Drainage Improvement Report for the City of Patterson

Louisiana State Highway 90/Red Cypress Road/Hickory Street/Taft Street
Patterson, Louisiana
St. Mary Parish, Louisiana

Executive Summary

Providence Engineering and Design, LLC (Providence) was authorized by the City of Patterson (Patterson) to investigate the hydrologic and hydraulic conditions of multiple areas within the City of Patterson. The areas observed in this study are LA Highway 90, Red Cypress Road, Hickory Street, and Taft Street. This task was undertaken due to reports of flooding within the City of Patterson and along LA Highway 90. LA Highway 90 is the main drainage path for runoff within the City of Patterson; therefore, it was thoroughly examined for potential drainage improvements. Three streets within the City of Patterson (Red Cypress Road, Hickory Street, and Taft Street) are used to drain water from the northern half of Patterson to LA Highway 90. These three streets were also examined for potential drainage improvements.

Prior to this Drainage Improvement Report, preliminary design plans were created by Providence which addressed drainage issues south of LA Highway 90. Kelli Drive, David Drive, Mike Drive, and Leo Drive drain to Luccia Canal and were identified as needing drainage improvements. The data from these previously proposed improvements were not detailed in this report, but the improvements were still included in the construction cost for the proposed improvements.

The City of Patterson's watershed is one of the more significant watersheds in the Wax Lake East Drainage District (WLEDD). Berwick, Bayou Vista, Idlewild, Glenwild, Avalon, and Calumet are the other cities included in WLEDD, as shown in **Exhibit 1**. Also contained within the Wax Lake East Drainage District is the "Gravity Sub-Drainage District No. 1 of Gravity Drainage District No. 2." The WLEDD is defined by a levee system that surrounds all these previously mentioned cities and watersheds. All stormwater runoff within the WLEDD basin ultimately flows to the borrow canal. This canal is located to the south of Patterson and runs along and inside the ring levee previously mentioned. The borrow canal is drained by the Possum Bayou Pump Station and Cotten Road Pump Station, which all discharge into the Gulf Intracoastal Waterway (GIWW).

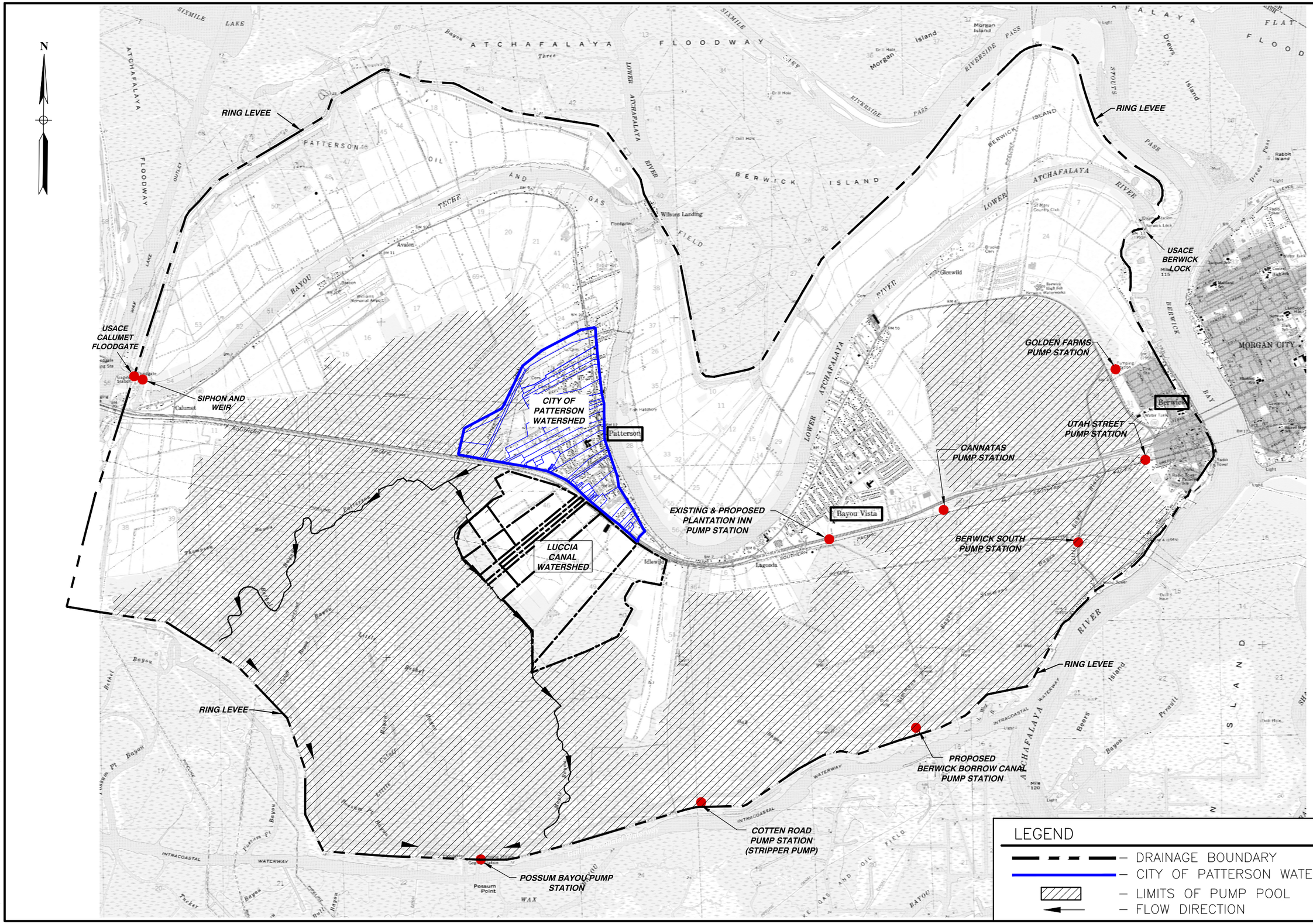
During the process of performing this study, Providence personnel performed a field topographic survey of LA Highway 90 and several streets within the City of Patterson. Data from this survey, along with publicly available hydrologic data, were compiled for input into the storm water computer model, XP-SWMM, originally developed by the USEPA. This model was used to predict water surface levels along LA Highway 90 for various storm intensities. Calibration of this model was achieved by reading rainfall gauge data from eight locations across Patterson and adjusting the model to match the head loss seen in the gauges.

The tailwater elevation in the WLEDD was determined by data provided from the Cotten Road Pump Station. Once adjustments for the datum were made, a tailwater elevation of -4.90 feet

NAVD88 (Geoid12.b) was for modeling of the City of Patterson. This means that the model had a base water elevation of -4.90 feet.

The results from the Drainage Improvement Report for the City of Patterson provided proposed improvements for seven areas within Patterson. The flooding issues are due to high water elevations in roadside ditches caused by undersized culverts, culvert composition and grade, sedimentation of culverts, and undersized drainage ditches. The report recommends the replacement of existing culverts with larger and smoother culverts sloped at more efficient grades, cleaning and sweeping ditches, and enlargement of existing undersized ditches at various locations along LA Highway 90, Red Cypress Road, and Hickory Street. The existing drainage structures along Taft Street were determined to be efficient and functional. The proposed improvements for Kelli, David, Mike, and Leo Drives are to remove and replace existing catch basins, and to fill existing ditches for subsurface drainage culverts as found in the prior study.

Exhibit 1 – Wax Lake East Drainage District (WLEDD) Map



REFERENCE SCALE: 1 0 0.5 1

CAD FILE NAME: overallDRAINMAP - Exhib 1.dwg

DESCRIPTION	DATE	BY

DESIGNED: C.P.H.
DRAFTED: C.P.H.
CHECKED: B.M.B.
DWG SCALE: 1"=500'
JOB No. 539-018-PED
DATE: 4 FEB 2020

PROVIDENCE ENGINEERING AND DESIGN, LLC
991 Grand Caillou Road, Houma, LA 70363
(985) 876-6380

JOB: CITY OF PATTERSON
LA HWY 90 DRAINAGE STUDY

EXHIBIT 1 - WAX LAKE EAST DRAINAGE DISTRICT MAP

OWNER: City of Patterson, St. Mary Parish, Louisiana

SHEET NO. 1

1 OF 1

P:\Projects\539 Patterson\539018 Patterson Drainage Study\Dwgs\Dwgs\Civil\WPSMM\Overall\DRAINMAP - Exhib 1.dwg - Layout2 02/04/2020 1:18pm cranevichent

Scope of Study

The scope of work was to determine the hydraulic capacity of the existing drainage structures within the City of Patterson and to study the impact of present and future developments. The study was to identify, recommend, and develop drainage improvements, if necessary. The study includes:

- Conducting a topographic survey to develop ditch cross-sections along LA Highway 90 and within the City of Patterson, and gather information on existing culverts, manholes, and other drainage items;
- Compiling available topographic information (as necessary) of the watershed area;
- Placing rainfall gauges across the City of Patterson and gathering data from rainfall events;
- Developing a computer hydrologic model to simulate various rainfall events in the drainage areas affecting the system. Using data from rainfall gauges to calibrate hydrologic model;
- Analyzing the model results to determine hydraulic impacts on the watershed;
- Evaluating the hydraulic conditions of the system to develop possible drainage improvements; and
- Providing a report to include the hydrologic study, hydraulic conclusions, drainage improvement recommendations, and cost estimate for all proposed improvements.

Background

Providence was authorized by Patterson to investigate the hydrologic and hydraulic conditions along LA Highway 90 due to reports of flooding within the City of Patterson.

LA Highway 90 drains almost the entirety of Patterson, with multiple curb and gutter drain lines and roadside ditches running southwest down the streets of Patterson, until they intersect with LA Highway 90. Reports of street flooding within subdivisions prompted the city to identify causes, verify the adequacy of the existing drainage system, and determine courses of action to resolve the problem.

