BAYOU LIBERTY WATERSHED MANAGEMENT PLAN

ST. TAMMANY PARISH, LA

Prepared by
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1. Purpose:

Due to the rapid development of St. Tammany Parish in the last decade, many areas have experienced flooding that historically have not flooded. The Parish Administration and Council wishes to be proactive in the prevention of flooding while not stifling the development of the area. With this in mind, the Parish Council has passed ordinances that prohibit new developments from discharging stormwater into their drainage outfall at a higher rate than when the property was unimproved. The Parish Council also enacted ordinances that prohibit the filling of lots with material imported from other watersheds. This requires that any fill for pad sites must come from within the same watershed to not diminish that watershed's capacity to store stormwater and not increase the potential of flooding.

Further, the Parish Administration and Council intend to develop a hydrologic and hydraulic computer model for each of the major drainage basins. Such a model will allow the Parish to quantitatively determine the effect of a single development and the cumulative effect of all developments within a watershed. The model will also provide a tool to the Parish Administration and Council so proposed drainage improvements can be evaluated. Prior to expending design and construction costs, proposed improvements can be evaluated based upon a ratio of project cost to flood reduction benefit. Such an evaluation can be performed for either a single proposed project or a series of proposed projects. This tool will allow the Parish Administration and Council to maximize the effect of drainage improvements while minimizing the expenditure of project budgets.

This report provides a background for the Bayou Liberty Watershed Management Plan and documents the development of the Geographic Information System (GIS), the HEC-HMS model and HEC-RAS model. This report also documents the effects of various flood improvement alternatives.

2. Introduction:

In September 2001, Burk-Kleinpeter, Inc. (BKI) was authorized to proceed with Phase 1 of the Bayou Liberty Watershed Management Plan. The scope of the Phase 1 analysis was from a point approximately 3 miles below Highway 190 (measured along the stream) to a point just below Interstate Highway 12.

The Phase 1 analysis was based, in part, on an earlier report prepared by BKI entitled "Analysis of Flooding Impacts due to proposed Liberty Pointe Development in St. Tammany Parish, Louisiana", and dated June 2001.

For the Phase 1 analysis, the Corps of Engineer's HEC-RAS computer program was used to model the stream and to compute existing-conditions 10-Year and 100-Year flood profiles. In addition, the impacts on flooding due to the proposed Liberty Pointe

Development and Logan's Trace Development were investigated. The findings from the Phase 1 analysis were presented in an earlier report entitled "Bayou Liberty Drainage Study, Phase 1," dated April 2002.

In September 2002, BKI was authorized to proceed with Phase 2 of the Bayou Liberty Watershed Management Plan. Phase 2 includes the entire length of Bayou Liberty, Bayou Paquet below Tammany Trace, Tributary 1 below Interstate 12, and Tributary 2. Figure 1 shows the location of the Bayou Liberty and Bayou Paquet Watersheds. The drainage areas for Tributaries 1 and 2 are contained in the Bayou Liberty Watershed.

3. Geographic Information System (GIS):

A GIS was constructed for Phase 2 of the Bayou Liberty Watershed Management Plan. The GIS is made up of the following layers:

- Watershed Subareas. This layer was generated based on topographic data and aerial photos.
- Land Use Data. This layer shows existing and future land use information.
- Hydrography. This layer shows the locations of surface water features.
- Elevation Contours-LIDAR. This layer shows topographic contours at a 2-foot contour interval.
- Raster Quads. This layer shows a raster image of the USGS quadrangle maps.
- Field Survey Line Locations. This layer was generated from latitude/ longitude coordinates provided by the surveyor for this study.
- Aerial Photos. Recent aerial photography in MrSID format.
- Soils Data.
- DEQ Permit Holders
- National Wetlands Inventory (NWI) Data
- New Development. This layer shows scanned drawings for Logan's Trace, and Target Shopping Center.
- HEC-RAS cross sections. This layer shows the alignment of cross sections used in the hydraulic models of the watershed.
- Existing Conditions 10-, 25- and 100-year floodplains. This layer shows the existing conditions for the 10-, 25- and 100-year floodplains as determined for this analysis.
- Improved Conditions 10-, 25- and 100-year floodplains. These layers show the improved conditions for the 10-, 25- and 100-year floodplains as determined for five individual improvements and a combination of improvements.

