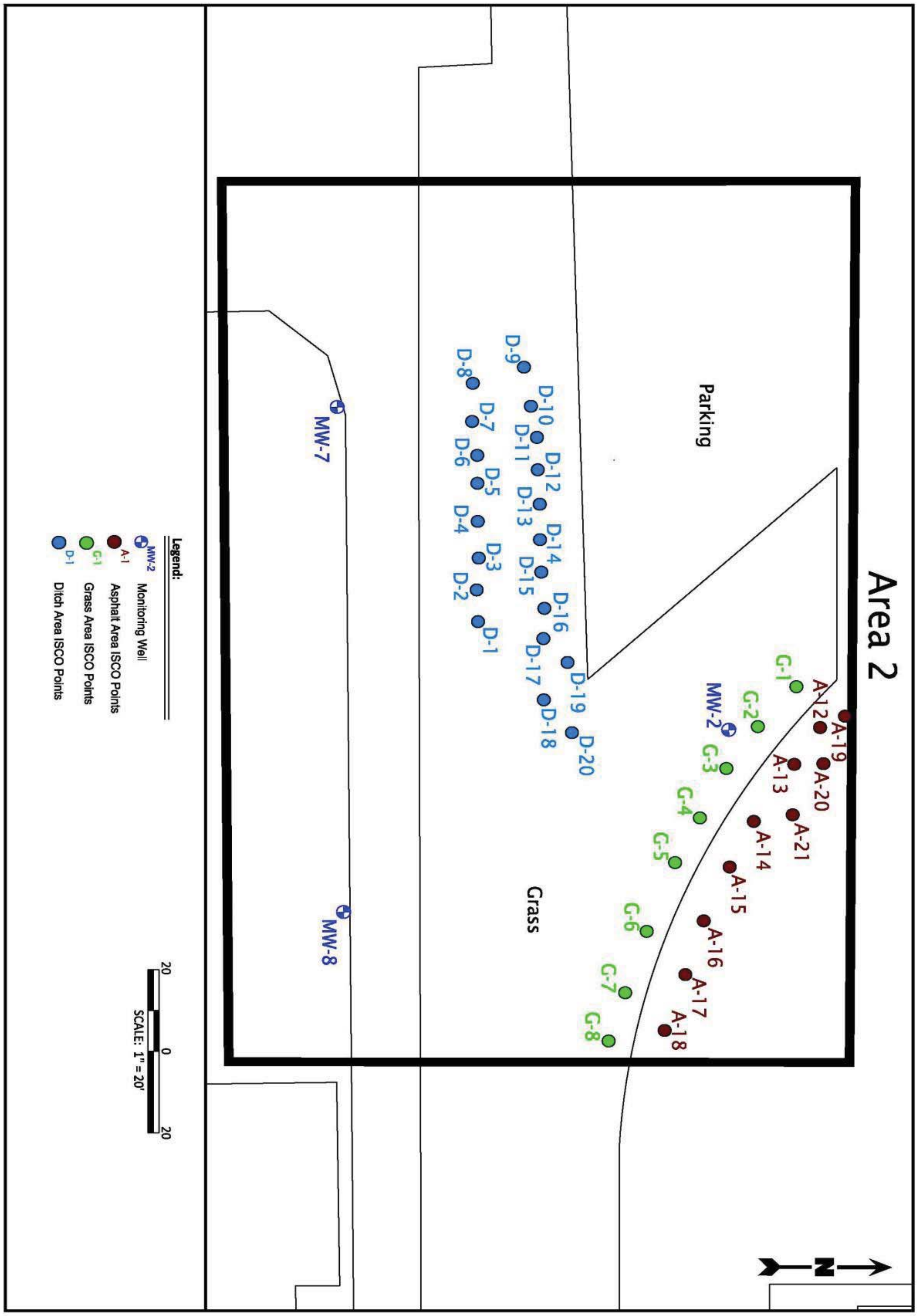


Figure 7- Injection Area 2:

Here is a close view of Injection area 2 all of the injection points are visible here as well.

Table 1
Area 1 RegenOx and ORC Advance Injection Volumes
Petro Stopping Centers #10
Hammond, LA

RegenOx

Injection Point	Date	(lbs)
R-4	6/5/2015	160
	6/10/2015	400
	6/24/2015	20
R-5	6/8/2015	135
	6/16/2015	25
	7/1/2015	1,000
R-6	6/4/2015	80
	6/12/2015	160
R-7	6/3/2015	160
	6/9/2015	65
	6/24/2015	90
R-8	6/8/2015	50
	6/12/2015	60
	6/16/2015	30
R-9	6/9/2015	10
	6/12/2015	160
	6/29/2015	180
R-10	6/4/2015	50
R-11	6/3/2015	160
	6/29/2015	300
R-12	6/8/2015	13
	6/15/2015	20
	6/26/2015	50
R-13	6/3/2015	160
	6/15/2015	180
	6/25/2015	650
	6/30/2015	680
R-14	6/8/2015	83
	6/11/2015	240
	6/26/2015	550
R-15	6/4/2015	80
	6/15/2015	90
	6/16/2015	30
R-16	6/8/2015	95
	6/16/2015	80
R-25	6/9/2015	70
	6/15/2015	160
	6/24/2015	170
	7/1/2015	50
R-26	6/5/2015	100
	6/9/2015	35
	6/12/2015	10
	6/16/2015	25
R-27	6/9/2015	40
	6/16/2015	30
R-28	6/4/2015	90
	6/11/2015	310
TOTAL		**7,385**

ORC Advance

Injection Point	Date	(lbs)
R-1	7/2/2015	160
R-2	7/1/2015	440
R-3	7/2/2015	120
R-8	7/2/2015	220
R-9	7/2/2015	20
R-10	6/25/2015	80
	6/30/2015	480
R-11	6/26/2015	280
R-16	7/2/2015	120
TOTAL		**1,920**

Table 2
Area 2 ORC Advance Injection Volumes
Petro Stopping Centers #10
Hammond, LA

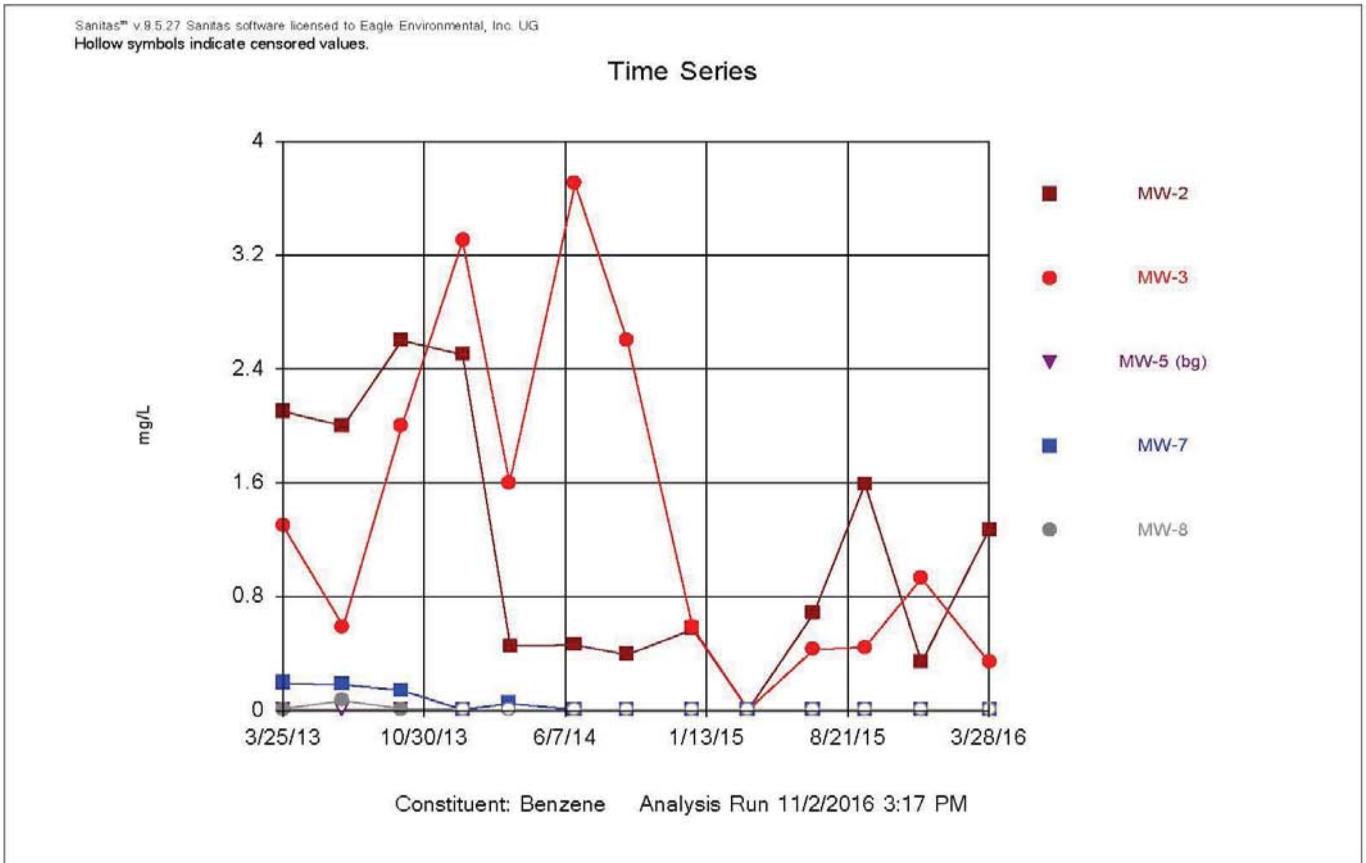
Injection Point	Date	(lbs)
A-12	6/17/2015	60
A-13	6/17/2015	60
A-14	6/17/2015	20
	6/19/2015	40
A-15	6/17/2015	20
	6/19/2015	40
A-16	6/18/2015	60
A-17	6/19/2015	60
A-18	6/19/2015	60
A-19	6/18/2015	60
A-20	6/18/2015	60
A-21	6/19/2015	60
G-1	6/18/2015	60
G-2	6/17/2015	60
G-3	6/18/2015	60
G-4	6/18/2015	60
G-5	6/18/2015	60
G-6	6/18/2015	60
G-7	6/19/2015	60
G-8	6/19/2015	20
D-1	6/23/2015	40
D-2	6/23/2015	40
D-3	6/23/2015	40
D-4	6/23/2015	40
D-5	6/23/2015	40
D-6	6/23/2015	40
D-7	6/23/2015	40
D-8	6/23/2015	40
D-9	6/23/2015	40
D-10	6/22/2015	40
D-11	6/22/2015	40
D-12	6/22/2015	40
D-13	6/22/2015	40
D-14	6/22/2015	40
D-15	6/22/2015	40
D-16	6/22/2015	40
D-17	6/22/2015	40
D-18	6/22/2015	40
D-19	6/22/2015	40
D-20	6/22/2015	40
TOTAL		**1,840**

It should also be noted that in the earlier sampling events, if Phase Separated Hydrocarbons (PSH), commonly referred to as free product, were observed by field personnel after purging the well then a sample of the well was not taken. PSH, gasoline, was visibly observed in the groundwater on many early sampling events in monitoring wells MW-2 and MW-3. Initially, monitoring was only for BTEX, TPH-GRO (total petroleum hydrocarbons), and MTBE. In 2010, sampling for; C6-C8 aliphatics, C8-C10 aliphatics and C8-C10 aromatics was added and TPH-GRO analysis was dropped. Under RECAP testing for TPH-GRO is no longer required, its data was not included.

Shown below in Figures 8-11 are graphed time series of analytical data taken between 3/25/2013 and 3/28/16 each graph contains data from one specific COC. Groundwater wells MW-2, MW-3, MW-5, MW-7 and MW-8 were chosen to represent the site during analysis. MW-5 is used as a background contamination well to represent a clean sample for the site. MW-2 and MW-3 are located in the center of the AOC and are used as examples of the highest amounts of contamination on the site. MW-7 and MW-8 are downgradient wells used to observe movement of COC's. The RECAP standards for the site, a GW-1B, can be reviewed in Appendix 1 of this document.

In an attempt to address the question of whether or not the decrease in concentration of COC's is significant or not, a trend analysis was performed on the data. Sen's Slope/Mann-Kendall trend tests have been performed for wells MW-2, MW-3, MW-5, MW-7 and MW-8. The Sen's Slope/Mann-Kendall trend test is a nonparametric statistical analysis used to determine whether suspected increasing or decreasing trends are statistically significant. Key values tabulated in this test include the test statistic (*S*) and the critical point. Only if the absolute value of *S* is larger than the critical point is a statistically significant increasing or decreasing trend indicated. All results are reported at the 98% confidence interval.

After running the results through the trend test most constituents appear to have a decreasing trend however, only a few have been proven significant. The decreasing trends for MTBE were proven significant in wells MW-2 and MW-5. MW-7 had significant decreasing trends for Benzene and Toluene. MW-8 displayed significant decreasing trends for toluene and xylenes. The trend test data is provided at the end of Appendix 4.



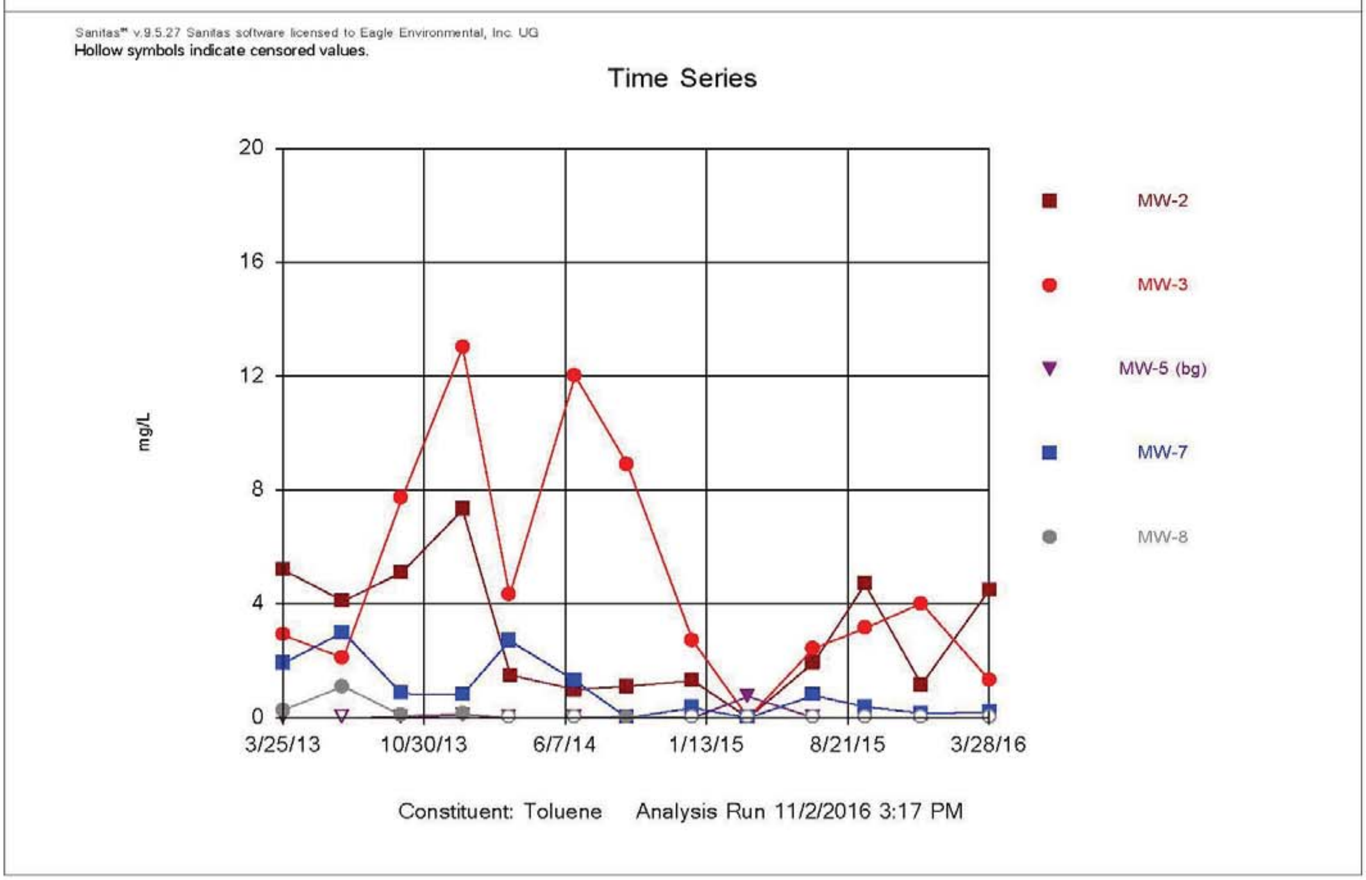
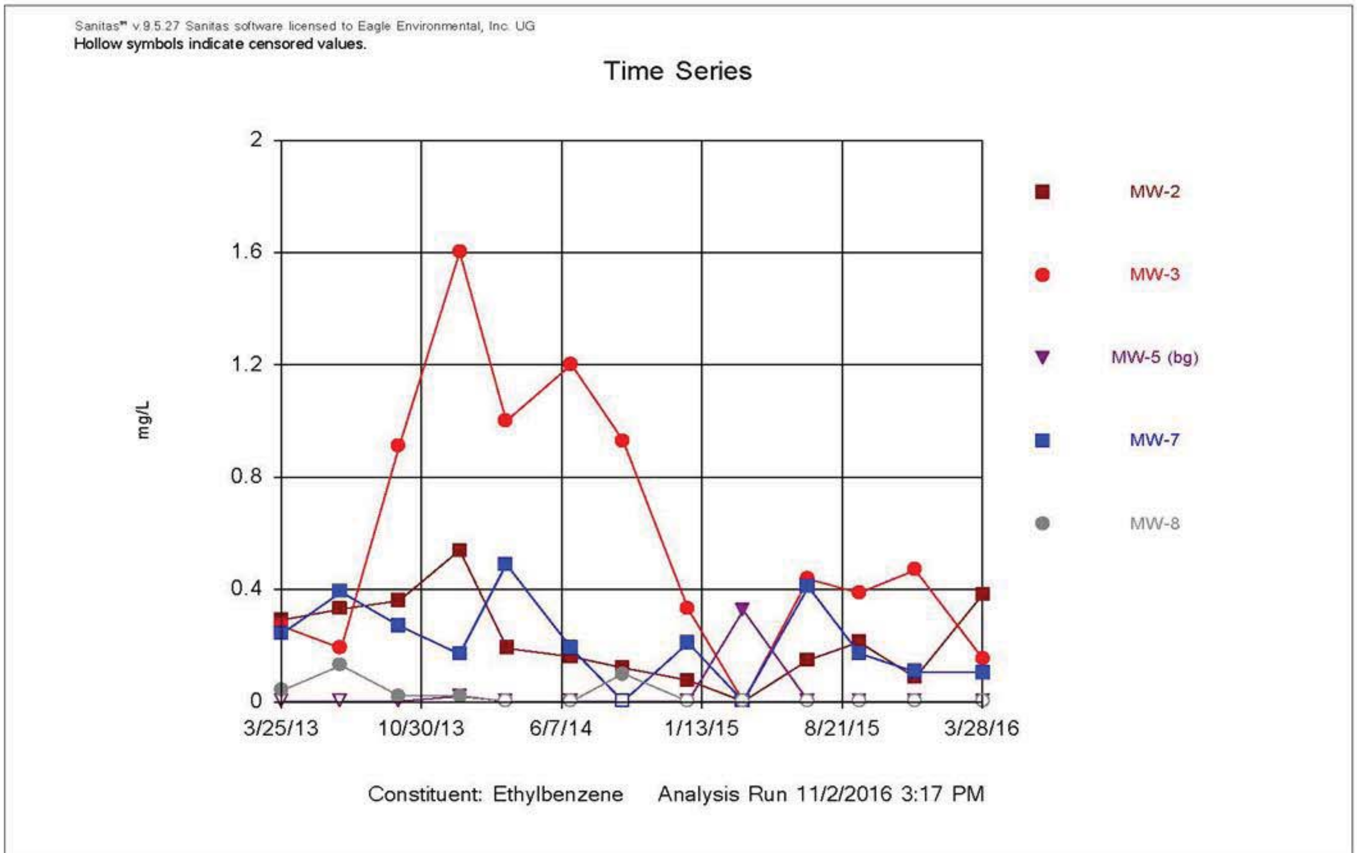


Figure 8.-Groundwater data for benzene and Toluene from 2013-2016



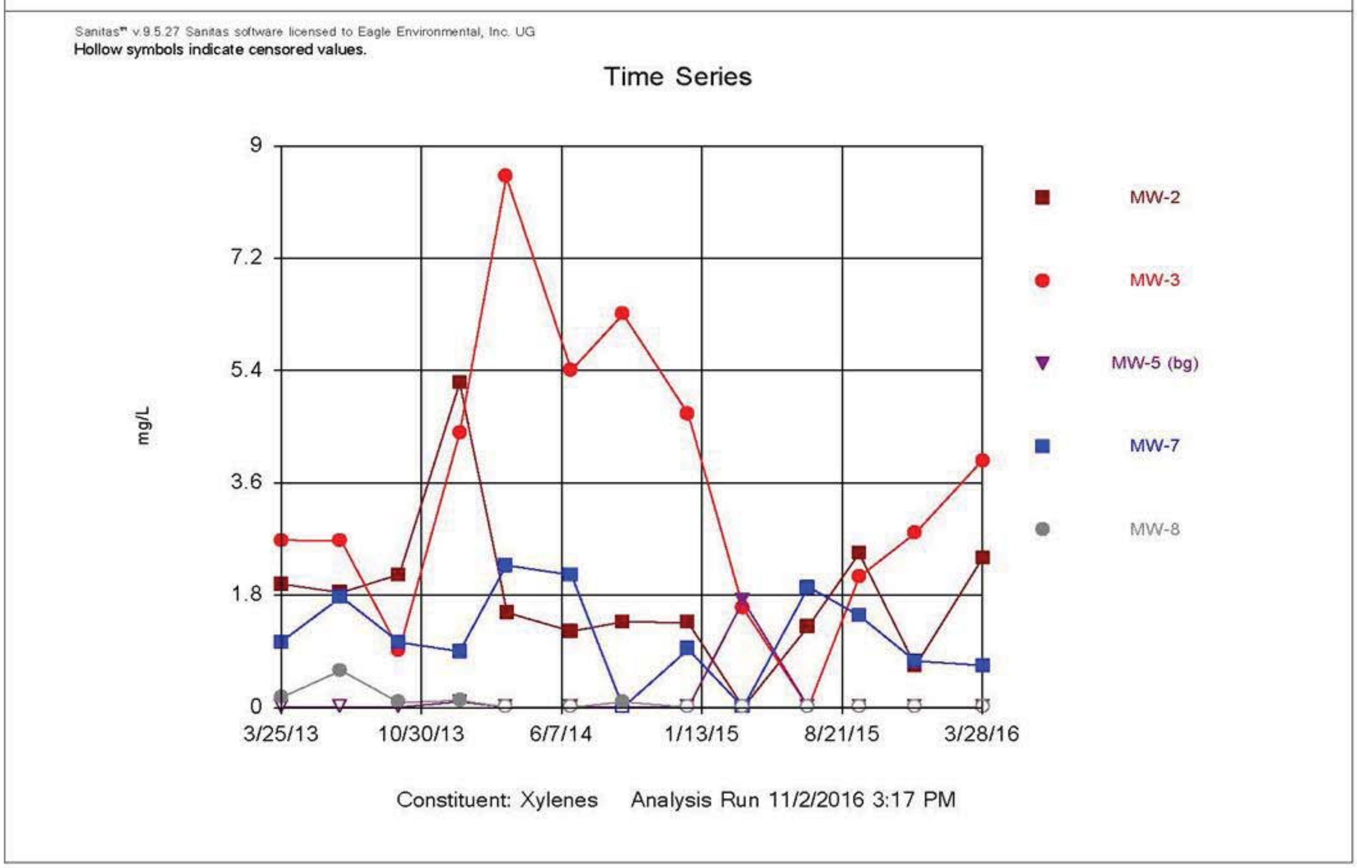


Figure 9.- Groundwater data for ethylbenzene and xylenes from 2013-2016

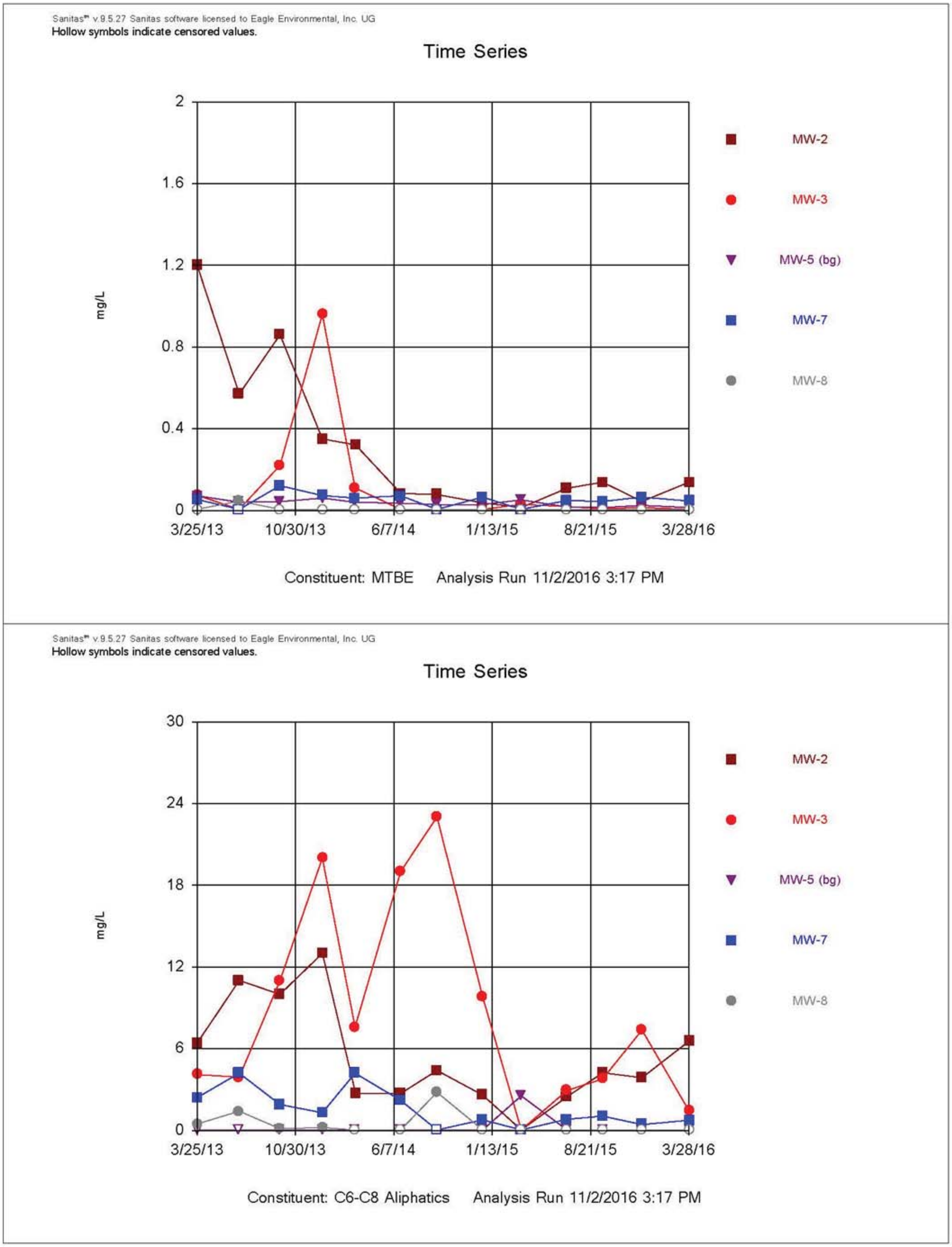
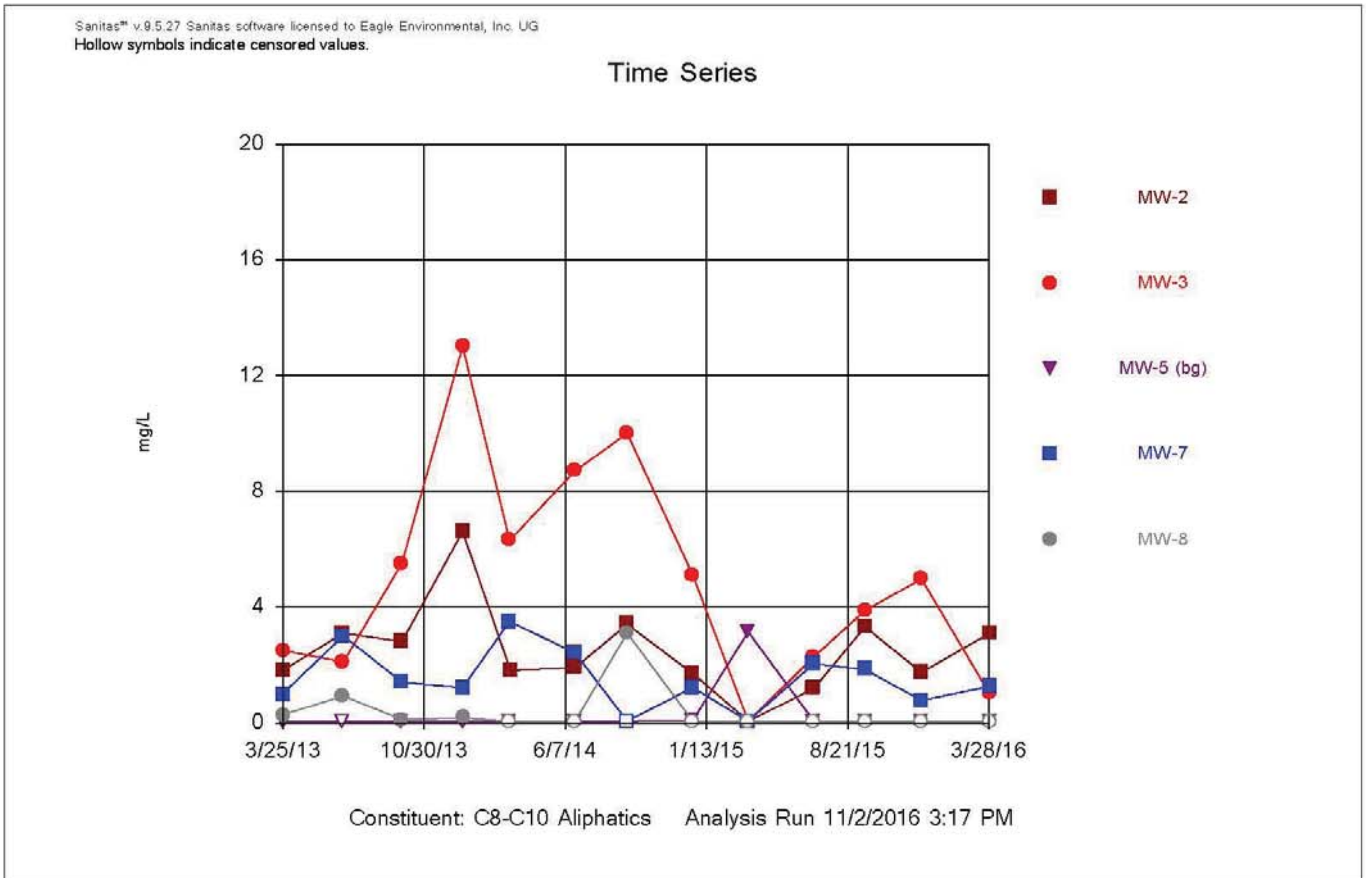


Figure 10- Groundwater data for MTBE and C6-C8 Aliphatics from 2013-2016



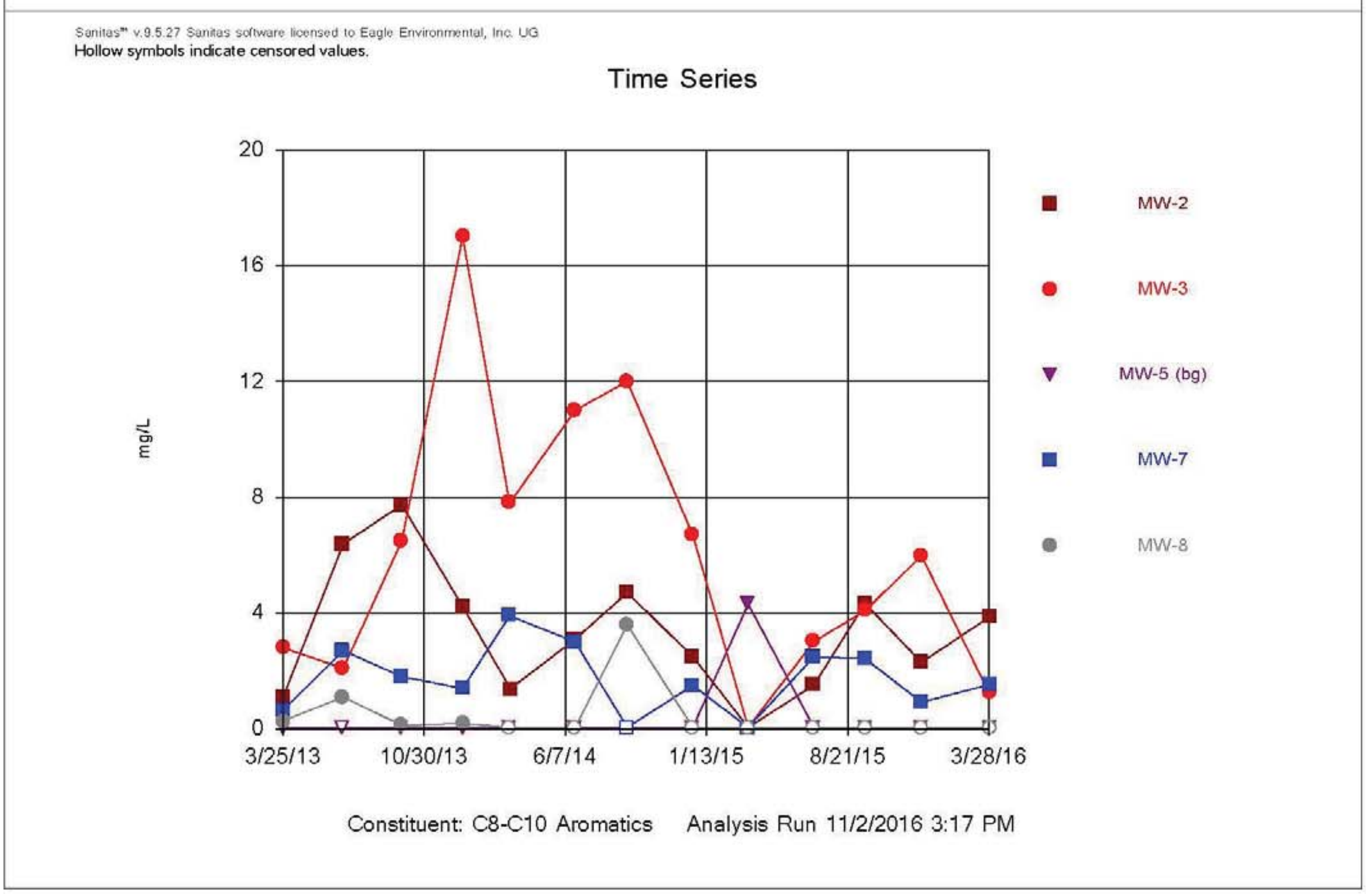


Figure 11- Groundwater data for C8-C10 Aliphatics and Aromatics from 2013-2016

DISCUSSION

The analytical data from five of the eight monitoring wells was graphed for further study and assessment. This was done after reviewing the data and selecting three wells as representative of the contaminated groundwater. The wells chosen to show the contaminating constituents of gasoline were MW-7, MW-3 and MW-2. Wells MW-8 and MW-7 were chosen to represent downgradient flow of the water to assess the movement of contaminates in the aquifer. Well MW-5 was chosen to represent background, i.e. a non-impacted area of the aquifer beneath Petro. The location of these wells in relation to the gasoline dispensers can be seen in the Materials and Methods in Figure 3. along with the flow of the groundwater carrying the contaminates. The degradation of BTEX constituents follows what was expected, for the most part, after reviewing the literature. According to Kang and Hua (2005) the constituents degrade from direct oxidation at a similar rate when in solution together. After analysis the BTEX constituents do follow a similar rate of degradation when compared side by side. The El-Naas group (2014) described toluene as the most readily biodegradable constituent in the BTEX group. Ethylbenzene not toluene however was the first of the BTEX group to come into compliance. MTBE was in compliance almost immediately after the first injection and was the first of the anilities to fall below RECAP standards.

In Figures 8-11, data for C8-10 aromatics and C6-10 aliphatics were also graphed. This analysis and graphing was done because analysis of these constituents of gasoline is required by RECAP. According to Stephen J. Lawrence (2006) these aliphatic and aromatic compounds can also be viewed as evidence of degradation, some of these compounds are degradation intermediates for BTEX (Lawrence, 2006). This can result in some overlap in analysis because some BTEX compounds are in the C8-10 aromatic range, Ethylbenzene and Xylenes. However, it is also noted that many products of the oxidation of BTEX are still aromatic at an intermediate stage in oxidative degradation or at some other endpoint of BTEX degradation (El-Naas et al. 2014). Aliphatics are further degradation products because they can result from the loss of electron rotation inside of the benzene ring, which is common in oxidative degradation of BTEX.

Over time the contaminate levels were observed dropping in monitoring well MW-2 and MW-3, in the early sampling events PSH were observed in the wells after purging. Free product in the wells was a cause to

not sample the well. During the years where PSH were observed in purged wells, no samples were analyzed, but it is assumed that the concentrations of BTEX were well above RECAP standards. In wells MW-2 and MW-3 it was noted that the level of C8-10 aromatics and C6-10 aliphatics increased after each ISCO injection event and the levels of BTEX dropped. Although the levels rebounded sometime after the injection events, they remained lower than before the ISCO injection events. This gives the data a “stair case” appearance. The levels of COC’s dropped to non-detectable levels during a sampling event on 3/19/15, and below RECAP standards then rebound the next event (see Figures 8-11).

Lab error may have occurred during the 3/19/15 event, however the decline shown over multiple sampling events is still evident showing the site is being remediated. According to Angel Cardoza and the Reynolds group (2008) after a RegenOx injection, desorption of contaminates from the soil can occur. This causes a spike in the concentrations then followed by a quick decline in COC concentrations (Herrington, T.,2008). This offers another explanation for the contaminated samples after the initial ISCO injection event and then the clean sampling on 3/19/15. Another source of contamination could be customers who are careless and spill gas on the ground during fueling. This incidental spilling would likely not impact the groundwater as quickly as it has been brought back to detectable levels because of the clay layer and the impermeable paved fueling area, but it is not out of the question to assume this may have some role to play in the sites continued contamination.

The resurgence of contamination may be the fault of the tight packed clay that sits above the aquifer. According to Saeid Gitipour (1997) clay has a natural affinity for organics such as BTEX. Gitipour’s study was the immobilization of organics using bentonite clays. In the case of Petro a layer of clay 12 feet thick sits above the sandy aquifer. Ordinary clay can absorb around to 30 percent by volume of the organic pollutants that pass through it (Gitipour, 1997). The leak at Petro persisted for an unknown amount of time allowing for the clay layer above the aquifer to become fully saturated with gasoline and its contaminates. The resurgence of Contaminates after each ISCO treatment may be due to the natural partitioning of gasoline contaminates between the clay and aquifer. As the contaminates in the sandy aquifer are degraded to acceptable levels the

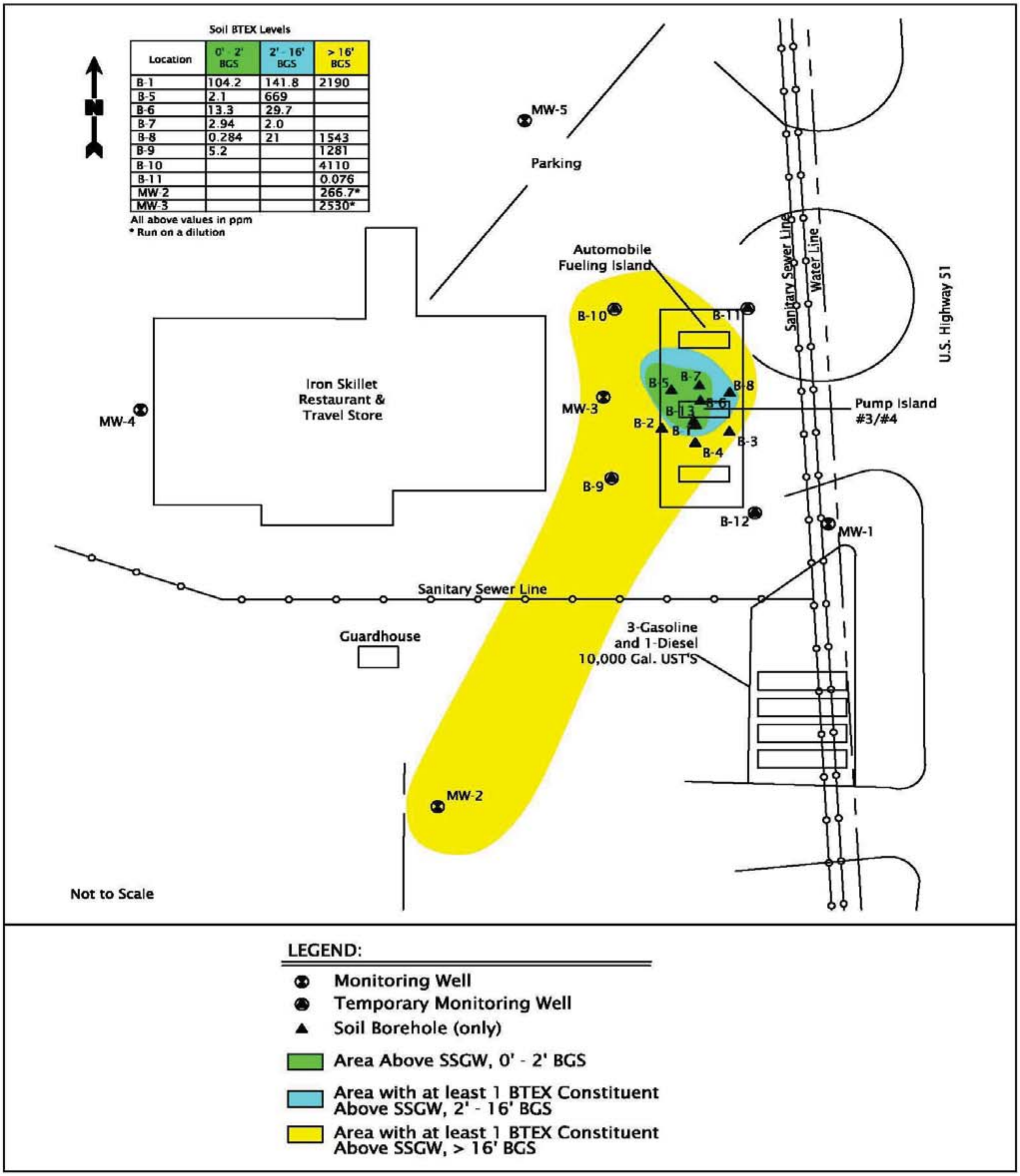
clay releases more to fill the void. As the clay becomes clean it will partition less contaminates than it could in the past. This can be seen in Figures 8-11 by the steady decline of contaminates over time.

Petro has not been declared clean after its two ISCO injection events. However, the wells all show trends of decreasing contaminate levels (Appendix 4) and most levels are below RECAP standards. The acceptable RECAP levels for each constituent analyzed are as follows: benzene 0.005 mg/l, toluene 1.0 mg/l, ethylbenzene 0.7 mg/l, xylenes1.0 mg/l, MTBE 0.02 mg/l, C8-10 aromatics 0.34 mg/l, C6-8 aliphatics 3.2 mg/l, and C8-10 aliphatics 1.3 mg/l. The limiting factor for declaring this site clean is the benzene concentration onsite all other constituents are close or below acceptable levels of contamination according to RECAP. The issue with the low level of compliance for benzene is a common one among leaking UST sites, benzene is only analytically detectable to 0.005 mg/l with today's analytical equipment in a certified lab. This means the limit of detection is the acceptable level. This makes it extremely difficult to declare a site clean. Benzene can also occur naturally in the environment through the burning of organic materials gas releases from geothermal activities and most commonly in crude oil. This organic constituent therefore can exist at a site not contaminated by anthropogenic means (ATSDR, 2007,2015).

Suggestions for improving the effectiveness of this remediation method would be the application of the ISCO materials low pressure over a wide range at once instead of pumping each borehole one at a time connect three or 4 boreholes at once and inject into all of them. Another thought would be the application of an activated carbon "wall" using the same injection tools as ISCO. This downgradient wall could immobilize the plume in the aquifer allowing for future ISCO injections up gradient from the activated carbon wall. The use of more long term bioremediation injection techniques like the ORC Advanced injections would aid in conjunction with the activated carbon injections.

PLUME FIGURES

The data gathered from sampling events was used to model plumes of the constituents in the aquifer. Figures 12-23 were drawn to show these estimated plumes. The series of figures shows the plumes through time drawn after sampling events in 2007,2011, and 2016 respectively. The plume appears to have decreased in size after the ISCO injection events in 2015.



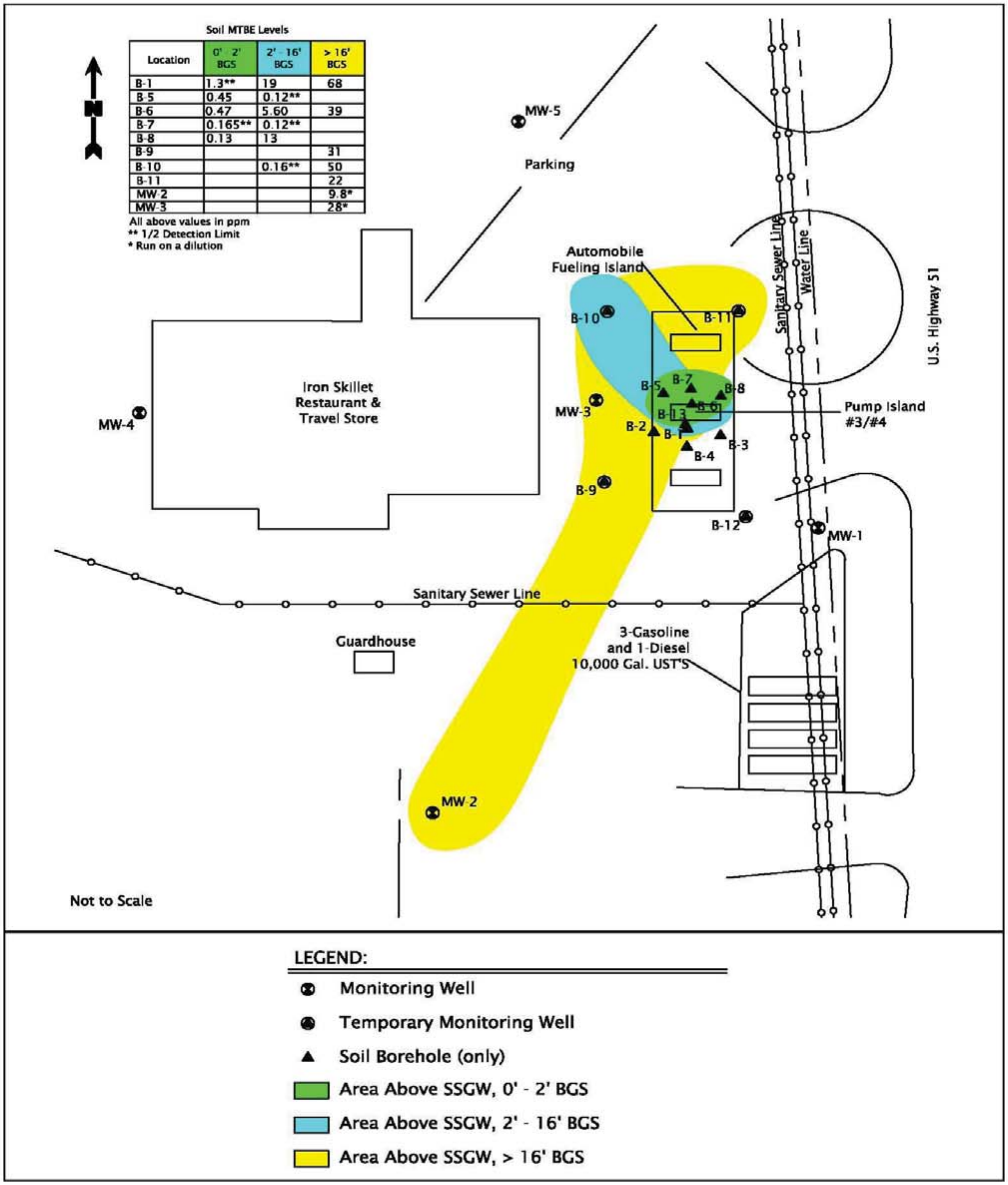
Soil BTEX Levels

Location	0' - 2' BGS	2' - 16' BGS	> 16' BGS
B-1	104.2	141.8	2190
B-5	2.1	669	
B-6	13.3	29.7	
B-7	2.94	2.0	
B-8	0.284	21	1543
B-9	5.2		1281
B-10			4110
B-11			0.076
MW-2			266.7*
MW-3			2530*

All above values in ppm
* Run on a dilution

Figure 12- BTEX Plume Map 2007:

This figure demonstrates the BTEX Plume in the aquifer after the first quarter sampling event of 2007. Unlike the Other figures the BTEX constituents are grouped here into one plume



Location	0' - 2' BGS	2' - 16' BGS	> 16' BGS
B-1	1.3**	19	68
B-5	0.45	0.12**	
B-6	0.47	5.60	39
B-7	0.165**	0.12**	
B-8	0.13	13	
B-9			31
B-10		0.16**	50
B-11			22
MW-2			9.8*
MW-3			28*

Figure 13- MTBE Plume Map 2007:

This figure demonstrates the MTBE Plume in the aquifer after the first quarter sampling event of 2007.

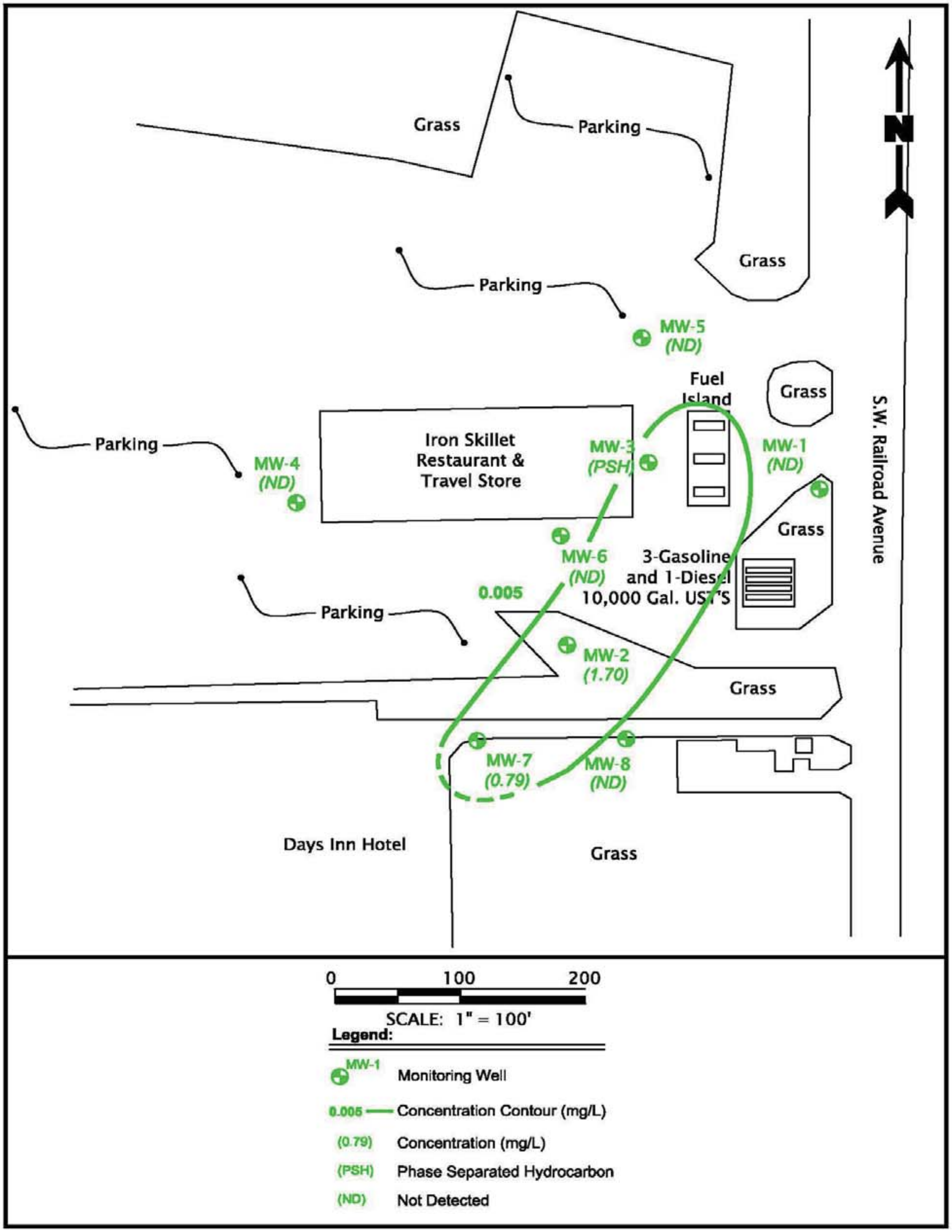


Figure 14- Benzene Plume Map 2011:

This figure demonstrates the Benzene Plume in the aquifer after the first quarter sampling event of 2011.

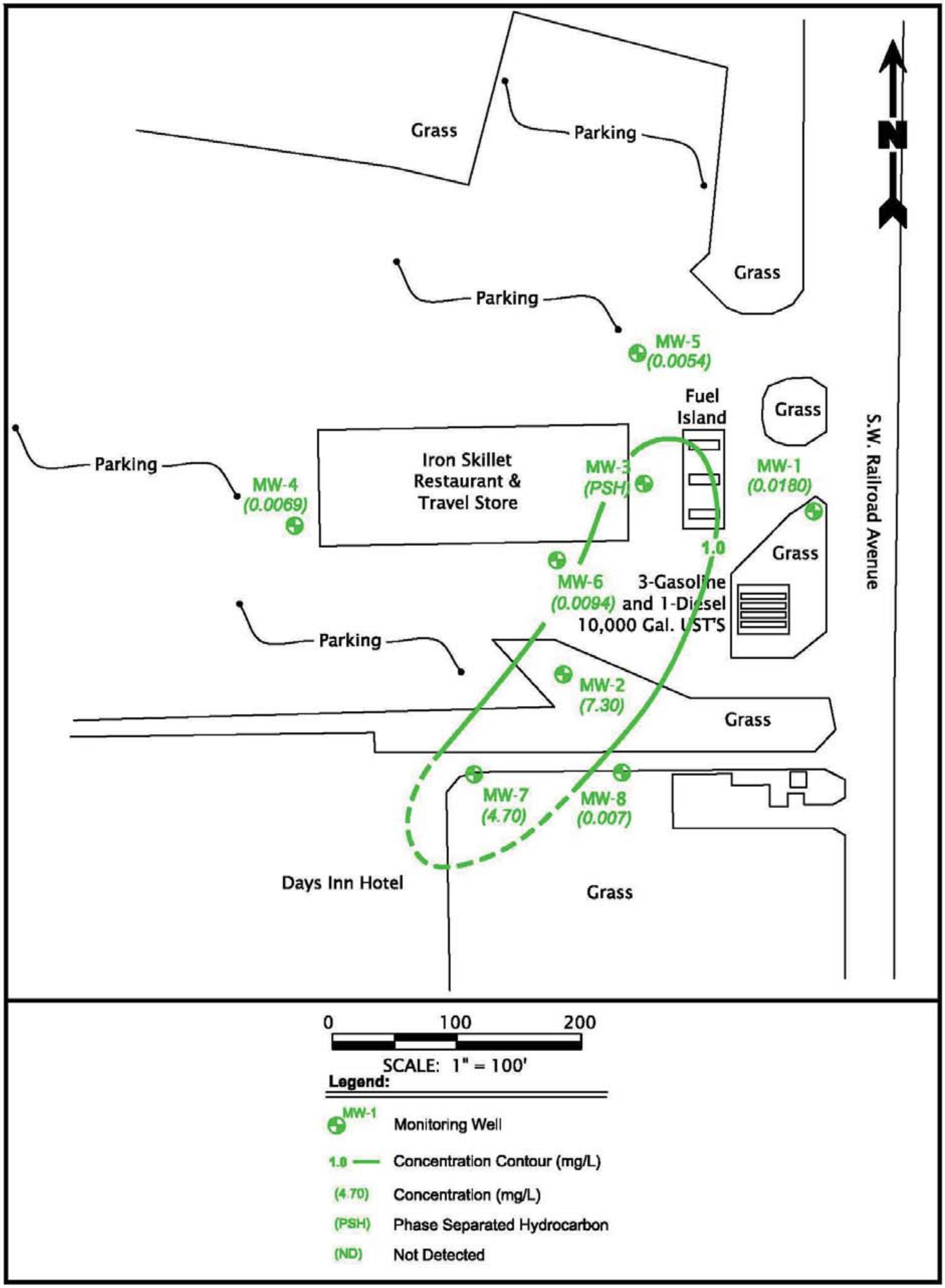


Figure 15- Toluene Plume Map 2011:

This figure demonstrates the Toluene Plume in the aquifer after the first quarter sampling event of 2011.

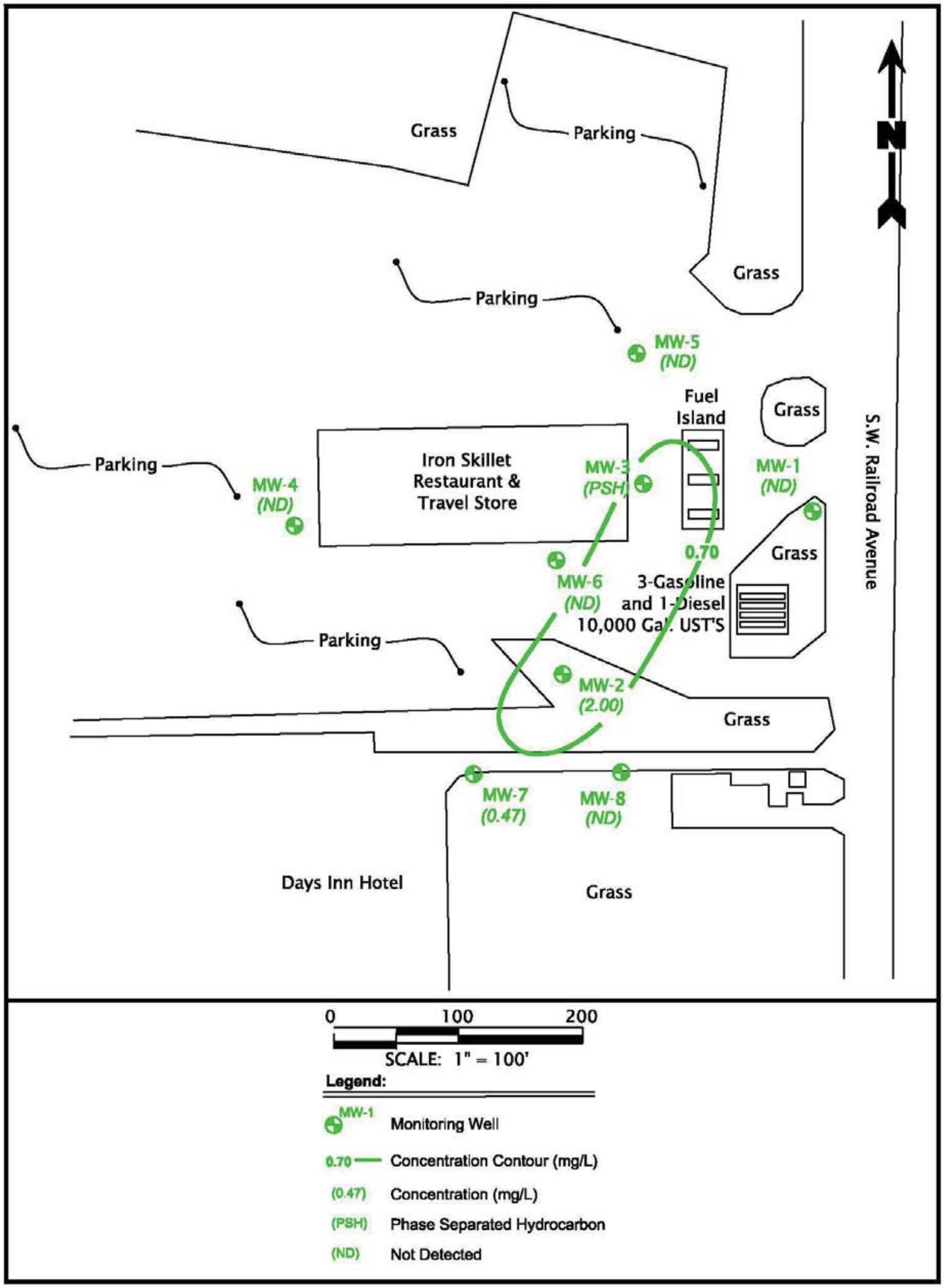


Figure 16- Ethylbenzene Plume Map 2011:

This figure demonstrates the Ethylbenzene Plume in the aquifer after the first quarter sampling event of 2011.

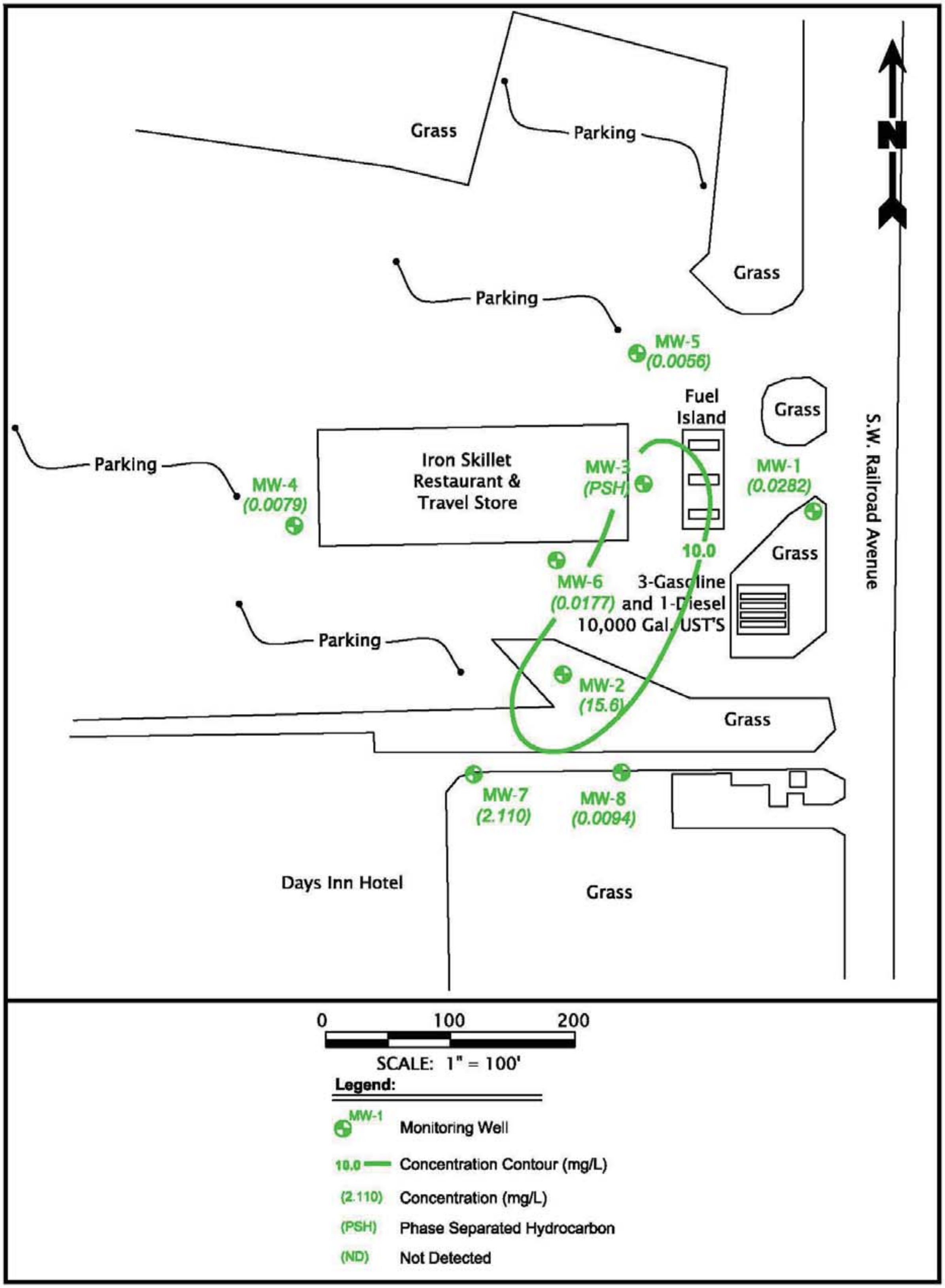


Figure 17- Xylenes Plume Map 2011:

This figure demonstrates the Xylenes Plume in the aquifer after the first quarter sampling event of 2011.

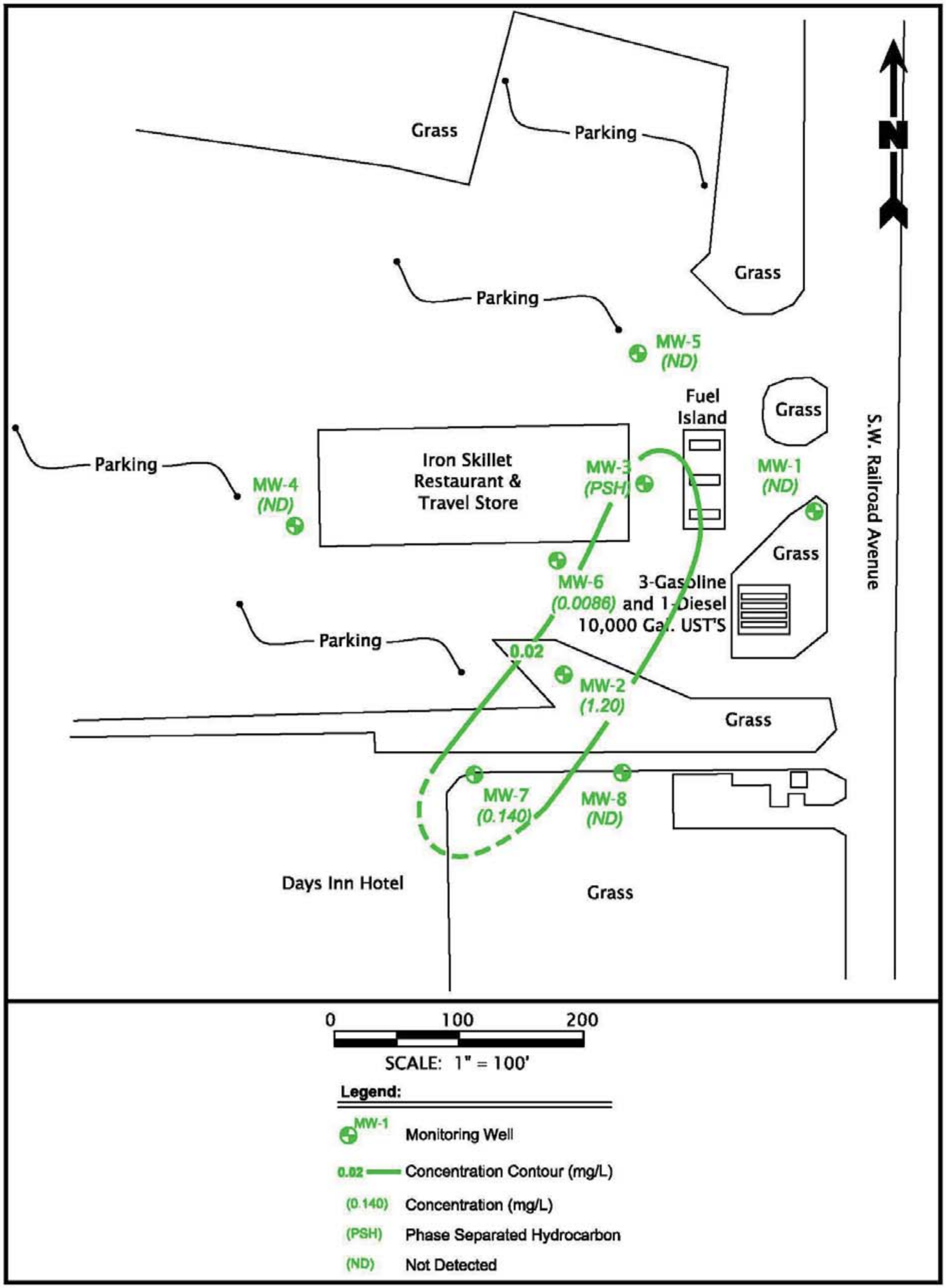


Figure 18- MTBE Plume Map 2011:

This figure demonstrates the MTBE Plume in the aquifer after the first quarter sampling event of 2011.

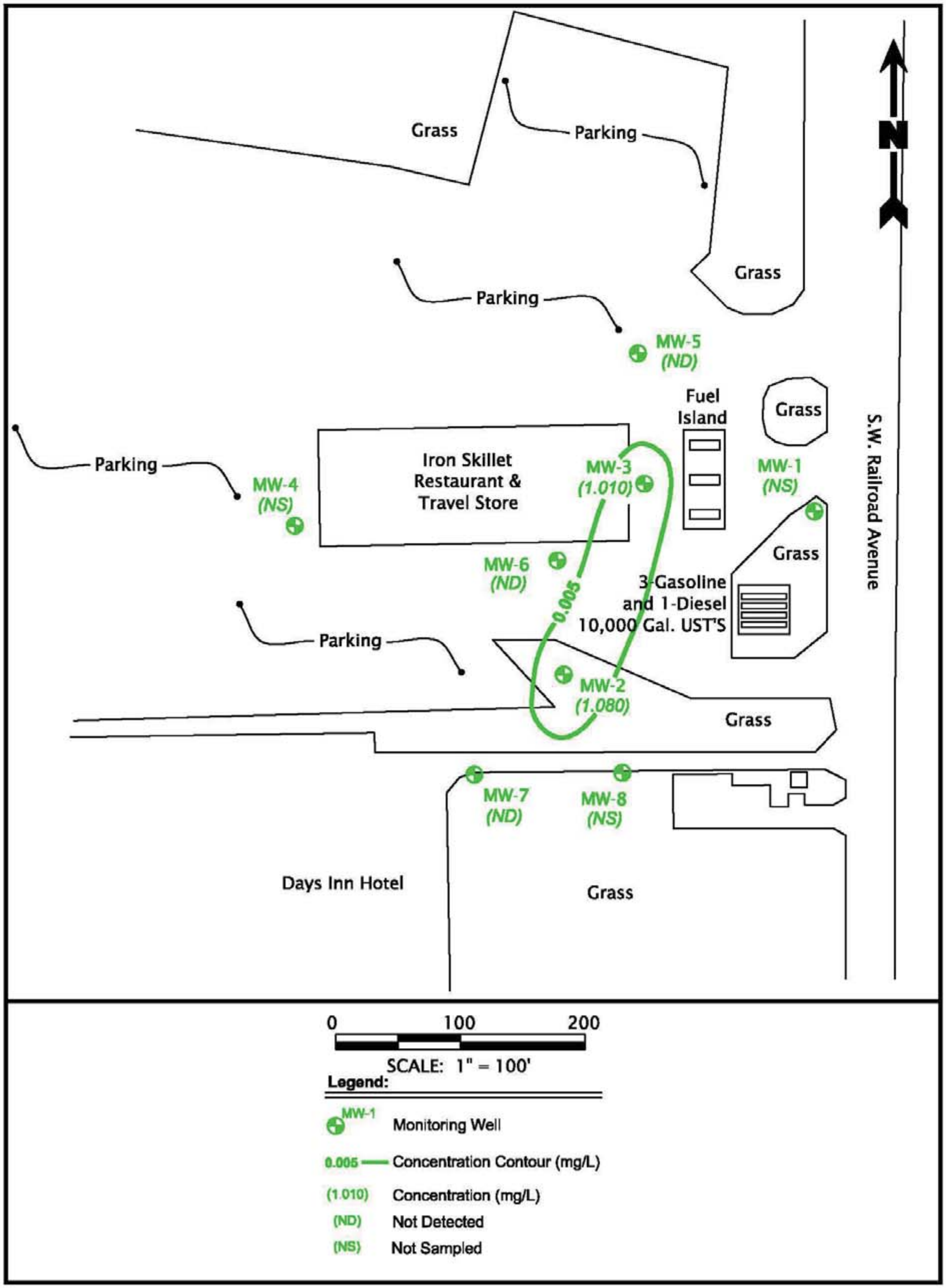


Figure 19- Benzene Plume Map 2016:

This figure demonstrates the Benzene Plume in the aquifer after the second quarter sampling event of 2016.

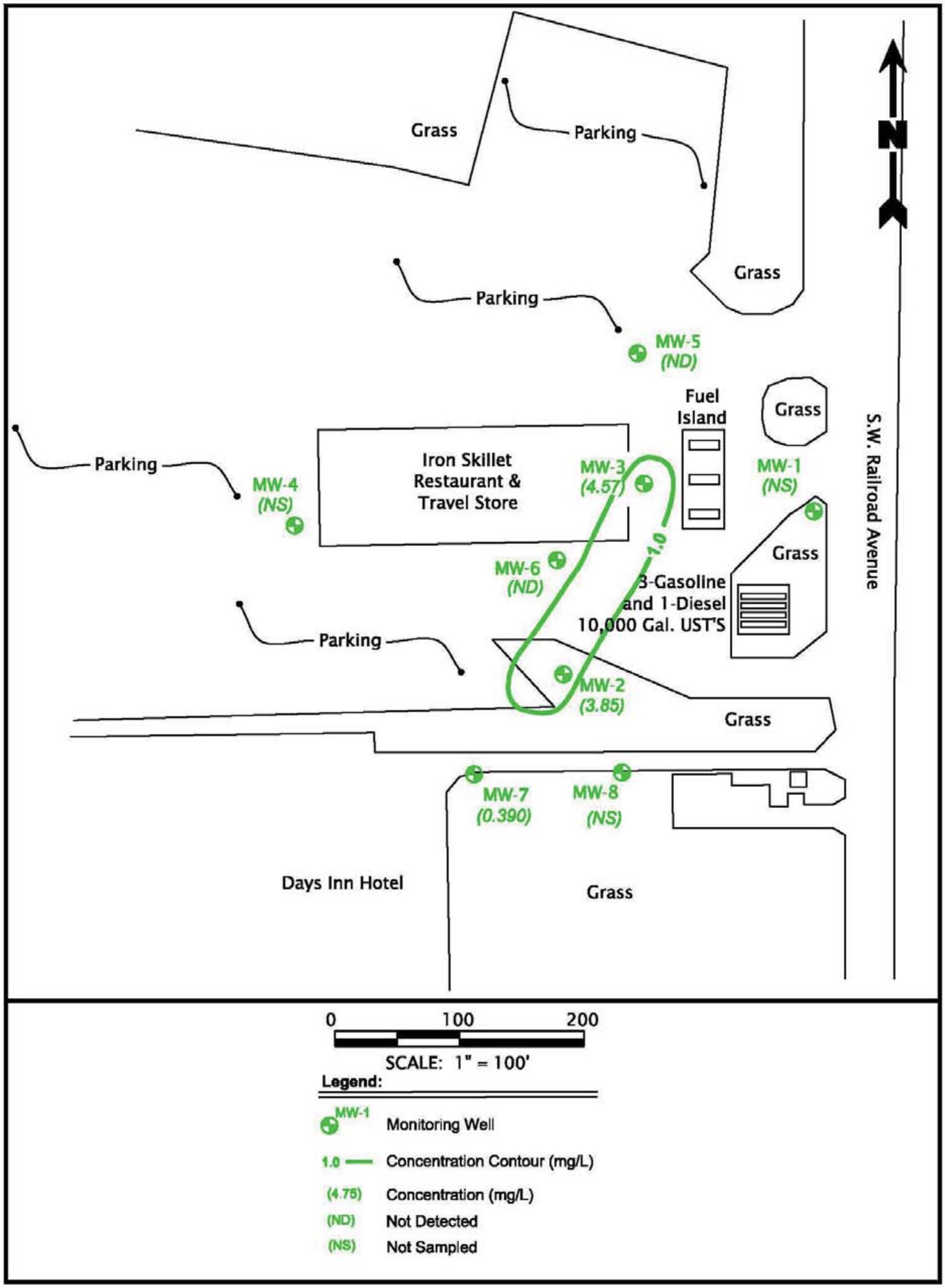


Figure 20- Toluene Plume Map 2016:

This figure demonstrates the Toluene Plume in the aquifer after the second quarter sampling event of 2016.

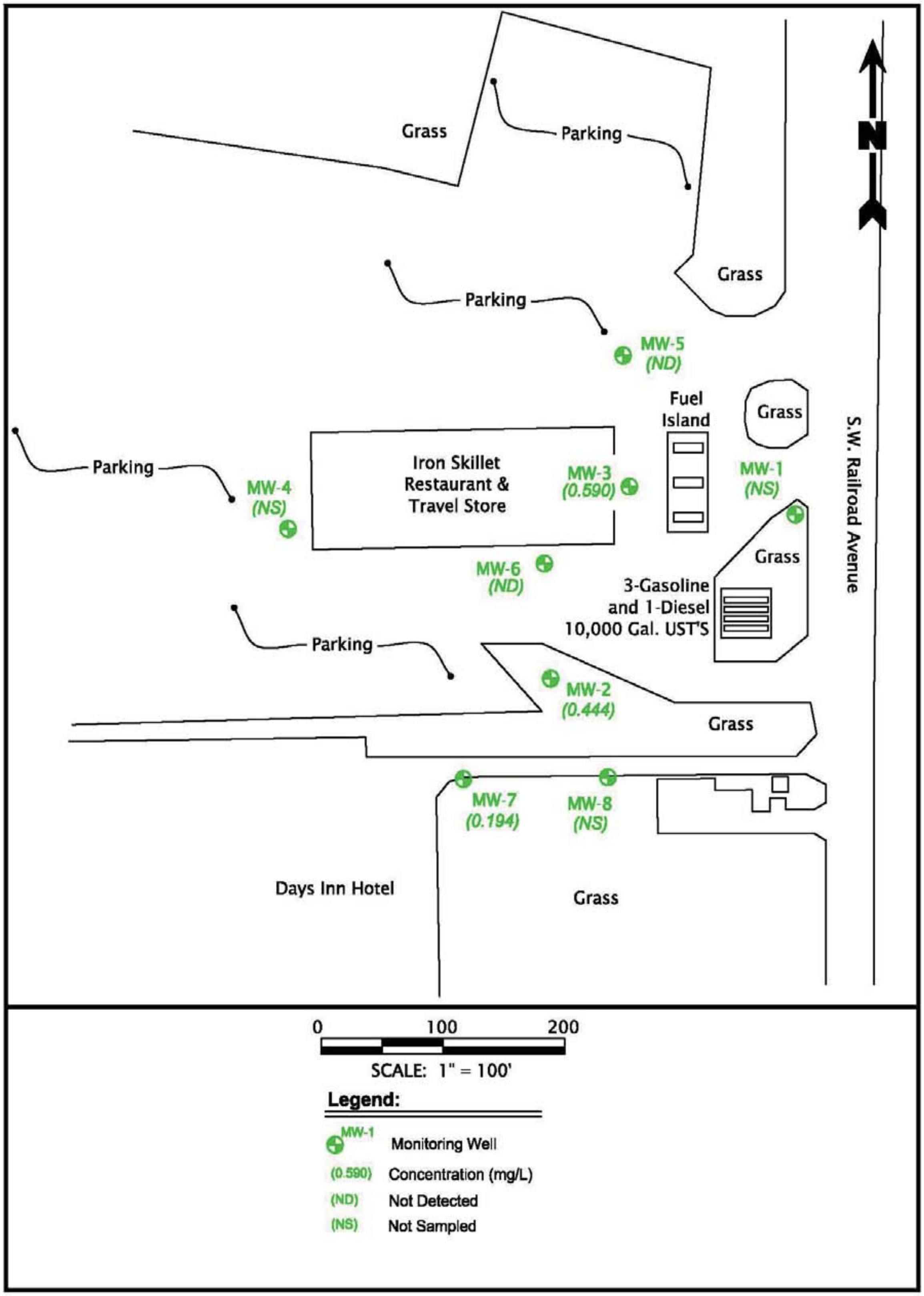


Figure 21- Ethylbenzene Plume Map 2016:

This figure demonstrates the Ethylbenzene in the aquifer, plume is too small to map, after the second quarter sampling event of 2016.

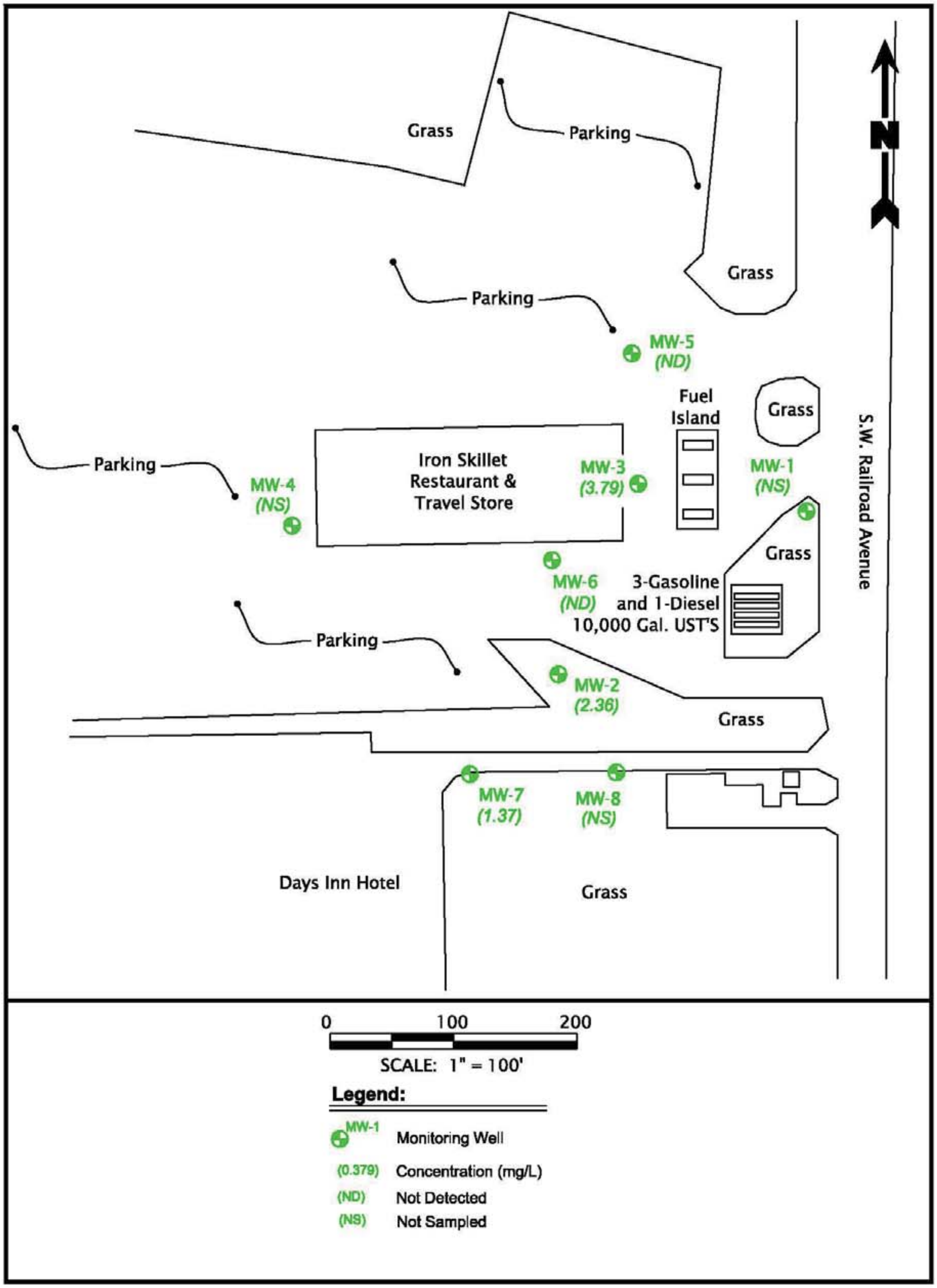


Figure 22- Xylenes Plume Map 2016:

This figure demonstrates the Xylenes Plume in the aquifer after the second quarter sampling event of 2016.

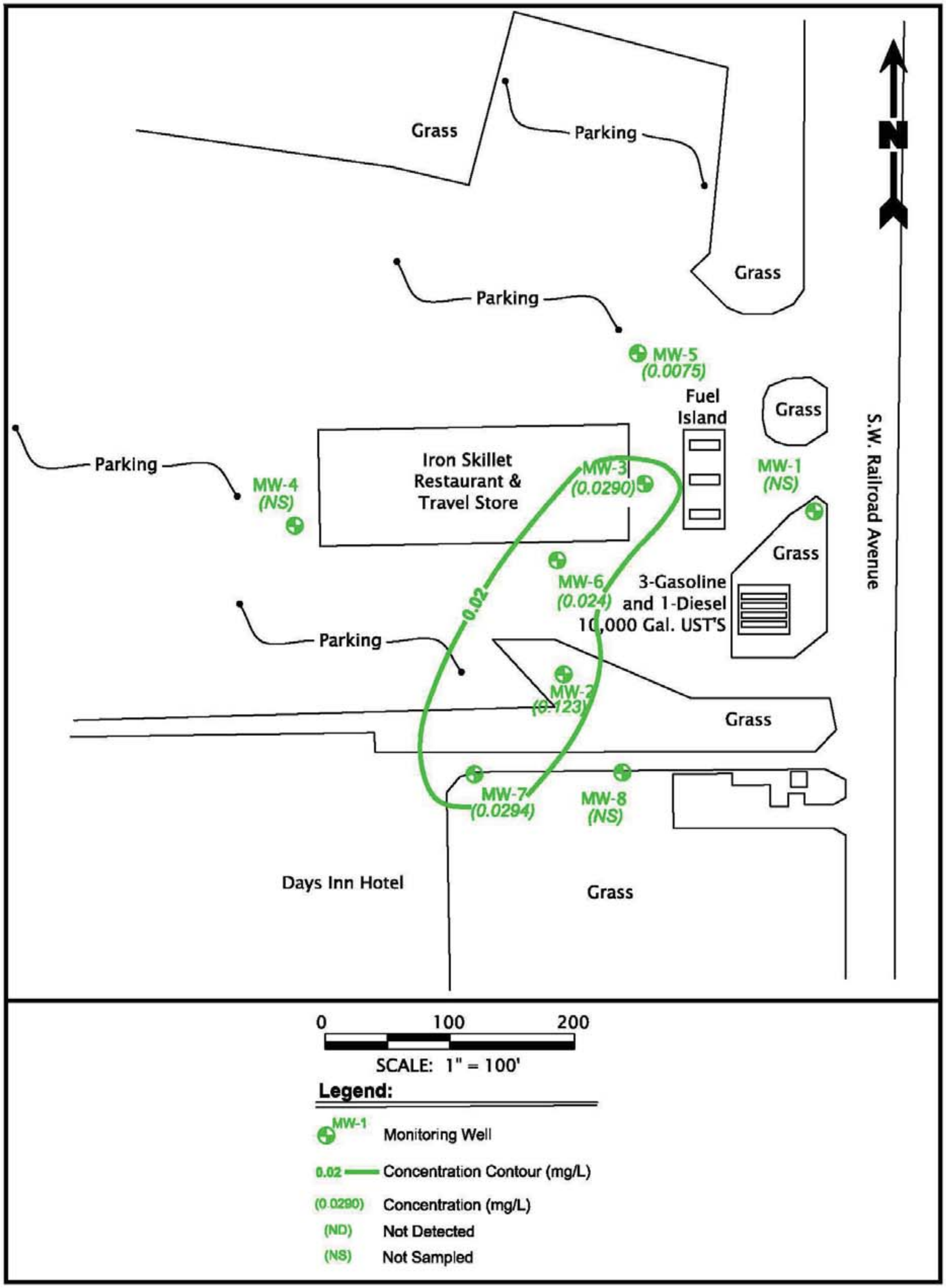


Figure 23- MTBE Plume Map 2016:

This figure demonstrates the MTBE Plume in the aquifer after the second quarter sampling event of 2016.

CONCLUSION

ISCO injections were performed at Petro in December 2013 and June 2015. The methodology was direct injection of a heavy oxidizer, RegenOx, followed by a time release oxygen compound, ORC Advanced, into a plume of gasoline sitting on top of the water in the aquifer in hope that this would degrade the contaminates, and remediate the aquifer. As shown in the results and discussion contaminate levels have lowered significantly at a 98% confidence interval, and the plume is shrinking. However, Petro has not achieved closure criteria according to RECAP standards.

The site was classified as a GW-1B, meaning it is subject to the most stringent of remediation requirements due to its ability produce enough water to be used as a drinking water source. The acceptable levels for each COC are as follows: benzene 0.005 mg/l, toluene 1.0 mg/l, ethylbenzene 0.7 mg/l, xylenes1.0 mg/l, MTBE 0.02 mg/l, C8-10 aromatics 0.34 mg/l, C6-8 aliphatics 3.2 mg/l, and C8-10 aliphatics 1.3 mg/l.

The analytical results show undulating levels of contaminates dropping to below detectable levels then resurging, the next sampling event, to levels above acceptable RECAP standards. Levels show steady decline in all the monitoring wells including downgradient monitoring wells. This undulating phenomenon can be explained by desorption of COCs, incidental spilling of gasoline, or the clay's affinity for organics. Further investigation into the clay will provide a better idea of which hypothesis is closer to the truth. During a sampling event, 3/19/15, levels were below detectable concentrations. Lab error offers an explanation for this event. The site still obviously has contamination on it, if that event produced clean samples is highly suspect.

The ISCO injections are successful at bringing gasoline contaminate concentrations down directly after an injection period. The method is effective and easy to apply. The resurgence of contaminates at this site is up for discussion and further study but the method of remediation used at Petro is an effective tool in remediating a gasoline contaminated aquifer. Suggestions for improving the effectiveness of this remediation method would be the application of an activated carbon "wall" using the same injection tools as ISCO in order to immobilize the plume in the aquifer allowing for future ISCO injections up gradient from the activated carbon wall. The use of more long term bioremediation injection techniques like the ORC Advanced injections would aid in conjunction with the activated carbon injections.

REFERENCES

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APPENDIX 1

RECAP STANDARDS FOR GROUNDWATER CONTAMINATION

LDEQ RECAP TABLE 3
MANAGEMENT OPTION 1, 2, AND 3
STANDARDS FOR GROUNDWATER
(mg/l)

COMPOUND	CAS #	GW 1	NOTE	GW 2	NOTE	GW 3 DW	NOTE	GW 3 NDW	NOTE	S	Gwesni*	Gwesi*	Gwaimi*	Gwairi*
Aromatics >C16-C21	NA	1.1E+00	N	1.1E+00	X DF 2	1.0E+00	X DF 3	2.4E+01	X DF 3	NA				
Aromatics >C21-C35	NA	1.1E+00	N	1.1E+00	X DF 2	1.0E+00	X DF 3	2.4E+01	X DF 3	NA				
TPH-GRO	NA	3.4E-01	N,I	3.4E-01	X DF2	1.3E+00	X DF3	3.1E+01	X DF3	NA	3.2E+00	7.9E+00	1.0E+03	1.0E+03
TPH-DRO	NA	3.4E-01	N,I	3.4E-01	X DF2	1.0E+00	X DF3	2.4E+01	X DF3	NA				
TPH-ORO	NA	1.1E+00	N,I	1.1E+00	X DF2	1.0E+00	X DF3	2.4E+01	X DF3	NA				

C - Based on carcinogenic health effects
F - GW 2 multiplied by maximum DF is less than GW 1 thus default to GW 1
G - GW 3 multiplied by maximum DF is less than GW 2 thus default to GW 2 and do not multiply by DF 2
H - GW 3 multiplied by maximum DF is less than GW 2 thus default to GW 2 and multiply by DF 2
I - TPH Standards are only applicable when used in conjunction with Standards for indicator compounds
MCL - Based on EPA's Maximum Contaminant Level (MCL) for drinking water
N - Based on non-carcinogenic health effects
NA - Not applicable
Q - Based on analytical quantitation limit
X DF 2 - Multiply GW 2 by the appropriate site specific dilution factor from the chart
X DF 3 - Multiply GW 3 DW or GW 3 NDW by the appropriate site specific dilution factor from the chart
T/O - EPA taste/odor advisory value
* The MO-1 GWes and MO-1 GWair are presented for screening purposes only; if the CC exceeds the MO-1 GWes and/or MO-1 GWair, then further assessment maybe warraned under MO-2 or MO-3.

