THE EFFECTS OF ELEVATED HIGHWAY CONSTRUCTION ON WATER QUALITY IN LOUISIANA WETLANDS

FINAL REPORT

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REPORT NUMBER FHWA/LA-81/148
RESEARCH REPORT NO. 75-4G
STATE PROJECT NO. 736-03-25

conducted by

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

In cooperation with

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

February, 1981

ACKNOWLEDGEMENTS

The authors wish to thank the following for their invaluable assistance. Ms. Beverly Morcum for the graphic presentations, Mr. Edward Bodker for additional first-hand knowledge of the project area, Mr. S. C. Shah for assistance with the statistical analysis and data interpretation, Messrs. Robert Long and John Daggett for their review and critique of the first drafts, Mr. Bob Mahoney for his critique of the final draft, and last but most importantly, Mrs. Donna McFarland for her patience, understanding and excellent typing.

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ABSTRACT

This study is to determine by physical, chemical and biological means the effects of bridged highway construction techniques on water quality in wetlands. Water quality was monitored before, during and after construction. The data shows the increase in pollution that occurred during construction. The areas where construction has been completed have shown gradual improvement towards the preconstruction ambient. The information obtained may be useful in predicting the degree and duration of impacts of future construction projects on wetland environments.

INTRODUCTION AND OBJECTIVES

The effects of highway construction on the water quality of wetland areas have been studied only to a limited degree. The apparent signs of water degradation, such as siltation and sedimentation, have been seen many times in similar construction situations. The degree of degradation is dependent upon construction techniques and watershed characteristics. Knowledge of the sedimentation process is necessary to assess the effects on the aquatic ecosystem. Chabreck (5)[1] observed that sedimentation and the resulting turbidity were dependent upon the vegetative cover and the soil type for a particular area. Hopkins (9) concluded that highway construction near watercourses should be watched very closely for silting and sedimentation.

The primary objectives of this research were as follows:

1. To provide a baseline or ambient condition for the existing water quality.
2. To determine the changes in the wetland water quality due to the dredging and construction of an elevated highway.
3. To determine the residual effect on water quality, if any, due to the construction and the time rate of change caused by the construction.

The area selected as a typical wetland was the new alignment for Interstate Route 55 beginning at the Interstate 10 junction north of LaPlace, Louisiana and ending a few miles north of Pass Manchac between Lake Maurepas and Lake Pontchartrain (see Figure 1). This corridor offered an excellent opportunity for study, as it contained areas not yet under construction, areas where construction was in process, and areas where construction was complete.

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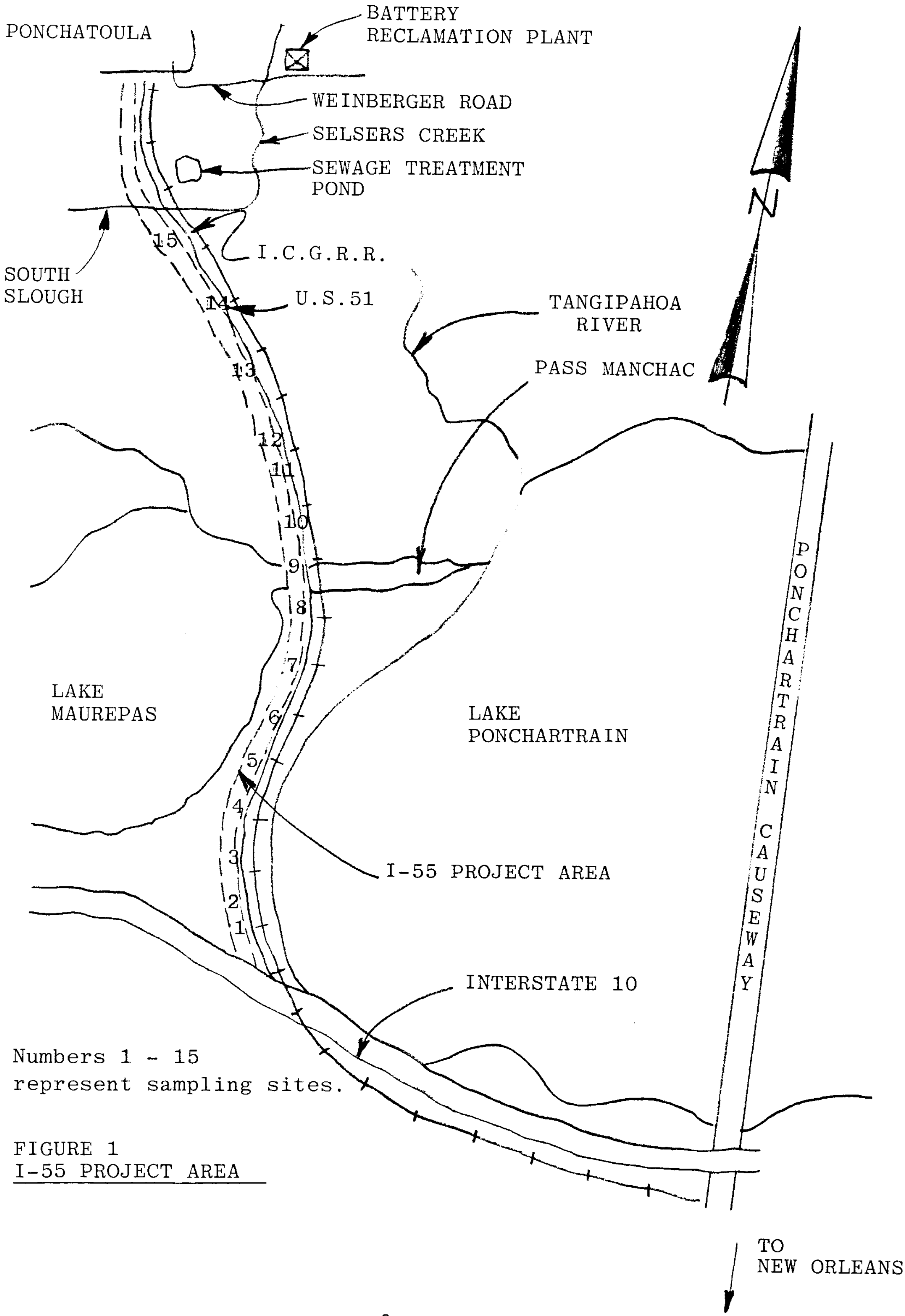
[1] Please see references on Page 35 for this and all other citations.



Numbers 1 - 15 represent sampling sites.

FIGURE 1
I-55 PROJECT AREA

The construction technique employed in this construction project consisted of using a dredge barge to construct an access canal between the existing borrow canal for Highway 51 and the Highway 51 roadway. This canal provides access for construction of the new bridged highway supported by concrete piles. In later years, the canal will provide access for maintenance of the structure as well as an area for a new aquatic habitat.

Two mitigation techniques were used on this construction project. The first technique was the placement of the spoil in areas that did not interfere with drainage to the channel being excavated. The spoil, a highly organic clay, was later dressed to a uniform appearance. Vegetative cover was not provided for the spoil banks, as the native vegetation grows very rapidly and covered the spoil very quickly.

The second technique was the use of earth plugs to minimize exchange of water along the new construction canal. The earth plugs were placed at intervals of approximately 2,000 feet (610 m).

STUDY AREA

The location of the study area is between 89° 44' and 90° 36' longitude and 30° 2' and 30° 25' latitude. The area consists of the Lake Maurepas and Lake Pontchartrain basin, which lies approximately 48.1 miles (77.4 Km) southeast of Baton Rouge and 29.1 miles (46.1 Km) northwest of New Orleans. Specifically, the microscale analysis for this research study was conducted in the old U.S. 51 borrow canal. The canal is approximately 200 yards (182.8 meters) west of U.S. 51 and is immediately adjacent to the alignment for the Interstate 55 construction.

The area is located in the Mississippi River deltaic plain. Formation of the lakes occurred when two former deltas of the Mississippi River, St. Bernard and Cocodrie, filled in a formerly open bay with clay and silt from high water flows. Only two passes, Chef Menteur and Rigolets, still serve as natural water routes to Lake Borgne and the Gulf of Mexico. At the present time, there are eight major tributaries flowing into the Pontchartrain Basin. The surface area of Lakes Pontchartrain and Maurepas is approximately 5,098,490 acres (629,159 hectares) of water. These two lakes represent the largest continuous esturine area in the coastal zone of Louisiana. Both of these lakes are surrounded by fresh-water marsh, cypress-tupelo swamp and brackish-water marsh.