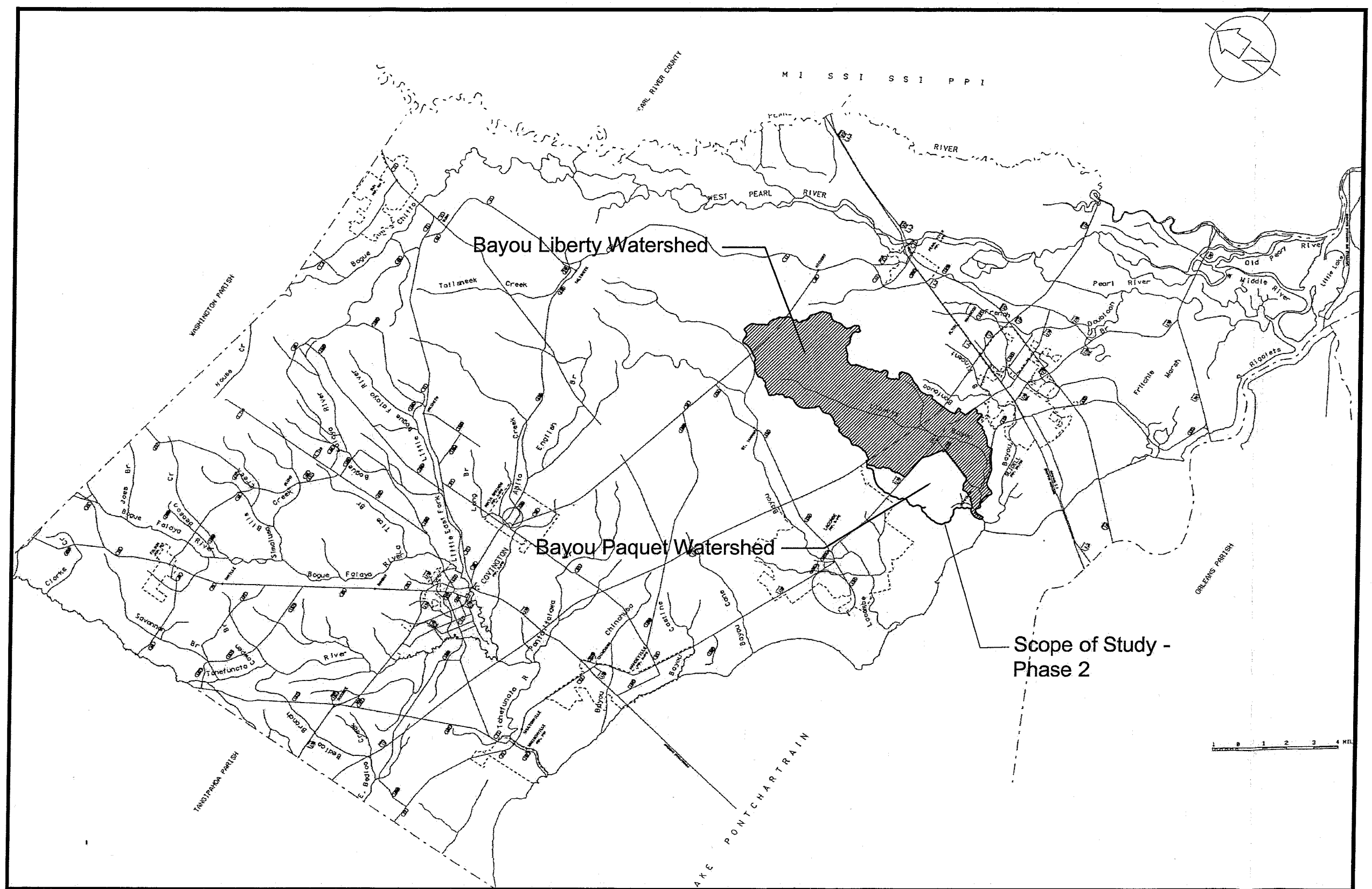

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FIGURE 1. SITE MAP

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4. Analysis of Existing Conditions:

4.1 Hydrology

The watershed area was broken up into subareas using the LIDAR topography, land use data and aerial photography. The subareas are shown on Figure 2. A listing of the drainage areas, in acres and square miles, associated with each subarea is given in Appendix A.

For each subarea a curve number was computed using the soils data, land use data and aerial photography. Curve numbers were determined using methods described in the Natural Resource Conservation Service's Technical Release 55 (TR-55). A listing of the curve numbers and the calculations are given in Appendix B.

For each subarea a time-of-concentration was calculated using a modified version of the methods given in TR-55. The time-of-concentration for a subarea was taken as the sum of the sheet flow and shallow concentrated flow travel times between the most remote point in the subarea (timewise) to the subarea outlet. A listing of the times-of-concentration and calculations is given in Appendix C.

The subareas, curve numbers, and time-of-concentrations were used to develop a HEC-HMS model of the Bayou Liberty and Bayou Paquet watersheds. One of two methods was used to route a computed hydrograph to a downstream location. For the stream reaches on Bayou Liberty, Bayou Paquet, and Tributaries 1 and 2 that were field surveyed, Modified Puls routing was used. For the other stream reaches the Muskingum routing method was used. The routing reaches are shown on Figure 3.

The Modified Puls method of routing requires a known relationship between channel storage and flow. This relationship was determined by using surveyed cross sections to create the HEC-RAS model. Flows were then estimated based upon a statistical non-linear regression between known subbasin drainage areas and measured runoff flows. For subbasins which had no measured data, the regression was employed to produce approximate flows. The storage capacity was then determined from the HEC-RAS model output for each reach.

For channels without survey data (i.e. those not to be modeled in HEC-RAS) the Muskingum routing method required two parameters for each reach: K and X. K and X can be estimated from measured inflow and outflow hydrographs, or other methods however they must be adjusted during model calibration. The values used in this model are shown in Table 1.