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 3
MANAGEMENT OPTION 1, 2, AND 3
STANDARDS FOR GROUNDWATER
(mg/l)

COMPOUND	CAS #	GW 1	NOTE	GW 2	NOTE	GW 3 DW	NOTE	GW 3 NDW	NOTE	S	Gwesni*	Gwesi*	Gwaimi*	Gwairi*
Pentachlorophenol	87-86-5	1.0E-03	MCL	1.0E-03	X DF 2	1.0E-03	X DF 3	1.0E-03	X DF 3	2.0E+03				
Phenanthrene	85-01-8	1.8E+00	N	1.8E+00	X DF 2	2.0E-01	X DF 3	2.1E-01	X DF 3	1.2E+00	7.3E+04	2.5E+05	1.0E+06	1.0E+06
Phenol	108-95-2	1.8E+00	N	1.8E+00	X DF 2	9.3E+00	X DF 3	8.3E+01	X DF 3	8.3E+04	1.3E+05	1.0E+06	1.0E+06	1.0E+06
Polychlorinated biphenyls	1336-36-3	5.0E-04	MCL	5.0E-04	X DF 2	5.0E-04	H	5.0E-04	H	3.1E-02				
Pyrene	129-00-0	1.8E-01	N	1.8E-01	X DF 2	6.1E-01	X DF 3	1.4E+00	X DF 3	1.4E-01	1.2E+04	4.0E+04	6.8E+05	9.5E+05
Selenium	7782-49-2	5.0E-02	MCL	5.0E-02	X DF 2	5.0E-02	X DF 3	5.0E-02	X DF 3	NA				
Silver	7440-22-4	1.8E-01	N	1.8E-01	X DF 2	1.3E-01	X DF 3	5.4E-01	X DF 3	NA				
Styrene	100-42-5	1.0E-01	MCL	1.0E-01	X DF 2	1.0E-01	X DF 3	7.1E+00	X DF 3	3.1E+02	5.4E+02	1.3E+03	5.4E+04	5.4E+04
Tetrachlorobenzene,1,2,4,5-	95-94-3	1.1E-02	N	1.1E-02	X DF 2	5.4E-04	X DF 3	5.7E-04	X DF 3	6.0E-01				
Tetrachloroethane,1,1,1,2-	630-20-6	5.0E-03	Q	4.3E-04	X DF 2	8.4E-04	X DF 3	2.2E-03	X DF 3	1.1E+03	7.2E-02	1.8E-01	6.9E+00	6.9E+00
Tetrachloroethane,1,1,2,2-	79-34-5	5.0E-04	Q	5.5E-05	X DF 2	1.6E-04	X DF 3	1.8E-03	X DF 3	3.0E+03	6.2E+00	1.5E+01	4.1E+02	4.1E+02
Tetrachloroethylene	127-18-4	5.0E-03	MCL	5.0E-03	X DF 2	6.5E-04	X DF 3	2.5E-03	X DF 3	2.0E+02	1.5E+01	3.6E+01	3.0E+03	3.0E+03
Tetrachlorophenol,2,3,4,6-	58-90-2	1.1E+00	N	1.1E+00	X DF 2	1.5E-01	X DF 3	1.8E-01	X DF 3	1.0E+03				
Thallium	7440-28-0	2.0E-03	MCL	2.0E-03	X DF 2	2.0E-03	X DF 3	2.0E-03	X DF 3	NA				
Toluene	108-88-3	1.0E+00	MCL	1.0E+00	X DF 2	6.1E+00	X DF 3	4.6E+01	X DF 3	5.3E+02	8.9E+01	2.2E+02	1.3E+04	1.3E+04
Toxaphene	8001-35-2	3.0E-03	MCL	3.0E-03	X DF 2	3.0E-03	H	3.0E-03	H	7.4E-01				
Trichlorobenzene,1,2,4-	120-82-1	7.0E-02	MCL	7.0E-02	X DF 2	7.0E-02	X DF 3	1.9E-01	X DF 3	3.0E+02	4.5E+02	1.6E+03	3.1E+04	4.3E+04
Trichloroethane,1,1,1-	71-55-6	2.0E-01	MCL	2.0E-01	X DF 2	2.0E-01	X DF 3	9.1E+00	X DF 3	1.3E+03	1.3E+02	4.6E+02	2.7E+04	3.7E+04
Trichloroethane,1,1,2-	79-00-5	5.0E-03	MCL	5.0E-03	X DF 2	5.6E-04	X DF 3	6.9E-03	X DF 3	4.4E+03	8.4E+00	2.1E+01	6.2E+02	6.2E+02
Trichloroethene	79-01-6	5.0E-03	MCL	5.0E-03	X DF 2	2.8E-03	X DF 3	2.1E-02	X DF 3	1.1E+03	1.0E+01	2.5E+01	1.7E+03	1.7E+03
Trichlorofluoromethane	75-69-4	1.3E+00	N	1.3E+00	X DF 2	6.9E+00	X DF 3	2.0E+01	X DF 3	1.1E+03	3.1E+01	1.1E+02	8.7E+03	1.2E+04
Trichlorophenol,2,4,5-	95-95-4	3.7E+00	N	3.7E+00	X DF 2	5.4E-01	X DF 3	6.4E-01	X DF 3	1.2E+03				
Trichlorophenol,2,4,6-	88-06-2	1.0E-02	Q	6.0E-03	X DF 2	6.5E-04	X DF 3	8.2E-04	X DF 3	8.0E+02				
Vanadium	7440-62-2	2.6E-01	N	2.6E-01	X DF 2	2.3E-01	X DF 3	4.5E+00	X DF 3	NA				
Vinyl chloride	75-01-4	2.0E-03	MCL	2.0E-03	X DF 2	1.9E-03	X DF 3	3.6E-02	X DF 3	2.8E+03	2.0E-01	4.9E-01	6.0E+01	6.0E+01
Xylene(mixed)	1330-20-7	1.0E+01	MCL	1.0E+01	X DF 2	1.0E+01	X DF 3	1.0E+01	X DF 3	1.6E+02	2.6E+01	8.9E+01	3.9E+03	5.4E+03
Zinc	7440-66-6	1.1E+01	N	1.1E+01	X DF 2	5.0E+00	X DF 3	8.0E+00	X DF 3	NA				
Aliphatics C6-C8	NA	3.2E+01	N	3.2E+01	X DF 2	1.7E+02	X DF 3	3.9E+03	X DF 3	NA	9.2E+01	2.3E+02	2.9E+04	2.9E+04
Aliphatics >C8-C10	NA	1.3E+00	N	1.3E+00	X DF 2	3.4E+00	X DF 3	7.9E+01	X DF 3	NA	3.2E+00	7.9E+00	1.0E+03	1.0E+03
Aliphatics >C10-C12	NA	1.4E+00	N	1.4E+00	X DF 2	3.4E+00	X DF 3	7.9E+01	X DF 3	NA	2.2E+00	5.5E+00	7.0E+02	7.0E+02
Aliphatics >C12-C16	NA	1.4E+00	N	1.4E+00	X DF 2	3.4E+00	X DF 3	7.9E+01	X DF 3	NA	5.3E-01	1.3E+00	1.6E+02	1.6E+02
Aliphatics >C16-C35	NA	7.3E+01	N	7.3E+01	X DF 2	6.7E+01	X DF 3	1.6E+03	X DF 3	NA				
Aromatics >C8-C10	NA	3.4E-01	N	3.4E-01	X DF 2	1.3E+00	X DF 3	3.1E+01	X DF 3	NA	2.9E+01	7.1E+01	5.3E+03	5.3E+03
Aromatics >C10-C12	NA	3.4E-01	N	3.4E-01	X DF 2	1.3E+00	X DF 3	3.1E+01	X DF 3	NA	7.1E+01	1.8E+02	8.1E+03	8.1E+03
Aromatics >C12-C16	NA	3.4E-01	N	3.4E-01	X DF 2	1.3E+00	X DF 3	3.1E+01	X DF 3	NA	1.7E+02	4.1E+02	1.4E+04	1.4E+04

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 3
MANAGEMENT OPTION 1, 2, AND 3
STANDARDS FOR GROUNDWATER
(mg/l)

COMPOUND	CAS #	GW 1	NOTE	GW 2	NOTE	GW 3 DW	NOTE	GW 3 NDW	NOTE	S	Gwesni*	Gwesi*	Gwaimi*	Gwairi*
Endrin	72-20-8	2.0E-03	MCL	2.0E-03	X DF 2	2.6E-04	X DF 3	2.6E-04	X DF 3	2.5E-01				
Ethyl benzene	100-41-4	7.0E-01	MCL	7.0E-01	X DF 2	2.4E+00	X DF 3	8.1E+00	X DF 3	1.7E+02	2.3E+03	5.7E+03	3.6E+05	3.6E+05
Fluoranthene	206-44-0	1.5E+00	N	1.5E+00	X DF 2	3.1E-02	X DF 3	3.2E-02	X DF 3	2.1E-01				
Fluorene	86-73-7	2.4E-01	N	2.4E-01	X DF 2	7.4E-02	X DF 3	7.8E-02	X DF 3	2.0E+00	4.5E+03	1.6E+04	2.7E+05	3.8E+05
Heptachlor	76-44-8	4.0E-04	MCL	4.0E-04	X DF 2	4.0E-04	H	4.0E-04	H	1.8E-01				
Heptachlor epoxide	1024-57-3	2.0E-04	MCL	2.0E-04	X DF 2	2.0E-04	X DF 3	2.0E-04	X DF 3	2.0E-01				
Hexachlorobenzene	118-74-1	1.0E-03	MCL	1.0E-03	X DF 2	1.0E-03	H	1.0E-03	H	6.2E+00	2.7E-01	6.7E-01	2.2E+01	2.2E+01
Hexachlorobutadiene	87-68-3	8.5E-04	C	8.5E-04	X DF 2	9.0E-05	X DF 3	1.1E-04	X DF 3	3.2E+00				
Hexachlorocyclohexane,alpha	319-84-6	3.0E-05	Q	1.1E-05	X DF 2	1.8E-06	X DF 3	2.6E-06	X DF 3	2.0E+00				
Hexachlorocyclohexane,beta	319-85-7	6.0E-05	Q	3.7E-05	X DF 2	4.9E-06	X DF 3	6.5E-06	X DF 3	2.4E-01				
Hexachlorocyclohexane,gamma	58-89-9	2.0E-04	MCL	2.0E-04	X DF 2	1.1E-04	X DF 3	2.0E-04	X DF 3	6.8E+00				
Hexachlorocyclopentadiene	77-47-4	5.0E-02	MCL	5.0E-02	X DF 2	5.0E-02	X DF 3	5.0E-02	X DF 3	1.8E+00	6.0E-02	2.1E-01	8.5E+00	1.2E+01
Hexachloroethane	67-72-1	1.0E-02	Q	7.9E-04	X DF 2	1.0E-03	X DF 3	1.7E-03	X DF 3	5.0E+00	2.2E+02	5.5E+02	1.4E+04	1.4E+04
Indeno(1,2,3-cd)pyrene	193-39-5	3.7E-03	Q	9.1E-05	X DF 2	9.1E-05	H	9.1E-05	H	2.2E-05				
Isobutyl alcohol	78-83-1	1.1E+01	N	1.1E+01	X DF 2	9.8E+00	X DF 3	1.6E+02	X DF 3	8.5E+04				
Isophorone	78-59-1	7.0E-02	C	7.0E-02	X DF 2	3.3E-02	X DF 3	3.2E-01	X DF 3	1.2E+04				
Lead (inorganic)	7439-92-1	1.5E-02	MCL	1.5E-02	X DF 2	5.0E-02	X DF 3	5.0E-02	X DF 3	NA				
Mercury (inorganic)	7487-94-7	2.0E-03	MCL	2.0E-03	X DF 2	2.0E-03	X DF 3	2.0E-03	X DF 3	NA				
Methoxychlor	72-43-5	4.0E-02	MCL	4.0E-02	X DF 2	4.0E-02	X DF 3	4.0E-02	X DF 3	4.5E-02				
Methylene chloride	75-09-2	5.0E-03	MCL	5.0E-03	X DF 2	4.4E-03	X DF 3	8.7E-02	X DF 3	1.3E+04	9.8E+01	2.4E+02	9.0E+03	9.0E+03
Methyl ethyl ketone	78-93-3	1.9E+00	N	1.9E+00	X DF 2	2.0E+01	X DF 3	3.9E+02	X DF 3	2.2E+05	2.4E+05	5.9E+05	1.0E+06	1.0E+06
Methyl isobutyl ketone	108-10-1	2.0E+00	N	2.0E+00	X DF 2	2.6E+00	X DF 3	3.0E+01	X DF 3	1.9E+04	4.0E+04	9.9E+04	1.0E+06	1.0E+06
Methylnaphthalene,2-	91-57-6	6.2E-03	N	6.2E-03	X DF 2	2.6E-02	X DF 3	2.7E-02	X DF 3	2.5E+01	8.4E+01	2.9E+02	5.0E+03	7.0E+03
MTBE (methyl tert-butyl ether)	1634-04-4	2.0E-02	T/O	2.0E-02	X DF 2	2.0E-02	X DF 3	5.5E+02	X DF 3	5.1E+04	4.8E+03	1.7E+04	3.4E+05	4.7E+05
Naphthalene	91-20-3	1.0E-02	Q	6.2E-03	X DF 2	1.7E-01	X DF 3	2.2E-01	X DF 3	3.1E+01	1.0E+01	3.5E+01	6.6E+02	9.3E+02
Nickel	7440-02-0	7.3E-01	N	7.3E-01	X DF 2	6.7E-01	X DF 3	1.3E+01	X DF 3	NA				
Nitrate	14797-55-8	1.0E+01	MCL	1.0E+01	X DF 2	1.0E+01	X DF 3	1.0E+03	X DF 3	NA				
Nitrite	14797-65-0	1.0E+00	MCL	1.0E+00	X DF 2	1.0E+00	X DF 3	6.4E+01	X DF 3	NA				
Nitroaniline,2-	88-74-4	5.0E-02	Q	2.1E-04	X DF 2	8.7E-02	X DF 3	5.0E-01	X DF 3	1.3E+03	1.4E+00	4.7E+00	8.3E+01	1.2E+02
Nitroaniline,3-	99-09-2	5.0E-02	Q	1.8E-02	X DF 2	9.4E-02	X DF 3	9.3E-01	X DF 3	1.2E+03	1.7E+03	5.9E+03	1.0E+05	1.4E+05
Nitroaniline,4-	100-01-6	1.1E-01	N	1.1E-01	X DF 2	9.4E-02	X DF 3	9.3E-01	X DF 3	7.3E+02				
Nitrobenzene	98-95-3	3.4E-03	N	3.4E-03	X DF 2	1.5E-02	X DF 3	9.6E-02	X DF 3	2.1E+03	4.3E+03	1.1E+04	2.6E+05	2.6E+05
Nitrophenol,4-	100-02-7	2.9E-01	N	2.9E-01	X DF 2	2.3E-01	X DF 3	1.3E+00	X DF 3	1.2E+04				
Nitrosodi-n-propylamine,n-	621-64-7	1.0E-02	Q	1.0E-02	F	1.0E-02	G	4.4E-05	X DF 3	9.9E+03				
N-nitrosodiphenylamine	86-30-6	1.4E-02	C	1.4E-02	X DF 2	2.2E-03	X DF 3	3.2E-03	X DF 3	3.5E+01				

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 3
MANAGEMENT OPTION 1, 2, AND 3
STANDARDS FOR GROUNDWATER
(mg/l)

COMPOUND	CAS #	GW 1	NOTE	GW 2	NOTE	GW 3 DW	NOTE	GW 3 NDW	NOTE	S	Gwesni*	Gwesi*	Gwaimi*	Gwairi*
Chromium(III)	16065-83-1	1.0E-01	MCL	1.0E-01	X DF 2	5.0E-02	X DF 3	9.6E+02	X DF 3	NA				
Chromium(VI)	18540-29-97	1.0E-01	MCL	1.0E-01	X DF 2	5.0E-02	X DF 3	1.9E+00	X DF 3	NA				
Chrysene	218-01-9	9.1E-03	C	9.1E-03	X DF 2	3.8E-05	X DF 3	3.8E-05	X DF 3	1.6E-03				
Cobalt	7440-48-4	2.2E+00	N	2.2E+00	X DF 2	2.0E+00	X DF 3	3.9E+01	X DF 3	NA				
Copper	7440-50-8	1.3E+00	MCL	1.3E+00	X DF 2	1.0E+00	X DF 3	1.3E+00	X DF 3	NA				
Cyanide (free)	57-12-5	2.0E-01	MCL	2.0E-01	X DF 2	6.6E-01	X DF 3	1.3E+01	X DF 3	NA				
DDD	72-54-8	2.8E-04	C	2.8E-04	X DF 2	2.8E-04	H	2.8E-04	H	9.0E-02				
DDE	72-55-9	2.0E-04	C	2.0E-04	X DF 2	2.0E-04	H	2.0E-04	H	1.2E-01				
DDT	50-29-3	3.0E-04	Q	2.0E-04	X DF 2	2.0E-04	H	2.0E-04	H	2.5E-02				
Dibenz(a,h)anthracene	53-70-3	2.5E-03	Q	9.1E-06	X DF 2	9.1E-06	H	9.1E-06	H	2.5E-03				
Dibenzofuran	132-64-9	2.4E-02	N	2.4E-02	X DF 2	1.4E-02	X DF 3	1.5E-02	X DF 3	3.1E+00	1.6E+03	5.6E+03	9.6E+04	1.3E+05
Dibromo-3-chloropropane,1,2-	96-12-8	2.0E-04	MCL	2.0E-04	X DF 2	2.0E-04	X DF 3	2.0E-04	X DF 3	1.2E+03				
Dichlorobenzene,1,2-	95-50-1	6.0E-01	MCL	6.0E-01	X DF 2	6.0E-01	X DF 3	3.4E+00	X DF 3	1.6E+02	1.6E+02	5.5E+02	1.4E+04	2.0E+04
Dichlorobenzene,1,3-	541-73-1	1.0E-02	Q	5.5E-03	X DF 2	1.8E-02	X DF 3	4.5E-02	X DF 3	1.3E+02	1.7E+00	5.8E+00	1.8E+02	2.5E+02
Dichlorobenzene,1,4-	106-46-7	7.5E-02	MCL	7.5E-02	X DF 2	7.5E-02	X DF 3	7.5E-02	X DF 3	7.4E+01	8.8E+02	2.2E+03	8.4E+04	8.4E+04
Dichlorobenzidine,3,3-	91-94-1	2.0E-02	Q	1.5E-04	X DF 2	1.3E-05	X DF 3	1.5E-05	X DF 3	3.1E+00				
Dichloroethane,1,1-	75-34-3	8.1E-01	N	8.1E-01	X DF 2	3.0E+00	X DF 3	1.9E+01	X DF 3	5.1E+03	1.4E+02	4.9E+02	1.7E+04	2.4E+04
Dichloroethane,1,2-	107-06-2	5.0E-03	MCL	5.0E-03	X DF 2	3.6E-04	X DF 3	6.8E-03	X DF 3	8.5E+03	3.6E+00	8.9E+00	2.8E+02	2.8E+02
Dichloroethene,1,1-	75-35-4	7.0E-03	MCL	7.0E-03	X DF 2	5.0E-05	X DF 3	5.8E-04	X DF 3	2.3E+03	1.8E+01	6.2E+01	4.0E+03	5.6E+03
Dichloroethene,cis,1,2-	156-59-2	7.0E-02	MCL	7.0E-02	X DF 2	7.0E-02	X DF 3	1.7E+00	X DF 3	3.5E+03	1.3E+01	4.5E+01	1.3E+03	1.9E+03
Dichloroethene,trans,1,2-	156-60-5	1.0E-01	MCL	1.0E-01	X DF 2	1.0E-01	X DF 3	2.5E+00	X DF 3	6.3E+03	1.4E+01	4.7E+01	1.9E+03	2.6E+03
Dichlorophenol,2,4-	120-83-2	1.1E-01	N	1.1E-01	X DF 2	3.0E-04	X DF 3	2.3E-01	X DF 3	4.5E+03				
Dichloropropane,1,2-	78-87-5	5.0E-03	MCL	5.0E-03	X DF 2	5.0E-03	X DF 3	5.0E-03	X DF 3	2.8E+03	4.0E+03	9.8E+03	4.0E+05	4.0E+05
Dichloropropene,1,3-	542-75-6	5.0E-03	Q	3.9E-04	X DF 2	9.9E-03	X DF 3	1.6E-01	X DF 3	2.8E+03	9.3E+01	2.3E+02	7.4E+03	7.4E+03
Dieldrin	60-57-1	2.5E-03	Q	2.5E-03	F	2.5E-03	G	2.5E-03	G	2.0E-01				
Diethylphthalate	84-66-2	2.9E+01	N	2.9E+01	X DF 2	1.3E+01	X DF 3	2.3E+01	X DF 3	1.1E+03				
Dimethylphenol,2,4-	105-67-9	7.3E-01	N	7.3E-01	X DF 2	2.8E-01	X DF 3	4.5E-01	X DF 3	7.9E+03				
Dimethylphthalate	131-11-3	3.7E+02	N	3.7E+02	X DF 2	2.2E+02	X DF 3	5.7E+02	X DF 3	4.0E+03				
Di-n-octylphthalate	117-84-0	1.5E+00	N	1.5E+00	X DF 2	6.4E-01	X DF 3	1.2E+00	X DF 3	2.0E-02				
Dinitrobenzene,1,3-	99-65-0	1.0E-02	Q	3.7E-03	X DF 2	3.1E-03	X DF 3	2.8E-02	X DF 3	5.3E+02				
Dinitrophenol,2,4-	51-28-5	7.3E-02	N	7.3E-02	X DF 2	6.1E-02	X DF 3	5.0E-01	X DF 3	2.8E+03				
Dinitrotoluene,2,6-	606-20-2	3.7E-02	N	3.7E-02	X DF 2	2.9E-02	X DF 3	1.7E-01	X DF 3	1.8E+02				
Dinitrotoluene,2,4-	121-14-2	7.3E-02	N	7.3E-02	X DF 2	5.6E-02	X DF 3	2.9E-01	X DF 3	2.7E+02				
Dinoseb	88-85-7	7.0E-03	MCL	7.0E-03	X DF 2	7.0E-03	X DF 3	2.5E-02	X DF 3	5.2E+01				
Endosulfan	115-29-7	2.2E-01	N	2.2E-01	X DF 2	2.2E-01	H	6.4E-04	X DF 3	5.1E-01				

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 3
MANAGEMENT OPTION 1, 2, AND 3
STANDARDS FOR GROUNDWATER
(mg/l)

COMPOUND	CAS #	GW 1	NOTE	GW 2	NOTE	GW 3 DW	NOTE	GW 3 NDW	NOTE	S	Gwesni*	Gwesi*	Gwaimi*	Gwairi*
Acenaphthene	83-32-9	3.7E-01	N	3.7E-01	X DF 2	4.3E-01	X DF 3	5.4E-01	X DF 3	4.2E+00	2.8E+03	9.6E+03	1.7E+05	2.4E+05
Acenaphthylene	208-96-8	3.7E-01	N	3.7E-01	X DF 2	5.6E-01	X DF 3	7.7E-01	X DF 3	1.6E+01	3.6E+03	1.2E+04	2.1E+05	3.0E+05
Acetone	67-64-1	6.1E-01	N	6.1E-01	X DF 2	3.3E+00	X DF 3	7.2E+01	X DF 3	1.0E+06	5.8E+03	2.0E+04	3.5E+05	4.8E+05
Aldrin	309-00-2	1.9E-03	Q	1.9E-03	F	1.9E-03	G	1.9E-03	G	1.8E-01				
Aniline	62-53-3	1.2E-02	C	1.2E-02	X DF 2	5.7E-03	X DF 3	8.0E-02	X DF 3	3.6E+04				
Anthracene	120-12-7	1.8E+00	N	1.8E+00	X DF 2	1.1E-01	X DF 3	1.1E-01	X DF 3	4.3E-02	3.7E+04	1.3E+05	1.0E+06	1.0E+06
Antimony	7440-36-0	6.0E-03	MCL	6.0E-03	X DF 2	6.0E-03	X DF 3	2.6E-01	X DF 3	NA				
Arsenic	7440-38-2	1.0E-02	MCL	1.0E-02	X DF 2	5.0E-02	X DF 3	5.0E-02	X DF 3	NA				
Barium	7440-39-3	2.0E+00	MCL	2.0E+00	X DF 2	2.0E+00	X DF 3	4.5E+01	X DF 3	NA				
Benzene	71-43-2	5.0E-03	MCL	5.0E-03	X DF 2	1.1E-03	X DF 3	1.3E-02	X DF 3	1.8E+03	2.9E+00	7.2E+00	3.9E+02	3.9E+02
Benz(a)anthracene	56-55-3	7.8E-03	Q	9.1E-05	X DF 2	3.8E-07	X DF 3	3.8E-07	X DF 3	9.4E-03				
Benzo(a)pyrene	50-32-8	2.0E-04	MCL	2.0E-04	X DF 2	2.0E-04	X DF 3	2.0E-04	X DF 3	1.6E-03				
Benzo(b)fluoranthene	205-99-2	4.8E-03	Q	9.1E-05	X DF 2	9.1E-05	H	9.1E-05	H	1.5E-03				
Benzo(k)fluoranthene	207-08-9	2.5E-03	Q	9.1E-04	X DF 2	9.1E-04	H	9.1E-04	H	8.0E-04				
Beryllium	7440-41-7	4.0E-03	MCL	4.0E-03	X DF 2	4.0E-03	X DF 3	3.0E-01	X DF 3	NA				
Biphenyl,1,1-	92-52-4	3.0E-01	N	3.0E-01	X DF 2	2.3E-01	X DF 3	2.7E-01	X DF 3	7.5E+00	1.7E+02	4.2E+02	1.1E+04	1.1E+04
Bis(2-chloroethyl)ether	111-44-4	5.7E-03	Q	5.7E-03	F	2.8E-05	X DF 3	2.1E-04	X DF 3	1.7E+04	1.5E+01	3.7E+01	8.8E+02	8.8E+02
Bis(2-chloroisopropyl)ether	108-60-1	5.7E-03	Q	2.7E-04	X DF 2	3.1E-04	X DF 3	8.3E-04	X DF 3	1.7E+03	2.4E+00	1.3E+01	1.4E+02	3.1E+02
Bis(2-ethyl-hexyl)phthalate	117-81-7	6.0E-03	MCL	6.0E-03	X DF 2	6.0E-03	X DF 3	6.0E-03	X DF 3	3.4E-01				
Bromodichloromethane	75-27-4	1.0E-01	MCL	1.0E-01	X DF 2	1.0E-01	H	3.3E-03	X DF 3	6.7E+03	2.1E-01	1.1E+00	1.4E+01	3.0E+01
Bromoform	75-25-2	1.0E-01	MCL	1.0E-01	X DF 2	3.9E-03	X DF 3	3.5E-02	X DF 3	3.1E+03	1.8E+01	9.5E+01	1.1E+03	2.3E+03
Bromomethane	74-83-9	1.0E-02	Q	8.7E-03	X DF 2	4.5E-02	X DF 3	5.3E-01	X DF 3	1.5E+04	1.3E+00	4.5E+00	1.5E+02	2.1E+02
Butyl benzyl phthalate	85-68-7	7.3E+00	N	7.3E+00	X DF 2	9.1E-01	X DF 3	1.0E+00	X DF 3	2.7E+00				
Cadmium	7440-43-9	5.0E-03	MCL	5.0E-03	X DF 2	1.0E-02	X DF 3	1.0E-02	X DF 3	NA				
Carbon Disulfide	75-15-0	1.0E+00	N	1.0E+00	X DF 2	2.8E+00	X DF 3	1.5E+01	X DF 3	1.2E+03	5.3E+00	1.3E+01	1.3E+03	1.3E+03
Carbon Tetrachloride	56-23-5	5.0E-03	MCL	5.0E-03	X DF 2	2.2E-04	X DF 3	1.2E-03	X DF 3	7.9E+02	6.1E-01	1.5E+00	1.4E+02	1.4E+02
Chlordane	57-74-9	2.0E-03	MCL	2.0E-03	X DF 2	2.0E-03	H	2.0E-03	H	5.6E-02				
Chloroaniline,p-	106-47-8	1.5E-01	N	1.5E-01	X DF 2	1.2E-01	X DF 3	6.7E-01	X DF 3	5.3E+03				
Chlorobenzene	108-90-7	1.0E-01	MCL	1.0E-01	X DF 2	1.0E-01	X DF 3	7.1E-01	X DF 3	4.7E+02	4.4E+02	1.1E+03	4.9E+04	4.9E+04
Chlorodibromomethane	124-48-1	1.0E-01	MCL	1.0E-01	X DF 2	3.9E-04	X DF 3	5.1E-03	X DF 3	2.6E+03	4.5E-01	2.4E+00	2.8E+01	5.9E+01
Chloroethane (Ethylchloride)	75-00-3	1.0E-02	Q	3.8E-03	X DF 2	1.3E+01	X DF 3	1.2E+02	X DF 3	5.7E+03	5.1E+03	1.3E+04	1.1E+06	1.1E+06
Chloroform	67-66-3	1.0E-01	MCL	1.0E-01	X DF 2	5.3E-03	X DF 3	7.0E-02	X DF 3	7.9E+03	1.3E+00	3.1E+00	1.5E+02	1.5E+02
Chloromethane	74-87-3	1.0E-02	Q	1.5E-03	X DF 2	2.5E-03	X DF 3	3.7E-02	X DF 3	5.3E+03	9.0E+00	2.2E+01	1.9E+03	1.9E+03
Chloronaphthalene,2-	91-58-7	4.9E-01	N	4.9E-01	X DF 2	3.2E-01	X DF 3	3.6E-01	X DF 3	1.2E+01	2.3E+03	8.0E+03	1.4E+05	2.0E+05
Chlorophenol,2-	95-57-8	3.0E-02	N	3.0E-02	X DF 2	1.0E-04	X DF 3	1.3E-01	X DF 3	2.2E+04	8.2E+01	2.8E+02	5.2E+03	7.2E+03

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 2
MANAGEMENT OPTION 1
STANDARDS FOR SOIL
(mg/kg)

COMPOUND	CAS #	SOILni	NOTE	SOILi	NOTE	SOILGW1	NOTE	SOILGW2	NOTE	SOILGW3DW	NOTE	SOILGW3NDW	NOTE	SOILsat	SOILesni*	SOILesi*
Aromatics >C16-C21	NA	1.5E+03	N	1.0E+04	O,T	2.1E+03	A	2.1E+03	X DF2	1.9E+03	X DF3	1.0E+04	O,T	NA		
Aromatics >C21-C35	NA	1.8E+03	N	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA		
TPH-GRO	NA	6.5E+02	N,I	5.1E+03	N,I	6.5E+01	A	6.5E+01	X DF2	2.6E+02	X DF3	6.1E+03	X DF3	NA	8.6E+01	2.1E+02
TPH-DRO	NA	6.5E+02	N,I	5.1E+03	N,I	6.5E+01	A	6.5E+01	X DF2	2.6E+02	X DF3	6.1E+03	X DF3	NA		
TPH-ORO	NA	1.8E+03	N,I	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA		

A - Based on algorithm contained in Appendix H
B - Based on EPA's biokinetic and adult lead cleanup level models for lead
C - Based on carcinogenic health effects
D - DEQ established background level plus one standard deviation = 11.5
F - GW 2 soil water partition equation multiplied by maximum DF is less than SoilGW1 thus default to SoilGW 1
G - GW 3 soil water partition equation multiplied by maximum DF is less than SoilGW2 thus default to SoilGW 2 and multiply by X DF 2
H - GW 3 soil water partition equation multiplied by maximum DF is less than SoilGW2 thus default to GW 2 and do not multiply by DF 2
I - TPH Standards are only applicable when used in conjunction with Standards for indicator compounds
L - Soil level protective of groundwater for inorganic constituents based on leachability (TCLP listed)
L1 - Soil level protective of groundwater for inorganic constituents based on GW 1 because TCLP value not listed
N - Based on non-carcinogenic health effects
NA - Not applicable
O - Ceiling value based on aesthetic considerations
Q - Based on analytical quantitation limit
S - Soil level protective of groundwater for inorganic constituents based on the maximum concentration for the beneficial use of sewage sludge
T - TPH shall not exceed 10,000
X DF 2 - Multiply SOILGW2 by the appropriate site specific DF from the chart
X DF 3 - Multiply SOILGW3DW or SOILGW3NDW by the appropriate site specific DF from the chart
* The MO-1 SOILes is presented for screening purposes only; if the soil AOIC exceeds the MO-1 SOILes, then further assessment maybe warranted under MO-2 or MO-3.

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 2
MANAGEMENT OPTION 1
STANDARDS FOR SOIL
(mg/kg)

COMPOUND	CAS #	SOILni	NOTE	SOILi	NOTE	SOILGW1	NOTE	SOILGW2	NOTE	SOILGW3DW	NOTE	SOILGW3NDW	NOTE	SOILsat	SOILesni*	SOILesi*
Pentachlorophenol	87-86-5	2.8E+00	C	9.7E+00	C	1.7E+00	Q	1.1E-01	X DF 2	1.1E-01	X DF3	1.1E-01	X DF 3	NA		
Phenanthrene	85-01-8	2.1E+04	N	4.3E+05	N	6.6E+02	A	6.6E+02	X DF 2	1.2E+02	X DF3	1.2E+02	X DF 3	NA	1.0E+06	1.0E+06
Phenol	108-95-2	1.3E+04	N	1.5E+05	N	1.1E+01	A	1.1E+01	X DF 2	5.5E+01	X DF3	4.9E+02	X DF 3	NA	3.5E+04	1.2E+05
Polychlorinated biphenyls	1336-36-3	2.1E-01	C	9.0E-01	C	1.9E+01	A	1.9E+01	X DF 2	1.9E+01	G	1.9E+01	G	5.7E+01		
Pyrene	129-00-0	2.3E+03	N	5.6E+04	N	1.1E+03	A	1.1E+03	X DF 2	1.1E+03	X DF3	1.1E+03	X DF 3	NA	1.0E+06	1.0E+06
Selenium	7782-49-2	3.9E+02	N	1.0E+04	N	2.0E+01	L	2.0E+01	L	2.0E+01	L	2.0E+01	L	NA		
Silver	7440-22-4	3.9E+02	N	1.0E+04	N	1.0E+02	L	1.0E+02	L	1.0E+02	L	1.0E+02	L	NA		
Styrene	100-42-5	5.0E+03	N	4.3E+04	N	1.1E+01	A	1.1E+01	X DF 2	1.1E+01	X DF3	7.9E+02	X DF 3	1.7E+03	2.3E+03	5.7E+03
Tetrachlorobenzene,1,2,4,5-	95-94-3	1.2E+01	N	1.2E+02	N	6.9E+00	A	6.9E+00	X DF 2	3.4E-01	X DF3	3.6E-01	X DF 3	1.9E+01		
Tetrachloroethane,1,1,1,2-	630-20-6	2.7E+00	C	5.9E+00	C	4.6E-02	A	3.9E-03	X DF 2	7.7E-03	X DF3	2.0E-02	X DF 3	5.0E+02	2.5E-02	6.3E-02
Tetrachloroethane,1,1,2,2-	79-34-5	8.1E-01	C	2.0E+00	C	6.0E-03	A	6.5E-04	X DF 2	1.9E-03	X DF3	2.2E-02	X DF 3	1.8E+03	3.3E+00	8.0E+00
Tetrachloroethylene	127-18-4	8.3E+00	C	3.5E+01	C	1.8E-01	A	1.8E-01	X DF 2	2.3E-02	X DF3	8.9E-02	X DF 3	3.6E+02	1.2E+01	2.9E+01
Tetrachlorophenol,2,3,4,6-	58-90-2	1.4E+03	N	1.7E+04	N	3.1E+01	A	3.1E+01	X DF 2	4.2E+00	X DF3	5.0E+00	X DF 3	1.4E+03		
Thallium	7440-28-0	5.5E+00	N	1.4E+02	N	4.0E+00	L1	4.0E+00	L1	4.0E+00	L1	4.0E+00	L1	NA		
Toluene	108-88-3	6.8E+02	N	4.7E+03	N	2.0E+01	A	2.0E+01	X DF 2	1.2E+02	X DF3	9.1E+02	X DF 3	5.2E+02	5.5E+01	1.4E+02
Toxaphene	8001-35-2	4.4E-01	C	2.2E+00	C	3.4E+01	A	3.4E+01	X DF 2	3.4E+01	G	3.4E+01	G	NA		
Trichlorobenzene,1,2,4-	120-82-1	6.6E+02	N	1.2E+04	N	1.4E+01	A	1.4E+01	X DF 2	1.4E+01	X DF3	3.8E+01	X DF 3	NA	3.9E+03	1.3E+04
Trichloroethane,1,1,1-	71-55-6	8.2E+02	N	7.0E+03	N	4.0E+00	A	4.0E+00	X DF 2	4.0E+00	X DF3	1.8E+02	X DF 3	1.3E+03	6.2E+01	2.1E+02
Trichloroethane,1,1,2-	79-00-5	1.9E+00	C	4.3E+00	C	5.8E-02	A	5.8E-02	X DF 2	6.5E-03	X DF3	8.0E-02	X DF 3	2.5E+03	4.1E+00	1.0E+01
Trichloroethene	79-01-6	1.0E-01	C	2.1E-01	C	7.3E-02	A	7.3E-02	X DF 2	4.1E-02	X DF3	3.0E-01	X DF 3	8.0E+02	4.2E+00	1.0E+01
Trichlorofluoromethane	75-69-4	3.8E+02	N	2.6E+03	N	3.7E+01	A	3.7E+01	X DF 2	2.0E+02	X DF3	5.8E+02	X DF 3	1.6E+03	9.9E+00	3.4E+01
Trichlorophenol,2,4,5-	95-95-4	5.3E+03	N	6.6E+04	N	3.2E+02	A	3.2E+02	X DF 2	4.7E+01	X DF3	5.6E+01	X DF 3	NA		
Trichlorophenol,2,4,6-	88-06-2	4.0E+01	C	1.7E+02	C	1.3E+00	A	7.9E-01	X DF 2	8.6E-02	X DF3	1.1E-01	X DF 3	NA		
Vanadium	7440-62-2	5.5E+02	N	1.4E+04	N	5.2E+02	L1	5.2E+02	L1	5.2E+02	L1	5.2E+02	L1	NA		
Vinyl chloride	75-01-4	2.4E-01	C	7.9E-01	C	1.3E-02	A	1.3E-02	X DF 2	1.3E-02	X DF3	2.4E-01	X DF 3	9.2E+02	1.1E-02	2.8E-02
Xylene(mixed)	1330-20-7	1.8E+02	N	1.2E+03	N	1.8E+02	A	1.8E+02	X DF 2	1.8E+02	X DF3	1.8E+02	X DF 3	1.5E+02	1.5E+01	5.1E+01
Zinc	7440-66-6	2.3E+04	N	6.1E+05	N	2.8E+03	S	2.8E+03	S	2.8E+03	S	2.8E+03	S	NA		
Aliphatics C6-C8	NA	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA	3.6E+02	8.9E+02
Aliphatics >C8-C10	NA	1.2E+03	N	8.8E+03	N	5.3E+03	A	5.3E+03	X DF2	1.0E+04	O,T	1.0E+04	O,T	NA	8.6E+01	2.1E+02
Aliphatics >C10-C12	NA	2.3E+03	N	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA	4.6E+02	1.1E+03
Aliphatics >C12-C16	NA	3.7E+03	N	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA	2.1E+03	5.2E+03
Aliphatics >C16-C35	NA	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	1.0E+04	O,T	NA		
Aromatics >C8-C10	NA	6.5E+02	N	5.1E+03	N	6.5E+01	A	6.5E+01	X DF2	2.6E+02	X DF3	6.1E+03	X DF3	NA	1.5E+02	3.6E+02
Aromatics >C10-C12	NA	1.2E+03	N	1.0E+04	O,T	1.0E+02	A	1.0E+02	X DF2	4.1E+02	X DF3	9.6E+03	X DF3	NA	7.8E+02	1.9E+03
Aromatics >C12-C16	NA	1.8E+03	N	1.0E+04	O,T	2.0E+02	A	2.0E+02	X DF2	8.1E+02	X DF3	1.0E+04	O,T	NA	4.1E+03	1.0E+04

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 2
MANAGEMENT OPTION 1
STANDARDS FOR SOIL
(mg/kg)

COMPOUND	CAS #	SOILni	NOTE	SOILi	NOTE	SOILGW1	NOTE	SOILGW2	NOTE	SOILGW3DW	NOTE	SOILGW3NDW	NOTE	SOILsat	SOILesni*	SOILesi*
Acenaphthene	83-32-9	3.7E+03	N	6.1E+04	N	2.2E+02	A	2.2E+02	X DF 2	2.5E+02	X DF3	3.2E+02	X DF 3	NA	7.3E+04	2.5E+05
Acenaphthylene	208-96-8	3.5E+03	N	5.1E+04	N	8.8E+01	A	8.8E+01	X DF 2	1.4E+02	X DF3	1.9E+02	X DF 3	NA	3.8E+04	1.3E+05
Acetone	67-64-1	1.7E+03	N	1.4E+04	N	1.5E+00	A	1.5E+00	X DF 2	8.5E+00	X DF3	1.8E+02	X DF 3	1.3E+05	6.6E+02	2.3E+03
Aldrin	309-00-2	2.8E-02	C	1.3E-01	C	1.1E+01	A	1.1E+01	F	1.1E+01	H	1.1E+01	H	NA		
Aniline	62-53-3	2.4E+01	N	1.7E+02	N	6.5E-02	A	6.5E-02	X DF 2	3.2E-02	X DF3	4.4E-01	X DF 3	1.0E+04		
Anthracene	120-12-7	2.2E+04	N	4.8E+05	N	1.2E+02	A	1.2E+02	X DF 2	1.2E+02	X DF3	1.2E+02	X DF 3	NA	1.0E+06	1.0E+06
Antimony	7440-36-0	3.1E+01	N	8.2E+02	N	1.2E+01	L1	1.2E+01	L1	1.2E+01	L1	1.2E+01	L1	NA		
Arsenic	7440-38-2	1.2E+01	D	1.2E+01	D	1.0E+02	L	1.0E+02	L	1.0E+02	L	1.0E+02	L	NA		
Barium	7440-39-3	5.5E+03	N	1.4E+05	N	2.0E+03	L	2.0E+03	L	2.0E+03	L	2.0E+03	L	NA		
Benzene	71-43-2	1.5E+00	C	3.1E+00	C	5.1E-02	A	5.1E-02	X DF 2	1.1E-02	X DF3	1.3E-01	X DF 3	9.0E+02	1.0E+00	2.5E+00
Benz(a)anthracene	56-55-3	6.2E-01	C	2.9E+00	C	3.3E+02	A	3.9E+00	X DF 2	1.6E-02	X DF3	1.6E-02	X DF 3	NA		
Benzo(a)pyrene	50-32-8	3.3E-01	Q	3.3E-01	Q	2.3E+01	A	2.3E+01	X DF 2	2.3E+01	X DF3	2.3E+01	X DF 3	NA		
Benzo(b)fluoranthene	205-99-2	6.2E-01	C	2.9E+00	C	2.2E+02	A	1.3E+01	X DF 2	1.3E+01	G	1.3E+01	G	NA		
Benzo(k)fluoranthene	207-08-9	6.2E+00	C	2.9E+01	C	1.2E+02	A	1.2E+02	X DF 2	1.2E+02	G	1.2E+02	G	NA		
Beryllium	7440-41-7	1.6E+02	N	4.1E+03	N	8.0E+00	L1	8.0E+00	L1	8.0E+00	L1	8.0E+00	L1	NA		
Biphenyl,1,1-	92-52-4	2.9E+03	N	4.4E+04	N	1.9E+02	A	1.9E+02	X DF 2	1.4E+02	X DF3	1.7E+02	X DF 3	2.3E+02	4.6E+03	1.1E+04
Bis(2-chloroethyl)ether	111-44-4	3.3E-01	Q	1.1E+00	C	3.3E-01	Q	6.6E-02	F	3.3E-01	Q	2.4E-03	X DF 3	9.8E+03	7.6E+00	1.9E+01
Bis(2-chloroisopropyl)ether	108-60-1	4.9E+00	C	1.7E+01	C	8.0E-01	Q	2.7E-03	X DF 2	3.1E-03	X DF3	8.2E-03	X DF 3	8.4E+02	1.0E+00	5.5E+00
Bis(2-ethyl-hexyl)phthalate	117-81-7	3.5E+01	C	1.7E+02	C	7.9E+01	A	7.9E+01	X DF 2	7.9E+01	X DF3	7.9E+01	X DF 3	2.2E+02		
Bromodichloromethane	75-27-4	1.8E+00	C	4.2E+00	C	9.2E-01	A	9.2E-01	X DF 2	9.2E-01	G	3.0E-02	X DF 3	3.1E+03	8.2E-02	4.3E-01
Bromoform	75-25-2	4.8E+01	C	1.8E+02	C	1.8E+00	A	1.8E+00	X DF 2	6.9E-02	X DF3	6.1E-01	X DF 3	2.7E+03	1.4E+01	7.4E+01
Bromomethane	74-83-9	4.3E+00	N	3.0E+01	N	4.0E-02	A	3.5E-02	X DF 2	1.8E-01	X DF3	2.1E+00	X DF 3	3.0E+03	1.9E-01	6.4E-01
Butyl benzyl phthalate	85-68-7	1.2E+04	N	1.7E+05	N	4.4E+03	A	4.4E+03	X DF 2	1.5E+03	X DF3	1.7E+03	X DF 3	2.2E+02		
Cadmium	7440-43-9	3.9E+01	N	1.0E+03	N	2.0E+01	L	2.0E+01	L	2.0E+01	L	2.0E+01	L	NA		
Carbon Disulfide	75-15-0	3.6E+02	N	2.5E+03	N	1.1E+01	A	1.1E+01	X DF 2	2.9E+01	X DF3	1.5E+02	X DF 3	6.0E+02	9.2E-01	2.3E+00
Carbon Tetrachloride	56-23-5	5.3E-01	C	1.1E+00	C	1.1E-01	A	1.1E-01	X DF 2	5.0E-03	X DF3	2.7E-02	X DF 3	9.1E+02	2.6E-01	6.4E-01
Chlordane	57-74-9	1.6E+00	C	1.0E+01	C	1.2E+01	A	1.2E+01	X DF 2	1.2E+01	G	1.2E+01	G	NA		
Chloroaniline,p-	106-47-8	1.6E+02	N	1.7E+03	N	1.5E+00	A	1.5E+00	X DF 2	1.2E+00	X DF3	7.0E+00	X DF 3	NA		
Chlorobenzene	108-90-7	1.7E+02	N	1.2E+03	N	3.0E+00	A	3.0E+00	X DF 2	3.0E+00	X DF3	2.1E+01	X DF 3	7.0E+02	4.8E+02	1.2E+03
Chlorodibromomethane	124-48-1	2.2E+00	C	5.4E+00	C	1.0E+00	A	1.0E+00	X DF 2	3.9E-03	X DF3	5.1E-02	X DF 3	1.3E+03	2.0E-01	1.1E+00
Chloroethane (Ethylchloride)	75-00-3	4.1E+00	C	8.2E+00	C	3.5E-02	A	1.3E-02	X DF 2	4.4E+01	X DF3	4.3E+02	X DF 3	9.9E+02	3.7E+02	9.1E+02
Chloroform	67-66-3	4.4E-01	N	1.2E+00	C	9.0E-01	A	9.0E-01	X DF 2	4.8E-02	X DF3	6.3E-01	X DF 3	3.6E+03	4.1E-01	1.0E+00
Chloromethane	74-87-3	3.5E+00	C	7.3E+00	C	1.0E-01	Q	9.1E-03	X DF 2	1.5E-02	X DF3	2.2E-01	X DF 3	1.6E+03	1.2E+00	3.0E+00
Chloronaphthalene,2-	91-58-7	5.0E+03	N	8.3E+04	N	5.0E+02	A	5.0E+02	X DF 2	3.3E+02	X DF3	3.7E+02	X DF 3	NA	1.1E+05	3.6E+05
Chlorophenol,2-	95-57-8	1.5E+02	N	1.4E+03	N	1.4E+00	A	1.4E+00	X DF 2	4.6E-03	X DF3	5.8E+00	X DF 3	5.1E+04	1.7E+02	5.7E+02

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 2
MANAGEMENT OPTION 1
STANDARDS FOR SOIL
(mg/kg)

COMPOUND	CAS #	SOILni	NOTE	SOILi	NOTE	SOILGW1	NOTE	SOILGW2	NOTE	SOILGW3DW	NOTE	SOILGW3NDW	NOTE	SOILsat	SOILesni*	SOILesi*
Endrin	72-20-8	1.8E+01	N	2.5E+02	N	2.6E+00	A	2.6E+00	X DF 2	3.4E-01	X DF3	3.4E-01	X DF 3	NA		
Ethyl benzene	100-41-4	1.6E+03	N	1.3E+04	N	1.9E+01	A	1.9E+01	X DF 2	6.6E+01	X DF3	2.2E+02	X DF 3	2.3E+02	1.9E+03	4.8E+03
Fluoranthene	206-44-0	2.2E+03	N	2.9E+04	N	1.2E+03	A	1.2E+03	X DF 2	1.8E+02	X DF3	1.9E+02	X DF 3	NA		
Fluorene	86-73-7	2.8E+03	N	5.4E+04	N	2.3E+02	A	2.3E+02	X DF 2	6.8E+01	X DF3	7.2E+01	X DF 3	NA	1.9E+05	6.4E+05
Heptachlor	76-44-8	1.6E-02	C	3.5E-02	C	5.0E-01	A	5.0E-01	X DF 2	5.0E-01	G	5.0E-01	G	NA		
Heptachlor epoxide	1024-57-3	5.3E-02	C	2.6E-01	C	2.0E+00	A	2.0E+00	X DF 2	2.0E+00	X DF3	2.0E+00	X DF 3	NA		
Hexachlorobenzene	118-74-1	3.4E-01	C	2.0E+00	C	9.6E+00	A	9.6E+00	X DF 2	9.6E+00	G	9.6E+00	G	NA	1.1E+02	2.6E+02
Hexachlorobutadiene	87-68-3	4.5E+00	C	1.6E+01	C	5.5E+00	A	5.5E+00	X DF 2	5.8E-01	X DF3	7.1E-01	X DF 3	1.0E+03		
Hexachlorocyclohexane,alpha	319-84-6	8.2E-02	C	4.4E-01	C	6.4E-03	A	2.2E-03	X DF 2	3.7E-04	X DF3	5.5E-04	X DF 3	NA		
Hexachlorocyclohexane,beta	319-85-7	2.9E-01	C	1.6E+00	C	1.6E-02	A	9.5E-03	X DF 2	1.3E-03	X DF3	1.7E-03	X DF 3	NA		
Hexachlorocyclohexane,gamma	58-89-9	3.9E-01	C	2.0E+00	C	3.3E-02	A	3.3E-02	X DF 2	1.8E-02	X DF3	3.3E-02	X DF 3	NA		
Hexachlorocyclopentadiene	77-47-4	1.4E+01	N	9.4E+01	N	1.2E+03	A	1.2E+03	X DF 2	1.2E+03	X DF3	1.2E+03	X DF 3	2.2E+03	4.6E+01	1.6E+02
Hexachloroethane	67-72-1	3.2E+01	C	1.4E+02	C	2.2E+00	A	1.7E-01	X DF 2	2.2E-01	X DF3	3.8E-01	X DF 3	NA	2.1E+03	5.2E+03
Indeno(1,2,3-cd)pyrene	193-39-5	6.2E-01	C	2.9E+00	C	9.2E+00	A	9.2E+00	X DF 2	9.2E+00	G	9.2E+00	G	NA		
Isobutyl alcohol	78-83-1	7.3E+03	N	6.2E+04	N	3.0E+01	A	3.0E+01	X DF 2	2.7E+01	X DF3	4.3E+02	X DF 3	1.2E+04		
Isophorone	78-59-1	3.4E+02	C	1.1E+03	C	5.6E-01	A	5.6E-01	X DF 2	2.7E-01	X DF3	2.6E+00	X DF 3	4.9E+03		
Lead (inorganic)	7439-92-1	4.0E+02	B	1.4E+03	B	1.0E+02	L	1.0E+02	L	1.0E+02	L	1.0E+02	L	NA		
Mercury (inorganic)	7487-94-7	2.3E+01	N	6.1E+02	N	4.0E+00	L	4.0E+00	L	4.0E+00	L	4.0E+00	L	NA		
Methoxychlor	72-43-5	3.0E+02	N	4.3E+03	N	3.8E+02	A	3.8E+02	X DF 2	3.8E+02	X DF3	3.8E+02	X DF 3	NA		
Methylene chloride	75-09-2	1.9E+01	C	4.4E+01	C	1.7E-02	A	1.7E-02	X DF 2	1.5E-02	X DF3	2.9E-01	X DF 3	2.2E+03	1.3E+01	3.2E+01
Methyl ethyl ketone	78-93-3	5.9E+03	N	4.4E+04	N	5.0E+00	A	5.0E+00	X DF 2	5.2E+01	X DF3	1.0E+03	X DF 3	2.9E+04	2.8E+04	6.9E+04
Methyl isobutyl ketone	108-10-1	4.5E+03	N	6.3E+04	N	6.4E+00	A	6.4E+00	X DF 2	8.3E+00	X DF3	9.7E+01	X DF 3	3.1E+03	5.7E+03	1.4E+04
Methylnaphthalene,2-	91-57-6	2.2E+02	N	1.7E+03	N	1.7E+00	A	1.7E+00	X DF 2	7.0E+00	X DF3	7.3E+00	X DF 3	NA	1.0E+03	3.5E+03
MTBE (methyl tert-butyl ether)	1634-04-4	6.5E+03	N	4.7E+04	N	7.7E-02	A	7.7E-02	X DF 2	7.7E-02	X DF3	2.1E+03	X DF 3	9.8E+03	8.0E+02	2.8E+03
Naphthalene	91-20-3	6.2E+01	N	4.3E+02	N	1.5E+00	A	9.0E-01	X DF 2	2.5E+01	X DF3	3.2E+01	X DF 3	NA	6.3E+01	2.2E+02
Nickel	7440-02-0	1.6E+03	N	4.1E+04	N	1.5E+03	L1	1.5E+03	L1	1.5E+03	L1	1.5E+03	L1	NA		
Nitrate	14797-55-8	1.3E+05	N	1.0E+06	O	2.0E+04	L1	2.0E+04	L1	2.0E+04	L1	2.0E+04	L1	NA		
Nitrite	14797-65-0	7.8E+03	N	2.0E+05	N	2.0E+03	L1	2.0E+03	L1	2.0E+03	L1	2.0E+03	L1	NA		
Nitroaniline,2-	88-74-4	1.7E+00	Q	5.2E+00	N	1.7E+00	Q	1.7E+00	Q	3.9E-01	X DF3	2.3E+00	X DF 3	2.8E+02	2.8E-01	9.5E-01
Nitroaniline,3-	99-09-2	1.3E+02	N	1.4E+03	N	1.7E+00	Q	8.5E-02	X DF 2	4.4E-01	X DF3	4.3E+00	X DF 3	2.8E+02	3.5E+02	1.2E+03
Nitroaniline,4-	100-01-6	1.0E+02	N	1.0E+03	N	1.7E+00	Q	4.3E-01	X DF 2	3.7E-01	X DF3	3.6E+00	X DF 3	1.4E+02		
Nitrobenzene	98-95-3	2.2E+01	N	2.5E+02	N	3.3E-01	Q	5.7E-02	X DF 2	2.5E-01	X DF3	1.6E+00	X DF 3	1.8E+03	3.2E+03	7.9E+03
Nitrophenol,4-	100-02-7	3.2E+02	N	3.3E+03	N	2.6E+00	A	2.6E+00	X DF 2	2.1E+00	X DF3	1.2E+01	X DF 3	5.4E+03		
Nitrosodi-n-propylamine,n-	621-64-7	3.3E-01	Q	3.3E-01	Q	3.3E-01	Q	5.3E-02	F	5.3E-02	H	3.3E-01	Q	NA		
N-nitrosodiphenylamine	86-30-6	9.0E+01	C	4.0E+02	C	2.1E+00	A	2.1E+00	X DF 2	3.5E-01	X DF3	5.1E-01	X DF 3	NA		

NOTE: See end of Table for designation of letter symbols and footnotes.

LDEQ RECAP TABLE 2
MANAGEMENT OPTION 1
STANDARDS FOR SOIL
(mg/kg)

COMPOUND	CAS #	SOILni	NOTE	SOILi	NOTE	SOILGW1	NOTE	SOILGW2	NOTE	SOILGW3DW	NOTE	SOILGW3NDW	NOTE	SOILsat	SOILesni*	SOILesi*
Chromium(III)	16065-83-1	1.2E+05	N	1.0E+06	O	1.0E+02	L	1.0E+02	L	1.0E+02	L	1.0E+02	L	NA		
Chromium(VI)	18540-29-97	2.3E+02	N	6.1E+03	N	1.0E+02	L	1.0E+02	L	1.0E+02	L	1.0E+02	L	NA		
Chrysene	218-01-9	6.2E+01	C	2.9E+02	C	7.6E+01	A	7.6E+01	X DF 2	1.8E+00	X DF3	1.8E+00	X DF 3	NA		
Cobalt	7440-48-4	4.7E+03	N	1.2E+05	N	4.4E+03	L1	4.4E+03	L1	4.4E+03	L1	4.4E+03	L1	NA		
Copper	7440-50-8	3.1E+03	N	8.2E+04	N	1.5E+03	S	1.5E+03	S	1.5E+03	S	1.5E+03	S	NA		
Cyanide (free)	57-12-5	1.5E+03	N	3.6E+04	N	4.0E+02	L1	4.0E+02	L1	4.0E+02	L1	4.0E+02	L1	NA		
DDD	72-54-8	2.4E+00	C	1.6E+01	C	1.5E+00	A	1.5E+00	X DF 2	1.5E+00	G	1.5E+00	G	NA		
DDE	72-55-9	1.7E+00	C	1.1E+01	C	2.0E+00	A	2.0E+00	X DF 2	2.0E+00	G	2.0E+00	G	NA		
DDT	50-29-3	1.7E+00	C	1.2E+01	C	2.4E+01	A	1.6E+01	X DF 2	1.6E+01	G	1.6E+01	G	NA		
Dibenz(a,h)anthracene	53-70-3	3.3E-01	Q	3.3E-01	Q	5.4E+02	A	2.0E+00	X DF 2	2.0E+00	G	2.0E+00	G	NA		
Dibenzofuran	132-64-9	2.9E+02	N	6.5E+03	N	2.4E+01	A	2.4E+01	X DF 2	1.3E+01	X DF3	1.5E+01	X DF 3	1.5E+02	7.1E+04	2.4E+05
Dibromo-3-chloropropane,1,2-	96-12-8	3.5E-01	C	1.8E+00	C	1.0E-02	Q	2.6E-03	X DF 2	2.6E-03	X DF3	2.6E-03	X DF 3	7.8E+02		
Dichlorobenzene,1,2-	95-50-1	9.9E+02	N	7.4E+03	N	2.9E+01	A	2.9E+01	X DF 2	2.9E+01	X DF3	1.6E+02	X DF 3	3.8E+02	3.1E+02	1.1E+03
Dichlorobenzene,1,3-	541-73-1	2.1E+01	N	1.8E+02	N	2.1E+00	A	1.1E+00	X DF 2	3.8E+00	X DF3	9.2E+00	X DF 3	1.3E+03	1.3E+01	4.4E+01
Dichlorobenzene,1,4-	106-46-7	6.7E+00	C	1.6E+01	C	5.7E+00	A	5.7E+00	X DF 2	5.7E+00	X DF3	5.7E+00	X DF 3	NA	2.6E+03	6.5E+03
Dichlorobenzidine,3,3-	91-94-1	9.7E-01	C	4.2E+00	C	1.8E+00	A	1.3E-02	X DF 2	1.1E-03	X DF3	1.4E-03	X DF 3	NA		
Dichloroethane,1,1-	75-34-3	6.6E+02	N	4.7E+03	N	7.5E+00	A	7.5E+00	X DF 2	2.7E+01	X DF3	1.8E+02	X DF 3	2.3E+03	4.7E+01	1.6E+02
Dichloroethane,1,2-	107-06-2	8.2E-01	C	1.8E+00	C	3.5E-02	A	3.5E-02	X DF 2	2.6E-03	X DF3	4.8E-02	X DF 3	3.0E+03	1.1E+00	2.6E+00
Dichloroethene,1,1-	75-35-4	1.3E+02	N	9.1E+02	N	8.5E-02	A	8.5E-02	X DF 2	6.1E-04	X DF3	7.0E-03	X DF 3	1.4E+03	4.3E+00	1.5E+01
Dichloroethene,cis,1,2-	156-59-2	4.8E+01	N	3.4E+02	N	4.9E-01	A	4.9E-01	X DF 2	4.9E-01	X DF3	1.2E+01	X DF 3	1.2E+03	3.4E+00	1.2E+01
Dichloroethene,trans,1,2-	156-60-5	6.9E+01	N	4.8E+02	N	7.7E-01	A	7.7E-01	X DF 2	7.7E-01	X DF3	1.9E+01	X DF 3	2.4E+03	3.4E+00	1.2E+01
Dichlorophenol,2,4-	120-83-2	1.6E+02	N	2.0E+03	N	1.2E+01	A	1.2E+01	X DF 2	3.2E-02	X DF3	2.5E+01	X DF 3	NA		
Dichloropropane,1,2-	78-87-5	8.3E-01	C	1.8E+00	C	4.2E-02	A	4.2E-02	X DF 2	4.2E-02	X DF3	4.2E-02	X DF 3	1.2E+03	1.3E+03	3.1E+03
Dichloropropene,1,3-	542-75-6	3.1E+00	C	1.0E+01	C	4.0E-02	A	3.2E-03	X DF 2	8.0E-02	X DF3	1.3E+00	X DF 3	1.1E+03	3.1E+01	7.7E+01
Dieldrin	60-57-1	3.0E-02	C	1.5E-01	C	7.6E+00	A	7.6E+00	F	7.6E+00	H	7.6E+00	H	NA		
Diethylphthalate	84-66-2	3.6E+04	N	3.9E+05	N	3.6E+02	A	3.6E+02	X DF 2	1.6E+02	X DF3	2.8E+02	X DF 3	6.7E+02		
Dimethylphenol,2,4-	105-67-9	9.3E+02	N	1.1E+04	N	2.0E+01	A	2.0E+01	X DF 2	7.6E+00	X DF3	1.2E+01	X DF 3	NA		
Dimethylphthalate	131-11-3	4.2E+05	N	1.0E+06	O	2.8E+03	A	2.8E+03	X DF 2	1.6E+03	X DF3	4.3E+03	X DF 3	1.5E+03		
Di-n-octylphthalate	117-84-0	2.4E+03	N	3.5E+04	N	2.0E+05	A	2.0E+05	X DF 2	2.0E+05	X DF3	2.0E+05	X DF 3	1.0E+04		
Dinitrobenzene,1,3-	99-65-0	4.5E+00	N	5.0E+01	N	2.5E-01	Q	7.5E-02	X DF 2	6.4E-02	X DF3	5.7E-01	X DF 3	5.5E+02		
Dinitrophenol,2,4-	51-28-5	7.1E+01	N	6.9E+02	N	1.7E+00	Q	3.4E-01	X DF 2	2.8E-01	X DF3	2.3E+00	X DF 3	NA		
Dinitrotoluene,2,6-	606-20-2	4.3E+01	N	4.6E+02	N	3.9E-01	A	3.9E-01	X DF 2	3.1E-01	X DF3	1.8E+00	X DF 3	NA		
Dinitrotoluene,2,4-	121-14-2	8.9E+01	N	9.8E+02	N	1.0E+00	A	1.0E+00	X DF 2	7.9E-01	X DF3	4.1E+00	X DF 3	NA		
Dinoseb	88-85-7	4.7E+01	N	5.4E+02	N	1.4E-01	Q	1.2E-01	X DF 2	1.2E-01	X DF3	4.4E-01	X DF 3	NA		
Endosulfan	115-29-7	3.4E+02	N	4.5E+03	N	5.4E+01	A	5.4E+01	X DF 2	5.4E+01	G	1.6E-01	X DF 3	NA		

NOTE: See end of Table for designation of letter symbols and footnotes.

APPENDIX 2

TANGIPAHOA PARISH GEOLOGY

GROUND-WATER RESOURCES OF SOUTHERN TANGIPAHOA PARISH AND ADJACENT AREAS, LOUISIANA

By Timothy R. Rapp

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 92-4182

Prepared in cooperation with the
DEPARTMENT OF PUBLIC UTILITIES,
JEFFERSON PARISH, LOUISIANA

Baton Rouge, Louisiana

1994

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U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Box 25286
Denver, CO 80225

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
foot per second (ft/s)	0.3048	meter per second
foot per year (ft/yr)	0.3048	meter per year
foot per mile (ft/mi)	0.1894	meter per kilometer
cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$	0.09290	cubic meter per day per square meter times meter of aquifer thickness
cubic foot per day per square foot $(ft^3/d)/ft^2$	0.3048	cubic meter per day per square meter
mile (mi)	1.609	kilometer
pound per square inch (lb/in^2)	6.895	kilopascal
gallon (gal)	3.785	liter
gallon per minute (gal/min)	0.06308	liter per second
million gallons per day (Mgal/d)	3,785	cubic meter per day

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: $°F = 1.8 \times °C + 32$.

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in this report:

micrograms per liter (µg/L)

milligrams per liter (mg/L)

microsiemens per centimeter at 25 degrees Celsius (µS/cm)

GROUND-WATER RESOURCES OF SOUTHERN TANGIPAHOA PARISH AND ADJACENT AREAS, LOUISIANA

By Timothy R. Rapp

Abstract

Ground-water resources in southern Tangipahoa Parish and adjacent areas were studied to determine their potential for development as an alternative to the Mississippi River as a water-supply source for Jefferson Parish. The complex clay, sand, and gravel sequences in the area are typical of the aquifers and confining units of southeastern Louisiana. Eight major aquifers consisting of thick sand units that underlie the study area are, in descending order, the shallow, upper Ponchatoula, lower Ponchatoula, Abita, Covington, Tchefuncta, Hammond, and Amite.

A fault zone, referred to as the Baton Rouge fault, crosses southern Tangipahoa Parish. The results of the test-well drilling program indicated that the Baton Rouge fault zone disrupts ground-water flow in the aquifers of intermediate depth in the study area. Analyses of geophysical logs indicated that the deep aquifers south of the fault zone have been displaced from 350 to 400 feet, and that the deeper aquifers were not in hydraulic connection with the flow system north of the fault.

The ground-water resources of southeastern Louisiana are immense and the quality of ground water in Tangipahoa Parish is suitable for most uses. The freshwater aquifers of the southeastern Louisiana hydrologic system generally yield a soft sodium bicarbonate type water with dissolved-solids concentration of less than 300 mg/L. The quality of water in these aquifers generally meets the U.S. Environmental Protection Agency's standards for public supply.

The hydrologic system underlying Tangipahoa Parish and adjacent areas in 1990 supplied about 19 Mgal/d (million gallons per day) of water that was suitable for public supply. Based on the thickness and hydrologic characteristics of the aquifers in southern Tangipahoa Parish, it is estimated that a minimum of 28 Mgal/d could be withdrawn from a single well field. At the current (1990) rate of withdrawal, the hydrologic system appears to be approaching equilibrium. However, substantial increases in pumping from the aquifer system would result in renewed water-level declines throughout the hydrologic system until a new equilibrium is established.

A test well, Ta-576, located at the Bedico Community Center in southern Tangipahoa Parish, penetrated eight aquifers. Total thickness of freshwater sand beds penetrated by the 3,003-foot test hole was more than 1,900 feet. Resistivity values from an electric log of the test well typically averaged 200 ohm-meters, which indicated that the water has low dissolved-solids and chloride concentrations.

An analysis of the Abita aquifer at Ruddock in St. John the Baptist Parish, for two of three hypothetical well fields, indicated that for a hypothetical well field with a pumping rate of 112 Mgal/d, the freshwater-saltwater interface could arrive at the outer perimeter well in 10 to 14 years. The current (1990) location of the interface in the Abita aquifer is 1.9 miles from the southernmost part of the potential location of the 112 Mgal/d well field.

INTRODUCTION

In 1990, the Jefferson Parish Department of Water supplied 80 Mgal/d of potable water from its sole source, the Mississippi River, to approximately 468,400 people and industry (Lovelace, 1991). Saltwater intrusion from the Gulf of Mexico during periods of low flow and accidental spills of hazardous substances along the Mississippi River could cause the closing of the parish's raw-water intakes on the river. In addition, pesticides in agricultural runoff (Arcement and others, 1989; Goolsby and others, 1991) have caused mounting concerns about the long-term suitability of the Mississippi River as a source of public water supply.

In response to the above concerns, Jefferson Parish entered into cooperative agreements with the U.S. Geological Survey (USGS) for studies that would determine the availability, quantity, and quality of ground-water resources that could provide an emergency or alternative water supply. Two studies were completed as a result of these cooperative agreements. The first study by Dial and Tomaszewski (1988) focused on evaluation of ground-water resources in and immediately adjacent to northern Jefferson Parish. Results of this study indicated that increasing pumpage from the Gonzales-New Orleans aquifer by 50 Mgal/d would increase the rate of water movement at the freshwater-saltwater interface substantially, from 65 to 200 ft/yr, and would cause water levels to decline as much as 166 ft at some well sites. Results of this study indicated that the ground-water resources in and adjacent to Jefferson Parish had limited potential for further development.

The second study (described in this report) considered available ground-water resources of a larger area north of Jefferson Parish as an alternative water supply. This area included southern Tangipahoa Parish and parts of adjacent parishes.

Purpose and Scope

This report describes the hydrogeology and defines the southern limit of freshwater in the aquifers underlying southern Tangipahoa Parish, adjacent parishes, and northwestern Lake Pontchartrain. The report also presents the results of an analysis of the effects of pumping on the Abita aquifer at Ruddock (St. John the Baptist Parish), Louisiana. Included is a review of published reports and the results of a test-well drilling program (which included the construction of four wells), a water-quality sampling program, and an analysis of seismic survey data. Water-quality data presented for water samples collected from wells in the area include major inorganic constituents, trace elements, and organic compounds, including insecticides and herbicides. The use of seismic survey data to delineate faults in the study area is discussed.

Study Area

The study area includes northern St. John the Baptist Parish, southern Tangipahoa Parish, southwestern St. Tammany Parish, and the northwestern part of Lake Pontchartrain (fig. 1). The land surface of the study area consists of a series of sloping terraces that generally dip toward the gulf coast. The terrain bordering Lakes Pontchartrain and Maurepas and associated waterways includes swamps, marshes, and natural levees (Cardwell and others, 1967, p. 4). This study originally focused on the hydrologic system and the ground-water resources of St. John the Baptist Parish. As the study progressed and the limitations of the Abita aquifer to supply water in excess of 100 Mgal/d became apparent, the study area was expanded north to southern Tangipahoa Parish. The eight principal aquifers in the study area include the shallow, upper Ponchatoula, lower Ponchatoula, Abita, Covington, Tchefuncta, Hammond, and Amite.

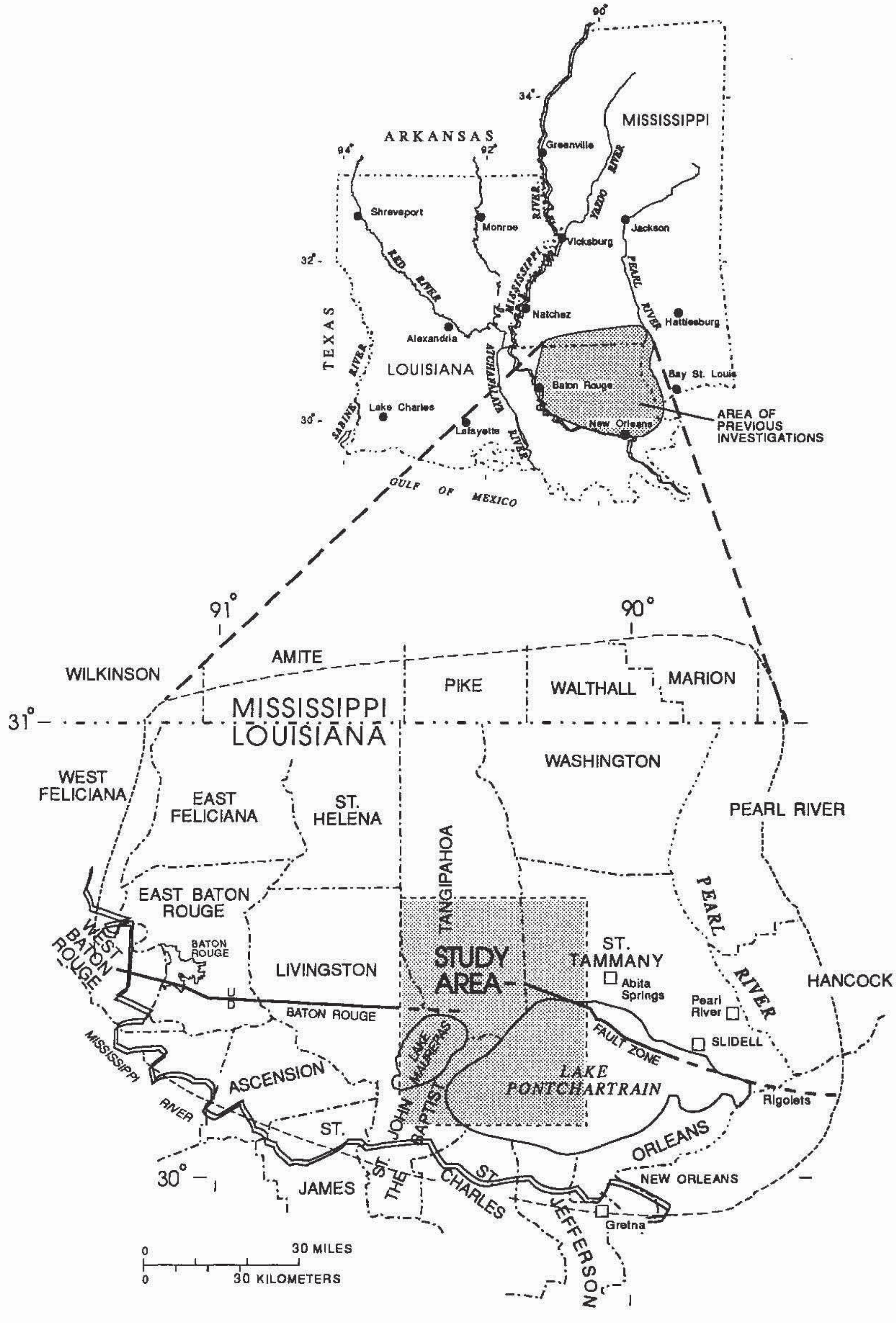


Figure 1. Location of study area in southeastern Louisiana.

3

Method of Study

Basic data on extent, thickness, water level, and water quality of the aquifers underlying southeastern Louisiana were obtained from previously published USGS reports. Additional data were collected for this study to supplement available data. Seismic geophysical data were used to determine the location of the Baton Rouge fault.

Four test wells were drilled to provide additional hydrogeologic data. Test wells were completed in compliance with Louisiana water-well regulations (Bolourchi, 1985). A suite of geophysical well logs were run on each test well to determine the characteristics of the sediments and to ensure proper well completion.

The four test wells were drilled using a mud-rotary water-well drilling rig. The wells were cased with standard-schedule steel casing, and the entire length of casing was grouted using the pump-down method. This procedure ensured hydraulic isolation of the screened aquifer, prevented migration of saline water in the annulus between the bore hole and well casing, and increased the structural integrity of the well casing and screen unit.

Ground-water quality was assessed by analyzing water samples from wells (fig. 2) completed in the eight principal aquifers in the study area. Water samples were collected from each well for analysis of inorganic constituents, trace elements, and volatile organic compounds; samples were collected from selected wells for analysis of insecticides, herbicides, and polychlorinated biphenyls (PCBs). Samples were collected using techniques described by Wershaw and others (1987). The samples were analyzed at a USGS laboratory, using the methods described by Fishman and Friedman (1989).

Previous Investigations

Reports from previous investigations of the geology, aquifer characteristics, water levels, and water quality in the study area were reviewed. Winner (1963) reported on results of a general reconnaissance of the hydrologic system underlying Livingston, St. Helena, St. Tammany, Tangipahoa, and Washington Parishes. The water resources of the eastern Lake Pontchartrain area were described in detail by Cardwell and others (1967). The test-well drilling program completed as part of the study by Cardwell and others provided information on the location of the fault zone in northern Lake Pontchartrain and the effect of the fault zone on the ground-water system. A comprehensive study of the ground-water resources of Tangipahoa and St. Tammany Parishes was completed by Nyman and Fayard (1978); their study described the hydrologic characteristics of each of the major aquifers that make up the aquifer system. Three reports discuss the effect of the Baton Rouge fault zone on the aquifers underlying East Baton Rouge Parish (Whiteman, 1979; Torak and Whiteman, 1982; Huntzinger and others, 1985). Other reports and scientific papers that provide additional background on relevant topics are listed in "Selected References."

Acknowledgments

The permission and assistance of the following property owners to drill test wells is gratefully acknowledged: Dorothy Schenk, the Dendinger and Dietz families, Wilbur Portier, and Bedico Community Center President, Lawrence Byers, who permitted access to the drill site at test well Ta-576. Mobil Exploration and Production, U.S. Inc., provided seismic geophysical data for the Baton Rouge fault zone.

Also, special thanks are due to Richard P. McCulloh, Research Geologist, Louisiana Geological Survey, who assisted in interpretation and analysis of well logs for the Baton Rouge fault zone, and David J. Macaluso, Director, Jefferson Parish Department of Public Utilities, who contributed significantly to the design and format of the report.

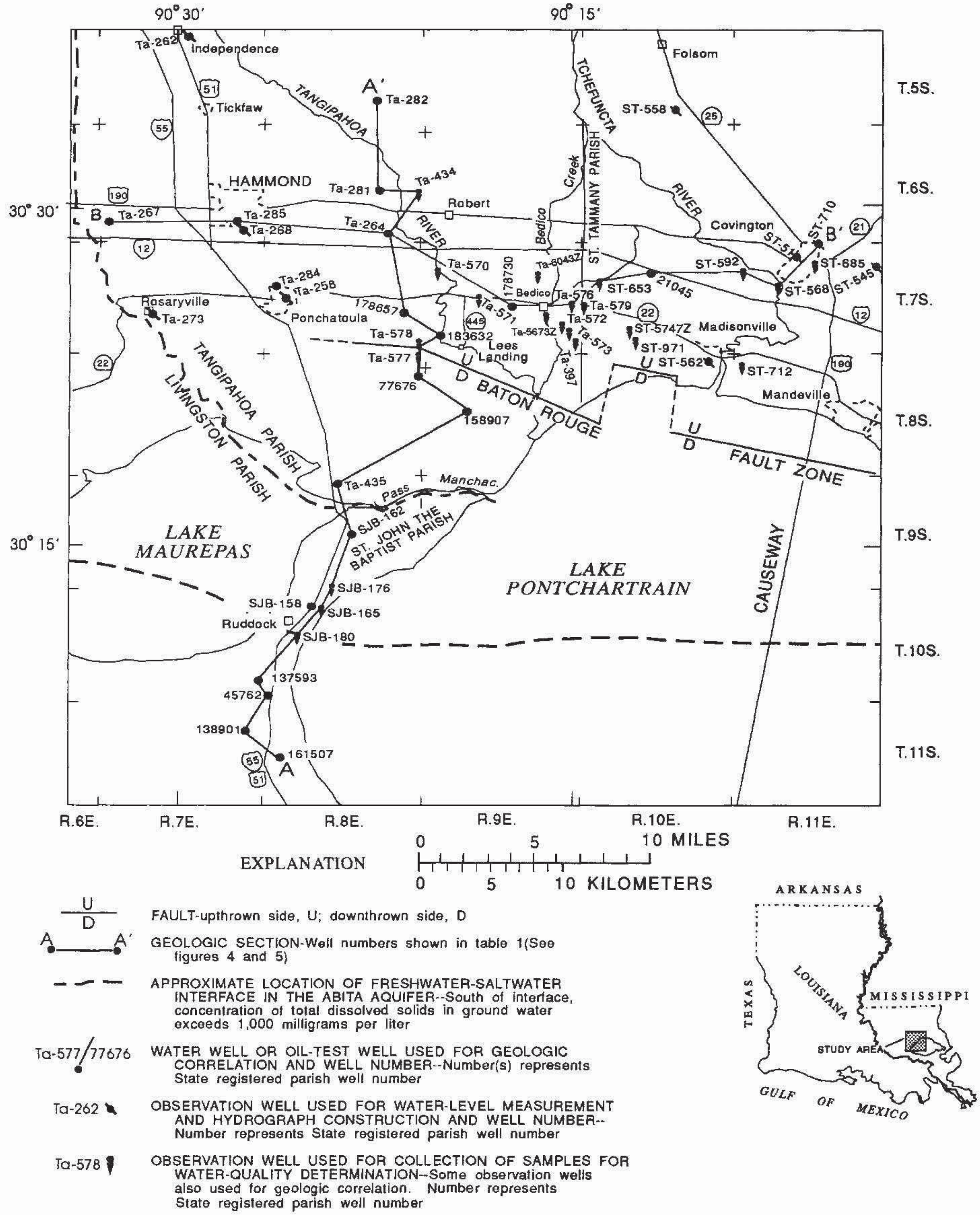


Figure 2. Water-quality sampling sites, hydrogeologic sections, Baton Rouge fault zone, major surface-water bodies, southern extent of freshwater in the Abita aquifer, and major municipalities.

HYDROGEOLOGIC SETTING

The study area lies within the Mississippi River Deltaic Plain and is underlain by sediments deposited during the Tertiary and Quarternary periods. The complex sequence of clay, sand, and gravel beds of southeastern Louisiana are part of a regional aquifer system and are typical of the aquifers and confining layers in the study area. Although the aquifers have a fairly uniform east-west strike, they can thin or thicken abruptly to the north or south (Cardwell and others, 1967, p. 10).

The aquifers underlying southeastern Louisiana primarily are recharged by water percolating through shallow Quarternary sands and gravels in southern Mississippi and southeastern Louisiana parishes bordering the Mississippi-Louisiana State line (fig. 3). Natural ground-water flow in the regional aquifer system generally moves from north to south. In the recharge area, some water flows vertically from shallower aquifers through the separating clay layers into the deeper aquifers. Downdip the hydraulic gradient is reversed, and higher hydraulic heads in the deeper aquifers allow some recharge of shallower aquifers by upward leakage through the confining clay layers. Aquifers deeper than 200 ft generally are confined; most wells completed in these aquifers will flow at land surface without pumping.

Eight aquifers underlie the study area (figs. 4 and 5). Information for wells used to construct hydrogeologic sections are included in table 1. Hydrogeologic units of the regional aquifer system are shown in figure 6. Dip rates of 20 to 80 ft/mi are common for fluvial sediments containing the aquifers in the study area, because of the original gradient at the time of deposition and downwarping of sediments in subsiding coastal basins. The rate of dip increases with depth and to the southeast, becoming about 100 ft/mi below a depth of 3,000 ft near Slidell, La. (Nyman and Fayard, 1978, p. 6).

BATON ROUGE FAULT

The Gulf Coastal Plain of the United States contains numerous faults. The Baton Rouge fault zone trends approximately west-northwest from a point just north of the Rigolets through southern West Baton Rouge Parish (fig. 1). Where it crosses the study area (fig. 2) the fault shows "increasing displacement with depth on the downthrown block as a result of movement contemporaneous with sediment accumulation" (McCulloh, 1991, p. 1), which is characteristic of a growth fault. The location of the fault zone generally coincides with the first appearance of saline water in the aquifers of intermediate depth of the regional hydrologic system.

Analysis of Seismic Data

The existence of the Baton Rouge fault zone in southeastern Louisiana has been known for some time (Fisk, 1944), but the effect of the displacement on ground-water movement generally is not well understood. The general location of the fault, along the northern border of Lake Maurepas and the northern part of Lake Pontchartrain in southern Tangipahoa Parish, was mentioned in an abstract by Durham and Peeples (1956). A more accurate determination of the fault-zone location was necessary to better evaluate the water-supply potential of the ground-water resource. Seismic data generated from oil and gas exploration by the petroleum industry during mapping of the sedimentary structures in the area provided the basic data necessary to locate the Baton Rouge fault (Scott Brodie, Mobil Exploration and Production, U.S. Inc., oral commun., 1989). Deep seismic data were not available for viewing by USGS personnel, but shallow seismic data (from 0 to 8,000 ft below land surface) were used to identify the displacement of sedimentary layers, which is characteristic of faulting. Location of the Baton Rouge fault at land surface was based on estimates of the dip and strike of the fault from the seismic data. Local geophysical well logs, driller's log information, and water-quality data were utilized to further refine the estimated location of the Baton Rouge fault in the study area.

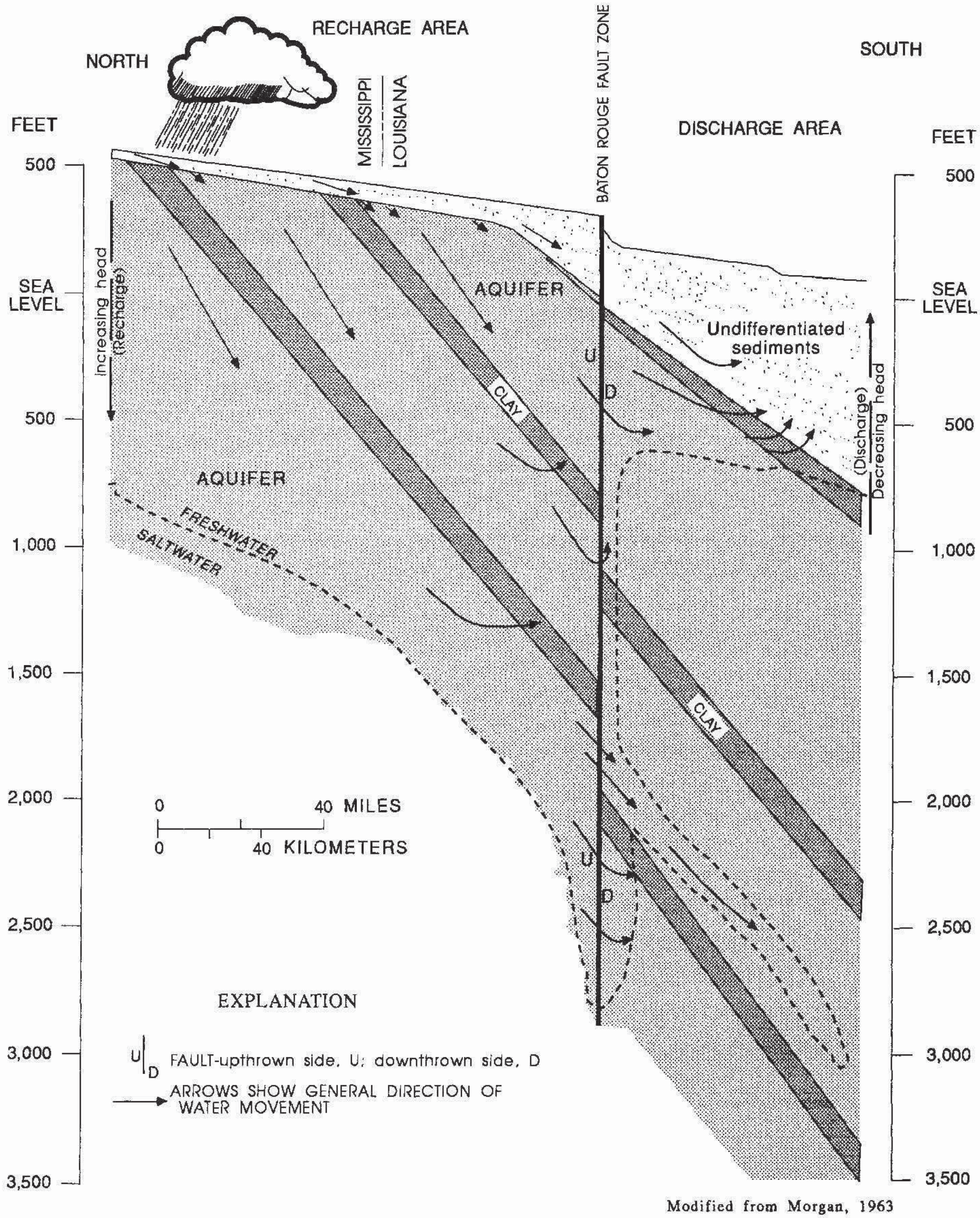


Figure 3. Generalized hydrogeologic section showing simplified view of the regional aquifer system, including recharge, ground-water flow, and discharge.

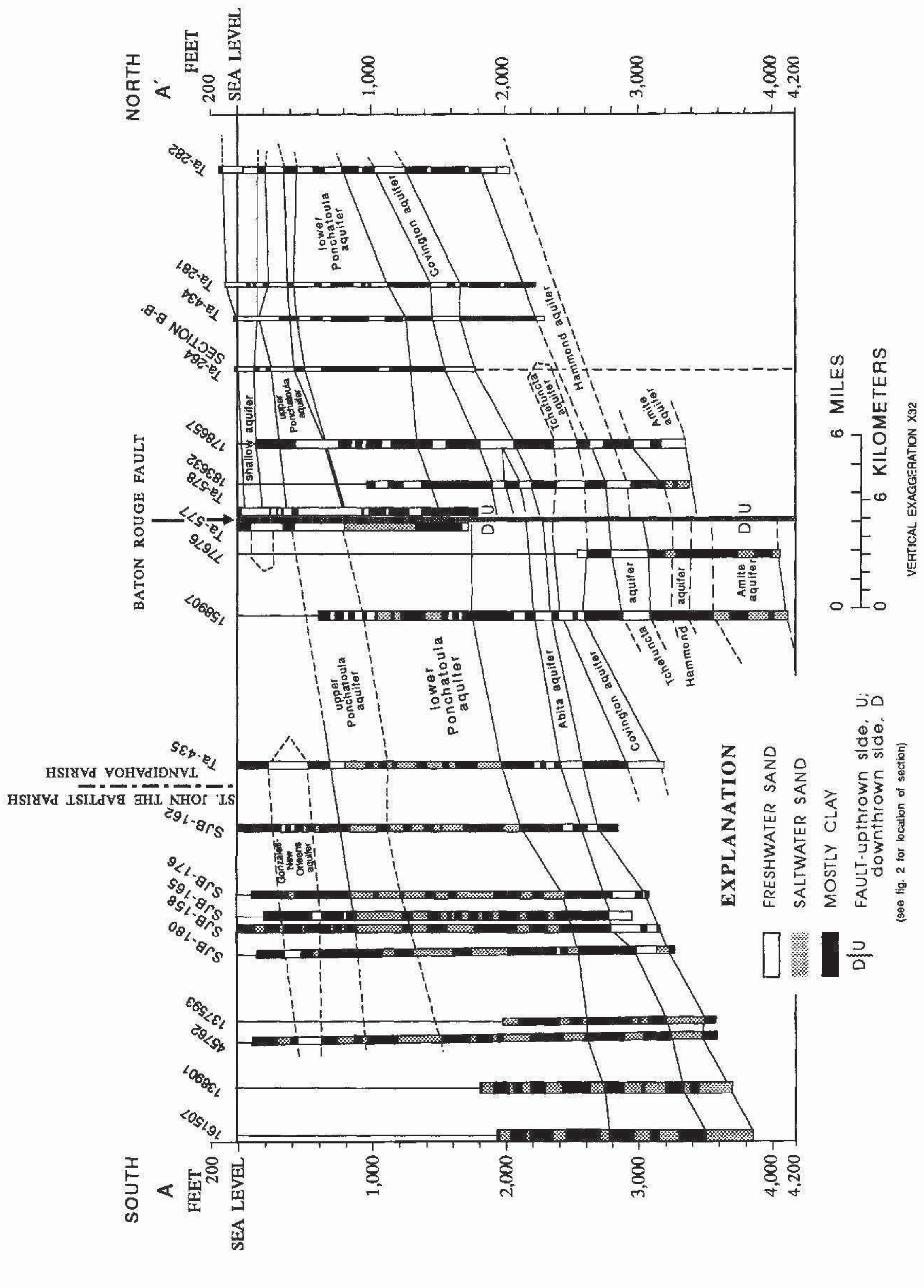


Figure 4. Hydrogeologic section A-A′.

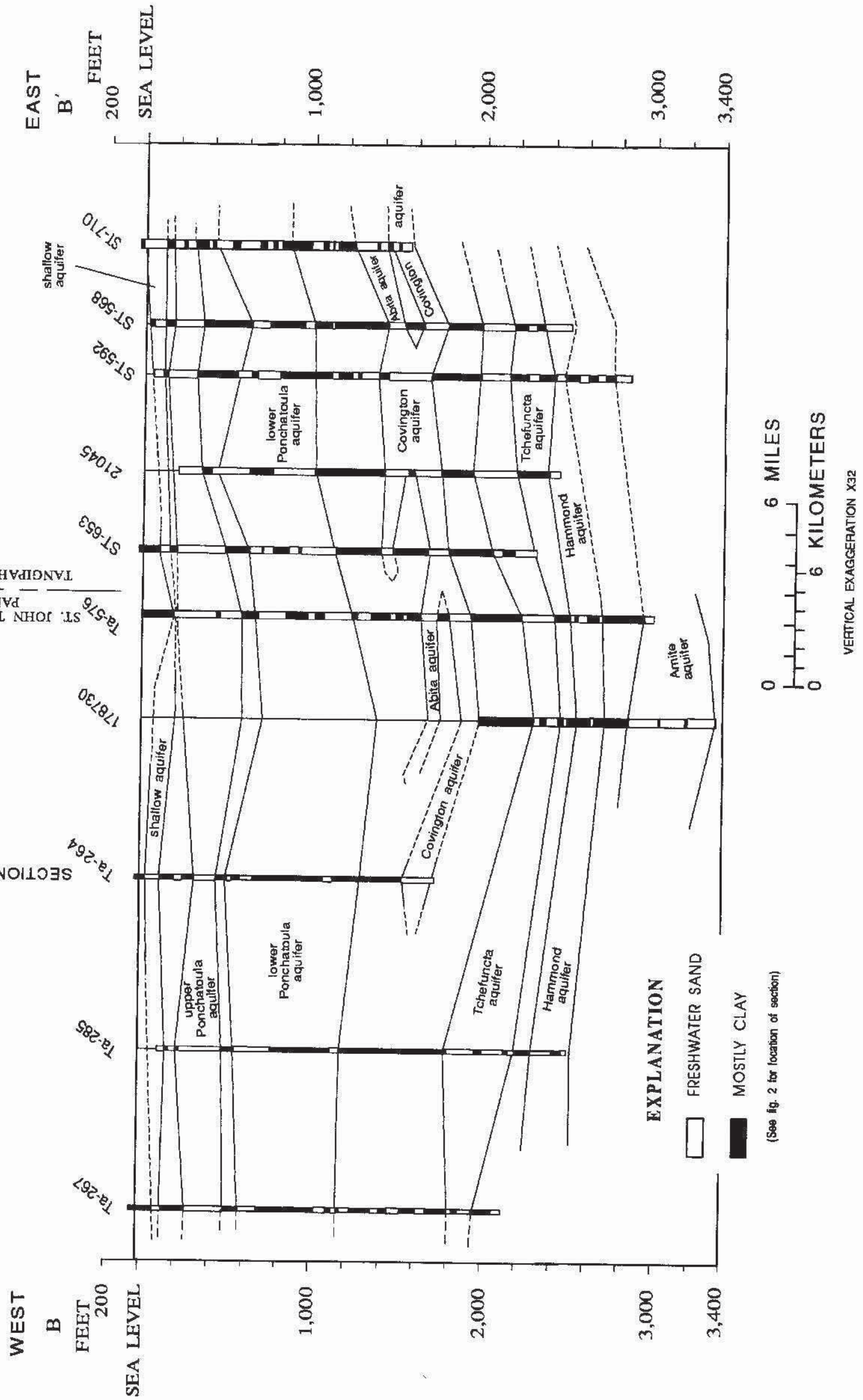


Figure 5. Hydrogeologic section B-B′.

After the location of the Baton Rouge fault in the study area was determined, the USGS completed two test holes (Ta-577 and Ta-578) that bracketed the location of the fault (fig. 2). The well logs for each test hole included dual induction, focused resistivity, spontaneous potential (SP), and natural gamma ray logs. The dual induction and focused resistivity logs were used as water-quality indicators. The deflection in their respective traces was compared and related to known ground water-quality characteristics in the area. The SP log was used to delineate changes in lithology. The natural gamma ray log was used for lithologic determination when the SP was unable to provide conclusive lithologic contacts.

Table 1. Water and oil-test wells in sections A-A′ and B-B′

[Water well identified by parish and number; oil or gas well identified by serial number; SJB, St. John the Baptist Parish; Ta, Tangipahoa Parish; ST, St. Tammany Parish]

Well number	Section, township, range	Total depth drilled (feet)	Year completed
	South-north section A-A′		
161507	7 11S 8E	9,047	1978
138901	1 11S 7E	9,684	1971
45762	25 10S 7E	10,500	1952
137593	24 10S 7E	10,175	1971
SJB-180	7 10S 8E	3,320	1990
SJB-158	5 10S 8E	3,199	1971
SJB-165	5 10S 8E	3,054	1974
SJB-176	33 9S 8E	3,089	1985
SJB-162	15 9S 8E	2,853	1971
Ta-435	33 8S 8E	3,180	1971
158907	8 8S 9E	19,137	1978
77676	36 7S 8E	9,250	1960
Ta-577	25 7S 8E	1,702	1990
Ta-578	25 7S 8E	1,801	1990
183632	47 7S 9E	7,952	1982
178657	14 7S 8E	15,255	1982
Ta-264	39 6S 8E	1,752	1954
Ta-434	13 6S 8E	2,319	1970
Ta-281	37 6S 8E	2,290	1963
Ta-282	15 5S 8E	2,136	1963
	West-east section B-B′		
Ta-267	25 6S 6E	2,169	1956
Ta-285	23 6S 7E	2,516	1964
Ta-264	39 6S 8E	1,728	1954
178730	10 7S 9E	9,055	1981
Ta-576	38 7S 9E	3,000	1990
ST-653	31 6S 10E	2,305	1965
21045	33 6S 10E	2,510	1938
ST-592	31 6S 11E	2,843	1965
ST-568	41 6S 11E	2,540	1958
ST-710	22 6S 11E	1,506	1969

Period	Aquifer system/confining unit	Aquifer[1]		
		Baton Rouge area	Tangipahoa, St.Tammany, St. John the Baptist, and Washington Parishes	New Orleans area and lower Mississippi River parishes
Quaternary	Chicot equivalent/southeast Louisiana	"400-foot" sand "600-foot" sand	shallow upper Ponchatoula	Gramercy Norco Gonzales-New Orleans "1,200-foot" sand
Tertiary	Evangeline equivalent/southeast Louisiana	"800-foot" sand "1,000-foot" sand "1,200-foot" sand "1,500-foot" sand "1,700-foot" sand	lower Ponchatoula Big Branch Kentwood Abita Covington Slidell	no freshwater
	unnamed confining unit			
	Jasper equivalent/southeast Louisiana	"2,000-foot" sand "2,400-foot" sand "2,800-foot" sand	Tchefuncta Hammond Amite Ramsay	
	unnamed confining unit			

Modified from J.K.Lovelace (1991)

[1] Clay units separating aquifers in southeastern Louisiana are discontinuous and unnamed.

Figure 6. Hydrogeologic units in southeastern Louisiana.

Effects of the Fault

Data from test wells Ta-577 and Ta-578 indicate a substantial downward displacement of the aquifers in the downthrown block south of the fault zone relative to the aquifers north of the fault zone. The aquifers south of the fault zone of intermediate depth that correlate to the lower Ponchatoula aquifer north of the fault zone contain ground water with higher chloride concentrations. Aquifers in the downthrown block also have lower water levels than would be expected for aquifers of similar depth in southern Tangipahoa Parish. Thus, the Baton Rouge fault zone has affected ground-water quality and flow in the aquifers of southern Tangipahoa Parish.

Displacement of Sediments by the Fault

Well Ta-577 was drilled south of the Baton Rouge fault and penetrated alternating layers of soft clay and sand (0 to 890, 902 to 1,105, and 1,148 to 1,290 ft below land surface) and thinner layers of pea gravel (890 to 902 and 1,105 to 1,148 ft below land surface). The clay became substantially harder at 1,290 ft and generally predominated to 1,650 ft below land surface, but was interspersed with thin lenses of sand. The top of a sand was reached at 1,650 ft below land surface and the bottom of this sand occurred at a depth of 1,702 ft below land surface.

Sediments penetrated in well Ta-578 were soft clay and fine- to medium-grained sand to a depth of 800 ft. Coarse sand was present from 800 to 865 ft; fine and medium sand and soft clay was present from 865 to 1,080 ft. At approximately 1,080 ft, the clay became substantially harder and was resistant to drilling. The base of the last major sand was at a depth of approximately 1,285 ft with streaky clay present to a total depth of 1,801 ft.

Displacement of sediments by the fault can be estimated by careful analysis of the clay confining units at test wells Ta-577 in the downthrown block and Ta-578 in the upthrown block. The clay layer at approximately 295 ft in well Ta-578 corresponds to a comparable clay layer at 410 ft in well Ta-577. Similarly, the clay layer at 430 ft in well Ta-578 is comparable to a clay layer at 560 ft in well Ta-577. Correlation of these layers indicated a displacement of about 125 ft. In the Baton Rouge metropolitan area, there is 200 ft of displacement at the Baton Rouge fault zone in sands at a depth of about 350 ft (Whiteman, 1979). Additional correlation of the clay layer at 950 ft in well Ta-578 and the clay layer at 1,280 ft in well Ta-577 indicated an increase in displacement of approximately 330 ft.

A sand located at a depth of approximately 1,250 ft in well Ta-578 in the upthrown block corresponds to a sand at a depth of 1,650 ft in well Ta-577 in the downthrown block; this indicates a displacement of approximately 390 to 400 ft. The vertical displacement of about 400 ft in well Ta-577 at a depth of 1,650 ft is 275 ft more than the vertical displacement in the same well at a depth of 560 ft, or 1,000 ft shallower.

Increasing displacement with depth is a characteristic of growth faults. Durham and Peeples (1956) reported that displacement of sedimentary layers was relatively consistent beneath deposits of Pleistocene age--about 350 ft above a depth of 2,000 ft, with displacement increasing to about 450 ft at depths of 5,000 to 10,000 ft. Based on the analysis of logs from nearby oil test-wells north and south of test wells Ta-577 and Ta-578, the maximum displacement is about 500 ft at a depth of about 7,000 ft. Previous studies of the Baton Rouge fault zone indicate that the fault is probably a rejuvenated zone that was last active in the early- to middle-Tertiary period (McCulloh, 1991). The significant displacement in the study area of 350 to 450 ft within the first 5,000 ft agrees with what generally exists at other locations along the fault zone. These large displacements in the sediments at depths of 100 to 5,000 ft have resulted in a disruption of flow in major aquifers of the hydrologic system adjacent to the Baton Rouge fault.

Water Quality in Wells Ta-577 and Ta-578

South of the Baton Rouge fault, the lower Ponchatoula aquifer can be found at an intermediate depth in the freshwater section of the hydrologic system, and contains saline water. The log of well Ta-578 shows high-resistivity freshwater in all sand beds 20 ft or thicker (fig. 7). The log of well Ta-577, located south of the mapped location of the fault zone, shows high-resistivity freshwater in all sand beds 20 ft or thicker to a depth of approximately 760 ft (fig. 7). Although the natural gamma ray curve shows a sand bed below 770 ft, the resistivity has decreased to 9 ohm-meters, thus indicating that the sand contains saline water (fig. 7). The low resistivity of sand beds indicated by the well log corresponds to the first occurrence of saline water in sand beds of intermediate depth in the southern reaches of the hydrologic system.

Well Ta-577, 0.25 mi south of the fault, was screened (from 1,114 to 1,134 ft) in a low-resistivity sand bed that contained water with a specific conductance of 4,720 μS/cm and dissolved-chloride concentration of 1,300 mg/L (appendix). High chloride concentrations were first detected from sand beds of intermediate depth of 770 ft in well Ta-577 (fig. 7). All sand beds below 770 ft in well Ta-577 contain saline water. Water from the screened section of well Ta-578 (from 800 to 840 ft) 0.25 mi north of the fault zone had a significantly lower average specific conductance (245 μS/cm) than water from well Ta-577. Water from well Ta-578 had a dissolved-chloride concentration of 2.0 mg/L, which is significantly less than the dissolved-chloride concentration of 1,300 mg/L in water from well Ta-577.

Water Levels Adjacent to the Fault Zone

The water level in well Ta-578, which is 0.25 mi north of the fault zone and completed in a freshwater aquifer at a depth of about 800 ft, is about 33 ft above sea level. The water level is about 43 ft above sea level in well Ta-6043Z, located about 6 mi northeast of well Ta-577 and completed at a depth of 1,187 ft. These water levels are typical for Louisiana aquifers at these depths (Nyman and Fayard, 1978).

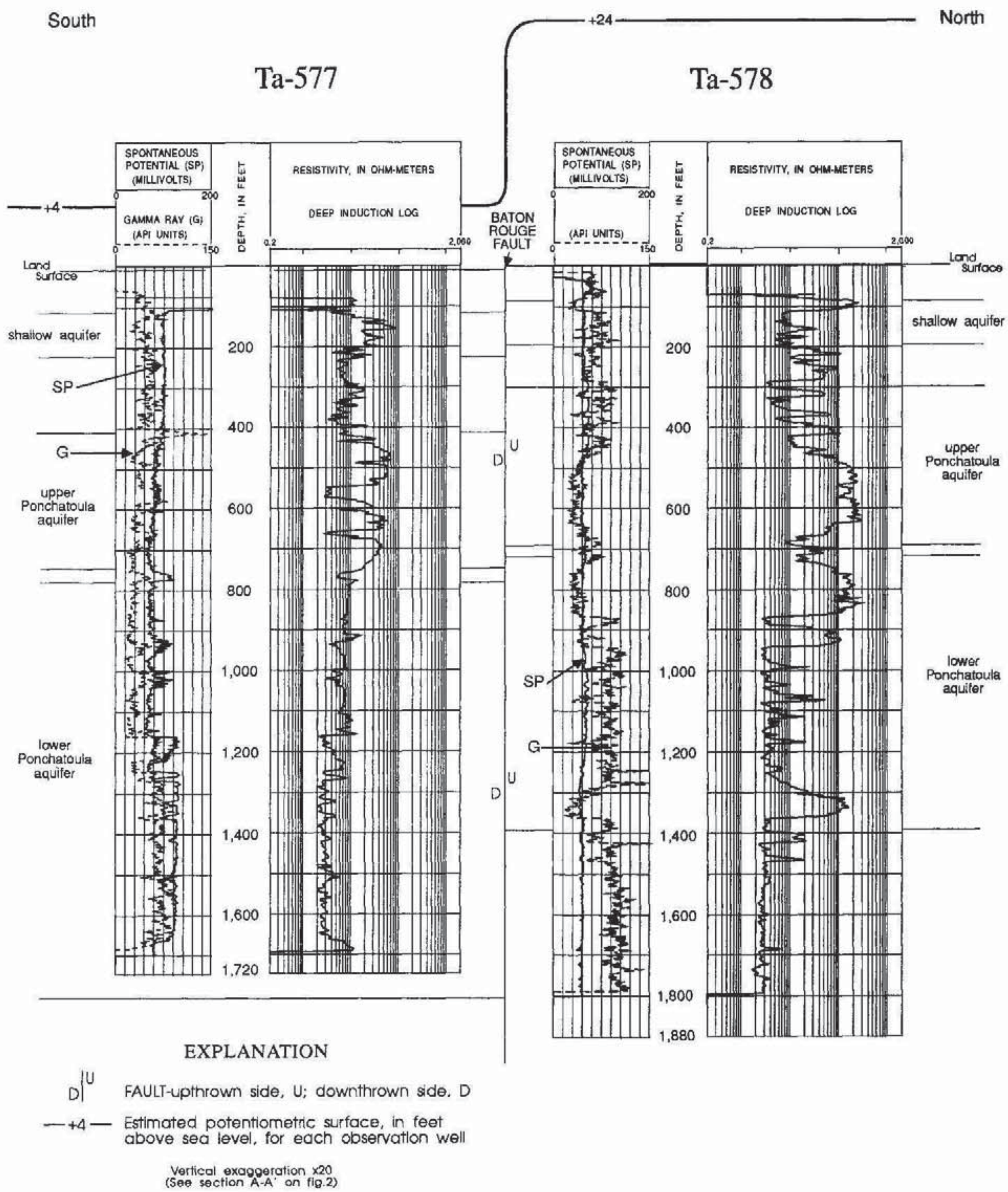


Figure 7. South-north hydrogeologic section showing geophysical logs of wells Ta-577 and Ta-578 and the effects of the Baton Rouge fault.

In contrast to the water levels in aquifers north of the fault zone, the water level in well Ta-577, which is 0.25 mi south of the fault zone and completed in a saline aquifer at a depth of 1,114 ft, is 8.2 ft above sea level. This water level is only 4.0 ft above land surface, indicating that the hydraulic pressure of the aquifer is only slightly elevated above what might be expected for a normally pressured aquifer for that depth. The unusually low hydraulic head in well Ta-577, completed in the downthrown side of the fault zone, is a result of the fault almost totally isolating the aquifers of intermediate depth south of the fault zone from hydraulic connection with the freshwater aquifers north of the fault zone. The slightly elevated water levels of those aquifers of intermediate depth could be accounted for by leakage from overlying and underlying aquifers. Water levels in the aquifers of intermediate depth may be elevated without having a direct hydraulic connection to the aquifer system north of the fault due to leakage across the clay confining units that separate the aquifers.

Hydrogeologic section A-A′ (fig. 4) shows that many of the sand beds in the lower Ponchatoula aquifer of well Ta-577 are not adjacent to freshwater sand in the same aquifer across the fault, and thus are prevented from being flushed by freshwater of the hydrologic system north of the fault zone. The presence of saline aquifers (penetrated by well Ta-577) above 950 ft and adjacent to freshwater aquifers (penetrated by well Ta-578) north of the fault zone indicates that the fault in the study area at these depths acts as a total or partial barrier to flow of ground water. This conclusion is supported by the findings of earlier studies of the Baton Rouge fault zone in localities such as the Baton Rouge metropolitan area. In a study of the Baton Rouge fault and its effect on the aquifer system in the Baton Rouge area, Rollo (1969), determined that the fault was not an effective barrier to ground-water flow above the "600-foot" aquifer but formed a more effective barrier to ground-water flow at depths greater than 600 ft.

GROUND-WATER RESOURCES

The ground-water resources of southeastern Louisiana are immense. Eight of the aquifers in southern Tangipahoa Parish at the site of test well Ta-576 collectively contain 1,900 ft of sand, indicating these aquifers are a potential source of freshwater for public supply. Water in these sands generally is of an acceptable quality for public supply. Selected water-quality characteristics of ground water in Tangipahoa Parish are summarized in the following table (data are from USGS files):

Constituent or property	Equivalent aquifer system			Test well
	Chicot	Evangeline	Jasper	Ta-576
Dissolved solids (milligrams per liter)	154-164	149-188	169-257	188
Iron (milligrams per liter)	0.05-0.5	0.02-0.5	0.01-0.1	0.04
Hardness (milligrams per liter)	13-33	10-98	2-5	0-1
pH	7.5-8.1	7.3-8.8	6.9-8.2	8.8
Color (platinum-cobalt units)	0-15	0	0-5	0

Hydrogen sulfide is present in low concentrations in ground water at some localities but generally is below the level detectable by most people.

Aquifers of Southern Tangipahoa Parish

Eight major aquifers consisting of thick sand units that underlie the study area are, in descending order, the shallow, upper Ponchatoula, lower Ponchatoula, Abita, Covington, Tchefuncta, Hammond, and Amite (fig. 6). The aquifers can be grouped into three systems: the Chicot equivalent/southeast Louisiana aquifer system, the Evangeline equivalent/southeast Louisiana aquifer system, and the Jasper equivalent/southeast Louisiana aquifer system. The Baton Rouge fault zone tends to disrupt the natural north-south flow of ground water in southern Tangipahoa Parish; therefore, the area north of the fault zone has the greatest potential source of ground water.

Chicot Equivalent/Southeast Louisiana Aquifer System

Hydrogeology

The Chicot equivalent aquifer system consists of the shallow and the upper Ponchatoula aquifers (fig. 6). The shallow aquifer consists of sand and gravel deposits underlying the upland terraces and flood plain deposits of major streams. Locally, the shallow aquifer can contain a large percentage of silt and clay, resulting in widely varying well yields. Transmissivities for the shallow aquifer ranging from 9,400 to 46,000 $[(ft^3/d)/ft^2]ft$ and hydraulic conductivities ranging from 70 to 140 $(ft^3/d)/ft^2$ were estimated from seepage-runs along the Tangipahoa River main channel (Nyman and Fayard, 1978, p. 14).

The upper Ponchatoula aquifer consists of extensive deposits of sand and gravel and typically is 200 to 300 ft thick, but thins southward. The upper Ponchatoula is thickest in the vicinity of Tickfaw and Hammond, La., and thins to about 200 ft at Ponchatoula, La. An aquifer test conducted at well Ta-284 indicated that transmissivity of the upper Ponchatoula is 27,000 $[(ft^3/d)/ft^2]ft$ and hydraulic conductivity is about 180 $(ft^3/d)/ft^2$. (See Nyman and Fayard, 1978.) At well Ta-576 (fig. 2) the upper Ponchatoula and shallow aquifers combine to form a massive sand unit that is more than 350 ft thick (including interfingered clay stringers).

Water Quality

Water quality in the shallow aquifer generally is suitable for most uses, as indicated by analyses of water from wells Ta-572 and Ta-573 (appendix). Temperature was as low as 21 °C, and pH ranged from 7.0 to 7.6. Hardness of water from wells Ta-572 and Ta-573 was 13 and 33 mg/L. Iron (dissolved) concentrations were 0.05 mg/L in well Ta-573 and 0.11 mg/L in well Ta-572, and dissolved-solids concentrations averaged 162 mg/L.

Water quality in the upper Ponchatoula aquifer generally is excellent for most uses, although hydrogen sulfide can be present locally in concentrations as high as 0.5 mg/L (Nyman and Fayard, 1978, p. 26). Temperature, pH, and hardness averaged 21 °C, 7.4, and 16 mg/L, respectively. Color of water in a sample from well ST-712 was 15 platinum-cobalt units, which was the highest color measured in wells sampled, and is typical of wells completed in the upper Ponchatoula aquifer. The quality of water in these aquifers generally meets the U.S. Environmental Protection Agency's (USEPA) standards for public supply (U.S. Environmental Protection Agency, 1986).

Pumping and Water Levels

Pumping from the shallow aquifer by small public facilities, small water systems, and schools account for the estimated 1.0 Mgal/d withdrawn for public supply (1991). Withdrawals for agriculture, small industrial facilities, and rural domestic use were not estimated but probably are substantially higher. Pumping from the upper Ponchatoula totaled approximately 0.9 Mgal/d in 1990 (Lovelace, 1991). Water levels in the upper Ponchatoula aquifer declined during 1940-76 at an average rate of

approximately 0.1 to 0.2 ft/yr. Water-level data are not available after 1976, but based on the relatively large size of this ground-water resource and the estimated small increase in daily pumping since 1975, the rate of water-level decline probably has not increased substantially.

Estimated potential yield from the upper Ponchatoula at test well Ta-576 was 9 Mgal/d. This pumpage was estimated to result in a 26-foot decline in water level in the aquifer at a 1,000-foot radius from the pumped well after 1 yr of continuous pumping. The method used to determine these withdrawal and drawdown estimates is discussed in a later section, "Potential for Development."

Evangeline Equivalent/Southeast Louisiana Aquifer System

Hydrogeology

The lower Ponchatoula, Kentwood, Abita, and Covington aquifers are included in the Evangeline equivalent aquifer system. The lower Ponchatoula aquifer generally is more continuous than the upper Ponchatoula but the sands tend to be thinner and the sand grains are finer. Thickness of sands commonly are less than 100 ft, although at test well Ta-576 one sand was 200 ft thick. This aquifer generally consists of medium sand, but locally gravel also might be present. Estimated hydraulic conductivities, based on grain size, range from 35 to 65 $(ft^3/d)/ft^2$.

The Kentwood aquifer of northern Tangipahoa and western Washington Parishes bifurcates downdip into the Abita and Covington aquifers (fig. 8). In the southeastern part of St. Tammany Parish, the Covington aquifer (fig. 8) bifurcates into the Covington aquifer and the underlying Slidell aquifer (Nyman and Fayard, 1978, p. 30). The Abita and Covington aquifers underlie the study area. Although the Abita aquifer generally is continuous throughout the study area, it may be absent locally (Nyman and Fayard, 1978). South of the Baton Rouge fault zone this aquifer has been down-faulted and abuts the Covington aquifer north of the fault zone. The Abita aquifer can vary widely in thickness but is typically 50 to 100 ft thick north of the Baton Rouge fault zone and 150 to 300 ft thick south of the fault zone. The Abita aquifer is 80 ft thick at well Ta-576. Sand in the aquifer ranges from medium to coarse grained; coarse sand with some small gravel occurs at 1,659 ft. Transmissivities for this aquifer, north of the Baton Rouge fault zone, range from 10,000 to 13,000 $[(ft^3/d)/ft^2]ft$ (Nyman and Fayard, 1978, p. 34). Transmissivities, south of the fault zone, are estimated to range from 20,000 to 40,000 $[(ft^3/d)/ft^2]ft$, based on aquifer thickness and estimated hydraulic conductivity.

The Covington aquifer is continuous through most of the study area and is an important source of water across much of the southern half of the southeast Louisiana hydrologic system. As with the Abita aquifer, the Covington aquifer is hydraulically connected to the Kentwood aquifer (fig. 8). The Covington aquifer has been displaced 350 to 400 ft along the Baton Rouge fault zone. As a result, the freshwater sand beds north of the Baton Rouge fault zone are adjacent to a younger, mostly clay unit on the south side of the fault zone, and freshwater sand beds south of the fault zone are adjacent to older, freshwater sands of the Tchefuncta aquifer on the north side of the fault zone. The thickness of the Covington aquifer ranges from 100 to 200 ft across the study area north of the Baton Rouge fault zone and is presumed to be thicker south of the fault. The Covington aquifer was determined to be 155 ft thick at well Ta-576. The coarse sand sampled from the Covington aquifer at well Ta-576 was typical of the aquifer across the region. Transmissivities for this aquifer typically average 27,000 $[(ft^3/d)/ft^2]ft$, and hydraulic conductivities about 220 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978).

Water Quality

The water quality of the lower Ponchatoula aquifer generally is suitable for public supply; although, as is typical of the deeper aquifers in the study area, hydrogen sulfide can be present locally in concentrations as high as 0.5 mg/L. Temperature of water in wells completed in the lower Ponchatoula aquifer in

the study area ranged from 21 to 26 °C. Color was not detected in water from these wells; pH ranged from 6.9 to 7.7; and hardness averaged 5.5 mg/L. The quality of water in well Ta-579, which supplies water to the Bedico Community Center, is typical of wells completed in this aquifer. Of all wells sampled in the study area, water from this well had the lowest sodium concentration (37 mg/L).

Waters in the Abita and Covington aquifers are similar in chemical composition. Temperature of water in well Ta-576 completed in the Covington aquifer was 29 °C. Iron concentrations in water from the Covington aquifer can be as high as 3 mg/L, and manganese is present at concentrations of 0.1 mg/L or less in water from most wells completed in this aquifer. In the study area, however, iron concentrations in water from the Covington aquifer ranged from less than 0.02 to 0.24 mg/L. Water from well Ta-576 had an iron concentration of 0.04 mg/L and a chloride concentration of 3.0 mg/L. Water from the Abita and Covington aquifers typically have dissolved solids concentrations that range from 50 to 400 mg/L, and pH values that range from 6.5 to 9.0. Hydrogen sulfide is present locally in water from these

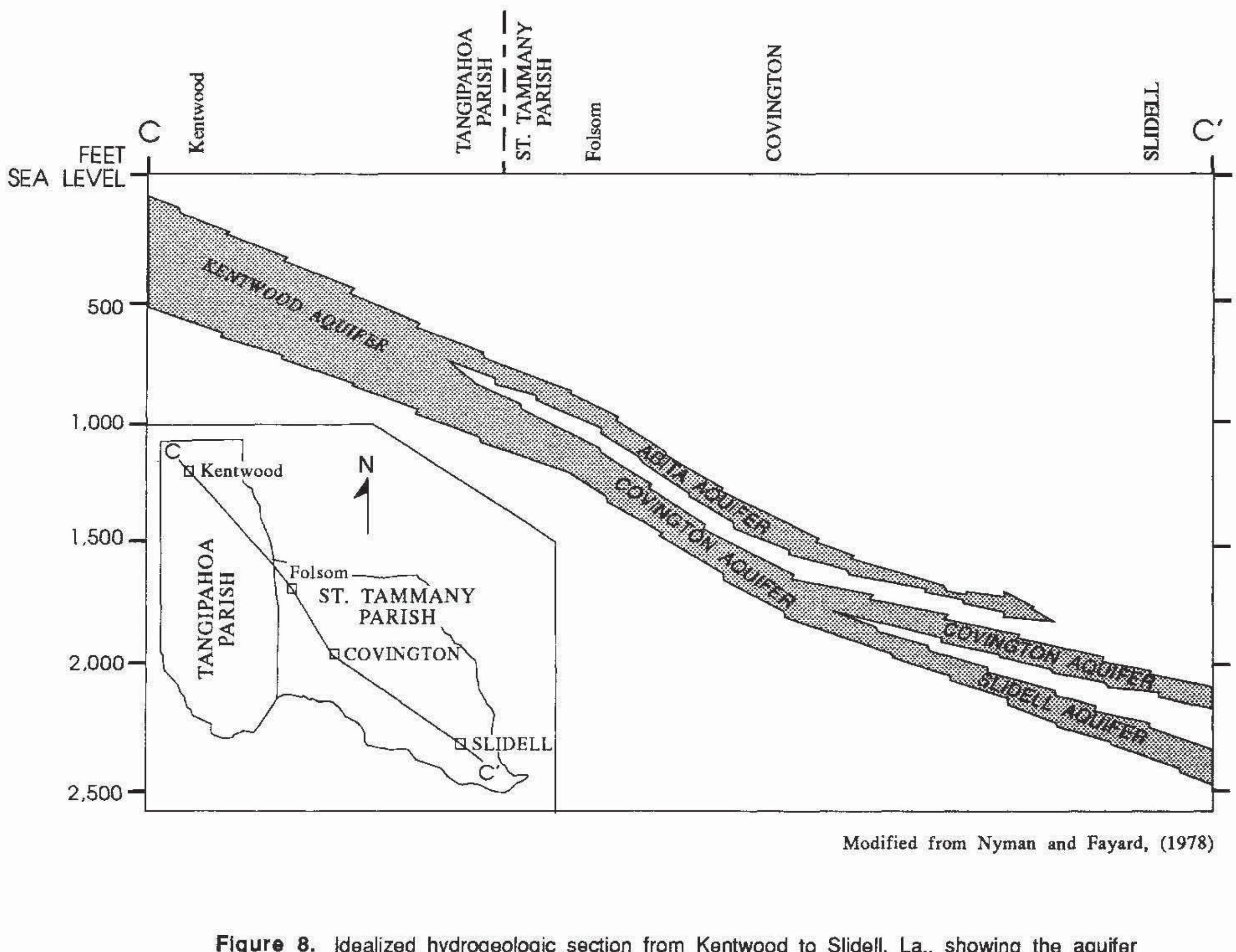


Figure 8. Idealized hydrogeologic section from Kentwood to Slidell, La., showing the aquifer units that are hydraulically connected to the Kentwood aquifer.

aquifers but usually at concentrations less than 0.5 mg/L. (See Nyman and Fayard, 1978.) In the study area, no water wells completed in the Abita aquifer were available for sampling. The quality of water in these aquifers in other areas, however, generally meets the USEPA standards for public supply (U.S. Environmental Protection Agency, 1986).

Water from wells SJB-165, SJB-176, Ta-576, and Ta-579, completed in the Evangeline equivalent aquifer system, were analyzed for the synthetic organic compounds listed in table 2 in addition to the analyses listed in the appendix. With the exception of heptachlor, these organic compounds were below detection limits for all wells sampled; heptachlor was detected in water from well SJB-165 at 0.01 µg/L, the lowest detectable level.

Pumping and Water Levels

Pumping from the lower Ponchatoula aquifer is estimated to be less than that from the upper Ponchatoula aquifer; continuous historic records were not available for this aquifer within the study area. Pumpage from the lower Ponchatoula aquifer for public supply in 1991 was estimated to be about 0.7 Mgal/d.