The Water Pollution Control Division, Office of Environmental Affairs, Louisiana State Department of Natural Resources (11) describes the Pontchartrain Basin as follows:

> "Lake Pontchartrain Basin consists of the tributaries and distributaries of Lake Pontchartrain, a brackish natural lake in southeast Louisiana. The tributaries, such as the Comite

River, Amite River and Tangipahoa River to the north, and the distributaries, such as Rigolets and Chef Menteur Pass to the south, along with the Lake itself form the hydrologic system. In addition, the coastal marshes along the Mississippi Sound are influenced by the system.

The Basin is bounded by the Mississippi State Line on the north, the left descending Mississippi River levee on the west, the drainage divide of the Pearl River Basin on the east and the Mississippi Sound on the south.

The elevation of the basin ranges from minus five feet at New Orleans to over 200 feet in the northern part of the basin.

Over half of the population in the State lives within this basin, as the two largest metropolitan areas (New Orleans and Baton Rouge) are in the basin."

The same source, in their evaluation of the basin's water quality, states:

"Lake Pontchartrain Basin as a whole has good water quality. This is not true, however, of the system of canals and drainage ditches in the New Orleans metropolitan area. These have very acute dissolved oxygen and coliform problems as a result of the discharge of treated, partially treated and untreated municipal sewage discharges. These problems are also experienced to a lesser degree in the north shore area around Slidell.

Frequent pH violations in major streams (Amite, Tangipahoa, and Tchefuncte Rivers) have been attributed to influx of low pH waters from surrounding hardwood swamps."

The above descriptions are in general concurrence with those of the researchers.

The wetlands of the area have undergone a number of changes in the past. In the late 1800's - early 1900's, logging and the Illinois Central Gulf railroads were two of the first man-made impacts to this sensitive area. The railroads built along the shores of Lake Pontchartrain formed barriers which limited the flushing action of the wetland ecosystem. Cypress logging activities from approximately 1910 to approximately 1935 left scars which may be seen even now as the area is viewed from the air. In 1954, the muck-fill construction of U.S. Highway 51 added to the problem of water movement within this marsh system. These alterations of the drainage patterns have contributed to the spread of the now overpopulated water hyacinth (Eichhornia crassipes).

Another major change occurring in this area is a rather rapid decline in the amount of trees, shrubs, and grasses growing in the swamp. During the past ten to fifteen years, there has been a noticeable decline in at least the following: three corner grass (Dulichium arundinaceum), saw grass (Cladium jamaicense), young cypress trees (Taxodium distichum), wax myrtle (Myrica cerifera), palmetto (Sabal minon), marsh grass (Spartina alterniflora), cinnamon fern (Osmunda cinnamonea), and black gum tree (Nyssa sylvatica).

What was once a thickly vegetated swamp, providing habitat for an abundance of wildlife, is now considered "open swamp" which is less productive. This has become a topic of great concern for many local residents, especially those who make a living off of these resources. The area of sparse vegetation is moving from south to north. The cause of this phenomena has not been identified.

HYDROLOGY

The major tidal flows and currents are in the lakes, east-west in direction. Normal tidal fluctuations are one to two feet with storm tides of three to four feet. The borrow canal being studied generally travels in a north-south direction. Therefore, the tidal actions and currents from Lake Pontchartrain and Lake Maurepas exert a minimal effect on the study waterway. There are two major exceptions, one being the unusual phenomenae of nature (floods, drought and hurricanes), and the other a little bayou (Ruddock Canal) which serves as a bypass from Lake Maurepas thereby flushing the study area from sampling sites 5 through 8, inclusive. Data on the volume of water flowing through the Pontchartrain Basin and the study area are not readily available.

MATERIALS AND METHODS

The objectives of this research as outlined in Section 1 dictated that a monitoring study be conducted in order to assess the pollution impact of wetland construction. In establishing a monitoring program, water sampling sites that will adequately represent the characteristics of the watershed must be selected, so that an assessment of environmental impacts can be made. This section discusses the elements involved in the selection of sampling locations and water quality parameters used in the monitoring program.

RECONNAISSANCE

An aerial reconnaissance of the research area was made by helicopter in order to identify land features, tributaries, and adjacent watersheds. Figure 1 (Page 2) shows the major elements of the study area which have an influence on the water quality of the swamps and marshes of the Manchac Peninsula. Also shown are the transportation systems affecting the area and the initial sampling sites.

The entire Pontchartrain Basin, including Lake Maurepas, Pass Manchac and Lake Pontchartrain west of U.S. 11, is considered suitable for primary and secondary water usage as well as fish and wildlife propagation. Primary water usage is defined as: waters which may be used for swimming and other water contact sports where water may be accidentally ingested, raw water source for public water supplies, as well as for agricultural, irrigation, industrial usage, navigation, and the propagation of aquatic flora and fauna. Secondary water usage is defined as: water wading, fishing, boating, or other activities where ingestion of water is not probable. The general chemical criteria for the study area, as established by the Water Pollution Control Division, Office of Environmental Affairs, Louisiana State Department of Natural Resources, is shown in Table 1.

TABLE 1

GENERAL CHEMICAL CRITERIA

WITHIN THE PONTCHARTRAIN BASIN

SOURCE: WATER QUALITY CRITERIA, LOUISIANA STREAM CONTROL COMMISSION, 1977 (11)

Segment Description	Criteria						
	Chloride (ppm) Maximum	Sulfate (ppm) Maximum	Dissolved Oxygen (ppm) Minimum	pH Range	Bacteria Standard	Temperature °C Maximum	Total Dissolved Solids (ppm) Maximum
Lake Maurepas	1000	200	5.0	6.0 to 8.5	1	32	3000
Pass Manchac - Lake Maurepas to Lake Pontchartrain	1000	1000	5.0	6.5 to 9.0	1	32	3000
Lake Pontchartrain - West of Highway 11 Bridge	Not Applicable	Not Appli-cable	4.0	6.5 to 9.0	1	35	Not Appli-cable

Projected land use studies showed that within a short period of time, Lake Maurepas-Lake Pontchartrain-Pass Manchac area will be widely used as an area for primary and secondary recreation (U.S. Army Corps of Engineers) (14). The Louisiana Wildlife and Fisheries Commission has recently opened the Manchac Wildlife Management Area in the marsh between the present U.S. Highway 51 and the shore of Lake Pontchartrain near Manchac offering waterfowl hunting for the public. Many camps can be seen in the area, and a large number of area residents work as commercial fishermen.

SAMPLING

Sampling sites were established in three different areas: one area not yet under construction, one area under construction, and one area where construction was completed. Fifteen sites were selected for the monitoring study (Figure 1, Page 2). Sites which exhibited the stream characteristics most "typical" or representative of the area were chosen. Stream characteristics include depth, velocity of flow, stream bottom substrate, vegetation and aquatic and wildlife habitat. Other factors used in site selection were the type of construction in the area and accessibility of the site.

SAMPLING FREQUENCY

The sampling frequency should include the collection of a sufficient number of samples over a wide range of stream-flows that would enable the researcher to present a valid discussion of the water quality characteristics of a given area. Sampling frequency is dependent upon such factors as the number of parameters, defined controlled variables, non-controlled variables, sound scientific and statistical evaluation of the requirements to be satisfied in order to achieve the objectives of the study and the in-house abilities to meet those requirements.

The sampling program set up was such that samples could be taken and processed within a one-week period.

The original sampling frequency as shown in Table 2 was based on seasonal and climatic factors and construction activities. This sampling schedule was modified to the one shown in Table 3. This was done in order to better achieve the objectives of the study.

The new sampling program was not fully carried out because of work load and personnel turnover within the research staff, and also because of unusual natural pehnomena, such as floods and hurricanes.

TABLE 2

ORIGINAL SAMPLING SCHEDULE

PARAMETER	BEFORE CONSTRUCTION	DURING CONSTRUCTION	AFTER CONSTRUCTION
Turbidity	1 per week	2 per week	1 per week
Chemical Analysis	2 per month	2 per month	2 per month
Algae	Quarterly	Quarterly	Quarterly

NOTE: More frequent sampling would occur in the case of increased runoff or unusual events.

TABLE 3

MODIFIED SAMPLING SCHEDULE

PARAMETER	CONSTRUCTION	CONSTRUCTION	CONSTRUCTION
Turbidity	2 per week	2 per week*	2 per week*
Conductivity	2 per week	2 per week*	2 per week
Dissolved Oxygen	2 per week	2 per week*	2 per week

*Sampling rates listed are minimum figures and are only used as guidelines.

**Rate of sampling may be decreased to 1 sample per month while trying to establish the return rate to the ambient condition.

The data analysis of test results from this study's Interim Report (8-31-80), indicated that the sampling and testing program required substantial revision to identify and isolate the sources of variation appearing in the analyzed data. The new sampling-testing program reduced the number of sights from 15 to 5, and additionally required that all samples be taken in triplicate, and that each sample be analyzed separately. The sampling schedule was changed to a frequency of one sampling period every two weeks. Table 4 represents the modified sampling program in a condensed form.