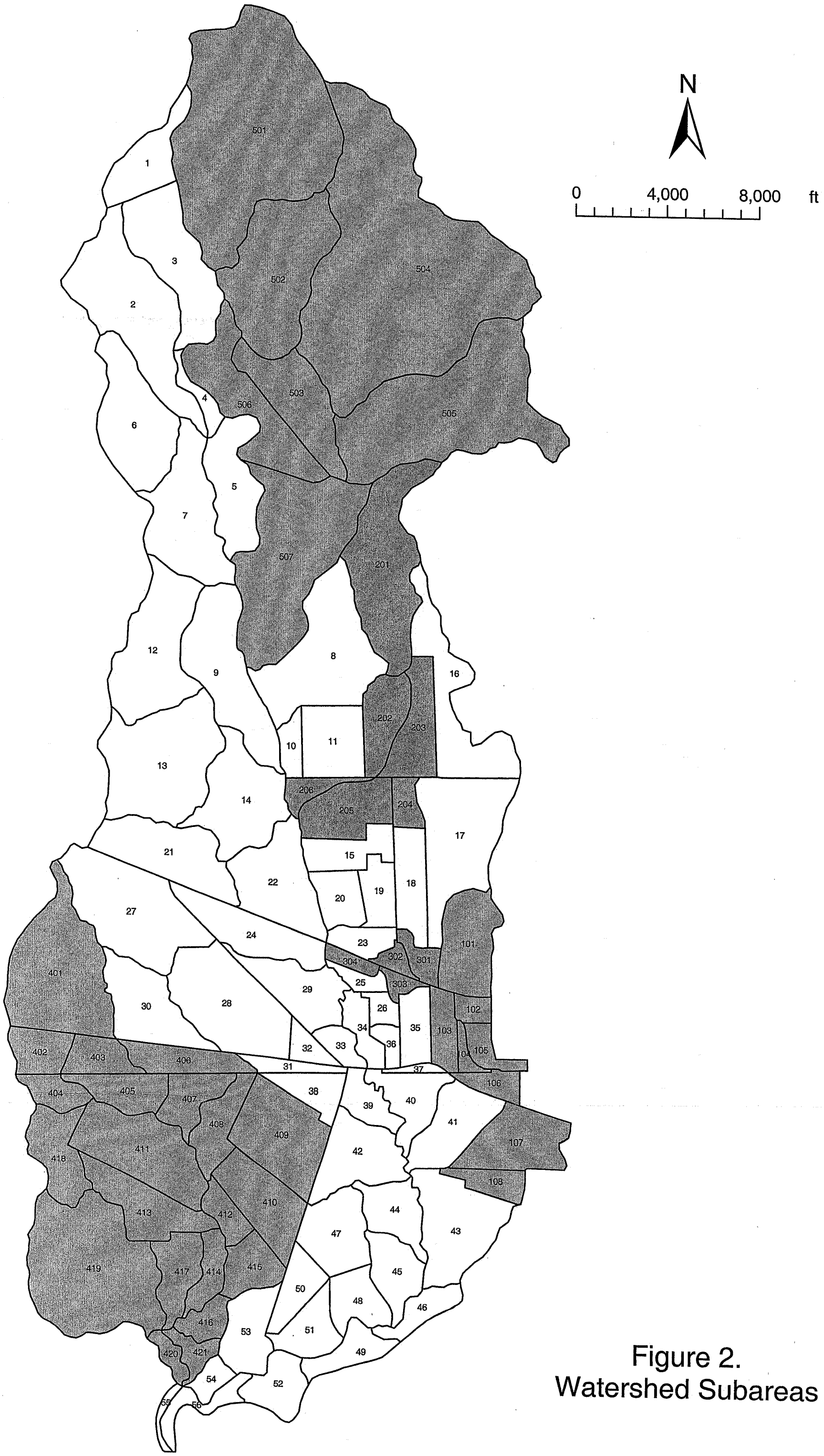

Figure 2.
Watershed Subareas

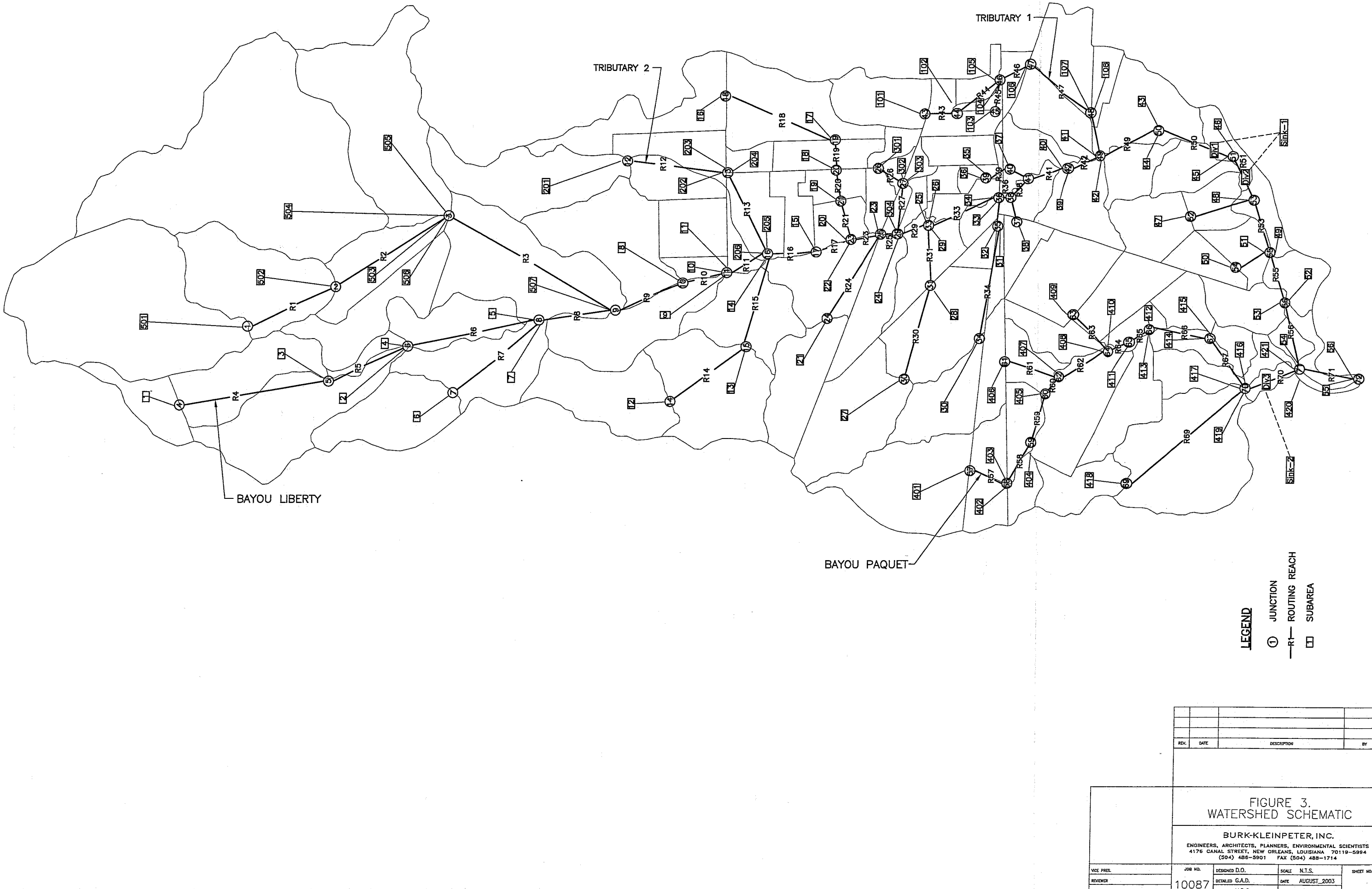

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FIGURE 3.
WATERSHED SCHEMATIC

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Table 1. Bayou Liberty Watershed Muskingum Routing Parameters

Reach	K [hr]	X ~
R1	4.2	0
R2	5.6	0
R3	8.3	0
R7	2.1	0.2
R14	1.7	0.2
R15	1.4	0.2
R18	2.3	0.2
R19	0.5	0.2
R20	0.5	0.2
R21	0.5	0.2
R24	1.4	0.2
R26	0.5	0.2
R27	0.7	0.2
R30	1.7	0.2
R31	1.0	0.2
R34	2.1	0.2
R39	0.3	0.2
R45	0.5	0.2
R57	0.7	0.2
R61	0.7	0.2
R63	0.7	0.2
R69	2.4	0.2

4.2 Hydraulics

Stream cross sections were generated from two sources. The channel portion of each stream section was field surveyed from top of bank to top of bank. For the overbank portion of the section, cross section coordinates were determined by manually extrapolating the surveyed sections according to the topographic LIDAR data.

Using this stream geometry a HEC-RAS model was developed. The alignments of the cross sections included in that model are shown on Figure 4. The cross sections are listed by stream in Tables 2a-2d.

Roughness coefficients (Manning's n-values) were evaluated to be 0.04 for the channel areas and 0.1 for the overbank areas. These values are consistent with the range of values for this stream presented in the Federal Emergency Management Agency's Flood Insurance Study report. Photos of the various channels and other flow conduits are shown in Appendix D.

Bridge geometry, including layout, top-of-road elevations, and low-chord elevations were obtained from field surveys. Bridge data used for input into HEC-RAS is shown in Appendix E.

4.3 Model Calibration

The US Geological Survey (USGS) operates a continuous recording stream gage at Tammany Trace on Bayou Liberty. Approximately 27 months of stream elevation data were available at the time of the Phase 2 analysis. Plots of those data are shown in Appendix F. Three (3) flooding events were chosen for the model calibration: March 3, 2001, August 5, 2002, and September 26, 2002 (Note that June 2001 peak was not chosen because it occurred as a result of tropical storm Allison, thus causing multiple peaks and distortion due to multiple rainfall events.) The stages for the August 5, 2002 event were later determined to be too small to be used for the calibration. In addition to the stage data at Tammany Trace, peak stages are published by USGS for several other locations along Bayou Liberty for the event that produces the highest stages for a given year.

The hourly rainfall data for Slidell Airport were obtained for the corresponding rainfall events from the Southern Regional Climate Center. However, the March 3, 2001 rainfall data was incomplete for the hours leading up to the peak stage at Tammany Trace. Therefore, only the September 26, 2002 event was used for the calibration. A plot of the rainfall data for the September 26, 2002 event is shown in Appendix G.