Data for well ST-449 at Abita Springs, La., indicated average water-level declines of approximately 0.2 ft/yr for the period 1950-67. The rate of decline decreased in 1967, and water levels began to rise in 1972.

Estimated potential yield from the lower Ponchatoula aquifer at test well Ta-576 were 2 Mgal/d. This pumping is estimated to result in a 15-foot decline in water level in the aquifer at a 1,000-foot radius from the pumped well after 1 yr of continuous pumping. The method used to determine these withdrawal and drawdown estimates is discussed in the section, "Potential for Development."

Pumping from the Abita aquifer is moderate compared to pumping from other aquifers in the study area. Total public-supply and industrial pumpage for this aquifer in southeastern Louisiana is estimated to be 1.0 Mgal/d (1991), but pumpage in the study area is estimated at only 0.3 Mgal/d (1991). The hydrograph of well ST-545 indicates a relatively uniform water-level decline of 1 to 2 ft/yr (fig. 9). Water levels in well ST-51, located 0.20 mi from public supply well ST-57, experienced an erratic but similar 1 to 2 ft/yr decline averaged over a 28-year period. The sharp decline in water level and associated decreased rate of water-level decline after 1953, shown in the hydrograph of ST-51, probably results from pumping interference from public supply well ST-57. Estimated potential yield from the Abita aquifer at test well Ta-576 is 4 Mgal/d, based on estimates and assumptions discussed in the section, "Potential for Development." It is estimated that the withdrawal of 4 Mgal/d will result in a 62-foot decline in water level in the aquifer at a 1,000-foot radius from the pumped well after 1 yr of continuous pumping (Lovelace, 1991)

Pumpage from the Covington aquifer in the study area totaled an estimated 1.5 Mgal/d for 1990. This aquifer is used throughout the region because it contains water of uniformly high quality. Water levels in the aquifer are affected by pumping centers outside the study area. Public supply well Ta-258, at Ponchatoula, La., had a 1.2 ft/yr rate of decline in water levels from 1945 to 1974 (fig. 10). The accelerated water-level decline for the period 1954-65 followed by a sharp recovery at well Ta-258 corresponds to a period of increasing demand that was followed by the installation of a new public-supply well to meet the city of Ponchatoula's increasing water demands. After installation of public-supply well Ta-284, the local water-level decline of 1.2 ft/yr was observed at public supply well Ta-258. Water levels in well ST-562, at Madisonville, La., declined at a rate of 1.7 ft/yr over a 27-year period (fig. 10). Potential yield from the Covington aquifer at Ta-576 is estimated to be 3 Mgal/d, based on estimates and assumptions discussed in the section, "Potential for Development." It is estimated that a withdrawal of 3 Mgal/d will result in a 14-foot decline in water level at a 1,000-foot radius after 1 year of pumping.

Table 2. Detection limits for analyzed synthetic organic compounds

[Level of detection in water is in micrograms per liter]

Compound	Lowest level of detection	Compound	Lowest level of detection
Volatile organic compounds			
Benzene	0.27	Trichlorofluoromethane	0.2
Bromoform	.2	1,1-Dichloroethylene	.2
Carbon tetrachloride	.2	1,2-Dibromoethylene	.2
Chlorobenzene	.2	1,1,2-Trichloroethane	.2
Chloroethane	.2	1,1,2,2-Tetrachloroethane	.2
Chloromethane	.2	Dichlorodifluoromethane	.2
Dibromochloromethane	.2	1,2 Dichloroethane	.2
1,1-Dichloroethane	.2	1,2-Dichloropropane	.2
Ethylbenzene	.2	1,3-Dichloropropene	.2
Methyl bromide	.2	1,2-Transdichloroethylene	.2
1,1,1-Trichloroethane	.2	2-Chloroethyl vinyl ether	.2
Chloroform	.2	1,2-Dichlorobenzene	.2
Methylene chloride	.2	Dichlorobromomethane	.2
Styrene	.2	Cis-1,3-Dichloropropene	.2
Tetrachloroethylene	.2	Trans-1,3-Dichloropropene	.2
Toluene	.2	1,3-Dichlorobenzene	.2
Trichloroethylene	.2	Vinyl chloride	.2
Acid-base/neutral extractable (semivolatile) organic compounds			
Acenaphthene	5.0	4-Chloro-3-methylphenol	30.0
Acenaphthylene	5.0	Chysene	10.0
Anthracene	5.0	Di-n-Butyl phthalate	5.0
Benzo(a)anthracene		Di-n-Octyl phthalate	10.0
1,2-Benzanthracene	5.0	Diethyl phthalate	5.0
Benzo(a)pyrene	10.0	Dimethyl phthalate	5.0
Benzo(b)fluoranthene	10.0	4,6-Dinitro-2-methylphenol	30.0
Benzo(ghi)perylene	10.0	Fluoranthene	5.0
Benzo(k)fluoranthene	10.0	Fluorene	5.0
Butyl benzyl phthalate	5.0	Hexachlorobenzene	5.0
Hexachlorobutadiene	5.0	1,4-Dichlorobenzene	5.0
Hexachlorocyclopentadiene	5.0	Bis(2-chloroethoxy)methane	5.0
Hexachloroethane	5.0	Bis(2-chloroethyl)ether	5.0
Indeno(1,2,3-CD)pyrene	10.0	Bis(2-ethylhexyl)phthalate	5.0
Naphthalene	5.0	2-Nitrophenol	5.0
Nitrobenzene	5.0	2,4-Dichlorophenol	5.0
N-nitrosodimethylamine	5.0	2,4-Dimethylphenol	5.0
Phenanthrene	5.0	2,4-Dinitrophenol	20.0
Pentachlorophenol	5.0	2,4-Dinitrotoluene	5.0
Phenol	5.0	2,4,6-Trichlorophenol	20.0
Pyrene	5.0	2,6-Dinitrotoluene	5.0
1,2-Dichlorobenzene	5.0	4-Bromophenyl phenyl ether	5.0
1,2,4-Trichlorobenzene	5.0	4-Chlorophenyl phenyl ether	5.0
1,3-Dichlorobenzene	5.0	4-Nitrophenol	30.0
Isophorone	5.0	2-Chloronaphthalene	5.0
N-nitrosodi-N-proplyamine	5.0	2-Chlorophenol	5.0

Table 2. Detection limits for analyzed synthetic organic compounds--Continued

Compound	Lowest level of detection	Compound	Lowest level of detection
Pesticides			
2,4-DP	0.10	P'p"DDE	0.01
2,4-D	.10	O'p"DDD	.01
2,4,5-TP	.10	Endrin	.01
Atrazine	.10	P'p"DDT	.01
2,4,5-T	.10	Methoxychlor	.01
Diazinon	.01	Mirex	.01
Ethion	.01	Prometryne	.1
Malathion	.01	P'p"DDD	.01
Methyl Parathion	.01	O'p"DDT	.01
Methyl Trithion	.01	beta-Endosulfan	.01
Parathion	.01	Perthane	.01
Trithion	.01	Prometone	.1
Chlordane	.01	Propazine	.1
Toxaphene	.50	Simazine	.1
Dieldrin	.10	Simetryne	.1
gamma-BHC	.01	Alachlor	.1
Heptachlor	.01	Metolachlor	.1
Aldrin	.01	Metribuzin	.1
Heptachlor epoxide	.01	Trifluralin	.1
O'p"DDE	.01	Ametryne	.1
Alpha Endosulfan	.01	Cyanazine	.1
Polychlorinated Biphenyls (PCB's)			
PCB-1016	0.10	PCB-1248	0.10
PCB-1221	.10	PCB-1254	.10
PCB-1232	.10	PCB-1260	.10
PCB-1242	.10		

Jasper Equivalent/Southeast Louisiana Aquifer System

Hydrogeology

The Tchefuncta, Hammond, and Amite aquifers of the Jasper equivalent aquifer system underlie the study area. The Tchefuncta aquifer contains freshwater as far south, possibly, as the northern border of St. John the Baptist Parish. Available data are not sufficient to precisely locate the southern extent of freshwater in this aquifer. The Tchefuncta aquifer on the north side of the Baton Rouge fault at well Ta-578 is adjacent to the Covington aquifer on the south side of the fault because of a 350- to 400-foot vertical displacement (fig. 4, south-north hydrogeologic section A-A'). The top of the Tchefuncta aquifer was encountered at a depth of 2,242 ft at well Ta-576 at the Bedico Community Center. The aquifer is 200 ft thick and consists mostly of coarse sand at this location. This follows a regional trend of medium- and coarse-grained sand in the aquifer. Transmissivities for the aquifer range from approximately 8,000 to 27,000 $[(ft^3/d)/ft^2]ft$ and hydraulic conductivities range from 70 to 130 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978, p. 7).

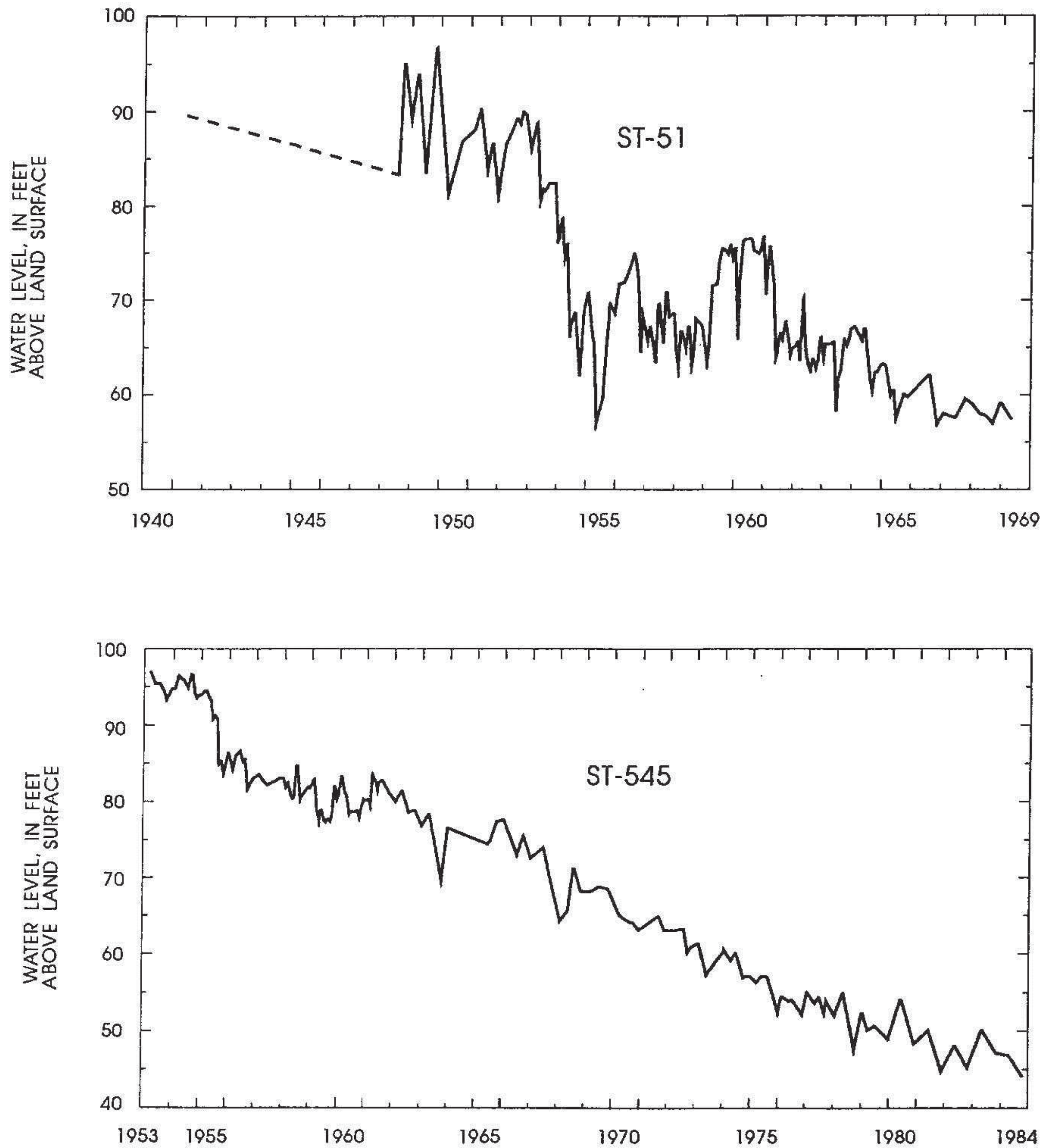
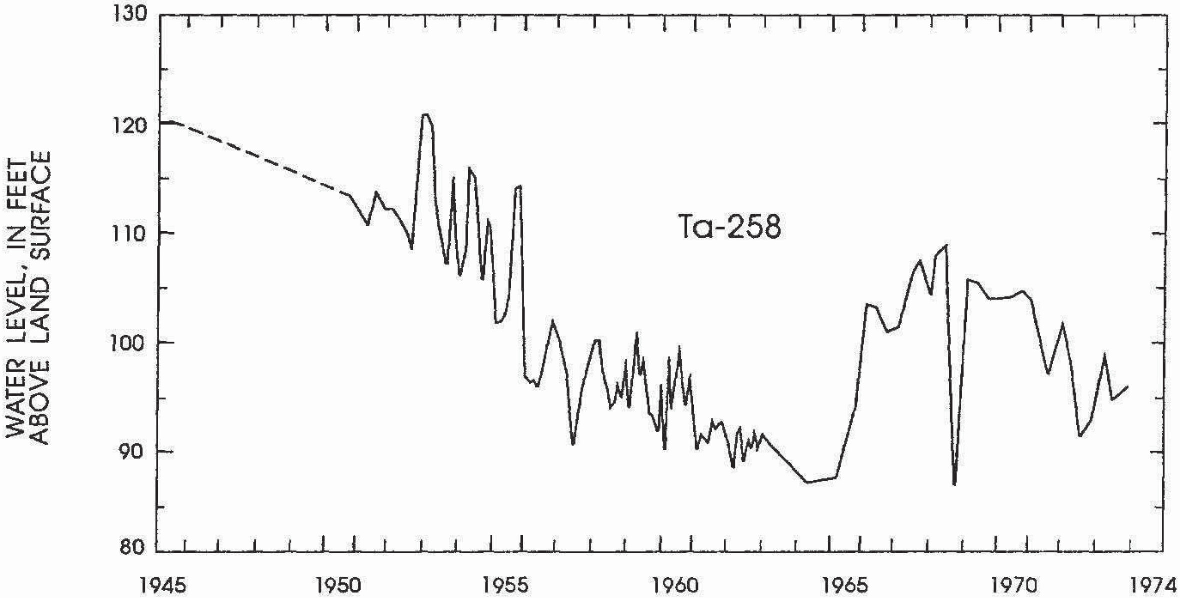


Figure 9. Water levels for wells ST-51 and ST-545 completed in the Abita aquifer.



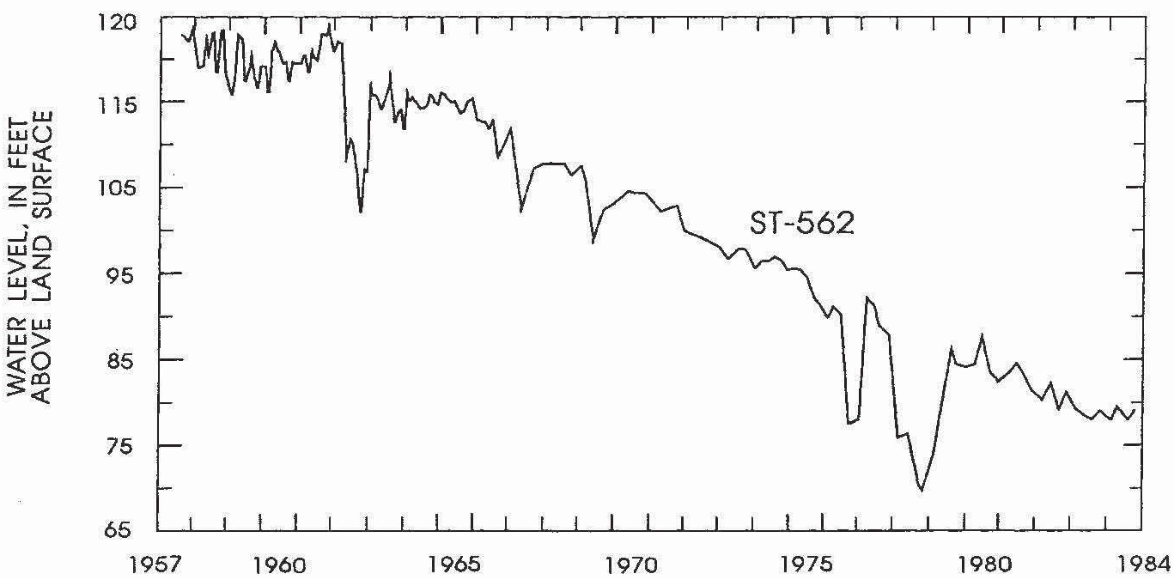


Figure 10. Water levels for wells Ta-258 and ST-562 completed in the Covington aquifer.

The Hammond aquifer is a major aquifer across the region. The thickness of this aquifer generally ranges from 100 to 200 ft in the study area. At well Ta-576 the aquifer consists of two thin sands with a total thickness of 50 ft, but generally thickens in every direction from that location. Results of an aquifer test at well ST-568 at Covington indicated a transmissivity of about 27,000 [$(ft^3/d)/ft^2$]ft and a hydraulic conductivity of more than 200 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978, p. 51). The aquifer at well ST-568 is 200 ft thick and consists of sand that is well sorted, indicating a higher permeability. The aquifer at Hammond, La., consists of fine- to medium-grained sand in the upper part, grading to medium- and coarse-grained sand in the lower one-third. The Hammond aquifer has been down-faulted below the base of freshwater for the southeastern Louisiana aquifer system south of the Baton Rouge fault zone; this represents its approximate southern limit of freshwater in the study area.

The Amite aquifer is one of the most continuous aquifers in the region north of the Baton Rouge fault zone and attains an appreciable thickness in the study area. The thickness is typically 100 to 150 ft, but becomes increasingly variable at the southern limit of freshwater where the aquifer may thin or thicken abruptly. The top of the Amite aquifer is at a depth of 2,965 ft below land surface at well Ta-576. The water in this sand has a resistivity of approximately 48 ohm-meters (measured from the well log), indicating freshwater. Approximately 4 mi southwest of well Ta-576, at oil test well 178730, the Amite aquifer reaches a thickness of approximately 420 ft and contains freshwater. Less than half a mile farther southwest, the aquifer consists of two thin sands having a total thickness of 100 ft and containing brackish water. Reported transmissivities for the aquifer range from 17,000 to 27,000 [$(ft^3/d)/ft^2$]ft, and the hydraulic conductivity is 150 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978, p. 7).

Water Quality

The Tchefuncta aquifer in the study area contains a soft, sodium bicarbonate type water with no color in water sampled from well ST-653. The pH of the water was 8.0 and dissolved-solids concentration was 214 mg/L. The iron concentration in water from the well completed in this aquifer was 0.04 mg/L. Manganese also was present at an average concentration of 0.04 mg/L. Hydrogen sulfide is present in some areas, but generally in concentrations less than 0.1 mg/L (Nyman and Fayard, 1978).

Water in the Hammond aquifer is a soft, sodium bicarbonate type typical of water in other aquifers of this regional ground-water system. Few wells are completed in this aquifer because of the depth to the aquifer in the study area. The temperature of the water flowing from well Ta-434 was approximately 30 °C; color was not detected (appendix). The pH was 7.6 in water from well Ta-434. Iron concentration in water from wells completed in the Hammond aquifer ranged from 0.01 to 1.1 mg/L. The manganese concentration ranged from 0.03 to 0.13 mg/L, and the dissolved-solids concentration ranged from 178 to 207 mg/L. Hydrogen sulfide is present locally, but typical concentrations are 0.1 mg/L or less (Nyman and Fayard, 1978).

The Amite aquifer contains a sodium bicarbonate type water that is low in iron and manganese. Few wells have been completed in the aquifer in southern Tangipahoa Parish because of the extreme depth to the aquifer in the study area. The wells sampled were located in St. Tammany Parish as close to the study area as possible. The color ranged from 0 to 5 platinum-cobalt units. The average pH was 9.0 in water from wells ST-592 and ST-726. Of all wells sampled, well ST-592 contained water with the highest dissolved-sodium concentration, 96 mg/L. The iron concentration was less than 0.01 mg/L. The average manganese concentration was 0.13 mg/L, and dissolved-solids concentration ranged from 169 to 257 mg/L. Hydrogen sulfide is present locally in concentrations as high as 0.5 mg/L (Nyman and Fayard, 1978). The quality of water in these aquifers generally meets the USEPA standards for public supply (U.S. Environmental Protection Agency, 1986).

Pumping and Water Levels

In southern Tangipahoa and St. Tammany Parishes, the city of Hammond is the largest reported user of water from the Tchefuncta aquifer. Total public-supply and industrial pumpage from this aquifer is estimated at approximately 1.5 Mgal/d (1991). The average rate of water-level decline in well Ta-273 near Rosaryville, west of Ponchatoula in Tangipahoa Parish, was about 2.2 ft/yr for the period 1960-77, but the rate of decline has decreased and has been about 1 ft/yr for the last 10 yr (fig. 11). Heavy pumping of water from equivalent aquifers in East Baton Rouge and Livingston Parishes affects the water levels in the Tchefuncta aquifer in the study area.

Potential yield from the Tchefuncta aquifer from a well field near Ta-576 is estimated at 7 Mgal/d. The withdrawal of 7 Mgal/d at this site probably would result in a 37-foot decline in water level in the aquifer at a 1,000-foot radius from the pumped well after 1 yr of continuous pumping. The method and assumptions used to estimate withdrawals and water-level declines due to pumping is discussed in the section, "Potential for Development."

The city of Hammond also is reported to be the largest user of water from the Hammond aquifer in southern Tangipahoa and St. Tammany Parishes. Total public-supply and industrial withdrawals from this aquifer are estimated at approximately 4.6 Mgal/d (1991). The average rate of water-level decline in well Ta-268 in Hammond for the period 1959-76 was 3 to 4 ft/yr, but water-level trends for the last 10 yr indicate that the rate of water-level decline has decreased to about 2 ft/yr (fig. 12). Heavy pumping of water from correlative aquifers in the Baton Rouge area affects water levels in the Hammond aquifer in the study area. The sands of the Hammond aquifer penetrated by well Ta-576 were unusually thin; for this reason, yield was not estimated for the aquifer at this location.

Total public-supply and industrial pumpage for the Amite aquifer in southern Tangipahoa and St. Tammany Parishes is estimated to be 0.8 Mgal/d (1991). Major pumping centers are the communities of Hammond and Independence in Tangipahoa Parish. Average water-level declines at well Ta-262 in Independence for the period 1964-84 was nearly 2.2 ft/yr, but water-level declines have decreased during the last 6 yr (fig. 13). Water well ST-558, located northeast of well Ta-576, had an average water-level decline of 1.5 ft/yr for a 10-year period ending in 1978 (fig. 13).

Estimated potential yield for the Amite aquifer at well Ta-576, assuming an aquifer thickness of 150 ft, is 3 Mgal/d. Withdrawals totaling 3 Mgal/d probably would result in a 19-foot decline in water level in the aquifer at a 1,000-foot radius from the pumped well after 1 yr of continuous pumping. The method and assumptions used to estimate withdrawals and water-level declines due to pumping is discussed in the section, "Potential for Development."

Potential for Development

The potential for development of the six major freshwater aquifers in the study area described in this section is based on a number of data sources, including information obtained from test well Ta-576 in southeastern Tangipahoa Parish. Additional data sources that were referenced to provide hydrologic values for the analysis are listed in the section "Selected References." The general location of test well Ta-576 was chosen after a review of previously published USGS reports to determine the aquifer thickness and sand percentage in southern Tangipahoa Parish. The data collected from the well were similar to data cited in earlier reports and are considered representative of the aquifer system in southern Tangipahoa Parish.

Test well Ta-576, located at the Bedico Community Center, was completed in July 1990. Total depth of the test hole was 3,000 ft, and it penetrated eight major aquifers. The well screen was set at a depth from 1,901 to 1,922 ft in the Covington aquifer.

Interpretation of the well log (fig. 14) indicated that all of the sands penetrated in the test well contain freshwater. Total thickness of the freshwater sands was more than 1,900 ft. Resistivity values from the deep-penetrating resistivity log typically averaged 200 ohm-meters. These high resistivity values indicate water with low dissolved-solids concentrations. The chemical analysis of water from the Covington

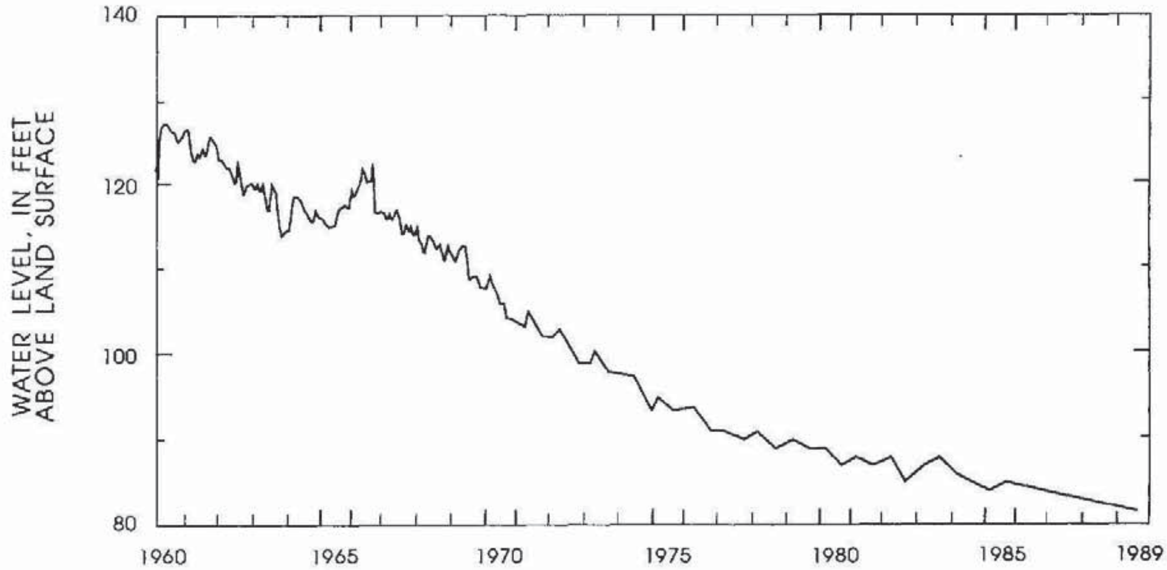


Figure 11. Water level for well Ta-273 completed in the Tchefuncta aquifer.

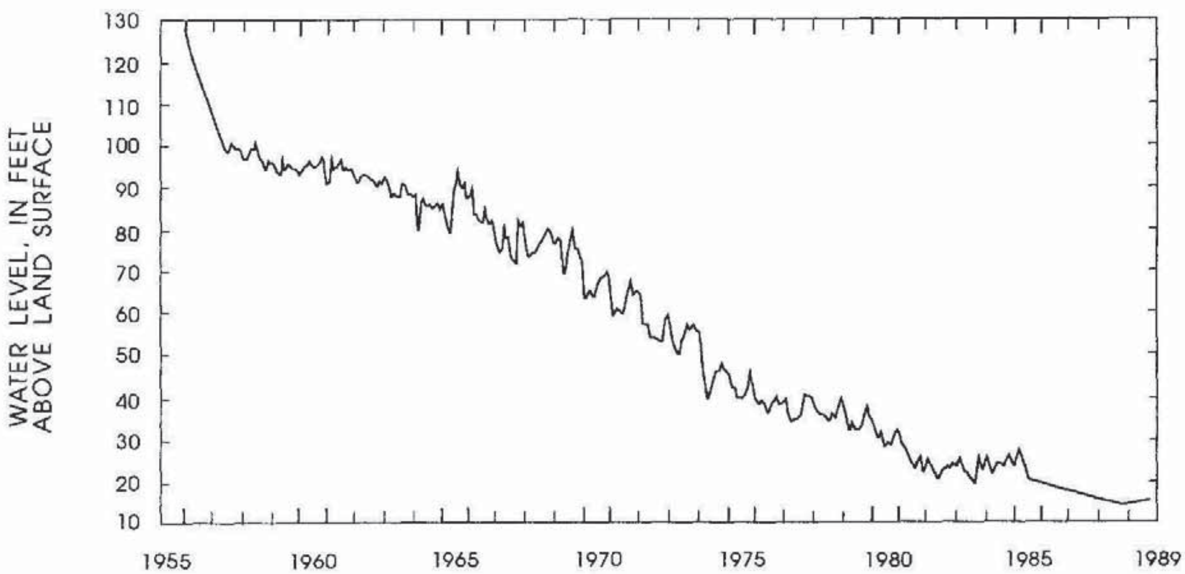
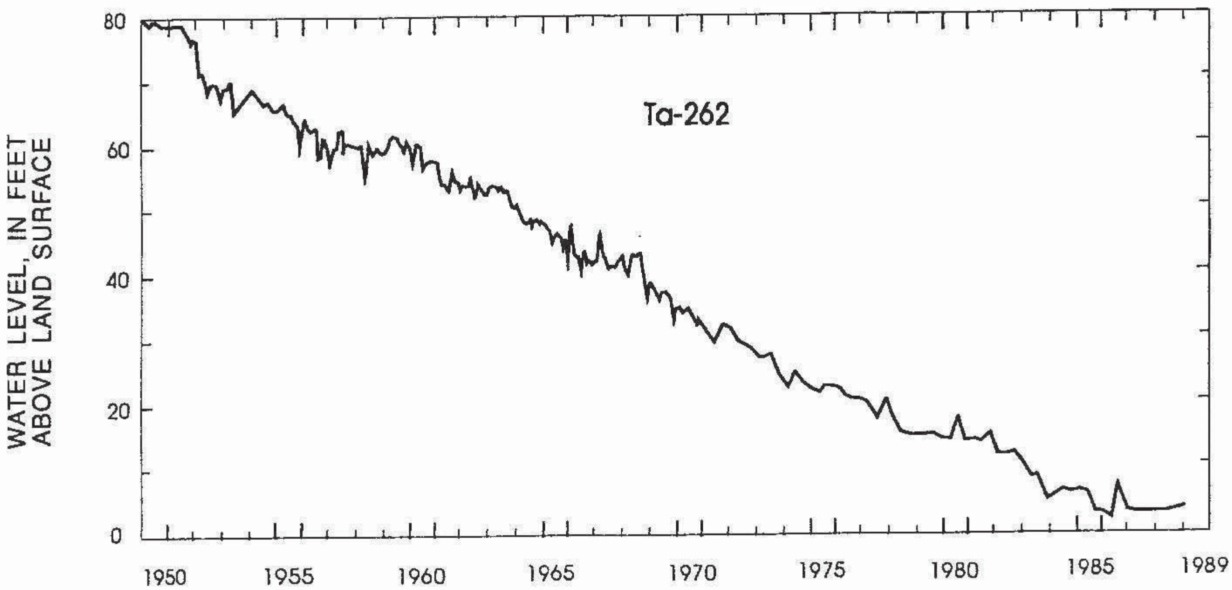


Figure 12. Water level for well Ta-268 completed in the Hammond aquifer.



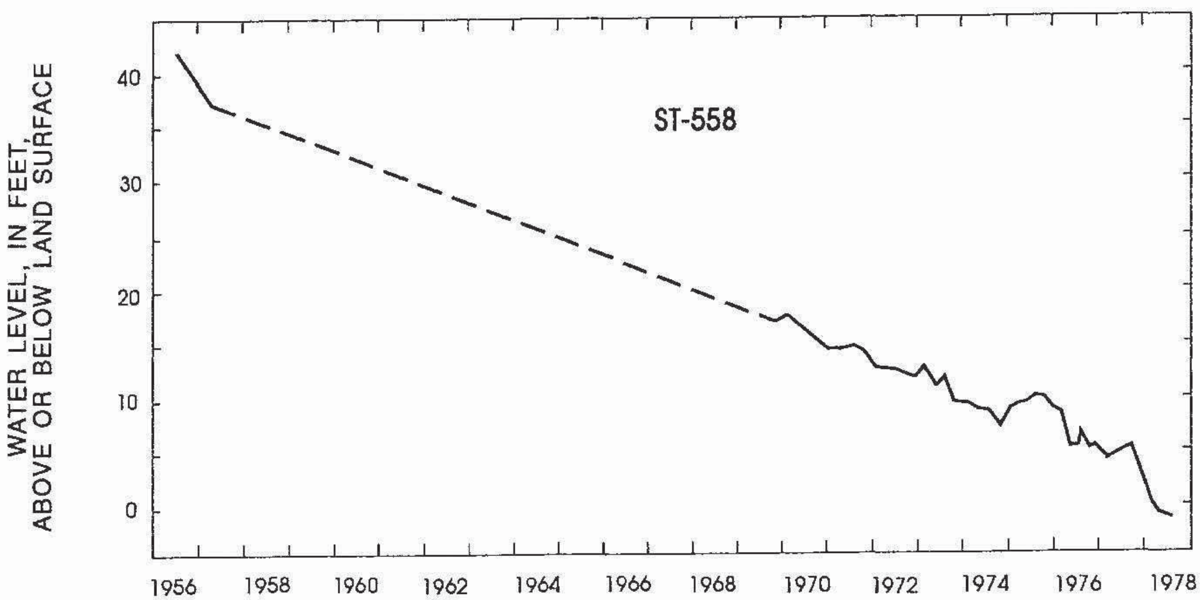


Figure 13. Water levels for wells Ta-262 and ST-558 completed in the Amite aquifer.

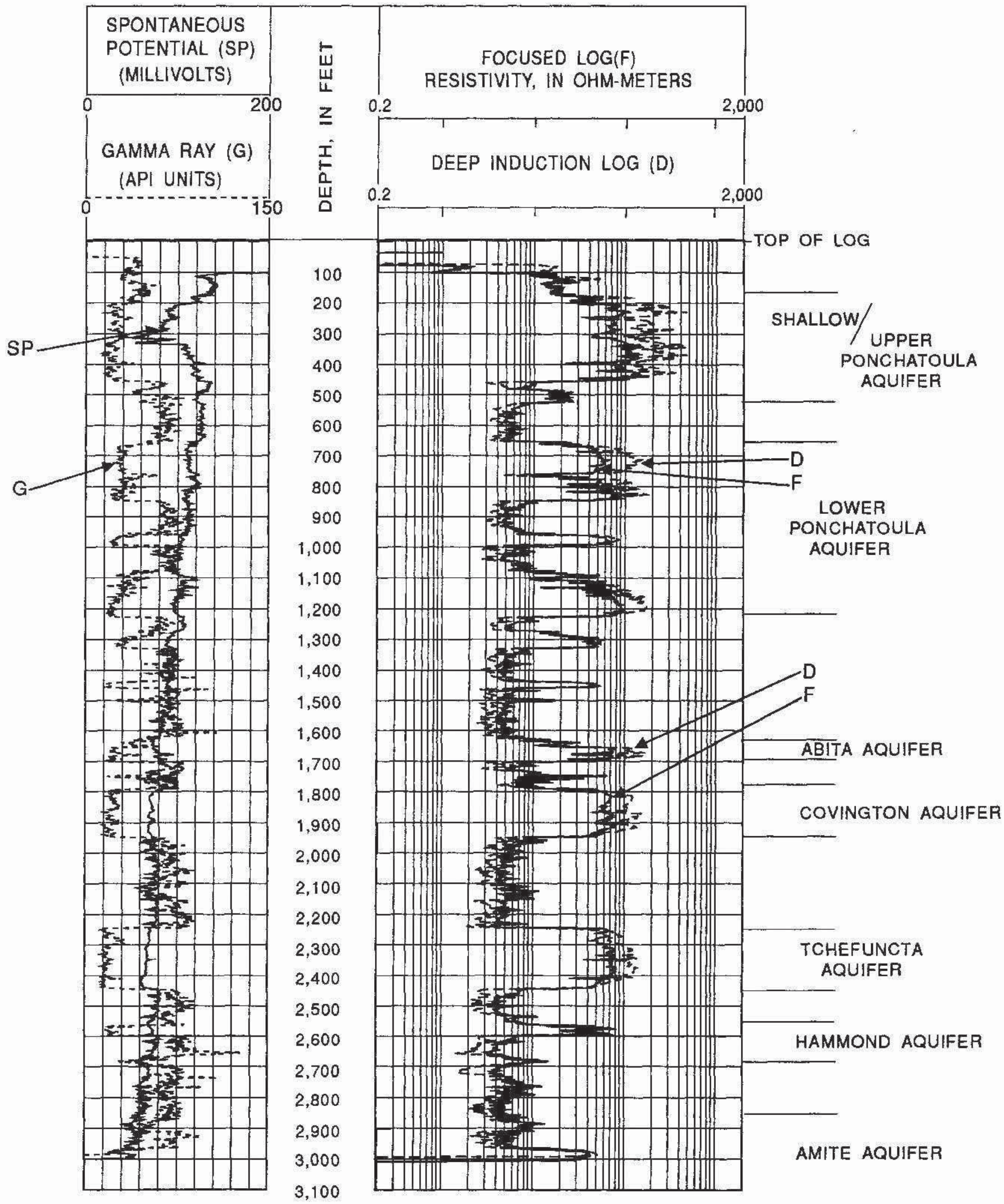


Figure 14. Geophysical log of test well Ta-576.

aquifer verified the presence of high quality water, low in hardness, dissolved solids concentration, and iron concentration.

Potential yields from aquifers in the vicinity of test well Ta-576 could exceed 28 Mgal/d, based on reported hydraulic conductances, grain-size distribution, and thicknesses of the sand beds at this location. Yields from each aquifer was estimated by multiplying the average specific capacity for that aquifer by the maximum allowable drawdown of 75 ft to obtain a total pumping rate from that aquifer unit. Well-screen entrance velocities for a maximum well-screen diameter of 16 in. (and the computed pumping rate) were calculated to ensure that ground-water entrance velocities did not exceed the critical value of 0.1 ft/s, given as a guideline to maximize well-screen life. A Theis analysis of drawdown in the aquifer resulting from the proposed pumping for a period of 1 yr gave estimated drawdowns at a distance of 1,000 ft from the well location. Estimated yields for the individual aquifers at well Ta-576 are included in the "Pumping and Water Levels" section for each aquifer discussed in this report except the Hammond aquifer. Sand in the Hammond aquifer at well Ta-576 was considered to be too thin for substantial water withdrawals at that location. The potential yield and estimated drawdown values are summarized in table 3.

Table 3. Potential yield and estimated drawdown values for a hypothetical well field at test well Ta-576

[Mgal/d, million gallons per day]

Aquifer	Potential yield (Mgal/d)	Estimated drawdown after 1 year at a distance of 1,000 feet from pumping well (feet)
Upper Ponchatoula	9.0	26.0
Lower Ponchatoula	2.0	15.0
Abita	4.0	62.0
Covington	3.0	14.0
Tchefuncta	7.0	37.0
Hammond	(1)	(1)
Amite	3.0	19.0
Total pumpage	28.0	

[1] No estimate of yield was made at test well Ta-576, due to reduced aquifer thickness at this location.

A number of assumptions must be made when applying the Theis method to an aquifer subjected to pumping. The ideal aquifer to which the Theis solution is best applied is (1) horizontal, (2) confined between impermeable formations on top and bottom, (3) infinite in horizontal extent, (4) of constant thickness, and (5) homogeneous and isotropic with respect to its hydrogeological parameters (Freeze and Cherry, 1979, p. 315). To the extent that the actual aquifer differs from an ideal aquifer, the calculated yields and the effect of withdrawals will differ from actual yields and effects of withdrawals on water levels. Although no aquifer in nature will stringently meet the assumptions applied to the ideal Theis aquifer, the Theis equation provides a good method of approximating aquifer response to withdrawals.

Two factors that were not considered with the analysis that would reduce calculated yields are interference from other wells in the same aquifer and the derivation of hydraulic-conductivity values from pumping tests. Interference effects from the drawdown cones of other wells pumping water from the same aquifer will result in lower yields and higher water-level rates of decline at the primary pumped well. The hydraulic-conductivity values are only estimates calculated from aquifer tests that are based on idealized assumptions. The hydraulic conductivity values derived from aquifer tests are then used in the Theis equation. The resulting errors in hydraulic conductivity are assumed to be small enough that the overall analysis is not significantly affected.

At current rates of withdrawal, the hydrologic system seems to be moving towards equilibrium aided by induced recharge across clay confining units. The massive sand beds of the shallower aquifers (the shallow, upper Ponchatoula, and lower Ponchatoula aquifers) seem to be closer to reaching equilibrium than the deeper aquifers (the Abita, Covington, Tchefuncta, Hammond, and Amite aquifers), with modest recovery of water levels in some areas (Nyman and Fayard, 1978). Water levels in the study area are affected by pumping elsewhere in the region for those aquifers that are major sources of public supply in other areas. Water levels also can be affected by disruptions in ground-water flow at the Baton Rouge fault zone in southern Tangipahoa Parish.

Increases in pumpage of 30, 50, or 100 Mgal/d from the aquifer system would result in substantial increases in water-level declines throughout the hydrologic system. A digital model that could be used to simulate the response of all aquifers to the proposed increased pumping is needed to provide a more thorough understanding of the effect of increased pumping on the aquifer system.

Aquifers Underlying Lake Pontchartrain

The Baton Rouge fault zone that extends east-southeasterly from west of Baton Rouge through the northern part of Lake Pontchartrain (fig. 1) disrupts ground-water flow in the intermediate and deep aquifers of the large freshwater aquifer system north of Lake Pontchartrain. For each of the deep freshwater aquifers, the southern limit of freshwater extends south of the fault zone. Beyond this limit, defined as the freshwater-saltwater interface, chloride concentrations generally are greater than the 250 mg/L maximum concentration considered suitable for public-supply use (U.S. Environmental Protection Agency, 1986). Generally, the shallowest of the aquifers below the lower Ponchatoula aquifer have freshwater-saltwater interfaces extending farthest south of the Baton Rouge fault zone (fig. 4). The Abita aquifer is the southernmost of all the deep aquifers that contain freshwater south of the fault zone.

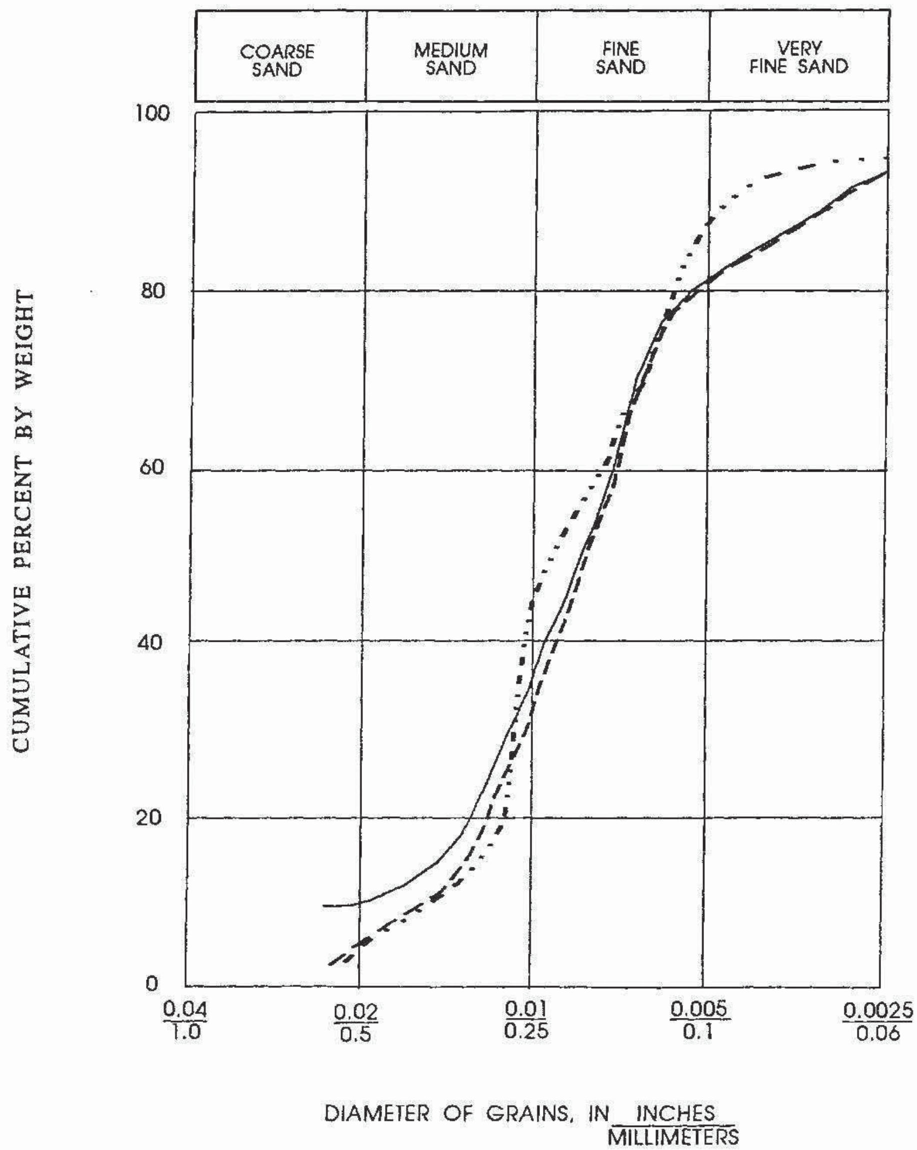
Abita Aquifer at Ruddock, Louisiana

Where the Baton Rouge fault zone crosses the study area, the Abita aquifer has been displaced downward approximately 350 ft and abuts the Covington aquifer on the north side of the fault. The approximate location of the freshwater interface in the Abita aquifer under Lakes Pontchartrain and Maurepas (fig. 2), has been estimated by Smoot (1988). The aquifer dips to the southwest at a rate varying from 40 to 70 ft/mi (Nyman and Fayard, 1978). At Ruddock, La., the Abita aquifer dips at a rate of 60 ft/mi.

Sieve analyses of sand from the Abita aquifer from well SJB-165 (from USGS files), 18.5 mi southwest of the study area at Ruddock, shows a predominantly medium- to fine-grained sand (fig. 15). This aquifer varies in thickness but typically is 150 to 300 ft thick south of the Baton Rouge fault zone, and apparently thickens south of oil-test well Roy W. Guste No. 1, State serial number 161507. The hydraulic conductivity of the Abita aquifer at public supply well SJB-176, calculated from an aquifer test conducted at that well when it was installed, was 120 $(ft^3/d)/ft^2$. The hydraulic conductivity at well SJB-176 was the same as that determined from a pumping test conducted in a well located at the National Space Technology Laboratory near Bay St. Louis, Mississippi (Newcome, 1967, p. H11).

Limit of Freshwater in the Abita Aquifer

To determine the limit of freshwater in the Abita aquifer in northern St. John the Baptist Parish, and to acquire hydrogeologic data in the vicinity of the freshwater-saltwater interface, a test/observation well was constructed 1.5 mi south of well SJB-165 near Ruddock. The well site chosen was at the northern end of the Ruddock boat launch, 0.5 mi north of the Ruddock exit on Interstate 55. Test well SJB-180 was completed on December 10, 1990, to a depth of 3,321 ft (fig. 4, section A-A′).



EXPLANATION

Symbol	Depth interval, in feet
——— (solid line)	2,890 - 2,900
— — — (dashed line)	2,940 - 2,950
········ (dotted line)	2,980 - 2,990

Figure 15. Sieve analysis of sand samples from well SJB-165 completed in the Abita aquifer.

The electric and natural gamma ray logs of test well SJB-180 are shown in figure 16. The sands that constitute the Abita aquifer can be delineated from inspection of these geophysical logs. Based on the deflection of traces of the logs, the Abita aquifer extends from about 2,990 to 3,190 ft. A zone of lower resistivity water begins at 3,100 ft and extends to the base of the aquifer. Resistivity in this zone decreases with depth, indicating that chloride concentrations probably increase with depth. The well screen was set from 3,065 to 3,085 ft. A chloride concentration of 44 mg/L was measured in a water sample from the Abita aquifer at this point immediately above the lower resistivity water zone.

Based on the log, the screen is directly above the extreme forward edge of the freshwater-saltwater interface. This is correct if the interface forms a plane in the aquifer that is offset from vertical by some angle. The angle of the plane is dependent on the relative density difference between the freshwater and saltwater at the interface, vertical and horizontal conductivities of the aquifer, and ground-water flow rates at the interface. Assuming the planar interface surface moves northward in response to higher rates of pumping, the well depth should allow northward movement of the freshwater-saltwater interface to be monitored. The angled surface of the interface will pass the test well as the interface moves northward. The increasingly higher chloride concentration of the saltwater south of the interface should be reflected in a rising chloride concentration in water sampled from the test well.

Freshwater in the Abita aquifer generally is a soft sodium bicarbonate type. Dissolved-solids and chloride concentrations typically are low. However, chloride concentrations in water from the Abita aquifer from well SJB-165 have been rising steadily (fig. 17). This well had been used continuously for public supply by the St. John the Baptist Parish Water District from April 1975 to August 1986. After August 1986, the water district also began withdrawals for public supply from well SJB-176, completed in the Abita aquifer and located approximately 1 mi north of well SJB-165. Both wells have been used since August 1986 to meet the parish public water-supply requirements.

During 1981-84, chloride concentrations increased from approximately 38 to 72 mg/L. This increase in chloride concentration might result from the capture of plumes of saline water from a nearby freshwater-saltwater interface, or from saline water leaking through the confining clay layer above or below the aquifer. Water samples collected above the freshwater-saltwater interface from test well SJB-180 contained a dissolved-chloride concentration of 44 mg/L (appendix). The chloride concentrations at the base of the Abita aquifer at well SJB-180 were estimated from resistivity log values (fig. 16) to range from 200 to 250 mg/L.

Analysis of Aquifer Response to Hypothetical Pumping

The Abita aquifer in St. John the Baptist Parish has been utilized as a public water source since April 1975. Pumping from the aquifer during the first 10 yr of use has averaged about 1.5 Mgal/d. Total pumpage for this aquifer by St. John the Baptist public-supply wells has increased from 2.0 to 2.3 Mgal/d during the last 5 yr (1986 to 1991). In Baton Rouge, withdrawals of 40 Mgal/d in the "2,000-foot" aquifer, an aquifer with hydrologic characteristics similar to the Abita aquifer in St. John the Baptist Parish (Torak and Whiteman, 1982, p. 5), has resulted in a lowering of the potentiometric surface to a level more than 220 ft below land surface (D.J. Tomaszewski, U.S. Geological Survey, oral commun., 1991) which represents a net decline in the potentiometric surface of more than 430 ft (Morgan, 1961). The Theis method of analysis was applied to the Abita aquifer at Ruddock to estimate the effect of pumping on water levels in the aquifer across the region and on ground-water flow in the Ruddock area. Two pumping scenarios with withdrawal rates of 31.5 and 112 Mgal/d for up to 10 yr were evaluated. These withdrawal rates were selected based on estimated requirements for an additional public water supply.

The scenarios for the largest and smallest pumping rates were evaluated for pumping periods of 1 and 10 yr. The orientation of the well fields and the placement of the individual wells are shown in figures 18 and 19. These figures also show the hypothetical location of the Abita aquifer freshwater-saltwater interface. At the time of the analysis, it was not known how close the freshwater-saltwater interface was to the southernmost wells of the hypothetical well fields; so a range of interface travel

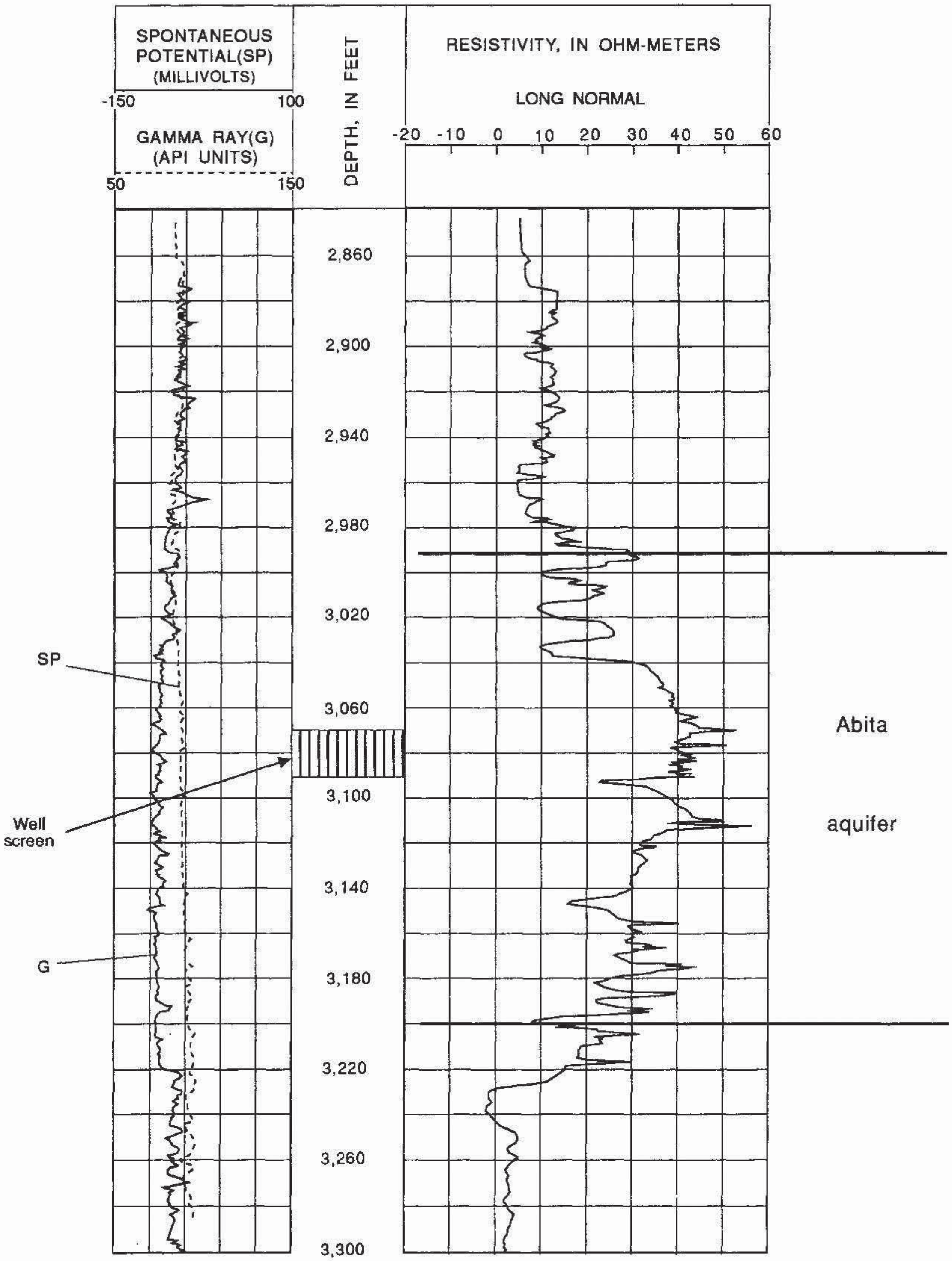


Figure 16. Electric and natural gamma ray logs of well SJB-180 completed in the Abita aquifer.

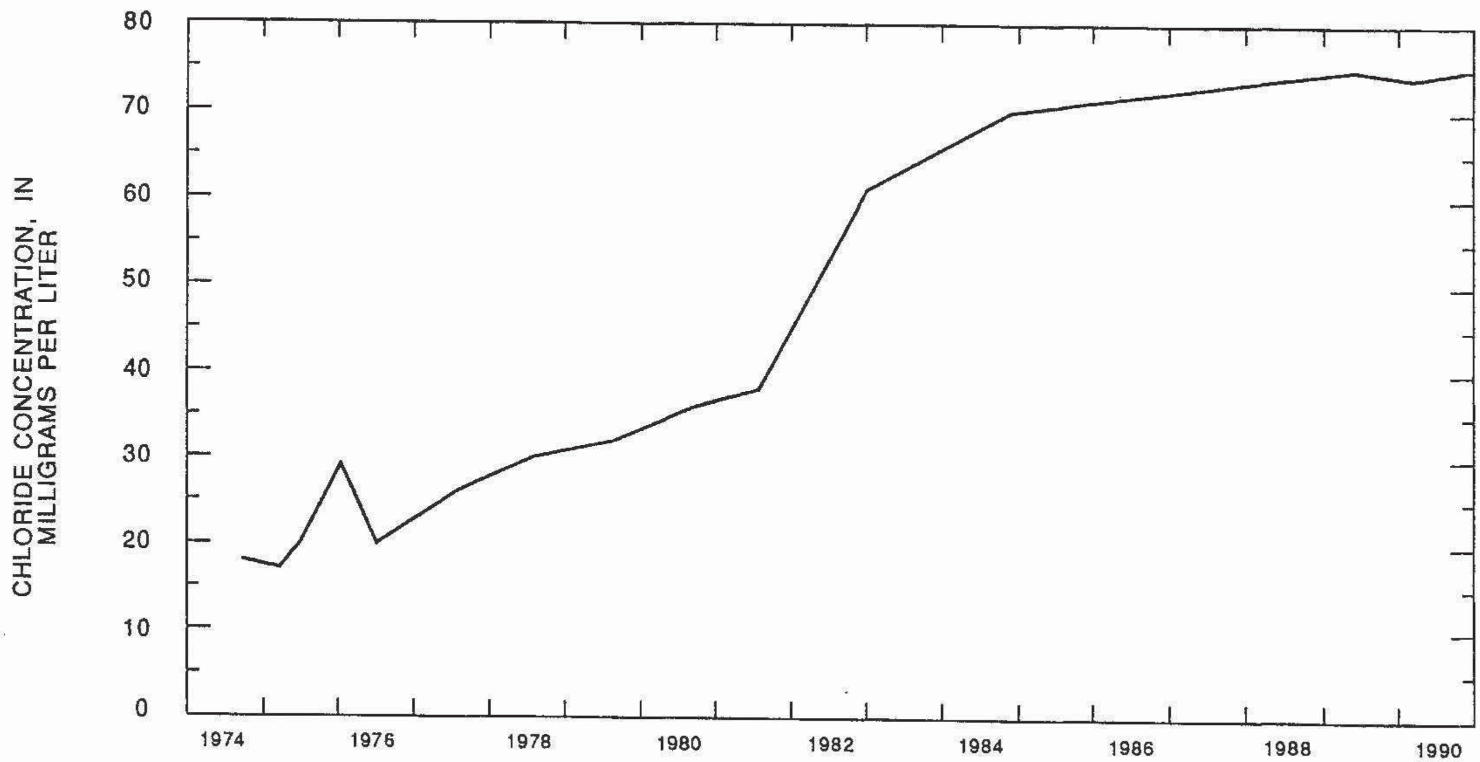
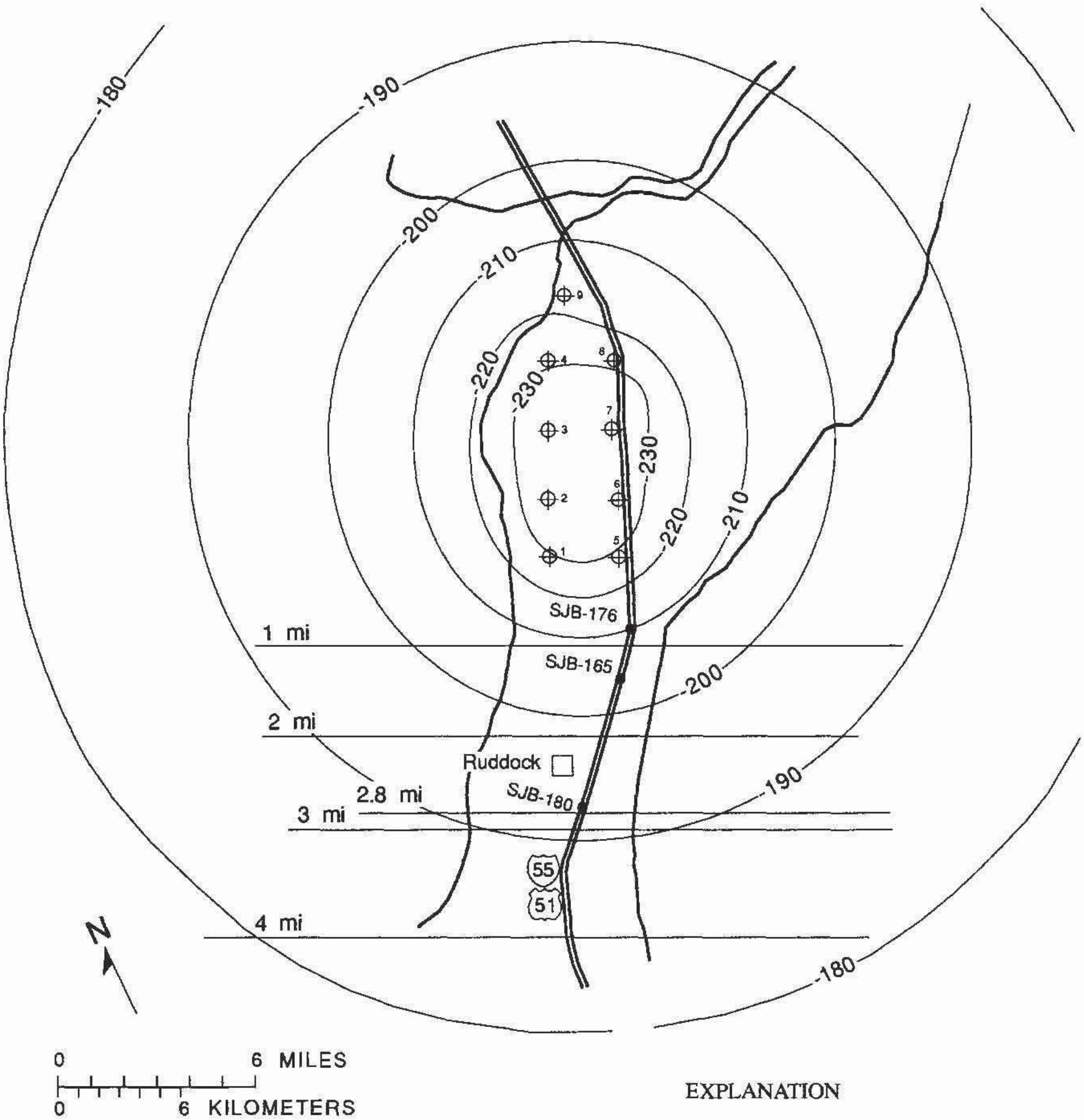


Figure 17. Chloride concentration in water from well SJB-165 completed in the Abita aquifer.



EXPLANATION

-200	POTENTIOMETRIC CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Contour interval 10 feet. Datum is sea level
SJB-180●	WATER WELL AND NUMBER
⊕4	HYPOTHETICAL PUMPED WELL
1 mi	HYPOTHETICAL SALTWATER INTERFACE--Number is distance in miles from southernmost located well in well field

Figure 18. Estimated drawdowns and positions of saltwater-freshwater interface in a hypothetical well field withdrawing 31.5 million gallons per day from the Abita aquifer, Ruddock, La.

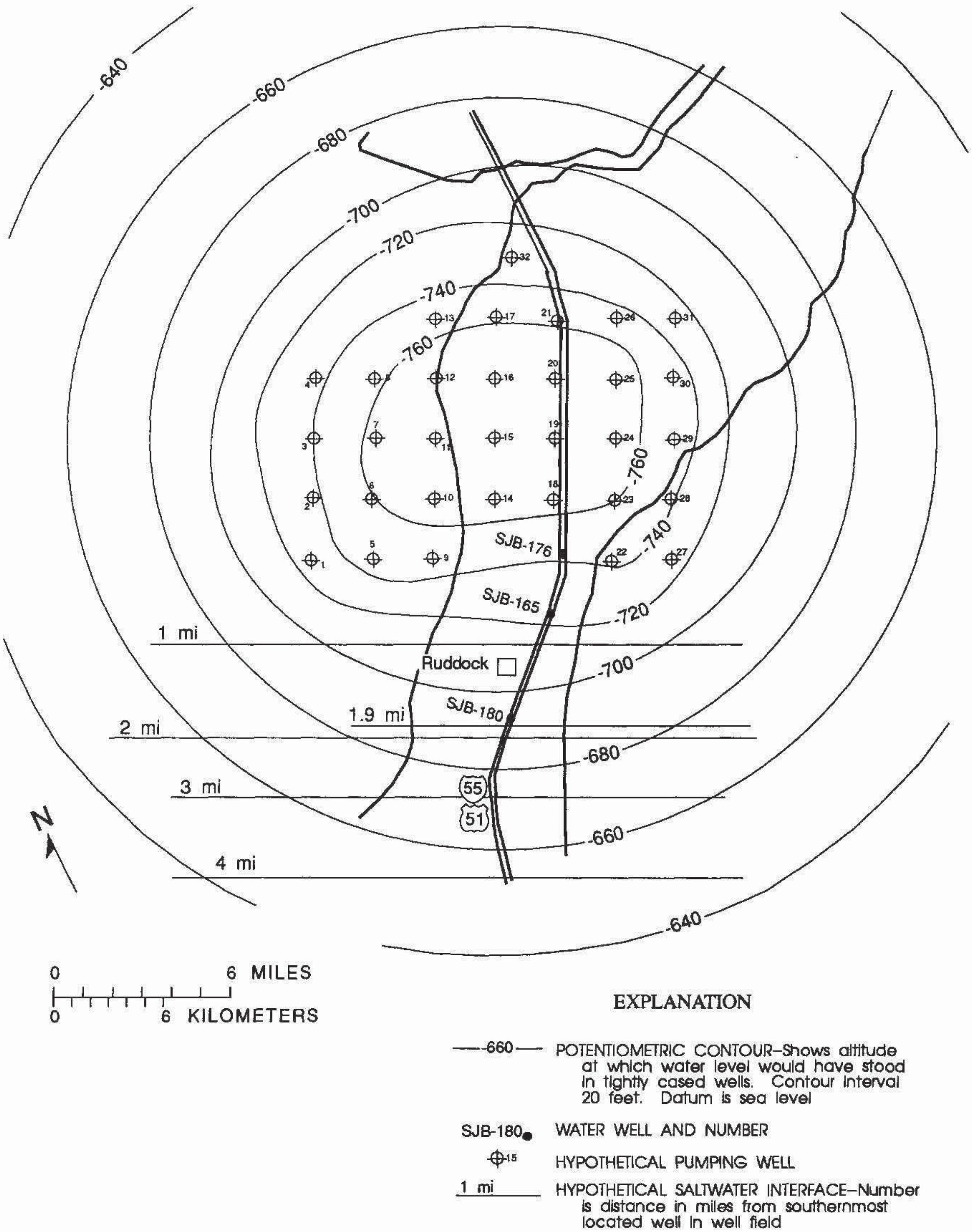


Figure 19. Estimated drawdowns and positions of saltwater-freshwater interface in a hypothetical well field withdrawing 112 million gallons per day from the Abita aquifer, Ruddock, La.

times were estimated, based on the distance of the interface from the southern edge of the hypothetical well fields. The interface travel times for the well field with a pumping rate between 31.5 and 112 Mgal/d would fall somewhere between the calculated time-of-travel values calculated for the two well fields analyzed.

Based on the Theis analysis of the Abita aquifer in northern St. John the Baptist Parish, drawdown maps were constructed. Numerical values for drawdown were calculated, based on assumed hydrologic parameter values, pumping rates, and pumping periods. These drawdown values were then contoured to generate maps of the water-level surface. The original water-level surface was assumed to be horizontal with zero drawdown and were assumed to be at land surface.

Application of the Theis method of analysis to the Abita aquifer indicated that most of the drawdown in the aquifer would occur in the first year of pumping. Additional pumping of the aquifer between the end of the first year and the tenth year produced only slight additional drawdowns in the aquifer. Due to the relatively small additional drawdown after 1 yr, the water-level surface generated by 1yr of continuous pumping was selected to represent steady-state conditions for the purposes of the analysis and was used to determine flow gradients in the aquifer. These gradients were then used with a range of effective porosities and a hydraulic conductivity of 120 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978, p. 7) to calculate flow velocities between equipotential lines. Flow velocities were then summed along flow paths to calculate total travel time. Assuming a constant pumping rate, ground-water flow rates increase as porosity decreases.

The general assumptions applied when analyzing the response of an aquifer to pumping through the use of the Theis methods is discussed in the section, "Potential for Development." An additional assumption applied to this multiple well analysis concerns the additive qualities of the Theis equation that arises from the Theis equation being a solution of the linear partial differential equation (Jacob, 1950):

$$\frac{\partial^2 h}{\partial r^2} + \frac{1}{r}\frac{\partial h}{\partial r} = \frac{S}{T}\frac{\partial h}{\partial t}, \qquad (1)$$

where
h is hydraulic head, ft;
S is storativity, dimensionless;
r is radial distance measured from pumped well, ft;
T is transmissivity $[(ft^3/d)/ft^2]ft$; and
t is time, day.

The additive qualities of linear partial differential equations allow the drawdown of hydraulic head at any point in a confined aquifer in which more than one well is pumping to be equal to the sum of the drawdowns of each of the wells operating independently (Freeze and Cherry, 1979, p. 327).

Data used in Hypothetical Pumping Analysis

St. John the Baptist Parish Water District pumpage records were used for withdrawal data. For periods of missing record, withdrawals were estimated using data preceding and following the period of absent record. Aquifer test data from public-supply well SJB-176 provided values for hydraulic parameters for approximation in the analysis. Regional water-level and hydraulic parameter trends were used as guides for adjusting hydrologic values.

The effective porosity of the Abita aquifer varies locally due to the heterogeneity that is characteristic of fluvial and deltaic aquifer systems. Values for aquifer porosity vary with sorting, the amount of clay mixed with the sand particles, and the size of the particles that make up the aquifer matrix. To facilitate the analysis of the effects of ground-water withdrawals, porosity was allowed to range from 20 to 30 percent (Cardwell and others, 1966, p. 20).

Water withdrawal rates of 31.5 and 112 Mgal/d were selected to analyze the aquifer response to pumping. Average values for transmissivity and storage coefficient were selected that would characterize the behavior of the Abita aquifer across northern and central St. John the Baptist Parish. The thickening of the Abita aquifer in central St. John the Baptist Parish, south of public-supply well SJB-165, necessitated a range of transmissivity values that would characterize the aquifer throughout the area. Based on the thickness of the Abita aquifer south of the Baton Rouge fault zone and its hydraulic conductivity of 120 $(ft^3/d)/ft^2$ (Nyman and Fayard, 1978, p. 7, table 4), aquifer transmissivity values range from 15,600 to 38,000 $[(ft^3/d)/ft^2]ft$. The average value of transmissivity selected for calculations was 26,700 $[(ft^3/d)/ft^2]ft$. A storage coefficient range of 0.0001 to 0.001 was estimated for the confined aquifers of southeastern Louisiana. The storage coefficient value of 0.0001 was selected as a representative regional aquifer value (Nyman and Fayard, 1978, fig. 5).

Results of Analysis

Application of the Theis analysis to the Abita aquifer for a 31.5 Mgal/d well field (fig. 18) produced five sets of interface time-of-travel periods that ranged from a minimum to a maximum time value depending on an assumed porosity. These time-of-travel periods were calculated for five hypothetical interface locations as discussed on page 36 of this report.

The time-of-travel for an interface located 2.8 mi south of the well field ranged from 34 to 51 yr. The location of this hypothetical interface was selected based on the results of test well SJB-180. Minimum time-of-travel estimates calculated for the other hypothetical interface locations ranged from 7 to 64 yr with maximum time-of-travel estimates ranging from 10 to 96 yr (table 4).

Table 4. Estimated rate of movement of the freshwater-saltwater interface for selected well field configurations and pumping rates

[Mgal/d, million gallons per day]

Number of wells	Pumping rate per well (Mgal/d)	Total pumping rate (Mgal/d)	Distance of interface from southern edge of well field (mile)	Travel time in years for assumed porosity of 20 percent	Travel time in years for assumed porosity of 30 percent
9	3.5	31.5	1	6.6	10.0
			2	19.7	29.5
			[1]2.8	34.1	51.2
			3	38.9	58.3
			4	64.0	96.0
32	3.5	112	1	4.8	5.3
			[1]1.9	9.7	14.4
			2	10.2	15.3
			3	16.6	24.8
			4	24.6	36.9

[1] Actual distance of freshwater-saltwater interface in the Abita aquifer from southern edge of hypothetical well field, based on data from test well SJB-180.

Estimates of interface time-of-travel for five hypothetical freshwater-saltwater interface locations also were calculated for the 112 Mgal/d well field. The time-of-travel estimated for a hypothetical interface located 1.9 mi from the southern edge of the well field ranged from 10 to 14 yr. This hypothetical

interface location was based on the results of test well SJB-180. Minimum estimates for time-of-travel calculated for other hypothetical interface locations ranged from 5 to 25 yr with maximum time-of-travel ranging from 5 to 37 yr (table 4).

Interpretation of the natural gamma ray log in figure 16 indicates that the Abita aquifer has less clay in the lower part than in the upper part. If a fully penetrating well were installed in this aquifer, the higher hydraulic conductivity of the lower part of the aquifer (based on less clay in this part of the aquifer) would result in a higher percentage of flow from that section of the aquifer. This would allow the lower part of the interface to arrive at a pumping well before all of the overlying freshwater in the top two thirds of the aquifer had been withdrawn. Because the computations of ground-water flow velocity assume uniform flow throughout the vertical extent of the aquifer to be the primary ground-water flow mechanism, any layered conductivity effect with high chloride water in the higher conductivity layer would decrease the useful life of a producing well field below the estimated well-field life.

Because the Theis analysis of aquifer response to pumping assumes there is no leakage through the confining units separating the Abita aquifer from aquifers above and below it, actual drawdown due to pumping may be less than computed in the analysis. The reduction in the drawdown in the potentiometric surface in the aquifer will slow the advancement of the freshwater-saltwater interface toward the hypothetical pumping field location. However, because test wells Ta-577 and Ta-578 had not been drilled at the time of this analysis and the magnitude of the displacement of the aquifers at the Baton Rouge fault zone was not known, it had been assumed that maximum recharge of freshwater to the aquifer from the hydrologic system north of the fault zone was possible. Data that will allow estimation of ground-water flow reduction at the fault zone are not available, but some reduction in freshwater flow to the pumped wells south of the fault zone may be assumed based on the effects of the Baton Rouge fault zone on the aquifer system in the metropolitan Baton Rouge area (Whiteman, 1979). Any reduction in freshwater recharge from the north will increase the rate of advance of the freshwater-saltwater interface movement toward any well field.

Location of Freshwater-Saltwater Interface

Due to the variability of the hydrologic and geologic characteristics of southeastern Louisiana aquifers, the line representing the interface between freshwater and saltwater is not straight as shown in figures 18 and 19 and locally may be quite sinuous. For this reason, the location of the freshwater-saltwater interface at well SJB-180 can only be used as point-source information when considering development of the Abita aquifer. Additional test wells would provide a more definitive confirmation of the general orientation of the interface locally with respect to the southern edge of the well field and provide the data needed for a more accurate assessment of the useful life of the hypothetical well field.

The life of a well field producing water for public supply from the Abita aquifer in St. John the Baptist Parish can be maximized if the southern edge of the well field is placed as far north from the southern limit of freshwater as possible. Limiting withdrawal rates to approximate recharge rates would also extend the life of the well field and prevent the unacceptable lowering of the potentiometric surface. Due to the possible disruption of flow at the Baton Rouge fault zone, recharge rates at the Abita-Covington aquifer interface would be difficult to estimate. For a given well field location, any increase in withdrawal rate above 112 Mgal/d would accelerate the effects of saltwater encroachment and vertical leakage, thus decreasing the useful life of the hypothetical well field. Once saltwater encroachment affected the southernmost public supply wells in the well field, careful management of the well field would be needed to prevent a rapid reduction in the usefulness of the rest of the field.

SUMMARY AND CONCLUSIONS

Jefferson Parish needs an emergency/alternative water supply to its current (1990) primary supply source, the Mississippi River. Ground water in the area surrounding Jefferson Parish has been studied to determine its potential as an alternative source to the Mississippi River.

The study area lies within the Mississippi River Deltaic Plain and is underlain by sediments deposited during the Tertiary and Quarternary periods. The complex sequence of clay, sand, and gravel beds of the aquifers and confining units in the area are typical of southeastern Louisiana. Eight major aquifers consisting of thick sand units underlie the study area; they are, in descending order, the shallow, upper Ponchatoula, lower Ponchatoula, Abita, Covington, Tchefuncta, Hammond, and Amite.

A fault zone, referred to as the Baton Rouge fault, crosses southern Tangipahoa Parish. The results of a test-well drilling program indicated that the Baton Rouge fault zone disrupts ground-water flow in the aquifers of intermediate depth in the study area. Analyses of geophysical logs of water-test wells and adjacent oil-test wells indicated that the deep aquifers south of the fault zone have been displaced from 350 to 400 ft, with the deeper aquifers not in hydraulic connection with the ground-water flow system north of the fault.

The ground-water resources of southeastern Louisiana are immense and the quality of ground water in Tangipahoa Parish is suitable for most uses. The freshwater aquifers of the southeastern Louisiana hydrologic system generally yield a soft sodium bicarbonate type water with a dissolved-solids concentration of less than 300 mg/L. The quality of water in these aquifers generally meets the U.S. Environmental Protection Agency's standards for public supply.

The aquifer systems underlying Tangipahoa Parish and adjacent areas currently (1990) supply about 19 Mgal/d of high-quality ground water for public supply. Based on the thickness and hydrologic characteristics of the aquifers in southern Tangipahoa Parish, a minimum of 28 Mgal/d could be withdrawn from a single well field. At the current (1990) rate of withdrawal, the hydrologic system appears to be approaching equilibrium. Substantial increases in pumping from the aquifer system would result in renewed water-level declines throughout the hydrologic system until a new equilibrium is established.

A test well, Ta-576, located at the Bedico Community Center in southern Tangipahoa Parish, penetrated eight aquifers. Total thickness of freshwater sand beds penetrated by the 3,003-foot test hole was more than 1,900 ft. Resistivity values from the electric log typically averaged 200 ohm-meters, which indicated high quality water, low in concentrations of dissolved solids and chloride.

A Theis analysis of the Abita aquifer at Ruddock in St. John the Baptist Parish was completed for two of three hypothetical well fields. For a hypothetical well field with a pumping rate of 112 Mgal/d and a freshwater-saltwater interface located 1.9 mi from the southernmost well, the interface could arrive at the outer perimeter of the well field in 10 to 14 yr.

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– PAGE 43 FOLLOWS –

Appendix. Water-quality data for selected wells in the study area

[μS/cm, microsiemens per centimeter at 25 degrees Celsius; deg. C, degrees Celsius; --, no data; mg/L, milligrams per liter; μg/L, micrograms per liter. Geologic unit: ABIT, Abita aquifer; HMND, Hammond aquifer; AMIT, Amite aquifer; TCFC, Tchefuncta aquifer; PNCLU, upper Ponchatoula aquifer; PNCLL, lower Ponchatoula aquifer; CVGN, Covington aquifer; UPTC, upland terrace deposits]

Well number	Date	Time	Depth (feet)	Geo-logic unit	Spe-cific con-duct-ance (μS/cm)	pH (stand-ard units)	Temper-ature water (deg. C)	Color (plat-inum-cobalt units)
				St. John the Baptist Parish				
SJB-165	03-14-90	1115	3,000	ABIT	--	--	--	70
	11-13-90	1245		ABIT	987	9.0	34.0	50
	01-15-91	0930		ABIT	--	--	37.0	--
	05-03-91	0900		ABIT	1000	--	33.5	--
SJB-176	03-14-90	1200	2,950	ABIT	--	--	--	40
	11-13-90	1130		ABIT	731	8.8	34.5	30
	01-15-91	0915		ABIT	--	--	38.0	--
	05-03-91	0915		ABIT	753	--	33.5	--
SJB-180	01-29-91	1210	3,091	ABIT	780	--	38.5	--
				St. Tammany Parish				
ST-568	04-16-90	1140	2,545	HMND	268	6.9	35.0	0
	01-22-91	1300		HMND	266	8.2	33.0	--
	05-16-91	0900		HMND	261	7.8	33.0	--
ST-592	04-16-90	1305	2,670	AMIT	425	8.4	31.0	5
ST-653	04-17-90	0830	2,305	TCFC	295	8.0	31.0	0
ST-685	04-17-90	1310	2,629	HMND	272	8.1	31.0	0
ST-712	04-10-90	1615	402	PNCLU	189	7.4	21.0	15
	01-22-91	1100		PNCLU	204	7.2	21.0	--
ST-726	04-18-90	0850	2,254	AMIT	272	7.8	30.0	0
ST-971	06-05-90	0930	960	PNCLL	225	7.7	24.0	0
ST-5747Z	06-05-90	1110	860	PNCLL	235	7.8	23.0	5
				Tangipahoa Parish				
Ta-397	04-10-90	1045	1,857	CVGN	236	7.6	21.0	0
Ta-434	06-06-90	1105	2,307	HMND	184	7.6	30.0	0
Ta-570	03-08-90	1230	1,820	CVGN	243	8.8	26.0	0
Ta-571	03-08-90	1430	525	PNCLU	206	7.3	21.0	0
Ta-572	06-06-90	1520	218	UPTC	215	7.6	23.0	10
Ta-573	04-18-90	1220	110	UPTC	244	7.0	21.0	0
Ta-576	01-17-91	1400	1,922	CVGN	292	8.8	29.0	0
Ta-577	01-17-91	1010	1,134	PNCLL	4720	7.9	26.0	0
Ta-578	01-17-91	1130	840	PNCLL	246	7.6	24.0	0
	05-16-91	1050		PNCLL	244	7.8	24.0	--
Ta-579	01-17-91	1400	1,200	PNCLL	179	7.1	25.0	0
Ta-5673Z	04-11-90	0945	735	PNCLL	234	6.9	21.0	0
Ta-6043Z	04-11-90	1300	1,110	PNCLL	186	7.4	24.5	0
	01-22-91	0930		PNCLL	189	7.4	25.0	--

Appendix. Water-quality data for selected wells in the study area--Continued

Well number	Date	Hardness total (mg/L as $CaCo_3$)	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity water whole total fixed end-point titration field (mg/L as $CaCo_3$)	Sulfate dissolved (mg/L as So_4)	Chloride, dissolved (mg/L as Cl)
				St. John the Baptist Parish					
SJB- 165	03-14-90	--	--	--	--	--	--	--	74
	11-13-90	4	1.4	<0.2	230	1.4	404	4.6	75
	01-15-91	--	--	--	--	--	--	--	76
	05-03-91	--	--	--	--	--	--	--	76
SJB- 176	03-14-90	--	--	--	--	--	--	--	19
	11-13-90	3	1.0	<0.2	180	1.1	351	7.4	22
	01-15-91	--	--	--	--	--	--	--	22
	05-03-91	--	--	--	--	--	--	--	24
SJB- 180	01-29-91	--	--	--	--	--	--	--	44
				St. Tammany Parish					
ST- 568	04-16-90	5	1.6	0.3	60	<1.0	118	9.6	3.2
	01-22-91	--	--	--	--	--	--	--	--
	05-16-91	--	--	--	--	--	123	--	--
ST- 592	04-16-90	4	1.4	<0.2	96	<1.0	200	12	2.4
ST- 653	04-17-90	4	1.4	<0.2	66	<1.0	135	8.6	3.1
ST- 685	04-17-90	8	3.1	<0.2	57	<1.0	125	8.7	3.0
ST- 712	04-10-90	14	4.1	0.9	42	2.2	--	10	2.2
	01-22-91	--	--	--	--	--	97	--	--
ST- 726	04-18-90	2	1.0	<0.2	60	<1.0	123	9.6	2.9
ST- 971	06-05-90	5	1.5	0.3	50	1.0	103	10	3.4
ST-5747Z	06-05-90	5	1.5	0.2	53	0.90	109	8.4	4.1
				Tangipahoa Parish					
Ta- 397	04-10-90	28	10	0.8	48	1.4	122	11	2.6
Ta- 434	06-06-90	--	<1.0	<0.2	41	<1.0	83	6.2	4.0
Ta- 570	03-08-90	10	3.2	0.5	51	<1.0	115	7.6	3.1
Ta- 571	03-08-90	19	5.6	1.1	40	1.6	96	9.8	2.1
Ta- 572	06-06-90	13	4.1	0.7	44	1.8	100	7.8	2.2
Ta- 573	04-18-90	33	9.4	2.2	43	2.2	126	0.8	2.2
Ta- 576	01-17-91	--	1.5	<0.2	65	<1.0	135	7.0	3.0
Ta- 577	01-17-91	98	25	8.5	970	3.9	270	15	1300
Ta- 578	01-17-91	3	0.9	0.2	53	1.0	114	8.6	2.0
	05-16-91	--	--	--	--	--	119	--	--
Ta- 579	01-17-91	9	2.8	0.4	37	1.4	76	7.8	2.9
Ta-5673Z	04-11-90	5	1.5	0.3	55	1.2	111	12	3.1
Ta-6043Z	04-11-90	9	2.8	0.4	41	1.2	88	11	2.2
	01-22-91	--	--	--	--	--	83	--	--

Appendix. Water-quality data for selected wells in the study area--Continued

Well number	Date	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 deg. C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, No_2+No_3 dissolved (mg/L as N)	Phosphorus dissolved (mg/L as P)	Antimony, dissolved (µg/L as Sb)	Arsenic dissolved (µg/L as As)
				St. John the Baptist Parish					
SJB- 165	03-14-90	--	--	--	--	--	--	--	--
	11-13-90	0.9	27	591	--	0.03	0.48	<1	<1
	01-15-91	--	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--	--
SJB- 176	03-14-90	--	--	--	--	--	--	--	--
	11-13-90	0.8	27	447	--	<0.02	0.40	<1	<1
	01-15-91	--	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--	--
SJB- 180	01-29-91	--	--	--	--	--	--	--	--
				St. Tammany Parish					
ST- 568	04-16-90	0.2	57	207	--	<0.02	0.50	--	<1
	01-22-91	--	--	--	--	0.02	--	--	--
	05-16-91	--	--	--	--	--	0.45	--	--
ST- 592	04-16-90	0.3	23	257	--	<0.02	0.23	--	<1
ST- 653	04-17-90	0.3	53	214	--	<0.02	0.53	--	<1
ST- 685	04-17-90	0.1	24	178	--	<0.02	0.18	--	<1
ST- 712	04-10-90	<0.2	46	154	164	<0.02	0.14	--	2
	01-22-91	--	--	--	--	--	--	--	--
		--	--	--	--	--	--	--	--
ST- 726	04-18-90	<0.2	23	169	--	<0.02	0.24	--	<1
ST- 971	06-05-90	0.2	46	172	174	<0.02	0.19	--	2
ST-5747Z	06-05-90	0.2	44	175	178	<0.02	0.21	--	3
				Tangipahoa Parish					
Ta- 397	04-10-90	<0.2	42	181	189	<0.02	0.12	--	<1
Ta- 434	06-06-90	0.2	43	192	--	<0.02	0.40	--	--
Ta- 570	03-08-90	0.1	52	187	--	<0.02	0.31	--	<1
Ta- 571	03-08-90	0.1	52	163	170	<0.02	0.14	--	2
Ta- 572	06-06-90	<0.2	43	164	164	<0.02	0.18	--	7
Ta- 573	04-18-90	<0.2	31	161	167	<0.02	0.12	--	<1
Ta- 576	01-17-91	0.2	30	188	--	<0.02	--	--	<1
Ta- 577	01-17-91	0.8	29	2290	2540	<0.02	--	--	<1
Ta- 578	01-17-91	0.2	49	170	183	<0.02	--	--	<1
	05-16-91	--	--	--	--	--	0.17	--	--
Ta- 579	01-17-91	<0.2	57	149	155	<0.02	--	--	<1
Ta-5673Z	04-11-90	<0.2	42	169	182	<0.02	0.20	--	1
Ta-6043Z	04-11-90	<0.2	56	157	167	<0.02	0.30	--	<1
	01-22-91	--	--	--	--	--	--	--	--

Appendix. Water-quality data for selected wells in the study area--Continued

Well number	Date	Barium, dis-solved (µg/L as Ba)	Beryl-lium, dis-solved (µg/L as Be)	Cadmium dis-solved (µg/L as Cd)	Chro-mium, dis-solved (µg/L as Cr)	Copper, dis-solved (µg/L as Cu)	Iron, dis-solved (µg/L as Fe)	Lead, dis-solved (µg/L as Pb)
				St. John the Baptist Parish				
SJB- 165	03-14-90	--	--	--	--	--	--	--
	11-13-90	<100	<10	<1	<1	<1	60	1
	01-15-91	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--
SJB- 176	03-14-90	--	--	--	--	--	--	--
	11-13-90	<100	<10	<1	<1	<1	<25	<1
	01-15-91	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--
SJB- 180	01-29-91	--	--	--	--	--	--	--
				St. Tammany Parish				
ST- 568	04-16-90	<100	--	<1	<10	<1	30	<1
	01-22-91	--	--	--	--	--	--	--
	05-16-91	--	--	--	--	--	--	--
ST- 592	04-16-90	<100	--	<1	<10	<1	<10	<1
ST- 653	04-17-90	<100	--	<1	<10	<1	40	<1
ST- 685	04-17-90	<100	--	<1	<10	<1	10	<1
ST- 712	04-10-90	<100	--	<1	<10	<1	--	<1
	01-22-91	--	--	--	--	--	510	--
ST- 726	04-18-90	<100	--	<1	<10	<1	<10	<1
ST- 971	06-05-90	<100	--	<1	<10	<1	50	<1
ST-5747Z	06-05-90	<100	--	<1	<10	<1	70	<1
				Tangipahoa Parish				
Ta- 397	04-10-90	<100	--	<1	<10	<1	240	<1
Ta- 434	06-06-90	<100	--	<1	<10	<1	1100	<1
Ta- 570	03-08-90	<100	--	<1	<10	1	120	<1
Ta- 571	03-08-90	<100	--	<1	<10	<1	20	<1
Ta- 572	06-06-90	<100	--	<1	<10	<1	110	<1
Ta- 573	04-18-90	<100	--	<1	<10	<1	50	<1
Ta- 576	01-17-91	<100	--	<1	<1	<1	40	<1
Ta- 577	01-17-91	800	--	<1	<1	<1	460	<1
Ta- 578	01-17-91	<100	--	<1	<1	<1	50	<1
	05-16-91	--	--	--	--	--	--	--
Ta- 579	01-17-91	<100	--	<1	<1	<1	110	<1
Ta-5673Z	04-11-90	<100	--	<1	<10	<1	80	<1
Ta-6043Z	04-11-90	<100	--	<1	<10	<1	20	<1
	01-22-91	--	--	--	--	--	--	--

Appendix. Water-quality data for selected wells in the study area--Continued

Well number	Date	Manganese, dissolved (µg/L as Mn)	Mercury dissolved (µg/L as Hg)	Nickel, dissolved (µg/L as Ni)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Zinc, dissolved (µg/L as Zn)	Carbon, organic dissolved (mg/L as C)
				St. John the Baptist Parish				
SJB- 165	03-14-90	--	--	--	--	--	--	--
	11-13-90	<20	<0.1	<1	<1	--	<10	2.2
	01-15-91	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--
SJB- 176	03-14-90	--	--	--	--	--	--	--
	11-13-90	<20	<0.1	<1	<1	--	<10	3.0
	01-15-91	--	--	--	--	--	--	--
	05-03-91	--	--	--	--	--	--	--
SJB- 180	01-29-91	--	--	--	--	--	--	--
				St. Tammany Parish				
ST- 568	04-16-90	29	<0.1	--	<1	<1	<10	0.9
	01-22-91	--	--	--	--	--	--	--
	05-16-91	--	--	--	--	--	--	--
ST- 592	04-16-90	10	<0.1	--	<1	<1	<10	1.0
ST- 653	04-17-90	42	<0.1	--	<1	<1	<10	0.4
ST- 685	04-17-90	27	<0.1	--	<1	<1	<10	0.6
ST- 712	04-10-90	110	<0.1	--	<1	<1	10	0.3
	01-22-91	--	--	--	--	--	--	--
ST- 726	04-18-90	17	<0.1	--	<1	<1	<10	0.3
ST- 971	06-05-90	10	<0.1	--	<1	<1	<10	0.5
ST-5747Z	06-05-90	10	<0.1	--	<1	<1	<10	0.5
				Tangipahoa Parish				
Ta- 397	04-10-90	73	<0.1	--	<1	<1	10	0.4
Ta- 434	06-06-90	130	<0.1	--	--	<1	<10	0.5
Ta- 570	03-08-90	170	<0.1	--	<1	<1	30	0.6
Ta- 571	03-08-90	150	<0.1	--	<1	<1	<10	0.5
Ta- 572	06-06-90	54	<0.1	--	<1	<1	<10	0.5
Ta- 573	04-18-90	75	<0.1	--	<1	<1	200	0.4
Ta- 576	01-17-91	<20	<0.1	--	<1	--	<10	0.4
Ta- 577	01-17-91	71	<0.1	--	<1	<1	10	1.0
Ta- 578	01-17-91	10	<0.1	--	<1	<1	<10	0.3
	05-16-91	--	--	--	--	--	--	--
Ta- 579	01-17-91	<20	<0.1	--	<1	<1	<10	0.2
Ta-5673Z	04-11-90	21	<0.1	--	<1	<1	<10	0.2
Ta-6043Z	04-11-90	65	<0.1	--	<1	<1	<10	0.3
	01-22-91	--	--	--	--	--	--	--

United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Louisiana Agricultural Experiment
Station
Louisiana Soil and Water
Conservation Committee

Soil Survey of Tangipahoa Parish, Louisiana

How To Use This Soil Survey

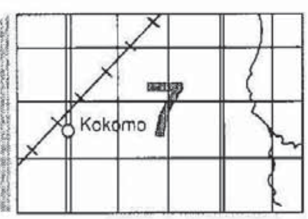
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

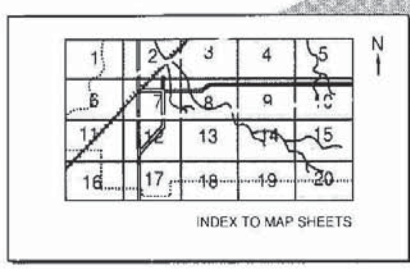
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

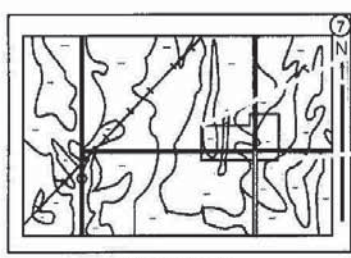


MAP SHEET

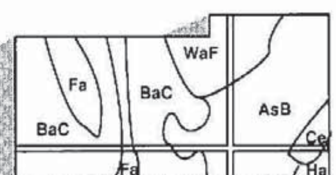
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This soil survey was made cooperatively by the Soil Conservation Service and the Louisiana Agricultural Experiment Station and the Louisiana Soil and Water Conservation Committee. It is part of the technical assistance furnished to the Tangipahoa-St. Helena Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Dairies are important farm enterprises in Tangipahoa Parish. These dairy cows are grazing Pensacola bahiagrass on Tangi silt loam, 1 to 3 percent slopes.

Contents

Soil Series

Issued April 1990

Index to Map Units

Summary of Tables

Foreword

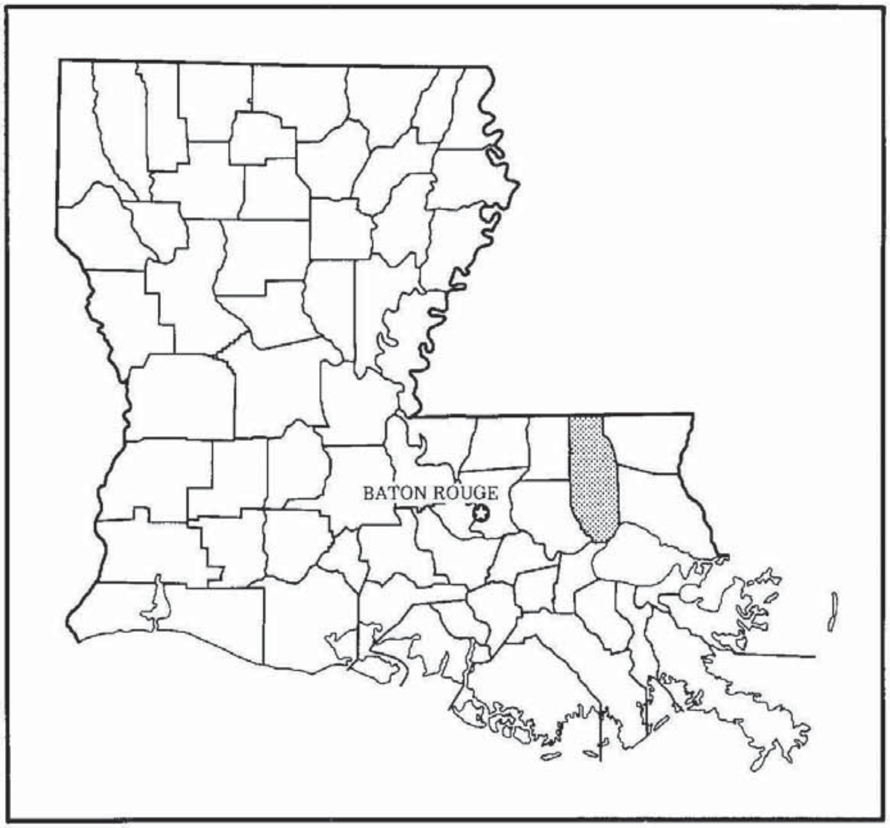
This soil survey contains information that can be used in land-planning programs in Tangipahoa Parish. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Horace J. Austin
State Conservationist
Soil Conservation Service



Location of Tangipahoa Parish in Louisiana.

Soil Survey of
Tangipahoa Parish, Louisiana

By Donald McDaniel, Soil Conservation Service

Field work by Donald McDaniel, Dennis Daugereaux, Wilton Stephens, and Betty Fleming, Soil Conservation Service, and Pamela Seeling, Louisiana Soil and Water Conservation Committee.

United States Department of Agriculture, Soil Conservation Service
In cooperation with Louisiana Agricultural Experiment Station and Louisiana Soil and Water Conservation Committee.

TANGIPAHOA PARISH, in southeastern Louisiana, has a total area of 536,148 acres, of which 22,228 acres is lakes, bayous, and rivers. This parish is bordered on the north by Amite and Pike Counties, Mississippi; on the south by Lake Pontchartrain, Lake Maurepas, and St. John the Baptist Parish; on the east by St. Tammany and Washington Parishes; and on the west by Livingston and St. Helena Parishes. According to the 1980 census, the parish population was 80,698. About 65 percent of the population is in rural areas. Land use is mainly woodland and agriculture. About 67 percent of the land area is woodland and 30 percent is cropland or pastureland. The trend indicates that urban areas are expanding rapidly, particularly in the southern part of the parish.

The parish is made up of three Major Land Resource Areas (MLRA's): the Central Coastal Plain, mainly in woodland and pastureland; the Eastern Gulf Coast Flatwoods, mainly in woodland, pastureland, and truck crops; and the Southern Mississippi Valley Alluvium, used mainly as habitat for wetland wildlife and for recreation. The soils of the Central Coastal Plain are loamy and are dominantly moderately well drained and well drained. The soils of the Eastern Gulf Coast Flatwoods are loamy and are dominantly poorly drained and somewhat poorly drained. The soils of the Southern Mississippi Valley Alluvium are mainly ponded and frequently flooded. These mucky and clayey soils are in swamps and marshes. Elevation ranges from about 340 feet above sea level in the uplands of the Central Coastal Plain to about 5 feet on the stream or marine terraces of the Eastern Gulf Coast Flatwoods. The swamps and marshes range from sea level to about 1 foot above sea level.

General Nature of the Survey Area

This section gives general information concerning the parish. It discusses climate, agriculture, history, transportation, and water resources.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Amite, Louisiana, in the period 1951 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 51 degrees F, and the average daily minimum temperature is 40 degrees. The lowest temperature on record, which occurred at Amite on January 12, 1962, is 9 degrees. In summer the average temperature is 81 degrees, and the average daily maximum temperature is 92 degrees. The highest recorded temperature, which occurred on July 1, 1954, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average

temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 34 inches. Of this, 19 inches, or 55 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 27 inches. The heaviest 1-day rainfall during the period of record was 8.55 inches at Amite on September 6, 1977. Thunderstorms occur on about 70 days each year, and most occur in summer.

Snowfall is rare. In 90 percent of the winters, there is no measurable snowfall. In 10 percent, the snowfall, usually of short duration, is more than 2 inches. The heaviest 1-day snowfall on record was more than 3 inches.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 90 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southeast. Average windspeed is highest, 10 miles per hour, in spring.

Agriculture

Tangipahoa Parish is primarily agricultural. According to the 1982 annual report of the Louisiana Cooperative Extension Service, 1,267 farms were in the parish. The value of the average farm, including land and buildings, was about 227,803 dollars. The average size of a farm in 1978 was about 133 acres, and by 1983 it had decreased to about 122 acres. The estimated gross value of all agricultural products in 1983 was 77 million dollars. According to the 1982 U.S. Census of Agriculture, 3 percent of the total population of the parish was employed by the agriculture industries.

The dairy industry is the principal agricultural revenue-producing enterprise. In 1983, the dairy industry generated over 43 million dollars in gross revenue. In 1978, according to the U.S. Census of Agriculture, 374 active dairies were in the parish. In 1983, there were 349 dairies.

In 1982, about 154,448 acres was used as cropland and pasture. About 92,512 acres was cropland and 48,989 acres was pasture. In 1983, the three major crops in order of cash value were bell peppers, strawberries, and soybeans. Other vegetable crops commercially produced are broccoli, cabbage, cucumber, okra, snap bean, and tomato. Small acreages of corn and wheat are also planted in most years.

History

Tangipahoa Parish was named after the Indian village originally in an area north of Lake Pontchartrain. The "Tangibao," corncob people or corn gatherers, were mentioned in accounts of French explorers dating back to 1683 *(22)*. These Indians, for reasons unknown, were successful farmers who moved toward the east bank of the Mississippi River, and there were slaughtered by a neighboring tribe, possibly the Houma Indians.

The Choctaw Indians followed the Tangipahoa Indians into this region on the banks of the Tangipahoa, Natalbany, and Tchefuncte Rivers. They were also farmers and like the Tangipahoa, depended upon corn cultivation for their subsistence *(22)*. The Choctaw were peaceful and pastoral and provided the first European settlers with the woodcrafts and swamp crafts necessary to survive in the region.

Today, the Indian heritage of Tangipahoa Parish is most evident in the place-names of Indian Origin *(22)*. Among these are Manchac, meaning "rear entrance;" Chappepeela, meaning "Hurricane River;" Natalbany, meaning "Bear Camp;" Pontchatoula, meaning "falling or hanging hair;" and Tickfaw, meaning "wild beasts shed their hair there."

Tangipahoa Parish owes much to the building of the New Orleans, Jackson, and Great Northern Railroad (currently the Illinois Central). This railroad crosses the Tangipahoa Parish from Manchac to the State of Mississippi *(22)*. The railroad changed Louisiana north of Manchac from a remote and sparsely settled area into a mass of towns, gins, mills, and farms.

Because of the increased population and demands for a new parish, Tangipahoa Parish was created in 1869 from the western parts of St. Tammany and Washington Parishes and the eastern parts of Livingston and St. Helena Parishes. This four-part parentage provides Tangipahoa's motto: "Out of Four One" *(22)*.

The railroad not only initiated the development of Tangipahoa Parish, it stimulated a major parish industry, the growing and shipping of strawberries *(22)*. Today, Tangipahoa Parish still produces more strawberries than any other parish in the state (fig. 1).

Shortly after strawberries were introduced, the Illinois Central Railroad, in cooperation with the Extension Department of Louisiana State University, introduced a systematic crop rotation program that included pasture grasses. This led to the growth and development of the livestock and dairy enterprises *(17)*.

During the latter part of the nineteenth century and early part of the twentieth century, lumber mills harvested the vast stores of timber to the north, and Sicilian immigrants moved in to claim cutover land for small truck farms. Later, when pine forests had been cut over, lumbermen moved into the swamps of Tangipahoa Parish to harvest the virgin cypress forests. Frontier conditions in the mill towns produced a violent lifestyle that generated the slogan "Bloody Tangipahoa" *(22)*.

Figure 1.—Tangipahoa Parish is first in strawberry production in the state. These strawberries are on Guyton silt loam.

Transportation

Tangipahoa Parish is served by two interstate highways and many other paved federal, state, and parish highways. An airport near the town of Hammond serves small private and commercial aircraft.

The parish is served by a north-south and east-west mainline of the Illinois Central Gulf Railroad. Amtrak also provides north-south passenger rail service.

Water Resources

Surface Water. The Tangipahoa, Tchefuncte, and Natalbany Rivers and their tributaries, are the major sources of surface water in Tangipahoa Parish. The average annual runoff of the Tangipahoa River at Robert is about 835,496 acre-feet per year *(10)*. The Tangipahoa River and its tributaries drain most of the north, central, and south-central parts of the parish. The Tchefuncte River and its tributaries drain a large portion of the northeastern and central-eastern parts of the parish. The average annual runoff of the Tchefuncte River near Folsom is 117,288 acre-feet per year *(10)*. The Natalbany River and its tributaries drain much of the southwestern part of the parish. The average annual runoff of the Natalbany River at Baptist is 84,708 acre-feet per year *(10)*. The Tangipahoa and Tchefuncte Rivers drain into Lake Pontchartrain. The Natalbany River flows into the Tickfaw River which, in turn, flows into Lake Maurepas.

Ground water. The aquifers in Tangipahoa and St. Tammany Parishes constitute one of the largest sources

of fresh ground water in Louisiana *(23)*. Twelve major aquifers, ranging from Miocene to Holocene in age yield water of good quality at rates of 1,000 gallons to more than 3,000 gallons per minute. Large capacity wells are as deep as 3,354 feet.

The rate of water level decline in the deep aquifers (deeper than 1,500 feet) generally exceeded 2 feet per year from 1969 to 1976. This decline reflects pumping within and outside of Tangipahoa Parish and also reflects adjustments in artesian pressure throughout the aquifer system. Water is moving from the little-used aquifers that have relatively high artesian heads to heavily pumped aquifers of lower artesian heads. Aquifers within 1,500 feet of the surface generally are pumped less and therefore, have a lower rate of water level decline than the deep aquifers.

The ground water in Tangipahoa Parish is a sodium bicarbonate type that generally contains less iron and hardness with depth. In most aquifers, the concentrations of iron and manganese are less than 0.5 milligrams per liter. Hardness is less than 30 milligrams per liter, and the content of dissolved solids is less than 350 milligrams per liter. Locally, water may contain objectionable amounts of hydrogen sulfide and silica. Water from most of the shallow aquifers and from many of the deep aquifers in the northern part of the parish tends to be corrosive.

The Kentwood, Covington, Ponchatoula, Tchefuncte, and shallow aquifers have the greatest potential for development. The Kentwood, Ponchatoula, and shallow aquifers are near sources of recharge, are not pumped heavily, and contain extensive deposits of sand and gravel. The Covington aquifer is pumped in many areas, but it is sufficiently thick and extensive to accomodate additional development. The Tchefuncte aquifer is used very little and has a large potential for development.

The water-level of the Amite, Hammond, and Slidell aquifers has declined more than 2 feet per year (1969-74) in some areas. Therefore, the potential for additional development is lower. These aquifers, however, can support additional development in areas distant from current pumping centers. The Big Branch aquifer is used very little and has limited potential for further development because of the low transmissivity of the aquifer.

Other aquifers having development potential include the Abita, Ramsay, and Franklinton aquifers. The Abita aquifer has a lower transmissivity than most of the other aquifers, but locally the sands are sufficiently thick and permeable to supply large-capacity wells (1,000 gallons per minute or more). The Abita aquifer now has a higher artesian head than any other aquifer of similar of more shallow depth in the area. The Ramsay and Franklinton aquifers are used very little because they are the deepest aquifers in the parish, and they may not contain freshwater near population centers. These very deep aquifers are generally excellent sources of high-quality water.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; and the kinds of crops and native plants growing on the soils. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material from which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they

could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area are generally collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. In the detailed soil map units, these latter soils are called inclusions or included soils. In the general soil map units, they are called soils of minor extent.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named and mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Descriptions, names, and delineations of soils in this survey do not fully agree with those in published surveys of adjacent parishes in Louisiana. These differences are the result of better information on soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey area.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or a building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The soils in the survey area vary widely in their potential for major land uses. Table 4 shows the extent of the map units shown on the general soil map. It lists the suitability of each, in relation to that of the other map units, for major land uses and shows soil properties that limit use. Soil suitability ratings are based on the practices commonly used in the survey area to overcome soil limitations. These ratings reflect the ease of overcoming the limitations. They also reflect the problems that will persist even if such practices are used.

Each map unit is rated for *cultivated crops, pastureland, woodland, urban uses,* and *intensive recreation areas.* Cultivated crops are those grown extensively in the survey area. Pastureland refers to pastures of native and improved grasses for livestock. Woodland refers to areas of native or introduced trees. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas are campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic.