Prior to this report, Providence was tasked with investing the hydrologic and hydraulic conditions within the "Luccia Canal Watershed" due to reports of flooding. The results from this investigation were to upgrade the existing drainage system along Kelli Drive, David Drive, Mike Drive, and Leo Drive. These proposed upgrades entailed the removal and replacement of existing culverts and catch basins, and to fill existing ditches for subsurface drainage.

Regional Drainage Patterns

Patterson is one of the main cities within the WLEDD watershed that has a substantial drainage area. The other notable drainage area is the city of Berwick; other cities included in the WLEDD are Bayou Vista, Idlewild, Glenwild, Avalon, and Calumet. All stormwater in the WLEDD watershed ultimately flows to the borrow canal through adjacent lowlands which form a larger reservoir or "pump pool." The "pump pool" is the area designed to be used to store peak runoff from the watershed during record storm events that are equal to or greater than one-year

rainfall events. The WLEDD's existing pump system has been reported to maintain a maximum level in the "pump pool" at approximately -4.90 feet NAVD. The borrow canal, along the perimeter ring levee, has a minimum depth of -6.0 feet NAVD. Once runoff enters this "pump pool", the watershed is drained by a series of pump stations and siphons placed along WLEDD levee. The borrow canal is drained by the Possum Bayou Pump Station and Cotten Road Pump Station, which all discharge into the Gulf Intracoastal Waterway. **Exhibit 1** shows the entirety of the WLEDD watershed.

Description of the Watershed

The Patterson watershed is enclosed on the north and east by Bayou Teche, on the south and southwest by LA Highway 90, and on the west by Patterson Canal. Runoff within the watershed travels from the northeast to the southwest at a general slope of 1.0%. The City of Patterson's watershed comprises of approximately 1,125 acres, with approximately 50% being used as quarter-acre lots for housing. The remainder of the watershed is comprised of undeveloped woodlands and lots, and LA Highway 90. A full map of the City of Patterson can be seen in **Exhibit 2**.

Ditches and culverts alongside these lots allow runoff to drain from City of Patterson. Runoff travels through this drainage system until it reaches the outfall point. The outfall for this watershed is located across LA Highway 90 from Red Cypress Road. The outfall is Patterson Canal and is the main drainage outlet for the entire City of Patterson. Once past LA Highway 90, Patterson Canal carries the runoff until it intersects with Bayou Patterson. From Bayou Patterson, the runoff drains towards the southwest until it deposits at the borrow canal. The issues found within this drainage system are mainly due to the existing ditches and culverts, which run alongside LA Highway 90 and the lots within Patterson, being undersized, sedimented, and course interiors causing higher friction. While Patterson Canal is the most critical path for runoff in City of Patterson, there are other means in which the watershed drains. A majority of these are minor bayous and canals which drain to the borrow canal. The other alternative is Luccia Canal, which is south of LA Highway 90. Once runoff enters into this southern system, the runoff drains through Luccia Canal and ultimately reaches the borrow canal.

Hydrology of the Watershed

The Patterson Watershed is predominantly composed of silty clay, silty loams, and clays. Approximately 97% of the area is composed of Hydrologic Soil Group D, with the other 3% being Group C soils. A percentage breakdown of the soil distribution can be seen in **Exhibit 3**.

As seen on the soil survey map in **Exhibit 4**, only small areas within Patterson are composed of Group C soils; therefore, Group D will be used for design of the drainage model. The SCS method assigns Curve Number, or CN, values according to the permeability of the soils in the drainage area that were analyzed. High CN values imply a higher percentage of rainfall runoff that occurs during a storm event. The CN also accounts for the percentage of the watershed covered by impermeable surfaces by development. Curve Number values are designated within the LADOTD Hydraulics Manual. Table 3-B.7.1 of the manual, **Appendix A**, shows what Curve Numbers are to be assigned to certain plots of land. For this drainage study, three different Curve Numbers were used. CN 80 will be used for the drainage areas with the median of LA Highway 90. These areas meet the criteria of "Good Condition: grass cover on 75% or more of the area." CN 84 will be used for drainage areas along either side of LA Highway 90. These areas meet the criteria for "Fair Condition: grass cover on 50% to 75% of the area." CN 87 will be used for the drainage areas found within the City of Patterson. These areas meet the criteria for "Average Lot Size of ¼ acre."

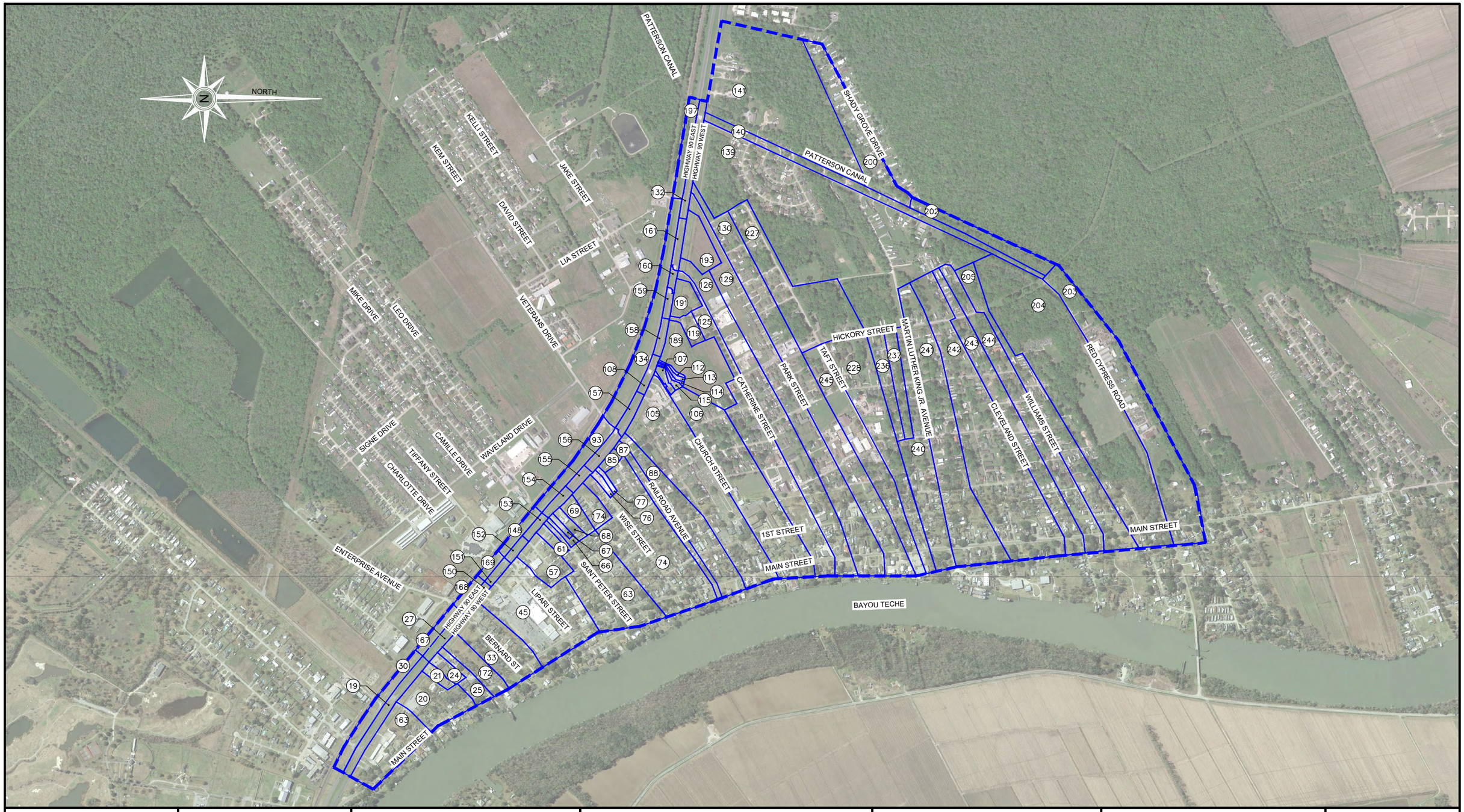
Within the watershed, a total of 77 sub-catchment areas were examined. These sub-catchment areas are notable areas within the system which appear to be outfall points of their respective areas; these areas are detailed within **Exhibit 5**. Most sub-catchment areas in this report are taken from the intersection of curb-and-gutter drainage within the City of Patterson to catch basins placed along LA Highway 90. The exceptions to the general sub-catchment area mentality are drainage areas found within the median of LA Highway 90, roadside drainage south of LA Highway 90, and the intersection of curb-and-gutter drainage to roadside ditches within the City of Patterson. For the most part, these sub-catchment areas are long and have about a 0.1% slope; therefore, long Times of Concentration are expected to be seen within these sub-catchment areas. Time of Concentration is defined as the time it takes a drop of water to travel from the upper region of a drainage area to the collection point or discharge point of that area. The Rational Method is used to calculate the Time of Concentration for this project. Also included in **Appendix A** is Figure 3-C.3-1 of the DOTD Hydraulics Manual, which can be used to calculate the Time of Concentration, given that the required parameters are available. These required parameters include the Hydraulic Length, Runoff Coefficient, and the Percent Slope. The Hydraulic Length is the displacement between the High Point in the system to the Outfall Point. The Runoff Coefficient represents the fraction of rainfall on a given area which may be expected to become runoff. The principal behind the Runoff Coefficient is the same as the Curve Number, but different values are used. For areas that correspond with a CN of 80, a Runoff Coefficient of 0.30 is used. For CN of 84, 0.40 is used and for CN of 87, 0.50 is used. Table 3-C.3-1 from the LADOTD Hydraulics Manual provides these values and can also be found in **Appendix A**. The Percent Slope of the watershed is estimated to be 0.10%. With these parameters, either the graph or the formula can be used to calculate the Time of Concentration. The graph's range for Time of Concentration is maximized at 35 minutes; therefore, the formula was used to calculate all Time of Concentrations, as shown in **Exhibit 6**.