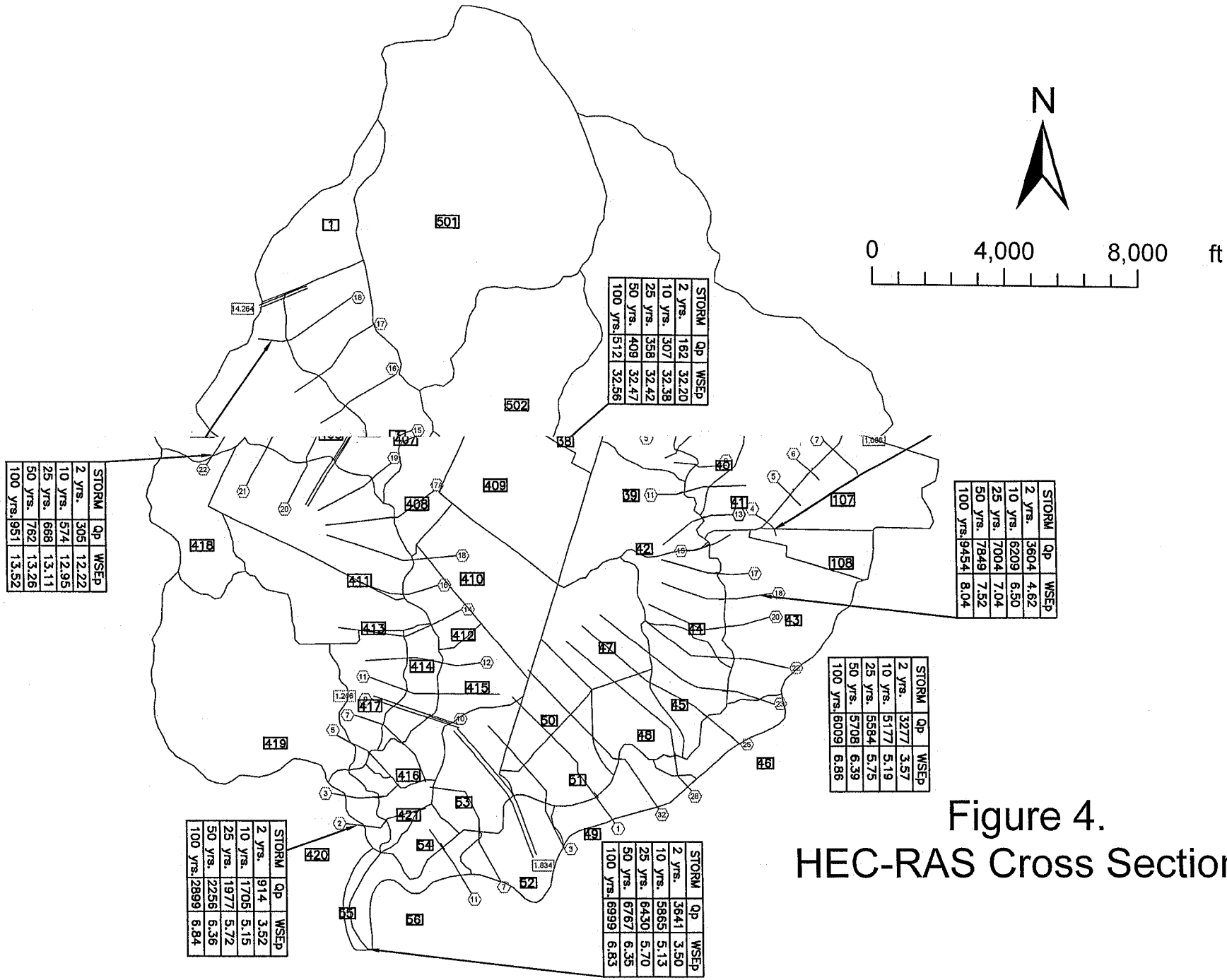


Figure 4.
HEC-RAS Cross Sections

Table 2a. Bayou Liberty Stream Stationing

RAS Reach	Section	Station
L1	Confluence	0.000
L1	14	0.455
L1	13	0.673
L2	12	0.826
L2	11	1.188
L2	7	1.461
L2	Hwy 433	1.831
L2	(sta. 1.834)	1.837
L2	3	2.037
L2	1	2.401
L2	32	2.596
L2	28	3.048
L2	25	3.365
L2	23	3.634
L2	22	3.748
L2	20	3.969
L2	18	4.169
L2	17	4.292
L2	15	4.559
L3	13	4.747
L3	11	5.006
L3	9	5.213
L3	7	5.406
L3	5	5.624
L3	Tamm Tr	6.007
L3	(sta. 6.010)	6.013
L3	Old Concr.	6.036
L3	(sta. 6.039)	6.041
L3	Hwy 190	6.042
L3	(sta. 6.047)	6.053
L3	2	6.240
L3	5	6.483
L3	7	6.639
L3	10	6.849
L3	13	7.157

RAS Reach		Station
L3	15	7.316
L4	I-12	7.454
L4	(sta. 7.464)	7.474
L4	Scenic Rd	7.564
L4	(sta. 7.567)	7.570
L4	1	7.854
L4	2	8.148
L4	3	8.429
L5	4	8.811
L5	5	9.117
L5	6	9.408
L5	7	9.685
L5	Journey Rd	9.963
L5	(sta. 9.966)	9.969
L5	7	10.237
L5	8	10.423
L5	Third Brdg	10.612
L5	(sta. 10.615)	10.618
L5	9	10.828
L5	101	11.248
L5	100	11.457
L5	11	11.678
L5	Fourth Brdg	11.990
L5	(sta. 11.993)	11.996
L5	13	12.250
L5	14	12.654
L5	Fifth Brdg	12.895
L5	(sta. 12.898)	12.901
L5	15	13.186
L5	16	13.479
L5	17	13.720
L5	18	14.013
L5	Sixth Brdg	14.261
L5	(sta. 14.264)	

Table 2b. Bayou Paquet Stream Stationing

RAS Reach	Section	Station
1	Confluence	0.000
1	1	0.028
1	2	0.217
1	3	0.389
1	5	0.853
1	7	1.033
1	Paquet Rd	1.263
1	(sta. 1.266)	1.269
1	11	1.445
1	12	1.582
1	14	1.851
1	16	2.127
1	18	2.276
1	17A	2.523
1	19	2.859
1	Monitor Rd	3.108
1	(sta. 3.111)	3.114
1	20	3.357
1	21	3.576
1	22	3.799
1	Tamm Tr	4.048
1	(sta. 4.051)	

Table 2c. Tributary 1 Stream Stationing

RAS Reach	Section	Station
1	Confluence	0.000
1	2	0.046
1	3	0.250
1	4	0.398
1	5	0.626
1	6	0.787
1	7	0.957
1	Hwy 190	1.080
1	(sta. 1.086)	1.092
1	8	1.161
1	Tamm Tr	1.324
1	(sta. 1.327)	1.330
1	Camp Villere	1.436
1	(sta. 1.439)	1.442
1	10	1.548
1	11	1.676
1	12	1.860
1	13	2.047
1	I-12	2.214
1	(sta. 2.224)	

Table 2d. Tributary 2 Stream Stationing

RAS Reach	Section	Station
1	Confluence	0.000
1	1	0.018
1	2	0.201
1	Royal 18 Rd	0.408
1	(sta. 0.411)	0.414
1	4	0.576
1	5	0.756
1	Bellaire Blvd	0.815
1	(sta. 0.835)	0.840
1	6	0.958
1	7	1.146
1	8	1.333

Table 3 shows the observed water surface elevations and those predicted by the existing conditions HEC-HMS and HEC-RAS models for the September 2002 flood event. Several iterations were necessary in order to obtain the computed water surface elevations shown in Table 3. The major changes included modifying the Muskingum routing parameters for the stream reaches in the upper part of the Bayou Liberty Watershed and lowering the roughness coefficient for the channel portion of Bayou Liberty between Scenic Drive and Belair Boulevard from 0.040 to 0.025. The computed flows associated with the September 2002 event are shown in Table 4.