The boundaries of the general soil map units in Tangipahoa Parish were matched, where possible, with those of the previously completed surveys of St. John the Baptist and St. Tammany Parishes and Amite and Pike Counties, Mississippi. In a few places, however, the lines do not join and the names of the map units differ. These differences resulted mainly because of design, and changes in soil patterns near survey area boundaries.

The general soil map units in this survey have been grouped into four general landscapes. Descriptions of each of the broad groups and the map units in each group follow.

Soils on Terrace Uplands

The two map units in this group consist mainly of very gently sloping to moderately steep, moderately well drained and well drained, loamy soils. These soils are on ridgetops and side slopes on the terrace uplands. Slopes range from 1 to 20 percent.

The map units make up about 41 percent of the land area. Most of the acreage is pasture or woodland. The soils have few limitations for timber production. Low fertility and steepness of slope are the main limitations for crops and pasture. Wetness, slope, and moderate to slow permeability are limitations for most urban uses.

1. Tangi-Ruston-Smithdale

Very gently sloping to moderately steep, moderately well drained and well drained soils that have a loamy surface layer and a loamy and clayey subsoil

The soils of this map unit are on ridgetops and side slopes on terrace uplands. The landscape is crossed by numerous small drainageways. Elevations range from about 105 to 360 feet above sea level. Slopes range from 1 to 8 percent on the ridgetops and from 3 to 20 percent on the side slopes.

This map unit makes up about 24 percent of the land area of the parish. It is about 43 percent Tangi soils, 39 percent Ruston soils, 14 percent Smithdale soils, and 4 percent soils of minor extent.

The Tangi soils are very gently sloping to moderately sloping. These moderately well drained soils are on narrow and broad ridgetops and on side slopes along drainageways. The surface layer is dark grayish brown silt loam. The subsoil is yellowish brown silt loam in the upper part; the lower part is a fragipan of mottled yellowish brown, yellowish red, and red loam, clay loam, clay, and sandy clay loam.

The Ruston soils are very gently sloping and rolling. These well drained soils are on narrow ridgetops and on side slopes. The surface layer is dark grayish brown fine

sandy loam. The subsoil is yellowish red, light reddish brown, and red sandy clay loam, and sandy loam.

The Smithdale soils are rolling and moderately steep. These well drained soils are on side slopes. The surface layer is very dark grayish brown or dark grayish brown fine sandy loam. The subsoil is red and yellowish red sandy clay loam in the upper part and red sandy loam in the lower part.

Of minor extent in this map unit are the Malbis, Ochlockonee, Ouachita, and Guyton soils. The Malbis soils are moderately well drained and are in positions similar to those of the Tangi soils. The Ochlockonee and Ouachita soils are well drained; the Guyton soils are poorly drained. These soils are on the narrow flood plains of streams.

The soils of this map unit are used mainly as woodland and pasture. Small acreages are used for crops and homesites.

The soils are well suited to use as woodland. Low fertility and a moderate hazard of erosion are the main limitations to this use. The soils of this map unit are well suited to pasture and moderately well suited to cultivated crops except the Smithdale soils that have moderately steep slopes. These Smithdale soils are poorly suited to crops and moderately well suited to pasture. The soils of this map unit are moderately well suited to urban uses and intensive recreation uses except the Smithdale soils that have moderately steep slopes. These Smithdale soils are poorly suited. Low strength for roads, moderate and very slow permeability, wetness, and the hazard of erosion are the main limitations to urban and recreation uses.

2. Toula-Tangi

Very gently sloping and moderately sloping, moderately well drained soils that have a loamy surface layer and a loamy and clayey subsoil

The soils of this map unit are on broad to narrow ridgetops and on side slopes along drainageways. Elevations range from about 60 to 240 feet above sea level. Slopes range from 1 to 3 percent on the ridgetops and from 3 to 8 percent on the side slopes.

This map unit makes up about 17 percent of the land area of the parish. It is about 56 percent Toula soils, 30 percent Tangi soils, and 14 percent soils of minor extent.

The Toula soils are very gently sloping and are on broad ridgetops. The surface layer is dark grayish brown silt loam. The subsoil is light yellowish brown and yellowish brown silt loam in the upper part; the lower part is a compact and brittle fragipan. It is mottled, yellowish brown and red silty clay loam, silt loam, and clay loam.

The Tangi soils are very gently sloping and moderately sloping and are on narrow and broad ridgetops and on side slopes along drainageways. The surface layer is dark grayish brown silt loam. The subsoil is yellowish brown silt loam in the upper part; the lower part is a fragipan of mottled yellowish brown, yellowish red, and red loam, clay loam, sandy clay loam, and clay.

Of minor extent are the Fluker, Guyton, Malbis, Ochlockonee, Ouachita, and Ruston soils. Fluker soils are somewhat poorly drained and are in depressional areas on ridgetops. Malbis soils are moderately well drained, and Ruston soils are well drained. These soils are on ridgetops and side slopes. Guyton soils are poorly drained, and Ochlockonee and Ouachita soils are well drained. These soils are on the flood plains of streams.

The soils of this map unit are used mainly as woodland and pasture. Small acreages are used for crops and homesites.

The soils of this map unit are well suited to woodland and have few limitations to this use. These soils are well suited to pasture and moderately well suited to cultivated crops. Low fertility and the hazard of erosion are the main limitations to these uses. The soils of this map unit are moderately well suited to urban uses and intensive recreation uses. Low strength for roads, wetness, and slow and very slow permeability are the main limitations to urban and recreation uses.

Soils on Stream or Marine Terraces

The map units in this group consist mainly of level to moderately sloping, poorly drained to well drained, loamy soils on stream or marine terraces. Slopes range from 0 to 6 percent.

The map units make up about 32 percent of the parish. Most of the acreage is woodland. Small acreages are used for pasture, truck crops, or homesites. Wetness and flooding are the main concerns in woodland management and for most agricultural and urban uses.

3. Guyton-Abita

Level to gently sloping, poorly drained and somewhat poorly drained soils that are loamy throughout

The soils of this map unit are mainly on broad flats, in drainageways or depressional areas, and on broad, slightly convex ridges on stream or marine terraces. Elevations range from 5 to 60 feet above sea level. Slopes are 0 to 1 percent on the flats and in depressional areas and range from 0 to 5 percent on the ridges.

This map unit makes up about 17 percent of the land area of the parish. It is about 50 percent Guyton soils, 46 percent Abita soils, and 4 percent soils of minor extent.

The Guyton soils are level and poorly drained. They are on broad flats, in swales and drainageways, and in depressional areas. The surface layer is brown or dark grayish brown silt loam. The subsurface layer is mottled grayish brown, gray, and light brownish gray silt loam. The subsoil is mottled light gray, gray, and grayish brown silty clay loam and silt loam.

The Abita soils are nearly level and gently sloping and are somewhat poorly drained. They are on broad, slightly

convex ridges and on side slopes along drainageways. The surface layer is dark grayish brown silt loam, and the subsurface layer is pale brown or light brownish gray silt loam. The subsoil is mottled brownish and grayish silt loam and silty clay loam.

Of minor extent in this map unit are the Cahaba, Brimstone, Myatt, Prentiss, and Stough soils. The Cahaba soils are well drained, and the Prentiss soils are moderately well drained. These soils are on convex ridges. Stough soils are somewhat poorly drained and are in positions on the landscape similar to those of the Abita soils. Brimstone and Myatt soils are poorly drained and are in positions similar to those of the Guyton soils.

The soils of this map unit are used mainly as woodland and pasture. Small acreages are used for truck crops and homesites.

The soils of this map unit are well suited to use as woodland. The main concerns in producing and harvesting timber are limitations in the use of equipment and seedling mortality caused by wetness and flooding. These soils are moderately well suited to crops and well suited to pasture. Low fertility and wetness are the main limitations. The Guyton soils that are subject to occasional flooding are poorly suited to crops. The soils of this map unit are poorly suited to urban uses and intensive recreation uses. Wetness, low strength for roads, moderate shrink-swell potential, and the hazard of flooding are the main limitations to urban and recreation uses.

4. Myatt-Guyton

Level, poorly drained soils that are loamy throughout

The soils of this map unit are on broad flats and in swales and small drainageways. Elevations range from 40 to 110 feet above sea level. Slopes are 0 to 1 percent.

This map unit makes up about 6 percent of the land area of the parish. It is about 49 percent Myatt soils, 33 percent Guyton soils, and 18 percent soils of minor extent.

The Myatt soils have a surface layer of very dark gray fine sandy loam and a subsurface layer of gray, mottled fine sandy loam. The subsoil is gray and light gray, mottled loam, clay loam, and sandy clay loam. The substratum is light gray, mottled clay loam.

The Guyton soils have a surface layer of brown or dark grayish brown silt loam. The subsurface layer is mottled grayish brown, gray, and light brownish gray silt loam. The subsoil is mottled light gray, gray, and grayish brown silty clay loam and silt loam.

Of minor extent in this map unit are the Cahaba, Brimstone, Prentiss, and Stough soils. The Cahaba soils are well drained, and the Brimstone soils are poorly drained. The Prentiss soils are moderately well drained, and the Stough soils are somewhat poorly drained. The Cahaba and Prentiss soils are on convex ridges. The Brimstone soils are intermingled with Guyton soils and have a high content of sodium in the subsoil.

The soils of this map unit are used mainly as woodland and pasture. A small acreage is used for homesites.

The soils are well suited to woodland production. The main concerns in producing and harvesting timber are limitations in the use of equipment and seedling mortality caused by wetness and flooding. These soils are well suited to pasture and moderately well suited to crops. Low fertility and wetness are the main limitations. Flooding is a hazard in some areas. The soils are poorly suited to urban development and intensive recreation uses. Wetness, slow permeability, low strength for roads, and the hazard of flooding are the main limitations.

5. Stough-Myatt

Level, somewhat poorly drained and poorly drained soils that are loamy throughout

The soils of this map unit are on slightly convex ridges and broad flats and in swales and small drainageways. Elevations range from 20 to 40 feet above sea level. Slopes are 0 to 1 percent.

This map unit makes up about 1 percent of the land area of the parish. It is about 85 percent Stough soils, 13 percent Myatt soils, and 2 percent soils of minor extent.

The Stough soils are somewhat poorly drained. They are on slightly convex ridges. The surface layer is dark grayish brown fine sandy loam, and the subsurface layer is pale brown, mottled fine sandy loam. The subsoil is light yellowish brown, mottled loam and mottled light yellowish brown, yellowish brown, strong brown, and light brownish gray sandy clay loam.

The Myatt soils are poorly drained. They are on broad flats and in swales and small drainageways. The surface layer is very dark gray fine sandy loam, and the subsurface layer is gray, mottled fine sandy loam. The subsoil is gray and light gray, mottled loam, clay loam, and sandy clay loam. The substratum is light gray, mottled clay loam.

Of minor extent in this map unit are the Abita, Cahaba, Guyton, and Prentiss soils. The Abita soils are somewhat poorly drained, the Cahaba soils are well drained, the Guyton soils are poorly drained, and the Prentiss soils are moderately well drained. The Abita soils are in positions on the landscape similar to those of the Stough soils. The Cahaba and Prentiss soils are on convex ridges. The Guyton soils are in positions similar to those of the Myatt soils.

The soils of this map unit are used mainly as woodland and pasture. Small acreages are used for truck crops and homesites.

The soils are well suited to woodland production. The main concerns in producing and harvesting timber are limitations in the use of equipment and seedling mortality caused by wetness. Flooding is also a hazard in some

areas of the Myatt soils. These soils are well suited to pasture and moderately well suited to crops. Low fertility and wetness are the main limitations. Flooding is a hazard in some areas of the Myatt soils. The soils are poorly suited to urban and recreation uses. Wetness and the hazard of flooding are the main limitations. Slow permeability is a limitation for some sanitary facilities.

6. Fluker-Savannah-Myatt-Cahaba

Level to moderately sloping, poorly drained to well drained soils that are loamy throughout

The soils of this map unit are mainly on broad flats and convex ridges and in swales and small drainageways on stream or marine terraces. Elevations range from about 95 to 240 feet above sea level. Slopes range from 0 to 6 percent.

This map unit makes up about 5 percent of the land area of the parish. It is about 36 percent Fluker soils, 33 percent Savannah soils, 16 percent Myatt soils, 13 percent Cahaba soils, and 2 percent soils of minor extent.

The Fluker soils are nearly level and are somewhat poorly drained. They are on broad flats on stream terraces. The surface layer is dark grayish brown silt loam. The subsoil is light yellowish brown, yellowish brown, and grayish brown, mottled silt loam and silty clay loam in the upper part; the lower part is a fragipan of yellowish brown, mottled silt loam and mottled strong brown, pale brown, and yellowish brown loam.

The Savannah soils are very gently sloping and moderately well drained. They are on slightly convex slopes. The surface layer is dark grayish brown silt loam. The subsoil is mottled stong brown and yellowish brown silt loam and loam in the upper part. The lower part is a fragipan of mottled brownish and reddish loam and sandy loam.

The Myatt soils are level and poorly drained. They are on broad flats and in swales and small drainageways. The surface layer is very dark gray fine sandy loam, and the subsurface layer is gray, mottled fine sandy loam. The subsoil is gray and light gray, mottled loam and clay loam.

The Cahaba soils are very gently sloping and moderately sloping and well drained. They are on convex ridges on stream terraces. The surface layer is dark brown fine sandy loam. The subsoil is yellowish red and strong brown sandy clay loam and sandy loam. The substratum is stratified light yellowish brown and yellowish brown loamy fine sand and strong brown fine sandy loam.

Of minor extent in this map unit are the Guyton, Ochlockonee, and Ouachita soils and areas of Pits and Arents along the Tangipahoa River. The Guyton soils are poorly drained, and the Ochlockonee and Ouachita soils are well drained. These soils are on flood plains along streams. Pits are the excavations from which sand or gravel was removed, and Arents are the spoil banks around the pits.

The soils are well suited to woodland production. Cahaba and Savannah soils have few limitations to this use. Limitations in the use of equipment and seedling mortality caused by wetness are problems in areas of the Fluker and Myatt soils. These soils are well suited to pasture and moderately well suited to crops. Low fertility and wetness are the main limitations. Flooding is a hazard in some areas of Myatt soils. The Fluker and Myatt soils are poorly suited to urban uses. The Cahaba soils are well suited, and the Savannah soils are moderately well suited. The main limitations are wetness, low strength for roads, and moderately slow and slow permeability. In addition, some areas of Myatt soils are subject to flooding.

7. Cahaba-Myatt

Level to moderately sloping, well drained and poorly drained soils that are loamy throughout

The soils of this map unit are on convex ridges and broad flats and in swales and small drainageways. Elevations range from about 20 to 110 feet above sea level. Slopes range from 0 to 6 percent.

This map unit makes up about 3 percent of the land area of the parish. It is about 70 percent Cahaba soils, 28 percent Myatt soils, and 2 percent soils of minor extent.

The Cahaba soils are very gently sloping and moderately sloping. These well drained soils are on convex ridges. The surface layer is dark brown fine sandy loam. The subsoil is yellowish red and strong brown sandy clay loam and sandy loam. The substratum is stratified light yellowish brown and yellowish brown loamy fine sand and strong brown fine sandy loam.

The Myatt soils are level and poorly drained. They are on broad flats and in swales and small drainageways. The surface layer is very dark gray fine sandy loam, and the subsurface layer is gray, mottled fine sandy loam. The subsoil is gray and light gray, mottled loam, clay loam, and sandy clay loam.

Of minor extent in this map unit are the Abita, Guyton, Prentiss, Stough, and Toula soils. The Abita and Toula soils are moderately well drained, the Guyton soils are poorly drained, the Prentiss soils are moderately well drained, and the Stough soils are somewhat poorly drained. The Abita, Prentiss, Stough, and Toula soils are on slightly convex ridges. The Guyton soils are in positions on the landscape similar to those of the Myatt soils.

The soils of this map unit are used mainly as cropland, woodland, and pasture. Small acreages are used for homesites and other urban uses.

The soils are well suited to cultivated crops. The main limitation is low fertility. Wetness and the hazard of flooding are additional limitations in areas of the Myatt

soils. The soils are well suited to woodland production. Cahaba soils have few limitations to this use; however, limitations in the use of equipment and seedling mortality caused by wetness and flooding are problems in areas of the Myatt soils. The soils are well suited to pasture. Low fertility is the main limitation of Cahaba soils. Myatt soils are limited by wetness, flooding, and low fertility. The Cahaba soils are well suited to urban and intensive recreation uses, and the Myatt soils are poorly suited. Wetness, slow permeability, and the hazard of flooding are the main limitations of the Myatt soils.

Soils on Flood Plains

The map unit in this group consists mainly of level to gently undulating, well drained and poorly drained, loamy soils that are frequently flooded. These soils are on flood plains. Slopes range from 0 to 3 percent.

This map unit makes up about 12 percent of the land area of the parish. Most of the acreage is in bottom land hardwoods. Small acreages are used for pasture and recreation. Wetness, low strength for roads, low fertility, and the hazard of flooding are the main limitations.

8. Ouachita-Ochlockonee-Guyton

Level to gently undulating, well drained and poorly drained soils that have a loamy surface layer and a loamy or loamy and sandy subsoil and underlying material

The soils of this map unit are on flood plains of streams. They are subject to frequent flooding. Elevations range from about 5 feet to 200 feet above sea level. Slopes range from 0 to 3 percent.

This map unit makes up about 12 percent of the land area of the parish. It is about 33 percent Ouachita soils, 28 percent Ochlockonee soils, 19 percent Guyton soils, and 20 percent soils of minor extent.

The Ouachita soils are gently undulating and well drained. They are on convex ridges. The surface layer is dark brown silt loam, and the subsoil is yellowish brown and dark yellowish brown silt loam.

The Ochlockonee soils are gently undulating and well drained. They are also on convex ridges. The surface layer is dark grayish brown sandy loam, and the underlying material is stratified yellowish and brownish sandy loam and loamy fine sand.

The Guyton soils are level and poorly drained. They are in swales and flats between the ridges. The surface layer is brown or dark grayish brown silt loam. The subsurface layer is mottled grayish brown, gray, and light brownish gray silt loam. The subsoil is mottled light gray, gray, and grayish brown silty clay loam and silt loam.

Of minor extent in this map unit are the Cahaba soils and soils that are similar to Guyton soils except that they contain more sand throughout. Cahaba soils are well drained and are on convex ridges on nearby stream terraces.

The soils of this map unit are used mainly as woodland. Small acreages are used for pasture or recreation.

The soils are moderately well suited to bottom land hardwoods. The main concerns in producing and harvesting timber are seedling mortality and limitations in the use of equipment caused by wetness and flooding. These soils are poorly suited to pasture. Wetness, low fertility, and the hazard of flooding are the main limitations. The soils are not suited to cultivated crops, urban uses, or intensive recreation uses. Wetness and the hazard of flooding are generally too severe for these uses. These soils are well suited to use as habitat for deer, squirrels, rabbits, ducks, turkeys, and numerous other small birds and animals.

Soils in Swamps

The map unit in this group consists mainly of level, very poorly drained, very fluid, mucky soils in swamps. These soils are flooded or ponded most of the time.

This map unit makes up about 15 percent of the land area of the parish. Most of the acreage is in native vegetation and is used for extensive forms of recreation and as habitat for wetland wildlife.

9. Maurepas

Level, very poorly drained, organic soils that are mucky throughout

The soils of this map unit are in swamps that are flooded or ponded most of the time. Elevations range from sea level to about 1 foot above sea level. Slope is less than 1 percent.

This map unit makes up about 15 percent of the land area of the parish. It is about 85 percent Maurepas soils and 15 percent soils of minor extent

Maurepas soils have a very dark grayish brown muck surface layer underlain by dark brown and dark reddish brown muck.

Of minor extent are the Barbary and Kenner soils. The Barbary soils are very poorly drained and are at slightly higher elevations. They are mostly fluid and clayey throughout. Kenner soils are in freshwater marshes.

Most of the acreage of this map unit is in native trees and aquatic vegetation. It is used for recreation and as habitat for wetland wildlife. The soils provide habitat for waterfowl, furbearers, alligators, swamp rabbits, and nongame birds. They are part of an estuary that contributes to the support of marine fishes and crustaceans. Hunting and outdoor activities are popular in areas of this map unit.

These soils are not suited to crops, pasture, woodland, or urban uses. The hazard of flooding, wetness, subsidence, and low strength are generally too severe for these uses.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Guyton silt loam, occasionally flooded, is one of several phases in the Guyton series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Brimstone-Guyton silt loams is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Ruston-Smithdale association, rolling, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Ouachita, Ochlockonee, and Guyton soils, frequently flooded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The Pits part of the Pits-Arents complex, 0 to 5 percent slopes, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 5 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

The boundaries of the detailed map units in Tangipahoa Parish were matched, where possible, with those of the previously completed surveys of St. John the Baptist and St. Tammany Parishes and Amite and Pike Counties, Mississippi. In a few places, the lines do not join and there are differences in the names of the map units. These differences result mainly from changes in soil series concepts, differences in map unit design, and changes in soil patterns near survey area boundaries.

All of the soils in Tangipahoa Parish were mapped at the same level of detail except for those rolling soils on uplands and those soils on bottom lands that are subject to frequent flooding. The steepness and irregularity of slope and the hazard of flooding limit the use and management of the soils, and separating all of the soils in these areas would be of little importance to the land user.

Aa—Abita silt loam, 0 to 2 percent slopes. This soil is nearly level and is somewhat poorly drained. It is on broad, slightly convex ridges on stream or marine terraces. Areas range from about 20 to 300 acres.

Typically, the surface layer is dark grayish brown, extremely acid silt loam about 5 inches thick. The subsurface layer to a depth of about 10 inches is pale brown, very strongly acid silt loam. The subsoil to a depth of about 16 inches is yellowish brown and light brownish gray, mottled, very strongly acid silt loam. To a depth of about 64 inches, the subsoil is mottled strong brown, yellowish brown, light brownish gray, and red, strongly acid silty clay loam in the upper part; light brownish gray, mottled, medium acid silty clay loam in the middle part; and light olive gray, mottled, medium acid silty clay loam in the lower part.

Included with this soil in mapping are a few small areas of Guyton, Myatt, Prentiss, and Stough soils. The Guyton and Myatt soils are poorly drained. They are in flat areas in low positions and are grayish throughout. The Prentiss soils are moderately well drained. They are in slightly higher positions than the Abita soil. They have more sand throughout and have a fragipan in the lower part of the subsoil. The Stough soils are somewhat poorly drained. They are in positions similar to those of the Abita soil and have more sand throughout. The included soils make up about 10 percent of the map unit.

This Abita soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate. Water runs off the surface at a slow rate and stands in low places for short periods after heavy rains. A seasonal high water table fluctuates between depths of about 1.5 and 3 feet from December to April. This soil has moderate shrink-swell potential in the subsoil.

This Abita soil is mainly used as woodland and pasture. Small acreages are used for truck crops, homesites, or intensive recreation areas, such as playgrounds and campsites.

This soil is well suited to sweetgum and loblolly pine, longleaf pine, and slash pine. The main concerns in producing and harvesting timber are equipment use limitations caused by wetness and the susceptibility of the soil to compaction. Soil compacts less if suitable logging systems are used, if skid trails are laid out in advance, and if timber is harvested when the soil is least susceptible to compaction. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from December to April. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Abita soil is well suited to pasture. The main limitations are wetness and low fertility. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, white clover, southern winter peas, vetch, tall fescue, and ryegrass. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly vegetables and soybeans. The main limitations are low fertility, wetness, and potentially toxic levels of exchangeable aluminum within the root zone. This soil is friable and easy to keep in good tilth. It can be worked throuthout a wide range of moisture content. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum.

This soil is moderately well suited to urban uses. The main limitations are wetness, low strength for roads, slow permeability, and moderate shrink-swell potential. This soil has moderate to severe limitations for building sites and severe limitations for local roads and streets and most sanitary facilities. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. Drainage is needed for most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units are suitable systems for sewage disposal. Roads and streets should be designed to offset the limited ability of the soil to support a load. Buildings and roads can be designed to offset the effects of shrinking and swelling.

This soil is moderately well suited to recreational development. Wetness and slow permeability are the main limitations, and good drainage is needed for most recreational uses. Plant cover can be maintained by controlling traffic and fertilizing the soil.

This soil is well suited to use as habitat for openland and woodland wildlife, such as deer, rabbit, quail, turkey, dove, and numerous small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants.

This Abita soil is in capability subclass IIw. The woodland ordination symbol is 11W.

Ab—Abita silt loam, 2 to 5 percent slopes. This soil is gently sloping and somewhat poorly drained. It is on side slopes along drainageways on stream or marine terraces. Areas range from about 100 to several hundred acres.

Typically, the surface layer is brown, strongly acid silt loam about 3 inches thick. The subsurface layer to a

depth of about 10 inches is light brownish gray, strongly acid silt loam. The subsoil to a depth of about 60 inches is yellowish brown, strongly acid, mottled silt loam in the upper part; light yellowish brown and gray, mottled, strongly acid silt loam in the middle part; and mottled pale brown, grayish brown, strong brown, and yellowish brown, strongly acid silty clay loam in the lower part.

Included with this soil in mapping are a few small areas of Cahaba and Guyton soils. The Cahaba soils are well drained. They are on convex ridges and have a subsoil that is reddish in the upper part. The Guyton soils are poorly drained. They are on the flood plains of drainageways and are grayish throughout. The included soils make up about 10 percent of the map unit.

This Abita soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate, and water runs off the surface at a medium rate. A seasonal high water table is at a depth of about 1.5 to 3 feet from December to April. The shrink-swell potential is moderate in the subsoil.

In most areas, this Abita soil is used as woodland and pasture. A few areas are used for crops or for urban and recreational development.

This soil is well suited to loblolly pine, slash pine, and sweetgum. The main concerns in producing and harvesting timber are soil compaction and equipment use limitations caused by wetness. When the soil is moist, standard-wheeled equipment causes rutting and compaction. Low pressure ground equipment causes less damage and helps maintain productivity. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This soil is well suited to pasture. Wetness and low fertility are the main limitations. Erosion is a minor hazard until plants are established. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, white clover, southern winter peas, vetch, tall fescue, and ryegrass. Seedbed preparation should be on the contour or across the slope where practical. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly soybeans and vegetables. The main limitations are a moderate hazard of erosion, low fertility, and potentially toxic levels of exchangeable aluminum within the root zone. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Seedbed preparation should be on the contour or across the slope where practical. Runoff and erosion can be reduced by plowing in fall, by fertilizing, and by seeding to a cover crop. Crops respond to fertilizer and lime, which overcome the low fertility and high levels of exchangeable aluminum.

This soil is moderately well suited to urban development. The main limitations are wetness, slow permeability, low strength for roads, and moderate shrink-swell potential. In addition, the hazard of erosion is moderate. Revegetating disturbed areas around construction sites as soon as possible helps to control erosion. This soil has moderate to severe limitations for building sites and severe limitations for local roads and streets and most sanitary facilities. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units are suitable systems for sewage disposal. Roads and streets should be designed to offset the limited ability of the soil to support a load. Buildings and roads can be designed to offset the effects of shrinking and swelling. Drainage is needed for most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens.

This soil is moderately well suited to recreational development. It is limited mainly by wetness, slow permeability, and a moderate hazard of erosion. Good drainage is needed for most recreational uses. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic and applying fertilizer.

This soil is well suited to use as habitat for deer, rabbit, quail, turkey, dove, and numerous small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Oaks and other fruit- and nut-producing trees are especially desirable for deer, turkey, and nongame birds.

This Abita soil is in capability subclass IIe. The woodland ordination symbol is 11W.

BB—Barbary muck. This soil is level, very poorly drained, and very fluid. It is a mineral soil that is in swamps. It is ponded and flooded most of the time. In mapping, the number of observations was fewer than in other areas because of poor accessibility. The detail in mapping, however, is adequate for the expected use of the soil. Areas range from about 200 to several thousand acres.

Typically, the surface layer is very dark grayish brown, slightly acid, very fluid muck about 4 inches thick. The subsurface layer to a depth of about 14 inches is dark gray, very fluid, mildly alkaline clay. The underlying material to a depth of about 70 inches is gray, mildly alkaline, very fluid clay in the upper part; gray, mildly alkaline, slightly fluid clay in the middle part; and greenish gray, mildly alkaline, slightly fluid clay in the lower part.

Included with this soil in mapping are a few large areas of Kenner and Maurepas soils. These soils are

very poorly drained. The Kenner soils are in freshwater marshes and have a thick organic surface layer. The Maurepas soils are in swamps and have thick organic layers of decomposed woody vegetation. The included soils make up about 15 percent of the map unit.

This Barbary soil is frequently flooded by fresh water for very long periods. The floodwater ranges in depth from 1 foot to 3 feet. When the soil is not flooded, the high water table fluctuates between 0.5 foot below the soil surface to 1 foot above the surface. This very fluid and slightly fluid soil has low strength and a low capacity to support loads. Permeability is very slow. The total subsidence potential is medium. If this soil is drained, the surface initially will subside from 3 to 12 inches.

This Barbary soil is mainly used as woodland, as habitat for wetland wildlife, and for extensive forms of recreation, such as hunting.

This soil is poorly suited to bottom land hardwoods. Because of wetness, flooding, and poor trafficability, few areas are managed for timber production. Trees grow slowly and special equipment is needed to harvest the timber. This soil cannot support the load of most harvesting equipment. The common trees are baldcypress, water tupelo, and black willow. Understory and aquatic vegetation is mainly alligatorweed, buttonbush, bulltongue, duckweed, pickerelweed, and water hyacinth.

This soil is well suited to use as habitat for large numbers of wetland wildlife, including crawfish, ducks, squirrels, alligators, wading birds, and furbearers, such as raccoon, mink, and otter. White-tailed deer, swamp rabbits, and turkey use areas of this soil when it is dry or not flooded too deeply. Alligator and furbearer trapping is an important enterprise. Natural vegetation consists of water-tolerant trees and aquatic understory plants. Habitat management that encourages oaks and other mast-producing trees improves the habitat for wood ducks, squirrels, deer, and nongame birds. The habitat for waterfowl can be improved by constructing shallow ponds.

Unless drained and protected from flooding, this soil is not suited to pasture or crops. Wetness and flooding are too severe for these uses. This soil generally is too soft and boggy for livestock grazing.

This soil is not suited to urban uses or intensive recreation uses, such as playgrounds and campsites. Wetness and low strength are severe limitations, and flooding is a severe hazard. Drainage and protection from flooding are possible only by constructing large water-control structures. Drainage ditches are difficult to construct because stumps and logs are buried in the soil. In addition, if this soil is drained, subsidence is a problem.

This Barbary soil is in capability subclass VIIw. The woodland ordination symbol is 4W.

Bg—Brimstone-Guyton silt loams. These soils are level and poorly drained. They are on broad flats and in slightly depressional areas on stream or marine terraces. They are subject to rare flooding. The Brimstone soil is in very slight dips on the landscape or in positions similar to those of the Guyton soil. The Guyton soil is in flat areas or on very slightly convex slopes. The Brimstone soil makes up about 55 percent of the complex and the Guyton soil about 35 percent. The soils of this complex are so intricately intermingled that mapping them separately at the selected scale was not practical. Areas of this map unit range from 20 to 2,000 acres.

Typically, the Brimstone soil has a surface layer of dark grayish brown, medium acid silt loam about 4 inches thick. The subsurface layer to a depth of about 21 inches is light brownish gray, mottled, slightly acid silt loam. Below that to a depth of 32 inches is a mixed layer of light brownish gray, mildly alkaline silt loam and light brownish gray, mottled, mildly alkaline silty clay loam. The subsoil to a depth of about 60 inches is light brownish gray, mottled, moderately alkaline silty clay loam.

The Brimstone soil has low fertility and moderately high levels of exchangeable aluminum that are potentially toxic to some crops. Water and air move through this soil at a slow rate. Water runs off the surface at a slow rate and stands in low places for short periods after heavy rains. A seasonal high water table fluctuates between a depth of about 1.5 feet and the soil surface from December to April. The concentrations of sodium in the subsoil restrict root development and limit the amount of water available to plants. This soil has moderate shrink-swell potential.

Typically, the Guyton soil has a surface layer of dark grayish brown, strongly acid silt loam about 5 inches thick. The subsurface layer to a depth of about 17 inches is light brownish gray, mottled, strongly acid silt loam. The subsoil to a depth of about 65 inches is grayish brown, mottled, strongly acid silty clay loam in the upper part; gray, mottled, medium acid silty clay loam in the middle part; and gray, mottled, slightly acid silty clay loam in the lower part.

The Guyton soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate. Water runs off the surface at a slow rate and stands in low places for short periods after heavy rains. An adequate supply of water is available to plants in most years. A seasonal high water table fluctuates between a depth of about 1.5 feet and the soil surface from December to May. This soil has low shrink-swell potential.

Included with these soils in mapping are a few small areas of Abita, Myatt, Prentiss, and Stough soils. The Abita soils are somewhat poorly drained. They are on low ridges at a slightly higher elevation and have a subsoil that is brownish in the upper part. The Myatt soils

are poorly drained. They are in positions on the landscape similar to those of the Guyton soil, and they have more sand throughout. The Prentiss soils are moderately well drained. They are on convex ridges and have a fragipan in the lower part of the subsoil. The Stough soils are somewhat poorly drained. They are on low ridges and have more sand throughout than the Brimstone and Guyton soils. In places are small areas of Brimstone and Guyton soils that are subject to occasional flooding. The included soils make up about 10 percent of the map unit.

In most areas, the Brimstone and Guyton soils are used as woodland. Some areas are used for pasture or truck crops. Small acreages are used for urban and recreational areas.

The Brimstone and Guyton soils are moderately well suited to loblolly pine, slash pine, and sweetgum. The main concerns in producing and harvesting timber are restricted use of equipment, soil compaction, and moderate seedling mortality caused by wetness. Excess sodium in the Brimstone soil also limits timber production somewhat. Conventional methods of harvesting timber generally can be used, but heavy equipment can compact the soil when it is wet. Using low-pressure equipment and logging during drier periods cause less damage to soil and help maintain productivity. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants.

These soils are moderately well suited to pasture. The main limitations are low fertility and wetness. Field ditches can remove excess surface water. The concentration of sodium in the Brimstone subsoil can limit the production of some pasture plants. Suitable pasture plants are common bermudagrass, bahiagrass, white clover, vetch, and ryegrass. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

These soils are moderately well suited to cultivated crops, mainly soybeans and vegetables. Low fertility, wetness, and potentially toxic levels of exchangeable aluminum within the root zone are the main limitations. The high content of sodium salts in the Brimstone soil limits the growth of most crops. Crops respond well to fertilizer and lime, which overcome the low fertility and high levels of exchangeable aluminum. These Brimstone and Guyton soils are friable and easy to keep in good tilth. The surface is subject to crusting, however, and a tillage pan forms easily if these soils are tilled when wet. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth.

These soils are poorly suited to urban uses, mainly because of wetness, flooding, slow permeability, and low strength for roads. The soils have severe limitations for building sites, local roads and streets, and most sanitary facilities. Drainage, dikes and levees, or other water-control systems are needed to control flooding and remove excess water. Selection of suitable vegetation is critical for establishing lawns, shrubs, trees, and vegetable gardens. Very slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units provide more suitable methods of sewage disposal. Roads should be designed to offset the limited ability of the soils to support a load.

These soils are poorly suited to recreational uses, mainly because of wetness and flooding. Good drainage is needed for most recreational uses. Protection from flooding is also needed where the soils are used as camp sites. Plant cover can be maintained by controlling traffic.

These soils are well suited to use as habitat for ducks, deer, rabbits, squirrels, quail, turkey, doves, and numerous small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Encouraging the growth of oak trees improves the habitat for squirrels, deer, and turkey. In wooded areas, prescribed burning every three years, rotated among several small tracts of land, can increase the amount of palatable deer browse and seed-producing plants for quail and turkey.

This Brimstone and Guyton complex is in capability subclass IIIs. The woodland ordination symbol for the Brimstone soil is 11T, and it is 9W for the Guyton soil.

Ca—Cahaba fine sandy loam, 1 to 3 percent slopes. This soil is very gently sloping and well drained. It is on convex ridges on broad stream or marine terraces and on low terraces along major drainageways. Areas range from about 5 to 150 acres.

Typically, the surface layer is dark brown, very strongly acid fine sandy loam about 6 inches thick. The subsoil extends to a depth of about 41 inches. It is yellowish red, strongly acid sandy clay loam in the upper part; yellowish red, very strongly acid sandy clay loam in the middle part; and strong brown, very strongly acid sandy loam in the lower part. The substratum to a depth of about 65 inches is light yellowish brown and yellowish brown, very strongly acid loamy fine sand stratified with bands of strong brown fine sandy loam.

Included with this soil in mapping are a few small areas of Fluker, Myatt, and Savannah soils. The Fluker soils are somewhat poorly drained. They are in lower positions on the landscape than the Cahaba soil and have a fragipan in the subsoil. The Myatt soils are poorly drained. They are in lower positions and are grayish throughout. The Savannah soils are moderately well drained. They are in slightly lower positions and have a fragipan in the subsoil. Also included are a few small

areas of Cahaba soils that are subject to rare flooding. Very small sand and gravel pits are included in a few places. The included soils make up about 10 percent of the map unit.

This Cahaba soil has low fertility and moderately high levels of exchangeable aluminum that are potentially toxic to some crops. Water and air move through this soil at a moderate rate and water runs off the surface at a medium rate. This soil dries quickly after rains. The water table is not within a depth of 6 feet. Roots penetrate this soil easily, and the effective rooting depth is 60 inches or more. The shrink-swell potential is low.

This Cahaba soil is mainly used as pasture and woodland. Small acreages are used for cultivated crops or homesites. In a few places, the underlying sand and gravel are mined and used for road or building construction.

This soil is well suited to pasture and has few limitations to this use. Suitable pasture plants are common bermudagrass, improved bermudagrass, bahiagrass, ball clover, crimson clover, and arrowleaf clover. Proper stocking and pasture rotation help keep the pasture in good condition. Seedbed preparation should be on the contour or across the slope where practical. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This Cahaba soil is well suited to loblolly pine, slash pine, sweetgum, and water oak. It has few limitations for woodland use and management. Conventional methods of harvesting timber generally can be used throughout the year. After harvesting, reforestation should be carefully managed to reduce competition from undesirable understory plants.

This soil is well suited to cultivated crops, mainly corn, soybeans, and vegetables. The main limitations are low fertility and potentially toxic levels of exchangeable aluminum within the root zone. The hazard of erosion is slight. Contour farming and stripcropping can help control erosion. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops are damaged by a lack of moisture during dry periods of some years. Supplemental irrigation can prevent damage to crops during dry periods where water of suitable quality is available. Most crops respond well to fertilizer and lime, which overcome the low fertility and moderately high levels of exchangeable aluminum.

This soil is well suited to use for homesites and other urban development. It has few limitations; however, where shallow excavations are constructed, the cutbanks cave easily. Seepage is a problem where the soil is used for sewage lagoons. Plans for homesite development should provide for the preservation of as many trees as possible. Mulching, fertilizing, and irrigation can help to establish lawn grasses and other small seeded plants.

Sand and gravel are available in areas of this soil, but excess fines are a problem in places.

This soil is well suited to intensive recreation uses, such as playgrounds and campsites. Limitations are few; however, a plant cover should be maintained where possible to control erosion. Plant cover can be maintained by controlling traffic.

This soil is well suited to use as habitat for rabbits, quail, dove, deer, turkey, and numerous nongame birds. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Timber should be selectively harvested to leave large den and mast-producing trees.

This Cahaba soil is in capability subclass IIe. The woodland ordination symbol is 9A.

Ch—Cahaba fine sandy loam, 3 to 6 percent slopes. This soil is moderately sloping and well drained. It is on convex ridges on broad stream or marine terraces and on low terraces along major drainageways. Areas range from about 5 to 30 acres.

Typically, the surface layer is very dark grayish brown, strongly acid fine sandy loam about 4 inches thick. The subsoil extends to a depth of about 48 inches. It is yellowish red, very strongly acid sandy clay loam. The substratum to a depth of about 60 inches is strong brown, very strongly acid sandy loam.

Included with this soil in mapping are a few large areas of soils similar to Cahaba soil except they have a thick loamy fine sand surface layer and a fine sandy loam subsoil. Included in most places are a few small areas of Cahaba soils that have slopes of 6 to 10 percent. The included soils make up about 10 percent of the map unit.

This Cahaba soil has low fertility. Water and air move through this soil at a moderate rate, and water runs off the surface at a medium rate. This soil dries quickly after rains. The water table is not within a depth of 6 feet. The effective rooting depth is 60 inches or more. The shrink-swell potential is low.

In most areas, this Cahaba soil is used as pasture and woodland. A small acreage is used for homesites.

This soil is well suited to pasture. The main limitation is low fertility. Erosion is a hazard until plants are established. Suitable pasture plants are common bermudagrass, improved bermudagrass, bahiagrass, ball clover, crimson clover, and arrowleaf clover. Proper stocking and pasture rotation help keep the pasture in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This Cahaba soil is well suited to loblolly pine, slash pine, sweetgum, and water oak, and it has few limitations to woodland use and management. Conventional methods of harvesting timber generally can be used throughout the year. After harvesting, reforestation

should be carefully managed to reduce competition from undesirable understory plants.

This soil is well suited to cultivated crops, mainly vegetables. The main limitations are low fertility and potentially toxic levels of exchangeable aluminum within the root zone. The hazard of erosion is moderate. All tillage should be on the contour or across the slope. Terraces and grassed waterways also help prevent erosion. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to lime and fertilizer, which overcome the low fertility and moderately high levels of exchangeable aluminum. Crops can be damaged by lack of moisture during dry periods. Supplemental irrigation can prevent damage to crops during dry periods where water of adequate quality is available.

This soil is well suited to homesites and other urban uses and has few limitations. However, erosion is a hazard and increases if the soil is left exposed during site development. Mulch, fertilizer, and irrigation can help in establishing lawn grasses and other small seeded plants. Plans for homesite development should provide for the preservation of as many trees as possible. Seepage is a limitation to some sanitary facilities. Where shallow excavations are constructed, the cutbanks cave easily. Sand and gravel are available in areas of this soil.

This soil is well suited to recreational development (fig. 2), although erosion ia a hazard. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Cuts and fills should be seeded or mulched.

The soil is well suited to use as habitat for rabbits, quail, dove, deer, turkey, and numerous small game birds. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants.

This Cahaba soil is in capability subclass IIe. The woodland ordination symbol is 9A.

Fu—Fluker silt loam. This soil is nearly level and is somewhat poorly drained. It is mainly on broad flats of stream terraces. Small areas are also in depressions on the terrace uplands. Areas range from about 20 to 1,000 acres.

Typically, the surface layer is dark grayish brown, extremely acid silt loam about 8 inches thick. The subsoil extends to a depth of about 70 inches. The upper part of the subsoil is light yellowish brown, mottled, extremely acid silt loam underlain by yellowish brown, mottled, very strongly acid silt loam and silty clay loam. Below that, it is grayish brown, mottled, very strongly acid silt loam. The lower part of the subsoil is a fragipan of yellowish brown, mottled, very strongly acid silt loam and mottled strong brown, pale brown, and yellowish brown, very strongly acid loam.

Included with this soil in mapping are a few small areas of Cahaba, Myatt, and Savannah soils. The Cahaba soils are well drained. They are on broad, slightly convex ridges on the stream terraces and do not have a fragipan. The Myatt soils are poorly drained. They are in broad, low areas, are grayish throughout, and do not have a fragipan. The Savannah soils are moderately well drained. They are in higher positions on the landscape than the Fluker soil and do not have gray mottles within 16 inches of the surface. The included soils make up about 10 percent of the map unit.

This Fluker soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through the upper part of this soil at a moderate rate and through the fragipan at a slow rate. Water runs off the surface at a slow rate. A high water table is perched on the fragipan at a depth of about 0.5 foot to 1.5 feet from December to April. This soil has low shrink-swell potential.

This Fluker soil is used mainly as woodland and pasture. Small acreages are used for homesites, recreation areas, or crops.

This soil is moderately well suited to sweetgum, loblolly pine, and slash pine. The main concerns in producing and harvesting timber are competition from understory plants and moderate equipment use limitations caused by wetness. When the soil is moist, it is subject to rutting and compaction by logging equipment. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from December to April. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This soil is well suited to pasture. The main limitations are wetness and low fertility. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, white clover, southern winter peas, vetch, and ryegrass. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and the soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to crops, mainly vegetables, soybeans, and corn. The main limitations are wetness, low fertility, and potentially toxic levels of exchangeable aluminum within the root zone. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to lime and

Figure 2.—Cahaba fine sandy loam, 3 to 6 percent slopes, provides good sites for recreational uses and homes.

fertilizer, which help to overcome the low fertility and high levels of exchangeable aluminum.

This soil is poorly suited to urban development. The main limitations are wetness, slow permeability, and low strength for roads. This soil has severe limitations for building sites, local roads and streets, and most sanitary facilities. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. Drainage is needed for most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Roads can be designed to offset the limited ability of the soil to support a load. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units are suitable systems for sewage disposal. Sand can be removed from some areas of this soil, but the content of silt and clay can be excessive.

This soil is poorly suited to recreational development, mainly because of wetness. Good drainage is needed for most recreational uses. Plant cover can be maintained by controlling traffic.

This soil is well suited to use as habitat for deer, rabbit, quail, turkey, dove, and numerous nongame birds. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Timber should be selectively harvested to leave large den and mast-producing trees. Prescribed burning every three years, rotated among several small tracts of land, can increase

the amount of palatable deer browse and seed-producing plants for quail and turkey.

This Fluker soil is in capability subclass IIw. The woodland ordination symbol is 11W.

Go—Guyton silt loam. This soil is level and poorly drained. It is on broad flats and in depressional areas on the terrace uplands and stream or marine terraces. It is subject to rare flooding. Areas are irregular in shape and are 10 to several hundred acres.

Typically, the surface layer is brown, very strongly acid silt loam about 3 inches thick. The subsurface layer to a depth of about 27 inches is grayish brown, mottled, very strongly acid silt loam in the upper part and light brownish gray, mottled, strongly acid silt loam in the lower part. The subsoil to a depth of about 70 inches is light gray and light brownish gray, mottled, medium acid silty clay loam and silt loam in the upper part and light gray, mottled, slightly acid silty clay loam in the middle and lower parts.

Included with this soil in mapping are a few small areas of Abita, Myatt, and Stough soils. The Abita soils are somewhat poorly drained. They are in higher positions on the landscape than the Guyton soil and have a subsoil that is brownish in the upper part. The Myatt soils are poorly drained. They are in positions similar to those of the Guyton soil and they have more sand throughout. The Stough soils are somewhat poorly drained. They are in slightly higher positions and have more sand throughout. In swales and drainageways are many small areas of Guyton soil that is subject to occasional flooding. The included soils make up about 20 percent of the map unit.

This Guyton soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate. Water runs off the surface at a slow rate and stands in low places for long periods after heavy rains. The soil is subject to rare flooding during the cropping season. A seasonal high water table fluctuates between a depth of about 1.5 feet and the surface from December to May. The shrink-swell potential is low.

This Guyton soil is used mainly as woodland. Small acreages are used for pasture, crops, or urban and recreational development.

This soil is well suited to loblolly pine, slash pine, and sweetgum. The productivity potential is high; however, management problems are severe. The main concerns in producing and harvesting timber are soil compaction, severe equipment use limitations, and moderate seedling mortality caused by wetness. Trees should be planted or harvested during dry periods to minimize rutting and soil compaction. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from December to May. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants.

This soil is well suited to pasture. The main limitations are wetness and low fertility. Excess water on the surface can be removed by field ditches and suitable outlets. Suitable pasture plants are common bermudagrass, bahiagrass, ryegrass, white clover, vetch, and southern winter peas. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly vegetables and soybeans. It is limited mainly by wetness, low fertility, and potentially toxic levels of exchangeable aluminum within the root zone. Proper row arrangement, field ditches, and suitable outlets are needed to remove excess surface water. This soil is friable and easy to keep in good tilth; however, the surface can crust during dry periods. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility, organic matter content, and tilth. Crops respond well to fertilizer and lime, which help overcome the low fertility and high levels of exchangeable aluminum.

This soil is poorly suited to urban development, mainly because of wetness, flooding, slow permeability, and low strength for roads. This soil has severe limitations for building sites, local roads and streets, and most sanitary facilities. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. This soil can be protected from flooding by constructing dikes or levees. In addition, buildings can be constructed on mounds and road beds can be elevated above normal flood levels. Selection of suitable vegetation is critical for the establishment of lawns, shrubs, trees, and vegetable gardens. Local roads and streets can be designed to offset the limited ability of the soil to support a load. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units can be used to dispose of sewage properly.

This soil is poorly suited to recreational development, mainly because of wetness. Good drainage and protection from flooding are needed for intensively used areas, such as playgrounds and camp sites. Plant cover can be maintained by controlling traffic and fertilizing.

This soil is well suited to use as habitat for ducks, deer, rabbit, quail, turkey, dove, and small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Habitat for ducks and furbearers can be improved by constructing shallow water areas.

This Guyton soil is in capability subclass IIIw. The woodland ordination symbol is 9W.

Gy—Guyton silt loam, occasionally flooded. This soil is level and poorly drained. It is in broad depressional areas and in swales and drainageways of stream or marine terraces and terrace uplands. This soil is subject to occasional flooding. Areas are irregular in shape and are 20 to several hundred acres.

Typically, the surface layer is dark grayish brown, medium acid silt loam about 8 inches thick. The subsurface layer to a depth of about 19 inches is gray, mottled, strongly acid silt loam. The subsoil to a depth of about 60 inches is gray and grayish brown, mottled, strongly acid silt loam in the upper part and grayish brown, mottled, strongly acid silty clay loam in the lower part.

Included with this soil in mapping are a few small areas of Abita, Myatt, and Stough soils. The Abita soils are somewhat poorly drained. They are in higher positions on the landscape than the Guyton soil and have a subsoil that is brownish in the upper part. The Myatt soils are poorly drained. They are in positions similar to those of the Guyton soil and they have more sand throughout. The Stough soils are somewhat poorly drained. They are in higher positions and have less clay in the subsoil and more sand throughout. In places are a few small areas of Guyton soil that is subject to rare flooding. The included soils make up about 20 percent of the map unit.

This Guyton soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate. Water runs off the surface at a slow rate and stands in low places for long periods. This soil dries slowly after heavy rains. A seasonal high water table fluctuates between a depth of about 1.5 feet and the surface from December to May. The shrink-swell potential is low.

This Guyton soil is used mainly as woodland and pasture. Small acreages are used for crops or urban and recreational development.

This soil is moderately well suited to loblolly pine, slash pine, and sweetgum. The main concerns in producing and harvesting timber are equipment use limitations and seedling mortality caused by flooding and wetness. Trees should be planted or harvested during dry periods to reduce soil compaction and rutting. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from December to May. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants.

This soil is moderately well suited to pasture. The main limitations are wetness and low fertility, and flooding is a hazard. Suitable pasture plants are common bermudagrass, bahiagrass, white clover, vetch, and singletary peas. Wetness limits the choice of plants and the period of grazing. Excess water on the surface can be removed by field ditches and vegetated outlets. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and the soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is poorly suited to cultivated crops, although vegetables and soybeans are grown. The soil is limited mainly by the hazard of flooding, wetness, low fertility, and the potentially toxic levels of exchangeable aluminum within the root zone. Flood control is possible, but only by constructing major flood control structures, such as levees. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. This soil is friable and easy to keep in good tilth; however, the surface tends to crust during dry periods. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum.

This soil is poorly suited to urban development. It generally is not suited to use as homesites unless it is protected from flooding (fig. 3). The main limitations are wetness, slow permeability, low strength for roads, and the hazard of flooding. Drainage and flood control are needed if roads and building foundations are constructed. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. Roads and streets should be located above the expected flood level and designed to offset the limited ability of the soil to support a load. Ring levees can be constructed around urban areas to protect buildings from overflow. Selection of suitable vegetation is critical for the establishment of lawns, shrubs, trees, and vegetable gardens. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. If flooding is controlled, lagoons and self-contained disposal units can be used to dispose of sewage properly.

This soil is poorly suited to recreational uses, mainly because of flooding and wetness. Major flood control structures are needed to protect the soil from overflow. Good drainage is needed for most recreational uses. Plant cover can be maintained by controlling traffic.

This soil provides habitat for ducks, deer, rabbit, quail, turkey, dove, and numerous small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. The habitat for ducks and most furbearers can be improved by constructing shallow ponds.

This Guyton soil is in capability subclass IVw. The woodland ordination symbol is 9W.

KE—Kenner muck. This soil is level, very poorly drained, and very fluid. It is an organic soil that is in freshwater marshes. It is ponded or flooded most of the

Figure 3.—Guyton silt loam, occasionally flooded, is poorly suited to use as homesites.

time. The number of observations was fewer than in other areas because of poor accessibility. The detail in mapping, however, is adequate for the expected use of the soil. Areas range from about 200 acres to several hundred acres.

Typically, the surface layer is very dark grayish brown, slightly acid, very fluid muck about 12 inches thick. The next layer is gray, slightly acid, very fluid clay about 1 inch thick underlain by a layer of black, slightly acid, very fluid muck to a depth of about 17 inches. Below that layer to a depth of about 49 inches is dark gray, neutral, very fluid clay. The next layer to a depth of 84 inches is black, neutral, very fluid muck.

Included with this soil in mapping are a few large areas of Barbary and Maurepas soils that are very poorly drained. These soils are in swamps. The Barbary soils are very fluid, clayey soils that have a thin organic surface layer. The Maurepas soils are organic soils that do not have thin clayey layers within the upper part of the profile. Also included are soils similar to the Kenner soil except that the underlying material is loamy. Many small ponds and perennial streams are in most areas. The included soils make up about 5 percent of the map unit.

This Kenner soil is ponded or flooded by several inches of fresh water most of the time. During storms, floodwater is as deep as 2 feet. The high water table generally is at or above the surface, but during periods of sustained north wind and low gulf tides, it is as much as 6 inches below the surface. This soil has a low capacity to support loads. Permeability is rapid in the organic layers and very slow in the clayey layers. The total subsidence potential is very high. The shrink-swell potential is low.

This soil is mainly used as habitat for wetland wildlife and for extensive forms of recreation, such as hunting and fishing.

The Kenner soil is well suited to extensive recreation uses and to use as habitat for wetland wildlife. Food and roosting areas are available for ducks and other waterfowl. This soil also provides habitat for crawfish, swamp rabbits, white-tailed deer, the American alligator, and furbearers, such as mink, nutria, otter, and raccoon. The natural vegetation is mainly bulltongue, maidencane, alligatorweed, cattail, common rush, pickerelweed, swamp smartweed, and swamp knotweed. Many species of finfish are in the small ponds and perennial streams in this map unit. Trapping of the American alligator and furbearers and commercial fishing are important enterprises in most areas of this map unit. Water-control structures, designed to improve the habitat for wildlife, are difficult to construct and maintain because of the instability of the organic material.

This soil is not suited to use as cropland, pasture, or woodland unless it is drained and protected from flooding. Wetness, flooding, and low strength are too severe for these uses. This soil is generally too soft and boggy for livestock grazing. Drainage and protection from flooding are possible, but extensive water-control structures, such as levees and water pumps, are required. Extreme acidity, subsidence, and low strength are continuing limitations after drainage.

This soil is not suited to intensive recreation uses, such as playgrounds and campsites, or to urban uses. Wetness, flooding, low strength, and the subsidence potential are too severe. Drainage is feasible, but only with an extensive system of levees and water pumps. Subsidence is a continuing limitation after drainage. The soil material is poorly suited to use in the construction of levees because it shrinks and cracks as it dries, causing levees to fail.

This Kenner soil is in capability subclass VIIIw. It is not assigned a woodland ordination symbol.

Ma—Malbis fine sandy loam, 3 to 8 percent slopes. This soil is moderately sloping and well drained. It is on ridgetops and side slopes on the terrace uplands. This soil is crossed by well-defined drainageways in most places. Areas range from about 10 to 200 acres.

Typically, the surface layer is very dark grayish brown, slightly acid fine sandy loam about 4 inches thick. The subsurface layer to a depth of about 8 inches is yellowish brown, medium acid fine sandy loam. The subsoil to a depth of about 60 inches is yellowish brown, very strongly acid sandy clay loam in the upper part; strong brown, very strongly acid sandy clay loam in the middle part; and brown, mottled, very strongly acid sandy clay loam in the lower part. The lower part of the subsoil contains numerous small red nodules of plinthite.

Included with this soil in mapping are a few small areas of Fluker, Ruston, Smithdale, and Tangi soils. The Fluker soils are somewhat poorly drained. They are in depressional areas on broad ridgetops and they have a fragipan. The Ruston soils are well drained. They are on more convex slopes than the Malbis soil and they have a redder subsoil. The Smithdale soils are well drained. They are on convex side slopes and have a reddish subsoil. The Tangi soils are in positions similar to those of the Malbis soil and they have a fragipan. The included soils make up about 10 percent of the map unit.

This Malbis soil has low fertility. Water and air move through the upper part of the soil at a moderate rate and through the lower part at a moderately slow rate. Water runs off the surface at a medium rate. A seasonal high water table is perched above the part of the subsoil that contains plinthite. The high water table is at a depth of about 2.5 to 4 feet from December to March. This soil has low shrink-swell potential.

This Malbis soil is used mainly as woodland and pastureland. Small acreages are used as cropland or homesites.

This Malbis soil is well suited to loblolly pine and slash pine and has few limitations to woodland use and management. However, management that minimizes the risk of erosion is important in harvesting timber. Conventional methods generally can be used, although logging when the soil is wet can cause soil compaction and rutting. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants.

This soil is well suited to pasture. The main management concern is the hazard of erosion until plants are established. Seedbed preparation should be on the contour or across the slope where practical. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, ball clover, crimson clover, and arrowleaf clover. Fertilizer and lime are needed for optimum growth of grasses and legumes. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition.

This Malbis soil is moderately well suited to cultivated crops, mainly soybeans and corn. Erosion is a hazard, and low fertility and potentially toxic levels of exchangeable aluminum in the root zone are the main limitations. In most years, plants are damaged by a lack of moisture during dry periods in the summer and fall. Practices that can control erosion include early fall

seeding, conservation tillage, and construction of terraces, diversions, and grassed waterways. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Using conservation tillage and returning all crop residue to the soil or regularly adding other organic matter improve fertility and help maintain soil tilth and content of organic matter. Crops respond to fertilizer and lime, which overcome the low fertility and high levels of exchangeable aluminum.

This soil is well suited to most intensive recreational uses and has few limitations for campsites, picnic areas, and paths and trails. It has moderate limitations to use as playgrounds, mainly because of slope and the hazard of erosion. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Constructing gradient terraces can also reduce erosion. Plant cover can be maintained by controlling traffic and applying fertilizer.

This Malbis soil is moderately well suited to homesites and other urban uses. Wetness, moderately slow permeability, slope, and low strength for roads are the main limitations. Preserving the existing plant cover during construction helps to control erosion. Only the part of the site that is used for construction should be disturbed. The moderately slow permeability in the subsoil is a limitation to the performance of septic tank absorption fields. This limitation can be overcome by enlarging the absorption field and installing the drainage lines on the contour. Roads can be designed to offset the limited ability of the soil to support a load.

This soil is well suited to use as habitat for squirrel, rabbit, quail, dove, deer, turkey, and many nongame birds. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Oaks and other mast-producing trees can improve the habitat for deer, squirrel, and turkey. Prescribed burning every three years, rotated among several small tracts of land, can increase the amount of palatable deer browse and seed-producing plants used by quail and turkey.

This Malbis soil is in capability subclass IIIe. The woodland ordination symbol is 9A.

MP—Maurepas muck. This soil is level, very poorly drained, and very fluid. It is an organic soil that is in swamps. It is ponded most of the time and frequently flooded. The number of observations was fewer than in other areas because of poor accessibility. The detail in mapping, however, is adequate for the expected use of the soil. Areas range from about 200 to several thousand acres.

Typically, the surface layer is very dark grayish brown, slightly acid, very fluid muck about 10 inches thick. The underlying material to a depth of about 84 inches is dark reddish brown and dark brown, slightly acid, very fluid muck. Logs, stumps, and wood fragments are common in the underlying material.

Included with this soil in mapping are a few large areas of Barbary and Kenner soils. These soils are very poorly drained. The Kenner soils are in freshwater coastal marshes and have thin layers of clay in the upper part of the profile. The Barbary soils are in positions on the landscape similar to those of the Maurepas soil. They are very fluid clayey soils that have a thin organic surface layer. Also included in places along major streams and around the edges of lakes are very narrow bands of soils that are grayish, loamy, and 2 to 3 feet higher in elevation than the surrounding soils. The included soils make up about 15 percent of the map unit.

This Maurepas soil is ponded most of the time and is frequently flooded by fresh water for very long periods. Floodwaters range in depth from 1 foot to 3 feet. When the soil is not flooded, the water table fluctuates between 0.5 foot below the soil surface and 1 foot above the surface. This soil has low strength. Permeability is rapid. The total subsidence potential is very high.

This Maurepas soil is mainly used as woodland. It is also used as habitat for wetland wildlife and for extensive forms of recreation, such as hunting.

This soil is poorly suited to bottom land hardwoods, mainly because of wetness, flooding, and poor trafficability. Few areas are managed for timber production because trees grow slowly and special equipment is needed for harvesting. This soil cannot support the load of most types of harvesting equipment. The natural vegetation is water-tolerant trees and aquatic understory plants. The main trees are baldcypress, water tupelo, and black willow. Understory and aquatic vegetation is mainly alligatorweed, buttonbush, bulltongue, duckweed, pickerelweed, and water hyacinth.

This soil is well suited to use as habitat for wetland wildlife, such as crawfish, ducks, alligators, and wading birds (fig. 4). Many furbearers, such as raccoon, mink, and otter, use areas of this soil. Alligator, crawfish, and furbearer trapping is an important enterprise. Timber management that encourages oak and other mast-producing trees improves habitat for wood ducks, squirrels, deer, and nongame birds. The habitat for waterfowl can be improved by constructing shallow ponds.

This soil is not suited to use as pasture or cropland because wetness and flooding are too severe, and it generally is too soft and boggy for livestock grazing.

This soil is not suited to recreational or urban uses because wetness, the hazard of flooding, and low strength are too severe. In addition, buried stumps and logs impede the digging of shallow excavations. Drainage and protection from flooding are possible by using water pumps to remove excess water and by constructing levees. The soil material is poorly suited to

Figure 4.—This swamp in an area of Maurepas muck provides habitat for many kinds of wetland wildlife.

use in the construction of levees because it shrinks and cracks as it dries. The shrinking and cracking of the soil material can cause levees to fail. Subsidence and low strength are continuing limitations after drainage.

This Maurepas soil is in capability subclass VIIIw. It is not assigned a woodland ordination symbol.

Mt—Myatt fine sandy loam. This soil is level and poorly drained. It is on broad flats and in swales and small drainageways on stream or marine terraces. It is subject to rare flooding. Areas are irregular in shape and are 20 to 500 acres.

Typically, the surface layer is very dark gray, extremely acid fine sandy loam about 4 inches thick. The subsurface layer to a depth of about 12 inches is gray, mottled, extremely acid fine sandy loam. The subsoil extends to a depth of about 56 inches. It is gray, mottled, extremely acid loam in the upper part; light gray, mottled, very strongly acid clay loam in the middle part; and light gray, mottled, very strongly acid sandy clay loam in the lower part. The substratum to a depth of about 70 inches is light gray, mottled, very strongly acid clay loam.

Included with this soil in mapping are a few small areas of Abita, Brimstone, Guyton, Prentiss, and Stough soils. The Abita soils are somewhat poorly drained. They are in higher positions on the landscape than the Myatt soil and have less sand in the subsoil. The Brimstone soils are poorly drained. They are in positions similar to those of the Myatt soil and they have a high content of sodium salts in the subsoil. The Guyton soils are poorly drained. They are in positions similar to those of the Myatt soils and they have less sand in the subsoil. The Prentiss soils are moderately well drained. They are on convex ridges and have a fragipan in the lower part of the subsoil. The Stough soils are somewhat poorly drained. They are also on slightly convex ridges and are

brownish throughout. Also included in swales and drainageways are many small areas of Myatt soils that are subject to occasional flooding. The included soils make up about 20 percent of the map unit.

This Myatt soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderately slow rate. Water runs off the surface at a slow or very slow rate. The surface layer of this soil remains wet for long periods after heavy rains. A seasonal high water table fluctuates between a depth of about 1 foot and the soil surface from November to April. This soil is subject to rare flooding that can occur anytime during the year. The shrink-swell potential is low.

This Myatt soil is used mainly as woodland. Small acreages are used for pasture, truck crops, homesites, or recreation.

This soil is well suited to sweetgum, loblolly pine, and slash pine. The productivity potential is high; however, management problems are severe. The main concerns in producing and harvesting timber are the restricted use of equipment and seedling mortality caused by wetness. Trees should be planted or harvested during dry periods to reduce soil compaction and rutting. Conventional methods of harvesting timber generally can be used except sometimes during rainy periods, generally from November to April. Competition from understory plants and soil compaction are additional concerns. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This soil is well suited to pasture. The main limitations are low fertility and wetness. Suitable pasture plants are bahiagrass, common bermudagrass, ryegrass, white clover, southern winter peas, and vetch. Excess water can be removed by field ditches and suitable outlets. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are generally needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly vegetables and soybeans. Wetness, low fertility, and potentially toxic levels of exchangeable aluminum are the main limitations. In addition, flooding is a hazard for the Myatt soil in some of the swales and drainageways. Proper row arrangement, field ditches, and suitable outlets are needed to remove excess surface water. Levees must be constructed to protect the included soils that are subject to occasional flooding. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Most crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of aluminum in the root zone.

This soil is poorly suited to urban uses and homesites. It has severe limitations for building sites, local roads and streets, and most sanitary facilities, mainly because of wetness, flooding, and moderately slow permeability. Drainage is needed if roads and building foundations are constructed. It is also needed for most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. Flooding can be controlled by constructing levees. Where levees are not constructed to control flooding, buildings and roads should be raised to elevations above normal flood levels. Moderately slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained disposal units can be used to dispose of sewage properly.

This soil is poorly suited to recreational development, mainly because of wetness and flooding. Good drainage is needed for most recreation uses. Flood control is needed where the soil is used as camp sites. Plant cover can be maintained by controlling traffic.

This soil is well suited to use as habitat for deer, squirrels, rabbits, quail, turkey, dove, and numerous small furbearers. Habitat for wildlife can be improved by selective harvesting of timber to leave large den and mast-producing trees. Controlled burning in wooded areas can increase the amount of browse palatable to deer and seed-producing plants for quail, turkey, and other nongame birds.

This Myatt soil is in capability subclass IIIw. The woodland ordination symbol is 9W.

My—Myatt fine sandy loam, occasionally flooded. This soil is level and poorly drained. It is in broad depressional areas and in swales and small drainageways on stream or marine terraces. Areas are irregular in shape and range from 20 to several hundred acres.

Typically, the surface layer is dark grayish brown, very strongly acid fine sandy loam about 4 inches thick. The subsurface layer to a depth of about 10 inches is light brownish gray, mottled, very strongly acid fine sandy loam. The subsoil extends to a depth of about 50 inches. It is light brownish gray and grayish brown, mottled, very strongly acid loam. The substratum to a depth of about 70 inches is gray, mottled, very strongly acid loam.

Included with this soil in mapping are a few small areas of Abita, Guyton, and Stough soils. The Abita soils are somewhat poorly drained. They are in higher positions on the landscape than the Myatt soil and have less sand throughout. The Guyton soils are poorly drained. They are in positions similar to those of the Myatt soil and they have less sand in the subsoil. The Stough soils are somewhat poorly drained. They are in

higher positions and have less clay in the subsoil. At slightly higher elevations are small areas of Myatt soil that is subject to rare flooding. The included soils make up about 20 percent of the map unit.

This Myatt soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderately slow rate. Water runs off the surface at a slow rate and stands in low places for long periods after heavy rains. This soil dries slowly after heavy rains. A seasonal high water table fluctuates between a depth of about 1 foot and the soil surface from November to April. Less often than twice in 5 years, this soil is subject to brief periods of flooding during the cropping season. Flooding occurs more often than twice in 5 years during other times of the year. The shrink-swell potential is low.

This Myatt soil is used mainly as woodland and pasture. Small acreages are used for crops, urban development, and intensive recreation areas, such as playgrounds and campsites.

This soil is moderately well suited to sweetgum, loblolly pine, and slash pine. The productivity potential is high; however, the soil has severe limitations to use and management. The main concerns in producing and harvesting timber are severe limitations in the use of equipment and severe seedling mortality caused by flooding and wetness. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from November to April. Limiting logging to the drier periods also helps to reduce rutting and soil compaction. Trees should be water tolerant, and they should be planted or harvested during dry periods. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Myatt soil is moderately well suited to pasture. The main limitations are low fertility and wetness, and flooding is a hazard. Suitable pasture plants are common bermudagrass and bahiagrass; however, tall fescue, white clover, vetch, and singletary peas have a moderate tolerance to flooding. Fertilizer and lime are needed for optimum growth of grasses and legumes. Wetness limits the period of grazing, and pasture grass is difficult to establish because of the hazard of flooding. Excess water on the surface can be removed by surface ditches and suitable outlets. Protection from flooding is possible, but only where major flood control structures are constructed. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition.

This soil is poorly suited to cultivated crops, mainly because of low fertility, potentially toxic levels of exchangeable aluminum, wetness, and the hazard of flooding. Drainage and flood control are needed if this soil is used for growing crops. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum in the root zone.

This soil is poorly suited to most urban uses, including use as building sites. It has severe limitations for building sites, local roads and streets, and most sanitary facilities mainly because of flooding, wetness, and moderately slow permeability. Drainage is needed if roads and building foundations are constructed. Major flood control structures are needed to prevent flooding. Excess water can be removed by using shallow ditches and providing the proper grade for drainage. Roads and streets should be located above the expected flood level. Selection of adapted vegetation is critical for establishing lawns, shrubs, trees, and vegetable gardens. Moderately slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. If flooding is controlled, lagoons and self-contained disposal units can be used to dispose of sewage properly.

This soil is poorly suited to recreational development, mainly because of wetness. Flooding is a hazard where the soil is used as campsites. Good drainage is needed for most recreational uses. Plant cover can be maintained by controlling traffic.

This soil is well suited to use as habitat for ducks, deer, squirrels, rabbits, quail, turkey, and numerous small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. The habitat for waterfowl and furbearers is improved by constructing shallow ponds.

This Myatt soil is in capability subclass IVw. The woodland ordination symbol is 9W.

OG—Ouachita, Ochlockonee, and Guyton soils, frequently flooded. These soils are level and gently undulating. They are on the flood plains of streams. The Ouachita and Ochlockonee soils are well drained and are on low ridges. The Guyton soil is poorly drained and is in low positions on the landscape. These soils were not mapped separately because frequent flooding limits their use and management. The Ouachita soil makes up about 35 percent of the map unit, the Ochlockonee soil about 30 percent, and the Guyton soil about 20 percent. Most mapped areas contain all three soils, but some areas contain only one or two. The areas typically are long and narrow and range to several thousand acres. Slopes range from 1 to 3 percent on the ridges and are 0 to 1 percent in the low positions between ridges.

Typically, the Ouachita soil has a surface layer of dark brown, very strongly acid silt loam about 5 inches thick. The subsoil to a depth of about 49 inches is dark

yellowish brown and yellowish brown, extremely acid silt loam in the upper part and dark yellowish brown, mottled, very strongly acid silt loam in the lower part. The subsoil is underlain by a buried layer that to a depth of about 70 inches is light brownish gray, mottled, very strongly acid silt loam.

The Ouachita soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderately slow rate. Water runs off the surface at a slow rate. This soil is subject to brief to long periods of flooding throughout the year. The water table is not within a depth of 6 feet. The shrink-swell potential is low.

Typically, the Ochlockonee soil has a surface layer of dark grayish brown, extremely acid sandy loam about 6 inches thick. The underlying material to a depth of about 60 inches is brown and dark yellowish brown, extremely acid sandy loam in the upper part; brownish yellow, extremely acid loamy fine sand in the middle part; and light brownish yellow, extremely acid loamy fine sand in the lower part.

This Ochlockonee soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderate rate, and water runs off the surface at a slow rate. This soil is subject to brief periods of flooding throughout the year. The seasonal high water table is at a depth of 3 to 5 feet from December to April. Plants are damaged by lack of water during dry periods in summer and fall of some years. This soil has low shrink-swell potential.

Typically, the Guyton soil has a surface layer of dark grayish brown, strongly acid silt loam about 5 inches thick. The subsurface layer to a depth of about 27 inches is grayish brown, mottled, very strongly acid silt loam. The subsoil to a depth of about 60 inches is mixed, grayish brown, mottled, very strongly acid silty clay loam and light brownish gray, very strongly acid silt loam in the upper part and grayish brown, mottled, very strongly acid silty clay loam in the lower part.

This Guyton soil has low fertility and high levels of exchangeable aluminum that are potentially toxic to most crops. Water and air move through this soil at a slow rate, and water runs off the surface at a slow rate. The surface layer is wet for long periods in winter and spring. This soil dries out more slowly than most adjacent soils at higher elevations. A seasonal high water table fluctuates between a depth of about 1.5 feet and the soil surface from December to May. This soil is subject to brief to long periods of flooding throughout the year. The shrink-swell potential is low.

Included with these soils in mapping are a few small areas of Cahaba soils. The Cahaba soils are on convex ridges at higher elevations than the Ouachita and Ochlockonee soils and they have a reddish subsoil. Also included are soils similar to the Guyton soil except that they are more sandy throughout. The included soils make up about 15 percent of the map unit.

The soils of this map unit are mainly used as woodland. A small acreage is pasture.

These soils are moderately well suited to loblolly pine, Nuttall oak, yellow poplar, eastern cottonwood, sweetgum, and American sycamore. The potential production is high. The main concerns in producing and harvesting timber are severe limitations in the use of equipment and high seedling mortality caused by wetness and flooding. Conventional methods of harvesting timber can be used except sometimes during rainy periods and periods of flooding, generally from December to May. Logging should be done during the drier periods to reduce soil compaction and rutting. Only trees that can tolerate seasonal wetness should be planted. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants.

These soils are poorly suited to pasture because of the hazard of flooding and low fertility. For the Guyton soil, wetness is an additional limitation. Suitable pasture plants are common bermudagrass and bahiagrass. Singletary peas, white clover, tall fescue, and vetch have a moderate tolerance to flooding and can be grown in some places. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

These soils generally are not suited to cultivated crops, urban uses, or intensively used recreation uses, such as playgrounds and campsites. The hazard of flooding is too severe for these uses.

These soils are well suited to use as habitat for deer, squirrel, rabbit, ducks, turkey, and numerous other small furbearers. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. The habitat for waterfowl can be improved by constructing shallow ponds.

The soils in this map unit are in capability subclass Vw. The woodland ordination symbol for the Ouachita and Ochlockonee soils is 11W, and it is 9W for the Guyton soil.

Pa—Pits-Arents complex, 0 to 5 percent slopes. This complex consists of pits and Arents soils. The pits are open excavations from which sand, gravel, or loamy material was removed. The Arents soils are the piles of soil material left beside the pits after the sand, gravel, or other soil material was removed. The pits and Arents soils are so intermingled that mapping them separately was not practical at the selected scale. Areas range from about 5 to several hundred acres. The pits make up about 65 percent of the complex and the Arents soils about 25 percent.

Gravel pits are open excavations from which gravel has been mined. Most of these pits are on the low terraces along the Tangipahoa River in the north and central parts of the parish. Sand pits are areas from which only sand has been removed. Borrow pits are areas from which soil and the underlying material have been removed for use in construction of roads and as fill in other areas.

The floor and walls of most pits are exposed geologic strata. This material has low fertility and generally is droughty to plants. Pits support little or no vegetation; however, a few willow trees and annual weeds grow on the floor of some pits. In wet seasons, some pits are ponded for long periods. The seasonal high water table in other pits ranges from near the surface to about 4 feet below the surface.

Typically, the Arents soils consist of stratified and mixed sandy and loamy soil material. These soils are spoil banks or piles of soil material left beside and in pits after the sand, gravel, or other material was removed. In places, thick or thin clayey layers are included in these soils.

The Arents soils have low fertility. The water table is not within a depth of 6 feet in most places. The available water capacity and permeability are variable within short distances. In many places, these soils are droughty to most plants.

Included with pits and Arents soils are a few small undisturbed areas of Cahaba, Fluker, and Myatt soils. These soils differ from the Arents soils in having an orderly sequence of soil layers in the profile. Also included are small areas of Arents soils that have slopes of 6 to 15 percent. The included soils make up about 10 percent of the map unit.

Most areas of pits and Arents soils are idle or used only for extensive forms of recreation and as habitat for wildlife. The natural vegetation is mainly annual and perennial grasses and forbs. Scrub pines are in some areas of the Arents soils, and willow trees are growing in many of the pits.

The soils of this map unit are poorly suited to use as cropland, pasture, woodland, or for urban development. The uneven topography, restricted drainage, ponding, and erosion hazard are the main limitations. Pits require major reclamation before they can be used for crops or pasture. The Arents soils can be planted to common bermudagrass or pine trees to protect the soils from erosion, but the trees and grass grow slowly because of the low fertility and droughtiness of these soils. Water collects in some of the pits and provides habitat for ducks.

Pits and Arents soils are not assigned a capability class nor a woodland ordination symbol.

Pt—Prentiss fine sandy loam. This soil is nearly level and is moderately well drained. It is on convex ridges on broad stream or marine terraces. Areas range from about 5 to 50 acres.

Typically, the surface layer is dark grayish brown, extremely acid fine sandy loam about 5 inches thick. The subsoil to a depth of about 26 inches is a friable loam. It is yellowish brown and extremely acid in the upper part and light yellowish brown and very strongly acid in the lower part. The subsoil between depths of 26 inches and 65 inches is a firm and brittle fragipan. It is mottled yellowish brown and light gray, very strongly acid loam.

Included with this soil in mapping are a few small areas of Abita, Guyton, Myatt, and Stough soils. The included soils are in lower positions on the landscape than the Prentiss soil and do not have a fragipan. The Abita and Stough soils are somewhat poorly drained. The Guyton and Myatt soils are poorly drained. The included soils make up about 10 percent of the map unit.

This Prentiss soil has low fertility, and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through the surface layer and the upper part of the subsoil at a moderate rate and through the lower part at a moderately slow rate. Water runs off the surface at a medium rate. Water is perched above the fragipan at a depth of about 2 to 2.5 feet from January to March. The effective rooting depth and available water capacity are restricted by the fragipan. Plants are damaged by a lack of water during dry periods in summer and fall of some years. The shrink-swell potential is low.

This Prentiss soil is used mainly as woodland and pasture. Small acreages are used for crops or homesites.

This soil is well suited to loblolly pine and slash pine. It has few limitations to woodland use and management. Timber production is limited somewhat by soil droughtiness and the moderately shallow rooting depth. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Conventional planting and harvesting equipment generally can be used throughout the year; however, logging should be done during the drier periods to prevent soil compaction.

This Prentiss soil is well suited to pasture. It is limited mainly by low fertility. Soil droughtiness in late summer limits forage production in some years. Suitable pasture plants are common bermudagrass, improved bermudagrass, bahiagrass, ball clover, crimson clover, and ryegrass. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly corn, soybeans, and vegetables. The main limitations are low fertility and the potentially toxic levels of exchangeable aluminum in the root zone. The fragipan limits rooting depth and available water capacity. Most crops respond well to fertilizer and lime, which help to

overcome the low fertility and high levels of exchangeable aluminum. This soil generally is wet in spring; however, crops are damaged by the lack of water during dry periods in summer and fall of some years. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Maintaining crop residue on or near the surface helps to conserve moisture and maintain soil tilth.

This soil is moderately well suited to rural homesites and to urban development. Wetness and moderately slow permeability are the main limitations. This soil has moderate to severe limitations for building sites, local roads and streets, and most sanitary facilities. A seasonal high water table is perched above the fragipan, and drainage should be provided if buildings are constructed. Mulching, fertilizing, and irrigation are needed to establish lawn grasses and other small seed plants. Moderately slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units can be used to dispose of sewage properly.

This soil is moderately well suited to recreational development. It is limited mainly by wetness and moderately slow permeability. Good drainage is needed for most recreational uses. Plant cover can be maintained by controlling traffic and by adding fertilizer and lime. The soil can be somewhat droughty to grasses on golf fairways in late summer and fall of most years. Where adequate water is available, irrigating golf fairways will ensure a good grass cover.

This soil is well suited to use as habitat for rabbits, squirrels, quail, dove, deer, and turkey. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. In wooded areas, prescribed burning, rotated among several tracts of land, can increase the amount of palatable deer browse and seed-producing plants for quail and turkey.

This Prentiss soil is in capability subclass IIw. The woodland ordination symbol is 9A.

Rn—Ruston fine sandy loam, 1 to 3 percent slopes. This soil is very gently sloping and well drained. It is on ridgetops on the terrace uplands. Areas range from about 20 to 2,000 acres.

Typically, the surface layer is dark grayish brown, medium acid fine sandy loam about 6 inches thick. The subsurface layer to a depth of about 11 inches is yellowish brown, medium acid fine sandy loam. The subsoil to a depth of about 70 inches is yellowish red, very strongly acid sandy clay loam in the upper part; yellowish red and light reddish brown, very strongly acid sandy loam in the middle part; and red, very strongly acid sandy clay loam in the lower part.

Included with this soil in mapping are a few small areas of Malbis and Tangi soils that are moderately well drained. The Malbis soils have less convex slopes than the Ruston soil. They are brownish throughout and have nodules of plinthite in the lower part of the subsoil. The Tangi soils are in positions on the landscape similar to those of the Ruston soil and they have a fragipan. The included soils make up about 10 percent of the map unit.

This Ruston soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderate rate, and water runs off the surface at a medium rate. The water table is not within a depth 6 feet. This soil dries quickly after rains. Plants generally are damaged by a lack of water during dry periods in summer and fall of some years. The shrink-swell potential is low.

This Ruston soil is used mainly as woodland and pasture. Small acreages are used for crops, homesites, and intensive recreation areas, such as playgrounds and campsites.

This soil is well suited to loblolly pine, slash pine, and longleaf pine and has few limitations for timber production. After harvesting, reforestation should be managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Ruston soil is well suited to pasture. The main concerns are low fertility and a slight hazard of erosion. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, ball clover, crimson clover, and arrowleaf clover. Proper stocking and pasture rotation help keep the pasture in good condition. Seedbed preparation should be on the contour or across the slope where practical. Periodic mowing and clipping help to maintain uniform growth, discourages selective grazing, and reduces clumpy growth. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This Ruston soil is moderately well suited to cultivated crops, mainly corn and soybeans. It is limited mainly by the hazard of erosion, low fertility, and potentially toxic levels of exchangeable aluminum. Runoff and erosion can be reduced by plowing in fall, fertilizing, and seeding to a cover crop. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help to maintain fertility and reduce runoff and erosion. Most crops respond well to fertilizer and lime, which help to overcome the low fertility and high levels of aluminum in the root zone.

This Ruston soil is well suited to use for homesites and other urban development. The main limitations are low strength for roads and moderate permeability. Low strength is a limitation where this soil is used for local roads and streets; however, roads can be designed to

offset the limited ability of the soil to support a load. Seepage is a limitation if this soil is used for sewage lagoons. Moderate permeability increases the possibility that septic tank absorption fields will fail. This limitation can be overcome by increasing the size of the absorption field. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

This Ruston soil is well suited to recreational development and has few limitations to most recreational uses. Erosion can be a hazard where the soil is used as playgrounds. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic.

This soil is well suited to use as habitat for deer, squirrels, rabbits, turkey, dove, quail, and numerous other nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants.

This Ruston soil is in capability subclass IIe. The woodland ordination symbol is 9A.

RS—Ruston-Smithdale association, rolling. These soils are rolling and well drained. They are on narrow ridgetops and on side slopes on the terrace uplands. The Ruston soil is on ridgetops and side slopes and has long, smooth slopes that range from 3 to 8 percent. The Smithdale soil is on side slopes and has shorter and steeper slopes that range from 5 to 12 percent. Individual areas of both soils are large enough to be mapped separately but were not because the steepness of slopes and shape of the areas limit the use and management of the soils. The Ruston soil makes up about 60 percent of the association and the Smithdale soil about 25 percent. Areas are irregular in shape and range from about 20 to several thousand acres.

Typically, the Ruston soil has a surface layer of dark grayish brown, very strongly acid fine sandy loam about 5 inches thick. The subsurface layer to a depth of about 9 inches is light yellowish brown, very strongly acid fine sandy loam. The subsoil to a depth of about 83 inches is yellowish red, very strongly acid sandy clay loam in the upper part; yellowish red and light yellowish brown, very strongly acid sandy loam in the middle part; and red, mottled, very strongly acid sandy clay loam in the lower part.

The Ruston soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderate rate, and water runs off the surface at a medium rate. This soil dries quickly after rains. The water table is not within a depth of 6 feet. Roots penetrate this soil easily. Plants are damaged by a lack of water during dry periods in summer and fall of some years. The shrink-swell potential is low.

Typically, the Smithdale soil has a surface layer of very dark grayish brown, strongly acid fine sandy loam about 4 inches thick. The subsurface layer to a depth of about 8 inches is yellowish brown, very strongly acid fine sandy loam. The subsoil to a depth of about 65 inches is yellowish red and red, very strongly acid sandy clay loam in the upper part and red, very strongly acid sandy loam in the lower part.

This Smithdale soil has low fertility. Water and air move through this soil at a moderate rate, and water runs off the surface at a rapid rate. This soil dries quickly after rains. The water table is not within a depth of 6 feet. Roots penetrate this soil easily. Plants are damaged from a lack of water during dry periods in summer and fall of some years. The shrink-swell potential is low.

Included with these soils in mapping are a few small areas of Malbis and Tangi soils. The Malbis soils are well drained, and the Tangi soils are moderately well drained. The Malbis and Tangi soils have smooth slopes that have a gradient of less than 5 percent. The Malbis soils are brownish throughout and have plinthite in the subsoil. The Tangi soils have a fragipan. Also included are a few small areas of Smithdale soils that have slopes of more than 12 percent. Typically, these Smithdale soils are moderately to severely eroded and do not have a surface layer. The included soils make up about 15 percent of the map unit.

The soils of this association are used mainly as woodland. Small acreages are used for pasture, recreation areas, or homesites.

The Ruston and Smithdale soils are well suited to loblolly pine, longleaf pine, and slash pine and have few limitations for timber production. In some small areas, however, irregular slopes and gullies restrict the use of equipment. Practices designed to minimize the risk of erosion are needed when timber is harvested. Conventional methods of harvesting timber generally can be used throughout the year. After harvesting, reforestation should be managed to reduce competition from undesirable understory plants.

These soils are moderately well suited to pasture. The main concerns in pasture management are the severe hazard of erosion, complex slopes, and low fertility. The most suitable pasture plants are bahiagrass, improved bermudagrass, common bermudagrass, ball clover, crimson clover, arrowleaf clover, and ryegrass. Proper stocking and pasture rotation help keep the pasture in good condition. Seedbed preparation should be on the contour or across the slope where practical. Fertilizer and lime are needed for optimum growth of grasses and legumes.

These soils are poorly suited to cultivated crops mainly because of low fertility, potentially toxic levels of exchangeable aluminum, and the hazard of erosion. Irregular slopes and gullies hinder tillage operations in some areas. Practices that can control erosion include early fall seeding, conservation tillage, and construction

of terraces, diversions, and grassed waterways. These soils are friable and easy to keep in good tilth. They can be worked throughout a wide range of moisture content. Most crops respond well to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum in the root zone.

These soils are moderately well suited to recreational development. Steepness of slope is the main limitation. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Plant cover can be maintained by controlling traffic. Paths and trails should extend across the slope.

The Ruston and Smithdale soils are moderately well suited to urban development. Steepness of slope is the main limitation. Seepage is a limitation to some sanitary facilities. Moderate permeability in the Ruston soil is a limitation to septic tank absorption fields. This limitation can be overcome by enlarging the size of the absorption field. Preserving the existing plant cover during construction helps to control erosion. Only the part of the site that is used for construction should be disturbed. Roads and streets should be designed to offset the limited ability of the Ruston soil to support a load.

These soils are well suited to use as habitat for squirrels, rabbits, quail, dove, deer, turkey, and numerous other small nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Prescribed burning every three years, rotated among several small tracts of land, can increase the amount of palatable deer browse and seed-producing plants for quail and turkey.

The Ruston soil is in capability subclass IIIe, and the Smithdale soil is in capability subclass IVe. The woodland ordination symbol for both soils is 9A.

Sa—Savannah silt loam, 1 to 3 percent slopes. This soil is very gently sloping and moderately well drained. It is on slightly convex slopes on stream terraces near major drainageways. Areas are irregular in shape and range from 20 to 300 acres.

Typically, the surface layer is dark grayish brown, strongly acid silt loam about 5 inches thick. The subsoil to a depth of about 25 inches is strong brown, mottled, extremely acid silt loam in the upper part and mottled strong brown and yellowish brown, extremely acid loam in the lower part. The subsoil between depths of about 25 inches and 61 inches is a fragipan. In the upper part, it is extremely acid loam that is mottled in shades of brown and red. It is yellowish brown, mottled, extremely acid sandy loam in the middle and lower parts.

Included with this soil in mapping are a few small areas of Cahaba, Fluker, and Myatt soils. The Cahaba soils are well drained. They are in positions on the landscape similar to those of the Savannah soil and they do not have a fragipan. The Fluker soils are somewhat poorly drained. They are in lower positions and have grayish mottles in the upper part of the subsoil. The Myatt soils are poorly drained. They are also in lower positions and do not have a fragipan. The included soils make up about 10 percent of the map unit.

This Savannah soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderate rate in the surface layer and upper part of the subsoil and at a moderately slow rate in the fragipan. Water runs off the surface at a medium rate. Water is perched above the fragipan at a depth of about 1.5 to 3 feet from January to March. The shrink-swell potential is low.

This Savannah soil is used mainly as woodland and pasture. Small acreages are used for truck crops, homesites, or recreation areas.

This soil is well suited to loblolly pine and slash pine and has few limitations to this use. Soil compaction and the competition from understory plants are the main concern in producing and harvesting timber. In addition, trees are subject to windthrow because of the limited rooting depth. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from January to March. Logging should be done during the drier seasons to reduce soil compaction and rutting. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Savannah soil is well suited to pasture. The main concerns in pasture management are low fertility and the moderate hazard of erosion until plants are established. Suitable pasture plants are bahiagrass, improved bermudagrass, common bermudagrass, white clover, southern winter peas, vetch, tall fescue, and ryegrass. Fertilizer is needed for optimum growth of grasses and legumes. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition.

This soil is moderately well suited to cultivated crops, mainly vegetables, soybeans, and corn. Low fertility, potentially toxic levels of exchangeable aluminum, and the moderate hazard of erosion are the main limitations. Runoff and erosion can be reduced by plowing in fall, by fertilizing, and by seeding to a cover crop. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help to maintain fertility and tilth. Most crops respond well to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum.

This Savannah soil is moderately well suited to urban development. The main limitations are moderately slow permeability, low strength for roads, and wetness. A

seasonal high water table is perched above the fragipan, and drainage should be provided if buildings are constructed. Preserving the existing plant cover during construction helps to control erosion. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. Moderately slow permeability and a seasonal high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal units can be used to dispose of sewage properly. Roads and streets should be designed to offset the limited ability of the soil to support a load.

This soil is moderately well suited to recreational development. The main limitations are wetness and moderately slow permeability. Erosion is a hazard where this soil is used as playgrounds. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Good drainage is needed for intensively used areas, such as playgrounds.

This soil is well suited to use as habitat for deer, squirrels, rabbits, turkeys, quail, doves, and numerous other small nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation or by propagating desirable plants. Oaks and other mast-producing trees are important plants for deer and squirrels. The practices of prescribed burning and providing small open areas in forest land encourage the growth of understory plants.

This Savannah soil is in capability subclass IIe. The woodland ordination symbol is 9A.

Sm—Smithdale fine sandy loam, 12 to 20 percent slopes. This soil is moderately steep and well drained. It is on escarpments between the terrace uplands and alluvial plains and on side slopes along major entrenched drainageways on the terrace uplands. Areas are irregular in shape and range from 20 to 200 acres.

Typically, the surface layer is dark grayish brown, very strongly acid fine sandy loam about 4 inches thick. The subsoil to a depth of about 42 inches is red, very strongly acid sandy clay loam. The substratum to a depth of about 60 inches is red, very strongly acid sandy loam.

Included with this soil in mapping are a few small areas of Malbis, Ruston, and Tangi soils. The Malbis soils are moderately well drained. They are on less steep side slopes than those of the Smithdale soil and have nodules of plinthite in the subsoil. The Ruston soils are well drained. They are also on less steep side slopes and they have a subsoil that has as much or more clay in the lower part as in the upper and middle parts. The Tangi soils are moderately well drained. They are on the upper part of side slopes that are less steep than those of the Smithdale soil and they have a fragipan in the lower part of the subsoil. Also included are a few small areas of Smithdale soils that have slopes of 8 to 12 percent. In places are a few gullies and small areas of Smithdale soil where the surface layer and part of the subsoil have eroded away. The included soils make up about 10 percent of the map unit.

This Smithdale soil has low fertility. High levels of exchangeable aluminum in the root zone are potentially toxic to most crops. Water and air move through this soil at a moderate rate, and water runs off the surface at a rapid rate. The water table is not within a depth of 6 feet. Plants are damaged by a lack of water during dry periods in summer and fall of some years. The shrink-swell potential is low.

This Smithdale soil is used mainly as woodland and pasture. Small acreages are used for recreational development.

This Smithdale soil is well suited to the production of loblolly pine, longleaf pine, and slash pine. The main concerns in producing and harvesting timber are a moderate limitation in the use of equipment and the hazard of erosion caused by moderately steep slopes. In places, gullies also limit the use of equipment. Mechanical planting of trees on the contour helps to control erosion. Roads and landings can be protected from erosion by constructing diversions and by seeding cuts and fills. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This soil is moderately well suited to pasture. The main limitations are low fertility and the hazard of erosion until plants are established. In places, the use of equipment is restricted by gullies. Suitable pasture plants are bahiagrass, common bermudagrass, ball clover, and crimson clover. Seedbed preparation should be on the contour or across the slope where practical. Drop structures can be installed in grassed waterways where needed to prevent gullying. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage.

This soil is generally not suited to use as cropland because of the moderately steep slopes and the severe hazard of erosion.

This Smithdale soil is poorly suited to urban use and intensive recreational uses, such as playgrounds and campsites, mainly because of the moderately steep slope. Preserving the existing plant cover and revegetating disturbed areas around construction sites as soon as possible help to control soil erosion. Effluent from septic tank absorption fields can surface in downslope areas and create a hazard to health. Self-contained sewage disposal units can be used to dispose of sewage properly and without the risk of seepage in downslope areas. Seepage is a limitation to sanitary facilities, such as sewage lagoons. The moderately steep slopes limit recreational uses mainly to a few paths and trails, which should extend across the slope.

This soil is well suited to use as habitat for deer, squirrels, rabbits, quail, turkey, and other nongame birds

and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Large mast-producing trees, such as oaks, should be preserved where possible. Creating small open areas in forest land can encourage the growth of understory plants for wildlife.

This Smithdale soil is in capability subclass VIe. The woodland ordination symbol is 9R.

St—Stough fine sandy loam. This soil is level and somewhat poorly drained. It is on broad, slightly convex ridges on the broad stream or marine terraces. Areas range from about 20 to 300 acres.

Typically, the surface layer is dark grayish brown, extremely acid fine sandy loam about 3 inches thick. The subsurface layer to a depth of about 6 inches is pale brown, mottled, extremely acid fine sandy loam. The subsoil to a depth of about 70 inches is light yellowish brown, mottled, very strongly acid loam in the upper and middle parts and multicolored, very strongly acid sandy clay loam in the lower part. Brittle masses make up from 5 to 45 percent of the volume of the middle and lower parts of the subsoil.

Included with this soil in mapping are a few small areas of Abita, Guyton, Myatt, and Prentiss soils. The Abita soils are somewhat poorly drained. They are in positions on the landscape similar to those of the Stough soil and they have less sand and more clay in the subsoil. The Guyton and Myatt soils are poorly drained. They are are in lower positions than the Stough soil and are grayish throughout. The Prentiss soils are moderately well drained. They are in higher positions and have a fragipan in the subsoil. The included soils make up about 10 percent of the map unit.

This Stough soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Water and air move through this soil at a moderately slow rate, and water runs off the surface at a slow rate. Effective rooting depth is limited somewhat by the concentrations of brittle masses in the middle and lower parts of the subsoil. A seasonal high water table fluctuates between depths of about 1 foot and 1.5 feet from January to April. Plants are damaged by a lack of water during dry periods in summer and fall of some years. This soil has low shrink-swell potential.

This Stough soil is used mainly as woodland. Small acreages are used as pasture, cropland, homesites, or recreation areas.

This soil is well suited to the production of sweetgum, loblolly pine, and slash pine. The main concerns in producing and harvesting timber are the understory plant competition and a moderate limitation in the use of equipment caused by wetness. Conventional methods of harvesting timber can be used except sometimes during rainy periods, generally from January to April. Logging should be done in the drier seasons to reduce soil compaction and rutting. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This soil is well suited to pasture. The main limitations are wetness and low fertility. Suitable pasture plants are bahiagrass, common bermudagrass, improved bermudagrass, white clover, southern winter peas, vetch, and tall fescue. Wetness limits the period of grazing. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly vegetables and soybeans. Wetness, low fertility, and potentially toxic levels of exchangeable aluminum are the main limitations. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum in the root zone.

This soil is poorly suited to urban development, mainly because of wetness and moderately slow permeability. Drainage is needed if roads and building foundations are constructed. Moderately slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Lagoons or self-contained sewage disposal systems can be used to dispose of sewage properly. Drainage is needed for most lawn grasses, shade trees, ornamental trees, shrubs, vines, and vegetable gardens.

This soil is poorly suited to recreational development, mainly because of wetness and moderately slow permeability. Good drainage is needed for most intensively used recreation areas, such as playgrounds and campsites. Maintaining a good vegetative cover helps to reduce erosion. Plant cover can be maintained by controlling traffic. The soil can be somewhat droughty to plants in summer and fall of some years. Where an adequate supply of water is available, irrigating golf fairways helps to maintain a good grass cover.

This soil is well suited to use as habitat for deer, squirrels, rabbits, quail, turkey, dove, and numerous other nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants.

This Stough soil is in capability subclass IIw. The woodland ordination symbol is 9W.

Ta—Tangi silt loam, 1 to 3 percent slopes. This soil is very gently sloping and moderately well drained. It is on narrow and broad ridgetops on the terrace uplands. Areas range from about 100 to 2,000 acres.

Typically, the surface layer is dark grayish brown, medium acid silt loam about 4 inches thick. The subsoil to a depth of about 25 inches is yellowish brown, strongly acid silt loam in the upper part and yellowish brown, mottled, medium acid silt loam in the lower part. The next layer is a fragipan. The upper part of the fragipan is yellowish brown, strongly acid loam. The middle part is yellowish red, strongly acid clay loam. The lower part to a depth of about 65 inches is red, strongly acid clay.

Included with this soil in mapping are a few small areas of Fluker, Malbis, Ruston, and Toula soils. The Fluker soils are somewhat poorly drained. They are in flat and concave areas and have gray mottles in the upper part of the subsoil. The Malbis soils are moderately well drained. They are in positions on the landscape similar to those of the Tangi soil and they do not have a fragipan. The Ruston soils are well drained. They have slightly more convex slopes than the Tangi soil and they do not have a fragipan. The Toula soils are moderately well drained. They have longer and smoother slopes than the Tangi soil and they have more sand and less clay in the fragipan. The included soils make up about 10 percent of the map unit.

This Tangi soil has low fertility and moderately high levels of exchangeable aluminum in the root zone that are potentially toxic to some crops. Permeability is moderate in the surface layer and upper part of the subsoil and very slow in the fragipan. Water runs off the surface at a medium rate. This soil dries quickly after rains. Water is perched above the fragipan at a depth of about 1.5 to 3 feet from December to April. Effective rooting depth is limited by the fragipan. Plants are damaged by lack of water during dry periods in summer and fall of some years. This soil has moderate shrink-swell potential.

This Tangi soil is used mainly as woodland, pasture, or cropland. In a few areas, it is used as homesites and intensive recreation areas, such as playgrounds or campsites.

This soil is well suited to loblolly pine and slash pine and has few limitations to woodland use and management. Logging should be done during the drier seasons to prevent soil compaction. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Tangi soil is well suited to pasture. The main limitations are low fertility and slight hazard of erosion until plants are established. Suitable pasture plants are bahiagrass, common bermudagrass, hybrid bermudagrass, ball clover, crimson clover, arrowleaf clover, and ryegrass. Seedbed preparation should be on the contour or across the slopes. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly soybeans and corn. It is limited mainly by low fertility, potentially toxic levels of exchangeable aluminum, and the slight hazard of erosion. Runoff and erosion can be reduced by plowing in fall, fertilizing, and seeding to a cover crop. Contour farming and terraces also reduce erosion. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond well to fertilizer and lime, which help to overcome the low fertility and moderately high levels of aluminum in the root zone.

This soil is moderately well suited to urban development. The main limitations are low strength for roads, moderate shrink-swell potential, very slow permeability, and wetness. Seepage is a limitation to some sanitary facilities. A seasonal high water table is perched above the fragipan, and drainage should be provided if buildings are constructed. Preserving the existing plant cover during construction helps to control erosion. Roads should be designed to offset the limited ability of the soil to support a load. Buildings and roads can be designed to offset the effects of shrinking and swelling. Very slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Self-contained sewage disposal units can be used to dispose of sewage properly.

This soil is moderately well suited to recreational development. Wetness and very slow permeability are the main limitations. Good drainage is needed for most intensively used recreation areas. Erosion is a slight hazard where this soil is used as playgrounds. Cuts and fills should be seeded or mulched to reduce erosion. Plant cover should be maintained by controlling traffic and applying fertilizer and lime.

This soil is well suited to use as habitat for deer, squirrels, rabbits, turkeys, quail, doves, and other small birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover or by propagating desirable plants.

This Tangi soil is in capability subclass IIe. The woodland ordination symbol is 13A.

Tg—Tangi silt loam, 3 to 8 percent slopes. This soil is moderately sloping and moderately well drained. It is on side slopes along drainageways. Areas range from about 100 to 2,000 acres.

Typically, the surface layer is dark grayish brown, strongly acid silt loam about 3 inches thick. The subsoil to a depth of about 24 inches is yellowish brown, strongly acid silt loam in the upper part and mottled yellowish brown and dark yellowish brown, strongly acid silt loam in the lower part. The next layer to a depth of about 70 inches is a fragipan. It is mottled strong brown, yellowish brown, and red. The upper part is strongly acid clay. The middle part is medium acid clay, and the lower part is medium acid sandy clay loam.

Included with this soil in mapping are a few small areas of Malbis, Ruston, Smithdale, and Toula soils. The Malbis soils are moderately well drained. They are in positions on the landscape similar to those of the Tangi soil, and they do not have a fragipan. The Ruston and Smithdale soils are well drained. They are on more convex slopes than the Tangi soil and they do not have a fragipan. The Toula soils are moderately well drained. They have smoother and less steep slopes than the Tangi soil and have less sand and clay in the fragipan. The included soils make up about 10 percent of the map unit.

This Tangi soil has low fertility and moderately high levels of exchangeable aluminum in the root zone that are potentially toxic to some crops. Permeability is moderate in the surface layer and upper part of the subsoil and very slow in the fragipan. Water runs off the surface at a medium rate. Water is perched above the fragipan at a depth of about 1.5 to 3 feet from December to April. Effective rooting depth is restricted by the fragipan. Plants are damaged by lack of water during dry periods in summer and fall of some years. This soil has a moderate shrink-swell potential.

This Tangi soil is used mainly as woodland, pasture, or cropland. In a few areas, it is used as homesites or recreation areas.

This soil is well suited to loblolly pine and slash pine and has few limitations to woodland use and management. Logging should be done during the drier seasons to reduce soil compaction. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Tangi soil is well suited to pasture. The main limitations are low fertility and the hazard of erosion until plants are established. Suitable pasture plants are bahiagrass, common bermudagrass, hybrid bermudagrass, ball clover, crimson clover, arrowleaf clover, and ryegrass. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Seedbed preparation should be on the contour or across the slope where practical. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops mainly soybeans and corn. The main limitations are low fertility, potentially toxic levels of exchangeable aluminum, and the moderate hazard of erosion. Practices that control erosion include early fall seeding, conservation tillage, and construction of terraces, diversions, and grassed waterways. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and moderately high levels of exchangeable aluminum.

This soil is moderately well suited to urban development. The main limitations are wetness, moderate shrink-swell potential, very slow permeability, and low strength for roads. Seepage is a limitation to some sanitary facilities, such as sewage lagoons. A seasonal high water table is perched above the fragipan, and drainage should be provided if buildings are constructed. Roads should be designed to offset the limited ability of this soil to support a load. Buildings and roads can be designed to offset the effects of shrinking and swelling. Very slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Self-contained sewage disposal units can be used to dispose of sewage properly. Preserving the existing plant cover during construction helps to control erosion. Proper fertilizing, seeding, mulching, and shaping of the slopes can help in establishing and maintaining plant cover.

This soil is moderately well suited to recreational development. Wetness and very slow permeability are moderate limitations for campsites, picnic areas, and paths and trails. Steepness of slope and the hazard of erosion are severe limitations where this soil is used as playgrounds. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Cuts and fills should be seeded or mulched as soon as possible.

This soil is well suited to use as habitat for deer, squirrels, rabbits, turkeys, quail, dove, and numerous nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining the existing plant cover, or by propagating desirable plants. Oaks and other large mast-producing trees should be preserved where possible. Prescribed burning can increase the amount of palatable deer browse and the number of seed-producing plants for quail and turkeys.

This Tangi soil is in capability subclass IIIe. The woodland ordination symbol is 13A.

To—Toula silt loam, 1 to 3 percent slopes. This soil is very gently sloping and moderately well drained. It is

on broad ridgetops on the terrace uplands. Areas range from about 100 to several thousand acres.

Typically, the surface layer is dark grayish brown, medium acid silt loam about 5 inches thick. The subsoil to a depth of 19 inches is light yellowish brown, mottled, medium acid silt loam in the upper part and yellowish brown, mottled, medium acid silt loam in the lower part. The next layer to a depth of about 48 inches is a fragipan. The upper part of the fragipan is mottled yellowish brown and red, medium acid silty clay loam. The middle and lower parts are yellowish brown, medium acid silt loam. Below the fragipan to a depth of about 65 inches is yellowish brown, mottled, medium acid clay loam.

Included with this soil in mapping are a few small areas of Fluker, Ruston, and Tangi soils. The Fluker soils are somewhat poorly drained. They are in level to slightly concave areas and have gray mottles in the upper part of the subsoil. The Ruston soils are well drained. They have steeper or more convex slopes than the Toula soil, are reddish throughout, and do not have a fragipan. The Tangi soils are moderately well drained. They have more convex slopes than the Toula soil and have more sand and clay in the fragipan. The included soils make up about 10 percent of the map unit.

This Toula soil has low fertility and high levels of exchangeable aluminum in the root zone that are potentially toxic to most crops. Permeability is moderate in the surface layer and upper part of the subsoil and slow in the fragipan. Water runs off the surface at a slow to medium rate. Water is perched above the fragipan at a depth of about 1.5 to 3 feet from December to April. Effective rooting depth is restricted by the fragipan. Plants are damaged by lack of water during dry periods in summer and fall of some years. This soil has low shrink-swell potential.

This Toula soil is mainly used as woodland, pasture, or cropland. In a few areas, it is used to produce Christmas trees (fig. 5). A few small areas are used for homesites or intensive recreation, such as playgrounds and campsites.

This soil is well suited to loblolly pine and slash pine. Logging should be done during the drier seasons to prevent soil compaction. After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. Competing vegetation can be controlled by proper site preparation and by spraying, cutting, or girdling to eliminate unwanted weeds, brush, or trees.

This Toula soil is well suited to pasture. The main limitations are low fertility and the slight hazard of erosion. Suitable pasture plants are bahiagrass, common bermudagrass, hybrid bermudagrass, ball clover, crimson clover, and arrowleaf clover. Proper stocking, pasture rotation, and restricted grazing during wet periods help keep the pasture and soil in good condition. Tillage for seedbed preparation should be on the contour or across the slopes where practical. Fertilizer and lime are needed for optimum growth of grasses and legumes.

This soil is moderately well suited to cultivated crops, mainly soybeans and corn. Low fertility, potentially toxic levels of aluminum, and the slight hazard of erosion are the main limitations. Crusting of the surface and compaction of the soil can be reduced by returning the crop residue to the soil and by using conservation tillage. Practices that control erosion include early fall seeding, conservation tillage, contour farming, and construction of diversions and grassed waterways. This soil is friable and easy to keep in good tilth. It can be worked throughout a wide range of moisture content. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixture help maintain fertility and tilth. Crops respond to fertilizer and lime, which help to overcome the low fertility and high levels of exchangeable aluminum.