Exhibit 3: Percentage of Soil Distribution

Map Unit Symbol	Map Unit Name	Acres	Percent of Area
BdA	Baldwin silty clay loam, 0 to 1 percent slopes	461.25	41.0%
GaA	Galvez silt loam, 0 to 1 percent slopes	33.75	3.0%
GxA	Uderts and Glenwils soils, 0 to 3 percent slopes, smoothed	79.88	7.1%
HRA	Harahan clay, 0 to 1 percent slopes	22.5	2.0%
IbA	Iberia clay, 0 to 1 percent slopes	289.12	25.7%
ShA	Schriever clay, 0 to 1 percent	229.5	20.4%
W	Water	9	0.8%
Totals for Areas		1,125	100%

Exhibit 4: Web Soil Survey Map

Exhibit 5 – Patterson Sub-Catchment Area Map



LEGEND	LEGEND

REVISIONS			
REV. NO.	DESCRIPTION	DATE	BY

GENERAL NOTES

APPROVED: _____

PATTERSON DRAINAGE
ST. MARY PARISH, LOUISIANA

1 0.5 0 1
REFERENCE SCALE

DATE: FEBRUARY 4, 2020	
SCALE: 1"=500'	
PLOT SCALE: 1:1	
FIELD BOOK: –	PAGE NO.: –
MAP PROJECTION: LA SOUTH–ZONE 1702	
DRAWN BY: C.P.H.	
JOB NO.: 0539–018–PED	CHECKED BY:
FILE NAME:Exhibit 5.dwg	SHEET: 1 OF 1

Prepared By:
PROVIDENCE
Providence Engineering and Design, LLC
Baton Rouge (225) 766-7400 · 991 Grand Caillou Road Houma, LA 70363 (985) 876-5380 · Kenner (504) 454-1710
www.providenceeng.com
Engineers • Architects • Surveyors

Exhibit 6 – Time of Concentration Calculations

ToC = 0.7039 x (HL0.3917) x (C-1.1309) x (S-0.1985)
ToC = Time of Concentration (minutes)
HL = Hydraulic Length (feet)
C = Runoff Coefficient
S = Percent Slope (%)

Subcatchment	Hydraulic Length (ft)	Runoff Coefficient	Percent Slope	**ToC (minutes)**
20	668.44	0.5	0.1	**31.12**
21	348.9	0.5	0.1	**24.12**
24	351.81	0.5	0.1	**24.20**
25	768.82	0.5	0.1	**32.87**
172	847.1	0.5	0.1	**34.14**
33	994.01	0.5	0.1	**36.35**
45	1253.28	0.5	0.1	**39.81**
57	517.13	0.5	0.1	**28.14**
61	362.47	0.5	0.1	**24.49**
63	1756.86	0.5	0.1	**45.44**
66	358.94	0.5	0.1	**24.39**
67	270.81	0.5	0.1	**21.84**
68	398.37	0.5	0.1	**25.41**
69	407.79	0.5	0.1	**25.64**
174	484.85	0.5	0.1	**27.44**
74	2059.63	0.5	0.1	**48.36**
76	307.59	0.5	0.1	**22.96**
77	310.84	0.5	0.1	**23.06**
85	283.25	0.5	0.1	**22.23**
87	2166.61	0.6	3	**20.43**
88	2258.02	0.6	3	**20.77**
105	2666.81	0.5	0.1	**53.51**
106	2985.46	0.5	0.1	**55.93**
107	312.8	0.5	0.1	**23.11**
115	300.56	0.5	0.1	**22.75**
114	324.85	0.5	0.1	**23.46**
113	298.68	0.5	0.1	**22.70**
112	287.74	0.5	0.1	**22.37**
189	1109.4	0.5	0.1	**37.95**
119	411	0.5	0.1	**25.72**

Subcatchment	Hydraulic Length (ft)	Runoff Coefficient	Percent Slope	**ToC (minutes)**
191	263.48	0.5	0.1	**21.61**
125	3973.5	0.5	0.1	**62.55**
126	4151.55	0.5	0.1	**63.64**
193	422.48	0.5	0.1	**26.00**
129	4914.7	0.5	0.1	**67.98**
130	5157.09	0.5	0.1	**69.28**
139	3503.99	0.5	0.1	**59.55**
140	4327.87	0.5	0.1	**64.68**
141	2019.53	0.5	0.1	**47.99**
200	606.74	0.5	0.1	**29.96**
202	1809.99	0.5	0.1	**45.97**
203	3587.39	0.5	0.1	**60.10**
204	3420.06	0.5	0.1	**58.98**
205	3333.59	0.5	0.1	**58.39**
244	3158.23	0.5	0.1	**57.17**
243	3144.02	0.5	0.1	**57.07**
242	3073.8	0.5	0.1	**56.57**
241	3014.08	0.5	0.1	**56.13**
240	2884.41	0.5	0.1	**55.18**
237	1295.31	0.5	0.1	**40.32**
236	1304.54	0.5	0.1	**40.44**
228	2957.37	0.5	0.1	**55.72**
245	2984.37	0.5	0.1	**55.92**
227	1811.31	0.5	0.1	**45.98**
19	2341.08	0.3	0.1	**90.60**
27	416.81	0.3	0.1	**46.09**
150	356.78	0.3	0.1	**43.36**
151	275.3	0.3	0.1	**39.17**
152	219.13	0.3	0.1	**35.83**
153	217.06	0.3	0.1	**35.69**

Subcatchment	Hydraulic Length (ft)	Runoff Coefficient	Percent Slope	**ToC (minutes)**
154	353.83	0.3	0.1	**43.22**
155	263.6	0.3	0.1	**38.51**
156	379.97	0.3	0.1	**44.44**
157	333.02	0.3	0.1	**42.21**
108	323.1	0.3	0.1	**41.71**
158	253.34	0.3	0.1	**37.92**
159	236.49	0.3	0.1	**36.91**
160	209.69	0.3	0.1	**35.21**
161	326.5	0.3	0.1	**41.88**
132	1158.09	0.3	0.1	**68.77**
30	2375.46	0.4	0.1	**65.81**
167	414.73	0.4	0.1	**33.22**
169	556.6	0.4	0.1	**37.28**
148	674.7	0.4	0.1	**40.20**
93	1272.46	0.4	0.1	**51.54**
134	2776.02	0.4	0.1	**69.96**
197	1173.48	0.4	0.1	**49.93**

Hydraulics of the Watershed

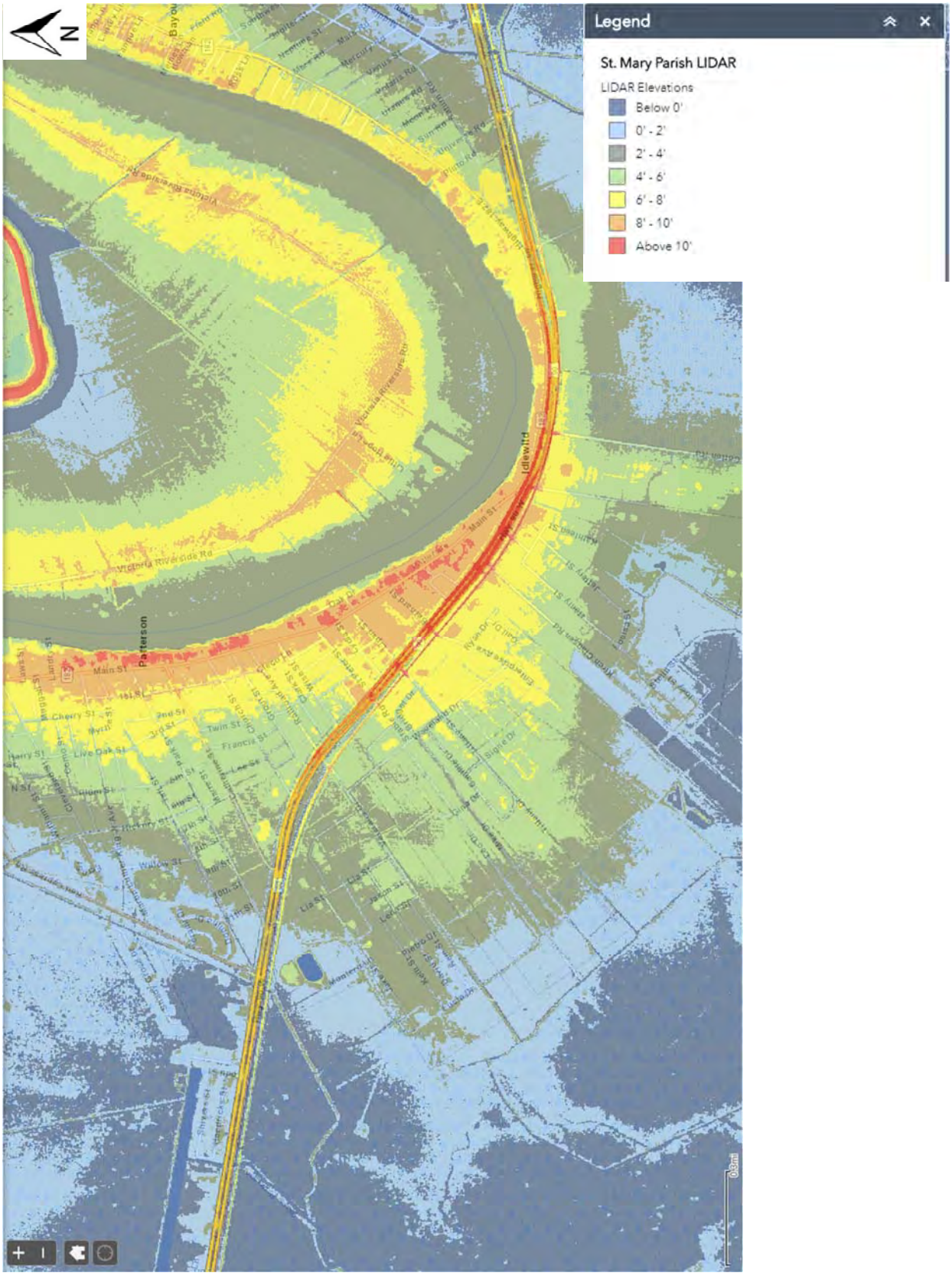
As previously described, the internal drainage of the developed areas of the City of Patterson consists of a combination of open ditches, culverts, and curb-and-gutters. These drainage elements, while controlling runoff to prevent flooding, ultimately increase the hydraulic gradient. This increase in hydraulic gradient is due in part by the increase in Time of Concentration from the rerouting of runoff through drainage conduits. To reduce the total travel time for runoff, improvements such as ditch expansion and culvert resizing can greatly assist in reducing the hydraulic gradient. When examining the hydraulic gradient, the head loss across the system is key in determining where drainage issues occur. A comparison of "Amount of Head Loss" to "Amount of Distance Traveled" should be made to figure where problems lie. In short, large head losses over short distances are signs of poor drainage.