4.4 Existing Conditions Water Surface Elevations

National Resources Conservation Service, formerly known as the Soil Conservation Service, synthetic rainfall distributions were used to compute flows for the 2-, 10-, 25-, 50-, and 100-year flood events in the calibrated existing-conditions HEC-HMS model. These rainfall distributions were Type III, 24-hour rainfall duration modeled by NRCS (National Resources Conservation Service) TR-55 Appendix B. The total rainfall amount for each storm frequency was interpolated from the rainfall hyetographs published in NRCS TR-55 Appendix B (2yr: 6 in, 10 yr: 9 in, 25 yr: 10 in, 50 yr: 11 in, and 100 yr: 13 in). These storm types were utilized in this watershed and all the remaining parish watersheds for parish-wide uniformity as recommended by parish-wide coordination consultants: Dr. James Cruise and Dr. Donald Barbe. These flow values are shown in Table 5. The predicted flows were then used to determine water surface elevations in the calibrated existing-conditions HEC-RAS model.

After the calibration analysis and development of rainfall distribution, the starting water surface elevation of the final outfall was required for the HEC-RAS calculation of predicted water surface elevations. This was determined by using maximum observed lake levels in Lake Pontchartrain for a data period over 10 years and performing a Log-Pearson Type III frequency analysis. This analysis provided statistical year lake levels that were matched to each statistical year hypothetical storm event (2yr: 3.50 ft, 10 yr: 5.13 ft, 25 yr: 5.85 ft, 50 yr: 6.35 ft, and 100 yr: 6.83 ft.). This methodology and calculation was performed by parish-wide coordination consultants Dr. James Cruise and Dr. Donald Barbe for all parish watersheds.

After the statistical year lake levels were developed, the lake levels were input into the HEC-RAS model as starting water surface conditions and floodplain water surface elevations were computed for the bayous and tributaries. The resulting water surface elevations are shown in Tables 6a-6d. The corresponding water surface profiles along the channel for Bayou Liberty, Bayou Paquet, Tributary 1 and Tributary 2 are shown in Figures 5a-5e. Also, the existing conditions 10-, 25-, and 100-year floodplain is shown on Figure 6.

Table 3. Bayou Liberty Calibration Data

Location	XS No.	Stream Sta.	September 2002 Event	
			Observed WSEL	Computed WSEL
At Bonfouca Marina	7	1.461	Data Missing	6.45
At Hwy 433	-	1.834	6.49	6.49
Near Dubisson Road	22	3.748	6.56	6.69
At Tammany Trace		6.010	7.13	7.35
Near Landis Road	10	6.849	8.37	8.45
At Scenic Drive	-	7.567	10.89	10.32
Near Belair Boulevard	4	8.811	15.37	15.59

WSEL: Water Surface Elevation

Table 4. September 2002 Event - Flows (From HEC-HMS Simulation)

Stream	Junction	Dr. Area [sq mi]	Q [cfs]
Liberty	J4	0.28	58
Liberty	J5	0.85	156
Liberty	J6	1.77	286
Liberty	J8	3.31	538
Liberty	J9	12.33	1454
Liberty	J16	17.78	2256
Liberty	J25	20.80	2764
Liberty	J29	21.40	2899
Liberty	J36	24.00	3323
Liberty	J49	26.79	3671
Liberty	J53	28.41	3384
Liberty	J71	35.55	3945
Paquet	J58	1.13	261
Paquet	J60	1.45	242
Paquet	J65	3.47	780
Paquet	J70	5.90	924
Trib 1	J43	0.37	116
Trib 1	J46	0.72	204
Trib 2	J12	0.73	148
Trib 2	J13	1.34	306
Trib 3	J27	0.19	59

Table 5. Existing Conditions - Flows (From HEC-HMS Simulations)

Stream	Junction	Dr. Area [sq mi]	Q_2 [cfs]	Q_{10} [cfs]	Q_{25} [cfs]	Q_{50} [cfs]	Q_{100} [cfs]
Liberty	J4	0.28	60	121	142	165	209
Liberty	J5	0.85	162	307	358	409	512
Liberty	J6	1.77	285	532	619	706	883
Liberty	J8	3.31	522	984	1145	1308	1638
Liberty	J9	12.33	1399	2595	3067	3490	4347
Liberty	J16	17.78	2058	3688	4246	4776	5766
Liberty	J25	20.80	2612	4659	5357	6000	7279
Liberty	J29	21.40	2734	4845	5570	6243	7575
Liberty	J36	24.00	3173	5506	6268	7025	8495
Liberty	J49	26.79	3604	6209	7004	7849	9454
Liberty	J53	28.41	3277	5177	5584	5708	6009
Liberty	J71	35.55	3641	5865	6430	6767	6999
Paquet	J58	1.13	305	574	668	762	951
Paquet	J60	1.45	257	510	610	708	905
Paquet	J65	3.47	978	1691	1925	2154	2604
Paquet	J70	5.90	919	1705	1977	2256	2899
Trib 1	J43	0.37	178	312	358	403	493
Trib 1	J46	0.72	273	466	518	570	676
Trib 2	J12	0.73	164	300	347	394	489
Trib 2	J13	1.34	347	604	692	781	960
Trib 3	J27	0.19	85	156	182	206	256

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L5	14.267	2-year	33.77	60
L5	14.267	10-year	34.46	121
L5	14.267	25-year	34.57	142
L5	14.267	50-year	34.67	165
L5	14.267	100-year	34.84	209
L5	14.264	**Sixth Bridge**		
L5	14.261	2-year	33.71	60
L5	14.261	10-year	34.41	121
L5	14.261	25-year	34.51	142
L5	14.261	50-year	34.60	165
L5	14.261	100-year	34.77	209
L5	14.013	2-year	33.69	60
L5	14.013	10-year	34.35	121
L5	14.013	25-year	34.43	142
L5	14.013	50-year	34.51	165
L5	14.013	100-year	34.65	209
L5	13.720	2-year	33.63	60
L5	13.720	10-year	34.27	121
L5	13.720	25-year	34.35	142
L5	13.720	50-year	34.42	165
L5	13.720	100-year	34.54	209
L5	13.479	2-year	33.31	60
L5	13.479	10-year	33.95	121
L5	13.479	25-year	34.06	142
L5	13.479	50-year	34.15	165
L5	13.479	100-year	34.30	209
L5	13.186	2-year	32.96	60
L5	13.186	10-year	33.29	121
L5	13.186	25-year	33.38	142
L5	13.186	50-year	33.46	165
L5	13.186	100-year	33.60	209
L5	12.901	2-year	32.80	162
L5	12.901	10-year	33.11	307
L5	12.901	25-year	33.17	358
L5	12.901	50-year	33.26	409
L5	12.901	100-year	33.37	512
L5	12.898	**Fifth Bridge**		
L5	12.895	2-year	32.80	162
L5	12.895	10-year	33.09	307
L5	12.895	25-year	33.17	358
L5	12.895	50-year	33.24	409
L5	12.895	100-year	33.37	512