This soil is moderately well suited to urban development. Wetness and slow permeability are the main limitations. A seasonal high water table is perched above the fragipan, and drainage should be provided if buildings are constructed. Low strength is a limitation where this soil is used for local roads and streets. Slow permeability and the high water table increase the possibility that septic tank absorption fields will fail. Seepage is a limitation for sewage lagoons. Self-contained sewage disposal units can be used to dispose of sewage properly. Preserving the existing plant cover during construction helps to control erosion. Proper fertilizing, seeding, mulching, and shaping of the slopes can help in establishing and maintaining plant cover.

This soil is moderately well suited to recreational development. Wetness and slow permeability are the main limitations. Slope is a moderate limitation to use as playgrounds. Cuts and fills should be seeded or mulched. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover. Good drainage is needed for most intensively used recreation areas, such as playgrounds and campsites.

This soil is well suited to use as habitat for deer, squirrels, rabbits, turkeys, quail, doves, and numerous nongame birds and animals. Habitat for wildlife can be improved by planting appropriate vegetation, by maintaining existing plant cover, and by propagating desirable plants. Preserving oaks and other large mast-producing trees improves the habitat for deer, squirrels, and turkeys.

This Toula soil is in capability subclass IIe. The woodland ordination symbol is 13A.

Figure 5.—Virginia pines, used as Christmas trees, grow well on Toula silt loam, 1 to 3 percent slopes.

Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Tangipahoa Parish are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources. Farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They are used for producing food or fiber or are available for these uses. Urban or built-up land, public land, and water areas cannot be considered prime farmland. Urban or built-up land is any contiguous unit of land 10 acres or more in size that is used for such purposes as housing, industrial, and commercial sites, sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water control structures. Public land is land not available for farming in national forests, national parks, military reservations, and state parks.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not subject to frequent flooding during the growing season. The slope ranges mainly from 0 to 6 percent.

The following map units, or soils, make up prime farmland in Tangipahoa Parish. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 5. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

Soils that have limitations, such as a high water table or have hazards, such as flooding, may qualify as prime farmland if these limitations or hazards are overcome by such measures as drainage or flood control. However, only those soils that have few limitations and need no additional improvements to qualify for prime farmland are included.

Aa Abita silt loam, 0 to 2 percent slopes
Ab Abita silt loam, 2 to 5 percent slopes
Ca Cahaba fine sandy loam, 1 to 3 percent slopes
Ch Cahaba fine sandy loam, 3 to 6 percent slopes
Fu Fluker silt loam
Go Guyton silt loam
Pt Prentiss fine sandy loam
Rn Ruston fine sandy loam, 1 to 3 percent slopes
Sa Savannah silt loam, 1 to 3 percent slopes
Ta Tangi silt loam, 1 to 3 percent slopes
To Toula silt loam, 1 to 3 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern that is in harmony with nature.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Dayton Matthews, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Differences in crop suitability and management needs result from differences in soil characteristics, such as fertility levels, erodibility, organic matter content, availability of water for plants, drainage, and the hazard of flooding. Cropping systems and soil tillage are an important part of management. Each farm has a unique soil pattern; therefore, each has unique management problems. Some principles of farm management, however, apply only to specific soils and certain crops. This section presents the general principles of management that can be applied widely to the soils of Tangipahoa Parish.

Pasture and hayland. Perennial grasses or legumes or a mixture of these are grown for pasture and hay (fig. 6). The mixture generally consists of either a summer or a winter perennial grass and a suitable legume. In addition, many farmers seed small grains or ryegrass in the fall for winter and spring forage. Excess grass in summer is harvested as hay for the winter.

Common and improved bermudagrass and Pensacola bahiagrass are the summer perennials most commonly grown. Improved bermudagrass and Pensacola bahiagrass produce good quality forage. Tall fescue, the main winter perennial grass, grows well only on soils that have a favorable moisture content. All of these grasses respond well to fertilizers, particularly nitrogen.

White clover, crimson clover, vetch, and southern winter peas are the most commonly grown legumes. All respond well to lime, particularly where grown on acid soils.

Proper grazing is essential for high quality forage, stand survival, and erosion control. Brush and weed control, fertilizer, lime, and renovation of the pasture are also important.

Forage production can be increased by grazing the understory native plants in woodland. Forage volume varies with the woodland site, the condition of the native forage, and the density of the timber stand. Although most woodland is managed mainly for timber, substantial

Figure 6.—Pensacola bahiagrass produces good forage on Fluker silt loam.

volumes of forage can be obtained from these areas if properly managed. Stocking rates and grazing periods need to be carefully managed for optimum forage production and to maintain an adequate cover of understory plants to control erosion. Additional information on the production of forage in woodland is in the section, "Woodland Management and Productivity."

Fertilization and liming. The soils of Tangipahoa Parish range from extremely acid to mildly alkaline in the upper 20 inches. Most soils used for crops are low in organic matter content and available nitrogen. They generally need lime and a complete fertilizer for crops and pasture plants. The amount of fertilizer needed depends on the kind of crop, on past cropping history, on the level of yield desired, and on the kind of soil. The amount should be determined on the basis of soil test results. Information and instructions on collecting and testing soil samples can be obtained from the Cooperative Extension Service.

Organic matter content. Organic matter is an important source of nitrogen for crops. It also increases the rate of water intake, reduces surface crusting, and improves tilth. In Tangipahoa Parish, most soils used for crops, especially those that have a silt loam or fine sandy loam surface layer, are low in organic matter content. The level of organic matter can be maintained by growing crops that produce an extensive root system and an abundance of foliage, by leaving plant residue on the surface, by growing perennial grasses and legumes in rotation with other crops, and by adding barnyard manure.

Soil tillage. Soils should be tilled only enough to prepare a seedbed and to control weeds. Excessive tillage destroys soil structure. Conservation tillage helps to maintain soil tilth. A compacted layer, generally known as a traffic pan or plowpan, sometimes develops just below the plow layer in loamy soils. This condition can be avoided by not plowing when the soil is wet or by varying the depth of plowing. If a plowpan develops, it

can be broken up by subsoiling or chiseling. Tillage implements that stir the surface but leave crop residue in place protect the soil from beating rains, thereby helping to control erosion, reduce runoff and surface crusting, and increase infiltration.

Drainage. Many soils in the parish need surface drainage to make them more suitable for crops. Early drainage methods involved a complex pattern of main ditches, laterals, and surface field ditches. The more recent approach to drainage in this parish is a combination of land smoothing with a minimum of surface drainage ditches. Larger and more uniformly shaped fields are created and are more suited to the use of modern, multirow farm machinery.

Control of erosion. Water erosion is a major hazard on many soils in Tangipahoa Parish. It is an especially serious problem on the soils on stream or marine terraces and uplands. Sloping soils, such as Ruston and Smithdale soils, are highly susceptible to erosion when left without plant cover for extended periods. If the surface layer of the soil is eroded away, most of the available plant nutrients and organic matter are also lost. Soils that have a fragipan, such as Tangi and Toula soils, especially need protection against water erosion. Soil erosion also results in sedimentation of drainage systems and pollution of streams by sediment, nutrients, and pesticides.

Cropping systems in which a plant cover is maintained on the soil for extended periods reduce soil erosion. Legume or grass cover crops reduce water erosion, increase the content of organic matter and nitrogen in the soils, and improve tilth. Terraces, diversions, grassed waterways, conservation tillage, contour farming, and cropping systems that rotate grass or close-growing crops with row crops, help to control erosion on cropland and pasture. Constructing water-control structures in drainageways to drop water to different levels can prevent gullying.

Cropping system. A good cropping system includes a legume for nitrogen, a cultivated crop to aid in weed control, a deep-rooted crop to utilize subsoil fertility and maintain subsoil permeability, and a close-growing crop to help maintain organic matter content. The sequence of crops should keep the soil covered as much of the year as possible.

A suitable cropping system varies according to the needs of the farmer and the characteristics of the soil. Producers of livestock, for example, generally use cropping systems that have higher percentages of pasture than the cropping systems of cash-crop farms.

Additional information on erosion control, cropping systems, and drainage practices can be obtained from the local office of the Soil Conservation Service, the Cooperative Extension Service, or the Louisiana Agricultural Experiment Station.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for use as cropland. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major, and generally expensive, landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The

numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations or hazards that restrict their use.

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations or hazards that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode, but they have other limitations or hazards, impractical to remove, that limit their use.

Class VI soils have severe limitations or hazards that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations or hazards that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations or hazards that nearly preclude their use for commercial crop production.

No class I soils are recognized in Tangipahoa Parish.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e* or *w* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless a close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage).

There are no subclasses in class I because the soils of this class have few limitations or hazards. The soils in class V are subject to little or no erosion, but they have other limitations or hazards that restrict their use to pasture, woodland, wildlife habitat, or recreation. Class V contains only the subclasses indicated by *w*.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

Carl V. Thompson, Jr., state staff forester, Soil Conservation Service, helped prepare this section.

This section has information on the relation between trees and their environment, particularly trees and the soils in which they grow. It includes information on the kind, amount, and condition of woodland resources in Tangipahoa Parish and soils interpretations that can be used in planning.

Soil directly influences the growth, management, harvesting, and multiple uses of forests. Soil is the medium in which a tree is anchored and from which it draws its nutrients and moisture. Soil characteristics, such as chemical composition, texture, structure, depth, and slope position, affect tree growth, seedling survival, species adaptability, and equipment limitations.

The ability of a soil to supply moisture and nutrients to trees is strongly related to soil texture, structure, and depth. Generally, sandy soils are less fertile and lower in available water capacity than clayey soils. However, aeration is often impeded in clayey soils, particularly under wet conditions. Slope position strongly influences species composition as well as growth within an individual tree.

These soil characteristics, in combination, largely determine the forest stand species composition and influence management and use decisions. Sweetgum, for example, is tolerant of many soils and sites, but grows best on the rich, moist, alluvial loamy soils of bottom lands. Use of heavy logging and site preparation equipment is more restricted on clayey soils than on better drained sandy or loamy soils.

Woodland Resources

The topography and vegetation in Tangipahoa Parish vary from the piney woods in the north to the freshwater marshes in the south. The dominant forest species are longleaf pine, slash pine, and loblolly pine on the higher sites; sweetgum, red oak, white oak, elm, pecan, green ash, willow, sycamore, and cottonwood in the stream and river bottoms; and baldcypress and tupelo gum in the swamps.

Tangipahoa Parish was once a vast virgin forest of pine woods in the north and baldcypress-tupelo gum in the south. No virgin forests are left. Most were cut during the "cut out-get out" period around the turn of the century. The timber barons of that time stripped both the upland pine and low-lying baldcypress-tupelo gum forests of commercial trees. No attempts at artificial regeneration were made at the time, and the second growth forests were strictly a product of nature. This second growth forest was largely unmanaged and subject to periodic wildfires and harvests with little or no thought of selective cutting or regeneration until the late 1940's and early 1950's. Then, a series of events took place that set the stage for forest management and reforestation. Effective fire protection was provided by the Louisiana Office of Forestry (then known as the Louisiana Forestry Commission). Then, the Office of Forestry increased operations of their pine seedling nurseries, making pine seedlings more readily available for planting the cut-over land. At last, timber and land values began to increase, providing an incentive to landowners to bring their property into production. Today, most of the forest land in Tangipahoa Parish is once again productively growing commercial timber, although a substantial part is now specifically in urban use, pastureland, cropland, and other non-forest uses.

Tangipahoa Parish has about 346,400 acres of commercial woodland representing about 67 percent of

the total land area *(34)*. Commercial forest land is defined as that producing or capable of producing crops of industrial wood and not withdrawn from timber use. The commercial woodland area decreased by about 42,000 acres between 1964 and 1974. Most of the cleared land was converted to cropland and pastureland. Other uses are urban land and transmission and transportation corridors. The conversion of cleared land reversed between 1974 and 1980, when the forest land acreage in Tangipahoa Parish increased by 40,400 acres, mainly the result of landowners converting marginal crop and pastureland back to woodland.

Forest land in Tangipahoa Parish will probably stabilize at the present acreage although minor fluctuations can occur in the future because of small changes in land use.

The ownership of forest land in Tangipahoa Parish is as follows: About 1 percent of the forest land is public, 12 percent is owned by the forest industry, 18 percent is owned by private farms, and 69 percent is in miscellaneous private ownership.

The parish is divided into three major land resource areas (MLRA's): Eastern Gulf Coast Flatwoods, Central Coastal Plain, and Southern Mississippi Valley Alluvium. The first two MLRA's support substantial acreages of commercial forest. A small acreage of commercial forest is in the Southern Mississippi Valley Alluvium MLRA.

The dominant trees in the Eastern Gulf Coast Flatwoods MLRA are loblolly pine, slash pine, longleaf pine, sweetgum, water oak, southern red oak, white oak, sycamore, and magnolia on the higher, well drained soils; and cottonwood, green ash, white oak, cherrybark oak, Nuttall oak, water oak, willow oak, sycamore, and tupelo gum on the lower, poorly drained sites. The Central Coastal Plain MLRA has loblolly and slash pine with associated sweetgum, shortleaf pine, longleaf pine, southern red oak, white oak, water oak, post oak, black cherry, elm, and red maple. The Southern Mississippi Valley Alluvium MLRA has ash, cottonwood, elm, and sycamore on well drained soils, and ash, elm, tupelo gum, baldcypress, water oak, pecan, hackberry, willow oak, and Drummond red maple on poorly drained soils.

Commercial forests may be further divided into forest types, which can be based on tree species, site quality, or age. As used in this survey, forest types are stands of trees of similar character, composed of the same species, and growing under the same ecological and biological conditions. The forest types are named for the dominant trees.

The *oak-gum-cypress* forest type makes up 28 percent of the forest land in Tangipahoa Parish. This type is composed of bottom land forests of tupelo gum, blackgum, sweetgum, oak, and baldcypress, singularly or in combination. Associated trees include cottonwood, black willow, ash, hackberry, maple, and elm.

The *loblolly-shortleaf pine* forest type makes up 21 percent of the forest land. Loblolly pine generally is dominant except on drier sites. Scattered hardwoods, such as sweetgum, blackgum, southern red oak, post oak, white oak, mockernut hickory, and pignut hickory, can be mixed with pines on well drained soils. On more moist sites, sweetgum, red maple, water oak, and willow oak can be mixed with pines. Ash and American beech are associated with this forest type in fertile, well drained coves and along stream bottoms.

The *oak-hickory* forest type makes up 19 percent of the forest land. Upland oaks or hickory, singly or in combination, generally make up most of the stocking. Where pines make up 25 to 50 percent of the stocking, the stand is classified as oak-pine. Common associated trees include elm and maple.

The *longleaf-slash pine* forest type makes up 18 percent of the forest land. In this forest type, 50 percent or more of the stand is longleaf pine or slash pine, singly or in combination. Common associated trees include other southern pines, oak, and gum.

The *oak-pine* forest type makes up about 12 percent of the forest land. About 50 to 75 percent of the stocking is hardwoods, generally upland oaks, and 25 to 50 percent is softwoods that do not include cypress. The species that make up the oak-pine type are mainly the result of soil, slope, and aspect. On the higher, drier sites, the hardwood components tend to be the upland oaks, such as post oak, southern red oak, and blackjack oak. On the more moist and more fertile sites, the trees are white oak, southern red oak, and blackjack oak. Blackgum, winged elm, red maple, and various hickories are associated with the oak-pine type in both of these broad site classifications.

The *elm-ash-cottonwood* forest type makes up 2 percent of the forest land. American elm, green ash, and eastern cottonwood make up most of the stocking. Major associated trees include water hickory, sweetgum, boxelder, black willow, sandbar willow, Nuttall oak, water oak, and overcup oak.

The forest land in Tangipahoa Parish, by physiographic class, is 63 percent pine, 4 percent upland hardwood, and 33 percent bottom land hardwood.

The marketable timber volume is about 64 percent pine and 36 percent hardwood. About 53 percent of the forest acreage is in sawtimber, 26 percent is in saplings and seedlings, and 18 percent is in pole timber. About 3 percent of the commercial forest land in Tangipahoa Parish is classified as "non-stocked."

Most of the more productive sites are in pasture or crops. Consequently, none of the forest land produces 165 cubic feet or more of wood per acre. About 21 percent produces 120 to 165 cubic feet per acre, 35 percent produces 85 to 120 cubic feet, 37 percent produces 50 to 85 cubic feet, and 7 percent produces less than 50 cubic feet per acre.

The importance of timber production to the economy of the parish is significant. Most of the upland pine sites are privately owned, in tracts of 500 acres or less. Most

of these privately owned tracts, and most of the bottom land tracts are producing well below potential. These tracts would benefit if stands were improved by thinning out mature trees and undesirable species. Protection from grazing, fire, insects, and diseases and tree planting and timber stand improvement are also needed to improve stands.

The Soil Conservation Service, Louisiana Office of Forestry, and the Louisiana Cooperative Extension Service can help determine specific woodland management needs.

Environmental Impact

Other values associated with woodlands include wildlife habitat, recreation, natural beauty, and conservation of soil and water.

The commercial forest land of Tangipahoa Parish provides food and shelter for wildlife and offers opportunity for sport and recreation to many users annually. Hunting and fishing clubs in the parish lease or otherwise use the forest land. Forest land provides watershed protection, helps to arrest soil erosion and reduce sedimentation, and enhances the quality and value of water resources.

Trees can be planted to screen distracting views of dumps and other unsightly areas, muffle the sound of traffic, reduce the velocity of winds, and lend beauty to the landscape. Trees produce fruits and nuts for use by people as well as wildlife. Trees and forests help filter out airborne dust and other impurities, convert carbon dioxide into life-giving oxygen, and provide shade from the sun's hot rays.

Production of Forage in Woodland

The kind and amount of understory vegetation that can be produced in an area is related to the soils, climate, and amount of tree overstory. In many pine woodlands, cattle grazing can be a compatible secondary use. Grazing is not recommended on hardwood woodland. Grasses, legumes, forbs, and many woody browse species in the understory are grazable if properly managed to supplement a woodland enterprise without damage to the wood crop. In fact, on most pine woodland, grazing is beneficial to the woodland program because it reduces the accumulation of heavy "rough," thus reducing the hazard of wildfires. Grazing also helps to suppress undesirable woody plants.

The success of a combined woodland and livestock program depends primarily on the degree and time of grazing of the forage plants. Intensity of grazing should be gauged toward maintaining adequate cover for soil protection and maintaining or improving the quantity and quality of trees and forage vegetation.

Forage production varies according to the type of woodland and the amount of sunlight that reaches the understory vegetation during the growing season.

Soils that have about the same potential to produce trees also have similar potential for producing about the same kind and amount of understory vegetation. The plant community on these soils will reproduce itself as long as the environment does not change.

Research has proven a close correlation exists between the total potential yield of grasses, legumes, and forbs in similar soils and the amount of sunlight reaching the ground at midday in the forest. Herbage production continues to decline as the forest canopy becomes more dense.

One of the main objectives in good woodland grazing management is to keep the woodland forage in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected.

This soil survey can be used by woodland managers planning ways to increase the productivity of forest land. Some soils respond better to fertilization than others, and some are more susceptible to erosion after roads are built and timber is harvested. Some soils require special efforts to reforest. In the section "Detailed Soil Map Units," each map unit in the survey area suitable for producing timber presents information about productivity, limitations for harvesting timber, and management concerns for producing timber. Table 7 summarizes this forestry information and rates the soils for a number of factors to be considered in management. *Slight*, *moderate*, and *severe* are used to indicate the degree of the major soil limitations to be considered in forest management.

The first tree listed for each soil under the column "Common trees" is the indicator species for that soil. An indicator species is a tree that is common in the area and that is generally the most productive on a given soil.

Table 7 lists the *ordination symbol* for each soil. The first part of the ordination symbol, a number, indicates the potential productivity of a soil for the indicator species in cubic meters per hectare. The larger the number, the greater the potential productivity. Potential productivity is based on the site index and the point where mean annual increment is the greatest.

The second part of the ordination symbol, a letter, indicates the major kind of soil limitation for use and management. The letter *R* indicates a soil that has a significant limitation because of steepness of slope. The letter *W* indicates a soil in which excessive water, either seasonal or year-round, causes a significant limitation. The letter *T* indicates a soil that has, within the root zone, excessive alkalinity, acidity, sodium salts, or other toxic substances that limit or impede development of desirable trees. The letter *A* indicates a soil that has no significant restrictions or limitations for forest use and management. If a soil has more than one limitation, the priority is as follows: R, W, and T.

Ratings of the *erosion hazard* indicate the probability that damage may occur if site preparation activities or harvesting operations expose the soil. The risk is *slight* if

no particular preventive measures are needed under ordinary conditions; *moderate* if erosion control measures are needed for particular silvicultural activities; and *severe* if special precautions are needed to control erosion for most silvicultural activities. Ratings of *moderate* or *severe* indicate the need for construction of higher standard roads, additional maintenance of roads, additional care in planning of harvesting and reforestation operations, or use of specialized equipment.

Ratings of *equipment limitation* indicate limits on the use of forest management equipment, year-round or seasonal, because of such soil characteristics as slope, wetness, or susceptibility of the surface layer to compaction. As slope gradient and length increase, it becomes more difficult to use wheeled equipment. On the steeper slopes, tracked equipment must be used. On the steepest slopes, even tracked equipment cannot operate; more sophisticated systems are needed. The rating is *slight* if equipment use is restricted by soil wetness for less than 2 months and if special equipment is not needed. The rating is *moderate* if slopes are steep enough that wheeled equipment cannot be operated safely across the slope, if soil wetness restricts equipment use from 2 to 6 months per year, or if special equipment is needed to avoid or reduce soil compaction. The rating is *severe* if slopes are steep enough that tracked equipment cannot be operated safely across the slope, if soil wetness restricts equipment use for more than 6 months per year, or if special equipment is needed to avoid or reduce soil compaction. Ratings of *moderate* or *severe* indicate a need to choose the most suitable equipment and to carefully plan the timing of harvesting and other management operations.

Ratings of *seedling mortality* refer to the probability of death of naturally occurring or properly planted seedlings of good stock in periods of normal rainfall as influenced by kinds of soil or topographic features. *Seedling mortality* is caused primarily by too much water or too little water. The factors used in rating a soil for seedling mortality are texture of the surface layer, depth and duration of the water table, rock fragments in the surface layer, rooting depth, and the aspect of the slope. Mortality generally is greatest on soils that have a sandy or clayey surface layer. The risk is *slight* if, after site preparation, expected mortality is less than 25 percent; *moderate* if expected mortality is between 25 and 50 percent; and *severe* if expected mortality exceeds 50 percent. Ratings of *moderate* or *severe* indicate that it may be necessary to use containerized or larger than usual planting stock or to make special site preparations, such as bedding, furrowing, installing surface drainage, or providing artificial shade for seedlings. Reinforcement planting is often needed if the risk is *moderate* or *severe*.

Ratings of *plant competition* indicate the likelihood of the growth or invasion of undesirable plants. *Plant competition* becomes more severe on the more productive soils, on poorly drained soils, and on soils having a restricted root zone that holds moisture. The risk is *slight* if competition from undesirable plants reduces adequate natural or artificial reforestation but does not necessitate intensive site preparation and maintenance. The risk is *moderate* if competition from undesirable plants reduces natural or artificial reforestation to the extent that intensive site preparation and maintenance are needed. The risk is *severe* if competition from undesirable plants prevents adequate natural or artificial reforestation unless the site is intensively prepared and maintained. A *moderate* or *severe* rating indicates the need for site preparation to ensure the development of an adequately stocked stand. Managers must plan site preparation measures to ensure reforestation without delays.

The potential productivity of *common trees* on a soil is expressed as a *site index*. Common trees are listed in the order of their observed general occurrence. Generally, only two or three tree species dominate.

The *site index* is determined by taking height measurements and determining the age of selected trees within stands of a given species. This index is the average height, in feet, that the trees attain in a specified number of years. This index applies to fully stocked, even-aged, unmanaged stands. The procedure and technique for determining site index are given in the site index tables used for the Tangipahoa Parish soil survey *(4, 5, 6, 7, 8, 24)*.

The *productivity class* represents an expected volume produced by the most important trees, expressed in cubic meters per hectare per year. Cubic meters per hectare can be converted to cubic feet per acre by multiplying by 14.3. It can be converted to board feet by multiplying by a factor of about 71. For example, a productivity class of 8 means the soil can be expected to produce 114 cubic feet per acre per year at the point where mean annual increment culminates, or about 568 board feet per acre per year.

Trees to plant are those that are used for reforestation or, if suitable conditions exist, natural regeneration. They are suited to the soils and will produce a commercial wood crop. Desired product, topographic position (such as a low, wet area), and personal preference are three factors of many that can influence the choice of trees to use for reforestation.

Recreation

In table 8, the soils of the survey area are rated according to the limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality,

vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational use by the duration and intensity of flooding and the season when flooding occurs (fig. 7). In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to

Figure 7.—This campsite is in an area of Ouachita, Ochlockonee, and Guyton soils, frequently flooded. It can be used only during periods when flooding does not occur, generally in summer and fall.

heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Billy R. Craft, state staff biologist, Soil Conservation Service, helped prepare this section.

Tangipahoa Parish has a large and varied population of fish and wildlife. The importance of these resources, both economically and ecologically, is illustrated by the large numbers of hunters and fishermen who participate in outdoor activities in the area. The parish's proximity to New Orleans contributes to the demand for its wildlife resources.

The 346,000 acres of forest land in Tangipahoa Parish is on the uplands and flatwoods and in swamps and creek bottoms. The upland areas are managed mainly for pine timber production. Wildlife management is secondary. The upland areas provide habitat for low to moderate populations of woodland wildlife, depending upon the type and quality of the habitat. Common animals using the forested areas are white-tailed deer, gray squirrels and fox squirrels, swamp rabbits and cottontail rabbits, mink, otter, raccoon, opossum, nutria, coyote, wild turkey, woodcock, wood duck, and many nongame birds, reptiles, and amphibians.

The 83,000 acres of forested flatwoods soils is a mix of pine forests, hardwoods, and mixed stands of pine-hardwood trees. The soils are mainly nearly level and poorly drained. They provide habitat for bobwhite quail and wild turkey; however, because of wetness and flooding, this habitat is of lower quality than that in the upland areas.

The 70,000 acres of swampland is vegetated mainly by trees and shrubs, such as baldcypress, water tupelo, buttonbush, and red maple *(25)*. The soils in swamps are flooded or ponded most of the time. They provide excellent wood duck habitat in the form of nesting, roosting, and brood cover. Many aquatic and semi-aquatic reptiles and amphibians also use this habitat.

The 59,000 acres of bottom land hardwoods provides the most productive forested habitat in the parish. These hardwoods provide an excellent annual crop of fruits and nuts. Squirrel, deer, and turkey populations range from medium to high in and adjacent to the large hardwood bottoms. The Tangipahoa River bottom is an example of this habitat.

Included on low terraces adjacent to the Tangipahoa River are many small to large, abandoned sand and gravel pits. Some of these pits are permanently ponded and are stocked with bream and game fish. Where the fish population is properly managed, these pits provide excellent fishing opportunities (fig. 8).

Pastureland, totaling about 49,000 acres, makes up the majority of the openland habitat. These pastures are managed mainly for forage used by dairy and beef cattle. The main pasture grasses are common bermudagrass, coastal bermudagrass, and bahiagrass. These open pasture areas provide limited habitat for mourning dove, bobwhite quail, rabbit, and wild turkey. Many private farm ponds have been constructed to provide water for livestock. These ponds also provide fishing for bluegill, redear, largemouth bass, and channel catfish.

A small acreage of cropland is in the parish. Corn and soybeans are the two main crops. Openland wildlife use the waste grain and cover provided in these crop fields.

A small area of freshwater marsh is near the southern tip of the parish. Common plants are maidencane, bulltongue, giant cutgrass, cattail, smartweed, pennywort, and millet. These marshes provide habitat for waterfowl, wading birds, such furbearers as nutria, and many nongame animals.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining

Figure 8.—Abandoned gravel pits in areas of Pits-Arents complex, 0 to 5 percent slopes, provide good fishing and swimming.

the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bermudagrass, bahiagrass, clover, and winter peas.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, and flood

hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, paspalum, and uniola.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, sugarberry, persimmon, sweetgum, hawthorn, dogwood, hickory, blackberry, and huckleberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are tree-huckleberry, redbay, and mayhaw.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and baldcypress.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are American beautyberry, waxmyrtle, sumac, American elder, and elderberry.

Wetland plants are annual and perennial, wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, and slope. Examples of wetland plants are smartweed, wild millet, wildrice, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are wetness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, mourning dove, meadowlark, field sparrow, cottontail, coyote, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and coyote.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, nutria, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet, and because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations must be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to: evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small

structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by a very firm dense layer, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. Depth to a high water table and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to a high water table, flooding, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, depth to a high water table, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and that good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, depth to a high water and flooding affect absorption of the effluent.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the

base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, depth to a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and organic material can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to a water table, slope, and flooding affect both types of landfill. Texture, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more

than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and releases a variety of plant-available nutrients as it decomposes.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives the restrictive features that affect each soil for drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of organic matter or salts or sodium. A high water table

affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and the salinity of the soil.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and subsidence of organic layers. Excavating and grading and the stability of ditchbanks are affected by slope and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water erosion and conserve moisture by intercepting runoff. Slope and wetness affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Wetness and slope affect the construction of grassed waterways. Low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as SP, SM, and SC; silty and clayey soils as ML, CL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20, or higher, for the poorest.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area, or from nearby areas, and on field examination.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate, or component, consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They influence the soil's adsorption of cations, moisture retention, shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of movement of water through the soil when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage in each major soil layer is stated in inches of water per inch of soil. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur over a sustained period without affecting crop productivity. The rate is expressed in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity,

infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary covering of the soil surface by flowing water, is caused by overflowing streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall or snowmelt is not considered flooding. Standing water in swamps and marshes or in a closed depression is considered ponding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur.

Frequency, duration, and probable dates of occurrence are estimated. Frequency generally is expressed as *none, rare, occasional,* or *frequent. None* means that flooding is not probable. *Rare* means that flooding is unlikely but possible under unusual weather conditions and that it occurs less often than 1 year out of 10. *Occasional* means that flooding occurs, on the average, no more than twice in 5 years during the cropping season. *Frequent* means that flooding occurs, on the average, more than twice in 5 years during the cropping season. The cropping season in this survey area is considered to be the period from June 1 to November 30. Duration is expressed as *very brief* (less than 2 days), *brief* (2 to 7 days), *long* (7 days to 1 month), and *very long* (more than 1 month). The time of year that floods are most likely to occur is expressed in months. November-May, for example, means that flooding can occur during the period November through May. About two-thirds to three-fourths of all flooding occurs during the stated period.

These definitions differ from the National Soil Conservation Service definition of flooding found elsewhere in this publication, in that the frequency of flooding for each of the phases is slightly different. In addition, the definition is based on flooding for the period from June 1 to November 30, whereas the national definition is based on flooding occurring anytime during the year.

The information on flooding is based on evidence in the soil profile, namely, thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons, which are characteristic of soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, *perched* or *apparent;* and the months of the year that the water table commonly is highest. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

The two numbers in the "High water table-Depth" column indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. "More than 6.0" indicates that the water table is below a depth of 6 feet or that the water table exists for less than a month.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period

of several years. Table 16 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severely corrosive environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and the amount of sulfates in the saturation extract.

Soil Fertility Levels

Dr. M.C. Amacher and Dr. B.J. Miller, Department of Agronomy, Louisiana State University, helped prepare this section.

Factors Affecting Crop Production

Crop composition and yield are a function of many soil, plant, and environmental factors. In this section, a brief description of the more important factors is given:

Environmental factors. The main environmental factors are light (intensity and duration), temperature (air and soil), precipitation (distribution and amount), and atmospheric carbon dioxide concentration.

Plant factors. These factors are species and hybrid specific. They include the rate of nutrient and water uptake and the rate of growth and related plant functions.

Soil Factors. These factors include both physical and chemical properties of the soils.

- *Physical properties*. These are particle-size distribution— texture, structure, surface area, bulk density, water retention and flow, and aeration.
- *Chemical properties (soil fertility factors)*. The effect that the chemical properties of soils have on crop growth can be better understood by discussing the quantity of a chemical element, its intensity, its relative intensity, the relationship of quantity and intensity, and the rate of replenishment of the elements to the soils.
- *Quantity factor*. This is the amount of an element in the soil that is readily available for uptake by plants. The quantity factor is often referred to as the available supply of an element. To determine the quantity factor the available supply is removed from the soil using a suitable extractant and analyzed.
- *Intensity factor*. The intensity factor is related to the concentration of an element species in the soil water. It is a measure of the availability of an element for uptake by plant roots. Two soils with identical quantities of an element's available supply, but with different element intensity factors will differ in element availability to the plant.
- *Relative intensity factor*. This is the effect that the availability of one element has on the availability of another element.
- *Quantity/Intensity relationship factor*. These relationships include the reactions between the soil surface and soil water that control the distribution of element species between the available supply in the soil and the soil water. A special type of quantity/intensity relationship is the buffer capacity of the soil for a given element. The buffer capacity is the amount of a given element that must be added to or removed from the available supply to produce a given change in the intensity factor for that element.
- *Replenishment factor*. Rate of replenishment of the available supply and intensity factors by weathering reactions, fertilizer additions, and transport by mass flow and diffusion.

These factors are interdependent. The magnitude of the factors and the interactions among them will control crop response. The relative importance of each factor changes from soil to soil, crop to crop, and environment to environment. The soil factors are only part of the overall system.

The goal of soil testing is to provide information for a soil and crop management program that establishes and maintains optimum levels and balance of the essential elements in the soil for crop and animal nutrition and protects the environment against the buildup of potentially toxic levels of essential and nonessential elements. Current soil tests measure only one soil factor, the available supply of nutrients in the surface layer or plow layer. Where crop production is clearly limited by the available supply of one or more nutrients in the plow layer, existing soil tests can generally diagnose the problem and reliable recommendations to correct the problem can be made. Soil management systems are generally based on physical and chemical alteration of the plow layer. Characteristics of this layer can vary from

one location to another, depending upon management practices and soil use.

Subsurface layers are less subject to change or change very slowly as a result of alteration of the plow layer. The properties of the subsoil reflect the soil's inherent ability to supply nutrients to plant roots and to provide a favorable environment for root growth. If soil fertility recommendations based on current soil tests are followed, major fertility problems in the plow layer are normally corrected. Crop production is then limited by crop and environment factors, physical properties of the plow layer, and physical and chemical properties of the subsoil.

Although the soil's available nutrient supply is only one factor affecting crop production, it is important. Information on the available nutrient supply in the subsoil allows evaluation of the native fertility levels of the soil.

Soil profiles were sampled during the soil survey and analyzed for pH; organic matter; extractable phosphorus; exchangeable calcium, magnesium, potassium, sodium, aluminum, and hydrogen; total acidity; and cation-exchange capacity. These results are summarized in table 17 and are discussed in the following sections with the emphasis on subsoil properties. More detailed information on the chemical analysis of soils is available *(1, 15, 16, 31, 32, 36)*.

Chemical Analyses Methods

The methods used to obtain the data are listed below. The codes in parentheses refer to published methods *(36)*.

pH: 1:1 soil—water solution (8C1a).
Organic carbon: dichromate, ferric sulfate titration (6A1a).
Extractable phosphorus: (Bray No. 2).
Exchangeable cations: ammonium acetate pH 7.0, uncorrected; calcium (6N2) magnesium (602), potassium (6Q2), sodium (6P2).
Exchangeable aluminum and hydrogen: potassium chloride extraction (6G2).
Total acidity: barium chloride-triathanolamine 1 (6H1a).
Effective cation-exchange capacity: sum of cations plus exchangeable aluminum and hydrogen (5A3b).
Sum cation-exchange capacity: sum of cation plus total acidity (5A3a).
Base saturation: sum of cations, TEA, pH 8.2 (5C3).
Exchangeable sodium percentage: Exchangeable sodium—sum cation-exchange capacity.
Aluminum saturation: exchangeable aluminum—effective cation-exchange capacity.

Nitrogen. Generally, over 90 percent of the nitrogen in the surface layer is in the form of organic nitrogen. Often, most of the nitrogen in subsoils is in the form of fixed ammonium nitrate. These forms of nitrogen are unavailable for plant uptake, but they can be converted to readily available ammonium and nitrate species.

Nitrogen is generally the most limiting nutrient element in crop production because plants have a high demand for it. Nitrogen fertilizer recommendations are nearly always based on nitrogen requirement of the crop rather than nitrogen soil test levels, since no reliable nitrogen soil tests are available.

Despite the lack of an adequate nitrogen soil test, the amounts of readily available ammonium- and nitrate-nitrogen in soils, the amount of organic nitrogen, the rate of mineralization of organic nitrogen to available forms of nitrogen, and the rate of conversion of fixed ammonium-nitrate to available forms of nitrogen provide information on the fertility status of a soil with respect to nitrogen. Unfortunately, since the amounts and rates of transformation of the various forms of nitrogen in the soils of Tangipahoa Parish are unknown, no assessment of the nitrogen fertility status of these soils can be given.

Phosphorus. Phosphorus exists in the soil as discrete solid phase minerals, such as hydroxyapatite, variscite, and strengite; as occluded or coprecipitated phosphorus in other minerals; as retained phosphorus on mineral surfaces, such as carbonates, metal oxides, and layer silicates; and in organic compounds. Because most of the phosphorus in soils is unavailable for plant uptake, the availability of soil phosphorus is an important factor in controlling phosphorus uptake by plants.

The Bray 2 extractant tends to extract more phosphorus than the more commonly used Bray 1, Mehlich I, and Olsen extractants. These extractants provide an estimate of the plant available supply of phosphorus in soils. The Bray 2 extractable phosphorus content of all the subsoils in Tangipahoa Parish is very low according to soil test interpretation guidelines. High levels of extractable phosphorus in the surface layer of some of the soil profiles result from addition of fertilizer phosphorus to the soil. The low levels of available phosphorus in most of the soils of Tangipahoa Parish are a limiting factor for crop production. These soils require continual additions of fertilizer phosphorus to buildup and maintain adequate levels of available phosphorus for sustained crop production.

Potassium. Potassium exists in three major forms in soils; exchangeable potassium associated with negatively charged sites on clay mineral surfaces, nonexchangeable potassium trapped between clay mineral interlayers, and structural potassium within the crystal lattice of minerals. The exchangeable form of potassium in soils is replaceable by other cations and is generally readily available for plant uptake. To become available, the other forms of potassium must be converted to the exchangeable form via weathering reactions.

The exchangeable potassium content of the soils is an estimate of the plant available supply of potassium. According to soil test interpretation guidelines, the available supply of potassium in the soils of Tangipahoa Parish is in the very low, low, or medium range

depending on the soil texture. Most of the soils are in the very low to low range. This range indicates a general lack of micaceous minerals, which are a source of exchangeable potassium during weathering. Generally, the higher levels of exchangeable potassium are in the loamy soils and in those where fertilizer potassium has been applied. Crops respond to fertilizer potassium where exchangeable potassium levels are very low to low. Low levels can be gradually built up by adding fertilizer potassium where soils have a sufficient amount of clay to hold the potassium. Exchangeable potassium levels can be maintained by adding enough fertilizer potassium to account for crop removal, fixation of exchangeable potassium to nonexchangeable potassium, and leaching losses. Many of the soils in Tangipahoa Parish do not have a sufficient amount of clay, and therefore, a sufficiently high cation-exchange capacity to maintain adequate quantities of available potassium for crop production. These soils require more frequent additions of potassium to balance losses of potassium by leaching.

Magnesium. Magnesium exists as exchangeable magnesium associated with negatively charged sites on clay mineral surfaces and as structural magnesium in mineral crystal lattices. Exchangeable magnesium is generally readily available for plant uptake while structural magnesium must be converted to exchangeable magnesium during mineral weathering reactions.

According to soil test interpretation guidelines, the exchangeable magnesium content of the soils of Tangipahoa Parish is in the medium to high range depending on soil texture. Generally, the exchangeable magnesium content increases with depth. The two notable exceptions are in the Ochlockonee series where the exchangeable magnesium content is low throughout the soil profile and in one of the Savannah profiles where the exchangeable magnesium content decreases with depth. The exchangeable magnesium for this particular Savannah profile is shown in table 17 (sample number S82LA105-3). Medium levels of exchangeable magnesium are adequate for crop production. Magnesium deficiencies in some plants are possible where levels are low; thus, additions of fertilizer magnesium can be beneficial to crop production on some of the soils of Tangipahoa Parish.

Calcium. Calcium exists as exchangeable calcium associated with negatively charged sites on clay mineral surfaces and as structural calcium in mineral crystal lattices. Exchangeable calcium generally is available for plant uptake while structural calcium is not.

The exchangeable calcium levels in the soils of Tangipahoa Parish are low to medium, depending on soil texture. Calcium deficiencies in plants are extremely rare. Calcium is normally added to soils by liming, which corrects problems associated with soil acidity.

Calcium is normally the most abundant exchangeable cation in soils. However, in the subsoils of the Fluker, Guyton, Ouachita, Prentiss, Ruston, Savannah, Smithdale, Tangi, and Toula series, the exchangeable magnesium levels are higher than the exchangeable calcium levels. In the other soil series, the exchangeable calcium levels are higher than or about the same as the exchangeable magnesium levels. The levels of exchangeable calcium can increase, remain about the same, or decrease with depth depending on the soil series. The higher levels of exchangeable calcium in the surface layer are associated with higher pH levels in the subsoil, which are the result of applications of lime to control soil acidity. Higher exchangeable calcium levels in the subsoil than in the surface layer are generally associated with higher clay content in the subsoil or with free carbonates when high pH levels are observed. The Brimstone series is an example.

Organic Matter. The organic matter content of a soil greatly influences other soil properties. High organic matter levels in mineral soils are desirable while low levels can lead to many problems. Increasing the organic matter content of a soil can greatly improve the soil's structure, drainage, and other physical properties. It can also increase the moisture-holding capacity, cation-exchange capacity, and nitrogen content.

Increasing the organic matter content is very difficult because organic matter is continually subjected to microbial degradation. This is especially true in Louisiana where temperatures increase microbial activity, thereby increasing the degradation rate. Native plant communities are in a dynamic steady state where the rate of breakdown of organic matter is balanced by the rate of input of fresh material. Disruption of this natural process can lead to a dramatic decline in the organic matter content of the soil. Soil management practices that promote soil erosion lead to a further decrease.

If no degradation of organic matter occurs, 10 tons of organic matter is needed to raise the organic matter content of the top 6 inches of soil by just 1 percent. Since breakdown of organic matter does occur in the soil, several decades of adding large amounts of organic matter to the soil are needed to produce a small increase in the organic matter content. Sound management practices, such as conservation tillage and the planting of cover crops, can slowly increase the soil's organic matter content over time, or at least prevent further declines.

The organic matter content of many of the soils of Tangipahoa Parish is low and decreases sharply with depth as fresh organic matter is confined to the surface layer. These low levels reflect the high rate of organic matter degradation, erosion, and cultural practices that make maintenance of organic matter difficult at higher levels.

Sodium. Sodium exists in soils as exchangeable sodium associated with negatively charged sites on clay

mineral surfaces and as structural sodium in mineral crystal lattices. Because primary sodium minerals are readily soluble and sodium generally is not strongly retained by soils, well drained soils subjected to a moderate or more intense degree of weathering from rainfall normally do not have significant amounts of sodium. Soils in low rainfall environments, soils that have restricted drainage in the subsoil, and Coastal Marsh soils have significant to substantial amounts of sodium. High levels of exchangeable sodium in soils are associated with undesirable physical properties, such as poor structure, slow permeability, and restricted drainage.

Although many soils in Tangipahoa Parish have more exchangeable sodium than exchangeable potassium, few soils have excessive levels of exchangeable sodium in the root zone. The one exception is the Brimstone soil. Unpublished analyses of selected layers of the Brimstone soil in Tangipahoa Parish indicate levels of exchangeable sodium in the root zone that are potentially injurious to some plants. Elevated levels of exchangeable sodium also can be at depth in the Fluker and Guyton series and are probably associated with restricted drainage in the subsoil.

pH, exchangeable aluminum and hydrogen, exchangeable and total acidity. The pH of the soil solution in contact with the soil affects other soil properties. Soil pH is an intensity factor rather than a quantity factor. The lower the pH, the more acidic the soil. Soil pH controls the availability of essential and nonessential elements for plant uptake by controlling mineral solubility, ion exchange, and adsorption/desorption reactions with soil surfaces. Soil pH also affects microbial activity.

Aluminum exists in soils as exchangeable monomeric hydrolysis species, nonexchangeable polymeric hydrolysis species, aluminum oxides, and aluminosilicate minerals. Exchangeable aluminum in soils is determined by extraction with neutral salts, such as potassium chloride or barium chloride. The exchangeable aluminum in soils is directly related to pH. Significant amounts of exchangeable aluminum are in soils that have pH aluminum below 5.5. Aluminum is toxic to plants; thus, plant growth of aluminum-sensitive crops is reduced significantly in soils that have a pH of less than 5.5 and appreciable amounts of exchangeable aluminum. The toxic effects of aluminum on plant growth can be alleviated by adding lime to the soil to convert exchangeable aluminum to nonexchangeable polymeric hydrolysis species. High levels of organic matter can also alleviate aluminum toxicity effects by complexing the aluminum.

Sources of exchangeable hydrogen in soils include hydrolysis of exchangeable and nonexchangeable aluminum and pH-dependent exchange sites on metal oxides, certain layer silicates, and organic matter. Exchangeable hydrogen as determined by extraction with neutral salts, such as potassium chloride, is normally not a major component of soil acidity. Exchangeable hydrogen is not readily replaceable by other cations unless accompanied by a neutralization reaction. Most of the neutral salt exchangeable hydrogen in soils apparently comes from aluminum hydrolysis.

Acidity from hydrolysis of neutral salt exchangeable aluminum plus neutral salt exchangeable hydrogen from pH-dependent exchange sites make up the exchangeable acidity in soils. Exchangeable acidity is determined by the pH of the soil. Titratable acidity is the amount of acidity neutralized to a selected pH, generally pH 7 or 8.2, and constitutes the total potential acidity of a soil determined up to a given pH. All sources of soil acidity including hydrolysis of monomeric and polymeric aluminum species and hydrogen from pH-dependent exchange sites on metal oxides, layer silicates, and organic matter, contribute to the total potential acidity. Total potential acidity in soils is determined by titration with base or incubation with lime; extraction with a buffered extractant followed by titration of the buffered extractant (pH 8.2, barium-chloride-triethanolamine method); or equilibration with buffers followed by estimation of acidity from changes in buffer pH.

Most of the soils of Tangipahoa Parish have a low pH, have significant quantities of exchangeable aluminum, and high levels of total acidity. In many cases the exchangeable aluminum levels are high enough to be a major limiting factor in crop production. High levels of exchangeable aluminum in the surface layer of the soils can be reduced by liming. At the present time, no economical methods are available to neutralize soil acidity at depth. Some reduction of exchangeable aluminum levels at depth can be achieved by applying gypsum to the surface layer so that the calcium leaches through the soil profile and exchanges with the aluminum.

Cation-Exchange Capacity. The cation-exchange capacity (CEC) represents the available supply of nutrient and non-nutrient cations in the soil. It is the amount of cations on permanent and pH-dependent negatively charged sites on soil surfaces. Permanent charge cation-exchange sites occur because a net negative charge develops on mineral surfaces from substitution of ions within the crystal lattice. A negative charge developed from ionization of surface hydroxyl groups on minerals and organic matter produces pH-dependent cation-exchange sites.

Several methods for determining cation-exchange capacity are available and can be classified as one of two types: methods that use unbuffered salts to measure the cation-exchange capacity at the pH of the soil and methods that use buffered salts to measure the cation-exchange capacity at a specified pH. These methods produce different results since unbuffered salt methods include only a part of the pH-dependent cation-exchange capacity and buffered salt methods include all of the pH-

dependent cation-exchange capacity up to the pH of the buffer (usually pH 7 or 8.2). Different methods also produce different results because of different errors in the saturation, washing, and replacement steps of the methods.

The effective cation-exchange capacity is the sum of exchangeable cations (calcium, magnesium, potassium, sodium) determined by extraction with pH 7, 1 molar ammonium acetate plus the sum of neutral salt exchangeable aluminum and hydrogen (exchangeable acidity). The sum cation-exchange capacity is the sum of exchangeable bases plus the total acidity determined by extraction with pH 8.2, barium chloride-triethanolamine. The effective cation-exchange capacity generally is less than the sum cation-exchange capacity and includes only that portion of the pH-dependent cation-exchange capacity that is determined by exchange of hydrogen with a neutral salt. The sum cation-exchange capacity includes all of the pH-dependent cation-exchange capacity up to pH 8.2. If a soil has no pH-dependent exchange sites or the pH of the soil is about 8.2, then the effective and sum cation-exchange capacity will be about the same. The larger the cation-exchange capacity, the larger the capacity to store nutrient cations.

Most of the cation-exchange capacity of the soils of Tangipahoa Parish is pH-dependent charge cation-exchange capacity from metal oxides, edges of clay minerals, and organic matter. Since this type of cation-exchange capacity increases with pH, liming results in a greater storage capacity for nutrient cations, such as potassium, magnesium, and calcium.

Physical and Chemical Analyses of Selected Soils

The results of physical analysis of several typical pedons in the survey area are given in table 18 and the results of chemical analysis in table 19. The data are for soils sampled at carefully selected sites. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." Soil samples were analyzed by the soil characterization laboratory, Agronomy Department, Louisiana State University Agricultural Center.

Most determinations, except those for grain-size analysis and bulk density, were made on soil material smaller than 2 millimeters in diameter. Measurements reported as percent or quantity of unit weight were calculated on an oven-dry basis. The methods used in obtaining the data are indicated in the list that follows. The codes in parentheses refer to published methods *(19)*.

Sand—(0.05-2.0 mm fraction) weight percentages of materials less than 2 mm (3A1).
Silt—(0.002-0.05 mm fraction) pipette extraction, weight percentages of all materials less than 2 mm (3A1).
Clay—(fraction less than 0.002 mm) pipette extraction, weight percentages of materials less than 2 mm (3A1).
Water retained—pressure extraction, percentage of oven-dry weight of less than 2 mm material; 1/3 or 1/10 (3/10) bar (4B1), 15 bars (4B2).
Water-retention difference—between 1/3 bar and 15 bars for less than 2 mm material (4C1).
Moist bulk density—of less than 2 mm material, saran-coated clods at field moist (4A3a), air dry (4A1b), and oven dry (4A1h).
Organic carbon—dichromate, ferric sulfate titration (6A1a).
Total nitrogen—Kjeldahl (6B1a).
Extractable cations—ammonium acetate pH 7.0, uncorrected; calcium (6N2), magnesium (6O2), sodium (6P2), potassium (6Q2).
Extractable acidity—barium chloride-triethanolamine I (6H1a).
Cation-exchange capacity—ammonium acetate, pH 7.0 (5A1b).
Base saturation—ammonium acetate, pH 7.0 (5C1).
Reaction (pH)—1:1 water dilution (8C1a).
Reaction (pH)—potassium chloride (8C1c).
Reaction (pH)—calcium chloride (8C1e).
Aluminum and hydrogen—potassium chloride extraction (6G).
Iron—dithionate-citrate extract (6C2b).
Available phosphorus—(Bray No. 1 and No. 2).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(35)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or on laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders, primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hydraquents (*Hydr*, meaning presence of water plus *aquent*, the suborder of the Entisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hydraquents. The formative elements and adjectives used in forming the classification name of the soils in this soil survey and their explanation or meaning are shown in table 21.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is very-fine, montmorillonitic, nonacid, thermic Typic Hydraquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. There can be some variation in the texture of the surface layer or of the substratum within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (33)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (35)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Abita Series

The Abita series consists of somewhat poorly drained, slowly permeable soils. They formed in loamy sediments on low, broad stream or marine terraces of late Pleistocene age. Slopes range from 0 to 5 percent.

Soils of the Abita series are fine-silty, siliceous, thermic Glossaquic Paleudalfs.

Abita soils commonly are near Brimstone, Cahaba, Guyton, Myatt, Prentiss, and Stough soils. Brimstone,

Guyton, and Myatt soils are poorly drained. These soils are in lower positions on the landscape than Abita soils. Brimstone soils have high concentrations of sodium in the subsoil, and Guyton and Myatt soils are light gray or gray throughout. Myatt and Cahaba soils are fine-loamy. Cahaba soils are well drained and are in higher positions on the landscape. Prentiss soils are moderately well drained, have a fragipan, and are in slightly higher positions. Stough soils are somewhat poorly drained and are in positions similar to those of Abita soils. Prentiss and Stough soils are coarse-loamy and formed in sediment older than that in which Abita soils formed.

Typical pedon of Abita silt loam, 0 to 2 percent slopes; 2.5 miles southeast of Louisiana State University Hammond Experiment Station, 2.25 miles north of Highway 22, 350 feet west of the Thibodaux Road, sec. 2, T. 7 S., R. 8 E.

A—0 to 5 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many fine roots; few fine faint dark yellowish brown oxidation stains around roots; extremely acid; clear wavy boundary.

E—5 to 10 inches; pale brown (10YR 6/3) silt loam; common fine faint yellowish brown mottles; weak fine subangular blocky structure; friable; few fine and coarse roots; common fine black and brown bodies; very strongly acid; clear smooth boundary.

B/E—10 to 16 inches; yellowish brown (10YR 5/4) silt loam (Bt); common fine faint yellowish brown mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; common fine and few medium roots; few fine random discontinuous tubular pores; B part, about 70 percent of the cross section, E part, about 30 percent; vertical seams of light brownish gray (10YR 6/2) albic material (E) between prisms about 3 centimeters thick throughout the cross section; few fine random discontinuous tubular pores; seams and pockets of yellowish brown (10YR 5/6) silt loam; few brown and black bodies; very strongly acid; clear wavy boundary.

Bt—16 to 34 inches; mottled strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), light brownish gray (2.5Y 6/2), and red (2.5YR 4/8) silty clay loam; weak coarse prismatic structure parting to weak coarse medium subangular blocky; firm; few fine and medium roots; few fine random discontinuous tubular pores; common thick continuous clay films on faces of peds; few patchy silt coatings on faces of peds and root channels; few brown and black concretions; strongly acid; gradual wavy boundary.

Btg1—34 to 45 inches; light brownish gray (2.5Y 6/2) silty clay loam; many medium distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/8) mottles; few medium prominent red (2.5YR 4/8) mottles; moderate medium subangular blocky structure; firm; few coarse roots; few fine random discontinuous tubular pores; many thick continuous clay films on faces of peds; few silt coatings on vertical faces of peds; medium acid; gradual wavy boundary.

Btg2—45 to 64 inches; light olive gray (5Y 6/2) silty clay loam; many medium prominent yellowish brown (10YR 5/8) mottles; few medium prominent red (2.5YR 4/8) mottles; weak coarse subangular blocky structure; firm and slightly sticky; few coarse roots; many thick continuous clay films on faces of peds; medium acid.

The solum is 60 to more than 80 inches thick. Gray mottles caused by wetness are within 30 inches of the surface. The effective cation-exchange capacity is 50 percent or more saturated with exchangeable aluminum in the control section to a depth of 30 inches or more.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is 3 to 7 inches thick. Reaction ranges from extremely acid to neutral.

The E horizon and the E part of the B/E horizon have hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 1 to 3. Texture is silt loam or very fine sandy loam. The E horizon is as much as 10 inches thick. Reaction typically is extremely acid to slightly acid, but ranges to neutral.

Some pedons have a BA or BE horizon. It has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6, and chroma of 3 to 6. Texture is silt loam or silty clay loam. Mottles in shades of gray, yellow, or red range from few to many. Reaction ranges from very strongly acid to neutral.

The B part of the B/E horizon and all of the Bt horizon have hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6, and chroma of 3 to 8; or they are mottled in shades of brown, gray, and red. Texture is silt loam or silty clay loam. Mottles in shades of gray range from few to many. Reaction ranges from very strongly acid to slightly acid.

The Btg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2. Texture is dominantly silty clay loam, clay loam, or loam, but some pedons have silty clay subhorizons in the lower part of the profile. Reaction ranges from very strongly acid to slightly acid in the upper part of the horizon and from strongly acid to mildly alkaline in the lower part.

Barbary Series

The Barbary series consists of very poorly drained, very slowly permeable soils. These soils formed in very fluid, clayey sediments that were deposited in water and have never air dried. They are in low, broad, ponded backswamps. Slopes are less than 1 percent.

Soils of the Barbary series are very-fine, montmorillonitic, nonacid, thermic Typic Hydraquents.

Barbary soils commonly are near Kenner and Maurepas soils. Kenner soils are in freshwater marshes and have a thick organic surface layer. Maurepas soils

are in swamps and have thick organic layers composed of decomposed woody material.

Typical pedon of Barbary muck; 5 miles west of Madisonville, 1 mile east of the Tangipahoa River, 1.2 miles south of Highway 22, NE1/4SE1/4 sec. 25, T. 7 S., R. 9 E.

Oa—0 to 4 inches; very dark grayish brown (10YR 3/2) muck; same color pressed and rubbed; massive; about 40 percent fiber, 15 percent rubbed; very fluid, flows easily between fingers when squeezed leaving hand empty; 60 percent mineral; slightly acid; clear smooth boundary.

A—4 to 14 inches; dark gray (N 4/0) clay; massive; nonsticky; very fluid, flows easily between fingers when squeezed leaving small residue in hand; mildly alkaline; clear smooth boundary.

Cg1—14 to 42 inches; gray (N 5/0) clay; few fine distinct light olive brown (2.5Y 5/4) mottles; nonsticky; very fluid, flows easily between fingers when squeezed leaving small residue in hand; mildly alkaline; clear smooth boundary.

Cg2—42 to 50 inches; gray (10YR 5/1) clay; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; slightly fluid, flows with difficulty between fingers leaving large residue in hand; mildly alkaline; clear smooth boundary.

Cg3—50 to 70 inches; greenish gray (5GY 5/1) clay; many medium distinct light olive brown (2.5Y 5/6) mottles; massive; slightly fluid, flows with difficulty between fingers leaving large residue in hand; mildly alkaline.

The *n* values are more than 0.7 to a depth of 40 inches or more.

The Oa horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2. It is typically 2 to 10 inches thick. Reaction ranges from medium acid to mildly alkaline.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 or 2; or it is neutral and has hue of 2.5Y and value of 4 or 5. Texture is clay or mucky clay. Reaction ranges from neutral to moderately alkaline.

The Cg horizon has hue of 10YR, 2.5Y, 5GY or 5Y, value of 4 or 5, and chroma of 1; or it is neutral and has hue of 2.5Y and value of 4 or 5. It is very fluid or slightly fluid clay or mucky clay. Reaction ranges from neutral to moderately alkaline.

Brimstone Series

The Brimstone series consists of poorly drained, slowly permeable soils that formed in loamy deposits of late Pleistocene age. They are on level to slightly depressional, broad flats on stream or marine terraces. These soils have a high concentration of sodium in the lower part of the subsoil. Slopes are less than 1 percent.

Soils of the Brimstone series are fine-silty, siliceous, thermic Glossic Natraqualfs.

Brimstone soils commonly are near Abita, Guyton, Myatt, Prentiss, and Stough soils. These soils do not have concentrations of sodium in the subsoil. Abita and Stough soils are somewhat poorly drained and are on ridges at slightly higher elevations. Guyton and Myatt soils are poorly drained and are in positions on the landscape similar to those of the Brimstone soils. Prentiss soils are moderately well drained and are on convex ridges. Prentiss and Stough soils are coarse-loamy.

Typical pedon of Brimstone silt loam, in an area of Brimstone-Guyton silt loams; 2.1 miles northeast of Ponchatoula, 100 feet east of Parish Road 3158, 0.9 mile south of Interstate 12, sec. 4, T. 7 S., R. 8 E.

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many fine roots; medium acid; clear smooth boundary.

E—4 to 21 inches; light brownish gray (10YR 6/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; many fine roots; light gray (10YR 7/2) silt coatings surrounding faces of ped; slightly acid; clear irregular boundary.

E/Btng—21 to 32 inches; about 70 percent tongues of light brownish gray (10YR 6/2) firm and brittle silt loam (E); about 30 percent light brownish gray (10YR 6/2) silty clay loam (Bt); common medium distinct strong brown (7.5YR 5/6) mottles; weak coarse primatic structure; friable; thin discontinuous clay films on faces of peds; few fine brown and black concretions; mildly alkaline; clear irregular boundary.

Btng1—32 to 47 inches; light brownish gray (2.5Y 6/2) silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; firm, slightly sticky and slightly plastic; thick continuous clay films on vertical faces of peds; about 10 percent light gray (10YR 7/1) silt loam interfingering between peds; common medium brown and black concretions; moderately alkaline; clear irregular boundary.

Btng2—47 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; firm, slightly plastic and slightly sticky; thick continuous clay films on vertical faces of peds; about 10 percent light gray (10YR 7/1) silt loam interfingering between peds; many medium brown and black concretions; moderately alkaline.

The solum is about 40 to 100 inches thick. Exchangeable sodium ranges from 15 to 30 percent within the upper 6 inches of the natric horizon or within

16 inches of the soil surface. Exchangeable sodium saturation decreases with depth and is typically less than 15 percent below a depth of 52 inches.

The A horizon has value of 3 to 5 and chroma of 1 or 2. It is 4 to 7 inches thick. Reaction ranges from very strongly acid to moderately alkaline.

The E horizon and E part of the E/Btng horizon have value of 5 or 6 and chroma of 1 or 2. The E horizon is 6 to 20 inches thick. Texture is silt loam or very-fine sandy loam. Tongues of the E horizon extend into the Btng horizon. Accumulations of dark gray clay, typically as discontinuous bands, are in the E horizon in some pedons. Reaction ranges from medium acid to moderately alkaline.

The Btng horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 or 2. Mottles in shades of brown or gray range from few to many. Texture is silt loam or silty clay loam. Calcium carbonate concretions range from none to common. Reaction ranges from neutral to moderately alkaline.

Cahaba Series

The Cahaba series consists of well drained, moderately permeable soils that formed in loamy and sandy alluvium. These soils are on ridges on broad stream or marine terraces and on low stream terraces along major drainageways. Slopes range from 1 to 6 percent.

Soils of the Cahaba series are fine-loamy, siliceous, thermic Typic Hapludults.

The Cahaba soils in map unit Ca are taxadjuncts to the Cahaba series because the base saturation by sum of the bases is 50 percent at a depth of 50 inches below the top of the argillic horizon. This is higher than allowed for the series, but this difference does not affect the use and management of the soils. The cation exchange capacity (sum) at that depth is 1.6 milliequivalents per 100 grams of soil. A base saturation of 50 percent is considered insignificant where the CEC is this low.

Cahaba soils are similar to Smithdale soils and commonly are near Abita, Fluker, Guyton, Myatt, and Savannah soils. Abita and Fluker soils are somewhat poorly drained. They are in lower positions on the landscape than the Cahaba soils and are fine-silty. Fluker soils have a fragipan. The Guyton and Myatt soils are poorly drained and have a subsoil that is grayish throughout. They are also in lower positions. The Savannah soils are moderately well drained and are in slightly lower positions. These soils have a fragipan. Smithdale soils are on steeper side slopes on the terrace uplands and have a thicker sola than the Cahaba soils.

Typical pedon of Cahaba fine sandy loam, 1 to 3 percent slopes; 3.3 miles northeast of Roseland, 1.3 miles northwest of Highway 1054, 500 feet east of Big Creek, 85 feet south of a farm road, Spanish Land Grant 47, T. 3 S., R. 7 E.

Ap—0 to 6 inches; dark brown (10YR 4/3) fine sandy loam; weak fine granular structure; friable; many fine roots; very strongly acid; clear smooth boundary.

Bt1—6 to 25 inches; yellowish red (5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; friable; few fine roots; common distinct thick discontinuous clay films on vertical faces of peds; strongly acid; clear smooth boundary.

Bt2—25 to 34 inches; yellowish red (5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; friable; common distinct thick discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

BC—34 to 41 inches; strong brown (7.5YR 4/6) sandy loam; weak fine blocky structure; friable; few thin patchy clay films; very strongly acid; clear wavy boundary.

C—41 to 65 inches; light yellowish brown (10YR 6/4) and yellowish brown (10YR 5/6) loamy fine sand stratified with bands of strong brown (7.5YR 4/6) fine sandy loam; massive; very friable; very strongly acid.

The solum is 40 to 60 inches thick. Sandy and gravelly materials commonly are within 5 feet of the surface and extend to a depth of 15 feet or more. Reaction ranges from very strongly acid to medium acid.

The A horizon has value of 3 to 5 and chroma of 2 to 4. It is 4 to 8 inches thick.

Some pedons have a thin E or E/B horizon. The E horizon and E part of the E/B horizon have hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. Texture is loamy fine sand, sandy loam, or fine sandy loam.

The Bt horizon has hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 6 or 8. It is sandy clay loam, loam, or clay loam. Clay content ranges from 18 to 35 percent.

The BC horizon has hue of 5YR, 2.5YR, or 7.5YR, value of 4 or 5, and chroma of 6 or 8. It is typically less clayey than the Bt horizon. Texture is sandy loam or fine sandy loam.

The C horizon has hue of 5YR, 2.5YR, 7.5YR, or 10YR, value of 4 or 5, and chroma of 6 or 8. It commonly is stratified sand, loamy sand, and fine sandy loam. Few to many gravels are in some pedons.

Fluker Series

The Fluker series consists of somewhat poorly drained soils that have a fragipan. Permeability is moderate in the upper part of the profile and slow in the fragipan. These soils are on stream terraces and terrace uplands. They formed in a loamy mantle less than 4 feet thick and in the underlying, more sandy sediments. Slopes range from 0 to 2 percent.

Soils of the Fluker series are fine-silty, siliceous, thermic Glossaquic Fragiudalfs.

Fluker soils commonly are near Cahaba, Myatt, and Savannah soils. Cahaba soils are well drained. They are on slightly higher convex ridges than those of Fluker soils. They are fine-loamy and do not have a fragipan. Myatt soils are poorly drained. They are in lower positions, are fine-loamy, and do not have a fragipan. Savannah soils are moderately well drained. They are in slightly higher positions and do not have grayish mottles in the upper part of the subsoil.

Typical pedon of Fluker silt loam; 3,000 feet south of the city limit of Tangipahoa, 300 feet west of Highway 51, Spanish Land Grant 39, T. 2 S., R. 7 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; common fine roots; extremely acid; abrupt smooth boundary.

Bw—8 to 13 inches; light yellowish brown (10YR 6/4) silt loam; common fine and medium faint yellowish brown (10YR 5/8) mottles, few fine distinct strong brown (7.5YR 5/6) mottles, and common fine faint light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; friable; few fine roots; common fine random discontinuous tubular pores; few black and brown concretions; extremely acid; clear wavy boundary.

Bt1—13 to 18 inches; yellowish brown (10YR 5/6) silt loam; common fine and medium distinct strong brown (7.5YR 5/6) mottles and many medium distinct light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; few fine and medium roots; few fine random discontinuous tubular pores; few black and brown concretions; thin vertical seams of light gray (10YR 7/2) silt loam; few thick discontinuous clay films on vertical faces of some peds; very strongly acid; clear wavy boundary.

Bt2—18 to 24 inches; yellowish brown (10YR 5/6) silty clay loam; common fine and medium distinct strong brown (7.5YR 5/6) mottles and many medium distinct light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; many thick continuous clay films on vertical faces of some peds; very strongly acid; clear wavy boundary.

B/E—24 to 31 inches; grayish brown (10YR 5/2) silt loam (Bt); many coarse distinct yellowish brown (10YR 5/8) and strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine and medium roots mainly in E material; many thick continuous clay films on vertical faces of some peds; few thick patchy clay films on horizontal faces of some peds; common vertical tongues of light gray (10YR 7/2) silt loam (E) about 1.5 inches wide make up 20 percent of the horizon; very strongly acid; clear wavy boundary.

2Btx1—31 to 40 inches; yellowish brown (10YR 5/6) silt loam; common medium distinct light brownish gray (10YR 6/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; very firm and brittle; few fine roots in light gray seams; few fine random discontinuous tubular pores; few thin patchy clay films on the vertical faces of some peds; few thin patchy clay films on horizontal faces of secondary peds; common vertical seams of light gray (10YR 7/2) silt loam are 0.25 inch wide and surround prisms; very strongly acid; gradual wavy boundary.

2Btx2—40 to 70 inches; mottled strong brown (7.5YR 5/6), pale brown (10YR 6/3), and yellowish brown (10YR 5/8) loam; weak coarse prismatic structure parting to moderate medium subangular blocky; very firm and brittle; common fine random discontinuous tubular pores; few thin patchy clay films on vertical faces of some peds; common vertical seams of light gray (10YR 7/2) fine sandy loam are 0.25 to 0.5 inch wide and surround prisms; very strongly acid.

The solum is more than 60 inches thick. Depth to the fragipan ranges from 18 to 40 inches. Reaction ranges from extremely acid to medium acid except where lime has been added.

The A horizon has value of 3 to 5 and chroma of 1 to 4. Where value is 3, the A horizon is less than 6 inches thick.

The Bw horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 8. Mottles in shades of brown or gray range from few to many. Fine or very fine black and brown concretions range from none to common.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 8. Mottles in shades of brown or gray range from few to many. Fine and very fine black and brown concretions range from none to common.

The Bt part of the B/E horizon has value of 5 or 6 and chroma of 2 to 6. The E part has value of 6 or 7. Some pedons have a grayish E horizon or a mottled E/B horizon. Vertical tongues of E material range in width from 0.25 inch to 2 inches and make up 10 to 30 percent of the horizon. Texture of the Bt part is silt loam or silty clay loam. Brownish mottles range from few to many and from fine to coarse.

The 2Btx horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6; or it has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 1 or 2. Mottles in shades of brown or gray range from few to many. Texture is silt loam, sandy clay loam, loam, fine sandy loam, or sandy loam. Total sand content typically is more than 25 percent.

Some pedons have a 2B or 2BC horizon below the 2Btx horizon that has the same range in colors and reaction as the 2Btx horizon. Texture is sandy loam, fine sandy loam, or loam.

Guyton Series

The Guyton series consists of poorly drained, slowly permeable soils that formed in loamy alluvium. These soils are on broad flats and in depressional areas on stream or marine terraces and terrace uplands and in level areas on narrow flood plains. Slopes are less than 1 percent.

Soils of the Guyton series are fine-silty, siliceous, thermic Typic Glossaqualfs.

Guyton soils commonly are near Abita, Brimstone, Myatt, Ouachita, Ochlockonee, and Stough soils. The Abita soils are somewhat poorly drained. They are on convex ridges and side slopes along major drainageways and have a subsoil that is brownish in the upper part. Brimstone and Myatt soils are poorly drained. They are in positions similar to those of the Guyton soils. Brimstone soils have concentrations of sodium salts in the subsoil. Myatt soils are fine-loamy. Ochlockonee and Ouachita soils are well drained. These soils are in high positions on narrow flood plains. They are brownish throughout and do not have an argillic horizon. Stough soils are somewhat poorly drained. They are in higher positions on the landscape than the Guyton soils and are coarse-loamy.

Typical pedon of Guyton silt loam; 4.5 miles northeast of Robert, 3.25 miles north of Highway 190, 4,000 feet east of Washley Creek, sec. 3, T. 6 S., R. 9 E.

A—0 to 3 inches; brown (10YR 4/3) silt loam; weak fine granular structure; friable; many fine roots; very strongly acid; clear smooth boundary.

Eg1—3 to 13 inches; grayish brown (10YR 5/2) silt loam; common medium distinct yellowish brown (10YR 5/4) mottles and common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine and coarse roots; gray (10YR 5/1) silt coatings on faces of peds; few fine soft black and brown accumulations; very strongly acid; clear smooth boundary.

Eg2—13 to 27 inches; light brownish gray (10YR 6/2) silt loam; common medium distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; gray (10YR 5/1) silt coatings on faces of peds; few coarse roots; many fine random discontinuous tubular pores; few fine soft black and brown accumulations; strongly acid; clear irregular boundary.

B/E—27 to 41 inches; light gray (10YR 6/1) silty clay loam (Bt); common medium distinct yellowish brown (10YR 5/8) mottles and few medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thick discontinuous clay films on vertical faces of peds; tongues of light brownish gray (10YR 6/2) silt loam (E) make up about 15 percent of the horizon; few fine random discontinuous tubular pores; few fine soft black and brown accumulations; medium acid; gradual wavy boundary.

Btg1—41 to 55 inches; light gray (10YR 6/1) silty clay loam; many coarse distinct yellowish brown (10YR 5/4) mottles and common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thick discontinuous clay films on vertical faces of peds; few fine random discontinuous tubular pores; brown oxidation stains surrounding root channels; slightly acid; gradual wavy boundary.

Btg2—55 to 70 inches; light gray (10YR 6/1) silty clay loam; many coarse distinct yellowish brown (10YR 5/4) mottles and common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; thick discontinuous clay films on vertical faces of peds; few fine random discontinuous tubular pores; slightly acid.

The solum is 50 to 80 inches thick. Sand, dominantly very fine, ranges in content from 10 to 40 percent in the control section.

The A or Ap horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. It is 3 to 8 inches thick. Reaction ranges from extremely acid to medium acid except where lime has been added.

The Eg horizon has hue of 10YR or 2.5Y, value of 5 to 8, and chroma of 1 or 2. It is 11 to 27 inches thick. Mottles in shades of brown range from few to many. Texture is silt loam, loam, or very fine sandy loam. Reaction ranges from extremely acid to medium acid.

The Btg horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. Texture is silt loam, silty clay loam, or clay loam. Reaction ranges from extremely acid to moderately alkaline.

Some pedons have BCg and Cg horizons that have the same range in colors as the Btg horizon. Texture is silt loam, silty clay loam, clay loam, or sandy clay loam. Reaction ranges from extremely acid to medium acid in the BCg horizon and from strongly acid to moderately alkaline in the Cg horizon.

Kenner Series

The Kenner series consists of very poorly drained, organic soils. Permeability is rapid in the organic layers and very slow in the clayey layers. The soils formed in herbaceous plant material stratified with clayey alluvium. They are in freshwater marshes and are ponded or flooded most of the time. Slopes are less than 1 percent.

Soils of the Kenner series are euic, thermic Fluvaquentic Medisaprists.

Kenner soils commonly are near Barbary and Maurepas soils. Barbary soils are in nearby swamps and are very fluid and mineral throughout. Maurepas soils are in deteriorated swamps and have thick organic layers of decomposed woody materials.

Typical pedon of Kenner muck; 2.25 miles southwest of Lees Landing, 0.75 mile west of Black Bayou, 4.25 miles east of Highway 51, sec. 36, T. 7 S., R. 8 E.

Oa—0 to 12 inches; very dark grayish brown (10YR 3/2) muck; same color pressed and rubbed; about 40 percent fiber, 10 percent rubbed; weak fine granular structure; very fluid, flows easily between fingers when squeezed leaving small residue in hand; many coarse live roots; dominantly herbaceous fiber; about 50 percent mineral; slightly acid; abrupt smooth boundary.

Cg—12 to 13 inches; gray (5Y 5/1) clay; massive; very fluid; flows easily between fingers when squeezed leaving hand empty; few fine live roots; slightly acid; abrupt smooth boundary.

O'a—13 to 47 inches; black (10YR 2/1) muck; same color pressed and rubbed; about 40 percent fiber, 5 percent rubbed; massive; very fluid; flows easily between fingers when squeezed leaving small residue in hand; few fine roots; dominantly herbaceous fiber; about 50 percent mineral; slightly acid; abrupt smooth boundary.

C'g—47 to 49 inches; dark gray (5Y 4/1) clay; massive; very fluid; flows easily between fingers when squeezed leaving hand empty; neutral; abrupt smooth boundary.

O''a—49 to 84 inches; black (10YR 2/1) muck; same color pressed and rubbed; about 50 percent fiber, about 5 percent rubbed; massive; very fluid; flows easily between fingers when squeezed leaving small residue in hand; dominantly herbaceous fiber; about 60 percent mineral; neutral.

Thickness of the organic material with thin mineral layers ranges from 51 to 100 inches. Salinity is none to low in more than half of the subsurface and bottom tiers. Soil reaction ranges from medium acid to mildly alkaline.

The organic material in the surface tier, 0 to 12 inches, has hue of 10YR, value of 2 or 3, and chroma of 1, or value of 4 and chroma of 3, or it has hue of 10YR or 7.5YR, value of 3, and chroma of 2. Percent fiber ranges from 5 to 60 percent after rubbing.

The organic material in the subsurface tier, 13 to 47 inches, has hue of 10YR, value of 2, and chroma of 1 or 2, or value of 3 and chroma of 1 to 3, or it has hue of 7.5YR, value of 3, and chroma of 2. Percent fiber ranges from 1 to 8 percent after rubbing.

The organic material in the bottom tier, 49 to 84 inches, has the same range in colors as the subsurface tier or it has hue of 5YR. The percent fiber after rubbing has the same range as the subsurface tier.

The mineral layers have hue of 5Y or 5GY and value of 4 or 5. Texture is clay, silty clay, or mucky clay. Before drainage, the mineral layers are very fluid.

Malbis Series

The Malbis series consists of moderately well drained soils. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. These soils formed in loamy sediments on the terrace uplands. Slopes range from 3 to 8 percent.

Soils of the Malbis series are fine-loamy, siliceous, thermic Plinthic Paleudults.

Malbis soils commonly are near Ruston, Smithdale, and Tangi soils. Tangi soils are moderately well drained and are in positions on the landscape similar to those of Malbis soils. They are fine-silty and have a fragipan. Ruston and Smithdale soils are well drained and have a redder subsoil and less plinthite in the subsoil than Malbis soils. Ruston soils have more convex slopes than Malbis soils, and Smithdale soils are on steeper side slopes.

Typical pedon of Malbis fine sandy loam, 3 to 8 percent slopes; 5.75 miles southeast of Springcreek, 2.25 miles west of McDaniel Cemetery, 0.25 mile north of Highway 1057, 50 feet west of a private road, sec. 12, T. 2 S., R. 8 E.

Ap—0 to 4 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; friable; slightly acid; abrupt wavy boundary.

E—4 to 8 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine granular structure; friable; medium acid; abrupt wavy boundary.

Bt1—8 to 28 inches; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; few fine discontinuous random tubular pores; few brittle masses of red (2.5YR 4/8); common distinct thick discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

Bt2—28 to 43 inches; strong brown (7.5YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; few fine discontinuous random tubular pores; 5 percent plinthite; common distinct thick discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

Bt3—43 to 60 inches; brown (7.5YR 4/4) sandy clay loam; many medium distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; firm; vertical cracks filled with gray sandy clay loam; few medium black and brown concretions; few thin patchy clay films on vertical faces of some peds; about 5 percent plinthite; thick gray clay films on vertical faces of some peds; very strongly acid.

The solum is 60 to 100 inches thick. The depth to a horizon with 5 percent or more plinthite ranges from 28 to 48 inches.

The A or Ap horizon has value of 3 to 5 and chroma of 2 or 3. It is 4 to 8 inches thick. Reaction ranges from strongly acid to slightly acid except where lime has been added.

The E horizon has value of 5 or 6 and chroma of 4 to 6. It is 3 to 10 inches thick, and texture is fine sandy loam or loam. Reaction ranges from very strongly acid to medium acid.

The Bt1 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. Texture is loam, sandy clay loam, or clay loam. Reaction is very strongly acid or strongly acid.

The Bt2 and Bt3 horizons have ranges in color and texture that are similar to those in the Bt1 horizon. The range in color includes hue of 10YR, value of 6, and chroma of 6 or 8. Gray mottles and fillings in cracks range from none to common below a depth of 40 inches. Nodules of plinthite range from 5 to 25 percent, by volume, in the Bt3 horizon. Reaction in the Bt2 and Bt3 horizons is very strongly acid or strongly acid.

Maurepas Series

The Maurepas series consists of very poorly drained, rapidly permeable, organic soils that formed in woody plant remains. These soils are in low, broad, ponded swamps. Slopes are less than 1 percent.

Soils of the Maurepas series are euic, thermic Typic Medisaprists.

Maurepas soils commonly are near Barbary and Kenner soils. Barbary soils are in positions on the landscape similar to those of Maurepas soils and they are clayey, very fluid mineral soils. Kenner soils are in freshwater marshes. They are organic soils that contain thin mineral layers within 51 inches of the surface.

Typical pedon of Maurepas muck; 2.8 miles southeast of Lees Landing, 4,600 feet west of the west bank of the Tangipahoa River, southwest corner of Spanish Land Grant, sec. 15, T. 8 S., R. 9 E.

Oa1—0 to 10 inches; very dark grayish brown (10YR 3/2) muck; same color pressed and rubbed; about 60 percent fiber, 15 percent rubbed; massive; very fluid, flows easily between fingers when squeezed leaving hand empty; 50 percent mineral; slightly acid; gradual wavy boundary.

Oa2—10 to 25 inches; dark brown (7.5YR 3/2) muck; same color pressed and rubbed; about 25 percent fiber, 5 percent rubbed; massive; very fluid, flows easily between fingers when squeezed leaving hand empty; dominantly woody fiber; 50 percent mineral; slightly acid; gradual wavy boundary.

Oa3—25 to 42 inches; dark reddish brown (5YR 3/2) muck; same color pressed and rubbed; 20 percent fiber, 5 percent rubbed; massive; very fluid, flows easily between fingers when squeezed leaving hand empty; dominantly woody fiber; many fragments of wood 0.5 to 1 inch in diameter; common logs; 50 percent mineral; slightly acid; gradual wavy boundary.

Oa4—42 to 84 inches; dark reddish brown (5YR 3/2) muck; same color pressed and rubbed; massive; very fluid, flows easily between fingers when squeezed leaving hand empty; dominantly woody fiber; many fragments of wood 0.5 to 1 inch in diameter; many logs; 40 percent mineral; slightly acid.

The organic material ranges from 51 to 80 inches or more in thickness. Salinity is none or slight in more than half of the subsurface and bottom tiers. Reaction ranges from medium acid to moderately alkaline.

The surface tier, 0 to 12 inches, has hue of 5YR, 7.5YR, or 10YR, value of 3 or less, and chroma of 2 or less. Percent fiber ranges from 2 to 40 after rubbing.

The subsurface tier, 12 to 36 inches, and bottom tier, 36 to 51 inches, have hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 4 or less. The subsurface tier contains as much as 60 percent fiber undisturbed, but less than 10 percent after rubbing. The bottom tier typically has less than 10 percent fiber after rubbing.

Fibers are dominantly woody, but some pedons have as much as 45 percent herbaceous fiber in the 0- to 51-inch control section. The organic layers contain 15 to 45 percent mineral matter. Logs, dominantly cypress, and wood fragments are commonly throughout the organic material. The organic layers are typically underlain by very fluid gray clay.

Myatt Series

The Myatt series consists of poorly drained, moderately slowly permeable soils that formed in marine and fluvial sediments of late Pleistocene age. These soils are on broad, depressional flats and along small drainageways on stream or marine terraces. Slopes are less than 1 percent.

Soils of the Myatt series are fine-loamy, siliceous, thermic Typic Ochraquults.

The Myatt soils in Tangipahoa Parish are taxadjuncts to the Myatt series because the A, E, and Btg1 horizons are extremely acid. Myatt soils typically are very strongly acid or strongly acid in these horizons. This difference, however, does not affect the use and management of these soils.

Myatt soils commonly are near Abita, Brimstone, Guyton, Prentiss, and Stough soils. Abita and Stough soils are somewhat poorly drained. They are in higher positions on the landscape than Myatt soils. Abita soils are fine-silty, and Stough soils are coarse-loamy. Brimstone and Guyton soils are poorly drained. They are in positions similar to those of Myatt soils and they are fine-silty. In addition, the Brimstone soils contain concentrations of sodium in the subsoil. Prentiss soils are moderately well drained. They are in higher positions

than Myatt soils and have a fragipan. Prentiss soils are coarse-loamy.

Typical pedon of Myatt fine sandy loam; 4 miles east of Robert, 1.5 miles north of Highway 190, 100 feet east of Lorraine Fire Tower Road, sec. 14, T. 6 S., R. 9 E.

A—0 to 4 inches; very dark gray (10YR 3/1) fine sandy loam; weak fine granular structure; friable; many fine and common medium and coarse roots; extremely acid; abrupt smooth boundary.

Eg—4 to 12 inches; gray (10YR 5/1) fine sandy loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; common fine, medium, and coarse roots; extremely acid; clear wavy boundary.

Btg1—12 to 29 inches; gray (10YR 6/1) loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; few fine, medium, and coarse roots; few fine black and brown concretions; many thick discontinuous clay films on vertical faces of peds; dark gray (10YR 4/1) ped coatings when exposed to air; extremely acid; clear wavy boundary.

Btg2—29 to 37 inches; light gray (10YR 7/1) clay loam; many coarse distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few coarse roots; few fine black and brown concretions; many thick discontinuous clay films on vertical faces of peds; dark gray (10YR 4/1) ped coatings when exposed to air; very strongly acid; clear wavy boundary.

BCg—37 to 56 inches; light gray (10YR 7/1) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; few thin discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

Cg—56 to 70 inches; light gray (10YR 7/1) clay loam; many coarse distinct yellowish brown (10YR 5/8) mottles; massive; firm; very strongly acid.

The solum is 40 to 60 inches thick.

The A or Ap horizon has value of 3 to 6, and chroma of 1 or 2. It is 4 to 9 inches thick. Reaction ranges from extremely acid to strongly acid.

The Eg horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is 2 to 8 inches thick. Texture is loamy fine sand, sandy loam, fine sandy loam, very fine sandy loam, or loam. Reaction ranges from extremely acid to strongly acid.

The Btg horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7, and chroma of 1 or 2. Texture is sandy clay loam, loam, or clay loam. Mottles in shades of brown, red, or yellow range from few to many. Reaction ranges from extremely acid to strongly acid.

The BCg horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 or 7, and chroma of 1 or 2. Mottles in shades of brown, red, or gray range from few to many. Texture is sandy loam, sandy clay loam, or loam. Reaction ranges from extremely acid to strongly acid.

The Cg horizon is mottled and has hue of 10YR or 5Y and value of 6 or 7. Texture is sandy loam, sandy clay loam, clay loam, or loam. Thin strata of sand and gravel are in some pedons. Mottles in shades of brown range from few to many. Reaction ranges from extremely acid to strongly acid. Some pedons have a 2Cg horizon that is similar in color, texture, and reaction to the Cg horizon.

Ochlockonee Series

The Ochlockonee series consists of well drained, moderately permeable soils that formed in sandy or loamy alluvium. These soils are on flood plains. Slopes range from 0 to 3 percent.

Soils of the Ochlockonee series are coarse-loamy, siliceous, acid, thermic Typic Udifluvents.

The Ochlockonee soils in Tangipahoa Parish are taxadjuncts to the Ochlockonee series because the reaction is extremely acid throughout. The Ochlockonee series typically is very strongly acid or strongly acid. This difference, however, does not affect the use and management of these soils.

Ochlockonee soils commonly are near Cahaba, Guyton, and Ouachita soils. Cahaba soils are well drained. They are on convex ridges on adjacent stream terraces and are fine-loamy. Guyton soils are poorly drained. They are in lower positions on the landscape than Ochlockonee soils and are fine-silty and grayish throughout. Ouachita soils are well drained. They are in positions similar to those of Ochlockonee soils, and they are fine-silty.

Typical pedon of Ochlockonee sandy loam, in an area of Ouachita, Ochlockonee, and Guyton soils, frequently flooded; 300 feet southwest of the Tangipahoa River, 1 mile east of Highway 442, 3.2 miles northeast of Tickfaw, sec. 42, T. 5 S., R. 8 E.

A—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam; weak fine granular structure; very friable; extremely acid; clear smooth boundary.

C1—6 to 19 inches; brown (10YR 5/3) sandy loam; weak fine granular structure; very friable; few fine roots; few fine black concretions; extremely acid; clear wavy boundary.

C2—19 to 32 inches; dark yellowish brown (10YR 4/6) sandy loam; weak fine granular structure; very friable; few fine roots; few fine faint pale brown uncoated sand grains; extremely acid; clear wavy boundary.

C3—32 to 42 inches; brownish yellow (10YR 6/6) loamy fine sand; single grained; very friable; few fine faint pale brown uncoated sand grains; extremely acid; clear wavy boundary.

C4—42 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand; single grained; very friable; few fine faint light gray uncoated sand grains; extremely acid.

The soil is extremely acid to strongly acid. Some pedons have strata of contrasting texture. Some pedons have gravelly strata at a depth of more than 40 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 2 to 4. Value and chroma of 3 are only in A horizons that are less than 7 inches thick. The A horizon is 4 to 12 inches thick.

The C horizon has hue of 10YR or 7.5YR. Some pedons have mottles below a depth of 20 inches that have value of 4 to 6 and chroma of 1 or 2. Strata within the C horizon range from loamy sand to silty clay loam, but the 10- to 40-inch control section averages sandy loam, silt loam, or loam. Buried A horizons are in some pedons.

Ouachita Series

The Ouachita series consists of well drained, moderately slowly permeable soils that formed in loamy alluvium. These soils are on flood plains. Slopes range from 0 to 3 percent.

Soils of the Ouachita series are fine-silty, siliceous, thermic Fluventic Dystrochrepts.

The Ouachita soils in Tangipahoa Parish are taxadjuncts to the Ouachita series because the Bw1 and Bw2 horizons are extremely acid. Typically, soils of the Ouachita series are very strongly acid or strongly acid. This difference, however, does not affect the use and management of these soils.

Ouachita soils commonly are near Cahaba, Guyton, and Ochlockonee soils. Cahaba soils are well drained. They are on convex ridges on adjacent stream terraces and are fine-loamy. Guyton soils are poorly drained. They are in lower positions on the landscape than Ouachita soils and are grayish throughout. Ochlockonee soils are well drained. They are in positions similar to those of Ouachita soils and they are coarse-loamy.

Typical pedon of Ouachita silt loam, in an area of Ouachita, Ochlockonee, and Guyton soils, frequently flooded; 0.5 mile east of Kentwood, 500 feet north of Highway 38, 500 feet west of Terrys Creek, sec. 43, T. 1 S., R. 7 E.

A—0 to 5 inches; dark brown (10YR 4/3) silt loam; weak fine granular structure; friable; common coarse and medium roots; very strongly acid; clear smooth boundary.

Bw1—5 to 8 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; friable; common coarse and medium roots; extremely acid; clear wavy boundary.

Bw2—8 to 17 inches; yellowish brown (10YR 5/4) silt loam; weak medium subangular blocky structure; friable; few coarse roots; extremely acid; clear smooth boundary.

Bw3—17 to 32 inches; dark yellowish brown (10YR 4/4) silt loam; common medium distinct pale brown (10YR 6/3) mottles; friable; weak medium subangular blocky structure; few coarse roots; very strongly acid; clear wavy boundary.

BC1—32 to 39 inches; dark yellowish brown (10YR 4/4) silt loam; many fine distinct light brownish gray (10YR 6/2) mottles and few fine faint yellowish brown mottles; weak medium subangular blocky structure; friable; few coarse roots; many fine discontinuous random tubular pores; very strongly acid; gradual wavy boundary.

BC2—39 to 49 inches; dark yellowish brown (10YR 4/4) silt loam; many coarse distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; friable; many fine discontinuous random tubular pores; very strongly acid; clear wavy boundary.

2Egb—49 to 70 inches; light brownish gray (10YR 6/2) silt loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak coarse and medium subangular blocky structure; firm and brittle; light gray (10YR 7/1) silt coatings around ped faces; common medium and fine discontinuous random tubular pores; common medium and coarse black and brown concretions; very strongly acid.

The solum is 40 to 80 inches thick. The content of organic matter decreases irregularly with depth.

The A horizon has value of 4 or 5 and chroma of 2 to 4. The A horizon is 1 to 6 inches thick. Reaction ranges from extremely acid to strongly acid except where lime has been added.

The Bw horizon has value of 4 to 6 and chroma of 3 to 8. Texture is silt loam, loam, silty clay loam, or clay loam. Reaction ranges from extremely acid to strongly acid.

The 2Egb horizon is silt loam, sandy loam, or loamy sand. Reaction is very strongly acid or strongly acid. Some pedons have a 2Ab horizon that has color, texture, and reaction similar to those of the 2Egb horizon.

Prentiss Series

The Prentiss series consists of moderately well drained soils that have a fragipan. These soils are moderately permeable in the upper part of the solum and moderately slowly permeable in the fragipan. They formed in loamy sediments on broad stream or marine terraces of late Pleistocene age. Slopes range from 0 to 2 percent.

Soils of the Prentiss series are coarse-loamy, siliceous, thermic Glossic Fragiudults.

The Prentiss soils in Tangipahoa Parish are taxadjuncts to the Prentiss series because the A and Bw1 horizons are extremely acid rather than very strongly acid or strongly acid as is typical in the Prentiss series. This difference, however, does not affect the use and management of the soils.

Prentiss soils are similar to Tangi soils and commonly are near Abita, Guyton, Myatt, and Stough soils. Abita and Stough soils are somewhat poorly drained, and Guyton and Myatt soils are poorly drained. These soils are in lower positions on the landscape than Prentiss soils and do not have a fragipan. Tangi soils are at a higher elevation on the terrace uplands and are fine-silty.

Typical pedon of Prentiss fine sandy loam; 2 miles east of Lorraine Lookout Terrace, 1 mile north of Highway 190, 30 feet west of parish line road, sec. 13, T. 8 S., R. 9 E.

A—0 to 5 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; friable; few coarse and common fine roots; extremely acid; clear smooth boundary.

Bw1—5 to 16 inches; yellowish brown (10YR 5/6) loam; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine black and brown concretions; extremely acid; clear wavy boundary.

Bw2—16 to 26 inches; light yellowish brown (10YR 6/4) loam; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; few strong brown (7.5YR 5/6) brittle bodies make up 10 percent of volume; few pockets of uncoated sand grains; very strongly acid; clear smooth boundary.

Btx1—26 to 45 inches; mottled yellowish brown (10YR 5/4, 5/6) and light gray (10YR 7/1) loam; weak very coarse prismatic structure parting to moderate medium subangular blocky; firm; strong brown (7.5YR 5/6) brittle bodies make up 80 percent of volume; few fine discontinuous random tubular pores; few fine discontinuous clay films; many medium black and brown concretions; gray seams of less clayey material between prism faces; very strongly acid; gradual wavy boundary.

Btx2—45 to 56 inches; mottled yellowish brown (10YR 5/4, 5/6) and light gray (10YR 7/1) loam; weak very coarse prismatic structure parting to moderate medium subangular blocky; firm; strong brown (7.5YR 5/6) brittle bodies make up 80 percent of the volume; few fine discontinuous random tubular pores; few fine discontinuous clay films on some faces of peds; many medium black and brown concretions; gray seams of less clayey material between prisms; very strongly acid; gradual wavy boundary.

Btx3—56 to 65 inches; mottled yellowish brown (10YR 5/4, 5/6) and light gray (10YR 7/1) loam; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; strong brown (7.5YR 5/6) brittle bodies make up 50 percent of the volume; few fine discontinuous random tubular pores; few fine discontinuous clay films on vertical faces of some peds; many medium black and brown concretions; gray seams of less clayey material between prisms; very strongly acid.

The solum is more than 60 inches thick. The depth to the fragipan ranges from 20 to 32 inches.

The A or Ap horizon has value of 3 to 5 and chroma of 1 to 6. It is 5 to 8 inches thick. Reaction ranges from extremely acid to strongly acid.

Some pedons have an E horizon. It has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. It is 2 to 6 inches. Texture is fine sandy loam, sandy loam, loam, or silt loam. Reaction ranges from extremely acid to strongly acid.

The Bw horizon has hue of 10YR, value of 5 or 6, and chroma of 3 to 6; or it has hue of 2.5Y, value of 5 or 6, and chroma of 4 to 6. Mottles in shades of gray are in the lower part of the Bw horizon and range from few to many. Texture is loam, fine sandy loam, or sandy loam. Reaction ranges from extremely acid to strongly acid.

The Btx horizon has colors similar in range to those of the Bw horizon. Mottles in shades of brown, red, or gray range from few to many. Texture is loam, sandy loam, fine sandy loam, or silt loam. Reaction is very strongly acid or strongly acid.

Ruston Series

The Ruston series consists of well drained, moderately permeable soils that formed in loamy marine or stream sediments. These soils are on the terrace uplands. Slopes range from 1 to 8 percent.

Soils of the Ruston series are fine-loamy, siliceous, thermic Typic Paleudults.

Ruston soils commonly are near Cahaba, Malbis, Tangi, Toula, and Smithdale soils. Cahaba soils are on stream terraces at a lower elevation than Ruston soils and have sola less than 60 inches thick. Malbis soils are moderately well drained and have less convex slopes than Ruston soils. They are brownish throughout and have plinthite in the lower part of the subsoil. Tangi soils are in positions similar to those of Ruston soils and have a fragipan. Toula soils have longer, smoother slopes than Ruston soils and they have a fragipan. Smithdale soils have steeper slopes and do not have a bisequal profile.

Typical pedon of Ruston fine sandy loam, in an area of Ruston-Smithdale association, rolling; 3.5 miles northwest of Kentwood, 4,400 feet east of Parish Road 1053, 3,000 feet west of Terrys Creek, sec. 7, T. 1 S., R. 7 E.

A—0 to 5 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak medium granular structure; friable; few fine roots; very strongly acid; clear smooth boundary.

E—5 to 9 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak medium granular structure; friable; few fine roots; very strongly acid; clear smooth boundary.

Bt1—9 to 22 inches; yellowish red (5YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable, few fine roots; many distinct thick continuous clay films on vertical faces of peds; very strongly acid; clear smooth boundary.

Bt2—22 to 37 inches; yellowish red (5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; friable; few fine roots; many distinct thick continuous clay films on vertical faces of peds; very strongly acid; clear smooth boundary.

B/E—37 to 46 inches; yellowish red (5YR 5/6) sandy loam (Bt) makes up 70 percent of the horizon; weak medium subangular blocky structure; firm; pockets, 1.5 inches in diameter, of light yellowish brown (10YR 6/4) sandy loam (E) make up 30 percent of the horizon; very strongly acid; clear smooth boundary.

B't1—46 to 65 inches; red (2.5YR 4/6) sandy clay loam; common medium distinct light yellowish brown (10YR 6/4) mottles; moderate medium subangular blocky structure; friable; common distinct thick discontinuous clay films on vertical faces of peds; very strongly acid; clear smooth boundary.

B't2—65 to 83 inches; red (2.5YR 4/6) sandy clay loam; light yellowish brown (10YR 6/4) mottles; moderate medium subangular blocky structure; friable; many distinct thick continuous clay films on vertical faces of peds; few small gravels; very strongly acid.

The solum is more than 60 inches thick. The B/E horizon is definitive for the series.

The A or Ap horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is 3 to 6 inches thick. Reaction ranges from very strongly acid to slightly acid.

The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. It is as much as 15 inches thick. Texture is fine sandy loam, sandy loam, very fine sandy loam, or loamy fine sand. Reaction ranges from very strongly acid to slightly acid. Some pedons have a thin BE horizon.

The Bt and B't horizons have value of 4 to 6 and chroma of 4 to 8. Texture is sandy clay loam, fine sandy loam, loam, or clay loam. Reaction ranges from very strongly acid to medium acid. The E part of the B/E horizon has value of 5 or 6 and chroma of 3 or 4. Texture is fine sandy loam or sandy loam. Gravel, as much as 15 percent, by volume, is in some horizons.

Savannah Series

The Savannah series consists of moderately well drained, moderately slowly permeable soils that have a fragipan. These soils formed in loamy marine or fluvial deposits on stream terraces. Slopes range from 1 to 3 percent.

Soils of the Savannah series are fine-loamy, siliceous, thermic Typic Fragiudults.

The Savannah soils in Tangipahoa Parish are taxadjuncts to the Savannah series because they are extremely acid in the Bt, Btx, and BC horizons and have a silt loam Bt1 horizon. The Savannah series is typically very strongly acid or strongly acid and has a loam, clay loam, or sandy clay loam Bt1 horizon. This difference, however, does not affect the use and management of these soils.

Savannah soils are similar to Tangi soils and commonly are near Cahaba, Fluker, and Myatt soils. Cahaba soils are well drained. They are in positions on the landscape similar to those of Savannah soils and do not have a fragipan. Fluker soils are somewhat poorly drained. They are in lower positions and have grayish mottles in the upper part of the subsoil. Fluker soils have a base saturation of more than 35 percent. Myatt soils are poorly drained. They are in lower positions than the Savannah soils and do not have a fragipan. Tangi soils are moderately well drained. They are on terrace uplands at a higher elevation and are fine-silty.

Typical pedon of Savannah silt loam, 1 to 3 percent slopes; 2,500 feet north of Arcola, 400 feet west of Highway 51, sec. 41, T. 2S, R. 7 E.

A—0 to 5 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; common fine roots; strongly acid; clear smooth boundary.

Bt1—5 to 17 inches; strong brown (7.5YR 5/6) silt loam; few medium distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; friable; fine, medium, and coarse roots; common thin discontinuous clay films on vertical faces of some peds; few red concretions; extremely acid; clear wavy boundary.

Bt2—17 to 25 inches; mottled strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4) loam; few medium distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; friable; few medium roots; few fine random discontinuous tubular pores; few black stains along root channels; few brittle bodies in the strong brown (7.5YR 5/6) material; common thin discontinuous clay films on the vertical faces of some peds; extremely acid; clear wavy boundary.

Btx1—25 to 36 inches; mottled yellowish red (5YR 5/6), strong brown (7.5YR 5/6), pale brown (10YR 6/3), and yellowish brown (10YR 5/4, 5/6) loam; very coarse prismatic structure parting to moderate

medium subangular blocky; firm and brittle; few fine random discontinuous tubular pores; many vertical and horizontal seams of light brownish gray (10YR 6/2) sandy loam surrounding prisms; few thin discontinuous clay films on vertical faces of some peds; extremely acid; gradual wavy boundary.

Btx2—36 to 49 inches; yellowish brown (10YR 5/4) sandy loam; many coarse distinct strong brown (7.5YR 5/8) mottles; many coarse prominent red (2.5YR 4/6) mottles; very coarse prismatic structure parting to moderate medium subangular blocky; firm and brittle; common fine random discontinuous tubular pores; vertical seams of light brownish gray (10YR 6/2) sandy loam surrounding prisms make up 30 percent of the horizon; many thick discontinuous clay films on vertical faces of some peds; extremely acid; gradual wavy boundary.

Btx3—49 to 61 inches; yellowish brown (10YR 5/6) sandy loam; many coarse distinct strong brown (7.5YR 5/8) mottles; moderate very coarse subangular blocky structure; firm and brittle; common fine random discontinuous tubular pores; many vertical and horizontal seams of light brownish gray (10YR 6/2) sandy loam between very coarse blocks; many thick discontinuous clay films on vertical faces of some peds; extremely acid; gradual wavy boundary.

The solum is 50 to more than 80 inches thick. Depth to the fragipan ranges from 16 to 38 inches.

The A horizon has value of 3 to 5 and chroma of 1 to 4. It is 5 to 8 inches thick. Reaction is very strongly acid or strongly acid.

Some pedons have an E horizon about 2 to 6 inches thick. It has the same range in colors and textures as the A horizon. Reaction ranges from extremely acid to strongly acid.

The Bt horizon has hue of 7.5YR or 10YR, value of 5, and chroma of 4, 6, or 8. Texture is silt loam, loam, or clay loam. Clay content ranges from 18 to 32 percent, and silt content ranges from 20 to 50 percent. Reaction ranges from extremely acid to strongly acid.

The Btx horizon is mottled in shades of yellow, brown, red, and gray; or it has hue of 10YR, value of 5, and chroma of 4 to 8, and has mottles in shades of gray. Texture is sandy loam, sandy clay loam, clay loam, or loam. Reaction ranges from extremely acid to strongly acid.

Some pedons have a BC horizon. It has the same range in colors and textures as the Btx horizon and also includes loamy sand and loamy fine sand. Reaction ranges from extremely acid to strongly acid.

Smithdale Series

The Smithdale series consists of well drained, moderately permeable soils that formed in loamy marine or stream sediments. These soils are on the terrace uplands. Slopes range from 8 to 20 percent.

Soils of the Smithdale series are fine-loamy, siliceous, thermic Typic Hapludults.

Smithdale soils are similar to Cahaba soils and commonly are near Malbis, Tangi, and Ruston soils. Cahaba soils are on stream terraces at a lower elevation and have a solum that is thinner than in the Smithdale soils. Malbis and Tangi soils are moderately well drained, and Ruston soils are well drained. These soils are in less sloping positions on the landscape than Smithdale soils. Ruston soils have a sola with a bisequum. Malbis soils have plinthite in the lower part of the subsoil, and Tangi soils have a fragipan.

Typical pedon of Smithdale fine sandy loam, in an area of Ruston-Smithdale association, rolling; 3.25 miles northeast of Husser, 3.5 miles south of Highway 16, 1,000 feet south of Parish Road 575, sec. 15, T .4 S., R. 9 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; very friable; many fine roots; strongly acid; abrupt smooth boundary.

E—4 to 8 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine granular structure; very friable; common fine roots; very strongly acid; clear wavy boundary.

Bt1—8 to 22 inches; yellowish red (5YR 5/8) sandy clay loam; weak medium subangular blocky structure; friable; few fine roots; common distinct thick discontinuous clay films on vertical faces of peds; very strongly acid; gradual smooth boundary.

Bt2—22 to 31 inches; red (2.5YR 4/8) sandy clay loam; many medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common distinct thick discontinuous clay films on vertical faces of peds; common uncoated sand grains; very strongly acid; gradual wavy boundary.

Bt3—31 to 48 inches; red (2.5YR 4/8) sandy clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; friable; moderate medium subangular blocky structure; common distinct thick discontinuous clay films on vertical faces of peds; many uncoated sand grains; very strongly acid; gradual wavy boundary.

Bt4—48 to 65 inches; red (2.5YR 4/8) sandy loam; weak medium subangular blocky structure; friable; common distinct thick discontinuous clay films on vertical faces of peds; few white crystals of barite; many pockets of uncoated sand grains; very strongly acid.

The solum is 60 to 120 inches thick. Reaction is very strongly acid or strongly acid except where lime has been added.

The A horizon has value of 3 or 4 and chroma of 1 to 3. It is 2 to 10 inches thick.

The E horizon has value of 5 or 6 and chroma of 2 to 4. It is 2 to 8 inches thick. Texture is fine sandy loam or sandy loam. Some pedons do not have an E horizon.

Some pedons have a BA or BE horizon that has hue of 7.5YR, 10YR, or 5YR, value of 4 or 5, and chroma of 4 to 8. The range in texture is the same as for the E horizon.

The Bt horizon has hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 6 to 8. Texture is clay loam, sandy clay loam, loam, or sandy loam. Mottles in shades of brown range from few to many. Content of gravel ranges from 0 to as much as 10 percent, by volume.

Stough Series

The Stough series consists of somewhat poorly drained, moderately slowly permeable soils that formed in marine and fluvial sediments. These soils are on broad, slightly convex ridges on stream or marine terraces of late Pleistocene age. Slopes are less than 1 percent.

Soils of the Stough series are coarse-loamy, siliceous, thermic Fragiaquic Paleudults.

The Stough soils in map unit St are taxadjuncts to the Stough series because they have extremely acid A and E horizons. Typically, Stough soils are very strongly acid or strongly acid. This difference, however, does not affect the use and management of the soils.

Stough soils commonly are near Abita, Brimstone, Guyton, Myatt, and Prentiss soils. Abita soils are in positions on the landscape similar to those of Stough soils and are fine-silty. Brimstone, Guyton, and Myatt soils are poorly drained. They are in lower positions than Stough soils. Brimstone soils have a high content of sodium in the subsoil, and Guyton and Myatt soils are grayish throughout. Prentiss soils are moderately well drained. They are in higher positions than Stough soils and have a fragipan.

Typical pedon of Stough fine sandy loam; 3.5 miles northeast of Robert, 2.25 miles north of Highway 190, 300 feet east of Washley Creek, sec. 10, T. 6 S., R. 9 E.

A—0 to 3 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; friable; many fine and few coarse roots; few fine black concretions; extremely acid; abrupt smooth boundary.

E—3 to 6 inches; pale brown (10YR 6/3) fine sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; few fine and common coarse roots; few black concretions; extremely acid; clear wavy boundary.

Bt—6 to 15 inches; light yellowish brown (10YR 6/4) loam; few fine distinct light brownish gray (10YR 6/2) mottles; common medium distinct yellowish brown (10YR 5/6) mottles; few medium distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine and coarse roots; few fine random discontinuous tubular pores; few thin patchy clay films; common fine and medium black and brown concretions; very strongly acid; clear wavy boundary.