Photographs showing representative sites before, during and after construction, and construction activities may be seen in Plates I-VII in Appendix A.

TABLE 4

FINAL SAMPLING PLAN

OLD SITE#	NEW SITE#	PARAMETERS	SAMPLING LEVEL	FREQUENCY
1	1	All	Triplicate	Every 2 weeks
5	2	All	Triplicate	Every 2 weeks
9	3	All	Triplicate	Every 2 weeks
12	4	All	Triplicate	Every 2 weeks
15	5	All	Triplicate	Every 2 weeks

CONSTRUCTION

For the purposes of this study, construction is defined as any activity preparatory to or a part of the actual erection of the structure. This includes such activities as clearing, grubbing, grading, filling, embankment development, and all structural work on the superstructure. This does not include finish work such as barrier rails, signs, safety markers, etc.

Non-construction indicates that none of the above activities were in progress at the time of sampling.

EQUIPMENT

All of the equipment used in this monitoring study was supplied by the Environmental Testing Section of the Louisiana Department of Transportation and Development. The equipment may be broken down into two usage categories, namely field and laboratory equipment.

Field equipment included the following: 20' water research boat, Hach DR-EL field kit, YSI model 51B dissolved oxygen meter, YSI SCT meter, and a water sample collector.

Laboratory equipment used in the water analysis for this research included the following: nephelometer for measuring turbidity, spectrophotometer for measuring color, and a Corning pH meter.

MEASURED PARAMETERS

The parameters selected for monitoring in this study were grouped into two categories. The first category included all parameters measured in the field study such as temperature, salinity, conductivity and dissolved oxygen. The second category was the laboratory study in which turbidity, color, pH, nutrients, and periodic oil and grease samples were evaluated.

While there are many parameters to explore in a water monitoring study, it was concluded that of the ones mentioned above, specifically turbidity, salinity, and dissolved oxygen would be most directly affected by a highway-related construction project.

This conclusion has since been supported by the National Cooperative Highway Research Program Reports 218A and B. These reports, entitled "Ecological Effects of Highway Fills on Wetlands" (14), identify many different types of ecological effects caused by highway construction, including hydrological, erosion-sedimentation, chemical, water quality and faunal movement effects. The NCHRP report delineates many of the possible effects of construction activities and indicates how a number of the effects may be interrelated and, as a result, produce complicated alterations in the wetlands.

All of the parameters covered in the NCHRP report are not included in this report, as some of the NCHRP parameters are beyond the scope and intent of this project.

DATA ANALYSIS AND INTERPRETATION

All parameters initially included in this study will be covered in this report. Many of these parameters are interrelated and are discussed as such. The results of sampling and testing at each site for all parameters are summarized in Appendix B. For each parameter, these tables give: the total number of samples taken at each site for the period of May, 1975 to March, 1980, (N), the mean for each site ($\overline{X}$), and the standard deviation of the samples taken during this period of time for each site (T or S.D.). The data have been divided and analyzed in relationship to preconstruction, construction, and post construction time frames. The sites are identified by their original site designation (See Figure 1, Page 2).

DATA ANALYSIS

The variability of the data is expressed sigma, the standard deviation of the observations. The magnitude of the standard deviation should be considered as a measure of the variability associated with material, sampling, and testing. Because of problems with the sampling plans as designed, it is difficult to isolate the magnitude of this variable assignable to these various components.

In order to determine the effect of construction on water quality, the statistical "T" test was applied to the water quality data at hand. Basically, it is desired to determine whether the means of two different samples could have come from the same populations, or from populations with the same means. In the present case of water quality, it is important to know whether the mean water quality before construction, as measured by some criteria, is significantly affected due to construction activity.

The pooled testing was retained as a tool to assist in the isolation of the sources of significant changes in combination with the non-pooled test results.

The "T" tests were designed as follows:

$T_1 = (\overline{X}_1 - \overline{X}_2)/SD_1$ where:

T_1 - Preconstruction vs. construction
X_1 - Preconstruction condition
X_2 - Construction condition
SD_1- Standard Deviation (preconstruction).

and positive values indicate preconstruction values are greater than construction values, and negative values indicate preconstruction values are less than construction values;

$T_2 = (\overline{X}_1 - \overline{X}_3)/SD_1$ where:

T_2 - Preconstruction vs. post construction
X_1 - Preconstruction condition
X_3 - Post construction condition
SD_3- Standard Deviation (post construction)

and positive values indicate preconstruction conditions are greater than post construction conditions, and negative values indicate preconstruction conditions are less than post construction conditions;

and $T_3 = (\overline{X}_2 - \overline{X}_3)/SD_3$ where:

T_3 - Construction vs. post construction
X_2 - Construction condition
X_3 - Post construction condition
SD_3- Standard Deviation (post construction)

and positive values indicate construction conditions are greater than post construction conditions and negative values indicate construction conditions are less than post construction conditions;

and $T_4 = (\overline{X}_2 - \overline{X}_4)/SD_4$ where:

T_4 - Construction vs. non-construction

X_2 - Construction condition

X_4 - Non-construction condition

SD_4 - Standard Deviation (non-construction)

and positive T values indicate construction conditions are greater than non-construction conditions and negative values indicate construction conditions are less than non-construction conditions.

The results of the various T tests are presented with the corresponding degrees of freedom in Appendix C.

CONSTRUCTION DATA

Construction progress is presented in the form of a graph (Appendix D) showing the activity that occurred at each of the sampling sites during each month of the study period. The construction progress as presented in the graph was used to determine the time frame, and therefore, the construction phase to be associated with each site at all sampling times.

TURBIDITY

Turbidity is the term used to describe the degree of opaqueness produced in the water by suspended particulate matter. It is measured in NTU's (nephelmetric turbidity units), an expression of the optical properties of a sample which causes light rays to be scattered at a 90° angle.

> The NCHRP describes turbidity as "excess suspended solids are a by-product of practically all phases of highway construction, maintenance, and use. They include both inorganic and organic materials, which vary in size from minute clay particles to materials the size of rocks. Turbidity is known to have adverse effects on aquatic primary productivity,

feeding, and reproductive success of higher organisms, and upstream migration and spawning in certain species. These effects may be of critical importance to the entire aquatic community and, when prolonged turbidity is experienced, significant changes in wetland function and class structure can be expected," (NCHRP, 15), (APHA, 1) (ASTM, 2).

The major effects of high turbidity are (1) the quenching of light penetration, thereby inhibiting photosyntheses and the production of oxygen by plants, (2) the building of zones of mud, silt, other sediments and detritus and (3) depletion of the dissolved oxygen as a result of respiration in the breaking down of suspended organic materials.

In an activity such as highway construction, an increase in turbidity may be caused by the introduction into the water of such materials as humus, clay, silt, organic detritus, colloidal matter and plant matter or resuspension of materials already in the sediments.

It must be noted that turbidity is not a uniform parameter even within a specific body of water. Seasonal increases in rainfall, runoff and stream discharge, for example, may introduce considerable amounts of silt and other sediments and materials, thereby altering the water's color and turbidity.

Preliminary results of the turbidity sampling are shown in Appendix B. The results given are the periodic construction phase means and standard deviations for each site. The sites which are identified in the introduction and objectives followed the progression of the construction which generally proceeded from south to north.

The analysis of the turbidity test data (Appendix C) indicated that there were localized effects of construction on the turbidity at site 1. The data also indicate that the turbidity is decreasing since the completion of construction activities. Day and Boucher indicated that this is the normal sequence of events with the parameter when related to construction activities (7).

The data also indicate that there is no trend at sites 9 and 15 for the waters to become more turbid. This is indicated by the pre and psot construction test data which show overall increases in turbidity of 18.62 NTU at site 9 and 6.74 NTU at site 15.

At site 9, the most probable cause is the result of increased currents and tidal changes. At site 15, the increased turbidity is the result of water pollution and low flows.

The effects of the construction were as predicted by Day and Boucher (6), that is, minimal, controllable, and not of long duration.

COLOR

Color is defined as a quality of a visible phenomena distinct from form, light and shade. The EPA also defines color to be separate from turbidity, although it may be influenced by turbidity.

"Filtration of water will remove suspended colorants leaving the so-called true color of the water." Cole (6). The true color of a water will vary with the type of source of the water. The waters involved in this project are eutrophic in source and, therefore, are in the yellow-brown range of colors.

The project used apparent color. The standard test used in this project is the Platinum Cobalt Spectrophotometric Procedure of the Environmental Protection Agency (USEPA, 16). All results are reported in Platinum-Cobalt color units.