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L5	12.654	2-year	32.66	162
L5	12.654	10-year	32.92	307
L5	12.654	25-year	33.00	358
L5	12.654	50-year	33.06	409
L5	12.654	100-year	33.18	512
L5	12.250	2-year	32.20	162
L5	12.250	10-year	32.38	307
L5	12.250	25-year	32.42	358
L5	12.250	50-year	32.47	409
L5	12.250	100-year	32.56	512
L5	11.996	2-year	30.63	285
L5	11.996	10-year	31.04	532
L5	11.996	25-year	31.17	619
L5	11.996	50-year	31.28	706
L5	11.996	100-year	31.46	883
L5	11.993	**Fourth Bridge**		
L5	11.990	2-year	30.60	285
L5	11.990	10-year	31.04	532
L5	11.990	25-year	31.16	619
L5	11.990	50-year	31.27	706
L5	11.990	100-year	31.46	883
L5	11.678	2-year	29.68	285
L5	11.678	10-year	30.23	532
L5	11.678	25-year	30.37	619
L5	11.678	50-year	30.50	706
L5	11.678	100-year	30.72	883
L5	11.457	2-year	29.00	285
L5	11.457	10-year	29.35	532
L5	11.457	25-year	29.48	619
L5	11.457	50-year	29.59	706
L5	11.457	100-year	29.79	883
L5	11.248	2-year	28.01	285
L5	11.248	10-year	28.74	532
L5	11.248	25-year	28.82	619
L5	11.248	50-year	28.90	706
L5	11.248	100-year	29.06	883
L5	10.828	2-year	27.35	285
L5	10.828	10-year	28.07	532
L5	10.828	25-year	28.18	619
L5	10.828	50-year	28.28	706
L5	10.828	100-year	28.46	883

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L5	10.618	2-year	25.94	522
L5	10.618	10-year	27.40	984
L5	10.618	25-year	27.51	1145
L5	10.618	50-year	27.60	1308
L5	10.618	100-year	27.76	1638
L5	10.615	**Third Bridge**		
L5	10.612	2-year	25.60	522
L5	10.612	10-year	26.79	984
L5	10.612	25-year	26.93	1145
L5	10.612	50-year	27.04	1308
L5	10.612	100-year	27.21	1638
L5	10.423	2-year	24.31	522
L5	10.423	10-year	25.21	984
L5	10.423	25-year	25.41	1145
L5	10.423	50-year	25.58	1308
L5	10.423	100-year	25.93	1638
L5	10.237	2-year	23.62	522
L5	10.237	10-year	25.03	984
L5	10.237	25-year	25.24	1145
L5	10.237	50-year	25.42	1308
L5	10.237	100-year	25.77	1638
L5	9.969	2-year	22.87	1399
L5	9.969	10-year	24.81	2595
L5	9.969	25-year	25.04	3067
L5	9.969	50-year	25.23	3490
L5	9.969	100-year	25.60	4347
L5	9.966	**Journey Road**		
L5	9.963	2-year	22.85	1399
L5	9.963	10-year	24.73	2595
L5	9.963	25-year	24.97	3067
L5	9.963	50-year	25.16	3490
L5	9.963	100-year	25.55	4347
L5	9.685	2-year	20.46	1399
L5	9.685	10-year	22.60	2595
L5	9.685	25-year	23.10	3067
L5	9.685	50-year	23.47	3490
L5	9.685	100-year	24.16	4347
L5	9.408	2-year	18.95	1399
L5	9.408	10-year	21.06	2595
L5	9.408	25-year	21.55	3067
L5	9.408	50-year	21.91	3490
L5	9.408	100-year	22.58	4347

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L5	9.117	2-year	17.17	1399
L5	9.117	10-year	18.78	2595
L5	9.117	25-year	19.14	3067
L5	9.117	50-year	19.43	3490
L5	9.117	100-year	19.88	4347
L5	8.811	2-year	15.48	1399
L5	8.811	10-year	15.94	2595
L5	8.811	25-year	16.15	3067
L5	8.811	50-year	16.31	3490
L5	8.811	100-year	16.64	4347
L4	8.429	2-year	13.27	2058
L4	8.429	10-year	14.66	3688
L4	8.429	25-year	14.80	4246
L4	8.429	50-year	15.07	4776
L4	8.429	100-year	15.80	5766
L4	8.148	2-year	9.37	2058
L4	8.148	10-year	12.64	3688
L4	8.148	25-year	13.54	4246
L4	8.148	50-year	14.14	4776
L4	8.148	100-year	15.33	5766
L4	7.854	2-year	9.38	2058
L4	7.854	10-year	12.63	3688
L4	7.854	25-year	13.50	4246
L4	7.854	50-year	14.10	4776
L4	7.854	100-year	15.29	5766
L4	7.570	2-year	9.18	2058
L4	7.570	10-year	12.51	3688
L4	7.570	25-year	13.39	4246
L4	7.570	50-year	13.99	4776
L4	7.570	100-year	15.18	5766
L4	7.567	**Scenic Road**		
L4	7.564	2-year	9.17	2058
L4	7.564	10-year	12.43	3688
L4	7.564	25-year	13.35	4246
L4	7.564	50-year	13.95	4776
L4	7.564	100-year	15.16	5766
L4	7.474	2-year	8.84	2612
L4	7.474	10-year	12.15	4659
L4	7.474	25-year	13.05	5357
L4	7.474	50-year	13.63	6000
L4	7.474	100-year	14.80	7279

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L4	7.464	**I-12**		
L4	7.454	2-year	8.83	2612
L4	7.454	10-year	12.14	4659
L4	7.454	25-year	13.04	5357
L4	7.454	50-year	13.62	6000
L4	7.454	100-year	14.51	7279
L3	7.316	2-year	8.43	2734
L3	7.316	10-year	10.87	4845
L3	7.316	25-year	11.52	5570
L3	7.316	50-year	11.96	6243
L3	7.316	100-year	12.66	7575
L3	7.157	2-year	8.04	2734
L3	7.157	10-year	10.63	4845
L3	7.157	25-year	11.29	5570
L3	7.157	50-year	11.73	6243
L3	7.157	100-year	12.39	7575
L3	6.849	2-year	7.41	2734
L3	6.849	10-year	10.11	4845
L3	6.849	25-year	10.88	5570
L3	6.849	50-year	11.39	6243
L3	6.849	100-year	12.13	7575
L3	6.639	2-year	7.01	2734
L3	6.639	10-year	9.80	4845
L3	6.639	25-year	10.57	5570
L3	6.639	50-year	11.11	6243
L3	6.639	100-year	11.89	7575
L3	6.483	2-year	6.72	2734
L3	6.483	10-year	9.49	4845
L3	6.483	25-year	10.28	5570
L3	6.483	50-year	10.82	6243
L3	6.483	100-year	11.60	7575
L3	6.240	2-year	6.55	2734
L3	6.240	10-year	9.34	4845
L3	6.240	25-year	10.13	5570
L3	6.240	50-year	10.66	6243
L3	6.240	100-year	11.42	7575
L3	6.053	2-year	6.19	3173
L3	6.053	10-year	8.82	5506
L3	6.053	25-year	9.57	6268
L3	6.053	50-year	10.04	7025
L3	6.053	100-year	10.62	8495