Btx1—15 to 20 inches; light yellowish brown (10YR 6/4) loam; common coarse distinct light brownish gray (2.5YR 6/2) mottles and common fine distinct yellowish brown (10YR 5/4) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable; few fine and coarse roots; few fine discontinuous random tubular pores; common brown and black concretions; strong brown (7.5YR 5/6) brittle bodies make up about 25 percent of the horizon; thin discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

Btx2—20 to 29 inches; light yellowish brown (10YR 6/4) loam; many coarse distinct light brownish gray (2.5YR 6/2) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable; few coarse roots; few fine discontinuous random tubular pores; few fine black and brown concretions; strong brown (10YR 5/8) brittle bodies make up about 40 percent of the horizon; thin discontinuous clay films on vertical faces of peds; very strongly acid; clear wavy boundary.

Btx3—29 to 40 inches; mottled light yellowish brown (10YR 6/4), yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and light brownish gray (2.5YR 6/2) sandy clay loam; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable; few fine discontinuous random tubular pores; few fine black and brown concretions; yellowish brown (10YR 5/6) brittle bodies make up about 45 percent of the horizon; thin discontinuous clay films on vertical faces of peds; very strongly acid; gradual wavy boundary.

Btx4—40 to 70 inches; mottled light yellowish brown (10YR 6/4), yellowish brown (10YR 5/6), and light brownish gray (2.5YR 6/2) sandy clay loam; weak coarse subangular blocky structure; friable; strong brown (7.5YR 5/6) brittle bodies make up about 5 percent of the horizon; very strongly acid.

The solum is more than 60 inches thick. The series control section contains from 8 to 18 percent clay and it has more than 20 percent silt.

The A or Ap horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 to 4. It is 3 to 6 inches thick. Reaction ranges from extremely acid to strongly acid.

The E horizon has hue of 10YR or 2.5Y, value of 6, and chroma of 2; or it has hue of 2.5Y, value of 5, and chroma of 2 to 4. Texture is fine sandy loam, sandy

loam, or loam. Reaction ranges from extremely acid to strongly acid.

Some pedons have a E/B or B/E horizon. They are mottled and have colors similar to those of the E and Bt horizons. Texture is sandy loam, fine sandy loam, or loam. Reaction is very strongly acid or strongly acid.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 4 or 6. Texture is fine sandy loam, loam, or sandy loam. Mottles in shades of brown and gray range from few to many and from fine to coarse. Black and brown concretions range from few to many and from fine to medium. Reaction is very strongly acid or strongly acid.

The Btx horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 4 to 6; or it is mottled in shades of brown, gray, or red. The browner part is brittle and compact and makes up from 40 to 55 percent of the horizon. Texture of the Btx horizon is fine sandy loam, sandy loam, loam, or sandy clay loam. Reaction is very strongly acid or strongly acid.

Tangi Series

The Tangi series consists of moderately well drained soils that have a fragipan. Permeability is moderate in the upper part of the subsoil and slow and very slow in the fragipan. These soils formed in a moderately thick mantle of loess over loamy Coastal Plain sediments of early Pleistocene age. They are on the terrace uplands. Slopes range from 1 to 8 percent.

Soils of the Tangi series are fine-silty, siliceous, thermic Typic Fragiudults.

Tangi soils commonly are near Fluker, Guyton, Malbis, Ruston, Smithdale, and Toula soils. Fluker soils are somewhat poorly drained. They are in level to concave areas and have gray mottles in the upper part of the subsoil. Guyton soils are poorly drained. They are in flat or depressional areas, are grayish throughout, and do not have a fragipan. Malbis soils are moderately well drained. They are in positions similar to those of Tangi soils. They are fine-loamy and do not have a fragipan. Smithdale soils are on steeper side slopes than Tangi soils, are fine-loamy, and do not have a fragipan. Toula soils are on longer, smoother, and less convex slopes than Tangi soils and they contain more sand and less clay in the fragipan.

Typical pedon of Tangi silt loam, 1 to 3 percent slopes; 1.5 miles northeast of Bolivar, 0.5 mile south of Highway 38, 600 feet north of Highway 1056, Spanish Land Grant 43, T. 1 S., R. 8 E.

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many fine roots; medium acid; abrupt smooth boundary.

Bt1—4 to 15 inches; yellowish brown (10YR 5/6) silt loam; weak medium and coarse subangular blocky structure; friable; common fine roots; few fine random discontinuous tubular pores; few thin patchy clay films on vertical faces of peds; strongly acid; clear wavy boundary.

Bt2—15 to 25 inches; yellowish brown (10YR 5/4) silt loam; many fine distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; friable; many fine roots; few fine and medium black and brown concretions; few brittle bodies that surround the mottles and concretions make up about 10 percent of the cross section in lower part of horizon; few fine random discontinuous tubular pores; thin patchy clay films on vertical faces of peds; medium acid; clear wavy boundary.

2Btx1—25 to 33 inches; yellowish brown (10YR 5/4) loam; moderate coarse prismatic structure parting to moderate medium subangular blocky; firm; many fine and medium black and brown concretions; few fine roots in seams between prisms; pale brown (10YR 6/3) vertical and horizontal seams of silt loam and uncoated sand grains surround some ped faces; many medium and coarse yellowish red (5YR 5/6) brittle bodies make up about 70 percent of the cross section; few vertical gray (10YR 6/1) seams about 5 to 20 millimeters thick; common thick continuous clay films on faces of peds; strongly acid; gradual wavy boundary.

2Btx2—33 to 48 inches; yellowish red (5YR 5/6) clay loam; moderate coarse and very coarse prismatic structure parting to moderate medium subangular blocky; about 70 percent of the cross section is compact and brittle and 30 percent is friable; few fine black and brown concretions; few fine roots in seams between prisms; seams of yellowish brown (10YR 5/6) silty clay loam between peds; thin coatings of silt and uncoated sand grains on some faces of peds; few fine random discontinuous tubular pores; common thick continuous clay films on vertical faces of peds; strongly acid; gradual wavy boundary.

2Btx3—48 to 65 inches; red (2.5YR 5/8) clay; moderate coarse and very coarse prismatic structure parting to moderate medium subangular blocky; about 80 percent of the cross section is firm and brittle and 20 percent is friable; few fine roots in seams between prisms; many bodies of friable, yellowish brown (10YR 5/6) silty clay loam; many yellowish brown (10YR 5/6) seams of silt loam and uncoated sand grains on vertical faces of peds; few fine random discontinuous tubular pores; common thick continuous clay films on vertical faces of peds; strongly acid.

The solum is more than 60 inches thick. Depth to the fragipan ranges from 18 to 38 inches. Reaction ranges from very strongly acid to medium acid except where lime has been added. The effective cation-exchange capacity of the solum below the surface layer is 20 to 50

percent or more saturated with exchangeable aluminum. Content of total sand in the family textural control section ranges from 10 to 25 percent. Less than 15 percent of the sand in the family textural control section is fine sand or coarser.

The A horizon has value of 3 to 5 and chroma of 1 to 4. It is 3 to 7 inches thick. Where color value is 3, the A horizon is less than 6 inches thick.

Some pedons have a thin silt loam BE horizon. It has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 8.

The Bt horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 to 8. Texture is silt loam or silty clay loam. Mottles in shades of brown range from few to common.

The 2Btx horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8; or it has hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 4 to 8. Hues of 10YR and 7.5YR are only in the uppermost subhorizon of the 2Btx horizon. Mottles in shades of brown, gray, or red range from few to many. Texture is loam, silty clay loam, clay loam, sandy clay loam, sandy clay, or clay. Content of total sand ranges from 25 to 60 percent. Content of clay in the 2Btx horizon ranges from 20 to 55 percent. At least one subhorizon of the 2Btx horizon contains more than 35 percent clay.

Toula Series

The Toula series consists of moderately well drained soils that have a fragipan. Permeability is moderate in the upper part of the subsoil and slow in the fragipan. These soils formed in a moderately thick mantle of loess over loamy sediments. They are on the terrace uplands. Slopes range from 1 to 3 percent.

Soils of the Toula series are fine-silty, siliceous, thermic Typic Fragiudults.

Toula soils commonly are near Fluker, Malbis, Ruston, and Tangi soils. Fluker soils are somewhat poorly drained. They are in level to slightly concave areas and have gray mottles to a depth of 16 inches. Malbis soils are moderately well drained and Ruston soils are well drained. These soils are on shorter, more convex slopes than Toula soils, are fine-loamy, and do not have a fragipan. Tangi soils have slightly more convex slopes and contain more sand and clay in the fragipan.

Typical pedon of Toula silt loam, 1 to 3 percent slopes; about 2.75 miles northwest of Loranger, 1.25 miles east of Highway 1054, 1.25 miles north of Sweetwater Creek, sec. 30, T. 4 S., R. 8 E.

A—0 to 5 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many fine roots and few coarse roots; medium acid; abrupt smooth boundary.

BE—5 to 11 inches; light yellowish brown (10YR 6/4) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; many fine roots; medium acid; clear smooth boundary.

Bt—11 to 19 inches; yellowish brown (10YR 5/6) silt loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common fine roots and few coarse roots; common fine random discontinuous tubular pores; common thick discontinuous clay films on vertical faces of peds; medium acid; clear wavy boundary.

Btx1—19 to 24 inches; mottled yellowish brown (10YR 5/4, 5/6) and red (2.5YR 5/6) silty clay loam; coarse prismatic structure parting to moderate medium subangular blocky; firm and brittle; common fine roots and few coarse roots in gray seams around peds; few fine random discontinuous tubular pores; light brownish gray (10YR 6/2) silt loam seams between prisms; many thick continuous clay films on vertical faces of peds; medium acid; clear wavy boundary.

2Btx2—24 to 35 inches; yellowish brown (10YR 5/6) silt loam; common medium distinct brown (10YR 5/3) mottles; coarse and very coarse prismatic structure parting to moderate medium subangular blocky; firm and brittle; common coarse roots between prisms; many thin discontinuous clay films on vertical faces of peds; gray (10YR 6/1) silt loam in vertical seams 5 to 15 millimeters wide between prisms and in root channels; few discontinuous horizontal bands of gray (10YR 6/1) silt loam on tops of prisms; prisms are dense and brittle and make up about 70 percent of the cross section; noticeable increase in sand; medium acid; clear wavy boundary.

2Btx3—35 to 48 inches; yellowish brown (10YR 5/6) silt loam; many medium distinct light olive brown (2.5Y 5/6) mottles; weak coarse and very coarse prismatic structure parting to moderate medium subangular blocky; firm and brittle; common coarse roots in gray seams around prisms; many thin discontinuous clay films on vertical faces of peds; gray (10YR 6/1) silt loam seams around prisms; prisms are dense and brittle and make up about 70 percent of the cross section; noticeable sand grains; medium acid; clear wavy boundary.

2Bt—48 to 65 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct gray (10YR 6/1) mottles and common coarse prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; friable; few thin patchy clay films on vertical faces of peds; medium acid.

The solum is more than 60 inches thick. Depth to the fragipan ranges from 18 to 38 inches. Depth to mottles having chroma of 2 or less is typically more than 20 inches, but ranges from 17 to 30 inches. Reaction ranges from very strongly acid to medium acid except where lime has been added. The effective cation-

exchange capacity of the soil is 20 to 50 percent or more saturated with exchangeable aluminum to a depth of 30 inches or more. Content of total sand in the textural family control section (Bt horizon) typically is less than 15 percent, but it ranges from 5 to 25 percent. Less than 15 percent of the sand in the textural family control section is fine sand or coarser.

The A horizon has value of 3 to 5 and chroma of 1 to 4. It is 3 to 7 inches thick. Where the value is 3, the A horizon is less than 6 inches thick.

The BE horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 8. Texture is silt loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 to 8. Texture is silt loam or silty clay loam. Mottles are in shades of brown and range from few to many. In some pedons, gray mottles are below a depth of 16 inches.

The Btx and 2Btx horizons have the same range in colors as the Bt horizon and are mottled in shades of brown, gray, or red. Texture is silt loam or silty clay loam in the Btx horizon and silt loam, loam, silty clay loam, sandy clay loam, or clay loam in the 2Btx horizon. Content of total sand in the 2Btx horizon ranges from 20 to 60 percent. Clay content in the fragipan ranges from 18 to 35 percent.

The 2Bt has the same range in colors and textures as the 2Btx horizon. Brittle bodies range from none to common and can make up 10 to 40 percent of the volume of the matrix.

Formation of the Soils

Dr. Brian A. Schumacher, Department of Agronomy, Agricultural Experiment Station, Louisiana State University Agricultural Center, helped prepare this section.

This section discusses the processes of soil formation and relates them to the soils in the survey area.

Processes of Soil Formation

The processes of soil formation influence the kind and degree of development of soil horizons *(9)*. The factors of soil formation— climate, living organisms, relief, parent material, and time—determine the rate and relative effectiveness of different processes.

Soil-forming processes include those that result in the addition of organic, mineral, and gaseous materials to the soil; the loss of these materials from the soil; the translocation of materials from one point to another within the soil; and the physical and chemical transformation of mineral and organic materials within the soil *(29)*.

Some processes take place simultaneously; in Tangipahoa Parish, for example, accumulation of organic matter, development of soil structure, and leaching of bases from some soil horizons. Other processes are dependent upon one another. For example, in the formation of gleyed horizons in Barbary soils, iron is first chemically reduced (a process of transformation), then it is leached from the surface layer to subsurface layers (a translocation process). Some soil-forming processes that apply to the soils in Tangipahoa Parish are discussed in the following paragraphs.

Organic matter accumulates, partly decomposes, and is incorporated into all the soils. Organic matter production is greatest in and above the surface layer; therefore, soils are formed in which the surface layer is higher in organic matter content than the deeper layers *(18, 19)*. The Stough soils, for example, have a dark surface layer that is high in organic matter content and a lighter, brownish subsoil that is low in organic matter content. The decomposition and mixing of organic residue into the soil is caused largely by the activity of living organisms. Many of the more stable products of decomposition remain as finely divided materials that give dark color to the soil, increase available water and cation-exchange capacities, contribute to granulation, and serve as a source of plant nutrients *(18, 19)*.

The addition of alluvial sediment on the surface has helped in forming several soils in the parish. Added sediment provides new parent material for soil formation. The soils that are classified as Entisols, such as the Barbary and Ochlockonee soils, undergo periodic additions of new sediments, as do the Ouachita soils, an Inceptisol, and the Kenner soils, a Histosol. During periods between flooding, the processes of soil formation are limited. Often, new material accumulates faster than the processes of soil formation can appreciably alter the deposited materials *(18, 19)*. This accumulation is evident as depositional strata in the lower horizons of many of the soils, such as the Ochlockonee soils, that are developing in alluvial sediment. Floodwater and rainwater also carry dissolved mineral matter and gasses, which are added to the soil as the water percolates through the soil layers. The retreat of floodwater or the downward flow of rainwater through the soil allows new gasses to enter the soil and fill the voids.

Loss of components from the soils is one process in their formation. Surface erosion and leaching of bases or free carbonates from the soil are two of the most common losses. Surface runoff and erosion cause great physical loss of organic matter, nutrients, and mineral materials from the surface layer and sometimes, when erosion is extensive, from layers that were once subsurface layers. Water moving through soil has leached soluble bases and any free carbonates that may have been initially present from some layers of most of the soils. The influence of leaching, a translocation process, becomes more pronounced as the period of soil development increases.

Highly weathered Ultisols, such as the Ruston and Smithdale soils, have undergone extensive leaching as indicated by their low base status, while the less developed Abita, Brimstone, and Fluker soils (all Alfisols) are less weathered and less leached soils that have higher base saturation.

Secondary accumulations of salts, calcium carbonate, and clays are examples of translocation processes commonly occurring in the soils in Tangipahoa Parish. Calcium carbonate and other salts dissolved from overlying horizons can be translocated to subsurface horizons and be redeposited at depth. For example, salts and carbonates have been translocated in the Brimstone soils. Other sources and processes can contribute in varying degrees to these secondary accumulations, such as segregation of material within the horizon, upward

translocation of materials in solution from deeper horizons during fluctuations of water table levels, and contributions of materials from readily weatherable minerals, such as the plagioclase feldspars *(18, 19)*.

The formation, translocation, and accumulation of clay are processes that have helped develop many of the soils in Tangipahoa Parish.

Horizons of secondary accumulations of clay result largely from translocation of clays from upper to lower horizons. As water moves downward, it can carry small amounts of clay in suspension. This clay is deposited, and it accumulates at the depth of the water penetration or in horizons where it becomes flocculated or filtered out by fine pores in the soil. Over long periods, such processes can result in distinct horizons of clay accumulation. These distinct horizons are referred to as argillic horizons in Soil Taxonomy. The Cahaba and Malbis soils are examples of soils in the parish that have a subsoil characterized by a secondary accumulation of clay.

Physical and chemical transformations of mineral and organic materials within the soil are major soil-forming processes. Several of the transformational processes that occur in Tangipahoa Parish are: organic matter decomposition, primary mineral weathering to form clay minerals and oxides, oxidation and reduction of iron and manganese compounds, and the formation of soil structure, fragipans, and plinthite.

Decomposition of organic matter has occurred in all the soils of Tangipahoa Parish to some extent. The accumulation and breakdown of organic residue have led to the formation of organic soils (Histosols), such as the Kenner and Maurepas soils. Organic matter decomposition is also partly responsible for the formation of soil structure place in all the soils in the parish. Other agents of structure formation include alternate wetting and drying, secretion of living organisms, clay flocculation, and cementation of soil particles by iron oxides and other chemical compounds in the soil.

Weathering of primary minerals to form secondary clay minerals and oxides in soils involves the release of silica and alumina from the primary minerals, such as feldspars. The silica and alumina can then recombine with the components of water to form secondary minerals, such as kaolinite. Other minerals that may have been present in the initial parent material or have been added to the soil at a later time, such as biotite and montmorillonite, can also be weathered to form other clay minerals, such as vermiculite or kaolinite.

Oxidation and reduction of iron and manganese compounds take place in soils that are poorly drained or very poorly drained. Reducing conditions are present when soils are poorly aerated for long periods of time. Under these conditions, iron and manganese are reduced and become more soluble in water. These reduced elements may be removed or translocated from one point to another within the soil by water. Reduced iron compounds, where abundant, give soils the characteristic gray colors and lead to the formation of gleyed horizons (Bg and Cg horizons) in such soils as the Barbary, Guyton, and Myatt soils. The presence of browner mottles in a predominantly gray soil indicates local areas or pockets of oxidizing conditions. The presence of gray mottles in a predominantly brown soil indicate local areas or pockets of reducing conditions.

Physical transformations that have occurred in the soils of Tangipahoa Parish are the formation of soil structure, fragipans, and plinthite. Soil aggregates can be formed by physical compaction caused by the shrinking and swelling of clays during alternate wetting and drying. Soil aggregates are cemented or bound by organic residue, by secretions of living organisms, and by the oxides of iron and manganese. Fragipan formation involves the hardening of the soil possibly through reversible cementation by one or more agents, not necessarily the same agents in all soils, or possibly through hydrogen bonding between silica and alumina in the soil *(36)*. Fragipans have formed in the subsoils of the Prentiss, Savannah, Tangi, and Toula soils in Tangipahoa Parish. Iron translocation and segregation, usually in the reduced form, and its subsequent oxidation are two important steps in the formation of plinthite. Exposure to wetting and drying cycles causes the plinthite to harden in the soil, and, ultimately, plinthite irreversibly hardens to form ironstone. Plinthite formation is one of many soil-forming processes occurring in the Malbis series.

Factors of Soil Formation

The interaction of five main factors influences the processes of soil formation and results in differences among the soils. These factors are climate, living organisms, relief, parent material, and time *(12)*. These factors can be further divided into two subgroups, the active and passive soil-forming factors, depending upon how they influence soil formation *(13)*. The active soil-forming factors are those that supply energy to the soil system to impel the various soil-forming processes. The active factors are climate and living organisms, which directly influence soil development. Passive soil-forming factors, relief, parent material, and time, do not actively affect soil genesis. Instead, they influence soil development by supplying the initial materials from which the soil is being formed (parent material), by influencing drainage, runoff, and soil moisture conditions (relief), and by influencing the extent or how long the soil-forming processes have had to change a soil (time).

The effect of a factor can differ from place to place, but the interaction of all the factors determines the kind of soil that forms. Many of the differences in soils cannot be attributed to differences in the effects of only one factor. For example, the organic matter content in the

soils of Tangipahoa Parish is influenced by several factors including living organisms, climate, relief, and time. The following paragraphs describe the factors of soil formation as they relate to soils in the survey area.

Climate

Tangipahoa Parish is in a region characterized by a humid subtropical climate. Detailed information about climate is in the section "General Nature of the Survey Area."

The climate is relatively uniform throughout the parish. Local differences in the soils are not a result of great differences in atmospheric climate. Climate influences soil formation mainly through the effects of temperature and precipitation. Generally, the warmer the annual temperature and the greater the annual precipitation, the more highly developed a soil will become unless some other soil-forming factor plays a more dominant role.

In this parish, the warm average temperatures and large amounts of precipitation favor rapid weathering of readily weatherable minerals in the soils. In spite of this, soils developing on flood plains, such as the Ochlockonee soils, are weakly developed because new sediment is continually being added to the soil surface and because the length of time the soils are exposed to influences of climate is short. Advanced weathering and leaching are typically indicated by acid soils with low base saturations, such as the Cahaba, Ruston, and Smithdale soils. Weathering of iron-bearing minerals releases iron into the soil. If reducing conditions are prevalent, iron will be reduced, resulting in a predominantly gray soil. Brimstone, Guyton, and Myatt soils are gray. Yellows, reds, and some browns indicate that oxidizing conditions are dominant and indicate a soil that is better drained. Oxidation and segregation of iron, as a result of alternating oxidizing and reducing conditions, is indicated by mottled horizons and iron and manganese concretions in most of the soils.

Living Organisms

Living organisms, including plants, bacteria, fungi, and burrowing animals, are a major influence on the kind and extent of soil horizons that develop. In some cases, living organisms are the predominant agents responsible for the kind of soil that is formed. Where the rate of accumulation of organic matter greatly exceeds its rate of decomposition (generally under poorly or very poorly drained conditions) and sufficient time has passed to allow the buildup of organic material, organic soils (Histosols), such as the Kenner and Maurepas soils, are formed.

Growth of plants and activity of other organisms disturb the soil, modify porosity, and influence the formation of structure and the incorporation of organic matter. Photosynthesis, the use of energy from the sun to synthesize compounds necessary for plant growth, produces additional organic matter. Growth of plants and their eventual decomposition provide recycling of nutrients from the soil. Decomposition serves as a major source of organic residue. This continual cycling of nutrients helps stem the loss of calcium, magnesium, phosphorus, potassium, and other essential elements from the soil system through leaching or erosional processes.

The Barbary soils formed primarily under a native vegetation consisting of various swamp grasses, baldcypress, red maple, and water tupelo. A mixed pine forest is the dominant vegetation on the Smithdale, Tangi, and Toula soils. The other mineral soils in Tangipahoa Parish formed under a forest vegetation consisting of mixed hardwoods and pines. Some areas of these soils have been cleared for cultivation or other uses.

The organic soils in the parish formed under two different vegetative schemes. The Kenner soils formed under freshwater marsh grasses, sedges, and rushes. Maurepas soils formed under baldcypress trees and encroaching marsh grasses.

Macro-organisms, such as worms and crayfish, are responsible for the mixing of soils. These organisms carry mineral materials and nutrients upward from subsurface horizons and redeposit them on the soil surface. The movement of these animals through the soil affects soil porosity, permeability, and aeration. The tunnels they make allow water and air to rapidly enter the soil. Mineral and organic matter are decomposed and released into the soil after digestion by certain organisms.

Micro-organisms, such as fungi and bacteria, decompose and incorporate organic matter into the soil. These two processes enhance the development of soil structure and generally increase the infiltration rate and available water capacity. The released organic compounds, if stable, generally have a large cation-exchange capacity, which increases the capability of a soil to absorb and store essential nutrients.

Organic matter accumulation depends upon the type and number of micro-organisms present. Well drained, aerated soils favor large populations of aerobic micro-organisms, which use the oxygen from the air to cause the rapid breakdown of organic residue. These organisms are the major decomposers of organic matter in soils and are predominant in the better drained soils, such as the Ochlockonee, Ouachita, Prentiss, and Ruston soils. The more poorly drained soils, such as the Bibb and Brimstone soils, as well as all the Histosols favor populations of anaerobic microbes. These organisms do not require oxygen and decompose organic matter very slowly.

Relief

Relief and other physiographic features influence the soil formation processes by affecting internal soil

drainage, surface runoff, erosion and deposition, and exposure to the sun and wind *(18, 19)*.

Tangipahoa Parish can generally be divided into four provinces based on relief characteristics. These provinces are terrace uplands, stream or marine terraces (Prairie Terrace), recent flood plains, and marshes and swamps. The influence of relief on internal soil drainage and on depths and duration of a seasonal high water table is evident in the soils in the different provinces in Tangipahoa Parish.

Soils forming on the highest landscape positions, the terrace uplands (province 1), have very gentle or gentle slopes and are moderately well drained or well drained. They have a seasonal high water table that is continually at a depth of 6 feet or more except where the water is perched on a fragipan or plinthite in the subsoil. The Malbis, Ruston, Smithdale, Tangi, and Toula soils are in this province.

Soils forming on stream and marine terraces of the Prairie Terrace (province 2), the second most elevated landscape province, range from poorly drained to well drained. Slopes range from level to gently sloping. Generally, as slope gradient increases, surface runoff increases and internal drainage becomes less restricted. Soils in this province include the Abita, Brimstone, Cahaba, Fluker, Guyton, Myatt, Prentiss, Savannah, and Stough soils. Depth to a seasonal high water table in most of these soils ranges from the surface to a depth of 3 feet from December to May. The Cahaba soils do not have a seasonal high water table within 6 feet of the surface.

The Guyton, Ochlockonee, and Ouachita soils are the main soils on nearly level, recent flood plains (province 3). The soils range from poorly drained to well drained, and the seasonal high water table in the Guyton soils ranges from the surface to a depth of 1.5 feet from December to May. In the Ochlockonee soils, the high water table ranges between depths of 3 and 5 feet; in the Ouachita soils, it remains below a depth of 6 feet year round.

Level and very poorly drained soils formed in the backswamps and marshes (province 4) and occupy the lowest landscape positions in Tangipahoa Parish. The seasonal high water table ranges from 0.5 foot below the surface to 1 foot above the surface. Soils in this group include the Barbary, Kenner, and Maurepas soils.

The formation of the Brimstone soils has a unique relationship to relief. The Brimstone soils are on broad flats at an intermediate elevation. These soils have a high content of exchangeable sodium, which is believed to be carried in water draining from slightly higher, surrounding soils.

Parent Material

Parent material has been defined as "the state of the soil system at time zero of soil formation" *(12)*. It is what the soil formed from. Generally, the younger the soil, the greater the influence of the parent material on soil properties. The nature of the parent material largely determines the soil color, texture, reaction, permeability, drainage, soil depth, and degree of leaching. The parent material also strongly influences the mineralogy and the initial fertility status of a soil.

The soils of Tangipahoa Parish formed from either marine or fluvial sediment except the Kenner, Maurepas, Tangi, and Toula soils. The Kenner and Maurepas soils (Histosols) developed mainly from *in situ* decomposition of plant and animal tissue. In these soils, mineral materials commonly are mixed with organic matter. The abundance of organic matter is more important in the formation and classification of the soils. Tangi and Toula soils formed in a moderately thick loess mantle underlain by Coastal Plain sediments of the early Pleistocene age. The loess deposits in Tangipahoa Parish generally are less than 3 feet thick. Silt loam and silty clay loam textures underlain by finer textural classes *(20)* in the Tangi and Toula soils indicate loess deposits.

Time

The length of time a soil or parent material is exposed to weathering processes influences the kind of soil horizons and the degree of development. Generally, the greater the length of time, the more developed a soil can become. Soils forming on flood plains are subject to continuous additions of new sediment. They show little soil development because of the relatively small amount of time these materials have been exposed to weathering. Well developed soils, such as the Cahaba, Myatt, Ruston, Savannah, Stough, Tangi, and Toula soils, have had sufficient time for advanced soil development.

In Tangipahoa Parish, soil development can be grouped into three different time periods. The youngest soils (less than about 10,000 years old) formed in alluvium deposited during Holocene time. These relatively young soils are those that formed on recent flood plains and in the marshes and swamps. Intermediate aged soils developed on coastwise stream or marine terraces (Prairie Terrace). The sediments were deposited during late Pleistocene time (approximately 10,000 to 75,000 years ago). Malbis, Ruston, and Smithdale soils of the terrace uplands formed in pre-Pleistocene age sediments of the Citronelle Formation and were deposited about 2 million years ago. The loess mantle in which the Tangi and Toula soils are developing is pre-Peorian loess deposited approximately 75,000 to 95,000 years ago *(14)*.

Landforms and Surface Geology

Dr. Bobby J. Miller, Department of Agronomy, Louisiana State University, helped to prepare this section.

Tangipahoa Parish occupies an area of approximately 803 square miles in southeastern Louisiana. Washington and St. Tammany Parishes form its eastern boundary. The state of Mississippi forms it northern boundary. Lake Pontchartrain and Lake Maurepas form the southern boundary, together with Pass Manchac, which flows between these two lakes and separates Tangipahoa Parish from St. John the Baptist Parish.

The north-south trending Tangipahoa, Tchefuncte, and Natalbany Rivers drain all but the southernmost part of the area. Small, short streams originating in the parish drain relatively small areas in the southernmost part.

Elevations in the parish range from sea level or below along the entire southern edge to approximately 340 feet on the highest interfluves in the northwestern part.

The parish can be divided into four general physiographic regions, each characterized by soils formed in a different kind or age of parent material. The northern part of the parish is a gently sloping to hilly upland that is called the High Terraces, or Terrace Uplands province in other parts of the survey. This area is underlain by late Tertiary or very early Pleistocene age deposits of the Citronelle Formation. The highest elevations and the oldest and most dissected land surfaces in the parish are in this area. At intermediate elevations are Pleistocene age terraces that either parallel streams or occur as coastwise terraces of more regional extent. Flood plains of the Tangipahoa, Natalbany, and Tchefuncte Rivers and smaller streams that drain the parish make up about 12 percent of the land area. The southern edge of the parish is a band of marshes and swamps at elevations near sea level. Important relationships among the physiographic, geologic, and soil features in these areas are explained in the following section.

Coastal Marshes and Swamps

About 15 percent of the parish is coastal marshes and swamps. They trend east-west in a band along the southern edge of the parish. Their position corresponds approximately to the Maurepas map unit on the General Soil Map. These soils and the stream flood plain deposits are formed in the youngest sediments in the parish. Deposits on and near the surface are of Holocene age (less than 10,000 years old), and most have been deposited since the formation of the Lake Pontchartrain Basin. The Lake Pontchartrain Basin was formed by embayment of the Gulf of Mexico when the Mississippi River and its distributaries changed courses and abandoned the Cocodrie and St. Bernard deltas 4,000 to 1,800 years ago *(28)*.

Elevations in the coastal marshes and swamps range from a few feet below sea level to only a few feet above sea level. Parts of the area are continuously flooded, and the rest is subject to frequent flooding. Exceptions are areas that have been artificially drained and are protected by flood control structures. Most of the sediments are continually saturated and have not dried since being deposited. Mineral soils are fluid throughout unless they are protected from flooding. Most of the mineral soils are clayey and all can have a thin organic surface layer. Barbary soils formed in swamps.

Thick deposits of organic materials have accumulated in many of the areas. These deposits are the parent materials of the Kenner and Maurepas soils, which are the two organic soils (Histosols) that are mapped in the parish. Most of the organic soils have thin layers of mostly mineral material, particularly in areas where they are adjacent to mineral soils. Mineral soils also have thin layers of organic material, especially in areas near the boundary between mineral and organic soils. Overall, the landmass is slowly subsiding *(21)*. Over time, subsidence and the varying flood stages and minor fluctuations in sea level have resulted in considerable variation in the soils. In places, Holocene age deposits overlie buried surfaces of the Pleistocene age terraces. In other places, the materials are mostly Mississippi River alluvium to great depths. In still others, the sediments are dominantly from the streams draining the parish.

Only freshwater swamps and marshes were mapped within the parish.

Recent Alluvial Plain Deposits

Alluvial plain deposits of the rivers and smaller streams draining the area make up about 12 percent of the land area of the parish. These recent deposits are of Holocene age and are only a few thousand years old at most. With few exceptions, the areas are subject to annual flooding and deposition of sediments.

The flood plains are characterized by level or nearly level topography marked, in places, by abandoned stream channels that are partly filled with sediment. Areas of these deposits correspond approximately to the Ouachita-Ochlockonee-Guyton map unit on the General Soil Map. These streams drain areas of highly weathered soils that are the source of the alluvial plain sediments. Consequently, the alluvial plain deposits are low in weatherable minerals and are parent materials of soils that have naturally low fertility. The area drained by the Tangipahoa River extends northward into southern Mississippi. The watersheds of other streams draining the parish are comparatively small and more local in origin.

Soils formed in the recent flood plain deposits along all the streams have minimal profile development and classify as Entisols or Alfisols. In most places, distinct depositional strata are evident at a depth of about 2 to 5 feet.

Pleistocene Age Terraces

From two to four Pleistocene age terraces have been identified in southeastern Louisiana *(11, 20, 26, 28, 30)*. Generally, each terrace represents an accumulation of sediments along major streams and the Gulf Coast during interglacial stages. This process is somewhat similar to the present accumulation. During periods of glaciation, sea level is lowered, exposing large areas of recently deposited materials. Streams draining adjoining areas flow onto and across these new surfaces. These extended, consequent streams carry sediments eroded from adjacent areas. Some of the sediments are deposited on the recently exposed surfaces. Receding glaciation results in a rise in sea level and a corresponding rise in the base level of streams. Stream deltas move inland, and sediment accumulation becomes pronounced. Part of the new landmass exposed during glaciation may remain above sea level, forming a terrace subject to subareal weathering and soil formation. Repeated cycles of glaciation can result in a series of terraces, progressing from youngest to oldest with increasing elevation. At least two Pleistocene age terraces are identified in Tangipahoa Parish.

Deweyville Terrace. The identification of a Deweyville Terrace in Tangipahoa Parish is tentative. The Deweyville Terrace is generally considered to be the youngest of the Pleistocene age terraces in the area *(27, 28, 30)* and probably was deposited between 20,000 and 25,000 years ago. Stratigraphically, the Deweyville Terrace lies between the Prairie Terrace and the Holocene flood plains. The major areas of the Deweyville Terrace are in the Cahaba-Myatt map unit on the General Soil Map. These areas form thin, elongated and intermittent bands adjoining and parallel to the stream flood plains. In Tangipahoa Parish, the Deweyville Terrace occurs only as a stream-paralleling fluvial terrace and at an elevation only a few feet above present stream flood plains. Sediments that make up the Deweyville Terrace are typically more sandy than those of the other Pleistocene terraces or the modern flood plain and are underlain by gravel in many places. The Deweyville Terrace has oversize meander belt features that include abandoned channels and point bar ridges and swales. When compared to Holocene meander belt features of the streams that formed the terrace, these features and the coarser nature of the deposits suggest that the streams had a much higher flow rate when the terrace was deposited than at present.

The Cahaba and Myatt soils are the major soils mapped on the Deweyville Terrace. The sediments in which these and other soils on the terrace formed are erosional detritus from areas of highly weathered soils. The low weatherable mineral content, low base status, and highly weathered nature of these sediments result mostly in the formation of Ultisols on the terrace.

Prairie Terrace. The Prairie Terrace occupies large areas in the southern part of Tangipahoa Parish. The terrace is part of an extensive regional coastwise terrace that extends far beyond the parish boundary on both the east and west sides. The terrace extends up the valleys of streams, such as the Tangipahoa and Natalbany Rivers. These rivers drain land areas older than the terrace. The Prairie Terrace corresponds approximately to the Guyton-Abita, Guyton-Brimstone-Abita, Myatt-Guyton, and Stough-Myatt map units on the General Soil Map.

The Prairie Terrace is level to gently sloping. Elevation ranges from near sea level in the southernmost part to about 60 feet in the northernmost part. Stream dissection of the terrace surface is minimal, and local relief is rarely more than 10 feet. Small streams that originate on the terrace drain much of the area. Extended consequent streams originating on older and higher landmasses drain a small part of the parish.

The Prairie Terrace probably was deposited during the Sangamon interglacial stage approximately 75 to 125 thousand years ago *(11, 28)*.

A large number of borings conducted during the course of the survey revealed a consistent stratigraphic sequence among the deposits generally at a depth of less than 30 feet throughout the coastwise component of the Prairie Terrace. These same studies showed a consistent relationship between the individual stratigraphic units exposed at the surface and the major soils mapped on the surface. Very clayey strata of undetermined thickness generally occur at a depth of less than 30 feet. The strata are not exposed at the surface. Recognizable soil profiles, accumulations of organic matter on the surface, and fragments of wood and other organic remains extracted from the surface of these clayey deposits indicate that they were subareally exposed for a significant period. These strata are, in turn, overlain by fluvial sandy deposits that range in thickness from less than 1 foot to more than 20 feet. The thickness depends on the location with respect to the ancient streams, which served as their source. These more sandy deposits fine upward and are parent materials for the Prentiss, Stough, and Myatt soils.

Surface exposures of the deposits correspond approximately to the Stough-Myatt map unit on the General Soil Map. In low-lying areas, these materials are, in turn, overlain by more silty deposits that have appreciably more clay than the underlying sediments. These deposits are the parent materials of the Abita, Brimstone, and Guyton soils. Surface exposures of these sediments are mostly concentrated near the southern edge of the Prairie Terrace and correspond approximately to the Guyton-Abita map unit on the General Soil Map. The sedimentation environment for most of these materials was probably characterized by the merging of fluvial and marine depositional environments.

Intermediate Terraces. Pleistocene age terraces older than the Prairie Terrace have been recognized in

parts of southeastern Louisiana and identified as Intermediate or Montgomery Terraces *(11, 28, 30)*. The Intermediate Terraces in Tangipahoa Parish comprise a gently and moderately sloping landscape that corresponds approximately to the Toula-Tangi map unit on the General Soil Map. Topographically and stratigraphically, they lie between the younger Prairie Terrace and the older High Terraces. The materials that make up the terrace generally are considered to have been deposited during the Yarmouth Interglacial, about 400,000 to 500,000 years ago. After deposition, these sediments were subareally exposed for long periods and highly developed soils formed on the terrace. A loess mantle, perhaps 3 feet thick, was then deposited on the Intermediate Terraces and older surfaces *(20)*. Pedogenic processes mixed the loess deposits to some extent with the underlying, more sandy sediments of the Intermediate Terrace. These silty loess deposits, containing a small admixture of the underlying terrace deposits, are the parent material of the Tangi and Toula soils. In sloping areas where most or all of the loess has been removed by erosion, soils that developed in the Intermediate Terraces deposits occur at the surface. Loess deposited on the Intermediate Terraces and older surfaces in Tangipahoa Parish were mostly older than Peorian loess, and little, if any, Peorian loess was deposited in the area *(20)*.

High Terraces. The High Terraces are in the northern part of the parish and account for about 24 percent of the land area. This area is the oldest, highest, and most dissected part of the parish and corresponds roughly to the Tangi-Ruston-Smithdale map unit on the General Soil Map. The region corresponds approximately to the outcrop area of the Citronelle Formation. The Citronelle Formation generally is considered to be late Pliocene or early Pleistocene in age. The time of deposition was about 2 million years ago. The Citronelle Formation is made up mostly of coarse-textured fluvial deposits consisting of interstratified gravelly sands with lesser amounts of silts and clays and occasional clayey lenses. The source of the sediments, as indicated by mineralogical and other studies *(11, 26, 28)*, is believed to be the western slopes of the Appalachian mountains far to the east.

The highest elevation of interfluves in the High Terraces ranges from about 340 feet in the northern part to about 60 feet in the southern part. The area is mainly a dissected, very gently sloping or moderately steep upland having local relief of more than 100 feet in places. The area is drained almost entirely by the Tangipahoa River and its tributaries, which form a generally north-south trending dendritic drainage pattern.

Soils formed on the High Terraces are mostly Ultisols, predominantly the Tangi, Ruston, and Smithdale soils. Soils on the High Terraces are characterized to great depths by low native fertility levels and low base status. The soils have thick sola and typically have distinct horizons of secondary clay accumulation (argillic horizons). The low base status and low native fertility levels are attributed to the paucity of weatherable minerals in the parent materials and to the long period of exposure to weathering during soil formation. The long duration of soil formation has enabled the thick sola, characterized by distinct argillic horizons, to form.

Although the soils formed on the High Terraces developed mainly in relatively sandy sediments, many have appreciable amounts of silt in and near the surface layer. Investigations conducted during the survey indicate that the oldest land surfaces in Tangipahoa Parish may have received between 2 and 3 feet of loess deposits during Pleistocene time. Loess distribution patterns and studies *(20)* indicate that Tangipahoa Parish might have received thin deposits of loess. Regionally, the loess deposits of the Lower Mississippi Valley are thicker near the Mississippi River flood plain and they thin with distance normal to the river. Studies *(20)* indicate that Tangipahoa Parish received deposits of a loess older than Peorian loess but received little, if any, of the Peorian loess deposits. Any loess deposited in Tangipahoa Parish has long since been eroded from the more steeply sloping landscape positions where the Ruston and Smithdale soils occur. In areas where loess deposits remain, pedogenic processes have thoroughly mixed them with the underlying material to a depth of 3 feet or more. The Tangi and Toula soils have developed in these areas that are made up of loess containing an admixture of the underlying material from the Citronelle Formation or the Intermediate Terraces.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels, i.e., clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic)—Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated)—Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, such as fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay are in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess sodium (in tables). Excess exchangeable sodium is in the soil. The resulting poor physical properties restrict the growth of plants.

Fast intake (in tables). The movement of water into the soil is rapid.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green-manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is, in part, a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as accumulation of clay, sesquioxides, humus, or a combination of these; prismatic or blocky structure; redder or browner colors than those in the A horizon; or a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock (unweathered bedrock) beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but

is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water to move through the profile. Permeability is measured as the number of inches per hour that water moves through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Subsurface tunnels or pipelike cavities are formed by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of the acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). There is a shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in organic matter content than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed on the contour or at a slight angle to the contour across sloping soils. The terrace intercepts surface runoff, so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). An otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced by atmospheric agents in rocks or other deposits at or near the earth's surface. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data recorded in the period 1951-79 at Amite, Louisiana]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	60.5	38.0	49.3	80	16	149	5.42	2.88	7.63	7	0.1
February---	64.5	40.4	52.5	82	20	171	6.04	2.65	8.93	7	0.3
March------	71.6	47.1	59.4	86	26	310	5.30	2.49	7.72	7	0.0
April------	79.4	55.6	67.5	89	36	525	6.25	2.47	9.42	5	0.0
May--------	85.7	62.1	73.9	95	44	741	5.34	2.54	7.76	6	0.0
June-------	91.4	67.9	79.7	99	55	891	4.55	1.94	6.77	6	0.0
July-------	92.7	70.8	81.8	100	64	986	7.47	4.65	10.01	11	0.0
August-----	92.1	70.3	81.2	98	60	967	4.87	2.81	6.70	8	0.0
September--	88.5	66.4	77.5	96	50	825	5.22	1.96	7.94	7	0.0
October----	80.8	54.2	67.5	93	33	543	2.61	0.51	4.26	3	0.0
November---	70.2	45.5	57.9	86	25	257	4.59	1.66	7.02	6	0.0
December---	63.4	40.0	51.7	82	18	138	5.94	3.34	8.23	7	0.0
Yearly:											
Average--	78.4	54.9	66.7	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	14	---	---	---	---	---	---
Total----	---	---	---	---	---	6,503	63.60	51.66	74.96	80	0.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 °F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data recorded in the period 1951-79 at Amite, Louisiana]

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 1	March 22	March 25
2 years in 10 later than--	February 20	March 12	March 20
5 years in 10 later than--	February 3	February 23	March 10
First freezing temperature in fall:			
1 year in 10 earlier than--	November 19	November 6	October 28
2 years in 10 earlier than--	November 27	November 13	November 2
5 years in 10 earlier than--	December 14	November 26	November 13

TABLE 3.--GROWING SEASON

[Data recorded in the period 1951-79 at Amite, Louisiana]

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	279	246	223
8 years in 10	291	256	232
5 years in 10	314	275	247
2 years in 10	336	294	263
1 year in 10	348	304	271

TABLE 4.--SUITABILITY AND LIMITATIONS OF MAP UNITS ON THE GENERAL SOIL MAP FOR MAJOR LAND USES

General soil map unit	Extent of area	Cultivated crops	Pastureland	Woodland	Urban uses	Intensive recreation areas
	Pct					
Tangi-Ruston-Smithdale	24	Moderately well suited: low fertility, exchangeable aluminum, slope.	Well suited	Well suited	Moderately well suited: slope, moderate and very slow permeability, wetness, shrink-swell, low strength for roads.	Moderately well suited: slope, very slow permeability, wetness.
Toula-Tangi	17	Moderately well suited: low fertility, exchangeable aluminum, slope.	Well suited	Well suited	Moderately well suited: wetness, slow and very slow permeability, wetness, shrink-swell, low strength for roads.	Moderately well suited: wetness, very slow permeability, slope.
Guyton-Abita	17	Moderately well suited: wetness, low fertility, exchangeable aluminum.	Well suited	Well suited	Poorly suited: flooding, wetness, slow permeability, shrink-swell, low strength for roads.	Poorly suited: wetness, flooding, slow permeability.
Myatt-Guyton	6	Moderately well suited: wetness, low fertility, exchangeable aluminum.	Well suited	Well suited	Poorly suited: wetness, flooding, slow permeability, low strength for roads.	Poorly suited: wetness, flooding, slow permeability.
Stough-Myatt	1	Moderately well suited: wetness, low fertility, exchangeable aluminum.	Well suited	Well suited	Poorly suited: wetness, moderately slow and slow permeability.	Poorly suited: wetness, moderately slow and slow permeability.
Fluker-Savannah-Myatt-Cahaba	5	Moderately well suited: low fertility, wetness, exchangeable aluminum.	Well suited	Well suited	Poorly suited: wetness, flooding, moderately slow and slow permeability, low strength for roads.	Poorly suited: wetness, moderately slow and slow permeability.
Cahaba-Myatt	3	Well suited	Well suited	Well suited	Well suited (Cahaba) Poorly suited (Myatt)	Well suited.

TABLE 4.--SUITABILITY AND LIMITATIONS OF MAP UNITS ON THE GENERAL SOIL MAP FOR MAJOR LAND USES--Continued

General soil map unit	Extent of area	Cultivated crops	Pastureland	Woodland	Urban uses	Intensive recreation areas
	Pct					
Ouachita-Ochlockonee-Guyton	12	Not suited: flooding.	Poorly suited: wetness, low fertility, flooding.	Moderately well suited: moderate and severe equipment use limitations, severe seedling mortality.	Not suited: flooding.	Not suited: flooding.
Maurepas	15	Not suited: flooding, ponding, wetness.	Not suited: flooding, ponding, wetness.	Not suited: flooding, ponding, severe equipment use limitations.	Not suited: flooding, ponding, wetness, subsidence, low strength.	Not suited: flooding, ponding, wetness, subsidence.

TABLE 5.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Aa	Abita silt loam, 0 to 2 percent slopes	30,531	5.7
Ab	Abita silt loam, 2 to 5 percent slopes	6,121	1.1
BB	Barbary muck	3,273	0.6
Bg	Brimstone-Guyton silt loams	9,787	1.8
Ca	Cahaba fine sandy loam, 1 to 3 percent slopes	16,635	3.1
Ch	Cahaba fine sandy loam, 3 to 6 percent slopes	208	*
Fu	Fluker silt loam	9,447	1.8
Go	Guyton silt loam	37,296	7.0
Gy	Guyton silt loam, occasionally flooded	14,010	2.6
KE	Kenner muck	3,705	0.7
Ma	Malbis fine sandy loam, 3 to 8 percent slopes	6,452	1.2
MP	Maurepas muck	66,278	12.5
Mt	Myatt fine sandy loam	14,584	2.7
My	Myatt fine sandy loam, occasionally flooded	9,832	1.8
OG	Ouachita, Ochlockonee, and Guyton soils, frequently flooded	59,181	11.0
Pa	Pits-Arents complex, 0 to 5 percent slopes	4,685	0.9
Pt	Prentiss fine sandy loam	702	0.1
Rn	Ruston fine sandy loam, 1 to 3 percent slopes	9,629	1.8
RS	Ruston-Smithdale association, rolling	66,144	12.3
Sa	Savannah silt loam, 1 to 3 percent slopes	8,482	1.6
Sm	Smithdale fine sandy loam, 12 to 20 percent slopes	1,455	0.3
St	Stough fine sandy loam	6,459	1.2
Ta	Tangi silt loam, 1 to 3 percent slopes	37,112	6.9
Tg	Tangi silt loam, 3 to 8 percent slopes	42,631	8.0
To	Toula silt loam, 1 to 3 percent slopes	49,281	9.2
Ww	Water	22,228	4.1
	Total	536,148	100.0

* Less than 0.1 percent.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Map symbol and soil name	Land capability	Soybeans	Common bermudagrass	Improved bermudagrass	Bahiagrass
		Bu	AUM*	AUM*	AUM*
Aa------------------------ Abita	IIw	30	5.0	11.5	8.0
Ab------------------------ Abita	IIe	25	5.0	11.0	8.0
BB------------------------ Barbary	VIIw	---	---	---	---
Bg------------------------ Brimstone-Guyton	IIIs	15	5.0	---	7.5
Ca, Ch-------------------- Cahaba	IIe	30	6.5	13.0	10.0
Fu------------------------ Fluker	IIw	25	6.0	11.0	7.5
Go------------------------ Guyton	IIIw	20	6.0	---	9.0
Gy------------------------ Guyton	IVw	---	4.5	---	8.0
KE------------------------ Kenner	VIIIw	---	---	---	---
Ma------------------------ Malbis	IIIe	25	6.0	13.0	9.0
MP------------------------ Maurepas	VIIIw	---	---	---	---
Mt------------------------ Myatt	IIIw	20	5.5	---	7.5
My------------------------ Myatt	IVw	---	5.0	---	7.0
OG------------------------ Ouachita, Ochlockonee, and Guyton	Vw	---	5.0	---	6.5
Pa. Pits-Arents					
Pt------------------------ Prentiss	IIw	25	5.0	9.0	9.0
Rn------------------------ Ruston	IIe	30	5.5	12.0	9.5
RS:					
Ruston--------------------	IIIe	---	5.5	12.0	9.5
Smithdale-----------------	IVe	---	5.0	9.0	8.0

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Map symbol and soil name	Land capability	Soybeans	Common bermudagrass	Improved bermudagrass	Bahiagrass
		Bu	AUM*	AUM*	AUM*
Sa------------------------ Savannah	IIe	25	6.0	11.0	9.0
Sm------------------------ Smithdale	VIe	---	4.5	---	7.0
St------------------------ Stough	IIw	25	5.5	10.5	8.0
Ta------------------------ Tangi	IIe	25	6.0	13.0	8.5
Tg------------------------ Tangi	IIIe	20	5.5	12.0	8.0
To------------------------ Toula	IIe	25	6.5	13.0	9.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Map symbol and soil name	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
Aa, Ab----------	11W	Slight	Moderate	Slight	Moderate	Loblolly pine-------	100	11	Loblolly pine, slash pine, longleaf pine, sweetgum.
Abita						Slash pine----------	95	12	
						Longleaf pine-------	---	---	
						Sweetgum------------	---	---	
						Southern red oak----	---	---	
						Water oak-----------	---	---	
BB--------------	4W	Slight	Severe	Severe	Severe	Baldcypress---------	80	4	Baldcypress.
Barbary						Water tupelo--------	60	6	
						Black willow--------	---	---	
Bq:									
Brimstone------	11T	Slight	Severe	Moderate	Severe	Slash pine----------	85	11	Slash pine, loblolly pine.
						Loblolly pine-------	80	8	
Guyton---------	9W	Slight	Severe	Moderate	Severe	Loblolly pine-------	90	9	Loblolly pine, sweetgum.
						Slash pine----------	90	11	
						Sweetgum------------	---	---	
						Green ash-----------	---	---	
						Southern red oak----	---	---	
						Water oak-----------	---	---	
Ca, Ch----------	9A	Slight	Slight	Slight	Slight	Loblolly pine-------	87	9	Loblolly pine, slash pine, yellow poplar, sweetgum.
Cahaba						Slash pine----------	91	12	
						Yellow poplar-------	---	---	
						Sweetgum------------	90	7	
Fu--------------	11W	Slight	Moderate	Slight	Severe	Slash pine----------	90	11	Loblolly pine, slash pine, sweetgum.
Fluker						Loblolly pine-------	90	9	
						Longleaf pine-------	---	---	
						Sweetgum------------	90	7	
						Southern red oak----	---	---	
						Green ash-----------	---	---	
						Water oak-----------	90	6	
Go, Gy----------	9W	Slight	Severe	Moderate	Severe	Loblolly pine-------	90	9	Loblolly pine, sweetgum, slash pine.
Guyton						Slash pine----------	90	11	
						Sweetgum------------	---	---	
						Green ash-----------	---	---	
						Southern red oak----	---	---	
						Water oak-----------	---	---	
Ma--------------	9A	Slight	Slight	Slight	Moderate	Loblolly pine-------	90	9	Loblolly pine, slash pine.
Malbis						Slash pine----------	90	11	
						Longleaf pine-------	80	7	
Mt, My----------	9W	Slight	Severe	Severe	Severe	Loblolly pine-------	88	9	Loblolly pine, slash pine, sweetgum.
Myatt						Slash pine----------	92	12	
						Sweetgum------------	92	8	
						Water oak-----------	86	6	
						Southern red oak----	---	---	
						White oak-----------	---	---	
						American sycamore---	---	---	
						Blackgum------------	---	---	
						Shumard oak---------	---	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordi-nation symbol	Management concerns: Erosion hazard	Equip-ment limita-tion	Seedling mortal-ity	Plant competi-tion	Potential productivity: Common trees	Site index	Produc-tivity class*	Trees to plant
OG:									
Ouachita-------	11W	Slight	Moderate	Severe	Slight	Loblolly pine-------	100	11	Loblolly pine, sweetgum, Nuttall oak, yellow poplar, American sycamore, eastern cottonwood.
						Sweetgum------------	100	10	
						Eastern cottonwood--	100	9	
Ochlockonee----	11W	Slight	Moderate	Severe	Slight	Loblolly pine-------	100	11	Loblolly pine, slash pine, sweetgum, eastern cottonwood.
						Slash pine----------	---	---	
						Eastern cottonwood--	---	---	
Guyton---------	9W	Slight	Severe	Severe	Severe	Loblolly pine-------	90	9	Loblolly pine, sweetgum.
						Slash pine----------	90	11	
						Sweetgum------------	---	---	
						Green ash-----------	---	---	
						Southern red oak----	---	---	
						Water oak-----------	---	---	
Pt-------------- Prentiss	9A	Slight	Slight	Slight	Slight	Loblolly pine-------	88	9	Loblolly pine, slash pine.
						Shortleaf pine------	79	9	
						Sweetgum------------	90	7	
						Cherrybark oak------	90	8	
						White oak-----------	80	4	
Rn-------------- Ruston	9A	Slight	Slight	Slight	Slight	Loblolly pine-------	91	9	Loblolly pine, slash pine, longleaf pine.
						Slash pine----------	91	12	
						Longleaf pine-------	76	6	
RS:									
Ruston---------	9A	Slight	Slight	Slight	Slight	Loblolly pine-------	91	9	Loblolly pine, slash pine, longleaf pine.
						Slash pine----------	91	12	
						Longleaf pine-------	76	6	
Smithdale------	9A	Slight	Slight	Slight	Slight	Loblolly pine-------	86	9	Loblolly pine, longleaf pine, slash pine.
						Longleaf pine-------	69	5	
						Slash pine----------	85	11	
Sa-------------- Savannah	9A	Slight	Slight	Slight	Moderate	Loblolly pine-------	88	9	Loblolly pine, slash pine, sweetgum, American sycamore, yellow poplar.
						Longleaf pine-------	78	7	
						Slash pine----------	88	11	
						Sweetgum------------	85	6	
Sm-------------- Smithdale	9R	Moderate	Moderate	Slight	Slight	Loblolly pine-------	86	9	Loblolly pine, longleaf pine, slash pine.
						Longleaf pine-------	69	5	
						Slash pine----------	85	11	
St-------------- Stough	9W	Slight	Moderate	Slight	Moderate	Loblolly pine-------	90	9	Loblolly pine, slash pine, sweetgum.
						Cherrybark oak------	85	7	
						Slash pine----------	86	11	
						Sweetgum------------	85	6	
						Water oak-----------	80	5	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordi-nation symbol	Management concerns: Erosion hazard	Equip-ment limita-tion	Seedling mortal-ity	Plant competi-tion	Potential productivity: Common trees	Site index	Produc-tivity class*	Trees to plant
Ta, Tg---------- Tangi	13A	Slight	Slight	Slight	Moderate	Slash pine----------	100	13	Loblolly pine, slash pine.
						Loblolly pine-------	109	12	
						Longleaf pine-------	---	---	
						Sweetgum------------	---	---	
						Southern red oak----	---	---	
						Green ash-----------	---	---	
To-------------- Toula	13A	Slight	Slight	Slight	Moderate	Slash pine----------	100	13	Loblolly pine, slash pine.
						Loblolly pine-------	101	11	
						Longleaf pine-------	74	6	
						Sweetgum------------	---	---	
						Southern red oak----	---	---	
						Green ash-----------	---	---	

* Productivity class is the yield in cubic meters per hectare per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The flooding limitation shown in this table is based on the period of flooding shown in the map unit]

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Aa: Abita	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
Ab: Abita	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
BB: Barbary	Severe: flooding, ponding, percs slowly.	Severe: ponding, excess humus, percs slowly.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
Bg:					
Brimstone	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Guyton	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Ca, Ch: Cahaba	Slight	Slight	Moderate: slope.	Slight	Slight.
Fu: Fluker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Go: Guyton	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Gy: Guyton	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
KE: Kenner	Severe: flooding, ponding, percs slowly.	Severe: ponding, excess humus, percs slowly.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: flooding, ponding, excess humus.
Ma: Malbis	Slight	Slight	Moderate: slope.	Slight	Slight.
MP: Maurepas	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
Mt: Myatt	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
My: Myatt	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
OG:					
Ouachita	Severe: flooding.	Moderate: flooding, percs slowly.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Ochlockonee	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Guyton	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Pa. Pits-Arents					
Pt Prentiss	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Moderate: droughty.
Rn Ruston	Slight	Slight	Moderate: slope.	Slight	Slight.
RS:					
Ruston	Slight	Slight	Moderate: slope.	Slight	Slight.
Smithdale	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Sa Savannah	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
Sm Smithdale	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
St Stough	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
Ta, Tg Tangi	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
To Toula	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly, slope.	Moderate: wetness.	Moderate: wetness.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Potential for habitat elements								Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Aa----------------- Abita	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Ab----------------- Abita	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
BB----------------- Barbary	Very poor.	Very poor.	Very poor.	Very poor.	---	Very poor.	Fair	Poor	Very poor.	Very poor.	Fair.
Bq: Brimstone----------	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Guyton------------	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Ca, Ch------------- Cahaba	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Fu----------------- Fluker	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Go----------------- Guyton	Fair	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Gy----------------- Guyton	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Poor	Fair	Good.
KE----------------- Kenner	Very poor.	Very poor.	Very poor.	---	---	---	Good	Very poor.	Very poor.	---	Good.
Ma----------------- Malbis	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
MP----------------- Maurepas	Very poor.	Very poor.	Very poor.	Very poor.	---	Very poor.	Fair	Very poor.	Very poor.	Very poor.	Fair.
Mt, My------------- Myatt	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
OG: Ouachita-----------	Poor	Fair	Fair	Good	Poor	Good	Good	Fair	Fair	Good	Fair.
Ochlockonee--------	Poor	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Guyton------------	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Poor	Fair	Good.
Pa. Pits-Arents											
Pt----------------- Prentiss	Fair	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Rn----------------- Ruston	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Map symbol and soil name	Potential for habitat elements								Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
RS:											
Ruston	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Smithdale	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sa: Savannah	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Sm: Smithdale	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
St: Stough	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Ta: Tangi	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Tg: Tangi	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
To: Toula	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation. The flooding limitation in this table is based on the period of flooding shown in the map unit]

Map symbol and soil name	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Aa, Ab: Abita	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: low strength.	Moderate: wetness.
BB: Barbary	Severe: excess humus, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding, excess humus.
Bg:					
Brimstone	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, low strength.	Severe: wetness.
Guyton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness.	Severe: wetness.
Ca: Cahaba	Slight	Slight	Slight	Slight	Slight.
Ch: Cahaba	Slight	Slight	Moderate: slope.	Slight	Slight.
Fu: Fluker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.	Severe: wetness.
Go: Guyton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness.	Severe: wetness.
Gy: Guyton	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
KE: Kenner	Severe: excess humus, ponding.	Severe: flooding, low strength, ponding.	Severe: flooding, low strength, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, excess humus.
Ma: Malbis	Moderate: wetness.	Slight	Moderate: slope.	Moderate: low strength.	Slight.
MP: Maurepas	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, low strength.	Severe: ponding, flooding, excess humus.
Mt: Myatt	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.
My: Myatt	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
OG:					
Ouachita----------	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
Ochlockonee-------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Guyton------------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
Pa. Pits-Arents					
Pt---------------- Prentiss	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: droughty.
Rn---------------- Ruston	Slight-----------	Slight-----------	Slight-----------	Moderate: low strength.	Slight.
RS:					
Ruston------------	Slight-----------	Slight-----------	Moderate: slope.	Moderate: low strength.	Slight.
Smithdale---------	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Sa---------------- Savannah	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Sm---------------- Smithdale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
St---------------- Stough	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
Ta---------------- Tangi	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: low strength.	Moderate: wetness.
Tg---------------- Tangi	Severe: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: low strength.	Moderate: wetness.
To---------------- Toula	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: low strength.	Moderate: wetness.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation. The flooding limitation in this table is based on the period of flooding shown in the map unit]

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Aa: Abita	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
Ab: Abita	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
BB: Barbary	Severe: flooding, ponding, percs slowly.	Severe: flooding, excess humus, ponding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, hard to pack, ponding.
Bg:					
Brimstone	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Guyton	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Ca, Ch: Cahaba	Slight	Severe: seepage.	Severe: seepage.	Slight	Fair: thin layer.
Fu: Fluker	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Severe: wetness.
Go: Guyton	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Gy: Guyton	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
KE: Kenner	Severe: flooding, percs slowly.	Severe: flooding, seepage, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
Ma: Malbis	Severe: wetness, percs slowly.	Moderate: slope.	Moderate: wetness.	Moderate: wetness.	Fair: wetness.
MP: Maurepas	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.
Mt: Myatt	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
My----------------- Myatt	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
OG: Ouachita-----------	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding, seepage.	Severe: flooding.	Fair: too clayey.
Ochlockonee--------	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Fair: wetness.
Guyton-------------	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Pa. Pits-Arents					
Pt----------------- Prentiss	Severe: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Fair: wetness.
Rn----------------- Ruston	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
RS: Ruston-------------	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Smithdale----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too clayey, slope.
Sa----------------- Savannah	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
Sm----------------- Smithdale	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
St----------------- Stough	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Ta, Tq------------- Tangi	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness, thin layer.
To----------------- Toula	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
Aa, Ab Abita	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
BB Barbary	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Bg:				
Brimstone	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Guyton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Ca, Ch Cahaba	Good	Probable	Improbable: excess fines.	Fair: small stones.
Fu Fluker	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Go, Gy Guyton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
KE Kenner	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Ma Malbis	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
MP Maurepas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Mt, My Myatt	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
OG:				
Ouachita	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ochlockonee	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Guyton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Pa. Pits-Arents				

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
Pt-------------------- Prentiss	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Rn-------------------- Ruston	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
RS:				
Ruston---------------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Smithdale------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Sa-------------------- Savannah	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sm-------------------- Smithdale	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
St-------------------- Stough	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ta, Tg--------------- Tangi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim.
To-------------------- Toula	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation. The flooding limitation in this table is based on the period of flooding shown in the map unit]

Map symbol and soil name	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
Aa-Abita	Slight	Moderate: wetness, piping.	Severe: no water.	Percs slowly	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Ab-Abita	Moderate: slope.	Moderate: wetness, piping.	Severe: no water.	Slope, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
BB-Barbary	Slight	Severe: excess humus, hard to pack, ponding.	Severe: slow refill.	Ponding, percs slowly, flooding.	Ponding, percs slowly.	Wetness, percs slowly.
Bg:						
Brimstone	Slight	Severe: wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, percs slowly.	Wetness, percs slowly, erodes easily.
Guyton	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Ca-Cahaba	Moderate: seepage.	Moderate: thin layer, piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Ch-Cahaba	Moderate: seepage, slope.	Moderate: thin layer, piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Fu-Fluker	Slight	Severe: wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, rooting depth.	Wetness, erodes easily, rooting depth.
Go-Guyton	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, rooting depth.	Wetness, erodes easily, rooting depth.
Gy-Guyton	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, flooding.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
KE-Kenner	Severe: seepage.	Severe: excess humus, ponding.	Slight	Ponding, percs slowly, flooding, subsides.	Ponding	Wetness, percs slowly.
Ma-Malbis	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
MP-Maurepas	Severe: seepage.	Severe: excess humus, ponding.	Slight	Ponding, flooding, subsides.	Ponding	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
Mt: Myatt	Moderate: seepage.	Severe: piping, wetness.	Severe: slow refill.	Favorable	Wetness	Wetness.
My: Myatt	Moderate: seepage.	Severe: piping, wetness.	Severe: slow refill.	Flooding	Wetness	Wetness.
OG:						
Ouachita	Slight	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Percs slowly.
Ochlockonee	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Favorable	Favorable.
Guyton	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, flooding.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Pa. Pits-Arents						
Pt: Prentiss	Moderate: seepage.	Severe: piping.	Severe: no water.	Favorable	Wetness, rooting depth.	Droughty, rooting depth.
Rn: Ruston	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
RS:						
Ruston	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Smithdale	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
Sa: Savannah	Moderate: seepage.	Severe: piping.	Severe: no water.	Favorable	Erodes easily, wetness, rooting depth.	Erodes easily, rooting depth.
Sm: Smithdale	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
St: Stough	Slight	Moderate: piping, wetness.	Severe: no water.	Favorable	Erodes easily, wetness.	Wetness, erodes easily, droughty.
Ta: Tangi	Moderate: seepage.	Moderate: piping, wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, rooting depth.	Erodes easily, percs slowly, rooting depth.
Tg: Tangi	Moderate: slope, seepage.	Moderate: piping, wetness.	Severe: no water.	Percs slowly	Erodes easily, wetness, rooting depth.	Erodes easily, percs slowly, rooting depth.
To: Toula	Moderate: seepage.	Moderate: wetness, piping.	Severe: no water.	Percs slowly	Erodes easily, wetness, rooting depth.	Erodes easily, percs slowly, rooting depth.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated. Some soils may have Unified classifications and USDA textures in addition to those shown. In general, the dominant classifications and textures are shown]

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
Aa------------- Abita	0-5	Silt loam--------	ML, CL-ML	A-4	100	100	90-100	70-90	<30	NP-7
	5-34	Silt loam, silty clay loam.	ML, CL-ML, CL	A-4, A-6	100	100	95-100	80-95	20-40	4-20
	34-45	Clay loam, loam, silty clay loam.	CL, CH	A-6, A-7-6	100	100	95-100	80-95	35-55	20-35
	45-64	Clay loam, silty clay loam, loam.	CL	A-6, A-7-6	100	100	95-100	80-95	30-50	15-30
Ab------------- Abita	0-10	Silt loam--------	ML, CL-ML	A-4	100	100	90-100	70-90	<30	NP-7
	10-21	Silt loam, silty clay loam.	ML, CL-ML, CL	A-4, A-6	100	100	95-100	80-95	20-40	4-20
	21-60	Clay loam, loam, silty clay loam.	CL, CH	A-6, A-7-6	100	100	95-100	80-95	35-55	20-35
BB------------- Barbary	0-4	Muck------------	PT	A-8	---	---	---	---	---	---
	4-70	Mucky clay, clay	OH, MH	A-7-5, A-8	100	100	100	95-100	70-90	35-45
Bg:										
Brimstone-------	0-21	Silt loam--------	CL-ML, CL	A-4, A-6	100	100	90-100	70-90	16-38	6-17
	21-32	Silt loam, silty clay loam.	CL	A-6, A-7-6	100	100	95-100	80-95	26-48	11-33
	32-60	Silty clay loam, silt loam.	CL	A-6, A-7-6	100	100	95-100	80-95	26-48	11-33
Guyton----------	0-17	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	65-90	<27	NP-7
	17-54	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-4	100	100	94-100	75-95	22-40	6-18
	54-65	Silt loam, silty clay loam, sandy clay loam.	CL, CL-ML, ML	A-6, A-4	100	100	95-100	50-95	<40	NP-18
Ca------------- Cahaba	0-6	Fine sandy loam	SM	A-4, A-2-4	95-100	95-100	65-90	30-45	---	NP
	6-34	Sandy clay loam, loam, clay loam.	SC, CL	A-4, A-6	90-100	80-100	75-90	40-75	22-35	8-15
	34-65	Sand, loamy fine sand, sandy loam.	SM, SP-SM	A-2-4	95-100	90-100	60-85	10-35	---	NP
Ch------------- Cahaba	0-4	Fine sandy loam	SM	A-4, A-2-4	95-100	95-100	65-90	30-45	---	NP
	4-48	Sandy clay loam, loam, clay loam.	SC, CL	A-4, A-6	90-100	80-100	75-90	40-75	22-35	8-15
	48-60	Sand, loamy sand, sandy loam.	SM, SP-SM	A-2-4	95-100	90-100	60-85	10-35	---	NP
Fu------------- Fluker	0-8	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	70-95	<25	NP-7
	8-13	Silt loam--------	CL, CL-ML	A-4, A-6	100	100	95-100	80-95	17-30	6-19
	13-31	Silt loam, silty clay loam.	CL	A-6	100	100	95-100	80-95	20-40	11-22
	31-70	Loam, silt loam, fine sandy loam.	ML, CL, SM-SC	A-4, A-6	100	100	70-90	36-75	16-30	3-14

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
Go------------- Guyton	0-27	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	65-90	<27	NP-7
	27-41	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-4	100	100	94-100	75-95	22-40	6-18
	41-70	Silt loam, silty clay loam, sandy clay loam.	CL, CL-ML, ML	A-6, A-4	100	100	95-100	50-95	<40	NP-18
Gy------------- Guyton	0-19	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	65-90	<27	NP-7
	19-30	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-4	100	100	94-100	75-95	22-40	6-18
	30-60	Silt loam, silty clay loam, sandy clay loam.	CL, CL-ML, ML	A-6, A-4	100	100	95-100	50-95	<40	NP-18
KE------------- Kenner	0-12	Muck-------------	PT	A-8	---	---	---	---	---	---
	12-13	Clay, silty clay, mucky clay.	MH, OH	A-7-5	100	100	100	95-100	70-100	30-55
	13-47	Muck-------------	PT	A-8	---	---	---	---	---	---
	47-49	Clay, silty clay, mucky clay.	MH, OH	A-7-5	100	100	100	95-100	70-100	30-55
	49-84	Muck-------------	PT	A-8	---	---	---	---	---	---
Ma------------- Malbis	0-8	Fine sandy loam	SM, ML	A-4	100	97-100	92-97	40-62	<30	NP-5
	8-28	Loam, sandy clay loam, clay loam.	CL-ML, CL	A-4, A-6	99-100	95-100	91-100	55-70	25-35	5-11
	28-60	Sandy clay loam, clay loam.	ML, CL	A-4, A-5, A-6, A-7	98-100	96-100	90-100	56-80	30-49	4-15
MP------------- Maurepas	0-84	Muck-------------	PT	A-8	---	---	---	---	---	---
Mt------------- Myatt	0-12	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	95-100	95-100	60-90	30-70	<25	NP-5
	12-56	Loam, sandy clay loam, clay loam.	SM, SC, ML, CL	A-4	95-100	95-100	80-100	40-80	<30	NP-10
	56-70	Gravelly fine sandy loam, sandy clay loam, clay loam.	SM-SC, SC, CL-ML, CL	A-6, A-4, A-2	75-100	60-90	60-80	30-70	15-40	5-20
My------------- Myatt	0-10	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	95-100	95-100	60-90	30-70	<25	NP-5
	10-50	Loam, sandy clay loam, clay loam.	SM, SC, ML, CL	A-4	95-100	95-100	80-100	40-80	<30	NP-10
	50-70	Gravelly fine sandy loam, sandy clay loam, loam.	SM-SC, SC, CL-ML, CL	A-6, A-4, A-2	75-100	60-90	60-80	30-70	15-40	5-20
OG:										
Ouachita--------	0-5	Silt loam--------	ML, CL, CL-ML	A-4, A-6	100	100	85-100	75-95	<30	NP-12
	5-49	Silt loam, loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6	100	100	85-100	80-100	25-40	5-20
	49-70	Fine sandy loam, silt loam, loamy fine sand.	SM, ML, CL-ML, SM-SC	A-4, A-2	100	100	50-95	20-75	<30	NP-5

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
OG:										
Ochlockonee-----	0-6	Sandy loam-------	SM, ML, SM-SC, CL-ML	A-4, A-2	100	95-100	65-90	40-70	<26	NP-5
	6-32	Fine sandy loam, sandy loam, silt loam.	SM, ML, SC, CL	A-4	100	95-100	95-100	36-75	<32	NP-9
	32-60	Loamy fine sand, sandy loam, silt loam.	SM, ML, CL, SC	A-4, A-2	100	95-100	85-99	13-80	<32	NP-9
Guyton----------	0-27	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	65-90	<27	NP-7
	27-60	Silt loam, silty clay loam, clay loam.	CL, CL-ML	A-6, A-4	100	100	94-100	75-95	22-40	6-18
Pa. Pits-Arents										
Pt--------------- Prentiss	0-5	Fine sandy loam	SC, SM-SC, SM	A-4	100	100	65-85	36-50	<30	NP-10
	5-26	Loam, sandy loam, fine sandy loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	100	100	70-100	40-75	20-35	4-12
	26-65	Loam, sandy loam, fine sandy loam.	CL-ML, CL, SC, SM-SC	A-6, A-4	100	100	70-100	40-75	20-35	4-12
Rn--------------- Ruston	0-11	Fine sandy loam	SM, ML	A-4, A-2-4	85-100	78-100	65-100	30-75	<20	NP-3
	11-40	Sandy clay loam, loam, clay loam.	SC, CL	A-6	85-100	78-100	70-100	36-75	30-40	11-20
	40-45	Fine sandy loam, sandy loam, loamy sand.	SM, ML, CL-ML, SM-SC	A-4, A-2-4	85-100	78-100	65-100	30-75	<27	NP-7
	45-70	Sandy clay loam, loam, clay loam.	SC, CL	A-6	85-100	78-100	70-100	36-75	30-42	11-20
RS:										
Ruston----------	0-9	Fine sandy loam	SM, ML	A-4, A-2-4	85-100	78-100	65-100	30-75	<20	NP-3
	9-37	Sandy clay loam, loam, clay loam.	SC, CL	A-6	85-100	78-100	70-100	36-75	30-40	11-20
	37-46	Fine sandy loam, sandy loam, loamy sand.	SM, ML, CL-ML, SM-SC	A-4, A-2-4	85-100	78-100	65-100	30-75	<27	NP-7
	46-83	Sandy clay loam, loam, clay loam.	SC, CL	A-6	85-100	78-100	70-100	36-75	30-42	11-20
Smithdale-------	0-8	Fine sandy loam	SM, SM-SC	A-4, A-2	100	85-100	60-95	28-49	<20	NP-5
	8-48	Clay loam, sandy clay loam, loam.	SM-SC, SC, CL, CL-ML	A-6, A-4	100	85-100	80-96	45-75	23-38	7-16
	48-65	Loam, sandy loam	SM, ML, CL, SC	A-4	100	85-100	65-95	36-70	<30	NP-10
Sa--------------- Savannah	0-17	Silt loam--------	ML, CL-ML	A-4	100	90-100	80-100	60-90	<25	NP-7
	17-25	Sandy clay loam, clay loam, loam.	CL, SC, CL-ML	A-4, A-6	98-100	90-100	80-100	40-80	23-40	7-19
	25-61	Loam, clay loam, sandy loam.	CL, SC, CL-ML	A-4, A-6, A-7	94-100	90-100	60-100	30-80	23-43	7-19
Sm--------------- Smithdale	0-4	Fine sandy loam	SM, SM-SC	A-4, A-2	100	85-100	60-95	28-49	<20	NP-5
	4-42	Clay loam, sandy clay loam, loam.	SM-SC, SC, CL, CL-ML	A-6, A-4	100	85-100	80-96	45-75	23-38	7-16
	42-60	Loam, sandy loam	SM, ML, CL, SC	A-4	100	85-100	65-95	36-70	<30	NP-10

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
St---------------- Stough	0-6	Fine sandy loam	SM-SC, SM, ML, CL-ML	A-4	100	100	65-85	35-65	<25	NP-7
	6-40	Loam, fine sandy loam, sandy clay loam.	ML, CL, CL-ML	A-4	100	100	75-95	50-75	<25	NP-8
	40-70	Sandy loam, sandy clay loam, loam.	SC, CL	A-4, A-6	100	100	65-90	40-65	25-40	8-15
Ta---------------- Tangi	0-4	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	80-95	<30	NP-7
	4-25	Silt loam, silty clay loam.	CL	A-4, A-6	100	100	95-100	80-95	20-35	8-18
	25-48	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-7-6	100	100	80-95	40-80	17-40	11-27
	48-65	Clay, clay loam, sandy clay.	CL, CH, SC	A-7-6	100	100	85-95	45-85	41-70	16-40
Tg---------------- Tangi	0-3	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	80-95	<30	NP-7
	3-24	Silt loam, silty clay loam.	CL	A-4, A-6	100	100	95-100	80-95	20-35	8-18
	24-70	Clay, sandy clay loam, loam.	CL, SC, CH	A-6, A-7-6	100	100	80-95	40-80	17-70	11-40
To---------------- Toula	0-5	Silt loam--------	ML, CL-ML	A-4	100	100	95-100	80-95	<30	NP-7
	5-19	Silt loam, silty clay loam.	CL	A-4, A-6	100	100	95-100	80-95	20-35	8-18
	19-24	Silt loam, silty clay loam.	CL	A-6	100	100	85-100	75-95	25-40	11-20
	24-48	Silt loam, silty clay loam, clay loam.	CL	A-6	100	100	80-100	65-80	25-40	11-20
	48-65	Silt loam, silty clay loam, clay loam.	CL	A-4, A-6	100	100	80-100	65-80	20-40	8-20

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
Aa---------------- Abita	0-5	2-12	1.35-1.65	0.6-2.0	0.16-0.23	3.6-7.3	Low-----------	0.49	5	.5-2
	5-34	12-32	1.35-1.65	0.2-0.6	0.19-0.21	3.6-7.3	Low-----------	0.43		
	34-45	20-45	1.35-1.70	0.06-0.2	0.15-0.18	4.5-6.5	Moderate-----	0.37		
	45-64	20-40	1.35-1.70	0.06-0.2	0.15-0.18	5.1-7.8	Moderate-----	0.37		
Ab---------------- Abita	0-10	2-12	1.35-1.65	0.6-2.0	0.16-0.23	3.6-7.3	Low-----------	0.49	5	.5-2
	10-21	12-32	1.35-1.65	0.2-0.6	0.19-0.21	3.6-7.3	Low-----------	0.43		
	21-60	20-45	1.35-1.70	0.06-0.2	0.15-0.18	4.5-6.5	Moderate-----	0.37		
BB---------------- Barbary	0-4	45-90	0.15-0.50	2.0-6.0	0.20-0.50	5.6-7.8	Low-----------	----	---	---
	4-70	60-95	0.60-1.50	<0.06	0.18-0.20	6.6-8.4	Low-----------	0.32		
Bg:										
Brimstone--------	0-21	5-14	1.35-1.65	0.6-2.0	0.13-0.20	4.5-8.4	Low-----------	0.49	3	.5-2
	21-32	17-32	1.35-1.70	0.06-0.2	0.10-0.16	5.6-8.4	Moderate-----	0.43		
	32-60	20-35	1.35-1.70	0.06-0.2	0.10-0.16	6.6-8.4	Moderate-----	0.43		
Guyton-----------	0-17	7-25	1.35-1.65	0.6-2.0	0.20-0.23	3.6-6.0	Low-----------	0.43	5	---
	17-54	20-35	1.35-1.70	0.06-0.2	0.15-0.22	3.6-6.5	Low-----------	0.37		
	54-65	20-35	1.35-1.70	0.06-2.0	0.15-0.22	3.6-8.4	Low-----------	0.37		
Ca---------------- Cahaba	0-6	7-17	1.35-1.60	2.0-6.0	0.10-0.14	4.5-6.0	Low-----------	0.24	5	.5-3
	6-34	18-35	1.35-1.60	0.6-2.0	0.12-0.15	4.5-6.0	Low-----------	0.28		
	34-65	4-20	1.40-1.70	2.0-20	0.05-0.10	4.5-6.0	Low-----------	0.24		
Ch---------------- Cahaba	0-4	7-17	1.35-1.60	2.0-6.0	0.10-0.14	4.5-6.0	Low-----------	0.24	5	.5-3
	4-48	18-35	1.35-1.60	0.6-2.0	0.12-0.15	4.5-6.0	Low-----------	0.28		
	48-60	4-20	1.40-1.70	2.0-20	0.05-0.10	4.5-6.0	Low-----------	0.24		
Fu---------------- Fluker	0-8	2-12	1.35-1.65	0.6-2.0	0.14-0.24	3.6-6.0	Low-----------	0.49	3	.5-4
	8-13	6-18	1.35-1.65	0.6-2.0	0.20-0.24	3.6-6.0	Low-----------	0.49		
	13-31	18-33	1.35-1.65	0.6-2.0	0.20-0.24	3.6-6.0	Low-----------	0.43		
	31-70	6-22	1.45-1.90	0.06-0.2	0.01-0.10	3.6-6.0	Low-----------	0.32		
Go---------------- Guyton	0-27	7-25	1.35-1.65	0.6-2.0	0.20-0.23	3.6-6.0	Low-----------	0.43	5	<2
	27-41	20-35	1.35-1.70	0.06-0.2	0.15-0.22	3.6-6.5	Low-----------	0.37		
	41-70	20-35	1.35-1.70	0.06-2.0	0.15-0.22	3.6-8.4	Low-----------	0.37		
Gy---------------- Guyton	0-18	7-25	1.35-1.65	0.6-2.0	0.20-0.23	3.6-6.0	Low-----------	0.43	5	<2
	18-30	20-35	1.35-1.70	0.06-0.2	0.15-0.22	3.6-6.5	Low-----------	0.37		
	30-60	20-35	1.35-1.70	0.06-2.0	0.15-0.22	3.6-8.4	Low-----------	0.37		
KE---------------- Kenner	0-12	---	0.05-0.25	6.0-20	0.20-0.50	5.6-7.8	Low-----------	----	---	---
	12-13	45-85	0.15-1.00	<0.06	0.12-0.18	5.6-7.8	Low-----------	0.32		
	13-47	---	0.05-0.50	6.0-20	0.20-0.50	5.6-7.8	Low-----------	----		
	47-49	45-85	0.15-1.00	<0.06	0.12-0.18	5.6-7.8	Low-----------	0.32		
	49-84	---	0.05-0.50	6.0-20	0.20-0.50	5.6-7.8	Low-----------	----		
Ma---------------- Malbis	0-8	10-25	1.30-1.60	0.6-2.0	0.10-0.15	4.5-6.5	Low-----------	0.24	5	.5-2
	8-28	18-33	1.30-1.70	0.6-2.0	0.12-0.20	4.5-5.5	Low-----------	0.28		
	28-84	20-35	1.45-1.70	0.2-0.6	0.06-0.12	4.5-5.5	Low-----------	0.28		
MP---------------- Maurepas	0-84	---	0.05-0.25	6.0-20	0.20-0.50	5.6-8.4	Low-----------	----	---	---
Mt---------------- Myatt	0-12	7-20	1.30-1.60	0.6-2.0	0.11-0.20	3.6-5.5	Low-----------	0.28	5	.5-4
	12-50	18-35	1.30-1.50	0.2-2.0	0.12-0.20	3.6-5.5	Low-----------	0.28		
	50-70	7-30	1.30-1.50	0.2-2.0	0.10-0.20	3.6-5.5	Low-----------	0.24		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Organic matter
								K	T	
	In	Pct	G/cc	In/hr	In/in	pH				Pct
My---------------- Myatt	0-10	7-20	1.30-1.60	0.6-2.0	0.11-0.20	3.6-5.5	Low-----------	0.28	5	.5-4
	10-50	18-35	1.30-1.50	0.2-2.0	0.12-0.20	3.6-5.5	Low-----------	0.28		
	50-70	7-30	1.30-1.50	0.2-2.0	0.10-0.20	3.6-5.5	Low-----------	0.24		
OG:										
Ouachita---------	0-5	8-25	1.25-1.60	0.6-2.0	0.15-0.24	3.6-5.5	Low-----------	0.37	5	1-3
	5-49	18-35	1.25-1.60	0.2-0.6	0.15-0.24	3.6-5.5	Low-----------	0.32		
	49-70	15-30	1.25-1.65	0.6-6.0	0.07-0.24	4.5-5.5	Low-----------	0.24		
Ochlockonee------	0-6	3-18	1.40-1.60	2.0-6.0	0.07-0.14	3.6-5.5	Low-----------	0.20	5	.5-2
	6-32	8-18	1.40-1.60	0.6-2.0	0.10-0.20	3.6-5.5	Low-----------	0.20		
	32-60	3-18	1.40-1.70	2.0-6.0	0.06-0.12	3.6-5.5	Low-----------	0.17		
Guyton-----------	0-27	7-25	1.35-1.65	0.6-2.0	0.20-0.23	3.6-6.0	Low-----------	0.43	5	<2
	27-60	20-35	1.35-1.70	0.06-0.2	0.15-0.22	3.6-8.4	Low-----------	0.37		
Pa. Pits-Arents										
Pt---------------- Prentiss	0-5	5-18	1.50-1.60	0.6-2.0	0.12-0.16	3.6-5.5	Low-----------	0.28	3	1-3
	5-26	5-18	1.50-1.60	0.6-2.0	0.12-0.16	3.6-5.5	Low-----------	0.24		
	26-65	10-20	1.65-1.75	0.2-0.6	0.06-0.09	4.5-5.5	Low-----------	0.24		
Rn---------------- Ruston	0-11	5-20	1.30-1.70	0.6-2.0	0.09-0.16	4.5-6.5	Low-----------	0.28	5	.5-2
	11-40	18-35	1.40-1.70	0.6-2.0	0.12-0.17	4.5-6.0	Low-----------	0.28		
	40-45	10-20	1.30-1.70	0.6-2.0	0.12-0.15	4.5-6.0	Low-----------	0.32		
	45-70	15-38	1.40-1.70	0.6-2.0	0.12-0.17	4.5-6.0	Low-----------	0.28		
RS:										
Ruston-----------	0-9	5-20	1.30-1.70	0.6-2.0	0.09-0.16	4.5-6.5	Low-----------	0.28	5	.5-2
	9-37	18-35	1.40-1.70	0.6-2.0	0.12-0.17	4.5-6.0	Low-----------	0.28		
	37-46	10-20	1.30-1.70	0.6-2.0	0.12-0.15	4.5-6.0	Low-----------	0.32		
	46-83	15-38	1.40-1.70	0.6-2.0	0.12-0.17	4.5-6.0	Low-----------	0.28		
Smithdale--------	0-8	2-15	1.40-1.50	2.0-6.0	0.14-0.16	4.5-5.5	Low-----------	0.28	5	.5-2
	8-48	18-33	1.40-1.55	0.6-2.0	0.15-0.17	4.5-5.5	Low-----------	0.24		
	48-65	12-27	1.40-1.55	2.0-6.0	0.14-0.16	4.5-5.5	Low-----------	0.28		
Sa---------------- Savannah	0-17	3-16	1.45-1.65	0.6-2.0	0.16-0.20	3.6-5.5	Low-----------	0.37	3	.5-3
	17-25	18-32	1.55-1.75	0.6-2.0	0.13-0.20	3.6-5.5	Low-----------	0.28		
	25-61	18-32	1.60-1.80	0.2-0.6	0.05-0.10	3.6-5.5	Low-----------	0.24		
Sm---------------- Smithdale	0-4	2-15	1.40-1.50	2.0-6.0	0.14-0.16	4.5-5.5	Low-----------	0.28	5	.5-2
	4-42	18-33	1.40-1.55	0.6-2.0	0.15-0.17	4.5-5.5	Low-----------	0.24		
	42-60	12-27	1.40-1.55	2.0-6.0	0.14-0.16	4.5-5.5	Low-----------	0.28		
St---------------- Stough	0-6	5-15	1.40-1.55	0.6-2.0	0.12-0.18	3.6-5.5	Low-----------	0.28	3	---
	6-40	8-18	1.45-1.60	0.2-0.6	0.07-0.11	4.5-5.5	Low-----------	0.37		
	40-70	5-27	1.55-1.65	0.2-0.6	0.07-0.11	4.5-5.5	Low-----------	0.37		
Ta---------------- Tangi	0-4	2-12	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.49	3	.5-4
	4-25	18-30	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.43		
	25-48	20-35	1.45-1.85	0.06-0.2	0.08-0.14	4.5-6.0	Low-----------	0.32		
	48-65	35-55	1.40-1.80	<0.06	0.08-0.14	4.5-6.0	Moderate-----	0.28		
Tg---------------- Tangi	0-3	2-12	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.49	3	.5-4
	3-24	18-30	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.43		
	24-70	35-55	1.40-1.80	<0.06	0.08-0.14	4.5-6.0	Moderate-----	0.28		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
To----------------	0-5	2-12	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.49	3	.5-4
Toula	5-19	12-30	1.35-1.65	0.6-2.0	0.20-0.24	4.5-6.0	Low-----------	0.43		
	19-24	18-35	1.45-1.85	0.06-0.2	0.08-0.14	4.5-6.0	Low-----------	0.37		
	24-48	18-35	1.45-1.85	0.06-0.2	0.08-0.12	4.5-6.0	Low-----------	0.37		
	48-65	12-35	1.35-1.65	0.6-2.0	0.18-0.22	4.5-6.0	Low-----------	0.37		

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated. The flooding frequencies shown in this table are for the period June through November]

Map symbol and soil name	Hydro-logic group	Flooding			High water table			Subsidence		Risk of corrosion	
		Frequency	Dura-tion	Months	Depth	Kind	Months	Initial	Total	Uncoated steel	Concrete
					Ft			In	In		
Aa, Ab--------- Abita	C	None-------	---	---	1.5-3.0	Apparent	Dec-Apr	---	---	High-----	Moderate.
BB------------- Barbary	D	Frequent---	Very long.	Jan-Dec	+1-0.5	Apparent	Jan-Dec	3-12	6-15	High-----	Moderate.
Bq:											
Brimstone-----	D	Rare-------	---	---	0-1.5	Perched	Dec-Apr	---	---	High-----	Low.
Guyton--------	D	Rare-------	---	---	0-1.5	Perched	Dec-May	---	---	High-----	Moderate.
Ca, Ch--------- Cahaba	B	None-------	---	---	>6.0	---	---	---	---	Moderate	Moderate.
Fu------------- Fluker	C	None-------	---	---	0.5-1.5	Perched	Dec-Apr	---	---	High-----	High.
Go------------- Guyton	D	Rare-------	---	---	0-1.5	Perched	Dec-May	---	---	High-----	Moderate.
Gy------------- Guyton	D	Occasional	Very brief to long.	Jan-Dec	0-1.5	Perched	Dec-May	---	---	High-----	Moderate.
KE------------- Kenner	D	Frequent---	Very long.	Jan-Dec	+1-0.5	Apparent	Jan-Dec	15-30	>51	High-----	Moderate.
Ma------------- Malbis	B	None-------	---	---	2.5-4.0	Perched	Dec-Mar	---	---	Moderate	Moderate.
MP------------- Maurepas	D	Frequent---	Very long.	Jan-Dec	+1-0.5	Apparent	Jan-Dec	15-30	>51	High-----	Moderate.
Mt------------- Myatt	D	Rare-------	---	---	0-1.0	Apparent	Nov-Apr	---	---	High-----	High.
My------------- Myatt	D	Occasional	Brief	Nov-Mar	0-1.0	Apparent	Nov-Apr	---	---	High-----	High.
OG:											
Ouachita------	C	Frequent---	Brief to long.	Dec-May	>6.0	---	---	---	---	Moderate	Moderate.
Ochlockonee---	B	Frequent---	Brief to long.	Dec-Apr	3.0-5.0	Apparent	Dec-Apr	---	---	Low------	High.
Guyton--------	D	Frequent---	Brief to long.	Jan-Dec	0-1.5	Perched	Dec-May	---	---	High-----	Moderate.
Pa. Pits-Arents											
Pt------------- Prentiss	C	None-------	---	---	2.0-2.5	Perched	Jan-Mar	---	---	Moderate	High.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Map symbol and soil name	Hydro-logic group	Flooding			High water table			Subsidence		Risk of corrosion	
		Frequency	Dura-tion	Months	Depth	Kind	Months	Initial	Total	Uncoated steel	Concrete
					Ft			In	In		
Rn------------- Ruston	B	None-------	---	---	>6.0	---	---	---	---	Moderate	Moderate.
RS:											
Ruston--------	B	None-------	---	---	>6.0	---	---	---	---	Moderate	Moderate.
Smithdale-----	B	None-------	---	---	>6.0	---	---	---	---	Low------	Moderate.
Sa------------- Savannah	C	None-------	---	---	1.5-3.0	Perched	Jan-Mar	---	---	Moderate	High.
Sm------------- Smithdale	B	None-------	---	---	>6.0	---	---	---	---	Low------	Moderate.
St------------- Stough	C	None-------	---	---	1.0-1.5	Perched	Jan-Apr	---	---	Moderate	High.
Ta, Tg--------- Tangi	C	None-------	---	---	1.5-3.0	Perched	Dec-Apr	---	---	Moderate	Moderate.
To------------- Toula	C	None-------	---	---	1.5-3.0	Perched	Dec-Apr	---	---	Moderate	Moderate.

TABLE 17.--FERTILITY TEST DATA FOR SELECTED SOILS

[Analyses by the Soil Fertility Laboratory, Louisiana Agricultural Experiment Station]

Soil name and sample number	Depth	Horizon	pH 1:1 H_2O	Organic matter	Extractable phosphorus	Exchangeable cations: Ca	Mg	K	Na	Al	H	Total acidity	Cation-exchange capacity (sum)	Base saturation	Saturation: Effective cation-exchange capacity Al	Sum of cation-exchange capacity Na
	In			Pct	Ppm	Meq/100g								Pct	Pct	Pct
Abita silt																
loam: 2/	0-5	A	5.2	0.90	18	1.1	0.4	0.0	0.1	0.8	0.3	5.3	6.9	23.2	29.6	1.4
(S82LĀ105-6)	5-9	B/E	5.3	0.28	5	2.5	1.1	0.0	0.2	3.2	0.3	6.7	10.5	36.2	43.8	1.9
	9-19	Bt1	5.7	0.10	5	3.2	3.5	0.1	0.7	7.0	0.3	12.9	20.4	36.8	47.6	3.4
	19-34	Bt2	5.7	0.01	5	4.3	5.1	0.1	1.1	2.2	0.0	4.8	15.4	68.8	17.2	7.1
	34-52	Btg1	6.1	0.01	5	7.9	8.5	0.1	2.0	0.0	0.0	2.0	20.5	90.2	0.0	9.8
	52-84	Btg2	6.9	0.00	5	11.7	10.6	0.2	2.4	0.0	0.2	2.0	26.9	92.6	0.0	8.9
Abita silt																
loam: 3/	0-5	A	5.4	2.00	5	2.4	0.6	0.1	0.2	0.6	0.2	7.2	10.5	31.4	14.6	1.9
(S82LĀ105-7)	5-10	B/E	5.4	0.28	5	2.0	0.9	0.0	0.2	2.3	0.3	5.3	8.4	36.9	40.4	2.4
	10-18	Bt	5.4	0.28	5	2.7	1.7	0.1	0.3	5.2	0.1	11.1	15.9	30.2	51.5	1.9
	18-28	Btg1	5.6	0.19	5	3.4	2.1	0.1	0.4	7.0	0.3	15.9	21.9	27.4	52.6	1.8
	28-45	Btg2	5.6	0.01	5	4.3	2.4	0.1	0.5	4.1	0.3	6.7	14.0	52.1	36.0	3.6
	45-60	Btg3	5.6	0.01	5	8.6	4.5	0.1	0.6	2.1	0.1	6.7	22.5	70.2	11.7	2.7
Cahaba fine sandy																
loam: 1/	0-6	Ap	5.0	2.22	104	2.2	0.7	0.3	0.0	0.5	0.2	8.7	11.9	26.9	12.8	0.0
(S84LĀ105-10)	6-25	Bt1	5.3	0.28	6	4.1	0.8	0.2	0.1	0.2	0.2	4.2	9.4	55.3	3.6	1.1
	25-34	Bt2	4.7	0.06	5	1.1	1.0	0.1	0.0	1.6	0.6	4.9	7.1	31.0	36.4	0.0
	34-41	BC	4.7	0.10	5	0.7	0.9	0.1	0.1	0.7	0.7	3.8	5.6	32.1	21.9	1.8
	41-65	C	4.5	0.02	5	0.4	0.4	0.0	0.0	0.4	0.1	0.8	1.6	50.0	30.8	0.0
Fluker silt																
loam: 4/	0-5	A	4.1	1.15	4	0.4	1.7	4.0	0.4	3.0	0.1	12.5	15.4	18.7	50.2	2.9
(S82LĀ105-19)	5-10	Bw	4.4	0.29	4	0.3	2.2	0.2	0.4	3.2	0.1	7.2	10.3	30.2	49.8	4.3
	10-23	Bt	4.6	0.19	4	0.1	6.5	0.2	0.6	4.6	0.2	10.2	17.6	42.2	37.6	3.6
	23-30	Btx1	5.0	0.07	4	0.2	12.7	0.4	1.1	6.7	0.1	15.1	29.5	48.7	31.7	3.7
	30-40	Btx2	4.9	0.03	4	0.1	10.2	0.4	1.0	4.8	0.1	11.2	22.9	51.1	28.9	4.3
	40-60	2Btx3	5.0	0.03	4	0.1	7.5	0.1	0.8	3.0	0.4	7.7	16.3	52.6	25.1	5.0
Fluker silt																
loam: 5/	0-6	A	5.6	2.67	244	4.4	2.4	0.9	0.1	0.0	0.2	0.5	8.3	94.0	0.0	1.2
(S82LĀ105-9)	6-15	Bt	5.3	0.24	5	1.6	2.2	1.0	0.2	1.2	0.5	7.7	12.7	39.4	17.9	1.6
	15-22	B/E	5.1	0.15	5	1.8	3.8	0.8	0.3	6.6	0.0	13.9	20.6	32.5	49.6	1.4
	22-35	Btx1	5.2	0.01	5	1.0	0.3	0.2	0.4	4.6	0.1	10.1	12.0	15.8	69.7	3.3
	35-47	Btx2	5.0	0.01	5	0.5	0.2	0.1	0.4	3.5	0.1	7.7	9.9	12.1	72.9	4.0
	47-60	2Btx3	5.1	0.01	5	0.7	1.8	0.0	0.3	3.2	0.1	5.8	8.6	32.6	62.7	3.5
Fluker silt																
loam: 6/	0-6	A	5.2	2.05	22	0.7	0.3	0.1	0.1	1.4	0.3	10.6	11.8	10.2	48.3	0.8
(S82LĀ105-10)	6-17	Bt	5.2	0.19	5	0.6	0.1	0.0	0.1	2.6	0.2	5.3	6.1	13.1	72.2	1.6
	17-25	B/E	5.7	0.02	5	0.3	1.8	0.1	1.2	5.0	0.1	9.1	12.5	27.2	58.8	9.6
	25-37	Btx1	5.3	0.01	5	0.2	1.6	0.0	2.3	2.7	0.5	5.3	9.4	43.6	37.0	24.5
	37-60	2Btx2	5.6	0.01	5	0.2	0.8	0.0	1.3	0.9	0.1	1.0	3.3	69.7	27.3	39.4

See footnotes at end of table.

TABLE 17.--FERTILITY TEST DATA FOR SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	pH 1:1 H_2O	Organic matter	Extractable phosphorus	Exchangeable cations						Total acidity	Cation-exchange capacity (sum)	Base saturation	Saturation	
						Ca	Mg	K	Na	Al	H				Effective cation-exchange capacity Al	Sum of cation-exchange capacity Na
	In			Pct	Ppm	Meq/100g								Pct	Pct	Pct
Guyton silt loam: 1/ (S84LĀ105-4)	0-3	A	4.6	1.47	5	1.2	0.4	0.0	0.1	1.0	0.4	6.1	7.8	21.8	32.3	1.3
	3-13	Eg1	4.8	0.37	5	1.1	0.9	0.0	0.1	1.9	0.2	5.8	7.9	26.6	45.2	1.3
	13-27	Eg2	5.3	0.15	5	1.3	2.1	0.0	0.3	1.0	0.3	4.3	8.0	46.2	20.0	3.8
	27-41	B/E	6.0	0.06	5	2.5	4.8	0.1	0.7	0.0	0.0	3.6	11.7	69.2	0.0	6.0
	41-55	Btg1	6.2	0.02	5	2.5	4.3	0.1	0.7	0.0	0.0	2.5	10.1	75.2	0.0	6.9
	55-70	Btg2	6.2	0.06	5	2.1	2.5	0.1	0.4	0.5	0.9	3.6	8.7	58.6	7.7	4.6
Guyton silt loam: 7/ (S82LĀ105-8)	0-5	A	5.6	2.22	5	4.7	1.1	0.1	0.1	0.0	0.4	8.6	14.6	41.1	0.0	0.7
	5-17	Eg	5.4	0.54	5	3.1	1.3	0.1	0.2	3.2	0.8	17.3	22.0	21.4	36.8	0.9
	17-25	Btg1	5.6	0.32	5	6.2	3.1	0.1	0.3	4.6	0.6	11.0	20.7	46.8	30.9	1.4
	25-54	Btg2	5.9	0.06	5	10.1	4.9	0.1	0.4	1.6	0.1	6.7	22.2	69.8	9.1	1.8
	54-63	Btg3	6.2	0.81	15	18.4	6.6	0.2	0.4	0.0	0.2	5.8	31.4	81.5	0.0	1.3
Malbis fine sandy loam: 1/ (S84LĀ105-8)	0-4	Ap	6.3	1.16	9	6.1	0.7	0.3	0.1	0.0	0.0	4.3	11.5	62.6	0.0	0.9
	4-8	E	6.0	0.82	5	5.0	0.8	0.2	0.1	0.0	0.0	3.4	9.5	64.2	0.0	1.1
	8-28	Bt1	4.7	0.16	5	1.5	0.7	0.1	0.1	2.2	0.5	6.5	8.9	27.0	43.1	1.1
	28-43	Bt2	4.5	0.06	5	0.6	1.0	0.0	0.0	2.3	0.8	6.1	7.7	20.8	48.9	0.0
	43-60	Bt3	4.6	0.06	5	0.7	1.1	0.0	0.1	1.6	0.4	5.3	7.2	26.4	41.0	1.4
Myatt fine sandy loam: 1/ (S84LĀ105-2)	0-4	A	3.9	3.15	5	0.7	0.2	0.1	0.0	3.4	0.2	14.0	15.0	6.7	73.9	0.0
	4-12	Eg	3.9	1.25	5	0.4	0.1	0.0	0.0	2.7	0.3	7.2	7.7	6.5	77.1	0.0
	12-29	Btg1	4.1	0.54	5	0.3	0.2	0.0	0.0	5.0	0.3	9.4	9.9	5.1	86.2	0.0
	29-37	Btg2	4.5	0.41	5	0.6	0.6	0.0	0.2	5.9	0.2	9.4	10.8	13.0	78.7	1.9
	37-56	BCg	4.5	0.02	5	1.3	1.2	0.1	0.3	6.3	0.1	10.4	13.3	21.8	67.7	2.3
	56-70	Cg	4.6	0.02	5	1.5	1.4	0.0	0.3	4.7	0.1	10.3	13.5	23.7	58.8	2.2
Ochlockonee sandy loam: 1/ (S84LA105-1T̄)	0-6	A	4.2	1.07	9	0.5	0.1	0.1	0.0	1.1	0.5	6.8	7.5	9.3	47.8	0.0
	6-19	C1	4.4	0.50	5	0.4	0.1	0.0	0.0	0.9	0.5	4.2	4.7	10.6	47.4	0.0
	19-32	C2	4.2	0.41	8	0.5	0.1	0.0	0.0	2.5	0.9	4.6	5.2	11.5	62.5	0.0
	32-42	C3	4.2	0.15	10	0.4	0.1	0.0	0.0	1.3	0.5	3.8	4.3	11.6	56.5	0.0
	42-60	C4	4.2	0.15	10	0.4	0.1	0.0	0.0	1.3	0.5	3.8	4.3	11.6	56.5	0.0
Ouachita silt loam: 1/ (S84LĀ105-7)	0-5	A	4.5	2.93	13	2.0	0.9	0.6	0.1	1.8	0.4	17.1	20.7	17.4	31.0	0.5
	5-8	Bw1	4.4	1.21	6	0.7	0.4	0.2	0.1	2.3	0.9	12.1	13.5	10.4	50.0	0.7
	8-17	Bw2	4.3	0.81	7	0.6	0.3	0.1	0.1	3.1	0.5	11.2	12.3	8.9	66.0	0.8
	17-32	Bw3	4.5	0.28	5	0.4	0.6	0.1	0.1	3.6	0.5	9.7	10.9	11.0	67.9	0.9
	32-39	BC1	4.6	0.24	5	0.4	0.7	0.1	0.0	3.4	0.6	9.4	10.6	11.3	65.4	0.0
	39-49	BC2	4.7	0.28	5	0.4	0.8	0.1	0.1	3.2	0.8	9.0	10.4	13.5	59.3	1.0
	49-70	2Ebg	4.8	0.15	5	0.4	1.1	0.1	0.2	4.0	0.9	10.8	12.6	14.3	59.7	1.6

See footnotes at end of table.

TABLE 17.--FERTILITY TEST DATA FOR SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	pH 1:1 H_2O	Organic matter	Extractable phosphorus	Exchangeable cations: Ca	Mg	K	Na	Al	H	Total acidity	Cation-exchange capacity (sum)	Base saturation	Saturation: Effective cation-exchange capacity Al	Sum of cation-exchange capacity Na
	In			Pct	Ppm	Meq/100g								Pct	Pct	Pct
Prentiss fine sandy loam: 1/ (S84LA105-5)	0-5	A	4.3	2.36	5	0.7	0.1	0.0	0.0	1.9	0.5	12.6	13.4	6.0	59.4	0.0
	5-16	Bw1	4.4	0.32	5	0.5	0.2	0.0	0.0	1.9	0.5	6.8	7.5	9.3	61.3	0.0
	16-26	Bw2	5.0	0.10	5	0.4	0.4	0.0	0.1	2.0	0.4	5.4	6.3	14.3	60.6	1.6
	26-45	Btx1	4.9	0.06	5	0.5	0.7	0.0	0.1	2.0	0.4	4.7	6.0	21.7	54.1	1.7
	45-56	Btx2	4.8	0.01	5	0.5	0.8	0.0	0.1	1.5	0.6	4.1	5.5	25.5	42.9	1.8
	56-65	Btx3	4.8	0.01	5	0.7	1.3	0.1	0.1	2.6	0.4	5.8	8.0	27.5	50.0	1.2
Ruston fine sandy loam: 1/ (S84LA105-6)	0-5	A	4.4	0.81	5	0.5	0.1	0.0	0.0	0.9	0.7	7.6	8.2	7.3	40.9	0.0
	5-9	E	4.5	0.54	5	0.4	0.1	0.0	0.0	1.1	0.5	4.1	4.6	10.9	52.4	0.0
	9-22	Bt1	4.7	0.10	5	0.5	1.3	0.1	0.0	2.9	0.7	7.9	9.8	19.4	52.7	0.0
	22-37	Bt2	4.8	0.06	5	0.5	0.9	0.1	0.1	2.2	0.9	6.2	7.8	20.5	46.8	1.3
	37-46	B/E	4.8	0.01	5	0.5	0.7	0.0	0.1	1.6	0.7	5.4	6.7	19.4	44.4	1.5
	46-65	B't1	4.8	0.01	5	0.4	0.7	0.0	0.0	1.8	0.7	5.6	6.7	16.4	50.0	0.0
	65-83	B't2	4.8	0.01	5	0.5	1.0	0.0	0.1	1.6	0.7	5.3	6.9	23.2	41.0	1.4
Savannah silt loam: 8/ (S82LA105-3)	0-5	A	5.0	1.96	5	0.4	0.1	0.0	0.1	2.1	0.6	10.1	10.7	5.6	63.6	0.9
	5-8	E	5.2	0.28	5	0.2	0.3	0.0	0.1	2.1	0.5	5.8	6.4	9.4	65.6	1.6
	8-16	Bt1	5.4	0.10	5	0.2	1.1	0.1	0.2	3.7	0.7	6.8	8.4	19.0	61.7	2.4
	16-27	Bt2	5.4	0.01	5	0.4	1.7	0.0	0.3	4.2	0.4	8.1	10.5	22.8	60.0	2.8
	27-38	Btx1	5.4	0.01	5	0.2	1.2	0.0	0.2	2.7	0.5	4.8	6.4	25.0	56.2	3.1
	38-60	Btx2	5.4	0.01	5	0.4	1.2	0.1	0.2	2.3	0.6	4.3	6.2	30.6	47.9	3.2
Smithdale fine sandy loam: 1/ (S84LA105-9)	0-4	A	5.2	1.32	5	2.3	0.7	0.2	0.0	0.2	0.3	7.6	10.8	29.6	5.4	0.0
	4-8	E	4.9	0.60	5	1.4	0.5	0.1	0.1	1.1	0.3	7.2	9.3	22.6	31.4	1.1
	8-22	Bt1	4.7	0.28	5	1.0	0.8	0.1	0.0	2.9	0.5	8.4	10.3	18.4	54.7	0.0
	22-31	Bt2	4.6	0.06	5	0.6	0.7	0.1	0.1	2.5	0.7	8.4	9.9	15.2	53.2	1.0
	31-48	Bt3	4.6	0.06	5	0.5	0.8	0.0	0.1	2.5	0.6	6.5	7.9	17.7	55.6	1.3
	48-65	Bt4	4.7	0.02	5	0.5	1.0	0.1	0.1	2.0	0.7	6.5	8.2	20.7	45.5	1.2
Stough fine sandy loam: 1/ (S84LA105-3)	0-3	A	3.9	2.53	5	0.7	0.3	0.0	0.4	3.1	0.3	16.2	17.6	8.0	64.6	2.3
	3-6	E	4.3	0.59	5	0.7	0.2	0.0	0.1	1.6	0.6	9.4	10.4	9.6	50.0	1.0
	6-15	Bt	4.5	0.50	5	0.7	0.3	0.0	0.1	1.8	0.3	9.4	10.5	10.5	56.3	1.0
	15-20	Btx1	4.8	0.15	5	0.7	0.3	0.0	0.1	2.4	0.1	5.4	6.5	16.9	66.7	1.5
	20-29	Btx2	4.8	0.37	5	0.7	0.5	0.0	0.2	2.8	0.1	6.8	8.2	17.1	65.1	2.4
	29-40	Btx3	4.9	0.46	5	0.8	0.9	0.0	0.4	3.4	0.3	7.9	10.0	21.0	58.6	4.0
	40-70	Btx4	4.9	0.06	5	1.1	1.5	0.0	0.6	2.6	0.3	6.1	9.3	34.4	42.6	6.5

See footnotes at end of table.