The color results indicated that there was an overall trend for the color to increase in the north end of the project. The data also indicate that construction activities at sites 12 and 15 increased the color content and once the construction was completed, the trend was for the color to return to the ambient level.

SALINITY

Salinity is a measure of the concentration of dissolved salts in water to intrude into fresh water areas through dredged canals. "Salinity affects the numbers and kinds of animals that can live in the area. Salinity also affects the amount of oxygen that can be dissolved in the water." (Cole) (6).

Significant changes in salinity occurred at sites 1, 9, 12, and 15. The data for sites 1 and 9 indicate that salinity changes were probably due to factors other than the construction activities. The hydrology of the area is tidal in nature with channels and canals throughout the terrain. Salt water intrusion, together with the topography of the project area, is one possible cause of the salinity changes at sites 1 and 9.

Sites 12 and 15 were subject to pollution from a used automobile battery plant, and the effects of this are indicated by the change in salinity, particularly its decrease, after the pollution of the project area by the battery junkyard was reduced.

CONDUCTIVITY

Conductivity is a measure of the ability of electrons to flow through the water. It is the reciprocal of resistance. This parameter is measured in the field with a Salinity-Conductivity-Temperature Meter and readings were recorded on site. Conductivity is directly influenced by both temperature and salinity. Salinity can be measured by conductivity, but as Cole (6) points out, "the diversity of ionic composition will produce different conductivity values, while the salinity remains constant". The units of conductivity or MHOS/CM or more frequently micromhos/cm.

The extreme range of conductivity values (from less than 10 to over 3000) produces confounding in the T test which renders this test of no value in analyzing this parameter, which together with the relationship of conductivity and salinity, indicated that additional analysis of this parameter was not needed at this time.

DISSOLVED OXYGEN

The amount of oxygen found in the water and available for use by aquatic flora and fauna is termed dissolved oxygen. Dissolved oxygen is reported as mg/l. "The volume of oxygen dissolved in water at a given time is dependent upon (1) the temperature of the water, (2) the partial pressure of the air in contact with the water, (3) the concentration of dissolved salts (Salinity) in the water, and (4) the amount of suspended material in the water, . . . the solubility of oxygen in water is increased by a decrease in temperature and would decrease with an increase in salinity . . . dissolved oxygen concentrations are also influenced by the flow of water, wind action, photosynthesis and respiration". (Cole) (6).

"Highway construction affects dissolved oxygen by primarily introducing materials into the water which deplete the oxygen supply when they are decomposed." (Hopkins) (9).

All of the significant test data indicate that the D. O. content was continuously increasing at sites 1, 5, and 9 throughout the duration of the project. The remainder of the sites showed no significant changes. A possible cause for this is increased aeration of the water by various human activities in the area.

pH

The symbol pH represents the hydrogen ion activity and is expressed as the logarithm of the reciprocal of the H^+ ion activity in moles/l at a given temperature. All ions are formed by disassociation of the atoms which have retained a charge. In the case of water, the disassociation produces Hydrogen and hydroxyl ions.

The pH scale ranges from 0 to 14, with 7.0 being neutral. A pH of less than 7 indicates there are more hydrogen ions than hydroxyl ions. A pH greater than 7 indicates just the opposite. Pure deionized, distilled water has a pH very close to 7.0. The pH of most inland waters varies from 6.0 to 9.0, depending upon the amount and type of organic/mineral loads.

The waters in the project area are subject to heavy organic loading from the marshes and swamp which are also the source of many organic acids.

The only effects of the construction were shown as a general trend to varying degrees at sites 1, 5, and 9. There the pH became more acidic during construction then returned to the more alkaline ambient. One possible cause of the temporary change in pH could be the disruption of benthic deposits during construction. The sites 12 and 15 showed the same tendency; however, because of pollution with battery acid during the project, the effect cannot be definitely attributed to the construction activities (See Figure 1, Page 2).

ALKALINITY

Alkalinity may be defined as the acid combining ability or the buffering ability of the system in question.

Sources of alkalinity in water are dissolved CO_2 and the reaction of water with sedimentary carbonate rocks. Natural waters contain alkalinity producing compounds such as borate, humic acids, (Cole) (6) organic anions, the phosphate ions PO_4^{---}, HPO_4^{--} , $H_2PO_4^{-}$, in addition to carbonate, bicarbonate and hydroxyl ions which are the three usually given credit for causing alkalinity.

The test procedure used for alkalinity is the Environmental Protection Agency procedure for titration with 0.02 N Sulfuric Acid to an endpoint pH of 4.5 (USEPA, 16).

The only significant variations for alkalinity occurred at site 9. The data indicate that there is an overall increase in the alkalinity of the waters at site 9. This increase in alkalinity cannot be attributed to the construction activities, but possibly to changing hydrology in the Pass Manchac area.

HARDNESS

Hardness can be defined as the calcium and magnesium content of a water. The hardness of water is due to chemical reaction with di-valient metals, especially calcium and magnesium.

The standard test for hardness is titration with (ethylenedinitrilo) tetraacetic acid (EDTA) (APHA, 1). The EDTA chelates the Calcium and Magnesium, and with the use of an indicator and standardization will give total hardness in mg/l as Calcium Carbonate.

Hardness changes during construction were found at sites 5, 9, 12, and 15. The levels of hardness at sites 5 and 9 showed an increase during construction activity and a tendency to return toward the ambient after completion of construction. The hardness levels at sites 12 and 15 started dropping before construction and have continued to do so through the completion of the water testing. Again, the pollution with sulfuric acid from the automobile battey yard is suspected as the cause of this change.

CHLORIDE

From many studies of natural waters all over the world, chloride has been ranked as the third most prevalent anion in water. (Cole) (6).

Chloride in water may come from igneous rocks by leaching, atmospheric fallout from chlorides that have evaporated, wind blown from deposits where the water has evaporated, volcanic gases and ash and pollution. Chloride is very important as it can exert many of the same influences as salinity.

The test procedure for chloride is the one given in ASTM D512 B (ASTM, 2). The results of the testing for chloride presented a picture almost identical to hardness. The chloride values increased at sites 5 and 9 during construction and then followed the trend to return toward the ambient.

As with hardness, the chlorides at sites 12 and 15 have been declining for the entire duration of the project. Again, the pollution with sulfuric acid is the suspect cause.

SOLIDS

In this category are total solids, suspended solids, dissolved solids, and volatile solids. Suspended solids, which are measured indirectly as turbidity, may be weighed directly by filtering on a tared filter, drying and weighing. Anything in the water but not dissolved may be considered suspended. Dissolved solids are the residue left behind after low temperature evaporation of the water. This residue includes organic and non-organic materials. Total solids or total residue is the sum or combination of the suspended and dissolved solids. Volatile solids are those which evaporate at a temperature of 550°C. They are primarily organics. Appropriate EPA methods 160.1, 160.2, 160.3, and 160.4 are used (USEPA, 16).

The tests on the various categories of solids produced few significant results. The parameter of volatile solids was deleted due to excess variability. The dissolved residue data indicated no significant change. The suspended residue showed increases at sites 12 and 15 during construction and a return toward the ambient after completion of construction.

The only significant change in total solids was a decrease in total solids at site 15 between the preconstruction and post-construction conditions. Although the data indicate the decline in total solids continued through the construction activities, the initiation of the decline before and continuation of it after construction make it doubtful that this improvement in water quality is attributable to the construction activities.

TOTAL AND FECAL COLIFORMS

Tests for these organisms are normally run for Class A and B primary contact waters, and seafood production areas. This test indicates the possible pollution of a natural stream with raw sewage.

Tests for these organisms were run only occasionally, such as during fish kills, and on the north end of the project. There is a primary sewage treatment plant near the north end of the project, site 5 (old site 15) (See Figure 1, Page 2).

Data show some extremely low dissolved oxygen concentrations in the far northern section of the study area (sites 14 and 15). These low concentrations caused fish kills in the late summer of 1976. Investigation of this problem showed the presence of coliform bacteria, an indicator of the presence of raw sewage. The exact source of this pollution has not been determined, but the coliform counts were highest at site 15 (south slough). Continued testing showed that this was a situation localized to site 15. South slough is the receiving water for the effluent from the primary sewage treatment plant at Ponchatoula, Louisiana.

MISCELLANEOUS PARAMETERS

The following parameters were evaluated irregularly at the beginning of the study: nitrate, nitrite, total kjeldahl-nitrogen, ortho phosphate, total phosphate, sulfate, chemical oxygen demand, biochemical oxygen demand and oil and grease.

All of the above parameters were discontinued on or before the completion of the Interim report. The reason for the discontinuation was insufficient baseline (preconstruction) data to validly compare the effects the construction would have had on these parameters.