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L3	6.047	**Hwy 190**		
L3	6.042	2-year	6.12	3173
L3	6.042	10-year	8.71	5506
L3	6.042	25-year	9.46	6268
L3	6.042	50-year	9.91	7025
L3	6.042	100-year	10.45	8495
L3	6.041	2-year	6.10	3173
L3	6.041	10-year	8.68	5506
L3	6.041	25-year	9.43	6268
L3	6.041	50-year	9.88	7025
L3	6.041	100-year	10.41	8495
L3	6.039	**Old Struct.**		
L3	6.036	2-year	6.03	3173
L3	6.036	10-year	8.53	5506
L3	6.036	25-year	9.28	6268
L3	6.036	50-year	9.70	7025
L3	6.036	100-year	10.19	8495
L3	6.013	2-year	5.95	3173
L3	6.013	10-year	8.38	5506
L3	6.013	25-year	9.24	6268
L3	6.013	50-year	9.67	7025
L3	6.013	100-year	10.15	8495
L3	6.010	**Tamm. Tr.**		
L3	6.007	2-year	5.83	3173
L3	6.007	10-year	7.96	5506
L3	6.007	25-year	8.52	6268
L3	6.007	50-year	9.04	7025
L3	6.007	100-year	9.79	8495
L3	5.624	2-year	5.42	3173
L3	5.624	10-year	7.51	5506
L3	5.624	25-year	8.08	6268
L3	5.624	50-year	8.60	7025
L3	5.624	100-year	9.31	8495
L3	5.406	2-year	5.27	3173
L3	5.406	10-year	7.34	5506
L3	5.406	25-year	7.91	6268
L3	5.406	50-year	8.42	7025
L3	5.406	100-year	9.11	8495

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L3	5.213	2-year	5.10	3173
L3	5.213	10-year	7.13	5506
L3	5.213	25-year	7.69	6268
L3	5.213	50-year	8.20	7025
L3	5.213	100-year	8.85	8495
L3	5.006	2-year	4.97	3173
L3	5.006	10-year	6.97	5506
L3	5.006	25-year	7.53	6268
L3	5.006	50-year	8.03	7025
L3	5.006	100-year	8.67	8495
L3	4.747	2-year	4.89	3173
L3	4.747	10-year	6.87	5506
L3	4.747	25-year	7.43	6268
L3	4.747	50-year	7.93	7025
L3	4.747	100-year	8.54	8495
L2	4.559	2-year	4.76	3604
L2	4.559	10-year	6.68	6209
L2	4.559	25-year	7.23	7004
L2	4.559	50-year	7.71	7849
L2	4.559	100-year	8.27	9454
L2	4.292	2-year	4.68	3604
L2	4.292	10-year	6.58	6209
L2	4.292	25-year	7.12	7004
L2	4.292	50-year	7.61	7849
L2	4.292	100-year	8.15	9454
L2	4.169	2-year	4.62	3604
L2	4.169	10-year	6.50	6209
L2	4.169	25-year	7.04	7004
L2	4.169	50-year	7.52	7849
L2	4.169	100-year	8.04	9454
L2	3.969	2-year	4.53	3604
L2	3.969	10-year	6.34	6209
L2	3.969	25-year	6.89	7004
L2	3.969	50-year	7.38	7849
L2	3.969	100-year	7.88	9454
L2	3.748	2-year	4.40	3604
L2	3.748	10-year	6.12	6209
L2	3.748	25-year	6.67	7004
L2	3.748	50-year	7.16	7849
L2	3.748	100-year	7.64	9454
L2	3.700	Lat Struct		

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L2	3.634	2-year	4.31	3604
L2	3.634	10-year	5.99	6209
L2	3.634	25-year	6.53	7004
L2	3.634	50-year	7.03	7849
L2	3.634	100-year	7.50	9454
L2	3.500	Lat Struct		
L2	3.365	2-year	4.21	3604
L2	3.365	10-year	5.86	6209
L2	3.365	25-year	6.38	7004
L2	3.365	50-year	6.89	7849
L2	3.365	100-year	7.34	9454
L2	3.200	Lat Struct		
L2	3.048	2-year	4.07	3604
L2	3.048	10-year	5.67	6209
L2	3.048	25-year	6.16	7004
L2	3.048	50-year	6.70	7849
L2	3.048	100-year	7.13	9454
L2	2.596	2-year	3.94	3277
L2	2.596	10-year	5.56	5177
L2	2.596	25-year	6.07	5584
L2	2.596	50-year	6.62	5708
L2	2.596	100-year	7.06	6009
L2	2.401	2-year	3.89	3277
L2	2.401	10-year	5.51	5177
L2	2.401	25-year	6.03	5584
L2	2.401	50-year	6.59	5708
L2	2.401	100-year	7.04	6009
L2	2.037	2-year	3.82	3277
L2	2.037	10-year	5.45	5177
L2	2.037	25-year	5.98	5584
L2	2.037	50-year	6.55	5708
L2	2.037	100-year	7.00	6009
L2	1.837	2-year	3.74	3277
L2	1.837	10-year	5.37	5177
L2	1.837	25-year	5.91	5584
L2	1.837	50-year	6.50	5708
L2	1.837	100-year	6.96	6009
L2	1.834	**Hwy 433**		
L2	1.831	2-year	3.73	3277
L2	1.831	10-year	5.34	5177
L2	1.831	25-year	5.88	5584
L2	1.831	50-year	6.48	5708
L2	1.831	100-year	6.94	6009

Table 6a. Bayou Liberty Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
L2	1.461	2-year	3.63	3277
L2	1.461	10-year	5.24	5177
L2	1.461	25-year	5.80	5584
L2	1.461	50-year	6.42	5708
L2	1.461	100-year	6.89	6009
L2	1.188	2-year	3.57	3277
L2	1.188	10-year	5.19	5177
L2	1.188	25-year	5.75	5584
L2	1.188	50-year	6.39	5708
L2	1.188	100-year	6.86	6009
L2	0.826	2-year	3.54	3277
L2	0.826	10-year	5.16	5177
L2	0.826	25-year	5.73	5584
L2	0.826	50-year	6.37	5708
L2	0.826	100-year	6.85	6009
L1	0.673	2-year	3.52	3641
L1	0.673	10-year	5.14	5865
L1	0.673	25-year	5.71	6430
L1	0.673	50-year	6.36	6767
L1	0.673	100-year	6.84	6999
L1	0.455	2-year	3.50	3641
L1	0.455	10-year	5.13	5865
L1	0.455	25-year	5.70	6430
L1	0.455	50-year	6.35	6767
L1	0.455	100-year	6.83	6999