TABLE 17.--FERTILITY TEST DATA FOR SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	pH 1:1 H_2O	Organic matter	Extractable phosphorus	Exchangeable cations: Ca	Exchangeable cations: Mg	Exchangeable cations: K	Exchangeable cations: Na	Exchangeable cations: Al	Exchangeable cations: H	Total acidity	Cation-exchange capacity (sum)	Base saturation	Saturation: Effective cation-exchange capacity Al	Saturation: Sum of cation-exchange capacity Na
	In			Pct	Ppm	Meq/100g								Pct	Pct	Pct
Tangi silt loam: 9/ (S82LA105-1)	0-5	A	6.1	2.58	22	5.8	0.8	0.3	0.1	0.0	0.1	5.8	12.8	54.7	0.0	0.8
	5-9	BE	5.6	0.46	5	1.8	1.3	0.1	0.1	0.7	0.4	4.8	8.1	40.7	15.9	1.2
	9-18	Bt1	5.4	0.28	5	1.0	2.3	0.1	0.1	2.9	0.4	10.6	14.1	24.8	42.6	0.7
	18-27	Bt2	5.3	0.15	5	0.5	1.2	0.1	0.1	2.3	0.5	7.2	9.1	20.9	48.9	1.1
	27-38	2Btx1	5.5	0.02	5	0.6	1.4	0.1	0.2	2.3	0.3	7.2	9.5	24.2	46.0	2.1
	38-60	2Btx2	5.5	0.01	5	0.3	1.6	0.0	0.1	2.3	0.4	6.7	8.7	23.0	48.9	1.1
Tangi silt loam: 10/ (S82LA105-2)	0-6	A	5.2	2.53	5	2.1	0.5	0.1	0.1	1.1	0.3	11.0	13.8	20.3	26.2	0.7
	6-10	BE	5.9	0.54	5	2.5	0.9	0.0	0.2	0.2	0.2	4.8	8.4	42.8	5.0	2.4
	10-18	Bt1	5.7	0.24	5	3.2	1.6	0.1	0.2	1.0	0.5	6.2	11.3	45.1	15.1	1.8
	18-24	Bt2	5.6	0.10	5	1.2	1.9	0.0	0.1	1.2	0.4	5.8	9.0	35.6	25.0	1.1
	24-37	2Btx1	5.6	0.02	5	0.6	1.8	0.1	0.1	1.3	0.5	5.3	8.1	34.6	28.3	1.2
	37-68	2Btx2	5.5	0.02	5	0.6	2.4	0.0	0.5	2.8	0.3	8.1	11.6	30.2	41.8	4.3
Tangi silt loam: 11/ (S82LA105-4)	0-4	A	5.3	2.40	5	0.7	0.3	0.1	0.1	1.4	0.8	10.1	11.3	10.6	41.2	0.9
	4-7	BE	5.4	0.72	5	0.7	0.4	0.0	0.1	1.4	0.8	5.3	6.5	18.5	41.2	1.5
	7-18	Bt1	5.6	0.28	5	0.4	1.0	0.0	0.2	3.1	1.2	9.1	10.7	15.0	52.5	1.9
	18-27	Bt2	5.7	0.02	5	0.2	1.1	0.0	0.1	2.6	0.9	7.2	8.6	16.3	53.1	1.2
	27-46	2Btx1	5.8	0.01	5	0.3	1.1	0.0	0.2	2.3	0.9	4.3	6.2	30.6	45.1	3.2
	46-60	2Btx2	5.6	0.10	5	0.3	1.1	0.0	0.1	1.8	0.9	3.4	4.9	30.6	46.1	2.0

1/ Typical pedon for the survey area. For the description and location see the section "Soil Series and Their Morphology."

2/ This Abita pedon is located 0.25 mile east of Ponchatoula, 2,500 feet south of Highway 22, 2,100 feet north and 2,800 feet west of the southeast corner of sec. 17, T. 7 S., R. 8 E.

3/ This Abita pedon is located 2.5 miles southeast of the Louisiana State University Hammond Experiment Station, 2.25 miles north of Highway 22, 355 feet west of the Thibodaux Road, sec. 2, T. 7 S., R. 8 E.

4/ This Fluker pedon is located about 1.25 miles north of the city limit of Tangipahoa, 100 feet west of Highway 51, Spanish Land Grant sec. 51, T. 2 S., R. 7 E.

5/ This Fluker pedon is located about 3,020 feet south of the city limit of Tangipahoa, 315 feet west of Highway 51, Spanish Land Grant sec. 39, T. 2 S., R. 7 E.

6/ This Fluker pedon is located 3,000 feet south of the city limit of Tangipahoa, 305 feet west of Highway 51, Spanish Land Grant sec. 39, T. 2 S., R. 7 E.

7/ This Guyton pedon is located 1.9 miles northeast of Ponchatoula, 2,700 feet north of Highway 22, 1,650 feet west and 580 feet north of the southeast corner of Spanish Land Grant sec. 9, T. 7 S., R. 8 E.

8/ This Savannah pedon is located 1,100 feet northeast of the intersection of Highways 10 and 1054, 30 feet north of Highway 10, Spanish Land Grant sec. 41, T. 3 S., R. 8 E.

9/ This Tangi pedon is located 3.5 miles north of Highway 38, 100 feet east of parish road, SW1/4SW1/4 Spanish Land Grant sec. 48, T. 1 S., R. 8 E.

10/ This Tangi pedon is located 1.5 miles northeast of Bolivar, 0.5 mile south of Highway 38, 605 feet north of Highway 1056, Spanish Land Grant sec. 43, T. 1 S., R. 8 E.

11/ This Tangi pedon is located 2.5 miles northwest of Loranger, 1,600 feet south of Cooper Creek, sec. 21, T. 4 S., R. 8 E.

TABLE 18.--PHYSICAL TEST DATA FOR SELECTED SOILS

Soil name and sample number	Horizon	Depth	Particle-size distribution: Sand: Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Total (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Water content at tension: 1/3 bar	15 bar	WRD	Bulk density: Air dry	Oven dry	Field moisture	COLE 1/
		In	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	---Pct (wt)--			------G/cm^3-----			
Abita silt loam: 2/ (S82LA105-14)	A	0-5	0.0	1.0	1.6	3.6	12.5	18.7	75.6	5.7	23.9	9.9	14.0	1.45	1.46	1.42	0.009
	E	5-10	0.0	1.3	1.4	3.2	12.9	18.8	76.2	5.0	17.4	3.5	13.9	1.58	1.59	1.55	0.009
	B/E	10-16	0.0	0.6	1.0	3.6	11.3	16.5	68.3	15.2	24.1	7.1	17.0	1.56	1.57	1.53	0.009
	Bt	16-34	0.0	0.2	0.4	1.8	9.7	12.1	57.5	30.4	30.9	13.9	17.0	1.70	1.71	1.56	0.031
	Btg1	34-45	0.0	0.1	0.2	13.9	0.1	14.3	52.9	32.8	30.3	15.0	15.3	1.88	1.90	1.69	0.041
	Btg2	45-64	0.0	0.0	0.1	1.2	10.6	11.9	52.0	36.1	33.1	17.5	15.6	1.96	1.98	1.62	0.072
Fluker silt loam: 2/ (S83LA105-2)	Ap	0-8	0.0	2.7	9.0	9.5	5.1	26.3	69.4	4.3	35.6	6.2	29.4	1.47	1.48	1.46	0.004
	Bw	8-13	0.0	1.5	6.6	7.8	2.9	18.8	72.0	9.2	25.7	4.7	21.0	1.75	1.76	1.59	0.033
	Bt1	13-18	0.0	1.0	5.1	6.0	2.4	14.5	62.8	22.7	30.8	11.3	19.5	1.70	1.70	1.53	0.033
	Bt2	18-24	0.0	0.8	4.7	5.6	2.3	13.4	56.6	30.0	34.3	14.4	19.9	1.75	1.75	1.52	0.048
	B/E	24-31	0.0	1.2	6.9	7.6	2.6	18.3	57.0	24.7	27.4	11.6	15.8	1.60	1.63	1.42	0.047
	2Btx1	31-40	0.0	2.0	13.2	15.3	4.3	34.8	51.4	13.8	20.6	7.4	13.2	1.86	1.87	1.81	0.010
	2Btx2	40-70	0.0	2.2	18.0	21.4	5.7	47.3	44.0	8.7	14.5	4.7	9.8	1.95	1.96	1.94	0.002
Savannah silt loam: 3/ (S83LA105-1)	A	0-5	0.0	2.2	10.2	16.5	5.9	34.8	56.9	8.3	25.6	8.6	17.0	1.80	1.80	1.72	0.014
	Bt1	5-17	0.0	2.0	10.7	12.7	4.4	29.8	50.5	19.7	31.9	11.3	20.6	1.78	1.81	1.55	0.053
	Bt2	17-25	0.0	2.1	13.2	15.5	5.4	36.2	45.9	17.9	29.6	8.0	21.6	1.66	1.66	1.52	0.029
	Btx1	25-36	0.0	2.4	18.3	22.3	7.7	50.7	35.8	13.5	24.8	6.9	17.9	1.94	1.96	1.87	0.013
	Btx2	36-49	0.0	2.6	20.4	23.9	8.1	55.0	32.2	12.8	22.5	6.7	15.8	1.98	2.00	1.91	0.014
	Btx3	49-61	0.0	3.3	28.4	25.6	7.5	64.8	23.9	11.3	21.2	6.0	15.2	1.96	1.98	1.91	0.012
Tangi silt loam: 4/ (S82LA105-15)	A	0-3	0.0	1.5	2.9	16.7	9.1	30.2	59.0	10.8	25.5	7.4	18.1	1.51	1.51	1.45	0.012
	BE	3-7	0.0	0.5	2.2	12.0	6.8	21.5	58.2	20.3	25.5	10.2	15.3	1.48	1.49	1.41	0.015
	Bt1	7-13	0.0	0.5	2.0	12.0	6.9	21.4	53.2	25.4	26.8	12.4	14.4	1.62	1.64	1.56	0.020
	Bt2	13-27	0.0	0.5	2.0	12.9	7.3	22.7	47.7	29.6	26.7	13.5	13.2	1.61	1.62	1.52	0.021
	2Btx1	27-37	0.0	0.6	1.9	18.0	7.6	28.1	19.0	52.9	33.3	23.4	9.9	1.67	1.69	1.59	0.016
	2Btx2	37-45	0.0	0.6	2.5	17.8	7.8	28.7	27.6	43.7	35.1	21.7	13.4	1.71	1.73	1.66	0.015
	2Btx3	45-70	0.0	0.0	3.5	45.0	4.1	52.6	15.0	32.4	25.7	15.1	10.6	1.67	1.69	1.63	0.014
Tangi silt loam: 2/ (S82LA105-17)	Ap	0-4	0.0	1.8	2.5	9.9	7.4	21.6	66.6	11.8	32.1	2.7	29.4	1.59	1.60	1.57	0.006
	Bt1	4-15	0.0	1.3	1.6	9.3	4.9	17.1	59.3	23.6	30.2	11.3	18.9	1.54	1.55	1.48	0.015
	Bt2	15-25	0.0	1.2	1.8	12.1	5.8	20.9	57.0	22.1	28.4	9.8	18.6	1.65	1.66	1.60	0.011
	2Btx1	25-33	0.0	1.4	2.8	21.8	9.7	35.7	44.1	20.2	21.7	8.8	12.9	1.84	1.87	1.81	0.007
	2Btx2	33-48	0.0	0.1	1.9	28.9	7.9	38.8	26.1	35.1	23.3	15.8	7.5	1.82	1.84	1.78	0.007
	2Btx3	48-65	0.0	0.2	1.3	27.3	5.5	34.3	21.8	43.9	27.8	20.8	7.0	1.67	1.69	1.63	0.013

See footnotes at end of table.

TABLE 18.--PHYSICAL TEST DATA FOR SELECTED SOILS--Continued

Soil name and sample number	Horizon	Depth	Particle-size distribution: Sand: Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Total (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Water content at tension: 1/3 bar	15 bar	WRD	Bulk density: Air dry	Oven dry	Field moisture	COLE 1/
		In	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	---Pct (wt)--			------G/cm^3-----			
Toula silt loam: 2/ (S82LA105-16)	A	0-5	0.0	2.1	3.4	8.6	7.4	21.5	75.7	2.8	30.5	1.5	29.0	1.41	1.43	1.38	0.010
	BE	5-11	0.0	0.8	2.3	5.3	4.8	13.2	72.4	14.4	28.3	4.5	23.8	1.69	1.73	1.67	0.007
	Bt	11-19	0.1	0.4	1.3	4.5	3.8	10.1	64.7	25.2	31.0	10.7	20.3	1.59	1.62	1.50	0.023
	Btx1	19-24	0.0	0.5	2.0	5.9	5.0	13.4	53.3	33.3	32.2	13.8	18.4	1.68	1.70	1.63	0.014
	2Btx2	24-35	0.0	0.5	3.8	10.6	8.8	23.7	54.7	21.6	25.8	9.4	16.4	1.75	1.78	1.65	0.013
	2Btx3	35-48	0.0	0.4	3.8	10.8	9.4	24.4	51.2	24.4	24.7	9.5	15.2	1.82	1.83	1.78	0.007
	2Bt	48-65	0.0	0.4	3.2	9.5	8.6	21.7	50.4	27.9	26.4	12.1	14.3	1.83	1.83	1.77	0.013

1/ COLE (Coefficient of Linear Extensibility): A quantitative method of determining shrink-swell behavior of soil. It is an estimate of the vertical component of swelling of a natural soil clod. COLE is expressed as: low (<0.03); moderate (0.03-0.06); and high (>0.06).

2/ Typical pedon for the series. For the description and location see the section "Soil Series and Their Morphology."

3/ Typical pedon for the survey area. For the description and location see the section "Soil Series and Their Morphology."

4/ This Tangi silt loam pedon is located 2.5 miles northwest of Loranger, 1,600 feet south of Copper Creek, sec. 21, T. 4 S., R. 8 E.

TABLE 19.--CHEMICAL TEST DATA FOR SELECTED SOILS

[The symbol < means less than]

Soil name and sample number	Horizon	Depth	Extractable bases: Ca	Extractable bases: Mg	Extractable bases: Na	Extractable bases: K	Extractable acidity	Cation exchange capacity	Base saturation 1/	Organic matter	Nitrogen	Carbon-Nitrogen Ratio	pH H_2O 1:1	pH KCl 1:1	pH $CaCl_2$ 1:2	Extractable Iron	Extractable Aluminum	Extractable Hydrogen	Extractable Phosphorus Bray 1	Extractable Phosphorus Bray 2
		In	Milliequivalents/100 grams of soil						Pct	Pct	Pct					Pct	----Meq/100g---		Ppm	Ppm
Abita silt loam: 2/ (S82LA105-14)	A	0-5	1.6	0.9	0.2	0.2	13.8	8.5	34.1	1.60	0.16	10.00	4.2	3.5	3.8	0.40	1.7	0.3	>6	113
	E	5-10	0.6	0.2	0.2	0.2	4.2	3.4	35.3	0.14	0.04	5.75	5.0	4.2	4.9	0.40	1.5	0.3	6	16
	B/E	10-16	2.4	0.5	0.1	0.2	7.2	6.7	47.8	0.07	0.03	4.67	5.0	4.0	4.8	0.70	3.8	0.1	<5	<5
	Bt	16-34	4.6	2.3	0.1	0.6	9.9	12.4	61.2	0.05	0.03	2.33	5.3	4.1	4.9	1.00	5.9	0.0	<5	<5
	Btg1	34-45	7.8	3.4	0.2	0.7	9.7	17.5	69.1	0.05	0.02	2.50	5.6	4.0	5.0	1.19	4.0	0.0	<5	<5
	Btg2	45-64	10.9	4.6	0.2	0.9	9.0	22.2	70.7	0.05	0.02	2.50	5.7	4.0	5.1	1.26	3.0	0.2	<5	<5
Fluker silt loam: 2/ (S83LĀ105-2)	Ap	0-8	0.6	0.2	0.2	0.1	13.3	7.1	15.5	0.98	0.01	14.90	4.1	3.7	3.8	0.60	1.5	0.6	16	22
	Bw	8-13	0.6	0.2	0.2	0.1	6.5	4.3	25.6	0.09	0.02	4.10	4.3	3.6	3.7	0.70	1.7	0.6	<1	<1
	Bt1	13-18	0.6	1.2	0.2	0.4	14.0	10.5	22.9	0.09	0.03	3.20	4.7	3.5	3.7	1.00	5.3	0.5	<1	<1
	Bt2	18-24	0.4	2.2	0.2	1.4	18.0	15.7	26.8	0.06	0.03	2.20	4.7	3.4	3.7	1.10	6.4	0.4	<1	<1
	B/E	24-31	0.2	2.6	0.2	1.6	16.9	13.2	34.9	0.05	0.03	2.00	4.7	3.4	3.8	1.10	5.0	0.4	<1	<1
	2Btx1	31-40	0.2	1.8	0.2	1.8	6.5	7.4	54.1	0.01	0.02	0.70	4.7	3.4	3.9	0.60	2.3	0.4	<1	<1
	2Btx2	40-70	0.4	1.0	0.2	1.4	2.5	3.9	76.9	0.01	0.01	3.30	4.8	3.6	4.0	0.30	0.5	0.5	<1	<1
Savannah silt loam: 3/ (S83LĀ105-1)	A	0-5	4.6	1.0	0.2	0.1	14.4	11.8	50.0	2.24	0.16	13.90	5.1	4.5	4.7	0.70	0.0	0.0	28	36
	Bt1	5-17	1.2	0.6	0.2	0.1	10.4	7.7	26.0	0.18	0.04	4.40	4.2	3.6	3.7	1.20	3.2	0.1	<1	<1
	Bt2	17-25	0.6	0.6	0.2	0.1	10.4	7.1	21.1	0.14	0.03	4.80	4.0	3.6	3.7	0.90	3.1	0.2	<1	2
	Btx1	25-36	0.2	0.2	0.2	0.1	7.6	5.1	17.7	0.04	0.01	4.40	3.9	3.6	3.7	0.80	2.2	0.8	<1	<1
	Btx2	36-49	0.2	0.2	0.2	0.1	6.8	5.8	15.5	0.01	0.01	1.30	3.9	3.6	3.7	0.70	2.5	0.7	<1	<1
	Btx3	49-61	0.2	0.2	0.2	0.1	6.5	4.5	20.0	0.01	0.01	1.30	3.8	3.7	3.8	0.60	2.3	0.6	<1	<1
Tangi silt loam: 4/ (S82LĀ105-15)	A	0-3	0.7	0.1	0.1	0.3	8.7	7.4	16.2	1.13	0.07	16.14	5.4	4.5	4.9	0.79	1.9	0.8	<5	<5
	BE	3-7	0.4	0.5	0.1	0.3	9.1	8.1	14.3	0.46	0.03	15.33	5.3	4.3	4.8	1.21	3.9	0.1	<5	<5
	Bt1	7-13	0.2	0.7	0.1	0.3	9.3	8.8	14.8	0.21	0.03	7.00	5.5	4.2	4.8	1.30	4.2	0.0	<5	<5
	Bt2	13-27	0.2	0.9	0.1	0.3	8.6	7.3	20.6	0.13	0.02	6.50	5.5	4.2	4.7	0.91	4.6	0.2	<5	<5
	2Btx1	27-37	0.2	1.6	0.1	0.1	10.8	8.9	22.5	0.13	0.02	6.50	5.5	4.2	4.8	1.72	4.3	0.0	<5	<5
	2Btx2	37-45	0.1	1.2	0.1	0.1	10.8	9.3	16.1	0.11	0.02	5.50	5.7	4.2	4.8	1.68	4.3	0.3	<5	<5
	2Btx3	45-70	0.1	0.8	0.1	0.1	6.5	4.8	22.9	0.03	0.01	3.00	5.6	4.3	5.0	1.32	2.6	0.3	<5	<5
Tangi silt loam: 2/ (S82LA105-17)	Ap	0-4	4.4	0.7	0.1	0.1	10.6	10.3	51.5	1.44	0.12	12.00	5.6	4.7	5.3	0.77	0.3	0.3	<5	310
	Bt1	4-15	2.6	1.4	0.1	0.1	7.9	8.5	49.4	0.12	0.03	4.00	5.5	4.4	5.1	1.19	1.6	0.3	<5	5
	Bt2	15-25	1.1	1.8	0.1	0.1	5.8	7.9	39.2	0.10	0.03	3.33	5.6	4.4	5.0	1.02	1.7	0.7	<5	<5
	2Btx1	25-33	0.2	1.7	0.1	0.1	6.5	6.8	30.9	0.03	0.02	1.50	5.4	4.0	4.9	1.17	2.2	0.9	<5	<5
	2Btx2	33-48	0.1	1.7	0.1	0.1	7.9	7.1	38.2	0.03	0.02	1.50	5.4	4.2	4.8	1.55	2.6	0.6	<5	<5
	2Btx3	48-65	0.1	2.0	0.1	0.1	8.8	11.6	19.8	0.03	0.01	3.00	5.4	4.2	4.8	1.68	2.8	0.3	<5	<5

See footnotes at end of table.

TABLE 19.--CHEMICAL TEST DATA FOR SELECTED SOILS--Continued

Soil name and sample number	Horizon	Depth	Extractable bases: Ca	Extractable bases: Mg	Extractable bases: Na	Extractable bases: K	Extractable acidity	Cation exchange capacity	Base saturation 1/	Organic matter	Nitrogen	Carbon-Nitrogen Ratio	pH H_2O 1:1	pH KCl 1:1	pH $CaCl_2$ 1:2	Extractable Iron	Extractable Aluminum	Extractable Hydrogen	Extractable Phosphorus Bray 1	Extractable Phosphorus Bray 2
		In	Milliequivalents/100 grams of soil						Pct	Pct	Pct					Pct	----Meq/100g---		Ppm	Ppm
Toula silt loam: 2/ (S82LA105-16)	A	0-5	1.5	0.4	0.1	0.2	11.8	7.8	28.2	1.83	0.10	18.30	5.6	4.5	5.0	0.30	1.3	0.0	<5	<5
	BE	5-11	0.3	0.7	0.1	0.4	6.2	5.3	28.3	0.14	0.02	7.00	5.6	4.2	4.7	0.57	2.8	0.4	<5	<5
	Bt	11-19	0.2	1.2	0.1	0.3	11.2	8.2	22.0	0.17	0.04	4.25	5.6	4.2	4.7	0.91	4.9	0.0	<5	<5
	Btx1	19-24	0.1	2.4	0.1	0.2	13.3	12.7	22.1	0.12	0.03	4.00	5.7	4.1	4.7	1.28	7.0	0.0	<5	<5
	2Btx2	24-35	0.1	2.0	0.1	0.2	7.6	7.8	30.8	0.03	0.02	1.50	5.9	4.2	4.8	0.96	3.5	0.0	<5	<5
	2Btx3	35-48	0.1	2.0	0.1	0.3	7.6	7.7	32.5	0.03	0.02	1.50	6.0	4.1	4.8	0.96	3.5	0.0	<5	<5
	2Bt	48-65	0.2	2.6	0.1	0.3	7.6	8.8	36.4	0.02	0.01	2.00	5.9	4.1	4.9	1.32	3.2	0.0	<5	<5

1/ To calculate percent base saturation by sum of cations, divide sum of extractable bases by the sum of extractable acidity multiplied by 100.

2/ Typical pedon for the series. For the description and location see the section "Soil Series and Their Morphology."

3/ Typical pedon for the survey area. For the description and location see the section "Soil Series and Their Morphology."

4/ This Tangi silt loam pedon is located 2.5 miles northwest of Loranger, 1,600 feet south of Cooper Creek, sec. 21, T. 4 S., R. 8 E.

TABLE 20.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Abita	Fine-silty, siliceous, thermic Glossaquic Paleudalfs
Barbary	Very-fine, montmorillonitic, nonacid, thermic Typic Hydraquents
Brimstone	Fine-silty, siliceous, thermic Glossic Natraqualfs
*Cahaba	Fine-loamy, siliceous, thermic Typic Hapludults
Fluker	Fine-silty, siliceous, thermic Glossaquic Fragiudalfs
Guyton	Fine-silty, siliceous, thermic Typic Glossaqualfs
Kenner	Euic, thermic Fluvaquentic Medisaprists
Malbis	Fine-loamy, siliceous, thermic Plinthic Paleudults
Maurepas	Euic, thermic Typic Medisaprists
*Myatt	Fine-loamy, siliceous, thermic Typic Ochraquults
*Ochlockonee	Coarse-loamy, siliceous, acid, thermic Typic Udifluvents
*Ouachita	Fine-silty, siliceous, thermic Fluventic Dystrochrepts
*Prentiss	Coarse-loamy, siliceous, thermic Glossic Fragiudults
Ruston	Fine-loamy, siliceous, thermic Typic Paleudults
*Savannah	Fine-loamy, siliceous, thermic Typic Fragiudults
Smithdale	Fine-loamy, siliceous, thermic Typic Hapludults
*Stough	Coarse-loamy, siliceous, thermic Fragiaquic Paleudults
Tangi	Fine-silty, siliceous, thermic Typic Fragiudults
Toula	Fine-silty, siliceous, thermic Typic Fragiudults

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

TABLE 21.--FORMATIVE ELEMENTS AND ADJECTIVES OF THE HIGHER TAXONOMIC CLASSES

Formative element	Connotation
alf	Meaningless symbol.
aqu	A soil that is wet or that has been artificially drained.
dystr, dsy	Low base saturation. Indicates an infertile soil.
ent	Mineral soils; weak or no pedogenic horizons; no deep wide cracks in most years.
ept	Mineral soils; some pedogenic horizons and some weatherable minerals; moisture available to mature a crop in most years; no horizon of illuvial clays; relatively low in either organic matter or base saturation, or in both.
ert	To turn or invert.
fluv	Composed of recent alluvium.
frag	Presence of a fragipan.
gloss	Tongued. Presence of tongues of one soil layer extending downward into the next lower horizon.
hapl	The simplest set of horizons.
hydr	Presence of water.
ist	Organic in more than half of upper 80 centimeters.
med	A soil of midlatitudes.
natr	Presence of a natric horizon or layer with an accumulation of sodium.
ochr	A surface horizon that is either light in color or low in organic matter, or that is both.
pale	A soil having horizons that have more than normal development.
plinth	Presence of plinthite, a red or brick colored module of iron oxides.
sapr	Composed mostly of highly decomposed plant materials.
typic	Represents the central concept of its great group.
ud	Moist but not wet, and dry for short periods or not at all.
ult	Mineral soils; an illuvial horizon of silicate clays; low base saturation; moisture available to mature a crop in most years.

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APPENDIX 3

RegenOx AND

ORC ADVANCED MSD

REGENESIS
Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier RegenOx® Part A
Other means of identification None.
Recommended use Soil and Groundwater Remediation.
Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name Regenesis
Address 1011 Calle Sombra
San Clemente, CA 92673
Telephone 949-366-8000
E-mail CustomerService@regenesis.com
Emergency phone number CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Oxidizing solids	Category 2
Health hazards	Acute toxicity, oral	Category 4
	Serious eye damage/eye irritation	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
OSHA defined hazards	Not classified.	

Label elements

Signal word Danger
Hazard statement May intensify fire; oxidizer. Harmful if swallowed. Causes serious eye damage. Toxic to aquatic life.

Precautionary statement

Prevention Keep away from heat. Keep/Store away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Avoid release to the environment. Wear protective gloves/eye protection/face protection.

Response If swallowed: Call a poison center/doctor if you feel unwell. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. Rinse mouth. In case of fire: Use appropriate media to extinguish.

Storage Store away from incompatible materials.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Sodium Carbonate Peroxyhydrate	15630-89-4	≥95
Silicic Acid, Sodium Salt, Sodium Silicate	1344-09-8	<1

Composition comments	All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes. Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Do not rub eyes. Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Ingestion	Never give anything by mouth to a victim who is unconscious or is having convulsions. Rinse mouth. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical advice/attention if you feel unwell.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim warm. Keep victim under observation. Symptoms may be delayed.
General information	Take off all contaminated clothing immediately. Contact with combustible material may cause fire. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media	Water spray, fog (flooding amounts).
Unsuitable extinguishing media	Dry chemical, CO2, halon. Foam.
Specific hazards arising from the chemical	Greatly increases the burning rate of combustible materials. Containers may explode when heated. During fire, gases hazardous to health may be formed. Combustion products may include: carbon oxides and metal oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk. Use water spray to cool unopened containers.
Specific methods	Cool containers exposed to flames with water until well after the fire is out.
General fire hazards	May intensify fire; oxidizer. Contact with combustible material may cause fire.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep away from clothing and other combustible materials. Wear appropriate protective equipment and clothing during clean-up. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Collect dust using a vacuum cleaner equipped with HEPA filter. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Ventilate the contaminated area. This product is miscible in water. Stop the flow of material, if this is without risk. Absorb in vermiculite, dry sand or earth and place into containers. Large Spills: Sweep up or vacuum up spillage and collect in suitable container for disposal. Shovel the material into waste container. Minimize dust generation and accumulation. Avoid the generation of dusts during clean-up. Prevent product from entering drains. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. Place all material into loosely covered plastic containers for later disposal. For waste disposal, see section 13 of the SDS. Wear appropriate protective equipment and clothing during clean-up.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Minimize dust generation and accumulation. Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces. Keep away from heat. Provide appropriate exhaust ventilation at places where dust is formed. Keep away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Do not get this material in contact with eyes. Do not taste or swallow. When using, do not eat, drink or smoke. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Keep away from heat. Store in a cool, dry place out of direct sunlight. Store at temperatures not exceeding 40°C/104°F. Store in original tightly closed container. Store in a well-ventilated place. Do not store near combustible materials. Store away from incompatible materials (see Section 10 of the SDS). Protect from contamination.

8. Exposure controls/personal protection

Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. Provide eyewash station.

Individual protection measures, such as personal protective equipment

Eye/face protection	Unvented, tight fitting goggles should be worn in dusty areas.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier. Frequent change is advisable. Rubber, neoprene or PVC gloves are recommended.
Other	Wear appropriate chemical resistant clothing.
Respiratory protection	If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Recommended use: Wear respirator with dust filter.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Solid.
Form	Powder.
Color	White.
Odor	Odorless.
Odor threshold	Not available.
pH	10.5 (3% solution/water)
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Oxidizer.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.

Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	14.5 g/100g water @ 20 °C (minimum)
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	122 °F (50 °C)
Viscosity	Not available.
Other information	
Bulk density	0.9 - 1.2 g/ml

10. Stability and reactivity

Reactivity	Greatly increases the burning rate of combustible materials.
Chemical stability	Product may be unstable at temperatures above: 50°C/122°F. Decomposes on heating.
Possibility of hazardous reactions	Reacts slowly with water.
Conditions to avoid	Moisture. Heat. Avoid temperatures exceeding the decomposition temperature. Contact with incompatible materials.
Incompatible materials	Acids. Bases. Salts of heavy metals. Reducing agents. Combustible material.
Hazardous decomposition products	Oxygen. Steam. Heat.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Dust may irritate respiratory system.
Skin contact	Dust or powder may irritate the skin.
Eye contact	Causes serious eye damage.
Ingestion	Harmful if swallowed.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Dusts may irritate the respiratory tract, skin and eyes. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.

Information on toxicological effects

Acute toxicity Harmful if swallowed.

Components	Species	Test Results
Silicic Acid, Sodium Salt, Sodium Silicate (CAS 1344-09-8)		
Acute		
Oral		
LD50	Mouse	1100 mg/kg
	Rat	1.1 g/kg

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/eye irritation	Causes serious eye damage.
Respiratory or skin sensitization	
Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity Toxic to aquatic life.

Components		Species	Test Results
Silicic Acid, Sodium Salt, Sodium Silicate (CAS 1344-09-8)			
Aquatic			
Crustacea	EC50	Water flea (Ceriodaphnia dubia)	0.28 - 0.57 mg/l, 48 hours
Fish	LC50	Western mosquitofish (Gambusia affinis)	1800 mg/l, 96 hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability Decomposes in the presence of water. The product contains inorganic compounds which are not biodegradable.

Bioaccumulative potential The product does not contain any substances expected to be bioaccumulating.

Mobility in soil This product is water soluble and may disperse in soil.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number UN3378

UN proper shipping name Sodium carbonate peroxyhydrate

Transport hazard class(es)

Class 5.1

Subsidiary risk -

Label(s) 5.1

Packing group II

Environmental hazards

Marine pollutant No

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

Special provisions IB8, IP2, IP4, T3, TP33

Packaging exceptions 152

Packaging non bulk 212

Packaging bulk 240

IATA

UN number UN3378

UN proper shipping name	Sodium carbonate peroxyhydrate
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	No
ERG Code	5L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN3378
UN proper shipping name	SODIUM CARBONATE PEROXYHYDRATE
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	No
EmS	F-A, S-Q
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories
Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - Yes

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Not regulated.

US. New Jersey Worker and Community Right-to-Know Act

Not listed.

US. Pennsylvania Worker and Community Right-to-Know Law

Not listed.

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 26-March-2015

Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings Health: 3
Flammability: 0
Physical hazard: 2

NFPA ratings

Disclaimer Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

SAFETY DATA SHEET

1. Identification

Product identifier	**RegenOx® Part B**
Other means of identification	None.
Recommended use	Soil and Groundwater Remediation.
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name	Regenesis
Address	1011 Calle Sombra San Clemente, CA 92673
Telephone	949-366-8000
E-mail	CustomerService@regenesis.com
Emergency phone number	CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 2A
OSHA defined hazards	Not classified.	

Label elements

Signal word Warning

Hazard statement Causes skin irritation. Causes serious eye irritation.

Precautionary statement

Prevention Wash thoroughly after handling. Wear protective gloves. Wear eye/face protection.

Response If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If skin irritation occurs: Get medical advice/attention. If eye irritation persists: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC) None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Silicic Acid, Sodium Salt, Sodium Silicate	1344-09-8	25-40
SILICON DIOXIDE (AMORPHOUS SILICA GEL)	63231-67-4	<10
Ferrous sulfate	7720-78-7	2-5

Composition comments All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation	Move to fresh air. Keep victim at rest in a position comfortable for breathing. Call a physician if symptoms develop or persist.
Skin contact	Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation develops and persists.
Ingestion	Never give anything by mouth to a victim who is unconscious or is having convulsions. Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. Spray mist may irritate the respiratory system. Symptoms may include coughing, difficulty breathing and shortness of breath.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO_2).
Unsuitable extinguishing media	None known.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed. Combustion products may include: silicon oxides, metal oxides, sulfur oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store in a cool, dry, well-ventilated place. Maintain storage temperatures between 50°F to 140°F (10°C to 60°C). Store away from incompatible materials (see Section 10 of the SDS). Recommended storage containers: steel or plastic. Do not use containers made of aluminum, fiberglass, copper, brass, zinc or galvanized containers.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-3 (29 CFR 1910.1000)

Components	Type	Value
SILICON DIOXIDE (AMORPHOUS SILICA GEL) (CAS 63231-67-4)	TWA	0.8 mg/m3
		20 mppcf

US. ACGIH Threshold Limit Values

Components	Type	Value
Ferrous sulfate (CAS 7720-78-7)	TWA	1 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Ferrous sulfate (CAS 7720-78-7)	TWA	1 mg/m3
SILICON DIOXIDE (AMORPHOUS SILICA GEL) (CAS 63231-67-4)	TWA	6 mg/m3

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection To avoid contact with eyes, wear chemical goggles or shielded safety glasses.

Skin protection

Hand protection Wear appropriate chemical resistant gloves.

Other Wear appropriate chemical resistant clothing.

Respiratory protection If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Recommended use: Wear NIOSH approved respirator appropriate for airborne exposure at the point of use.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Liquid.

Form Liquid.

Color Green to dark blue.

Odor Odorless.

Odor threshold Not available.

pH 11 (10% solution/water)

Melting point/freezing point Not available.

Initial boiling point and boiling range Not available.

Flash point Not available.

Evaporation rate Not available.

Flammability (solid, gas) Not applicable.

Upper/lower flammability or explosive limits

Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	1.2 - 1.4
Solubility(ies)	
Solubility (water)	Miscible.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	< 10,000cP

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Hydrogen fluoride. Fluorine. Oxygen difluoride. Chlorine trifluoride. Strong acids. Strong bases. Oxidizers. Aluminum metal. Copper. Brass. Zinc. Galvanized metals.
Hazardous decomposition products	Thermal decomposition or combustion may produce: silicon oxides, metal oxides, sulfur oxides.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Prolonged inhalation may be harmful. Spray mists may cause respiratory tract irritation.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye irritation.
Ingestion	Ingestion may cause irritation and malaise.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. Inhalation may irritate lungs causing coughing and/or shortness of breath.

Information on toxicological effects

Acute toxicity	Not available.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Causes serious eye irritation.
Respiratory or skin sensitization	
Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

SILICON DIOXIDE (AMORPHOUS SILICA GEL) (CAS 63231-67-4) — 3 Not classifiable as to carcinogenicity to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.
Mobility in soil	This product is water soluble and may spread in the water system.
Other adverse effects	None known.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

US federal regulations	This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200. All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Ferrous sulfate (CAS 7720-78-7) LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)
Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List
Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)
Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List
Ferrous sulfate (CAS 7720-78-7)

US. New Jersey Worker and Community Right-to-Know Act
Ferrous sulfate (CAS 7720-78-7)

US. Pennsylvania Worker and Community Right-to-Know Law
Ferrous sulfate (CAS 7720-78-7)

US. Rhode Island RTK
Not regulated.

US. California Proposition 65
California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 02-April-2015

Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings
Health: 2
Flammability: 0
Physical hazard: 0

NFPA ratings

Disclaimer

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

REGENESIS
Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier **Oxygen Release Compound Advanced (ORC Advanced®)**
Other means of identification None.
Recommended use Soil and Groundwater Remediation.
Recommended restrictions None known.
Manufacturer/Importer/Supplier/Distributor information
Company Name Regenesis
Address 1011 Calle Sombra
San Clemente, CA 92673
Telephone 949-366-8000
E-mail CustomerService@regenesis.com
Emergency phone number CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Oxidizing solids	Category 2
Health hazards	Skin corrosion/irritation	Category 1
	Serious eye damage/eye irritation	Category 1
OSHA defined hazards	Not classified.	

Label elements

Signal word Danger
Hazard statement May intensify fire; oxidizer. Causes skin irritation. Causes serious eye damage.
Precautionary statement
Prevention Keep away from heat. Keep/Store away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Wash thoroughly after handling. Wear protective gloves/eye protection/face protection.
Response If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse. In case of fire: Use appropriate media to extinguish.
Storage Store away from incompatible materials.
Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC) None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Calcium hydroxide oxide	682334-66-3	≥85
Calcium hydroxide	1305-62-0	≤15
Dipotassium Phosphate	7758-11-4	<5
Monopotassium Phosphate	7778-77-0	<5

Composition comments All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.
Eye contact	Do not rub eyes. Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Ingestion	Never give anything by mouth to a victim who is unconscious or is having convulsions. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes. Skin irritation. May cause redness and pain.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	Take off all contaminated clothing immediately. Contact with combustible material may cause fire. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media	Water spray, fog (flooding amounts). Foam. Dry chemical powder. Carbon dioxide (CO_2).
Unsuitable extinguishing media	None known.
Specific hazards arising from the chemical	Greatly increases the burning rate of combustible materials. Containers may explode when heated. During fire, gases hazardous to health may be formed. Combustion products may include: metal oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk. Use water spray to cool unopened containers.
Specific methods	Cool containers exposed to flames with water until well after the fire is out.
General fire hazards	May intensify fire; oxidizer. Contact with combustible material may cause fire.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep away from clothing and other combustible materials. Wear appropriate protective equipment and clothing during clean-up. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Collect dust using a vacuum cleaner equipped with HEPA filter. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Ventilate the contaminated area. Stop the flow of material, if this is without risk. Absorb in vermiculite, dry sand or earth and place into containers. Large Spills: Sweep up or vacuum up spillage and collect in suitable container for disposal. Shovel the material into waste container. Minimize dust generation and accumulation. Avoid the generation of dusts during clean-up. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. Place all material into loosely covered plastic containers for later disposal. For waste disposal, see section 13 of the SDS. Wear appropriate protective equipment and clothing during clean-up.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling Minimize dust generation and accumulation. Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces. Keep away from heat. Provide appropriate exhaust ventilation at places where dust is formed. Keep away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Avoid contact with water and moisture. Do not get this material in contact with eyes. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities Keep away from heat. Store in a cool, dry place out of direct sunlight. Store in original tightly closed container. Store in a well-ventilated place. Do not store near combustible materials. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Calcium hydroxide (CAS 1305-62-0)	PEL	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

US. ACGIH Threshold Limit Values

Components	Type	Value
Calcium hydroxide (CAS 1305-62-0)	TWA	5 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Calcium hydroxide (CAS 1305-62-0)	TWA	5 mg/m3

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. If engineering measures are not sufficient to maintain concentrations of dust particulates below the Occupational Exposure Limit (OEL), suitable respiratory protection must be worn. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection Use dust-tight, unvented chemical safety goggles when there is potential for eye contact.

Skin protection

Hand protection Wear appropriate chemical resistant gloves. Frequent change is advisable. Recommended gloves include rubber, neoprene, nitrile or viton.

Other Wear appropriate chemical resistant clothing.

Respiratory protection If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Recommended use: Wear respirator with dust filter.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Solid.

Form Powder.

Color White to pale yellow.

Odor	Odorless.
Odor threshold	Not available.
pH	12.5 (3% suspension/water)
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Oxidizer.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Slightly soluble
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	527 °F (275 °C)
Viscosity	Not available.
Other information	
Bulk density	0.5 - 0.9 g/ml
Explosive limit	Non-explosive.

10. Stability and reactivity

Reactivity	Greatly increases the burning rate of combustible materials.
Chemical stability	Decomposes on heating. Product may be unstable at temperatures above: 275°C/527°F.
Possibility of hazardous reactions	Reacts slowly with water.
Conditions to avoid	Heat. Moisture. Avoid temperatures exceeding the decomposition temperature. Contact with incompatible materials.
Incompatible materials	Acids. Bases. Salts of heavy metals. Reducing agents. Combustible material.
Hazardous decomposition products	Oxygen. Hydrogen peroxide (H_2O_2). Steam. Heat.

11. Toxicological information

Information on likely routes of exposure	
Inhalation	Dust may irritate respiratory system. Prolonged inhalation may be harmful.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye damage.
Ingestion	Ingestion may cause irritation and malaise.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity

Components	Species	Test Results
Calcium hydroxide (CAS 1305-62-0)		
Acute		
Oral		
LD50	Rat	7340 mg/kg

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Due to the physical form of the product it is not expected to be an aspiration hazard.

Chronic effects Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Components		Species	Test Results
Calcium hydroxide (CAS 1305-62-0)			
Aquatic			
Fish	LC50	Zambezi barbel (Clarias gariepinus)	33.8844 mg/l, 96 hours

Persistence and degradability Decomposes in the presence of water. The product contains inorganic compounds which are not biodegradable.

Bioaccumulative potential The product does not contain any substances expected to be bioaccumulating.

Mobility in soil This substance has very low solubility in water and low mobility in the environment.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number UN1479

UN proper shipping name Oxidizing solid, n.o.s. (Calcium hydroxide oxide)

Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Label(s)	5.1
Packing group	II
Environmental hazards	
Marine pollutant	No
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	62, IB8, IP2, IP4, T3, TP33
Packaging exceptions	152
Packaging non bulk	212
Packaging bulk	240

IATA

UN number	UN1479
UN proper shipping name	Oxidizing solid, n.o.s. (Calcium hydroxide oxide)
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	No
ERG Code	5L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1479
UN proper shipping name	OXIDIZING SOLID, N.O.S. (Calcium hydroxide oxide)
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	No
EmS	F-A, S-Q
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - Yes
Pressure Hazard - No
Reactivity Hazard - Yes

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Calcium hydroxide (CAS 1305-62-0)

US. New Jersey Worker and Community Right-to-Know Act

Calcium hydroxide (CAS 1305-62-0)
Calcium hydroxide oxide (CAS 682334-66-3)

US. Pennsylvania Worker and Community Right-to-Know Law

Calcium hydroxide (CAS 1305-62-0)

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 02-April-2015

Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings
Health: 3
Flammability: 0
Physical hazard: 2

NFPA ratings

Disclaimer

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

APPENDIX 4

HISTORICAL GROUNDWATER DATA

Historical Analytical Groundwater Data
Petro Stopping Centers #10
Tangipahoa Parish
Hammond, Louisiana

Well	Date Sampled	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (mg/L)	TPH-GRO (mg/L)	MTBE (mg/L)	C6-C8 Aliphatics (mg/L)	C8-C10 Aliphatics (mg/L)	C8-C10 Aromatics (mg/L)
MW-1	12/8/2005	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	3/22/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	6/12/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	9/29/2006	<0.001	<0.005	<0.005	<0.001	**0.0527**	0.0078			
	12/27/2006	<0.001	<0.005	<0.005	<0.001	<0.10	<0.005			
	3/13/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			
	6/22/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			
	9/25/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	0.007			
	12/19/2007	<0.001	<0.0050	<0.0050	<0.01	**0.2300**	0.005			
	6/4/2008	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005			
	9/16/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	11/26/2008	<0.005	<0.005	<0.005	<0.01	<0.1	<0.005			
	3/17/2009	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	6/29/2009	<0.005	0.01	<0.005	0.02	0.21	0.01			
	9/15/2009	0.02	0.18	0.03	0.19	**1.40**	<0.005			
	12/10/2009	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	3/26/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	6/10/2010	<0.005	0.06	0.019	0.103	**0.560**	<0.005	0.16	**0.18**	**0.22**
	9/16/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	12/20/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	3/21/2011	<0.005	0.0180	<0.005	0.0282	NA	<0.005	<0.03	<0.05	<0.05
	6/24/2011	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/23/2011	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	12/21/2011	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	3/14/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	6/21/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/21/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	12/20/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	3/25/2013	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	6/27/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/26/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	12/30/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	3/13/2014	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.03	<0.05	<0.05
	6/23/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/12/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	12/23/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.030	<0.050	<0.050
	6/29/2015	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/17/2015	NS	NS	NS	NS	NS	NS	NS	NS	NS

	3/28/2016	<0.001	<0.001	<0.001	<0.002	NA	<0.001	<0.15	<0.15	<0.15
	6/22/2016	NS	NS	NS	NS	NS	NS	NS	NS	NS
	3/22/2006	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			**PSH***
	6/12/2006	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			**PSH***
	9/29/2006	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			**PSH***
	12/27/2006	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			**PSH***
	3/17/2007	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			**PSH***
	6/22/2007	**0.67**	**3.40**	**1.00**	4.90	**15.00**	**0.95**			**9.84**
	9/25/2007	**0.99**	**3.80**	**0.82**	4.00	**20.00**	**2.10**			**12.26**
	12/19/2007	**0.53**	**1.80**	0.37	1.80	**11.00**	**0.97**			**6.40**
	3/5/2008	**0.28**	0.57	0.10	0.42	**6.20**	**0.55**			**3.26**
	6/4/2008	**0.18**	0.36	0.08	0.30	**3.20**	**0.29**			**1.74**
	9/16/2008	**0.26**	0.36	0.61	0.25	**5.50**	**0.29**			**2.74**
	11/26/2008	**0.46**	**2.60**	0.53	2.84	**15.00**	**0.25**			**2.88**
	3/17/2009	**2.40**	**13.00**	**2.70**	**16.30**	**240.00**	**1.30**			**16.45**
	6/24/2009	**0.30**	**2.10**	0.50	2.53	**17.00**	0.14			**8.89**
	9/15/2009	**0.39**	**1.80**	0.34	1.78	**15.00**	0.14			**7.63**
	12/10/2009	**0.23**	0.75	0.15	0.59	**5.5**	**0.30**			**2.93**
	3/26/2010	**1.60**	**4.00**	0.48	2.56	**24.0**	**2.80**	**7.8**	**3**	**9.69**
	6/10/2010	**4.10**	0.94	**1.20**	6.70	**84.0**	**5.10**	**24**	**9.2**	**31.02**
	9/16/2010	**3.40**	**7.90**	**0.75**	4.40	**72.0**	**3.50**	**19**	**6.5**	**24.78**
	12/20/2010	**3.30**	**8.50**	**0.88**	4.80	**45.00**	**1.90**	**16**	**5.8**	**17.00**
MW-2	3/21/2011	**1.70**	**7.30**	**2.00**	**15.60**	NA	**1.20**	**15**	**23**	**15.75**
	6/24/2011	**4.50**	**7.70**	**1.20**	7.50	NA	**1.80**	**18**	**8.6**	**5.85**
	9/23/2011	**0.94**	**5.10**	**0.71**	2.90	NA	**0.24**	**7.9**	**7**	**2.79**
	12/21/2011	**1.60**	**3.60**	**0.43**	2.68	NA	**0.60**	**7.7**	**3.4**	**2.10**
	3/14/2012	**1.00**	**3.90**	**0.75**	4.40	NA	**0.34**	**5.4**	**3.9**	**4.28**
	6/21/2012	**0.61**	**1.20**	0.14	1.040	NA	<0.005	2.6	**3.5**	**0.81**
	9/21/2012	**0.28**	0.60	0.075	0.42	NA	**0.21**	1.8	**0.68**	**0.32**
	12/20/2012	**0.540**	**0.930**	0.110	0.480	NA	**0.42**	**29**	**10**	**1.601**
	3/25/2013	**2.100**	**5.200**	0.290	1.980	NA	**1.20**	6.4	**1.8**	**1.075**
	6/27/2013	**2.000**	**4.100**	0.330	1.840	NA	**0.57**	11	**3.1**	**6.392**
	9/26/2013	**2.600**	**5.100**	0.360	2.130	NA	**0.86**	**10**	**2.8**	**7.739**
	12/30/2013	**2.500**	**7.300**	0.540	5.200	NA	**0.35**	**13**	**6.6**	**4.220**
	3/14/2014	**0.450**	**1.500**	0.190	1.520	NA	**0.32**	2.7	**1.8**	**1.390**
	6/23/2014	**0.460**	0.990	0.160	1.220	NA	**0.08**	2.7	**1.9**	**3.100**
	9/12/2014	**0.390**	**1.100**	0.120	1.370	NA	**0.08**	4.4	**3.4**	**4.700**
	12/23/2014	**0.570**	**1.300**	0.076	1.360	NA	**0.037**	2.6	**1.7**	**2.500**
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	**0.0141**	<0.030	<0.050	<0.050
	6/29/2015	**0.683**	**1.940**	0.149	1.300	NA	**0.108**	2.46	**1.18**	**1.51**
	9/17/2015	**1.590**	**4.680**	0.213	2.470	NA	**0.138**	4.220	**3.310**	**4.330**
	12/14/2015	**0.339**	**1.16**	0.086	0.665	NA	**0.044**	3.86	**1.74**	**2.29**
	3/28/2016	**1.270**	**4.470**	0.381	2.390	NA	**0.1380**	6.550	**3.080**	**3.860**
	6/22/2016	**1.080**	**3.850**	0.444	2.360	NA	**0.1230**	0.617	**0.309**	**0.393**
	12/8/2005	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***	**PSH***			

	3/22/2006	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	6/12/2006	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	9/29/2006	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	12/27/2006	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	3/17/2007	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	6/22/2007	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	9/25/2007	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	12/19/2007	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	3/5/2008	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	6/4/2008	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	9/16/2008	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	11/26/2008	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	3/17/2009	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	6/24/2009	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	9/15/2009	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	12/10/2009	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	3/26/2010	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	6/10/2010	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	9/16/2010	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*			
	12/20/2010	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*
MW-3	3/21/2011	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*	PSH*
	6/24/2011	1.60	5.70	0.7	3.6	NA	<0.005	9.5	5.2	6.5
	9/23/2011	1.60	3.30	0.6	2.9	NA	0.046	8.5	4.8	5.1
	12/21/2011	1.20	2.80	0.48	2.59	NA	<0.1	7.9	5.6	6.8
	3/14/2012	1.20	2.20	0.23	0.75	NA	0.079	5.0	3.0	3.4
	6/21/2012	1.60	6.10	1.50	7.30	NA	0.3	14.0	20.0	16.0
	9/21/2012	1.00	1.80	0.31	1.28	NA	0.260	10.0	4.8	5.1
	12/20/2012	1.500	3.000	0.650	2.680	NA	0.2	1.2	0.6	0.7
	3/25/2013	1.300	2.900	0.270	2.670	NA	0.1	4.1	2.5	2.8
	6/27/2013	0.590	2.100	0.190	0.920	NA	<0.1	3.9	2.1	2.1
	9/26/2013	2.000	7.700	0.910	4.400	NA	0.2	11.0	5.5	6.5
	12/30/2013	3.300	13.000	1.600	8.500	NA	0.96	20.0	13.0	17.0
	3/13/2014	1.600	4.300	1.000	5.400	NA	0.11	7.6	6.3	7.8
	6/23/2014	3.700	12.000	1.200	6.300	NA	<0.005	19.0	8.7	11.0
	9/12/2014	2.600	8.900	0.930	4.700	NA	<0.005	23.0	10.0	12.0
	12/23/2014	0.580	2.700	0.330	1.590	NA	<0.005	9.8	5.1	6.7
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	0.0293	<0.030	<0.050	<0.050
	6/29/2015	0.427	2.430	0.437	2.090	NA	0.0186	2.93	2.27	3.01
	9/17/2015	0.444	3.140	0.388	2.790	NA	0.0079	3.78	3.88	4.08
	12/14/2015	0.928	4.010	0.469	3.960	NA	0.0135	7.37	4.97	5.97
	3/28/2016	0.338	1.330	0.154	1.110	NA	<0.010	1.440	1.020	1.230
	6/22/2016	1.010	4.570	0.590	3.790	NA	0.0290	7.340	4.850	6.370
	6/12/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
MW-4	9/29/2006	<0.001	<0.005	<0.01	<0.01	<0.005	<0.005			
	12/27/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	3/17/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			

	6/22/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			
	9/25/2007	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	12/19/2007	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	3/5/2008	<0.005	<0.005	<0.005	<0.01	<0.10	<0.005			
	6/4/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	9/16/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	11/26/2008	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	3/17/2009	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	6/24/2009	<0.005	0.01	<0.005	0.02	0.20	<0.005			
	9/15/2009	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	12/10/2009	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	3/26/2010	<0.005	<0.005	<0.005	<0.005	<0.1	0.007	<0.03	<0.05	<0.05
	6/10/2010	<0.005	<0.005	<0.005	<0.005	<0.10	0.0097	<0.03	<0.05	<0.05
	9/16/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	12/20/2010	<0.005	<0.005	<0.005	<0.005	<0.10	0.0073	<0.03	<0.05	<0.05
	3/21/2011	<0.005	<0.005	<0.005	0.0079	NA	<0.005	<0.03	<0.05	<0.05
	6/24/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0074	<0.03	<0.05	<0.05
	9/23/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0110	<0.03	<0.05	<0.05
	12/21/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0059	<0.03	<0.05	<0.05
	3/14/2012	<0.005	<0.005	<0.005	<0.005	NA	0.0170	<0.03	<0.05	<0.05
	6/21/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/21/2012	<0.005	<0.005	<0.005	<0.005	NA	0.0150	<0.03	<0.05	<0.05
	12/20/2012	<0.005	<0.005	<0.005	<0.005	NA	0.0150	<0.03	<0.05	<0.05
	3/25/2013	<0.005	<0.005	<0.005	<0.005	NA	0.0120	<0.03	<0.05	<0.05
	6/27/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/26/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	12/30/2013	NS	NS	NS	NS	NS	NS	NS	NS	NS
	3/13/2014	<0.005	<0.005	<0.005	<0.005	NS	0.0130	<0.03	<0.005	<0.05
	6/23/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	9/12/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	12/23/2014	NS	NS	NS	NS	NS	NS	NS	NS	NS
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	**0.0580**	<0.030	<0.050	<0.050
	6/29/2015	0.0012	0.0108	0.009	0.0456	NA	0.0107	<0.15	<0.15	<0.15
	9/17/2015	<0.001	<0.001	<0.001	<0.002	NA	0.0134	<0.15	<0.15	<0.15
	12/14/2015	<0.001	<0.001	<0.001	<0.002	NA	0.0146	<0.15	<0.15	<0.15
	3/28/2016	<0.001	<0.001	<0.001	<0.002	NA	0.0061	<0.15	<0.15	<0.15
	6/22/2016	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-5	6/12/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	9/29/2006	<0.005	<0.005	<0.01	<0.01	<0.005	<0.005			
	12/27/2006	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	3/17/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			
	6/22/2007	<0.001	<0.0050	<0.0050	<0.01	<0.10	<0.0050			
	9/25/2007	<0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	12/19/2007	0.001	<0.005	<0.005	<0.01	<0.10	<0.005			
	3/5/2008	0.005	<0.005	<0.005	<0.01	<0.10	<0.005			
	6/4/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			

	9/16/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	11/26/2008	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	3/17/2009	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	6/24/2009	<0.005	<0.005	<0.005	0.02	**0.16**	<0.005			
	9/15/2009	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005			
	12/10/2009	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	3/26/2010	<0.005	<0.005	<0.005	<0.005	<0.1	<0.005	<0.03	<0.05	<0.05
	6/10/2010	<0.005	0.043	0.013	0.071	**0.46**	<0.005	0.083	0.13	**0.15**
	9/16/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	12/20/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	3/21/2011	<0.005	0.0054	<0.005	0.0056	NA	<0.005	<0.03	<0.05	<0.05
	6/24/2011	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/23/2011	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	12/21/2011	<0.005	<0.005	<0.005	<0.005	NA	0.006	<0.03	<0.05	<0.05
	3/14/2012	<0.005	<0.005	<0.005	<0.005	NA	0.0092	<0.03	<0.05	<0.05
	6/21/2012	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/21/2012	<0.005	<0.005	<0.005	<0.005	NA	**0.0620**	<0.03	<0.05	<0.05
	12/20/2012	<0.005	<0.005	<0.005	<0.005	NA	**0.041**	<0.03	<0.05	<0.05
	3/25/2013	<0.005	<0.005	<0.005	<0.005	NA	**0.071**	<0.03	<0.05	<0.05
	6/27/2013	<0.005	<0.005	<0.005	<0.005	NA	**0.040**	<0.03	<0.05	<0.05
	9/26/2013	<0.005	0.007	<0.005	<0.005	NA	**0.043**	<0.03	<0.05	<0.05
	12/30/2013	<0.005	0.095	0.019	0.094	NA	**0.060**	<0.03	<0.05	<0.05
	3/13/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.040**	0.037	<0.05	<0.05
	6/23/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.035**	<0.03	<0.05	<0.05
	9/12/2014	<0.05	<0.05	<0.05	<0.05	NA	**0.029**	<0.03	<0.05	<0.05
	12/23/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.028**	<0.03	0.083	<0.05
	3/19/2015	0.0037	0.741	0.326	1.71	NA	**0.0508**	2.53	**3.14**	**4.31**
	6/29/2015	<0.001	<0.001	<0.001	<0.001	NA	0.0175	<0.15	<0.15	<0.15
	9/17/2015	<0.001	<0.001	<0.001	<0.002	NA	0.014	<0.15	<0.15	<0.15
	12/14/2015	<0.001	<0.001	<0.001	<0.002	NA	**0.0246**	<0.15	<0.15	<0.15
	3/28/2016	<0.001	<0.001	<0.001	<0.002	NA	0.0142	<0.15	<0.15	<0.15
	6/22/2016	<0.001	<0.001	<0.001	<0.002	NA	0.0075	<0.15	<0.15	<0.15
MW-6	6/4/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	9/16/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	11/26/2008	<0.005	<0.005	<0.005	<0.005	<0.1	0.012			
	3/17/2009	<0.005	<0.005	<0.005	<0.005	<0.1	0.007			
	6/24/2009	<0.005	<0.005	<0.005	<0.005	<0.1	0.012			
	9/15/2009	<0.005	<0.005	<0.005	0.01	<0.1	0.007			
	12/10/2009	<0.005	<0.005	<0.005	<0.005	<0.10	0.013			
	3/26/2010	<0.005	<0.005	<0.005	<0.005	<0.10	0.011	<0.03	<0.05	<0.05
	6/10/2010	<0.005	0.035	0.012	0.068	**0.43**	0.0085	0.074	0.11	0.14
	9/16/2010	<0.005	<0.005	<0.005	<0.005	**0.23**	0.011	<0.03	<0.05	<0.05
	12/20/2010	**0.0093**	0.130	0.028	0.120	**0.72**	0.0110	0.21	**0.19**	**0.22**
	3/21/2011	<0.005	0.009	<0.005	0.018	NA	0.0086	<0.03	<0.05	<0.05
	6/24/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0097	<0.03	<0.05	<0.05
	9/23/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0086	<0.03	<0.05	<0.05

	12/21/2011	<0.005	<0.005	<0.005	<0.005	NA	0.0100	<0.03	<0.05	<0.05
	3/14/2012	<0.005	<0.005	<0.005	<0.005	NA	0.0110	<0.03	<0.05	<0.05
	6/21/2012	<0.005	<0.005	<0.005	<0.005	<0.10	0.0110	<0.03	<0.05	<0.05
	9/21/2012	<0.005	<0.005	<0.005	<0.005	<0.10	0.020	<0.03	<0.05	<0.05
	12/20/2012	<0.005	<0.005	<0.005	<0.005	NA	**0.031**	<0.03	<0.05	<0.05
	3/25/2013	<0.005	<0.005	<0.005	<0.005	NA	**0.054**	<0.03	<0.05	<0.05
	6/27/2013	<0.005	<0.005	<0.005	<0.005	NA	**0.078**	<0.03	<0.05	<0.05
	9/26/2013	<0.005	<0.005	<0.005	<0.005	NA	**0.130**	<0.03	<0.05	<0.05
	12/30/2013	<0.005	0.015	<0.005	0.008	NA	**0.120**	<0.03	<0.05	<0.05
	3/13/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.066**	<0.03	<0.05	<0.05
	6/23/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.130**	<0.03	<0.05	<0.05
	9/12/2014	<0.05	<0.05	<0.05	<0.05	NA	**0.110**	<0.03	<0.05	<0.05
	12/23/2014	<0.005	<0.005	<0.005	<0.005	NA	**0.084**	<0.03	<0.05	<0.05
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	<0.0010	<0.030	<0.050	<0.050
	6/29/2015	<0.001	<0.001	<0.001	<0.001	NA	<0.001	<0.15	<0.15	<0.15
	9/17/2015	<0.001	<0.001	<0.001	<0.002	NA	**0.069**	<0.15	<0.15	<0.15
	12/14/2015	<0.001	<0.001	<0.001	<0.002	NA	**0.082**	<0.15	<0.15	<0.15
	3/28/2016	<0.001	<0.001	<0.001	<0.002	NA	**0.0388**	<0.15	<0.15	<0.15
	6/22/2016	<0.001	<0.001	<0.001	<0.002	NA	**0.0239**	<0.15	<0.15	<0.15
MW-7	6/4/2008	**0.10**	0.36	0.03	0.16	**1.70**	0.01			
	9/16/2008	**0.35**	0.93	0.13	0.56	**6.10**	**0.07**			
	11/26/2008	**0.23**	0.53	0.09	0.36	**3.20**	**0.028**			
	3/17/2009	**0.29**	0.99	0.15	0.67	**11.00**	<0.05			
	6/24/2009	**0.17**	0.52	0.06	0.28	**3.70**	**0.04**			
	9/15/2009	**0.54**	**1.70**	0.17	0.88	**9.00**	**0.06**			
	12/10/2009	<0.005	<0.005	**6.01**	<0.005	<0.10	<0.005			
	3/26/2010	**1.20**	**5.00**	0.42	2.32	**3.0**	**0.220**	**11**	**4.2**	**5.8**
	6/10/2010	**1.400**	**5.700**	0.62	3.300	**36.00**	**0.260**	**11**	**4.4**	**5.5**
	9/16/2010	**1.30**	**5.80**	0.55	2.82	**39**	**0.290**	**11**	**4.4**	**5.1**
	12/20/2010	**0.930**	**4.300**	0.51	2.230	**21.0**	**0.200**	7.9	**3.5**	**4.3**
	3/21/2011	**0.79**	**4.70**	0.47	2.110	NA	**0.140**	9.1	**4.1**	**5.2**
	6/24/2011	**0.430**	**2.60**	0.27	1.140	NA	**0.140**	2.9	**1.1**	**1.4**
	9/23/2011	**0.48**	**2.70**	0.35	1.390	NA	**0.110**	4.7	**2.1**	**2.2**
	12/21/2011	**0.150**	**1.60**	0.26	1.06	NA	**0.019**	2.4	**1.3**	**1.5**
	3/14/2012	**0.045**	**0.680**	0.12	0.40	NA	**<0.025**	1.3	**0.76**	**0.92**
	6/21/2012	**0.120**	**1.40**	0.22	0.79	NA	**0.017**	0.91	**4.2**	**3.8**
	9/21/2012	**0.057**	0.90	0.12	0.47	NA	0.015	1.2	**0.57**	**0.53**
	12/20/2012	**0.049**	0.390	0.130	0.460	NA	0.018	1.4	**0.95**	**0.91**
	3/25/2013	**0.190**	**1.900**	0.240	1.050	NA	**0.053**	2.4	**1**	**0.64**
	6/27/2013	**0.180**	**3.000**	0.390	1.770	NA	**<0.1**	4.2	**3**	**2.7**
	9/26/2013	**0.140**	0.840	0.270	1.040	NA	**0.120**	1.9	**1.4**	**1.8**
	12/30/2013	<0.005	0.810	0.170	0.900	NA	**0.073**	1.3	**1.2**	**1.4**
	3/13/2014	**0.048**	**2.700**	0.490	2.280	NA	**0.060**	4.2	**3.5**	**3.9**
	6/23/2014	<0.005	**1.300**	0.190	2.120	NA	**0.071**	2.2	**2.4**	**3**
	9/12/2014	<0.05	<0.05	<0.05	<0.05	NA	<0.005	<0.03	<0.05	<0.05
	12/23/2014	<0.005	0.34	0.21	0.93	NA	**0.065**	0.78	**1.2**	**1.5**

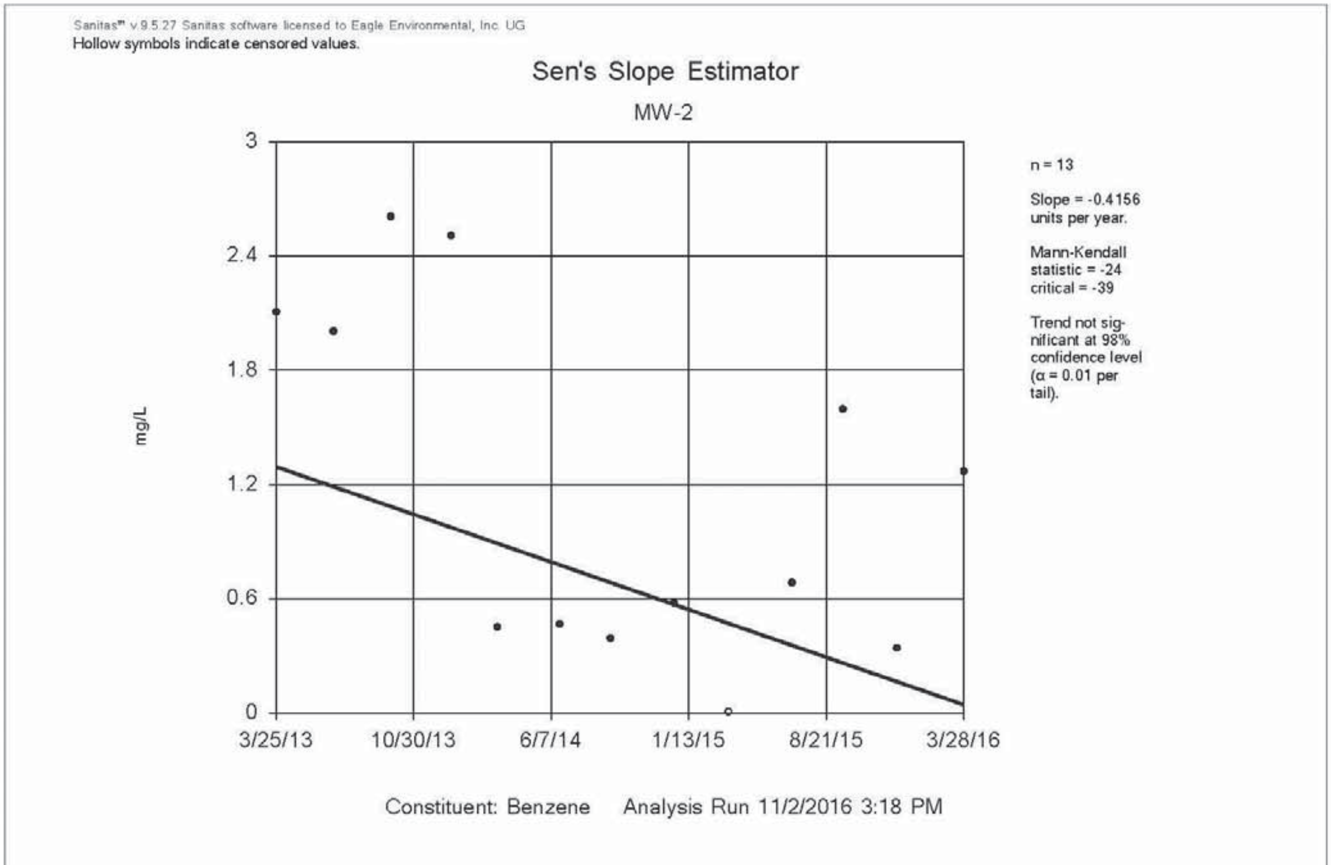
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	<0.0010	<0.030	<0.050	<0.050
	6/29/2015	<0.005	0.781	0.409	1.930	NA	**0.0484**	0.818	**2.03**	**2.48**
	9/17/2015	<0.001	0.384	0.172	1.470	NA	**0.0437**	1.050	**1.840**	**2.430**
	12/14/2015	<0.001	0.155	0.106	0.742	NA	**0.0645**	0.422	**0.761**	**0.917**
	3/28/2016	<0.001	0.187	0.105	0.674	NA	**0.0463**	0.748	**1.250**	**1.530**
	6/22/2016	<0.001	0.390	0.194	1.370	NA	**0.0294**	1.100	**1.860**	**2.600**
	6/4/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	9/16/2008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
	11/26/2008	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	3/17/2009	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	6/24/2009	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005			
	9/15/2009	<0.005	0.01	<0.005	0.02	**0.16**	<0.005			
	12/26/2009	**0.150**	0.750	0.082	0.320	**4.0**	**0.023**			
	3/26/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	6/10/2010	**0.005**	0.088	0.024	0.138	**0.62**	<0.005	0.12	**0.16**	**0.19**
	9/16/2010	<0.005	<0.005	<0.005	<0.005	<0.10	<0.005	<0.03	<0.05	<0.05
	12/20/2010	**0.041**	0.420	0.059	0.254	**1.90**	<0.005	0.65	**0.37**	**0.42**
	3/21/2011	<0.005	0.007	<0.005	0.0094	NA	<0.005	<0.03	<0.05	<0.05
	6/24/2011	<0.005	0.007	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/23/2011	**0.022**	0.210	0.023	0.084	NA	<0.005	0.32	0.13	0.12
	12/21/2011	**0.0150**	0.1900	0.0160	0.0670	NA	<0.005	0.46	0.26	**0.19**
	3/14/2012	**<0.005**	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
MW-8	6/21/2012	**0.0150**	0.3000	0.0300	0.1210	NA	<0.005	0.068	**0.5**	0.14
	9/21/2012	<0.005	0.130	0.019	0.073	NA	<0.005	0.2	0.13	0.16
	12/20/2012	<0.005	0.100	0.013	0.056	NA	<0.005	0.19	0.099	**0.2**
	3/25/2013	**0.011**	0.260	0.039	0.159	NA	<0.005	0.46	0.27	0.27
	6/27/2013	**0.068**	1.100	0.130	0.590	NA	0.046	1.4	0.92	1.1
	9/26/2013	**0.009**	0.073	0.021	0.077	NA	<0.005	0.12	0.11	0.12
	12/30/2013	<0.005	0.140	0.022	0.114	NA	<0.005	0.2	0.17	**0.19**
	3/13/2014	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	6/23/2014	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	9/12/2014	<0.05	0.045	0.1	0.09	NA	<0.005	2.8	**3.1**	**3.6**
	12/23/2014	<0.005	<0.005	<0.005	<0.005	NA	<0.005	<0.03	<0.05	<0.05
	3/19/2015	<0.0010	<0.0010	<0.0010	<0.0010	NA	<0.0010	<0.030	<0.050	<0.050
	6/29/2015	<0.001	<0.001	<0.001	<0.001	NA	<0.001	<0.15	<0.15	<0.15
	9/17/2015	<0.001	<0.001	<0.001	<0.002	NA	<0.001	<0.15	<0.15	<0.15
	12/14/2015	<0.001	<0.001	<0.001	<0.002	NA	<0.001	<0.15	<0.15	<0.15
	3/28/2016	<0.001	<0.001	<0.001	<0.002	NA	<0.001	<0.15	<0.15	<0.15
	6/22/2016	NS	NS	NS	NS	NS	NS	NS	NS	NS

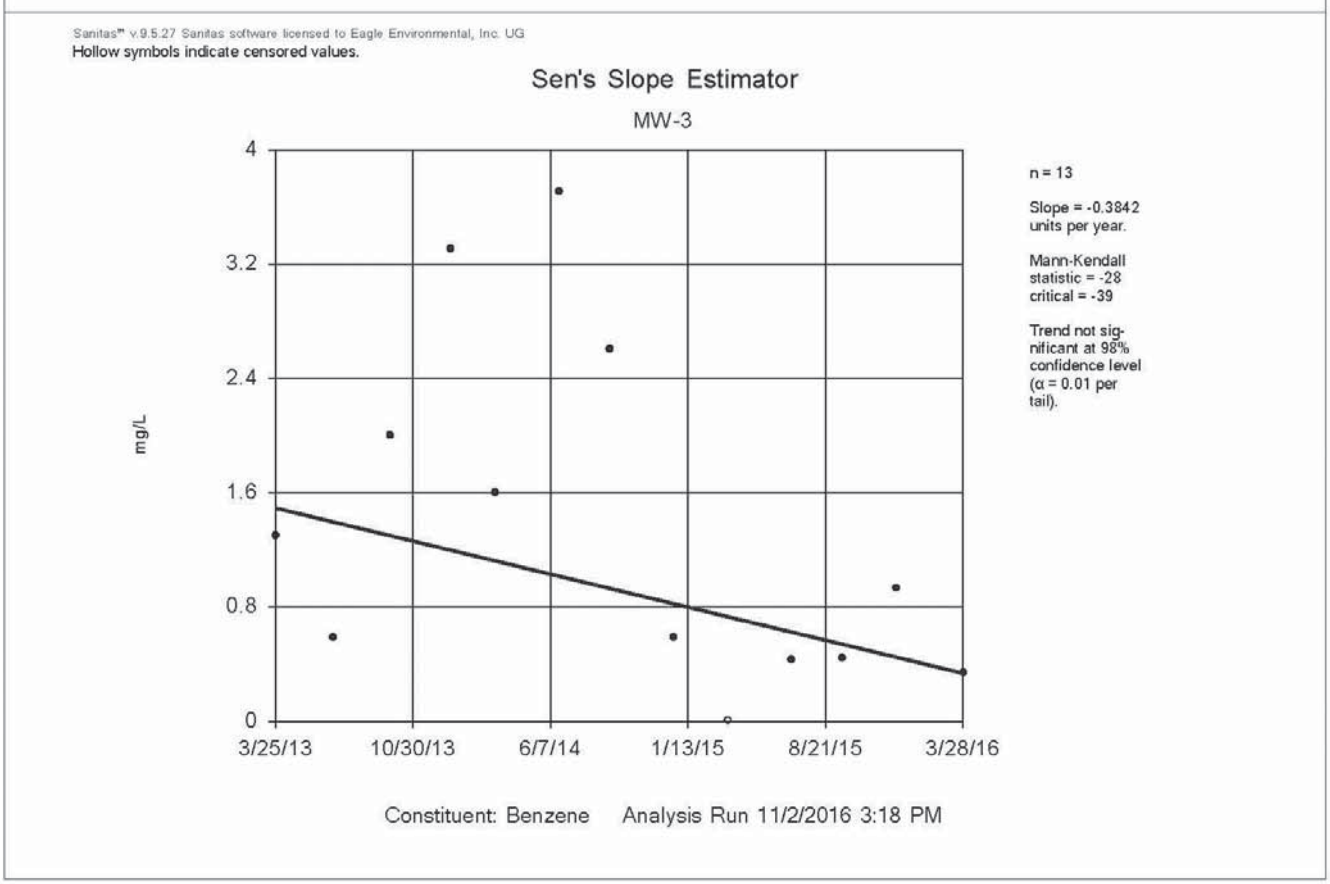
TPH-GRO Total Petroleum Hydrocarbons-Gasoline Range Organics (C6-C12)

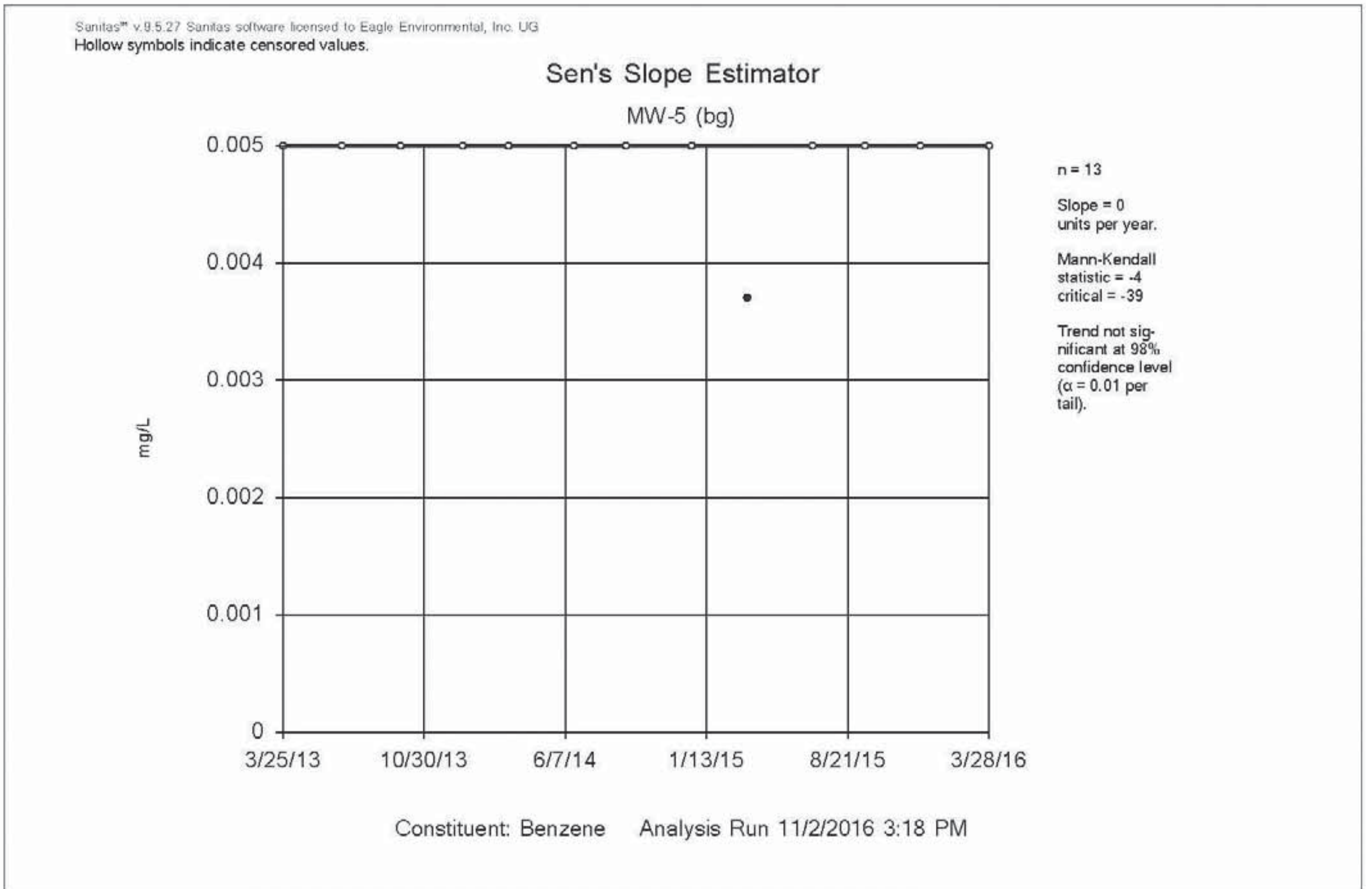
MTBE Methyl t-butyl ether

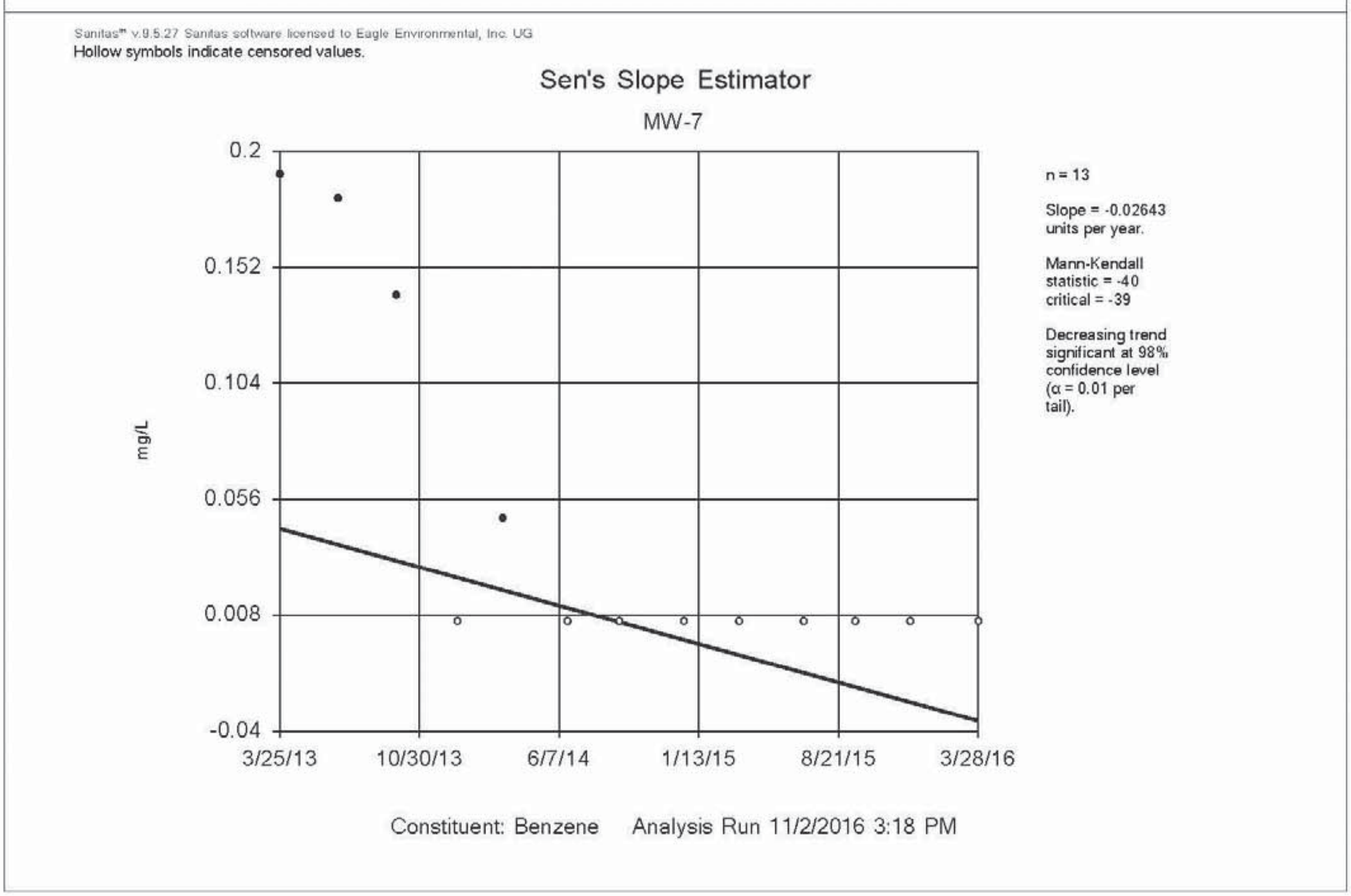
BTEX Benzene, Toluene, Ethylbenzene, Xylenes

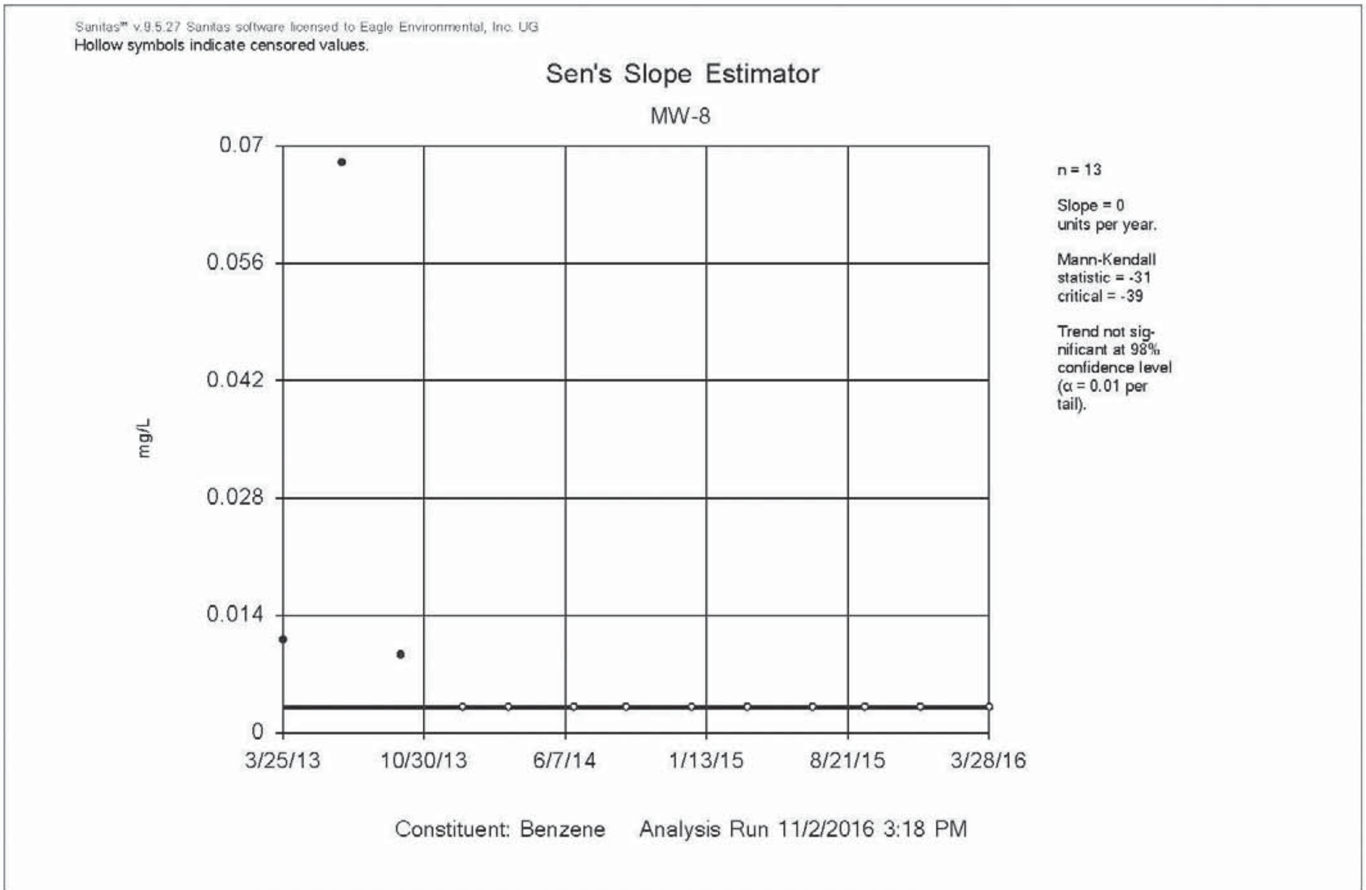
***** PSH observed in well

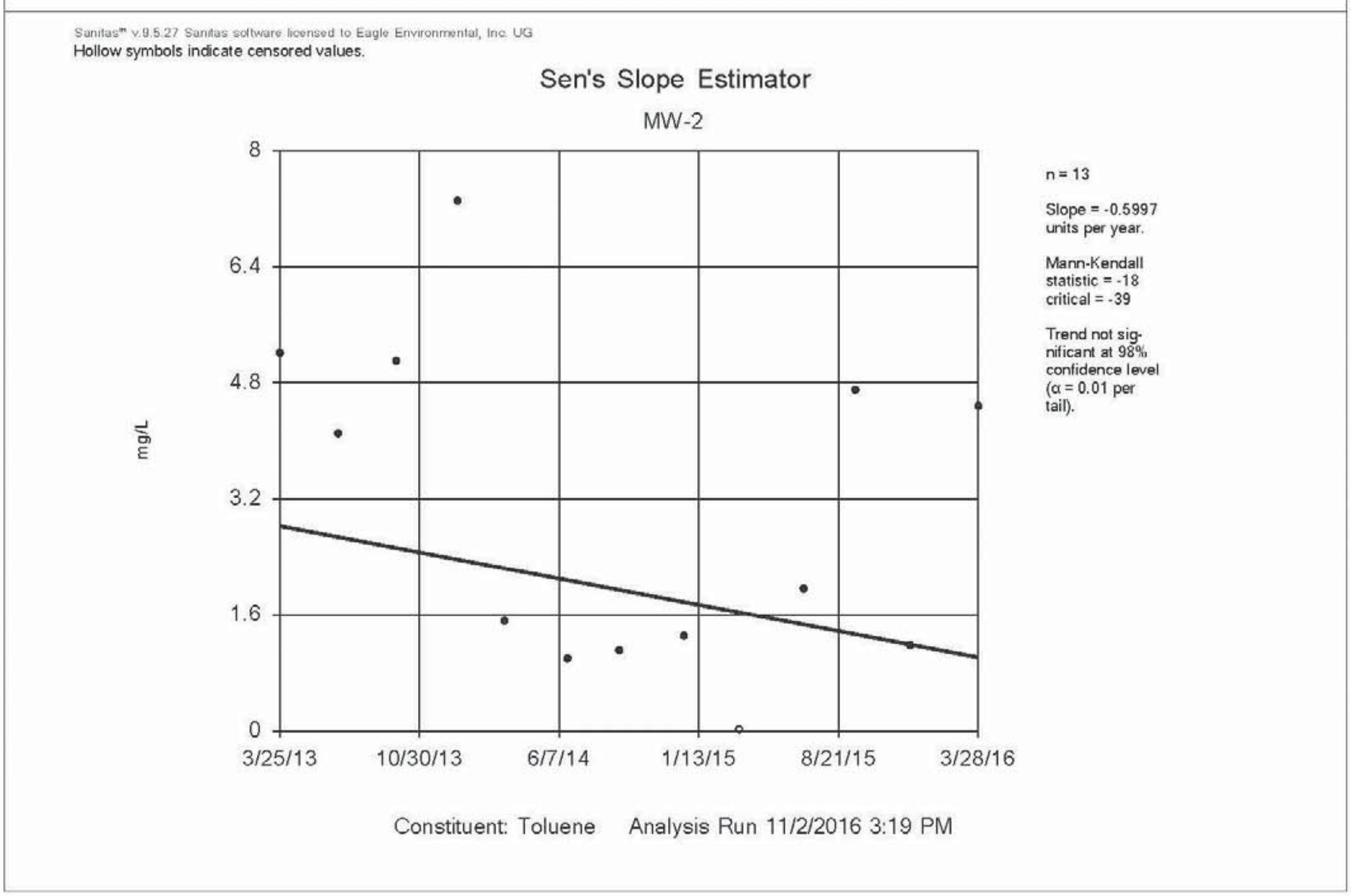

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
mg/L
3
2.4
1.8
1.2
0.6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.4156 units per year.
Mann-Kendall statistic = -24 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Benzene
Analysis Run 11/2/2016 3:18 PM

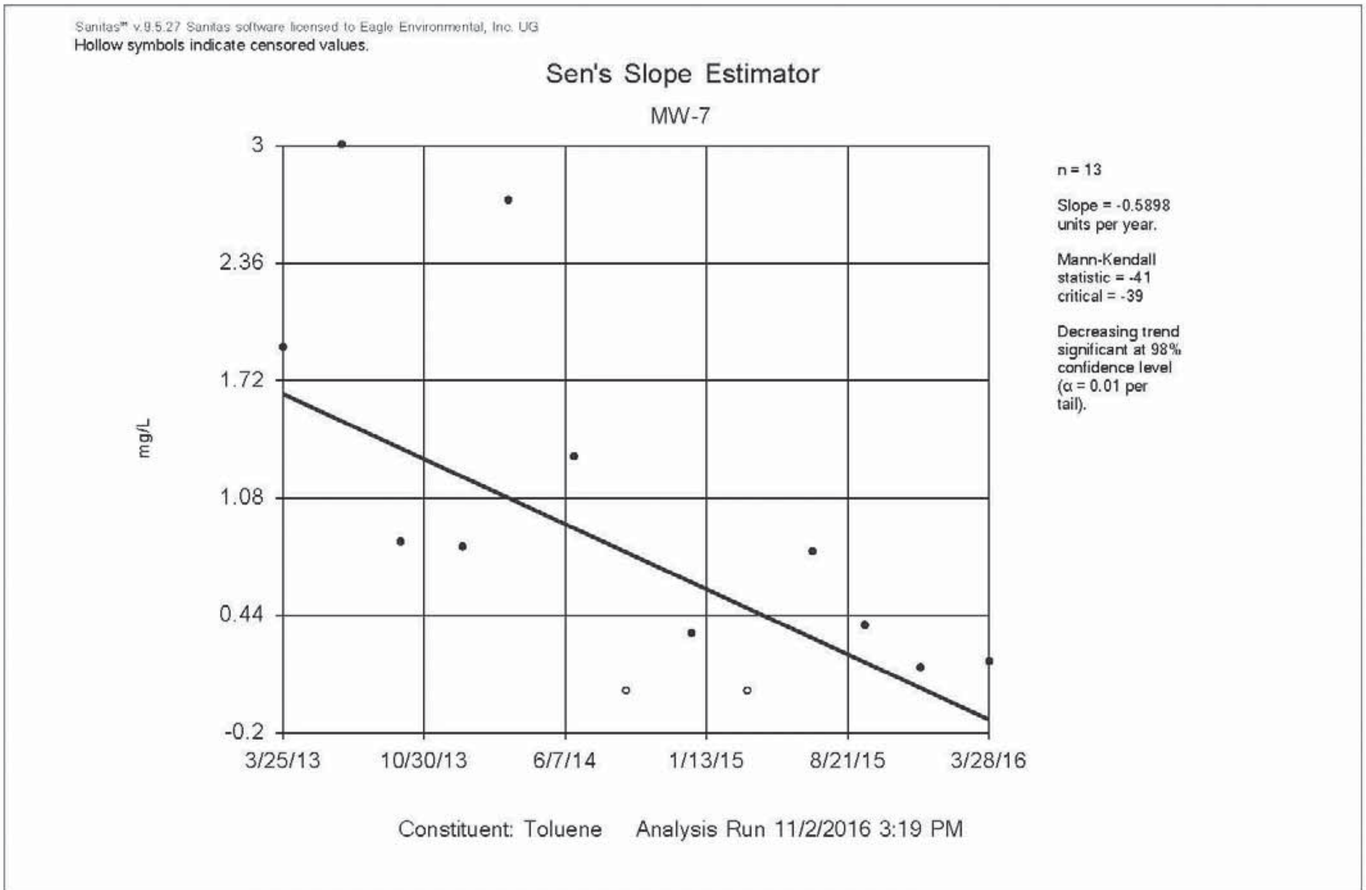

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-3
mg/L
4
3.2
2.4
1.6
0.8
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.3842 units per year.
Mann-Kendall statistic = -28 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Benzene
Analysis Run 11/2/2016 3:18 PM

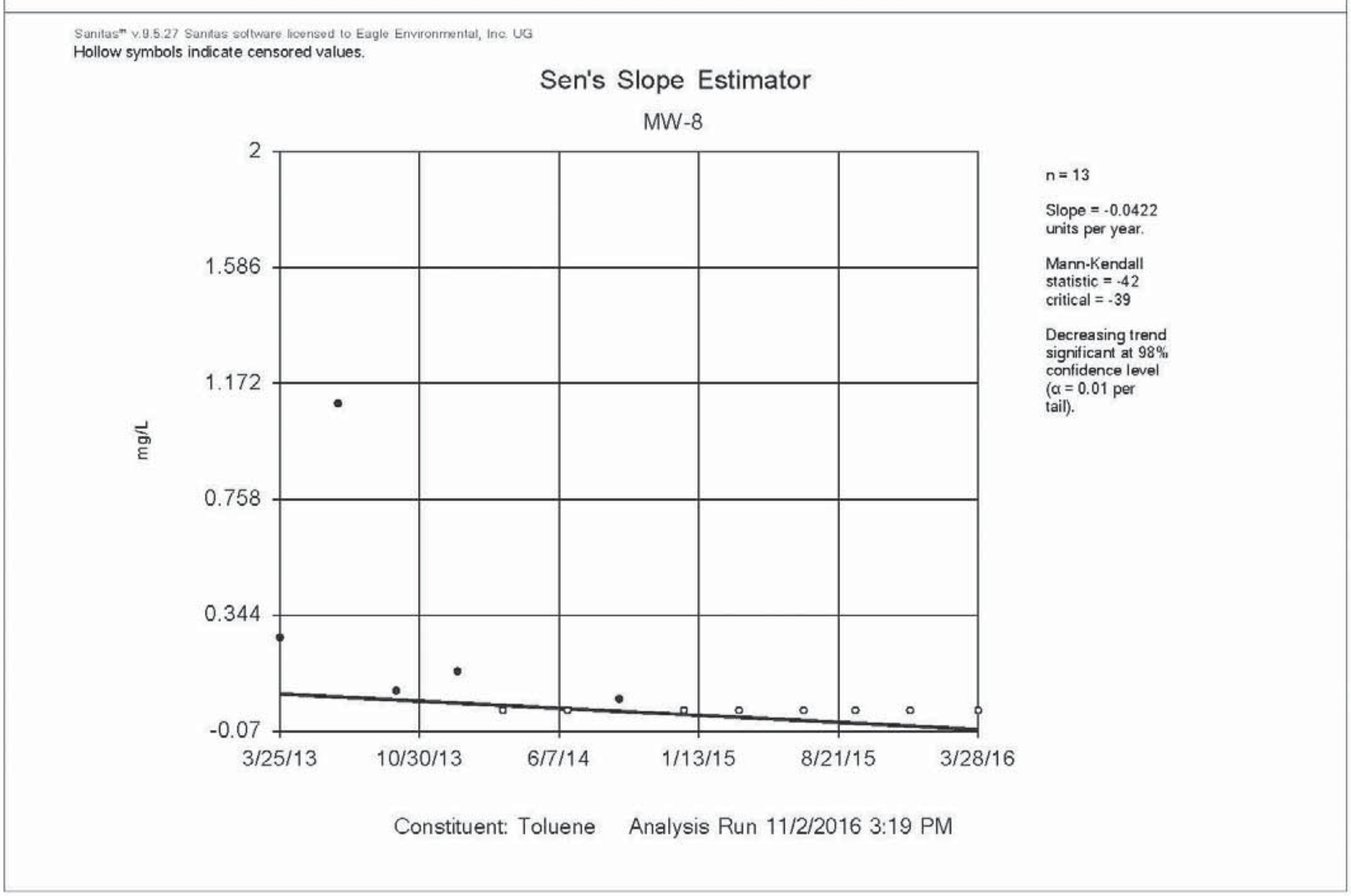

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-5 (bg)
0.005
0.004
0.003
0.002
0.001
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = 0
units per year.
Mann-Kendall
statistic = -4
critical = -39
Trend not sig-
nificant at 98%
confidence level
(α = 0.01 per
tail).
Constituent: Benzene
Analysis Run 11/2/2016 3:18 PM

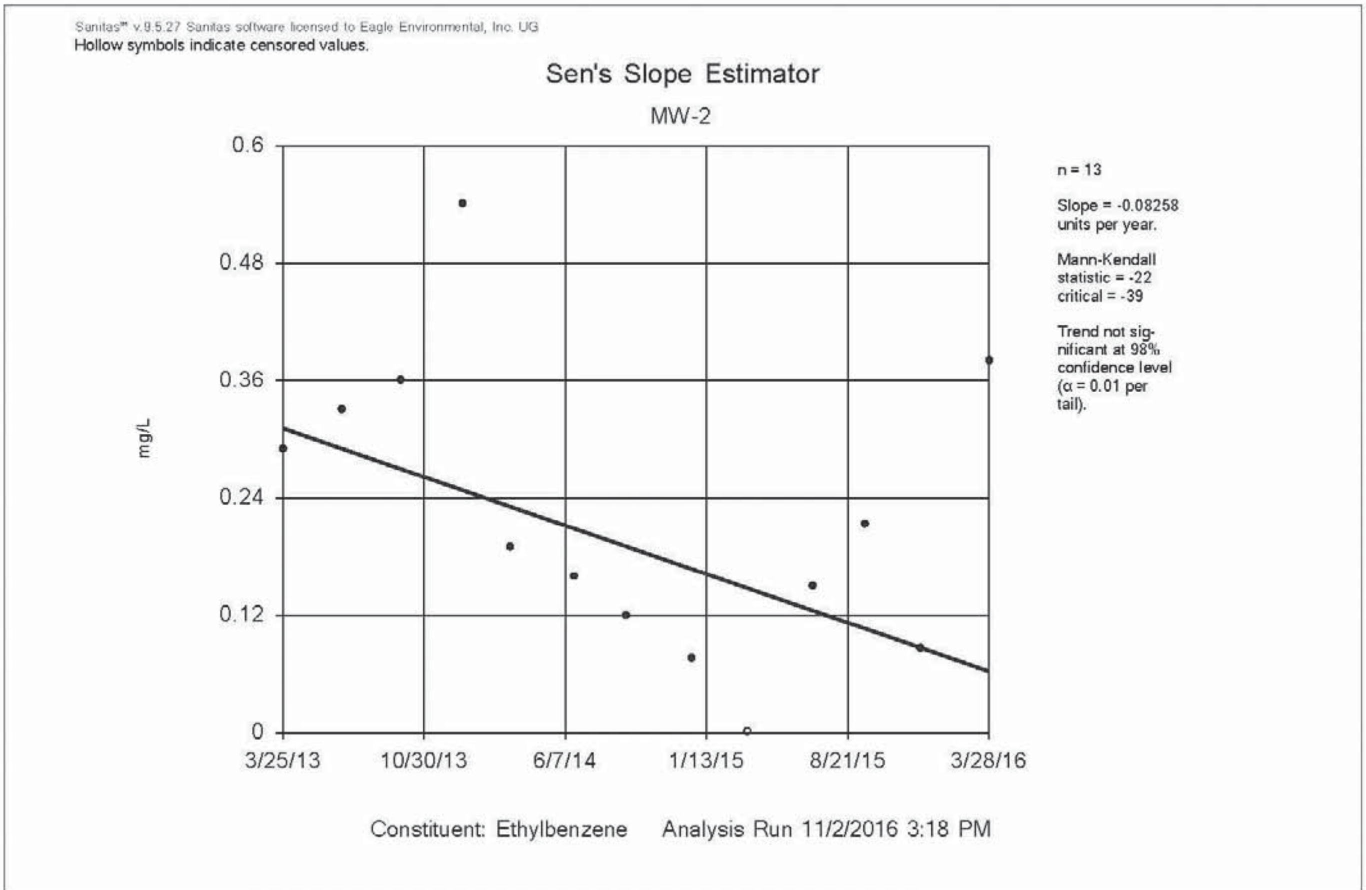

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
0.2
0.152
0.104
0.056
0.008
-0.04
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.02643
units per year.
Mann-Kendall
statistic = -40
critical = -39
Decreasing trend
significant at 98%
confidence level
(α = 0.01 per
tail).
Constituent: Benzene
Analysis Run 11/2/2016 3:18 PM

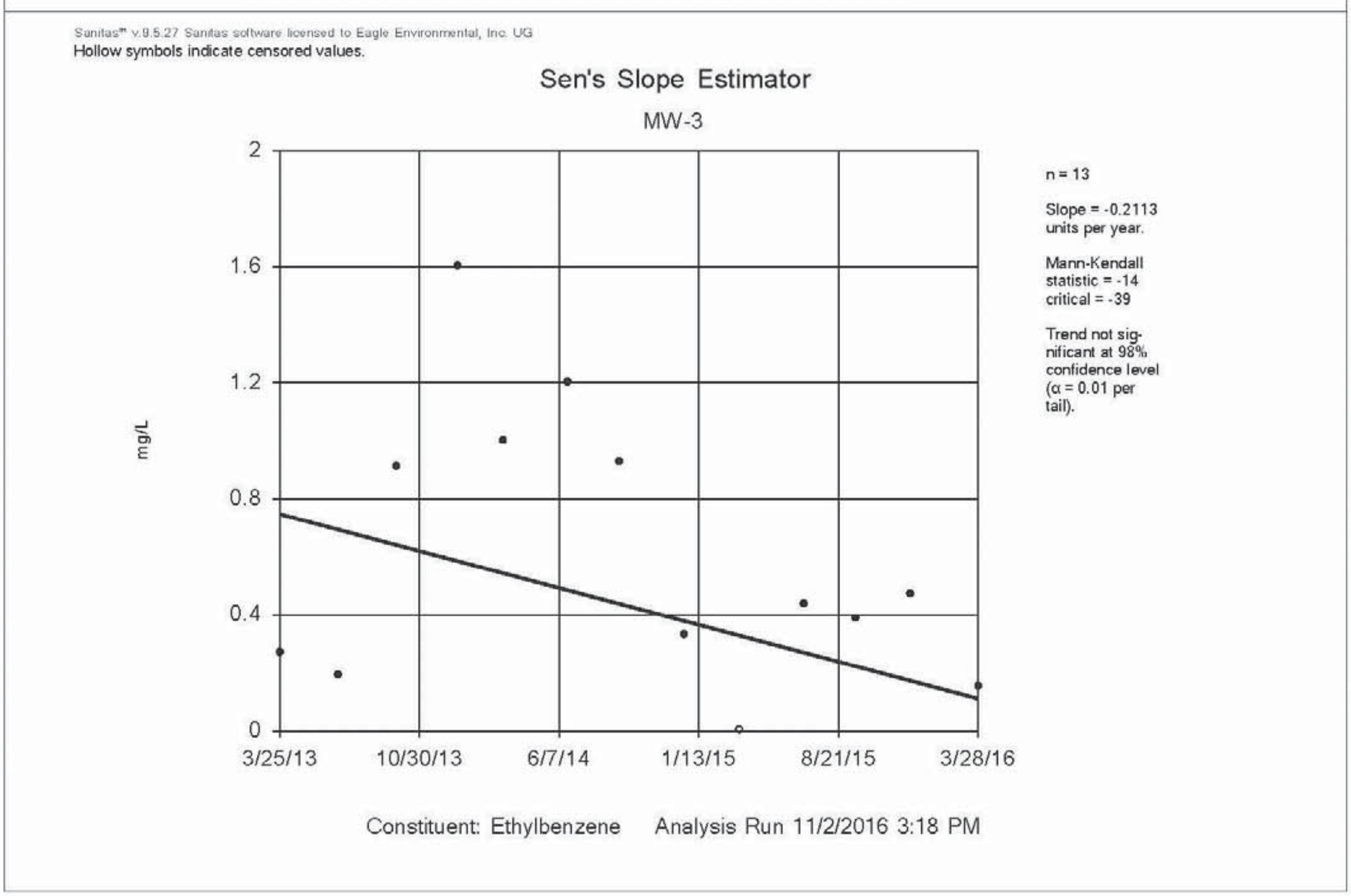

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
0.07
0.056
0.042
0.028
0.014
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = 0
units per year.
Mann-Kendall
statistic = -31
critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Benzene Analysis Run 11/2/2016 3:18 PM