Oil and grease measurements were complicated as the source of the oil and grease could not be identified. Some of the possible sources included recreational boats, commercial marine traffic, nearby highway and railroad traffic, local camps and cottages, and construction activity on I-55 itself.

CONCLUSIONS

Review of all the data and external conditions affecting the various parameters leads to three highly significant trends within the study. The first of the trends is that the effects of elevated highway construction with environmental controls are minimal on the quality of the surrounding water.

Secondly, any effects produced by the construction tend to be temporary in nature, and once the construction is completed, the water quality tends to return toward the preconstruction ambient.

The third trend identified in the data is that local activities other than highway construction may produce greater and longer lasting adverse affects on the water quality.

Before these conclusions can be considered to be statements of greater weight than trends, more research must be done in this area.

It is recommended that future projects for this type of evaluation select research areas which absolutely minimize the influences of activities other than highway construction. These future projects should be designed very carefully to insure a proper sampling program, a thorough evaluation of preconstruction (ambient) water quality conditions, and a sufficient post construction period of evaluation to definitely determine if the changes in water quality due to elevated highway construction are indeed reversible.

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APPENDIX A

Photographs of Construction Activities

PLATE I
STATE PROJECT NO. 736-03-25
INTERSTATE 55
PONCHATOULA - LA PLACE
SITE 15 BEFORE CONSTRUCTION

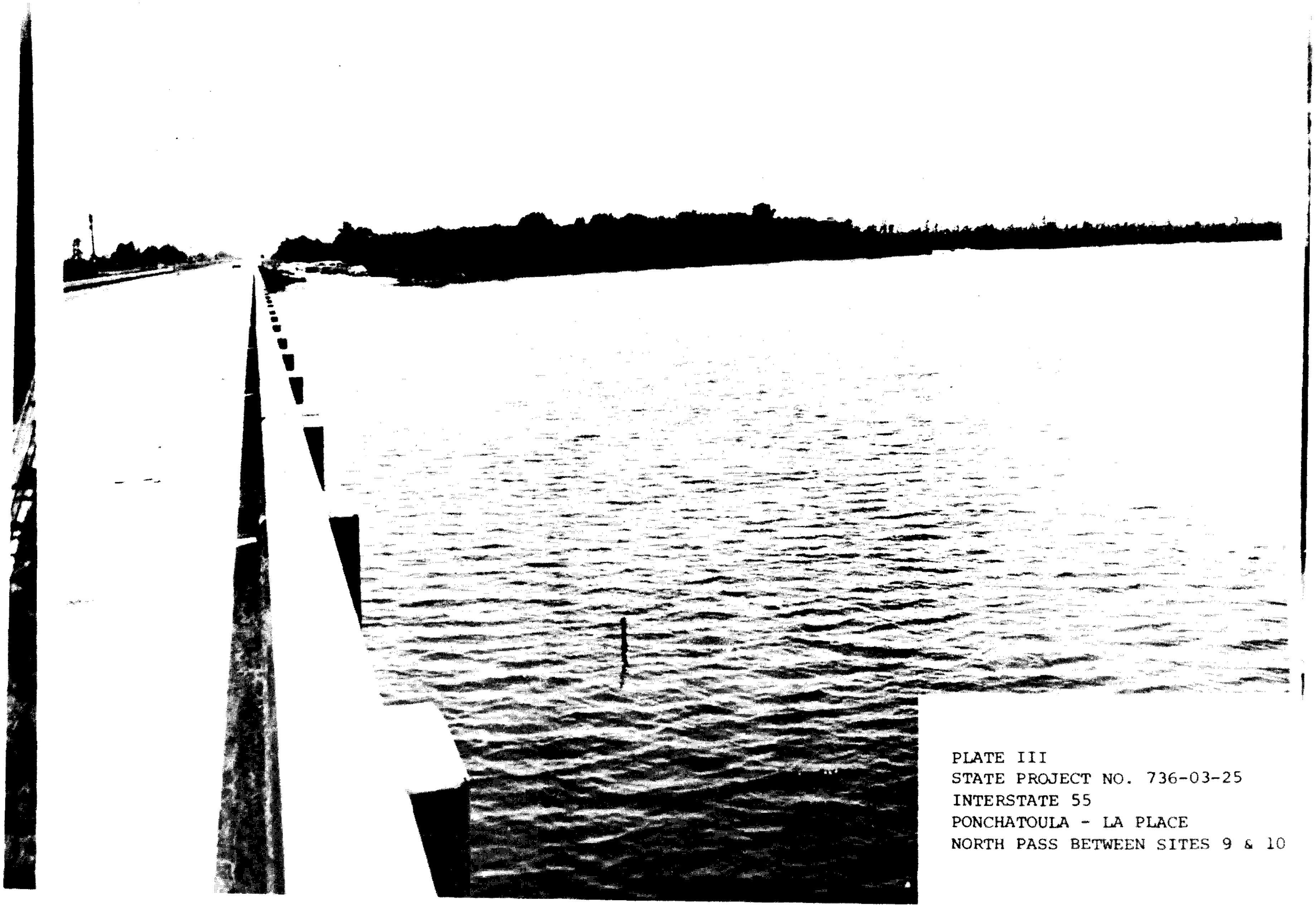


PLATE III
STATE PROJECT NO. 736-03-25
INTERSTATE 55
PONCHATOULA - LA PLACE
NORTH PASS BETWEEN SITES 9 & 10

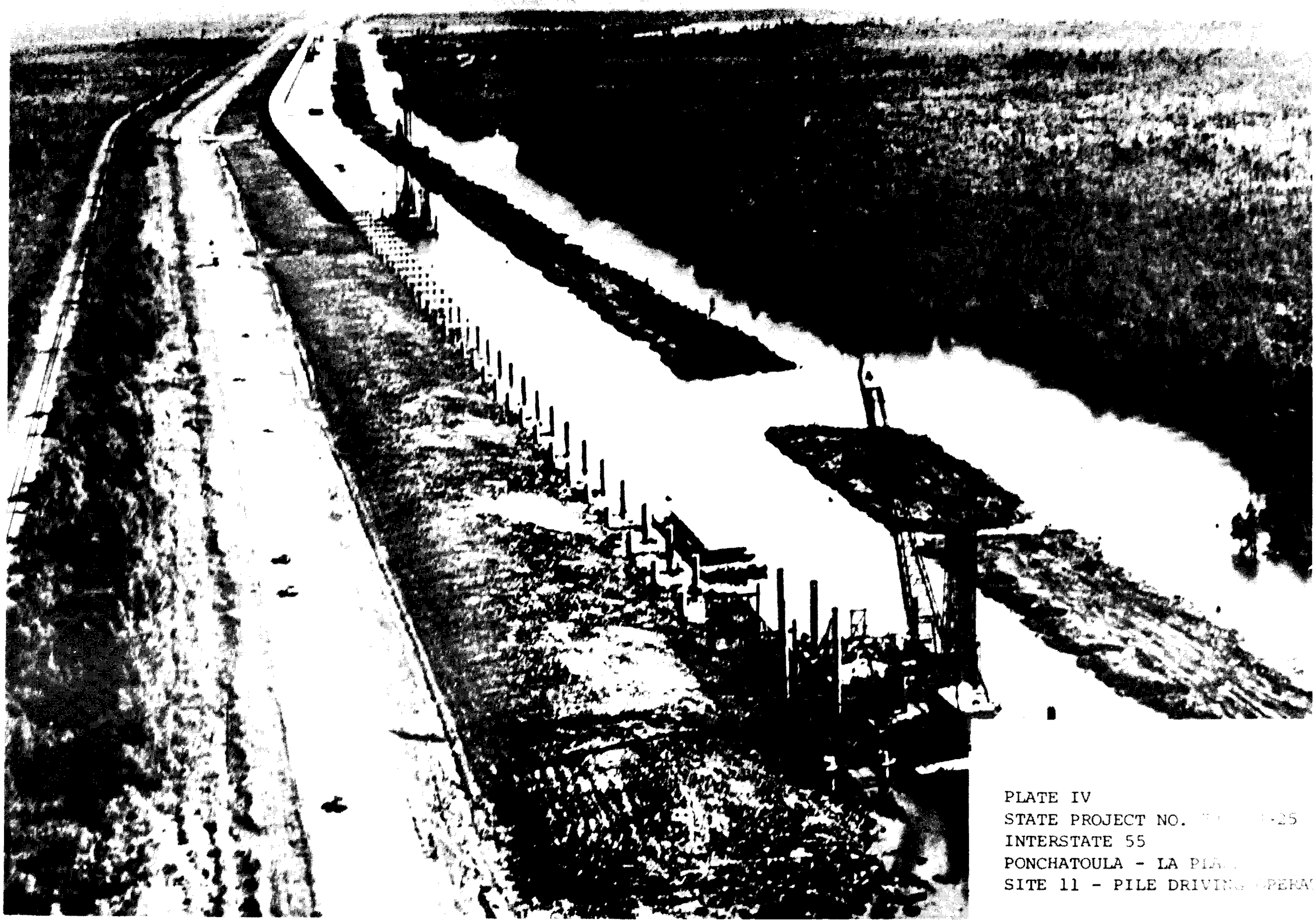


PLATE IV
STATE PROJECT NO. -25
INTERSTATE 55
PONCHATOULA - LA PLA
SITE 11 - PILE DRIVING

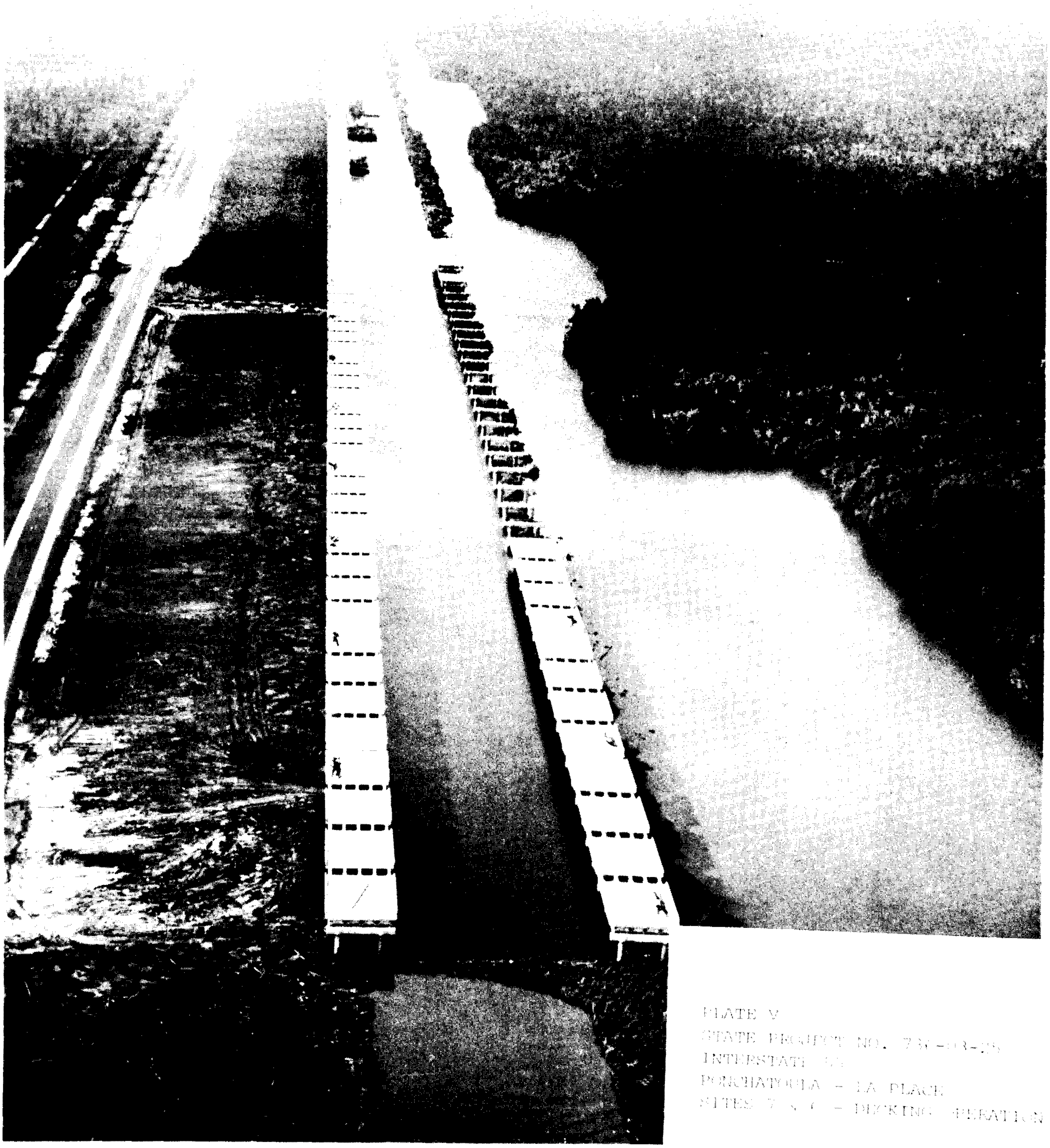


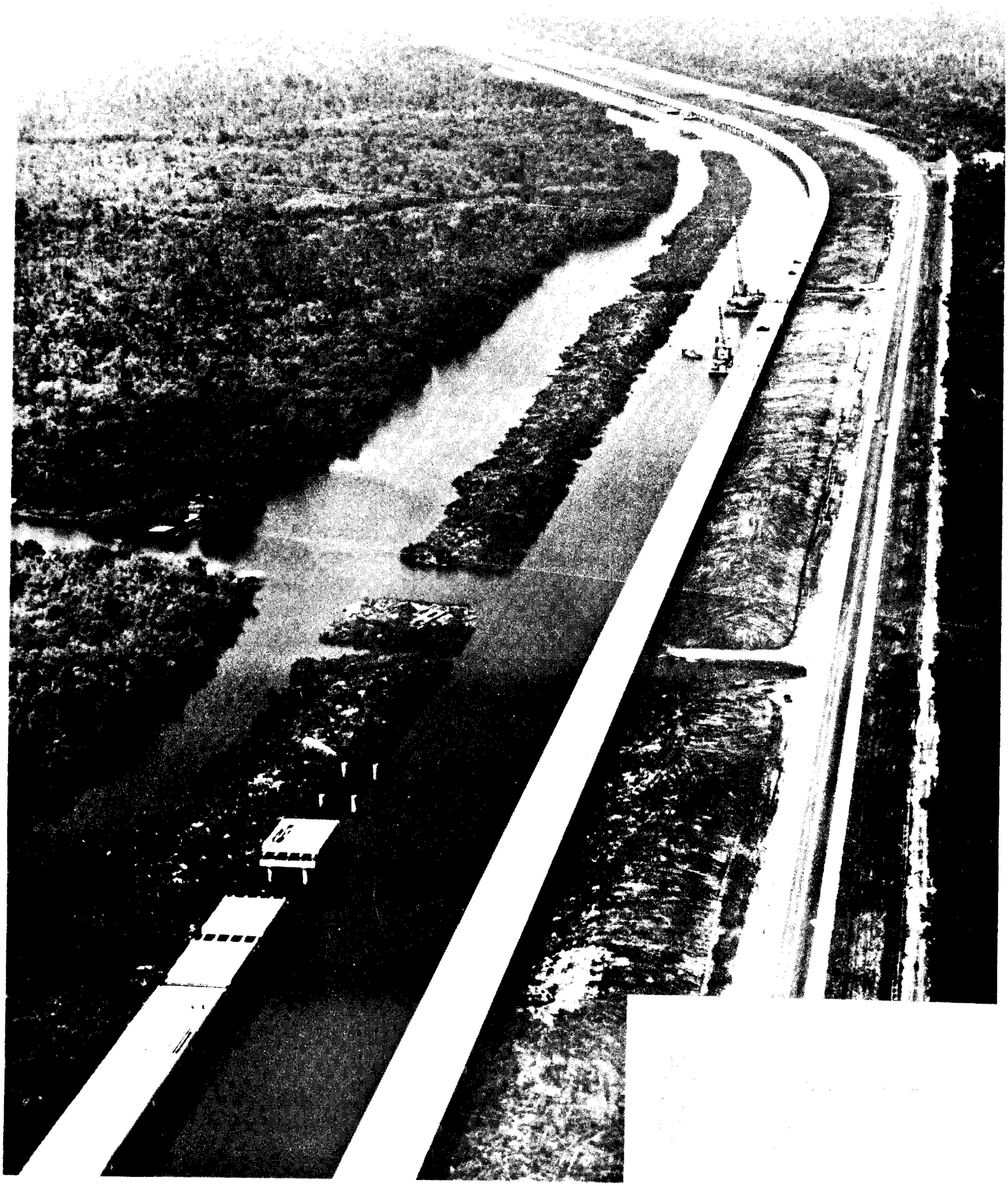
PLATE V
STATE PROJECT NO. 7[illegible]-[illegible]3-[illegible]
INTERSTATE [illegible]
PONCHATOULA - LA PLACE
SITES 7 & [illegible] - DECKING OPERATION

PLATE VI

STATE PR[illegible]

INTERSTATE [illegible]

[illegible]