Drainage in the City of Patterson is achieved with a vast system of drainage conduits. The average slope of these drainage elements is approximately 1.0%. The high point within this watershed is along the crown of Main Street, as shown in **Exhibit 7**, which is the road that directly borders Bayou Teche. From Main Street, runoff will either flow into Bayou Teche or into the City of Patterson. Once runoff enters Patterson, it is collected by a series of curb-and-gutters which run down many streets perpendicular to Main Street. These curb-and-guttered streets run from Main Street to LA Highway 90 and collect all the runoff from minor streets running parallel to Main Street. The runoff from these minor streets are drained with roadside ditches and culverts. These ditches range from depths of 2.0 feet to 3.0 feet, and top bank widths of 10.0 feet to 15.0 feet.

After being deposited into LA Highway 90, roadside ditches and culverts carry runoff to the intersection of Red Cypress Road and LA Highway 90. The general trend of these roadside ditches is to have smaller ditches upstream and larger ditches downstream. As in, upstream ditches are typically 3.0 feet deep and 15.0 feet wide, while downstream ditches are typically 5.0 feet deep and 30.0 feet wide. The smaller-sized upstream ditches gradually increase to the size of the larger downstream ditches across the distance of LA Highway 90. For the culverts, upstream culvert sizes of 24-inch diameter can be seen which gradually increase to 54-inch diameter culverts downstream. The amount and material of pipes appear to have no correlation with the upstream and downstream locations.

If the runoff reaches a certain elevation along LA Highway 90 West, cross drains transport runoff to the other side of LA Highway 90 East. The cross drains range in size from 24-inch diameter to 36-inch diameter. There is one outlier to this: a 60-inch diameter cross drain across from Church Street. Runoff from LA Highway 90 East is also carried to the intersection of Red Cypress Road and LA Highway 90. The ditches and culverts along LA Highway 90 East are typically larger than on LA Highway West. The ditches along LA Highway 90 East have top widths ranging from 25.0 feet to 60.0 feet, and have culverts ranging from 48-inch diameters to 60-inch diameters. In conjunction with wider ditches, they also run for longer stretches. These ditches and culverts run until they reach the intersection of Red Cypress Road and LA Highway 90. At this intersection, the runoff is deposited into Patterson Canal. As previously described, Patterson Canal brings this runoff to Bayou Patterson, which then transports that runoff to the borrow canal. The borrow canal, acting as a "pump pool", stores this runoff until the various pumps along the Wax Lake East Levee move it to the Gulf Intracoastal Waterway.

Exhibit 7: LIDAR of Patterson



Hydraulic Computer Model

Hydraulic computer modelling for present and future conditions were simulated using the XP-SWMM Model. The time/stage curves assumed for this study result in more conservative flood elevations (higher) in the study area than may be encountered in an actual 25-year or 100-year rainfall event. The model calculates the time-dependent flow (hydrographs) from the sub-catchment areas in the watershed resulting from a particular storm, as depicted in the graphs of **Appendix B**. The model then routes these flows through the hydraulic system of the watershed and predicts maximum flood levels at multiple points in the system. All models depict the flow characteristics of LA Highway 90, Red Cypress Road, Hickory Street, and Taft Street. This report contains the following four simulations.

1. Existing Conditions, 25-Year Rainfall Event
2. Existing Conditions, 100-Year Rainfall Event
3. Future Conditions, 25-Year Rainfall Event
4. Future Conditions, 100-Year Rainfall Event

The "Existing Conditions" models were calibrated using the rainfall gauge data from various sites around Patterson. These gauges were placed at locations determined to be important areas along the flow path, as shown in **Exhibit 8**. Each rainfall gauge placed corresponds with a node placed in the XP-SWMM model, as shown in **Exhibit 9**. The gauge number-to-node assignment can be seen in the table below:

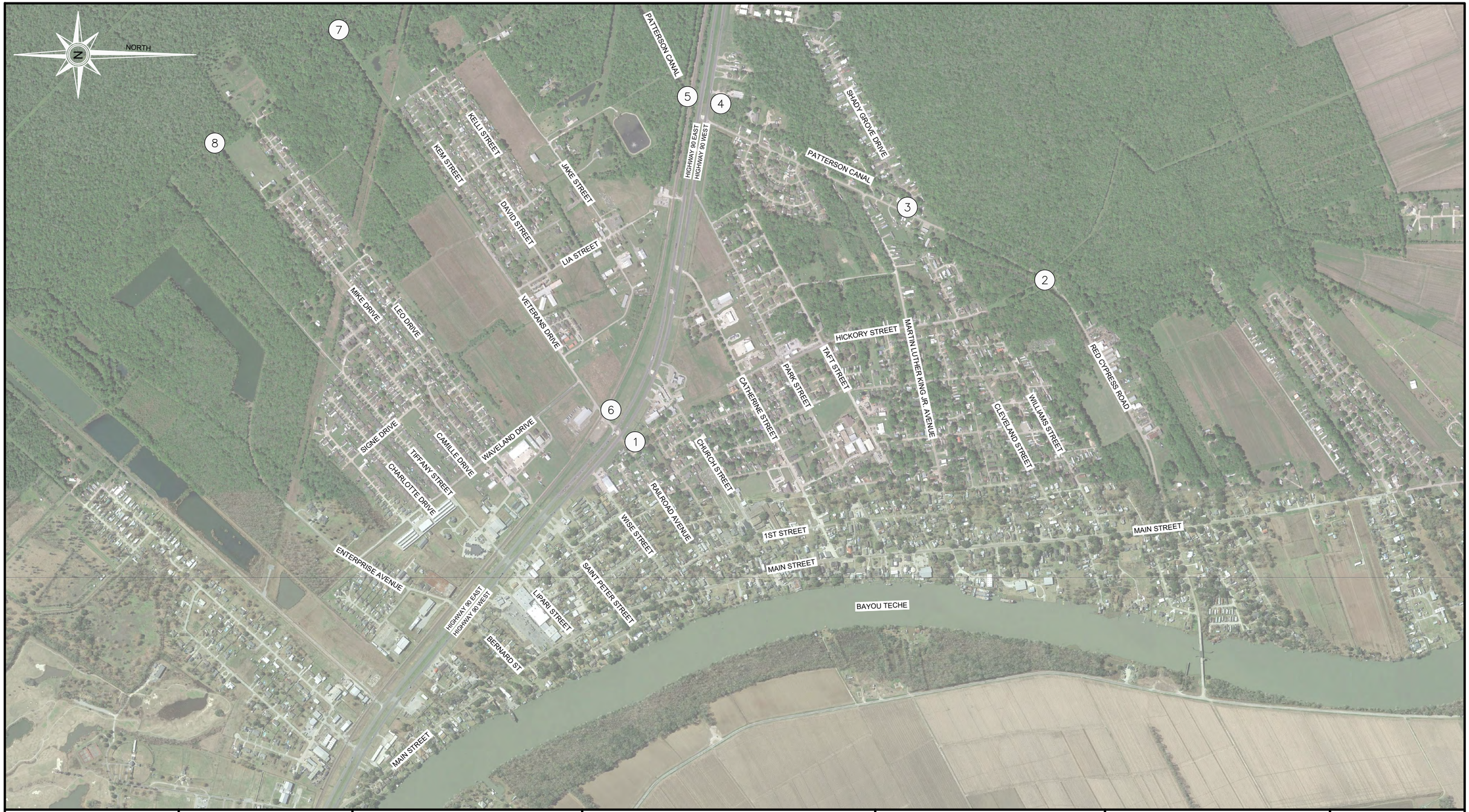
Location	Gauge Number	Node Number
End of Railroad Ave. (Highway 90 End)	1	88
Red Cypress Rd. Ditch Crossing	2	203
Shady Grove Dr. Ditch Crossing	3	201
Highway 90 West at Train Bridge	4	141
Highway 90 East at Train Bridge	5	142
Beginning of Veterans Dr. (Highway 90 End)	6	93
End of Kem St. and Lucia Dr.	7	202*
End of Mike Dr. and Lucia Dr.	8	227*

*Node Numbers correspond with data from the Luccia Drainage Model

Calibration was performed by mirroring the head losses found from the rain gauges onto the drainage model. Adjustments to the model such as the Ditch Overbank Length, Manning's Roughness Coefficient, and Time of Concentration were used to achieve calibration. **Appendix C** includes all the data provided to achieve calibration. As shown in the calibration data table included in **Appendix C**, the model was calibrated to be as close to actual conditions as possible.