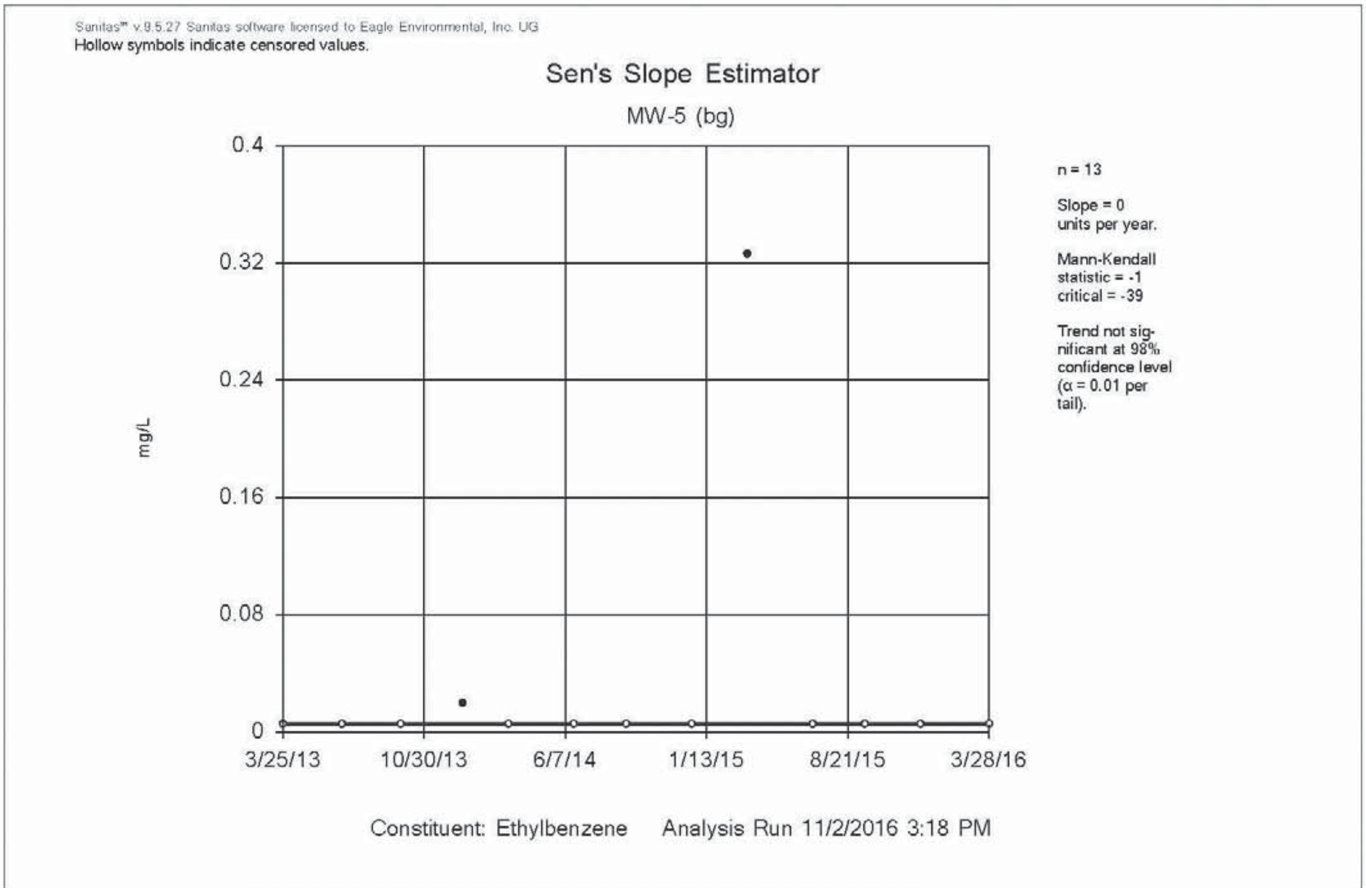

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
8
6.4
4.8
3.2
1.6
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.5997
units per year.
Mann-Kendall
statistic = -18
critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Toluene Analysis Run 11/2/2016 3:19 PM

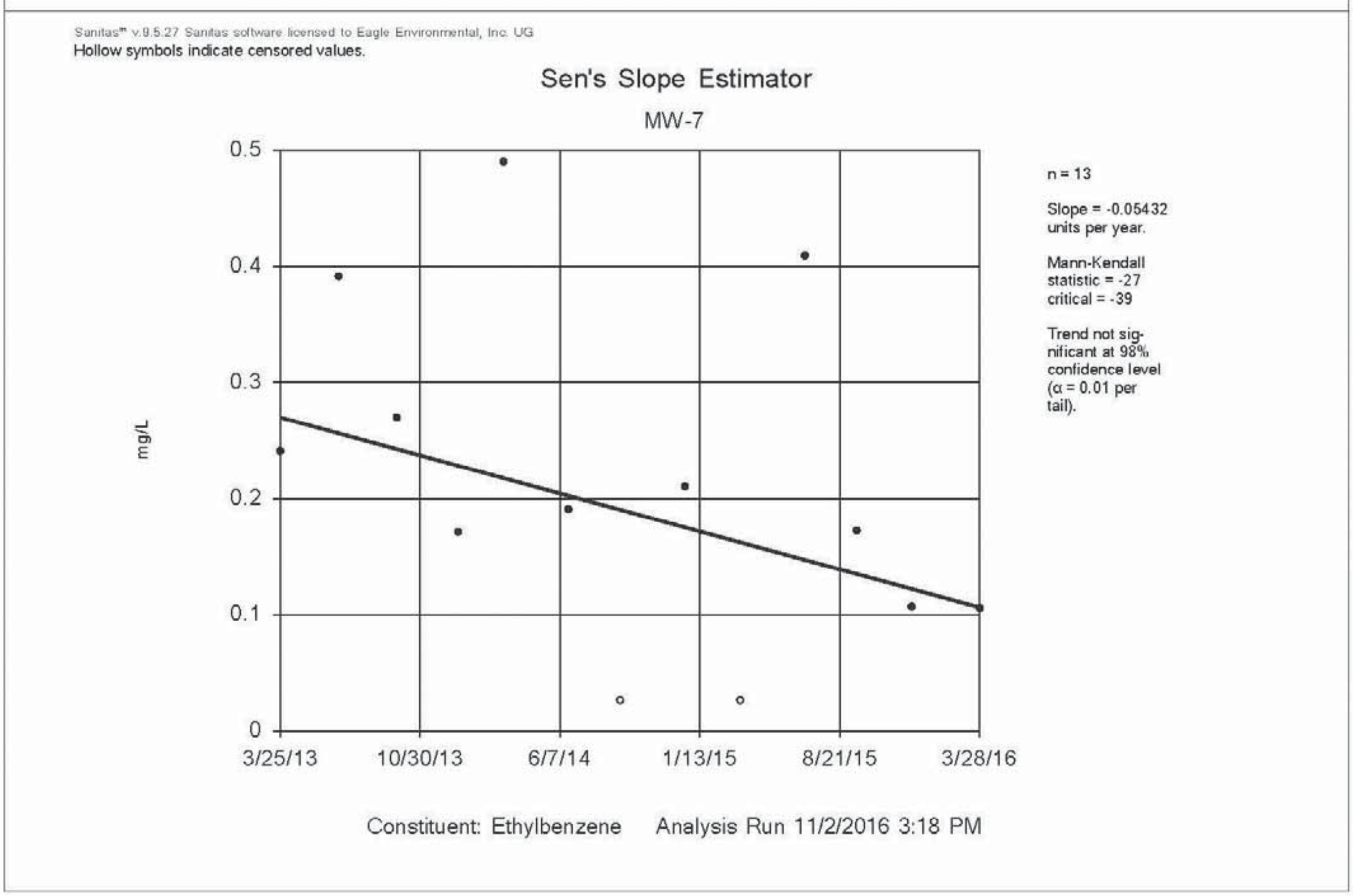

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
3
2.36
1.72
1.08
0.44
-0.2
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.5898 units per year.
Mann-Kendall statistic = -41 critical = -39
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).
Constituent: Toluene Analysis Run 11/2/2016 3:19 PM

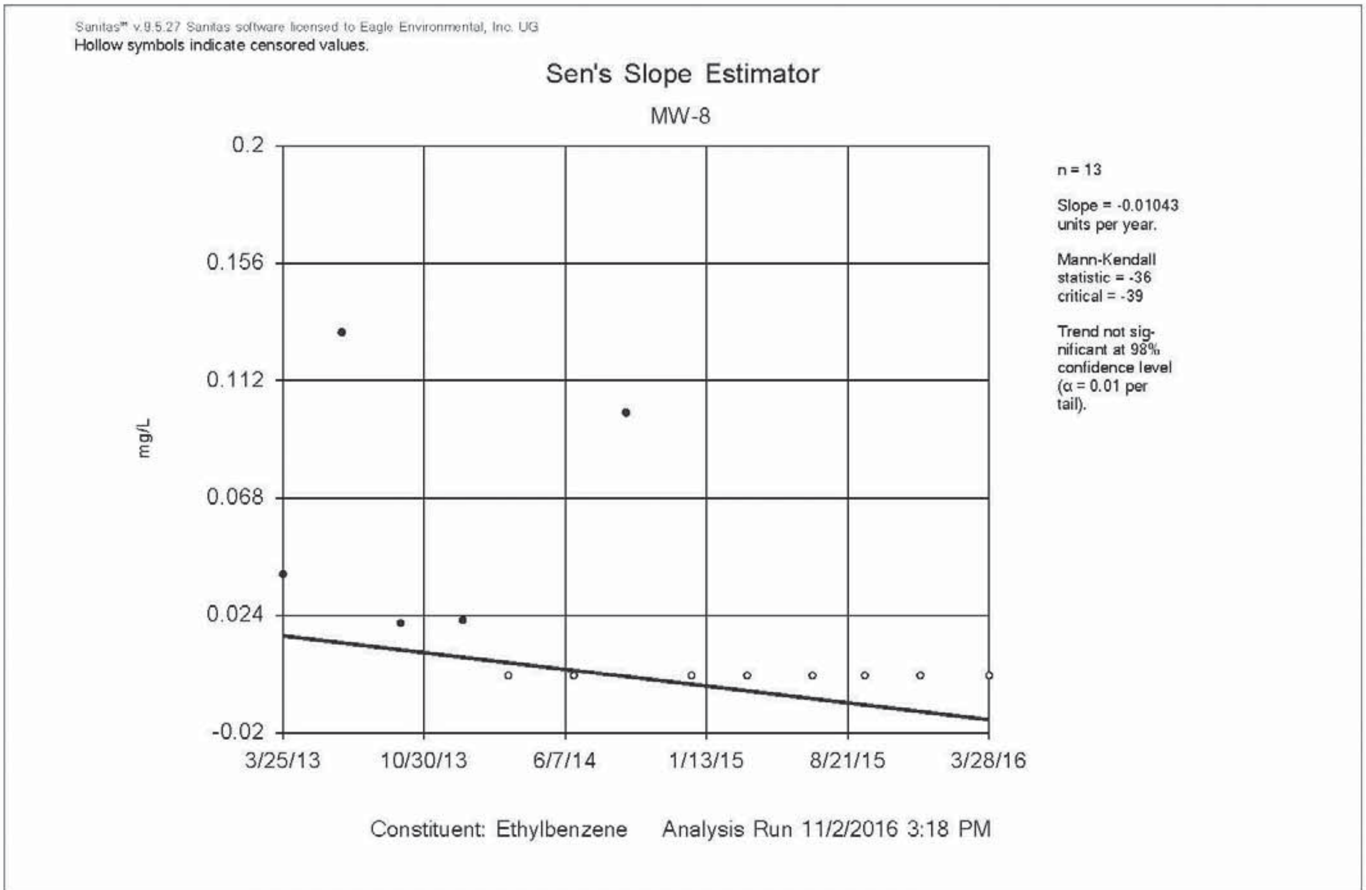

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
2
1.586
1.172
0.758
0.344
-0.07
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.0422 units per year.
Mann-Kendall statistic = -42 critical = -39
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).
Constituent: Toluene Analysis Run 11/2/2016 3:19 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
mg/L
0.6
0.48
0.36
0.24
0.12
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.08258 units per year.
Mann-Kendall statistic = -22 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Ethylbenzene
Analysis Run 11/2/2016 3:18 PM

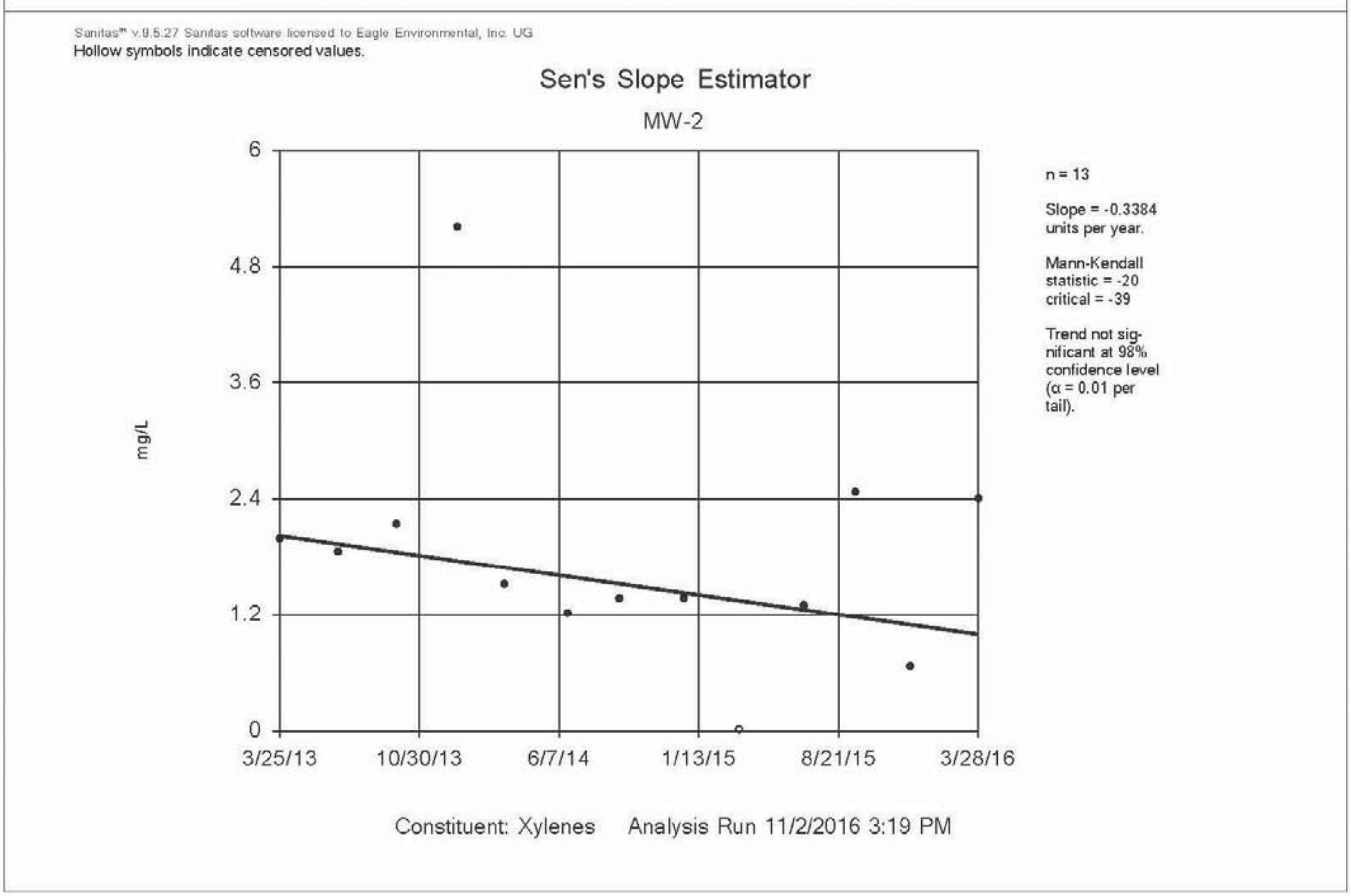

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-3
mg/L
2
1.6
1.2
0.8
0.4
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.2113 units per year.
Mann-Kendall statistic = -14 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Ethylbenzene
Analysis Run 11/2/2016 3:18 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-5 (bg)
0.4
0.32
0.24
0.16
0.08
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = 0
units per year.
Mann-Kendall
statistic = -1
critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Ethylbenzene
Analysis Run 11/2/2016 3:18 PM

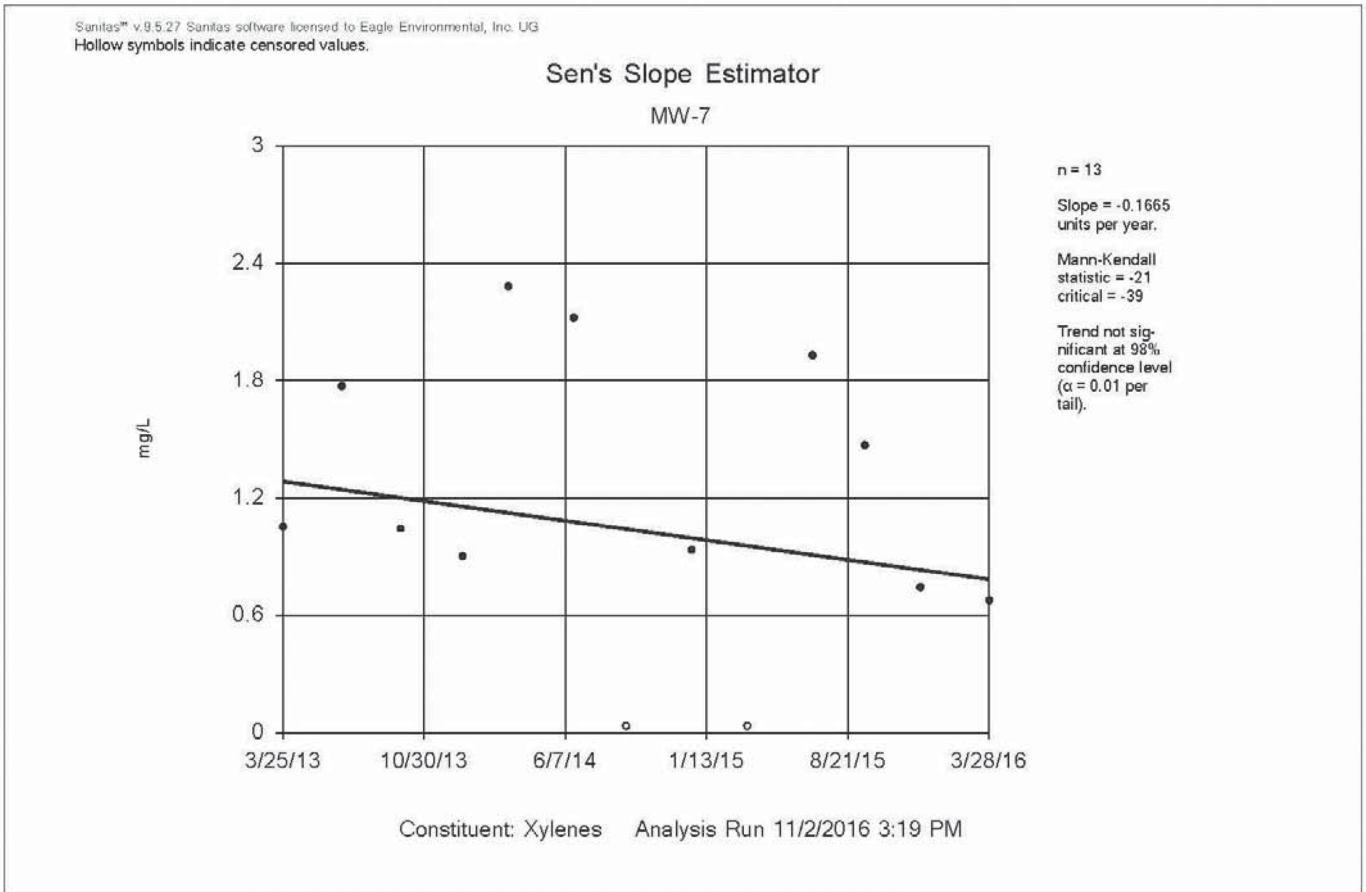

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
0.5
0.4
0.3
0.2
0.1
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.05432
units per year.
Mann-Kendall
statistic = -27
critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Ethylbenzene
Analysis Run 11/2/2016 3:18 PM

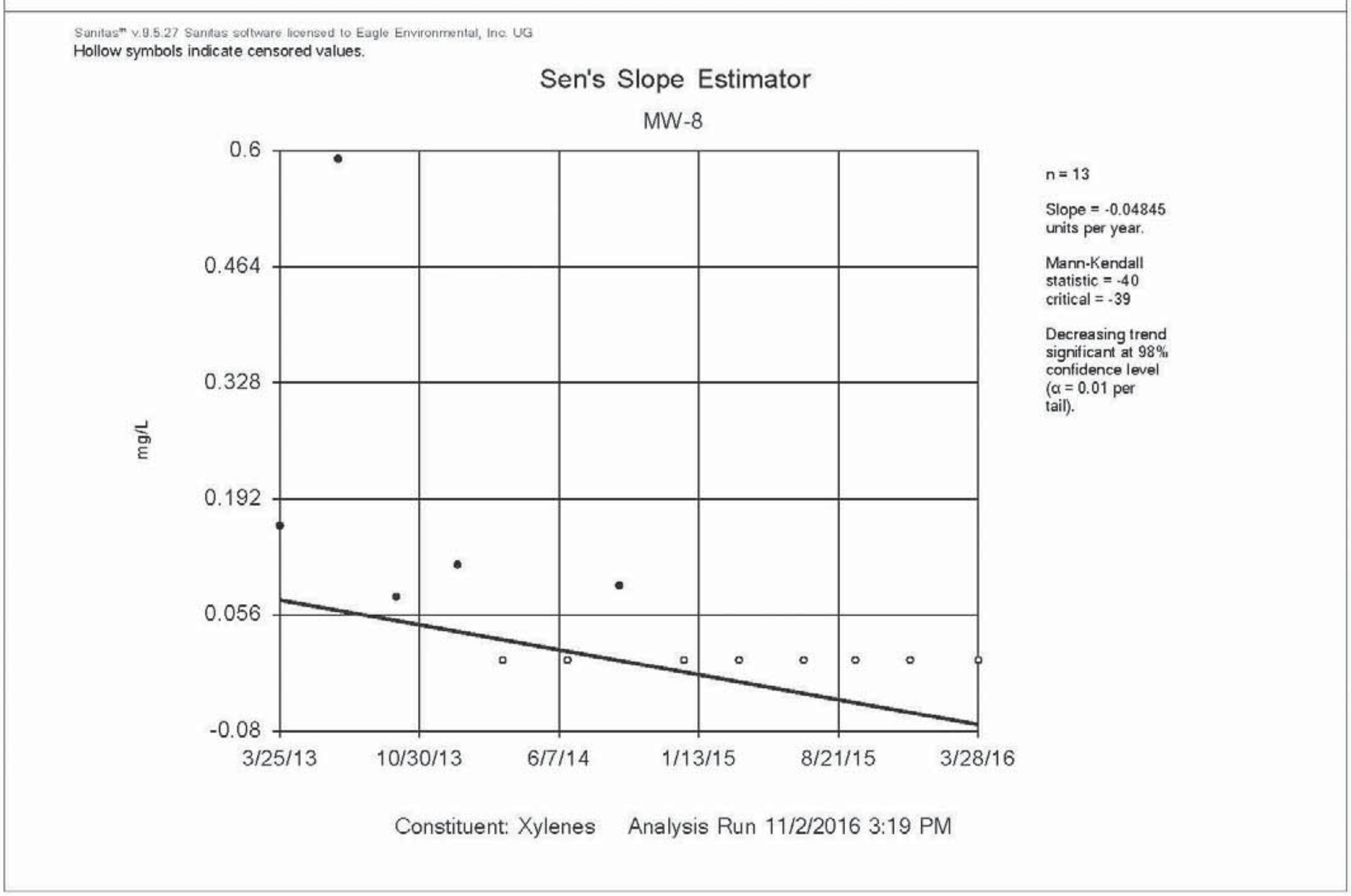


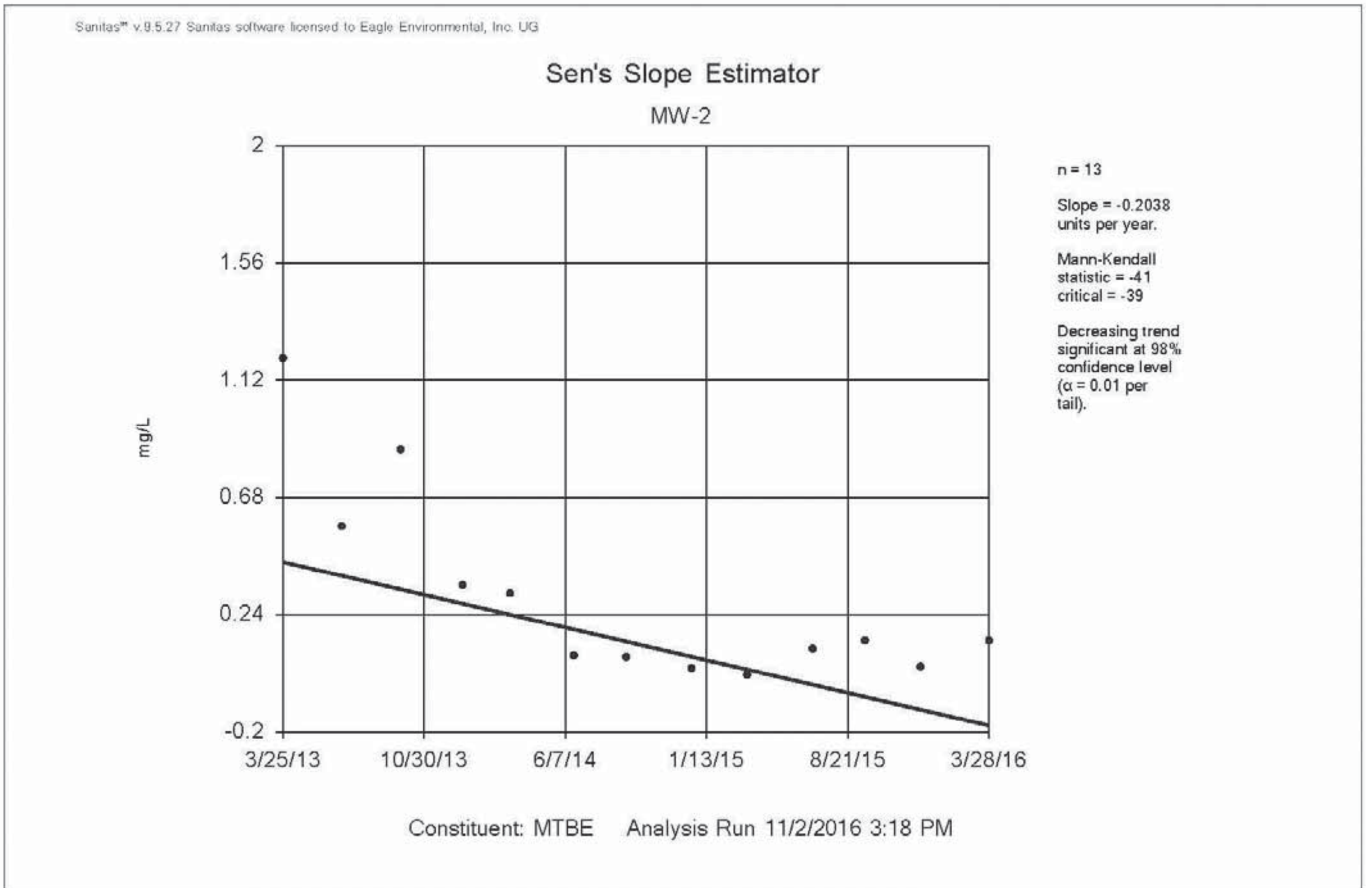
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
0.2
0.156
0.112
0.068
0.024
-0.02
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.01043 units per year.
Mann-Kendall statistic = -36 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Ethylbenzene Analysis Run 11/2/2016 3:18 PM

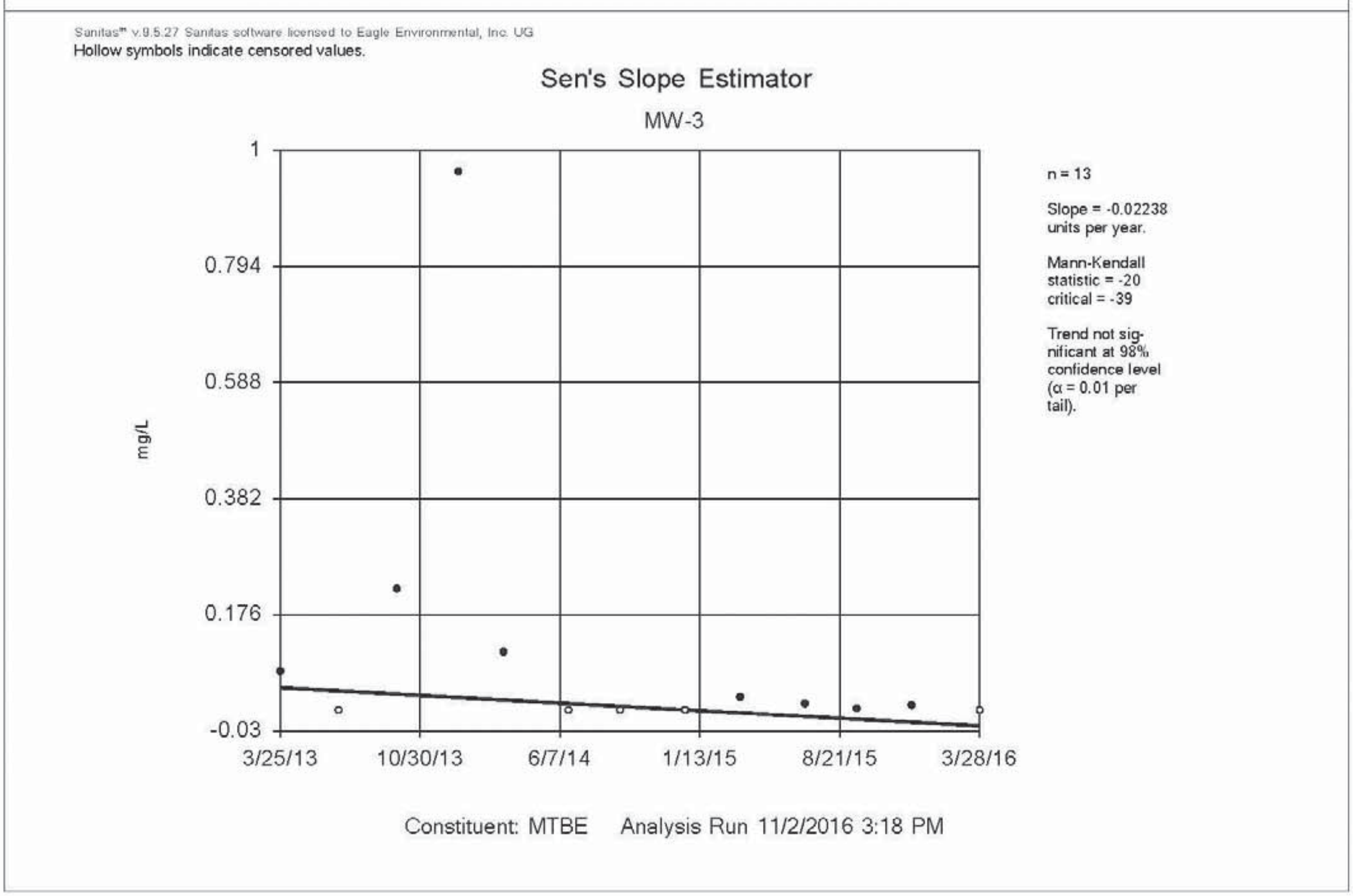


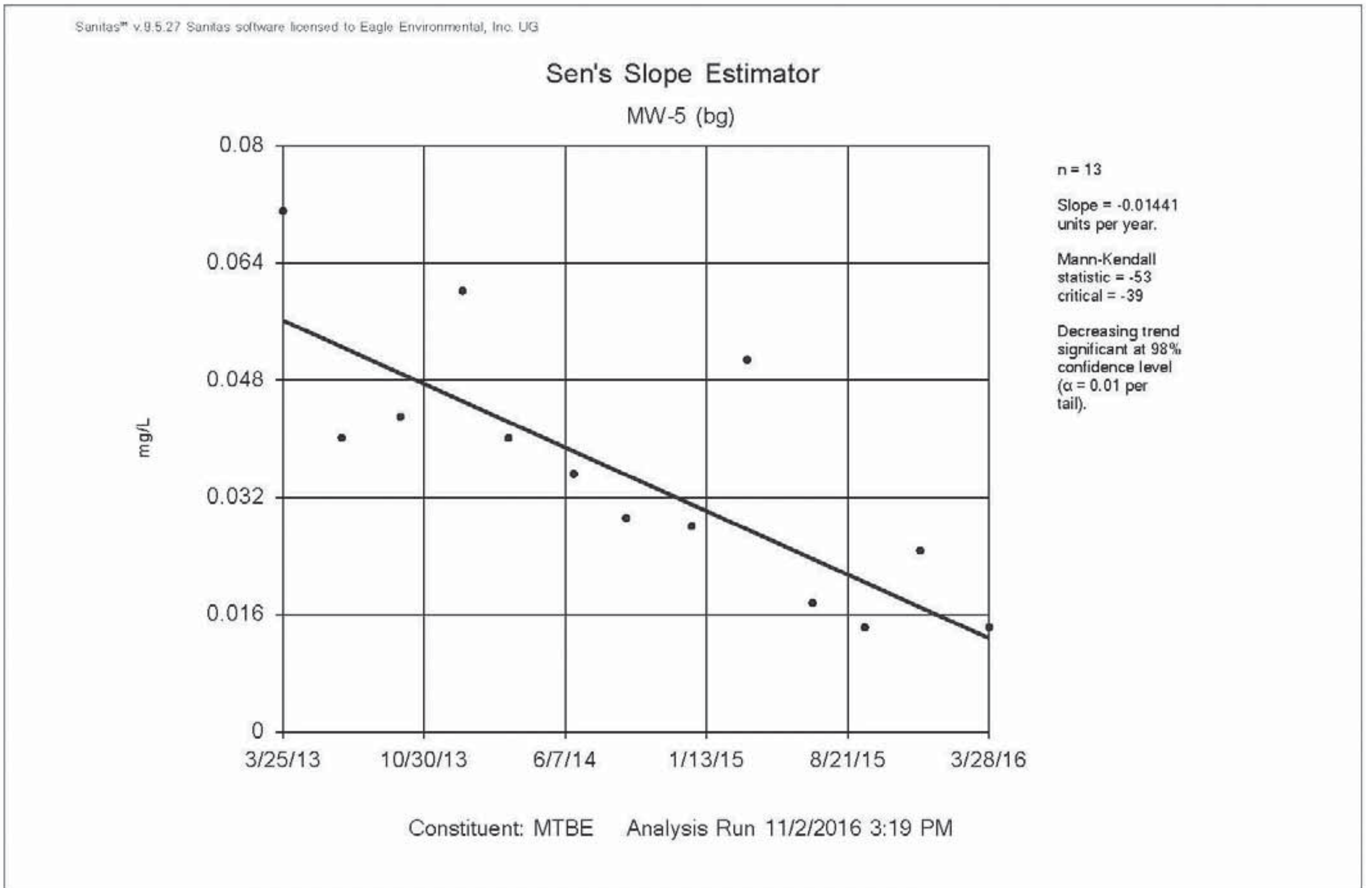
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
6
4.8
3.6
2.4
1.2
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.3384 units per year.
Mann-Kendall statistic = -20 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Xylenes Analysis Run 11/2/2016 3:19 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
mg/L
3
2.4
1.8
1.2
0.6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.1665 units per year.
Mann-Kendall statistic = -21 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: Xylenes Analysis Run 11/2/2016 3:19 PM

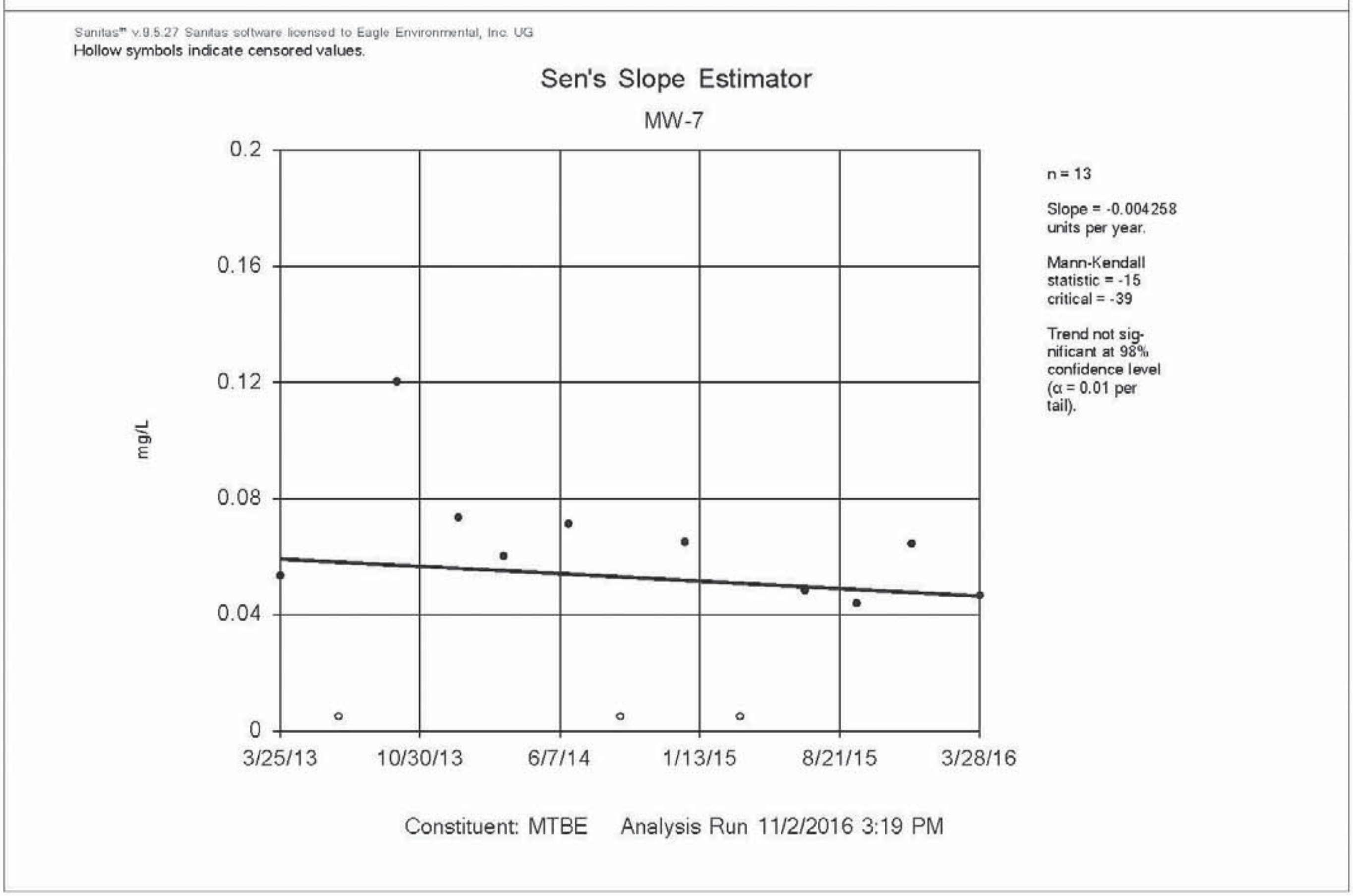

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
mg/L
0.6
0.464
0.328
0.192
0.056
-0.08
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.04845 units per year.
Mann-Kendall statistic = -40 critical = -39
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).
Constituent: Xylenes Analysis Run 11/2/2016 3:19 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Sen's Slope Estimator
MW-2
2
1.56
1.12
0.68
0.24
-0.2
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.2038 units per year.
Mann-Kendall statistic = -41 critical = -39
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).
Constituent: MTBE Analysis Run 11/2/2016 3:18 PM

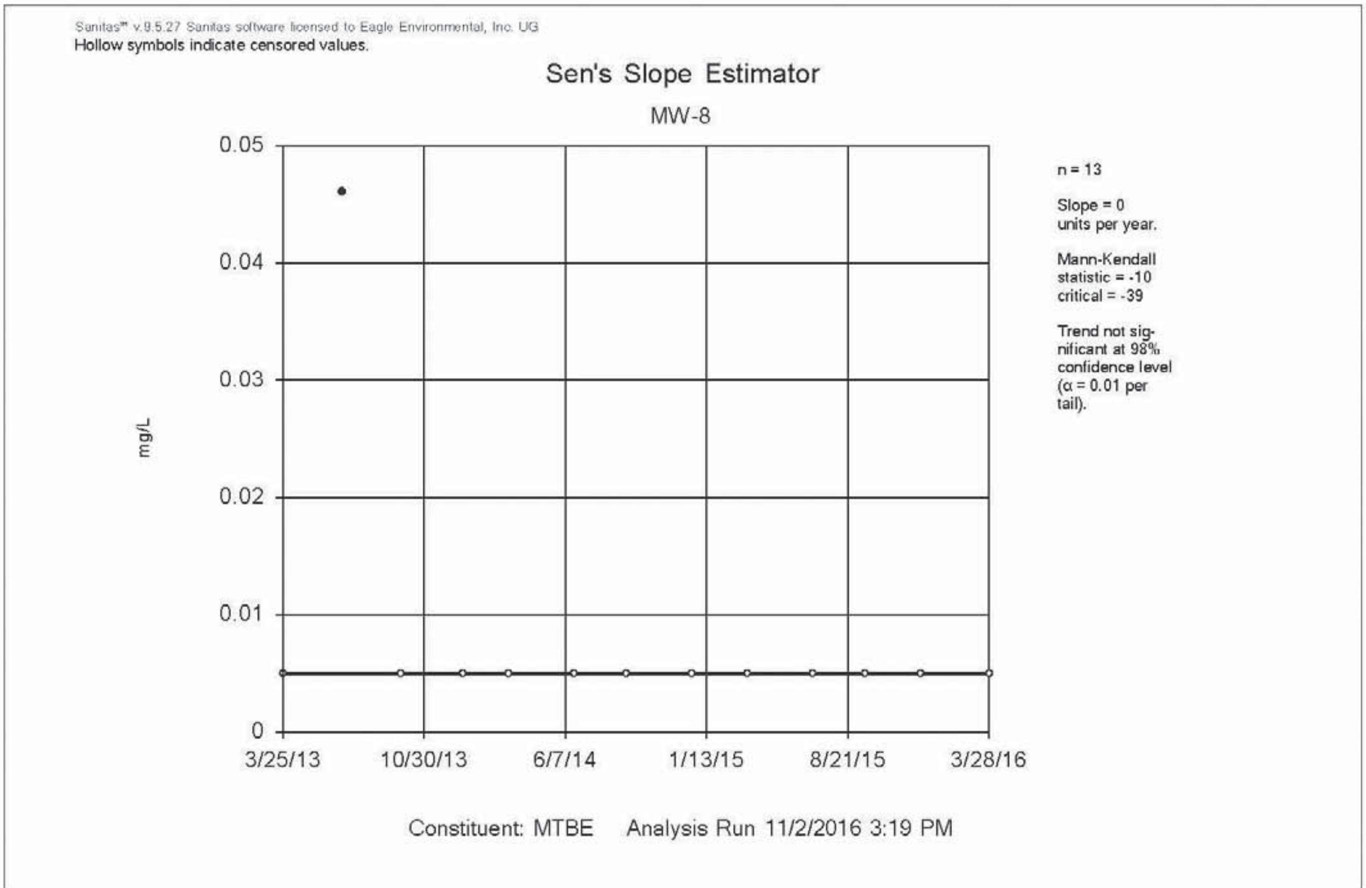

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-3
1
0.794
0.588
0.382
0.176
-0.03
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.02238 units per year.
Mann-Kendall statistic = -20 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: MTBE Analysis Run 11/2/2016 3:18 PM

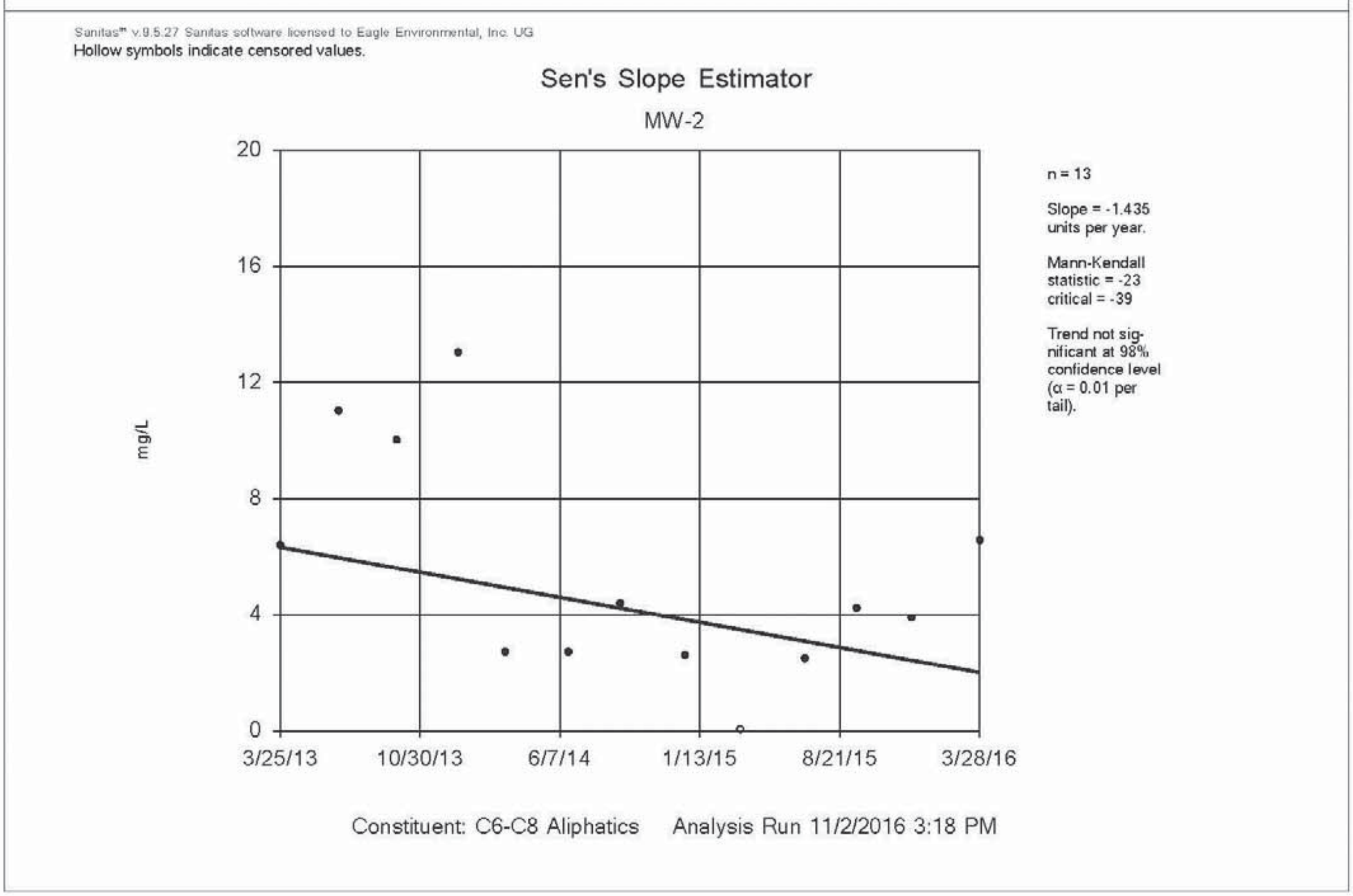


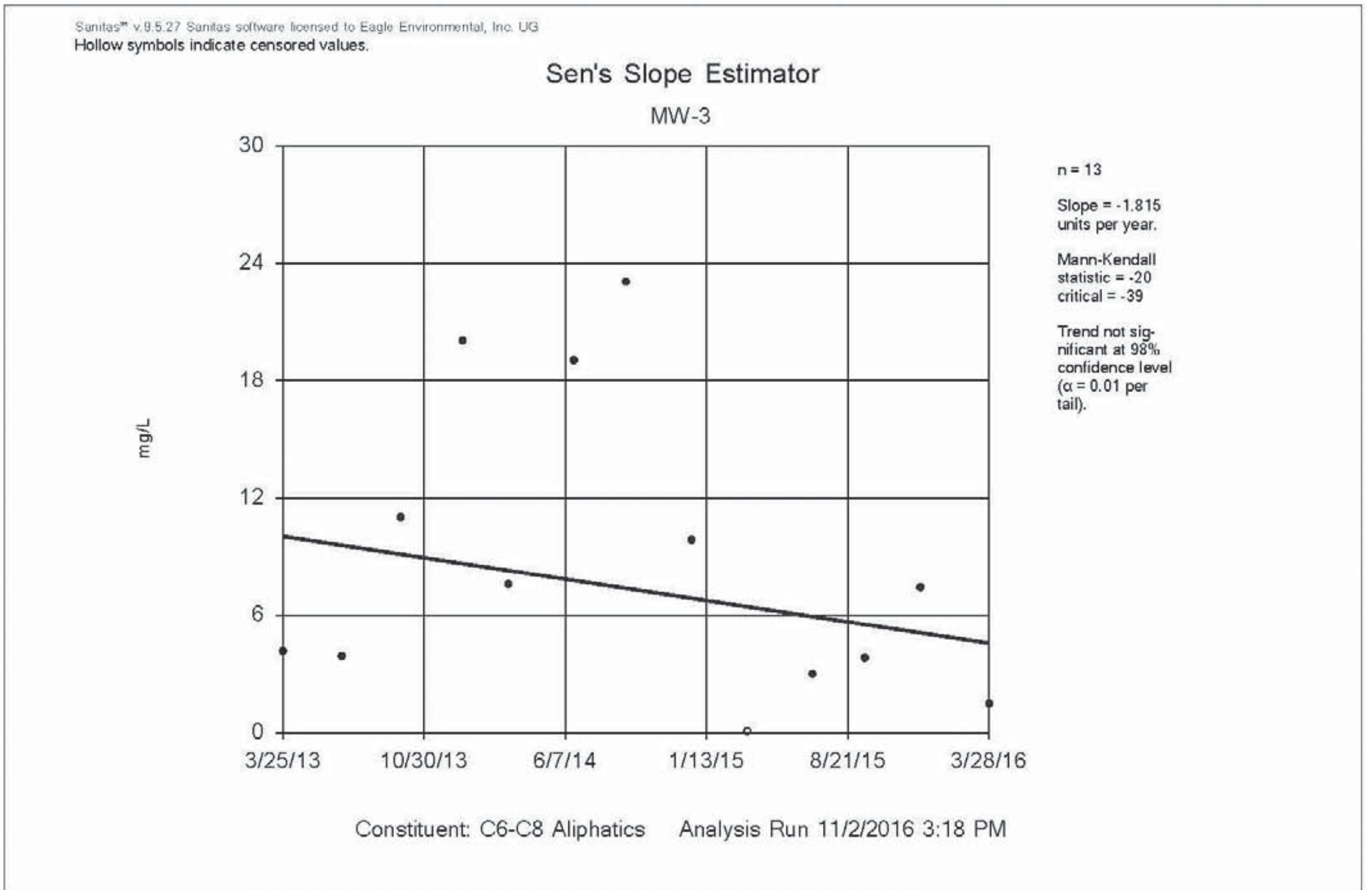
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Sen's Slope Estimator
MW-5 (bg)
0.08
0.064
0.048
0.032
0.016
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.01441 units per year.
Mann-Kendall statistic = -53 critical = -39
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).
Constituent: MTBE Analysis Run 11/2/2016 3:19 PM

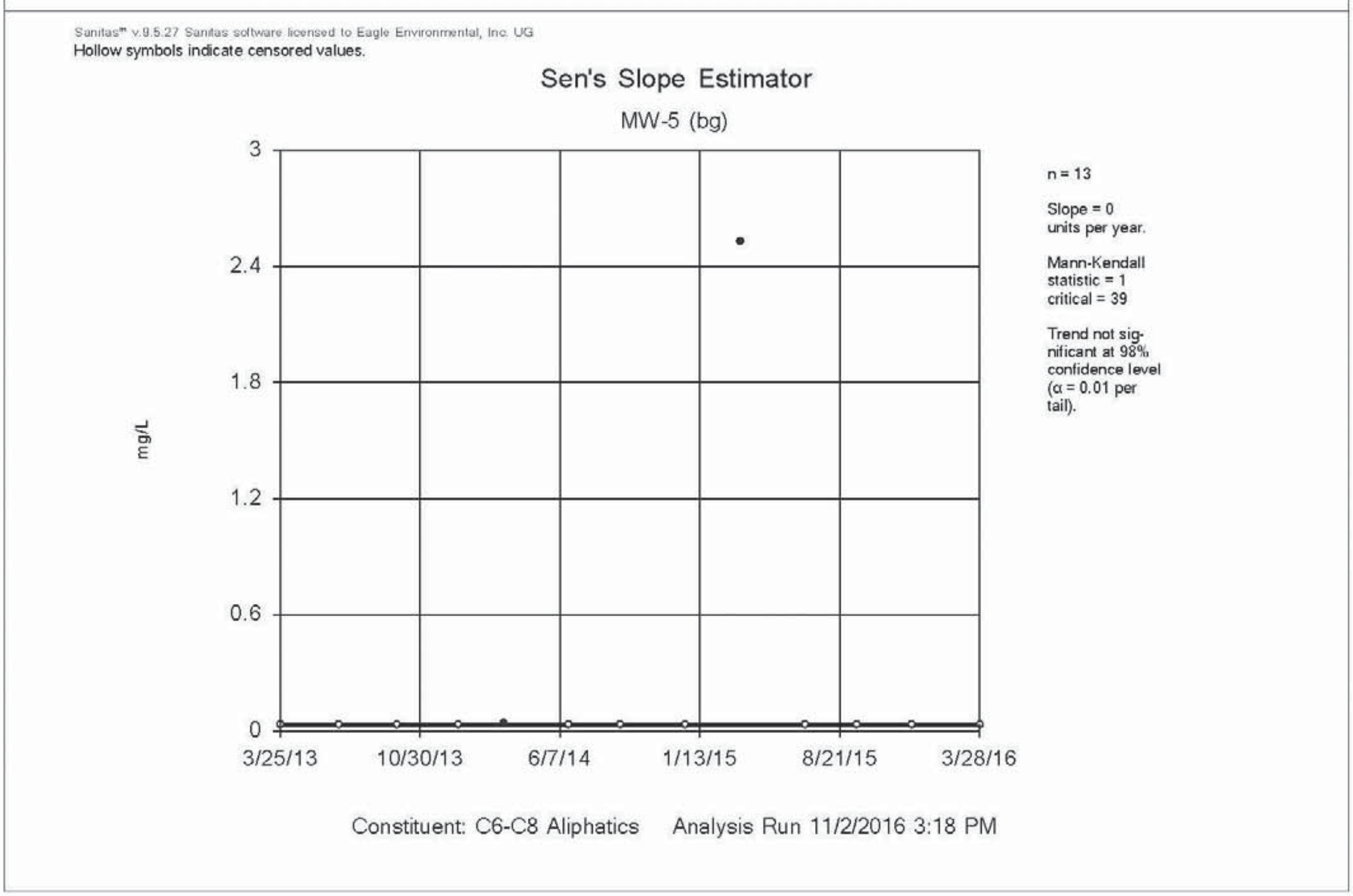


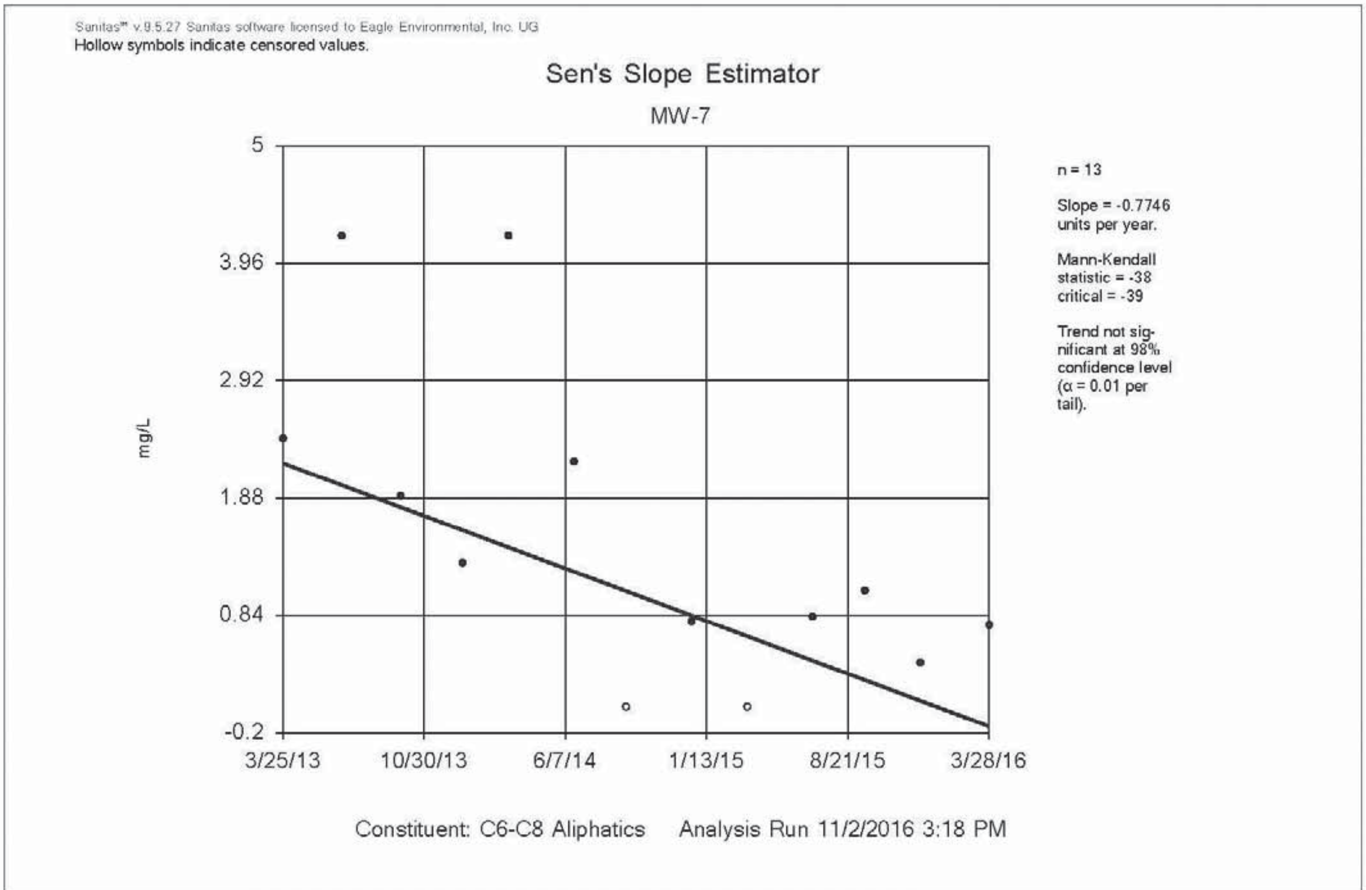
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
0.2
0.16
0.12
0.08
0.04
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.004258 units per year.
Mann-Kendall statistic = -15 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: MTBE Analysis Run 11/2/2016 3:19 PM

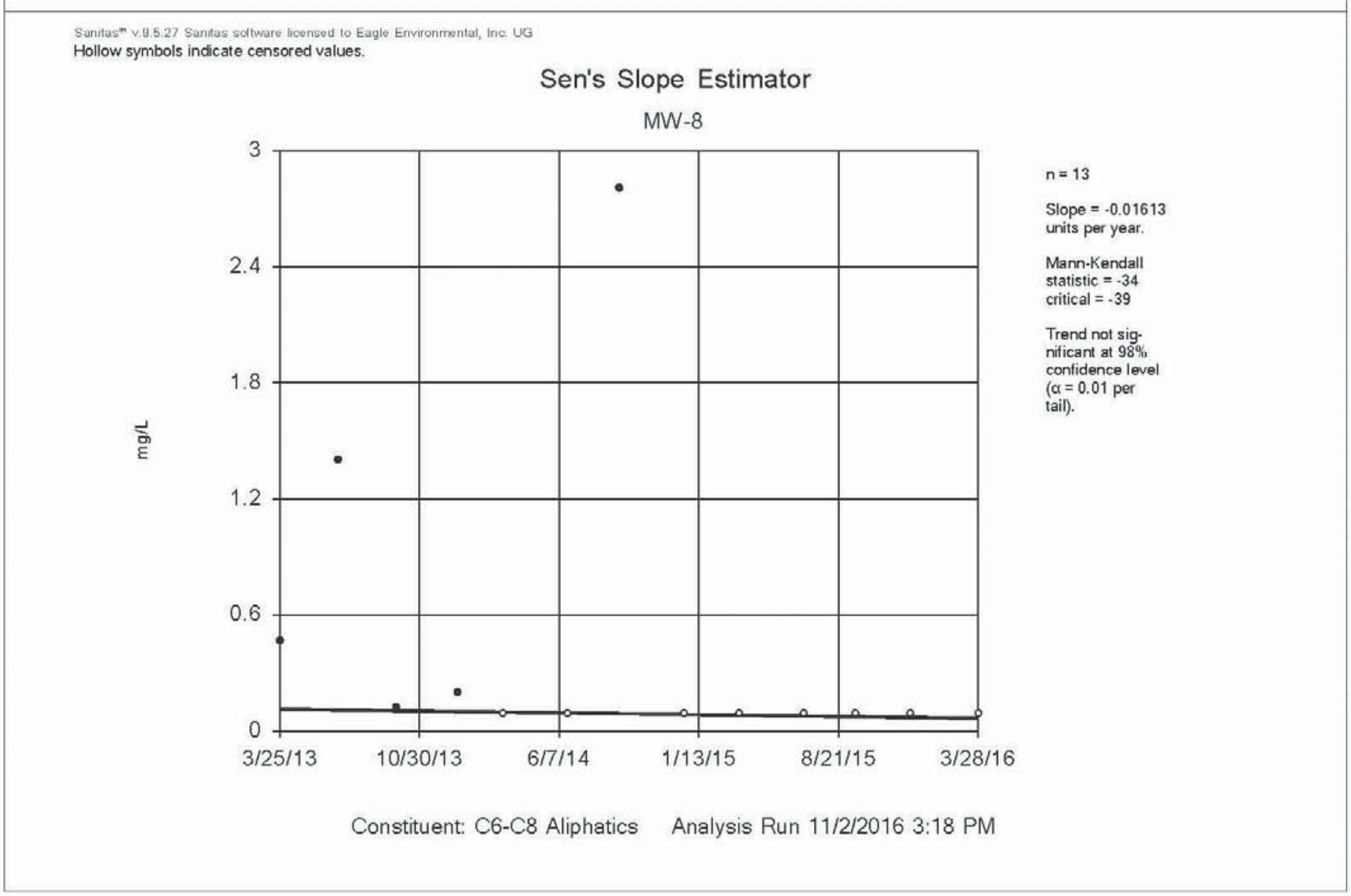

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
0.05
0.04
0.03
0.02
0.01
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = 0 units per year.
Mann-Kendall statistic = -10 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: MTBE Analysis Run 11/2/2016 3:19 PM

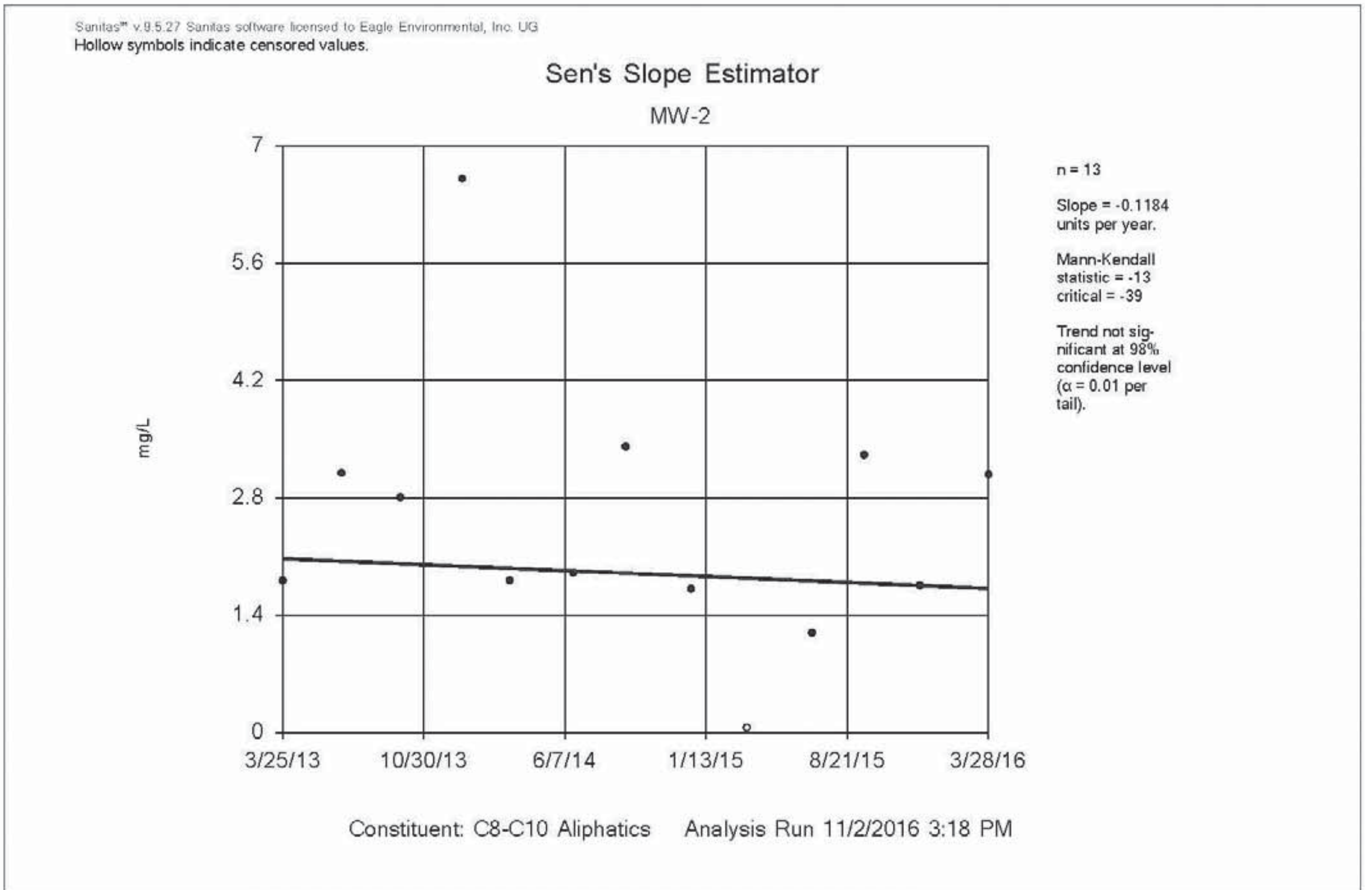

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
20
16
12
8
4
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -1.435 units per year.
Mann-Kendall statistic = -23 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C6-C8 Aliphatics Analysis Run 11/2/2016 3:18 PM

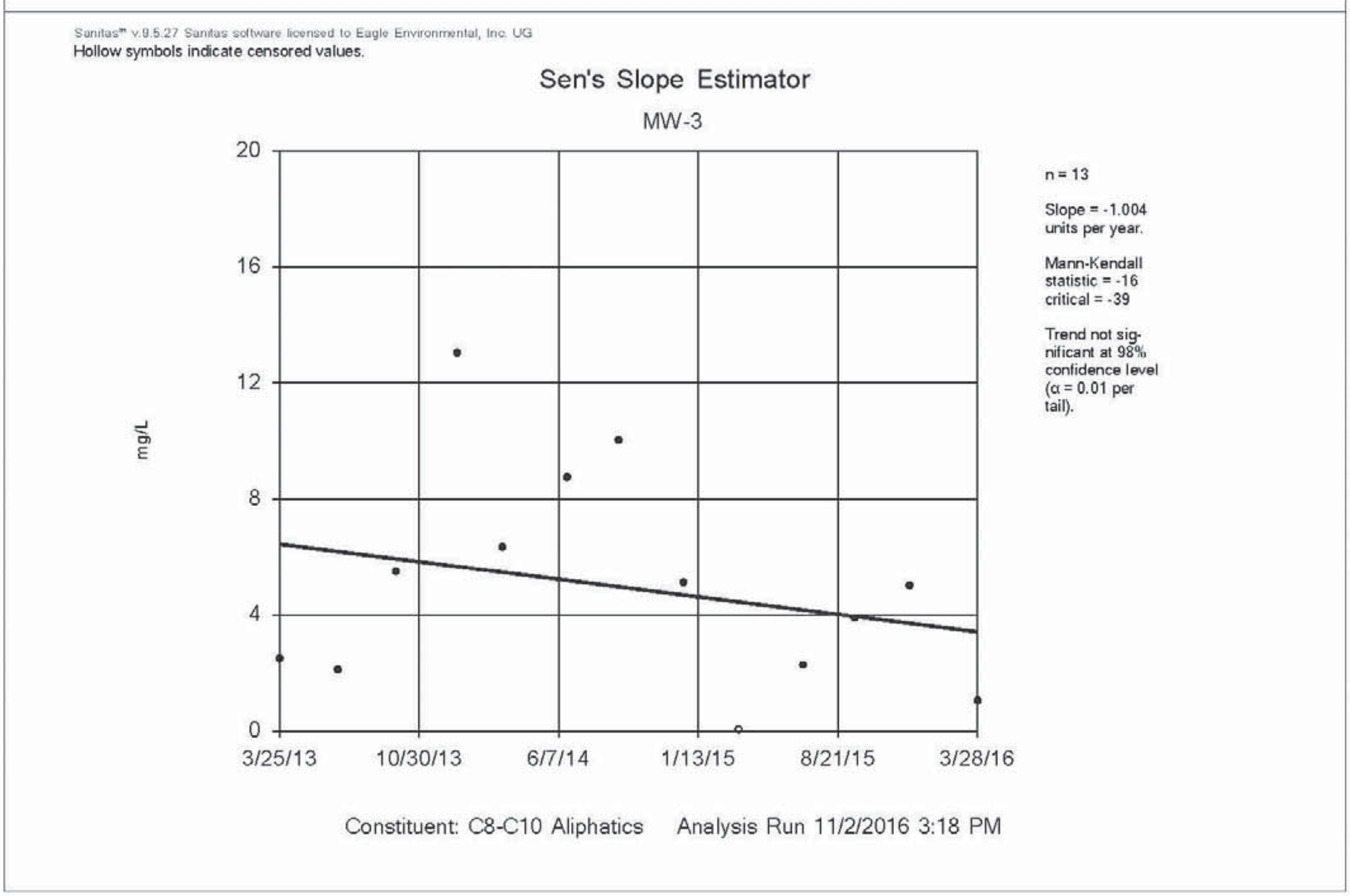

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-3
mg/L
30
24
18
12
6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -1.815 units per year.
Mann-Kendall statistic = -20 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C6-C8 Aliphatics Analysis Run 11/2/2016 3:18 PM

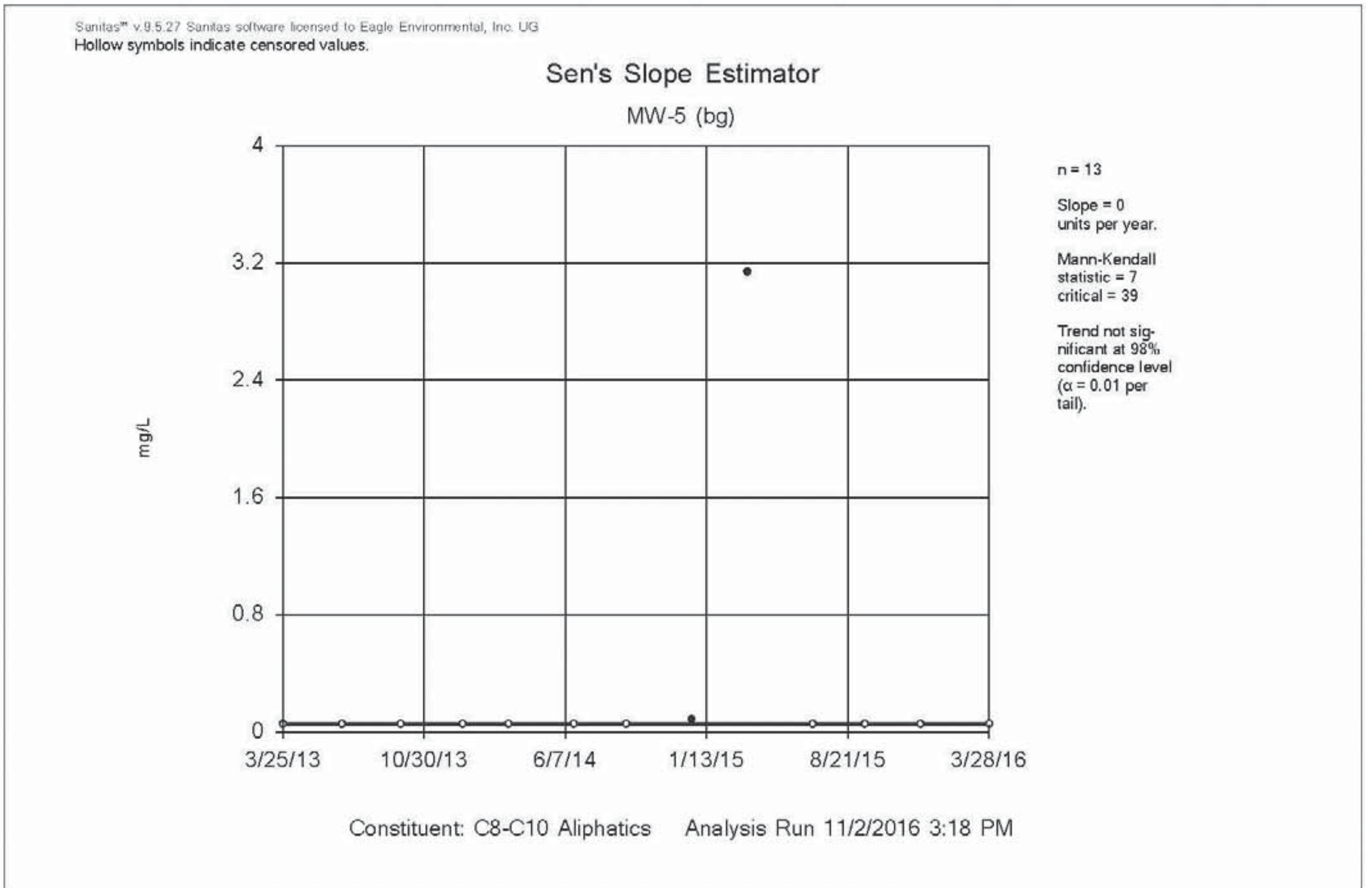

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-5 (bg)
mg/L
3
2.4
1.8
1.2
0.6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = 0 units per year.
Mann-Kendall statistic = 1 critical = 39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C6-C8 Aliphatics Analysis Run 11/2/2016 3:18 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
mg/L
5
3.96
2.92
1.88
0.84
-0.2
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.7746 units per year.
Mann-Kendall statistic = -38 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C6-C8 Aliphatics
Analysis Run 11/2/2016 3:18 PM

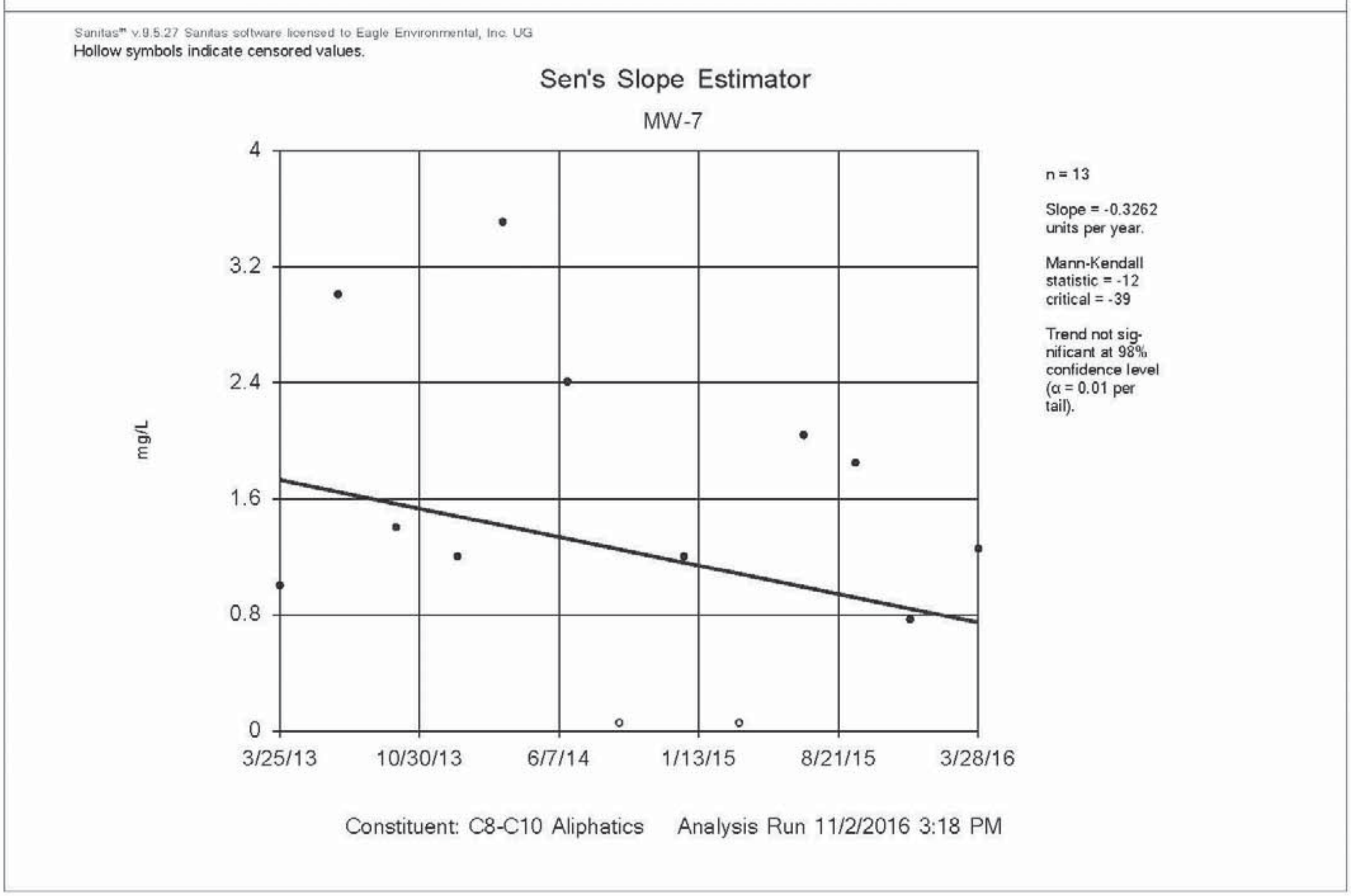

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
mg/L
3
2.4
1.8
1.2
0.6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.01613 units per year.
Mann-Kendall statistic = -34 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C6-C8 Aliphatics
Analysis Run 11/2/2016 3:18 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
mg/L
7
5.6
4.2
2.8
1.4
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.1184 units per year.
Mann-Kendall statistic = -13 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aliphatics
Analysis Run 11/2/2016 3:18 PM

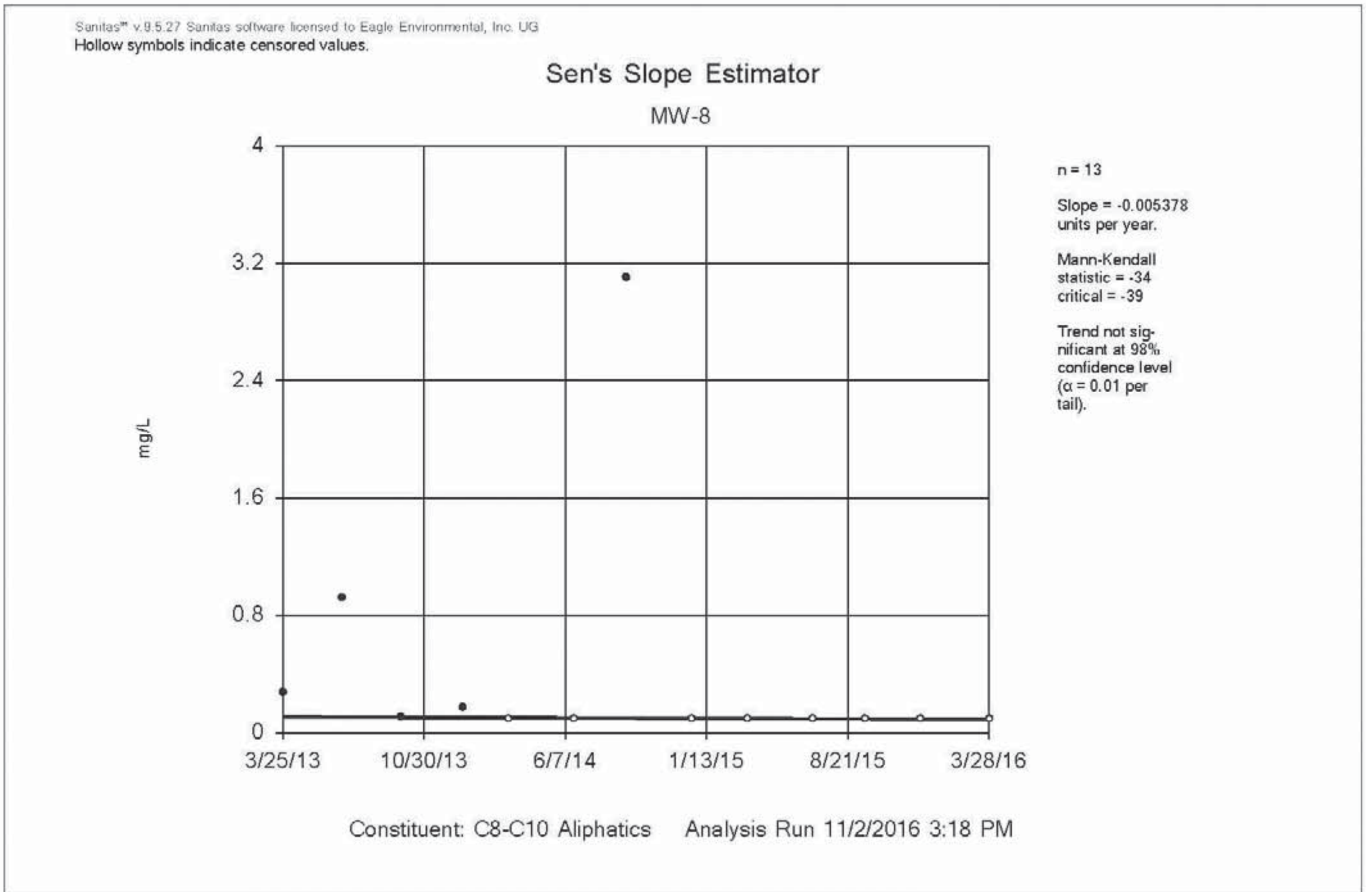

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-3
mg/L
20
16
12
8
4
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -1.004 units per year.
Mann-Kendall statistic = -16 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aliphatics
Analysis Run 11/2/2016 3:18 PM



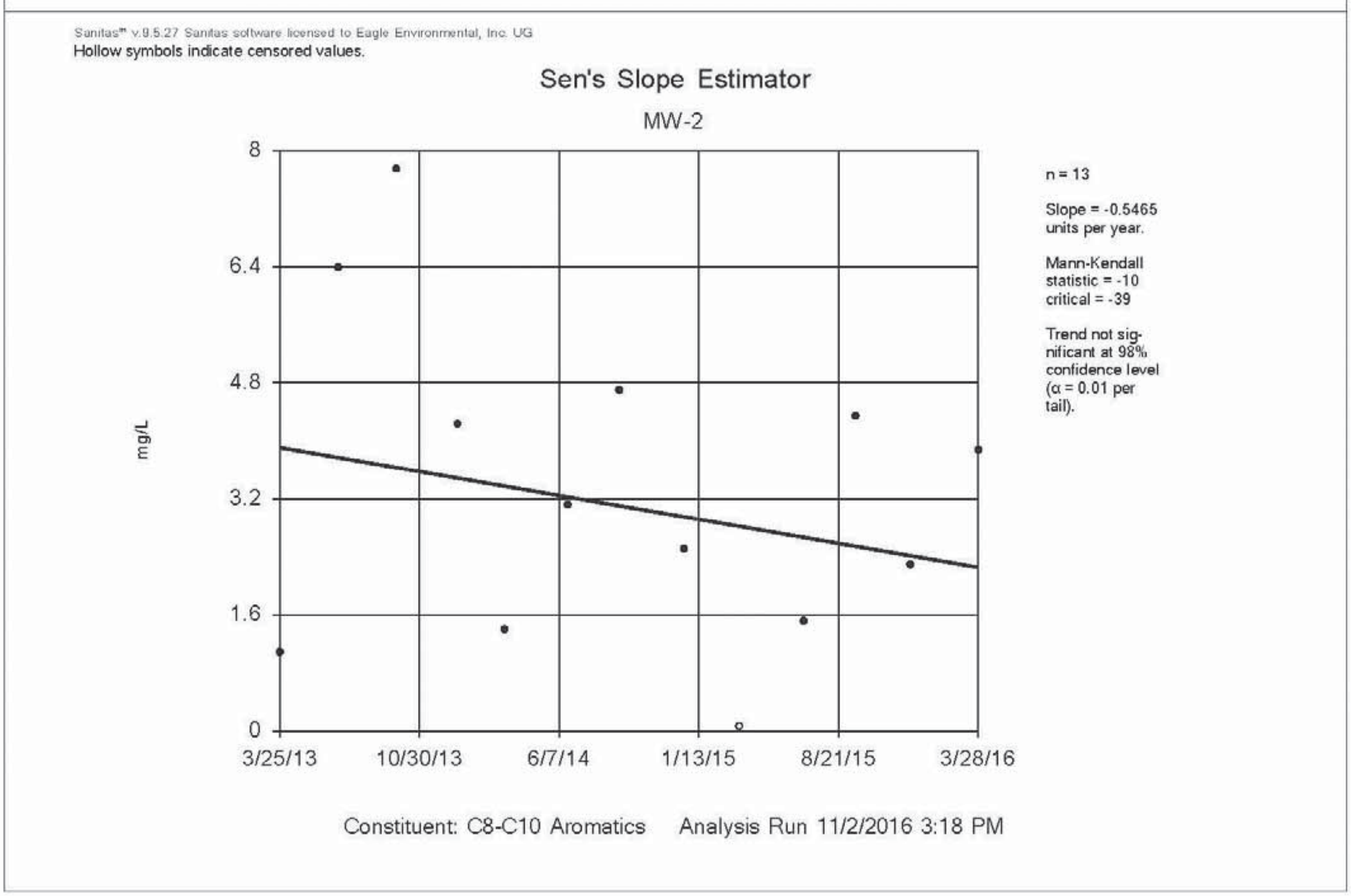
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-5 (bg)
n = 13
Slope = 0
units per year.
Mann-Kendall
statistic = 7
critical = 39
Trend not significant at 98% confidence level (α = 0.01 per tail).
mg/L
4
3.2
2.4
1.6
0.8
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
Constituent: C8-C10 Aliphatics Analysis Run 11/2/2016 3:18 PM



Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
n = 13
Slope = -0.3262
units per year.
Mann-Kendall
statistic = -12
critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
mg/L
4
3.2
2.4
1.6
0.8
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
Constituent: C8-C10 Aliphatics Analysis Run 11/2/2016 3:18 PM

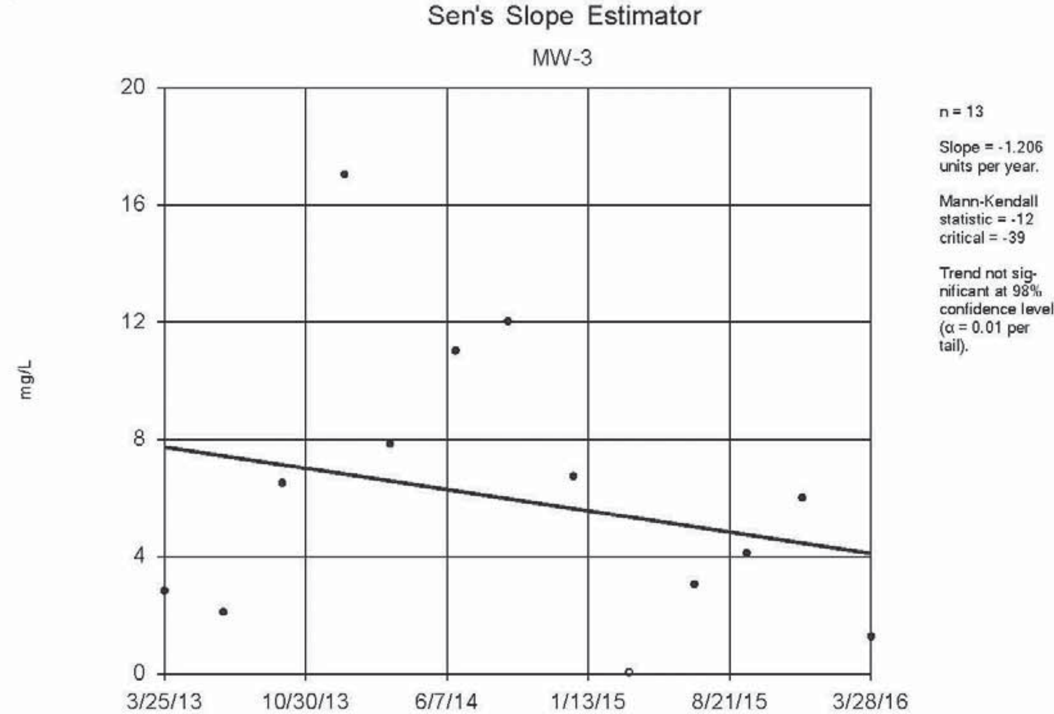


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
mg/L
4
3.2
2.4
1.6
0.8
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.005378 units per year.
Mann-Kendall statistic = -34 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aliphatics
Analysis Run 11/2/2016 3:18 PM



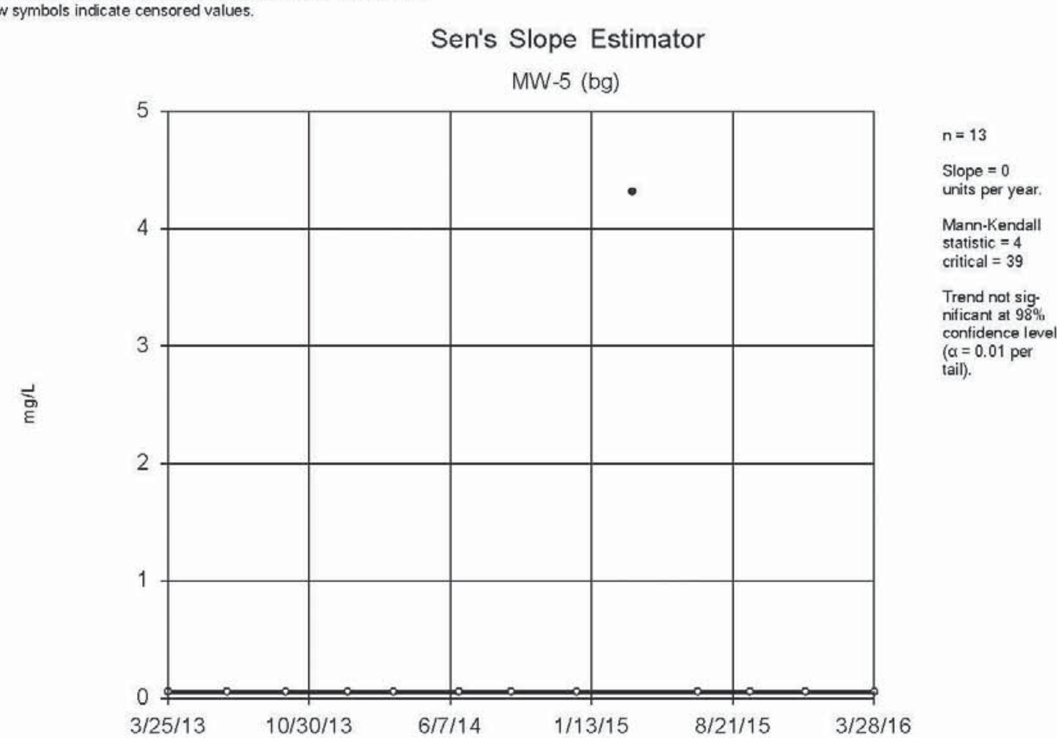
Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-2
mg/L
8
6.4
4.8
3.2
1.6
0
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.5465 units per year.
Mann-Kendall statistic = -10 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aromatics
Analysis Run 11/2/2016 3:18 PM

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.

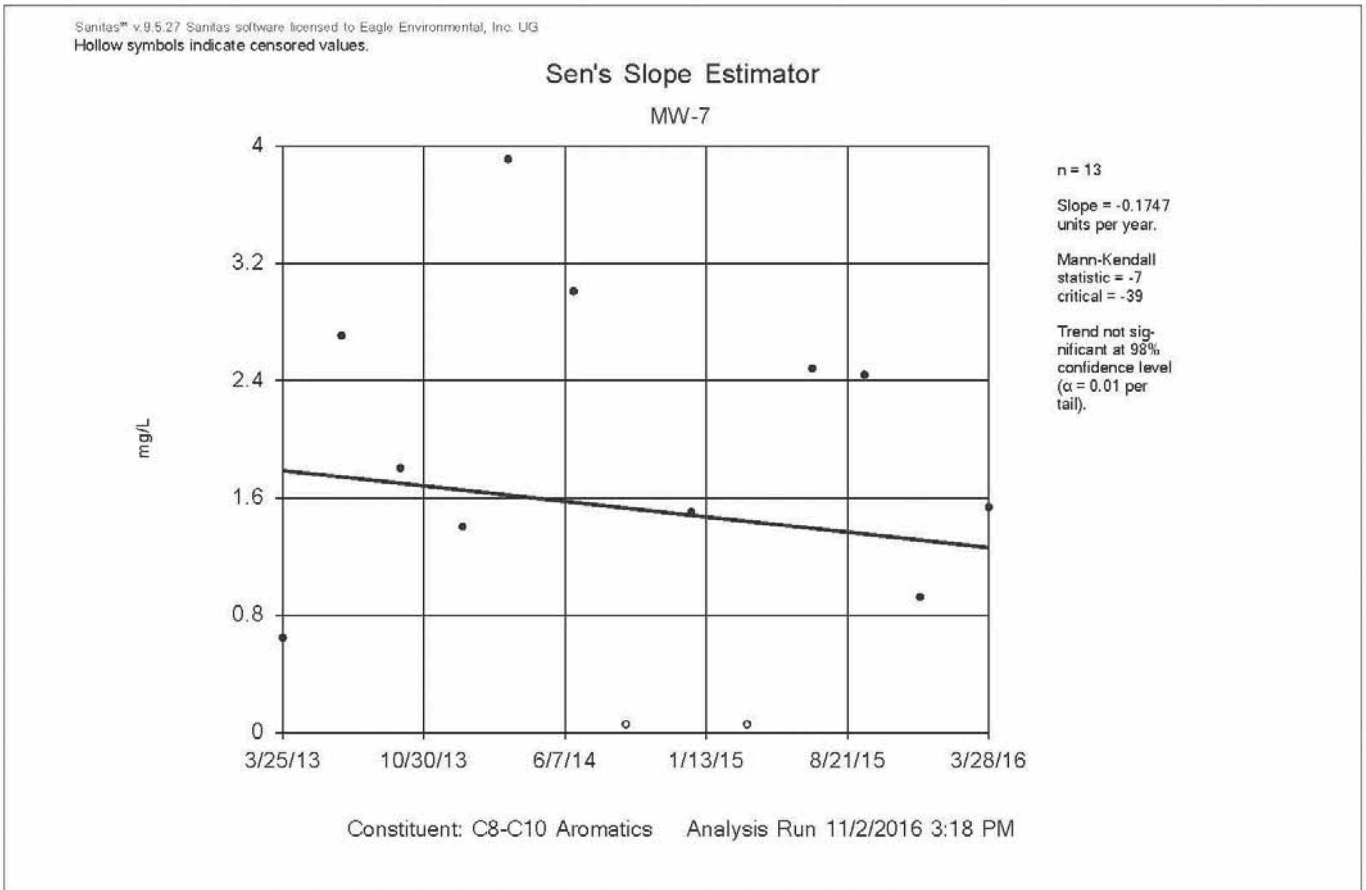


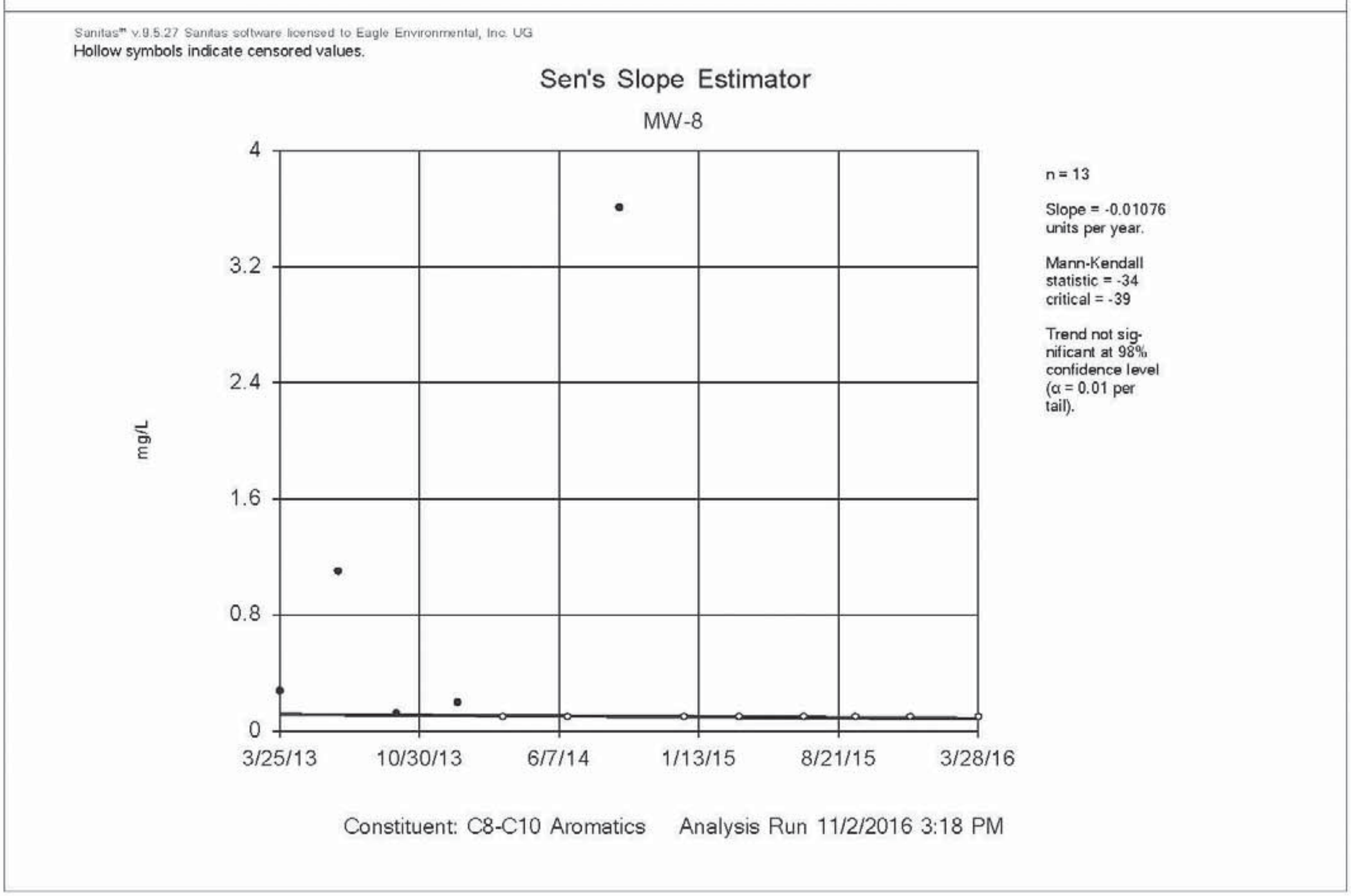
Constituent: C8-C10 Aromatics Analysis Run 11/2/2016 3:18 PM

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.

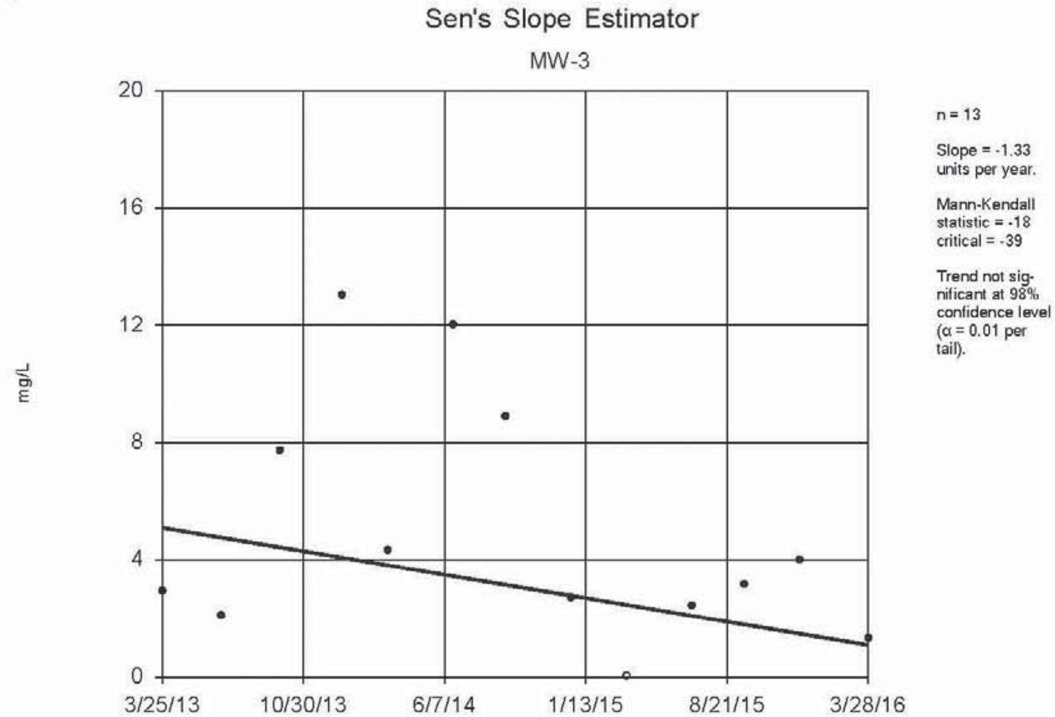


Constituent: C8-C10 Aromatics Analysis Run 11/2/2016 3:18 PM


Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-7
4
3.2
2.4
1.6
0.8
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.1747 units per year.
Mann-Kendall statistic = -7 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aromatics Analysis Run 11/2/2016 3:18 PM

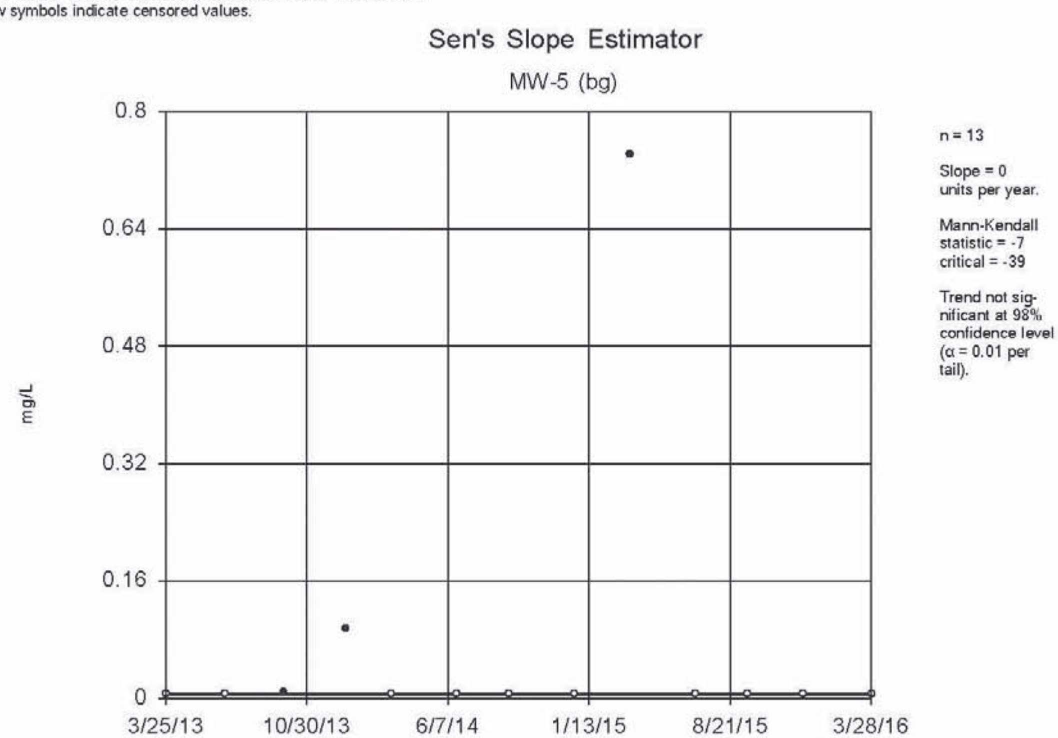

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.
Sen's Slope Estimator
MW-8
4
3.2
2.4
1.6
0.8
0
mg/L
3/25/13
10/30/13
6/7/14
1/13/15
8/21/15
3/28/16
n = 13
Slope = -0.01076 units per year.
Mann-Kendall statistic = -34 critical = -39
Trend not significant at 98% confidence level (α = 0.01 per tail).
Constituent: C8-C10 Aromatics Analysis Run 11/2/2016 3:18 PM

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.



Constituent: Toluene Analysis Run 11/2/2016 3:19 PM

Sanitas™ v.9.5.27 Sanitas software licensed to Eagle Environmental, Inc. UG
Hollow symbols indicate censored values.



Constituent: Toluene Analysis Run 11/2/2016 3:19 PM

VITA

Matthew Vidrine, a native of Acy, Louisiana and avid outdoorsman, received his undergraduate Degree in Biological Sciences from Louisiana State University (LSU) in 2014. He has worked hard studying many aspects of Louisiana and its current environmental concerns. He was accepted into the LSU department of Environmental Sciences majoring in biophysical systems. He anticipates graduating with his Master's degree in the Spring of 2017. He plans to continue pursuing the environmental sciences and all the field has to offer.