APPENDIX B

Statistical Data Recap

CONDITION	PRE-CONSTRUCTION			CONSTRUCTION			POST-CONSTRUCTION			NON-CONSTRUCTION		
PARAMETER & SITE	N	$\overline{x}$	σ	N	$\overline{x}$	σ	N	$\overline{x}$	σ	N	$\overline{x}$	σ
Turbidity (NTU's)												
1	--	--	--	33	20.71	20.67	60	6.17	6.11	60	6.17	6.11
5	17	15.82	7.61	23	15.57	11.28	51	23.92	31.17	68	21.46	27.39
9	37	18.62	12.68	23	19.30	18.89	33	37.24	36.95	70	27.38	26.97
12	40	15.30	18.00	17	18.66	16.04	33	22.46	33.91	73	18.52	26.39
15	19	8.37	8.62	27	21.39	20.44	27	15.11	18.33	46	12.35	15.13
Color (PCU)												
1	--	--	--	27	101.10	38.86	59	75.29	23.29	59	75.29	23.29
5	16	100.94	29.56	23	79.22	31.09	48	140.39	108.04	64	130.53	91.18
9	37	84.11	38.82	23	113.29	91.54	32	119.47	79.07	69	100.51	60.85
12	40	96.73	41.41	16	190.63	89.40	33	134.61	50.08	73	113.85	45.52
15	19	98.15	48.51	27	164.81	52.85	26	133.15	36.77	45	118.37	42.08
Salinity (PPT)												
1	--	--	--	28	0.33	0.41	49	0.63	0.35	49	0.63	0.35
5	16	0.43	0.27	17	0.81	1.35	42	0.52	0.37	58	0.50	0.35
9	33	0.36	0.32	14	1.37	1.43	32	0.94	0.62	65	0.65	0.49
12	33	0.44	0.54	11	0.50	0.39	32	0.21	0.32	65	0.33	0.44
15	19	0.46	0.73	15	0.28	0.31	27	0.09	0.22	46	0.24	0.50
Dissolved Oxygen (PPM)												
1	--	--	--	23	3.14	2.05	49	4.88	2.82	49	4.88	2.82
5	16	3.91	1.48	13	5.53	2.30	42	5.38	2.45	58	4.99	2.23
9	26	5.03	2.18	14	6.37	1.85	33	7.15	2.22	59	6.22	2.20
12	27	3.84	1.84	10	3.81	2.72	33	4.71	2.03	60	4.32	1.95
15	9	3.88	2.43	14	3.19	2.13	28	4.48	2.43	37	4.34	2.43

CONDITION	PRE-CONSTRUCTION			CONSTRUCTION			POST-CONSTRUCTION			NON-CONSTRUCTION		
PARAMETER & SITE	N	$\bar{x}$	σ	N	$\bar{x}$	σ	N	$\bar{x}$	σ	N	$\bar{x}$	σ
pH												
1	--	--	--	27	7.19	0.30	59	7.21	0.36	59	7.21	0.36
5	16	7.09	0.28	23	7.29	0.28	48	7.13	0.38	64	7.12	0.36
9	38	7.26	0.23	21	6.89	0.63	33	7.37	0.29	71	7.31	0.27
12	40	7.05	0.30	16	6.20	0.57	33	7.12	0.48	73	7.08	0.39
15	18	6.73	0.39	27	6.23	0.84	27	6.82	0.30	45	6.78	0.34
Alkalinity (PPM)												
1	--	--	--	3	158.30	1.53	62	137.65	95.76	62	137.65	95.76
5	--	--	--	13	58.69	40.14	51	62.29	45.84	51	62.29	45.84
9	9	27.00	5.77	24	28.54	23.41	33	39.79	11.78	42	37.23	10.87
12	13	27.31	5.15	17	26.12	30.81	33	28.91	10.48	46	28.49	9.33
15	12	28.00	6.97	27	30.48	35.29	27	32.85	10.66	39	31.41	9.71
Hardness (PPM)												
1	--	--	--	3	190.00	36.03	62	163.84	46.86	62	163.84	46.86
5	--	--	--	13	146.66	51.75	51	113.15	49.86	51	113.15	49.86
9	9	143.11	52.46	24	168.46	12.98	33	138.85	73.94	42	139.70	70.17
12	13	131.69	138.21	17	73.82	51.23	33	70.79	46.85	46	87.40	82.50
15	12	123.17	119.80	27	54.96	41.34	27	46.30	20.70	39	69.15	67.59
Chloride (PPM)												
1	--	--	--	3	167.00	32.45	62	210.05	95.75	62	210.05	95.75
5	--	--	--	13	321.46	261.83	51	199.55	169.89	51	199.55	169.89
9	9	395.11	186.29	24	522.89	429.50	33	327.24	195.94	42	340.81	194.05
12	13	415.08	504.77	17	182.58	275.25	33	178.48	138.56	46	243.00	288.88
15	12	408.00	536.92	28	119.05	169.45	29	119.63	76.45	41	200.97	292.42

CONDITION	PRE-CONSTRUCTION			CONSTRUCTION			POST-CONSTRUCTION			NON-CONSTRUCTION		
PARAMETER & SITE	N	$\overline{x}$	σ	N	$\overline{x}$	σ	N	$\overline{x}$	σ	N	$\overline{x}$	σ
Suspended Residue (PPM)												
1	--	--	--	2	64.00	36.76	59	40.64	43.79	59	40.64	43.79
5	--	--	--	11	30.72	35.64	50	48.24	68.85	50	48.24	68.85
9	8	35.30	34.30	23	47.27	48.46	32	46.38	60.84	40	44.38	132.66
12	11	22.36	26.38	17	38.88	21.67	32	26.25	21.18	43	25.30	22.56
15	10	19.70	30.44	27	52.50	44.48	27	28.48	20.04	37	26.22	23.16
Dissolved Residue (PPM)												
1	--	--	--	2	379.50	140.70	59	652.76	286.12	59	652.76	286.12
5	--	--	--	11	546.00	303.57	50	563.24	246.47	50	563.24	246.47
9	8	734.63	451.21	23	901.56	656.71	32	916.34	456.59	40	882.87	455.60
12	11	464.73	542.13	17	308.36	256.51	32	415.88	275.81	41	427.79	359.45
15	10	397.00	500.82	27	275.1	226.03	27	249.30	136.19	37	287.29	279.78
Total Residue (PPM)												
1	--	--	--	2	443.50	177.50	60	695.17	287.37	60	695.17	287.37
5	--	--	--	12	627.00	335.61	50	604.60	275.55	50	604.60	275.55
9	8	770.13	467.33	24	966.80	663.19	39	964.03	457.93	47	938.87	459.40
12	12	654.33	783.00	17	347.24	266.38	32	442.13	280.82	44	497.71	467.74
15	11	598.09	780.77	27	345.3	227.07	27	277.78	141.03	38	366.76	428.60

APPENDIX C

T Test Data Recap

CONDITION	PRE-CONSTRUCTION vs CONSTRUCTION			CONSTRUCTION vs POST-CONSTRUCTION			CONSTRUCTION vs NON-CONSTRUCTION			PRE-CONSTRUCTION vs POST-CONSTRUCTION		
PARAMETER & SITE	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*
Turbidity												
1	--	--	--	91	5.0796	Yes	--	--	--	--	--	--
5	38	0.0789	No	72	-1.2445	No	89	-1.0928	No	66	-1.0561	No
9	58	-0.1670	No	68	-2.1370	Yes	91	-1.3394	No	54	-2.8830	Yes
12	55	-0.6650	No	48	-0.4360	No	88	-0.0211	No	71	-1.1539	No
15	44	-2.6112	Yes	52	1.1886	No	71	2.1715	Yes	44	-1.4876	No
Color												
1	--	--	--	84	3.8137	Yes	--	--	--	--	--	--
5	37	2.1890	Yes	69	-2.6542	Yes	85	-5.3408	Yes	62	-1.4357	No
9	58	-1.7192	No	53	-0.2633	No	90	0.7718	No	67	-2.4072	Yes
12	54	-5.3978	Yes	47	2.8180	Yes	87	5.0207	Yes	71	-3.5384	Yes
15	44	-4.3547	Yes	51	2.5224	Yes	70	4.1380	Yes	43	-2.7555	Yes
Salinity												
1	--	--	--	75	-3.3976	Yes	--	--	--	--	--	--
5	31	-1.1043	No	57	1.2916	No	73	1.6006	No	56	-0.8852	No
9	45	-3.8873	Yes	44	1.4346	No	77	3.3087	Yes	63	4.7605	Yes
12	42	-0.3390	No	41	2.4518	Yes	74	-0.9599	No	63	2.0808	Yes
15	32	0.8914	No	40	2.3125	Yes	59	0.2983	No	44	2.4883	Yes
Dissolved Oxygen												
1	--	--	--	70	-2.6450	Yes	--	--	--	--	--	--
5	31	-2.2969	Yes	57	0.1955	No	69	0.7904	No	56	-2.2419	Yes
9	38	-1.9499	No	45	-1.1537	No	71	0.2373	No	57	-3.6705	Yes
12	35	0.0386	No	41	-1.1338	No	68	-0.7268	No	58	-1.7218	No
15	21	0.7181	No	40	-1.6866	No	49	-1.5759	No	35	-0.6444	