To mimic existing conditions, a tail-water elevation of -4.90 feet was input into every node which has an invert below this max pump drawdown of -4.90 feet. This allows the model to act as though the water level will never go below an elevation of -4.90 feet, where applicable.

Exhibit 8 – Rainfall Gauge Location Map



LEGEND	LEGEND

REVISIONS			
REV. NO.	DESCRIPTION	DATE	BY

GENERAL NOTES

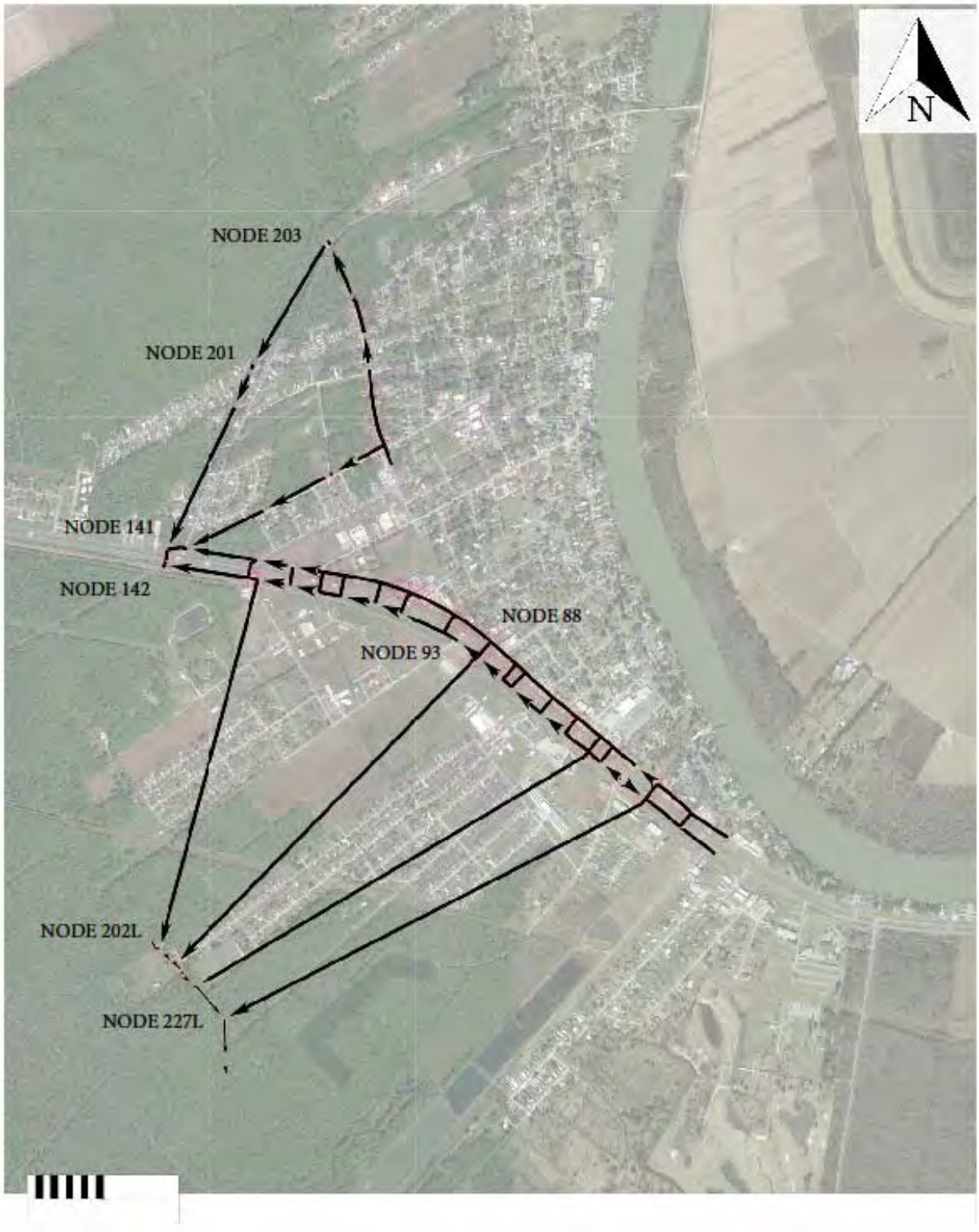
APPROVED:_____

PATTERSON DRAINAGE
ST. MARY PARISH, LOUISIANA

REFERENCE SCALE (1 0.5 0 1)	DATE: FEBRUARY 4, 2020
	SCALE: 1"=500'
	PLOT SCALE: 1:1
FIELD BOOK / PAGE NO.	MAP PROJECTION: LA SOUTH–ZONE 1702
– / –	DRAWN BY: C.P.H.
JOB NO.: 0539–018–PED	CHECKED BY:
FILE NAME:Exhibit 8.dwg	SHEET: 1 OF 1

Prepared By:
PROVIDENCE
Providence Engineering and Design, LLC
Baton Rouge (225) 766-7400 · 701 Grand Caillou Road, Houma, LA 70363 (985) 876-5180 · Kenner (504) 454-1710
www.providenceeng.com
Engineers • Architects • Surveyors

Exhibit 9 – XPSWMM Rainfall Gauge Map



Scale 1 : 18983.22

Simulation Nos. 1 and 2: Existing Conditions, 25-Year and 100-Year Rainfall Event

The first simulation modeled was an existing 25-year rainstorm event on the drainage structures along LA Highway 90, Red Cypress Road, Hickory Street, and Taft Street. In the model, all culvert lengths, slopes, and materials were modeled, as well as all ditch slopes and cross sections. When deciding design rainfall depth, the NRCS Method was used. According to Figure 3.4-2 of the LADOTD Hydraulics Manual (included in **Appendix D**), St. Mary Parish lies within Region I of Louisiana. For a storm with a 25-year return period, a rainfall depth of 9.6 inches in 24 hours was used for modelling. This value of 9.6 inches comes from Table 3.4-2 of the LADOTD Hydraulics Manual, which is also included in **Appendix D**.

The second simulation modeled was an existing 100-year rainstorm event on the drainage structures along LA Highway 90, Red Cypress Road, Hickory Street, and Taft Street. All the structures modeled in the first simulation are the same in the second. The only difference between the two models is the intensity of the rainstorm used. The NRCS Method was used once again to determine the design rainfall. For a storm with a 100-year return period, a rainfall depth of 12.6 inches in 24 hours was used for modelling. This value of 12.6 inches comes from Table 3.4-2 of the LADOTD Hydraulics Manual (**Appendix D**).

From the results of Simulation Nos. 1 and 2, seven areas were chosen for improvements. These areas were all found along either LA Highway 90 West, Red Cypress Road, or Hickory Street. The drainage structures along Taft Street appear to be adequate for draining the City of Patterson. Issues that were found along LA Highway 90, Red Cypress Road, and Hickory Street are large head losses, inadequate pipe size/material, unmaintained ditches/pipes, and sedimentation within culverts. Maps of all existing condition high-water elevations and proposed areas of work can be seen on **Exhibits 10** and **11**. Graphs depicting flow rate, velocity, upstream elevation, and downstream elevation for each proposed area can be seen on **Appendix E**. The description of each area and their problems are as follows:

Area 1: Intersection of Hickory Street Ditch and Red Cypress Road:

- Large head loss within Hickory Street Ditch and across Red Cypress Road
- Inadequate pipe sizing, material, and grading
- Inadequate ditch sizing

Area 2: Red Cypress Road:

- Unmaintained culverts

Area 3: Intersection of Red Cypress Road and Highway 90 West:

- Large head loss across Red Cypress Road
- Inadequate pipe sizing, material, and grading
- Sedimentation of downstream culvert and ditch

Area 4: Driveway to Patterson State Bank from Highway 90 West:

- Inadequate pipe sizing, material, and grading
- Sedimentation of downstream ditch

Area 5: Driveway to Circle K from Highway 90 West:

- Inadequate pipe sizing

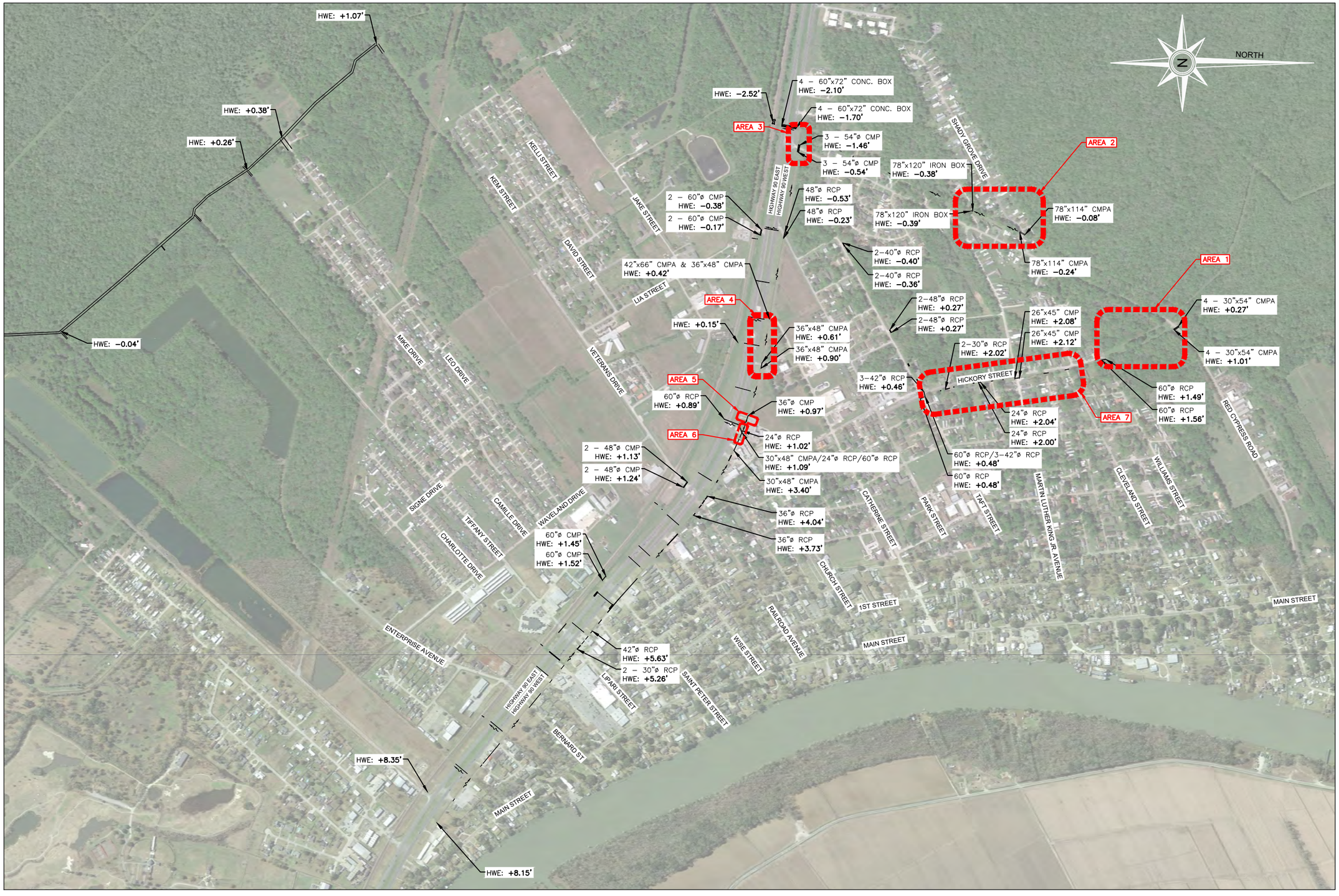
Area 6: Intersection of Church Street and Highway 90 West:

- Large head loss across Church Street
- Inadequate pipe sizing, material, and grade
- Sedimentation of upstream culvert
- Inadequate ditch sizing

Area 7: Hickory Street:

- Large head loss along Hickory Street
- Inadequate pipe sizing, material, and grade
- Sedimentation of culverts
- Inadequate ditch sizing

Exhibit 10 – Existing Conditions - 25-Year Storm - Highwater Elevation Map



25-YEAR STORM - EXISTING HIGH WATER ELEVATION MAP

SCALE: 1" = 500'

PRELIMINARY

FOR REVIEW ONLY

BRYAN M. BREAUD
License No. 38472

BY	DESCRIPTION	DATE
	EXHIBIT 10 – EXISTING CONDITIONS 25-YEAR HIGHWATER ELEVATION MAP	02/04/20

REFERENCE SCALE: 1 0 0.5 1

CAD FILE NAME: 5730I8 01 EXIST HWE.dwg

DESIGNED: C.P.H.
DRAFTED: C.P.H.
CHECKED: C.P.H.
DWG SCALE: 1"=500'
JOB No. 539-018-PED
DATE: 04 FEB 2020

PROVIDENCE ENGINEERING AND DESIGN, LLC
991 Grand Caillou Road, Houma, LA 70363
(985) 876-6380

JOB: CITY OF PATTERSON
LA HWY 90 DRAINAGE STUDY

25 - YEAR STORM - HIGH WATER ELEVATION MAP

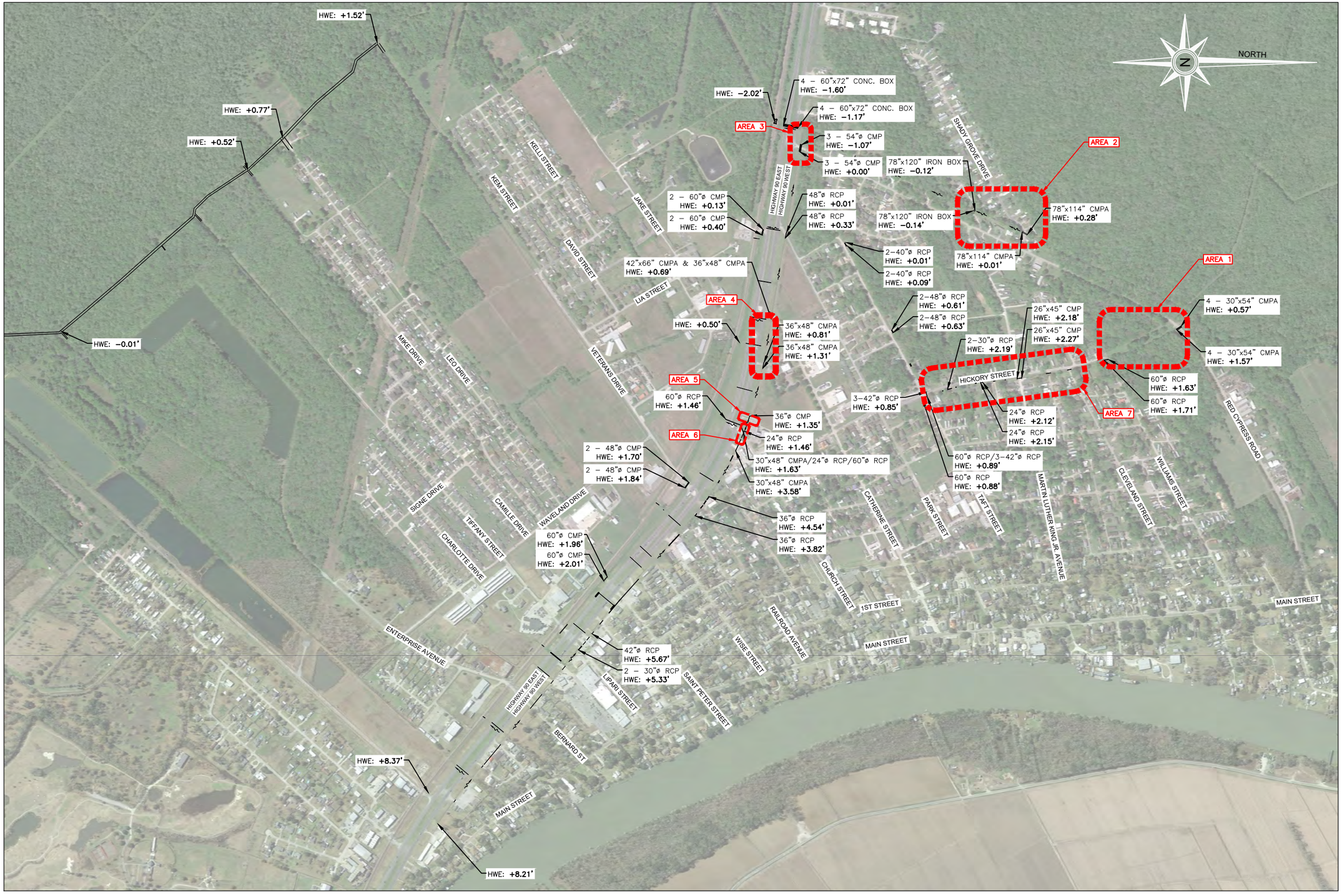
OWNER: City of Patterson, St. Mary Parish, Louisiana

SHEET NO. 1

1 OF 4

P:\Projects\539 Patterson\539.00 Patterson Drainage Study\Dwgs\5730I 8 01 EXIST HWE.dwg - I 02/ 2/2020 8:47am corbinthebert

Exhibit 11 – Existing Conditions - 100-Year Storm - Highwater Elevation Map



100-YEAR STORM - EXISTING HIGH WATER ELEVATION MAP

SCALE: 1" = 500'

PRELIMINARY

FOR REVIEW ONLY

BRYAN M. BREAUD
License No. 38472

BY	DATE	DESCRIPTION
	02/04/20	EXHIBIT 11 – EXISTING CONDITIONS 100-YEAR HIGHWATER ELEVATION MAP

REFERENCE SCALE: 1 0 1 / 0.5 0 1

CAD FILE NAME: 573018 01 EXIST HWE.dwg

DESIGNED: C.P.H.
DRAFTED: C.P.H.
CHECKED: B.M.B.
DWG SCALE: 1"=500'
JOB No. 539-018-PED
DATE: 04 FEB 2020

PROVIDENCE ENGINEERING AND DESIGN, LLC
991 Grand Caillou Road, Houma, LA 70363
(985) 876-6380

JOB: CITY OF PATTERSON
LA HWY 90 DRAINAGE STUDY

100 - YEAR STORM - HIGH WATER ELEVATION MAP

OWNER: City of Patterson, St. Mary Parish, Louisiana

SHEET NO. 2

2 OF 4

P:\Projects\539 Patterson\539.00 Patterson Drainage Study\Dwgs\573018.01 EXIST HWE.dwg - 2. 02/ 2/2020 8:48am corbinhebert

Simulation Nos. 3 and 4: Future Conditions, 25-Year and 100-Year Rainfall Event

Simulation Nos. 3 and 4 model the City of Patterson should the proposed improvements be implemented. The drainage structures from the "Existing Conditions" models to the "Future Conditions" model will be the same, except for the proposed improvements. For these simulations, the same rainfall depths were used for their respective storms. In the simulations of future conditions, the areas identified previously will have the following improvements made:

Area 1: Intersection of Hickory Street Ditch and Red Cypress Road:

- Increase four pipe sizes from 36-inch CMPA (Equiv.) to 48-inch RCPA (Equiv.)
- Adjust all pipe inverts so that upstream is at -4.0 feet and downstream is at -4.09 feet (0.15% slope)
- Lower entire upstream ditch by 1.0 foot.

Area 2: Red Cypress Road:

- Remove and replace existing 78-inch CMPA with 78-inch Ultraflow Pipe
- Remove and replace existing 78-inch x 120-inch Iron Box with new 78-inch x 120-inch Iron Box

Area 3: Intersection of Red Cypress Road and Highway 90 West:

- Increase three pipe sizes from 54-inch diameter CMP to 60-inch diameter RCP
- Adjust all pipe inverts so that upstream is at -6.10 feet and downstream is at -0.50 feet (0.50% slope)
- Excavate downstream ditch's upstream invert from -5.50 feet to -6.50 feet.
- Grade ditch to allow proper flow between proposed -6.50 feet and existing -7.10feet.

Area 4: Driveway to Patterson State Bank from Highway 90 West:

- Increase pipe size from 36-inch CMPA (Equiv.) to 48-inch RCPA (Equiv.)
- Clean-out downstream ditches of sedimentation to lower existing ground level of -3.40 feet to existing invert of pipe at -4.27 feet
- Grade ditch to allow proper flow between existing -1.75 feet to proposed -4.27 feet.

Area 5: Driveway to Circle K from Highway 90 West:

- Increase pipe size from 36-inch diameter RCP to 48-inch diameter RCP

Area 6: Intersection of Church Street and Highway 90 West:

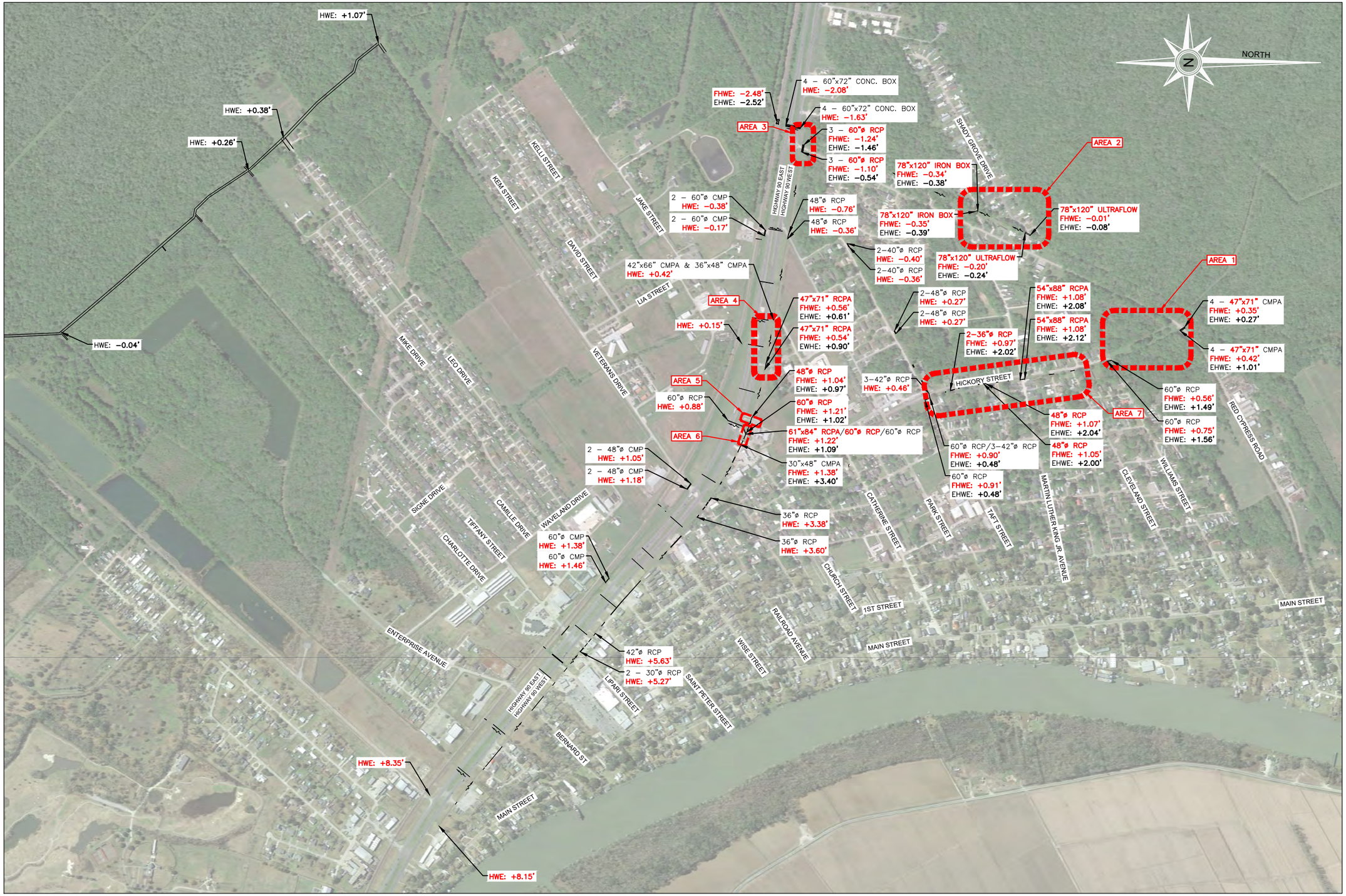
- Increase pipe size of 30-inch CMPA (Equiv.) to 60-inch RCPA (Equiv.)
- Increase pipe size of 24-inch diameter RCP to 60-inch diameter RCP
- Adjust inverts of proposed 60-inch RCPA (Equiv.) so that upstream is at -2.03 feet and downstream is at -2.16 feet (0.80% slope)
- Adjust inverts of proposed 60-inch diameter RCP so that upstream is at -1.59 feet and downstream is at -2.16 feet (1.0% slope)
- Excavate upstream ditch's downstream invert from -0.81 feet to -1.59 feet
- Grade ditch to allow proper flow from existing -0.30 feet to proposed -1.59 feet.

Area 7: Hickory Street:

- Increase size of all culverts along Hickory Street from Taft Street to Williams Street.
- Clean-out entire ditch alongside Hickory Street
- Adjust inverts of all and ditches culverts from Taft Street to Martin Luther King Jr. Avenue so that existing upstream of -3.39 feet can flow to proposed -4.03 feet
- Grade ditch to allow proper flow from existing -3.39 feet to proposed -4.03 feet.

Maps of all future condition high-water elevations and proposed areas of work can be seen as **Exhibits 12** and **13**.

Exhibit 12 – Future Conditions - 25-Year Storm - Highwater Elevation Map



25-YEAR STORM - FUTURE HIGH WATER ELEVATION MAP

SCALE: 1" = 500'

PRELIMINARY

FOR REVIEW ONLY

BRYAN M. BREAUD
License No. 38472

BY	DESCRIPTION	DATE
	EXHIBIT 12 – FUTURE CONDITIONS 25-YEAR HIGHWATER ELEVATION MAP	02/04/20

REFERENCE SCALE: 1 0.5 0 1

CAD FILE NAME: 573018 02 PROP HWE.dwg

DESIGNED: C.P.H.
DRAFTED: C.P.H.
CHECKED: C.P.H.
DWG SCALE: 1"=500'
JOB No. 539-018-PED
DATE: 04 FEB 2020

PROVIDENCE ENGINEERING AND DESIGN, LLC
991 Grand Caillou Road, Houma, LA 70363
(985) 876-6380