*At .05 Level

CONDITION	PRE-CONSTRUCTION vs CONSTRUCTION			CONSTRUCTION vs POST-CONSTRUCTION			CONSTRUCTION vs NON-CONSTRUCTION			PRE-CONSTRUCTION vs POST-CONSTRUCTION		
PARAMETER & SITE	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*
pH												
1	--	--	--	84	-0.2513	No	--	--	--	--	--	--
5	37	-2.1941	Yes	69	1.7964	No	85	2.0387	Yes	62	-0.3866	No
9	57	3.2659	Yes	52	-1.7811	No	90	-4.4488	Yes	44	-3.8033	Yes
12	54	7.2929	Yes	47	-5.9163	Yes	87	-7.4338	Yes	71	-0.7603	No
15	43	2.3551	Yes	52	-3.4371	Yes	70	-3.9416	Yes	43	-0.8739	No
Alkalinity												
1	--	--	--	63	0.3707	No	--	--	--	--	--	--
5	--	--	--	62	-0.7617	No	--	--	--	--	--	--
9	31	-0.1934	No	55	-2.3821	Yes	64	-2.0863	Yes	40	-3.1353	Yes
12	28	0.1372	No	48	-0.4734	No	61	-0.472	No	44	-0.5235	No
15	37	-0.2397	No	52	-0.3341	No	64	-0.1569	No	37	-1.4396	No
Hardness												
1	--	--	--	63	0.9505	No	--	--	--	--	--	--
5	--	--	--	62	2.1472	Yes	--	--	--	--	--	--
9	31	-2.2441	Yes	55	1.9357	No	64	2.0064	Yes	40	0.2614	No
12	28	1.5958	No	48	0.2099	No	61	-0.6395	No	44	2.2544	Yes
15	37	2.6588	Yes	52	0.9733	No	64	-0.9815	No	37	3.2782	Yes
Chloride												
1	--	--	--	63	-0.7715	No	--	--	--	--	--	--
5	--	--	--	62	2.0525	Yes	--	--	--	--	--	--
9	31	-0.8561	No	55	2.3123	Yes	64	2.3742	Yes	40	0.9301	No
12	28	1.6160	No	48	0.0704	No	61	-0.7523	No	44	2.5012	Yes
15	38	2.5987	Yes	55	0.0168	No	67	-1.3491	No	39	2.8731	Yes

*At .05 Level

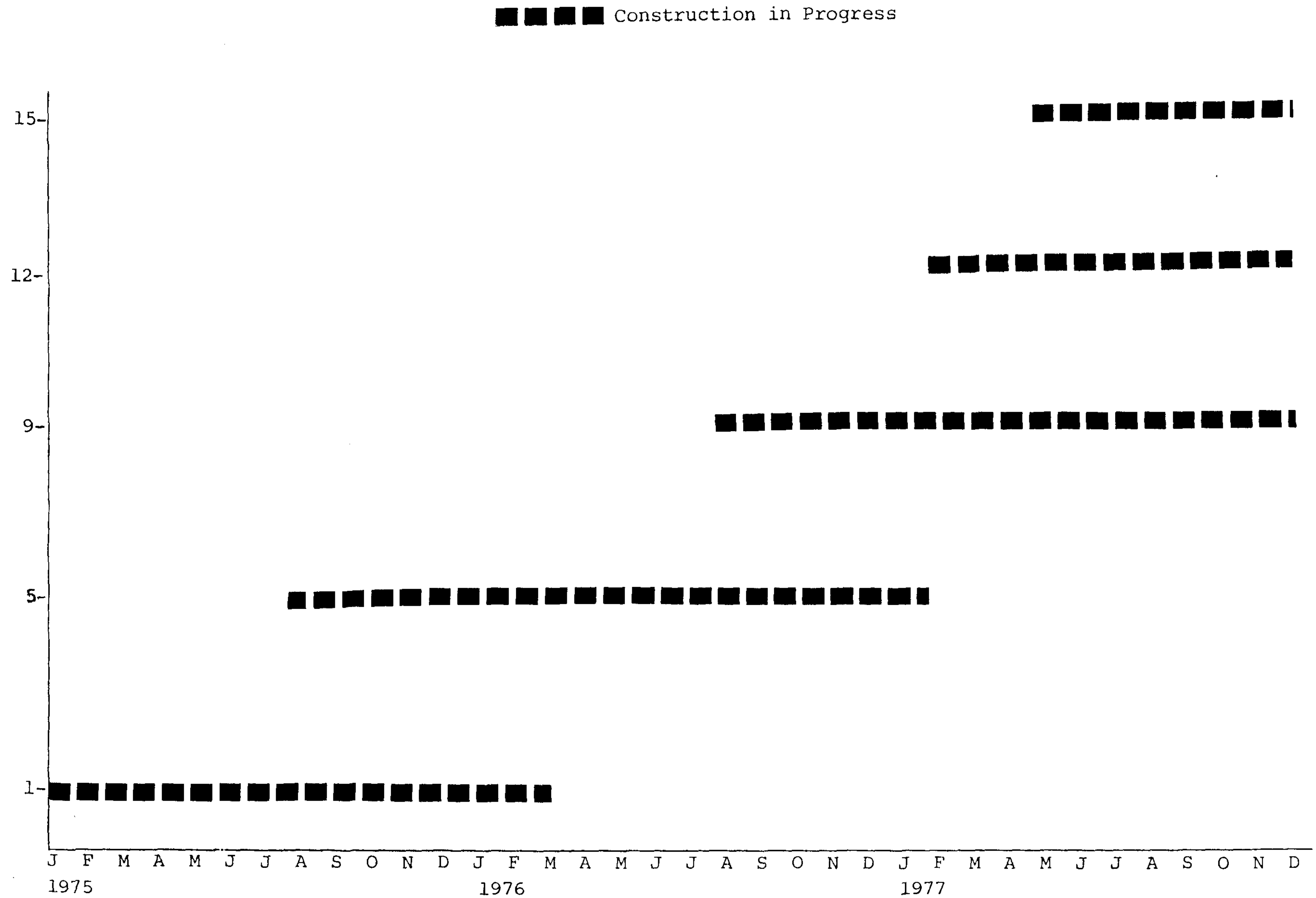
CONDITION	PRE-CONSTRUCTION vs CONSTRUCTION			CONSTRUCTION vs POST-CONSTRUCTION			CONSTRUCTION vs NON-CONSTRUCTION			PRE-CONSTRUCTION vs POST-CONSTRUCTION		
PARAMETER & SITE	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*	DF	T	SIGNIFICANCE*
Suspended Residue												
1	--	--	--	59	0.7438	No	--	--	--	--	--	--
5	--	--	--	59	-0.8164	No	--	--	--	--	--	--
9	29	-0.6309	No	53	0.0581	No	61	0.2064	No	38	-0.4838	No
12	26	-1.8095	No	47	1.9713	No	58	2.1429	Yes	41	-0.4934	No
15	35	-2.1439	Yes	51	2.5584	Yes	62	3.0852	Yes	35	-1.0239	No
Dissolved Residue												
1	--	--	--	59	-1.3369	No	--	--	--	--	--	--
5	--	--	--	59	-0.2014	No	--	--	--	--	--	--
9	29	-0.6631	No	53	-0.0986	No	61	0.1338	No	38	-1.0090	No
12	26	1.0313	No	47	-1.3298	No	56	-1.2295	No	41	0.3888	No
15	35	1.0288	No	51	0.5080	No	62	-0.1879	No	35	1.4261	No
Total Residue												
1	--	--	--	60	-1.2247	No	--	--	--	--	--	--
5	--	--	--	60	0.2424	No	--	--	--	--	--	--
9	30	-0.7732	No	61	0.0196	No	69	0.2088	No	45	-1.0875	No
12	27	1.5077	No	42	1.1456	No	59	-1.2600	No	47	1.3402	No
15	36	1.5549	No	52	1.3125	No	63	-0.2400	No	36	2.0893	Yes

* At .05 Level

APPENDIX D

Graph of Progress of Construction Activities

CONSTRUCTION TIME FRAME



CONSTRUCTION TIME FRAME