JOB: CITY OF PATTERSON
LA HWY 90 DRAINAGE STUDY

25 - YEAR STORM - HIGH WATER ELEVATION MAP

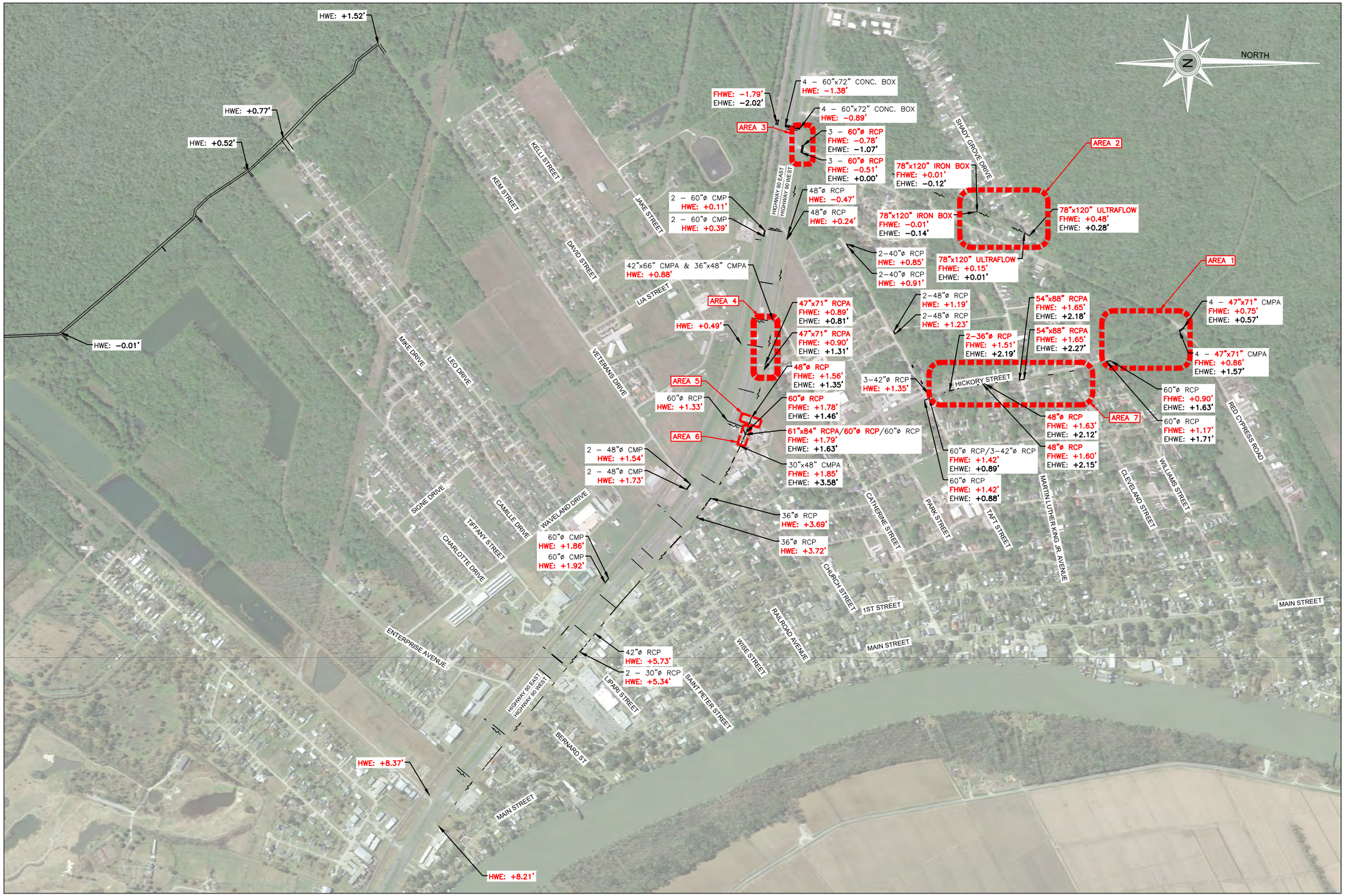
OWNER: City of Patterson, St. Mary Parish, Louisiana

SHEET NO. 3

3 OF 4

P:\Projects\539 Patterson\(6390) LA Patterson Drainage Study\Dwgs\[573018 02 PROP HWE.dwg - 3 02/12/2020 8:43am cotrinebert

Exhibit 13 – Future Conditions - 100-Year Storm - Highwater Elevation Map



100-YEAR STORM - FUTURE HIGH WATER ELEVATION MAP

SCALE: 1" = 500'

PRELIMINARY
FOR REVIEW ONLY

BRYAN M. BREAUD
License No. 38472

BY	DESCRIPTION	DATE
	EXHIBIT 13 – FUTURE CONDITIONS 100–YEAR HIGHWATER ELEVATION MAP	02/04/20

REFERENCE SCALE: 1 0 0.5 1

CAD FILE NAME: 5730I8 02 PROP HWE.dwg

DESIGNED: C.P.H.
DRAFTED: C.P.H.
CHECKED: B.M.B.
DWG SCALE: 1"=500'
JOB No. 539–018–PED
DATE: 04 FEB 2020

PROVIDENCE ENGINEERING AND DESIGN, LLC
991 Grand Caillou Road, Houma, LA 70363
(985) 876–6380

JOB: CITY OF PATTERSON
LA HWY 90 DRAINAGE STUDY

100 - YEAR STORM - HIGH WATER ELEVATION MAP

OWNER: City of Patterson, St. Mary Parish, Louisiana

SHEET NO. 4

4 OF 4

P:\Projects\539 Patterson\539018 Patterson Drainage Study\Dwgs\5730I8 02 PROP HWE.dwg - 4 02/12/2020 8:49am corbinhebert

Graphs depicting flow rate, velocity, upstream elevation, and downstream elevation for each proposed area can be seen in **Appendix F**. Tables 1 and 2 show the head loss differences for each area; across each drainpipe affected for both 25-year and 100-year storm events. As seen in these tables, the proposed improvements will greatly improve the hydraulic grade along LA Highway 90 and within the City of Patterson.

The proposed improvements of the City of Patterson do increase the hydraulic grade at the outfall for both 25-year and 100-year storms. From the high point of the system, the runoff travels through about 8,000 feet of roadside drainage until it reaches the outfall across from Red Cypress Road. For a 25-year storm, the runoff elevation at the outfall rises from the existing -2.52 feet to -2.46 feet. The results from the 100-year storm show the runoff elevation at the outfall has risen from -2.02 feet to -1.78 feet. Despite these slight increases to hydraulic grade, the Patterson Canal outfall is still capable of handling the flow.

Table 1: Head Loss Table for 25-Year Storm Event

Area	Location	Existing Upstream (ft)	Existing Downstream (ft)	**Existing Head Loss (ft)**	Future Upstream (ft)	Future Downstream (ft)	**Future Head Loss (ft)**
1	Hickory Street Ditch	+1.49	+1.01	**0.48**	+0.54	+0.42	**0.12**
	Red Cypress Road (Across)	+1.01	+0.27	**0.74**	+0.42	+0.35	**0.07**
2	Intersection of Red Cypress Road and Shady Grove Drive	-0.08	-0.24	**0.16**	-0.01	-0.19	**0.18**
	Red Cypress Road	-0.38	-0.39	**0.01**	-0.34	-0.35	**0.01**
3	Intersection of Red Cypress Road and LA Highway 90 West	-0.54	-1.46	**0.92**	-1.22	-1.34	**0.12**
4	Driveway to Patterson State Bank from LA Highway 90 West	+0.90	+0.61	**0.29**	+0.53	+0.56	**0.03**
5	Driveway to Circle K from LA Highway 90 West	+1.02	+0.97	**0.05**	+1.21	+1.04	**0.17**
6	Intersection of Church Street and LA Highway 90 West	+3.40	+1.09	**2.31**	+1.38	+1.22	**0.16**
7	Martin Luther King Jr. Avenue to Taft Street	+2.12	+0.48	**1.64**	+1.08	+0.90	**0.18**
	Martin Luther King Jr. Avenue to Williams Street	+2.12	+1.49	**0.63**	+1.08	+0.56	**0.52**

Table 2: Head Loss Table for 100-Year Storm Event

Area	Location	Existing Upstream (ft)	Existing Downstream (ft)	**Existing Head Loss (ft)**	Future Upstream (ft)	Future Downstream (ft)	**Future Head Loss (ft)**
1	Hickory Street Ditch	+1.63	+1.57	**0.06**	+0.76	+0.73	**0.03**
	Red Cypress Road (Across)	+1.57	+0.57	**1.00**	+0.73	+0.65	**0.08**
2	Intersection of Red Cypress Road and Shady Grove Drive	+0.28	+0.01	**0.27**	+0.36	+0.09	**0.27**
	Red Cypress Road	-0.12	-0.14	**0.02**	-0.04	-0.06	**0.02**
3	Intersection of Red Cypress Road and LA Highway 90 West	-0.00	-1.07	**1.07**	-0.51	-0.78	**0.27**
4	Driveway to Patterson State Bank from LA Highway 90 West	+1.31	+0.81	**0.50**	+0.90	+0.88	**0.02**
5	Driveway to Circle K from LA Highway 90 West	+1.46	+1.35	**0.11**	+1.78	+1.56	**0.22**
6	Intersection of Church Street and LA Highway 90 West	+3.58	+1.63	**1.95**	+1.85	+1.79	**0.06**
7	Martin Luther King Jr. Avenue to Taft Street	+2.27	+0.88	**1.39**	+1.65	+1.42	**0.23**
	Martin Luther King Jr. Avenue to Williams Street	+2.27	+1.63	**0.64**	+1.65	+0.90	**0.75**

Summary and Conclusions

The model shows that the drainage issues seen within and around the City of Patterson are caused by the inadequate drainage elements which are adjacent to the city and found within the city itself. Taking actions such as removing and replacing existing culverts with larger and smoother culverts sloped at more efficient grades, cleaning and sweeping ditches, and enlarging existing undersized ditches would benefit the City of Patterson and its drainage problems greatly. With the reduction of large head losses across LA Highway 90 and within the City of Patterson, it is recommended that the improvements presented in the "Simulations Nos. 3 and 4: Future Conditions, 25-Year and 100-Year Rainfall Event" section of this report be made. It is also recommended to implement the improvements previously designed for Kelli Drive, David Drive, Leo Drive, and Mike Drive, as depicted in **Appendix G**. The estimated project costs are shown on **Exhibit 14**. An itemized breakdown of the estimated quantities to complete all the improvements can be found in **Appendix H**.

Exhibit 14 – Probable Project Budget Summary

Area	Estimated Construction Cost	Total Probable Project Budget
(Area 1) Intersection of Hickory Street Ditch and Red Cypress Road	$79,000.00	$109,000.00
(Area 2) Red Cypress Road	$84,000.00	$116,000.00
(Area 3) Intersection of Red Cypress Road and Highway 90 West	$84,000.00	$109,000.00
(Area 4) Driveway to Patterson State Bank from Highway 90 West	$31,000.00	$52,000.00
(Area 5) Driveway to Circle K from Highway 90 West	$40,000.00	$60,000.00
(Area 6) Intersection of Church Street and Highway 90 West	$40,000.00	$60,000.00
(Area 7) Hickory Street	$115,000.00	$145,000.00
Kelli Drive	$403,000.00	$485,000.00
David Drive	$392,000.00	$470,000.00
Leo Drive	$579,000.00	$680,000.00
Mike Drive	$490,000.00	$580,000.00
TOTAL COST FOR ALL IMPROVEMENTS		**$2,866,000.00**