Table 6b. Bayou Paquet Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	4.048	2-year	12.42	305
1	4.048	10-year	13.07	574
1	4.048	25-year	13.24	668
1	4.048	50-year	13.39	762
1	4.048	100-year	13.65	951
1	3.799	2-year	12.22	305
1	3.799	10-year	12.94	574
1	3.799	25-year	13.11	668
1	3.799	50-year	13.26	762
1	3.799	100-year	13.52	951
1	3.576	2-year	11.84	305
1	3.576	10-year	12.53	574
1	3.576	25-year	12.69	668
1	3.576	50-year	12.82	762
1	3.576	100-year	13.06	951
1	3.357	2-year	10.92	305
1	3.357	10-year	11.57	574
1	3.357	25-year	11.69	668
1	3.357	50-year	11.80	762
1	3.357	100-year	12.02	951
1	3.114	2-year	10.15	257
1	3.114	10-year	11.19	510
1	3.114	25-year	11.25	610
1	3.114	50-year	11.27	708
1	3.114	100-year	11.38	905
1	3.111	**Monitor Road**		
1	3.108	2-year	9.57	257
1	3.108	10-year	10.44	510
1	3.108	25-year	10.70	610
1	3.108	50-year	10.90	708
1	3.108	100-year	11.25	905
1	2.859	2-year	8.79	257
1	2.859	10-year	9.51	510
1	2.859	25-year	9.75	610
1	2.859	50-year	9.90	708
1	2.859	100-year	10.15	905
1	2.523	2-year	6.46	257
1	2.523	10-year	7.54	510
1	2.523	25-year	7.58	610
1	2.523	50-year	7.94	708
1	2.523	100-year	8.57	905
1	2.276	2-year	5.16	257

Table 6b. Bayou Paquet Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	2.276	10-year	6.65	510
1	2.276	25-year	7.11	610
1	2.276	50-year	7.53	708
1	2.276	100-year	8.02	905
1	2.127	2-year	4.73	978
1	2.127	10-year	6.20	1691
1	2.127	25-year	6.71	1925
1	2.127	50-year	7.20	2154
1	2.127	100-year	7.68	2604
1	1.851	2-year	4.23	978
1	1.851	10-year	5.71	1691
1	1.851	25-year	6.23	1925
1	1.851	50-year	6.76	2154
1	1.851	100-year	7.27	2604
1	1.582	2-year	4.05	978
1	1.582	10-year	5.56	1691
1	1.582	25-year	6.07	1925
1	1.582	50-year	6.61	2154
1	1.582	100-year	7.11	2604
1	1.445	2-year	3.98	978
1	1.445	10-year	5.49	1691
1	1.445	25-year	6.00	1925
1	1.445	50-year	6.55	2154
1	1.445	100-year	7.04	2604
1	1.269	2-year	3.88	978
1	1.269	10-year	5.38	1691
1	1.269	25-year	5.91	1925
1	1.269	50-year	6.51	2154
1	1.269	100-year	7.00	2604
1	1.266	**Bayou Paquet Road**		
1	1.263	2-year	3.79	978
1	1.263	10-year	5.36	1691
1	1.263	25-year	5.90	1925
1	1.263	50-year	6.50	2154
1	1.263	100-year	6.99	2604
1	1.033	2-year	3.70	978
1	1.033	10-year	5.31	1691
1	1.033	25-year	5.85	1925
1	1.033	50-year	6.47	2154
1	1.033	100-year	6.97	2604
1	0.853	2-year	3.62	978

Table 6b. Bayou Paquet Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	0.853	10-year	5.24	1691
1	0.853	25-year	5.80	1925
1	0.853	50-year	6.43	2154
1	0.853	100-year	6.93	2604
1	0.500	Lat		
1	0.389	2-year	3.54	919
1	0.389	10-year	5.17	1705
1	0.389	25-year	5.73	1977
1	0.389	50-year	6.38	2256
1	0.389	100-year	6.86	2899
1	0.217	2-year	3.52	919
1	0.217	10-year	5.15	1705
1	0.217	25-year	5.72	1977
1	0.217	50-year	6.36	2256
1	0.217	100-year	6.84	2899
1	0.028	2-year	3.52	919
1	0.028	10-year	5.15	1705
1	0.028	25-year	5.72	1977
1	0.028	50-year	6.36	2256
1	0.028	100-year	6.84	2899

Table 6c. Tributary 1 Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	2.214	2-year	13.74	178
1	2.214	10-year	14.99	312
1	2.214	25-year	15.16	358
1	2.214	50-year	15.31	403
1	2.214	100-year	15.57	493
1	2.047	2-year	13.40	178
1	2.047	10-year	14.70	312
1	2.047	25-year	14.84	358
1	2.047	50-year	14.97	403
1	2.047	100-year	15.20	493
1	1.860	2-year	13.12	178
1	1.860	10-year	14.44	312
1	1.860	25-year	14.56	358
1	1.860	50-year	14.69	403
1	1.860	100-year	14.90	493
1	1.676	2-year	12.99	178
1	1.676	10-year	14.28	312
1	1.676	25-year	14.38	358
1	1.676	50-year	14.50	403
1	1.676	100-year	14.69	493
1	1.548	2-year	12.90	178
1	1.548	10-year	14.20	312
1	1.548	25-year	14.29	358
1	1.548	50-year	14.39	403
1	1.548	100-year	14.57	493
1	1.442	2-year	12.69	178
1	1.442	10-year	14.11	312
1	1.442	25-year	14.19	358
1	1.442	50-year	14.28	403
1	1.442	100-year	14.43	493
1	1.439	**Camp Villere Road / Railroad Spur**		
1	1.436	2-year	12.12	178
1	1.436	10-year	13.44	312
1	1.436	25-year	13.55	358
1	1.436	50-year	14.02	403
1	1.436	100-year	14.41	493
1	1.330	2-year	10.83	273
1	1.330	10-year	12.13	466
1	1.330	25-year	12.45	518
1	1.330	50-year	13.22	570
1	1.330	100-year	13.53	676
1	1.327	**Railroad Bridge**		

Table 6c. Tributary 1 Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	1.324	2-year	10.73	273
1	1.324	10-year	12.08	466
1	1.324	25-year	12.41	518
1	1.324	50-year	12.73	570
1	1.324	100-year	13.45	676
1	1.161	2-year	9.13	273
1	1.161	10-year	10.81	466
1	1.161	25-year	11.23	518
1	1.161	50-year	11.66	570
1	1.161	100-year	12.47	676
1	1.092	2-year	8.27	273
1	1.092	10-year	10.13	466
1	1.092	25-year	10.58	518
1	1.092	50-year	11.03	570
1	1.092	100-year	11.90	676
1	1.086	**Highway 190**		
1	1.080	2-year	8.22	273
1	1.080	10-year	9.93	466
1	1.080	25-year	10.34	518
1	1.080	50-year	10.75	570
1	1.080	100-year	11.49	676
1	0.957	2-year	7.43	273
1	0.957	10-year	9.25	466
1	0.957	25-year	9.70	518
1	0.957	50-year	10.13	570
1	0.957	100-year	10.89	676
1	0.787	2-year	6.67	273
1	0.787	10-year	8.67	466
1	0.787	25-year	9.16	518
1	0.787	50-year	9.63	570
1	0.787	100-year	10.27	676
1	0.626	2-year	6.08	273
1	0.626	10-year	8.03	466
1	0.626	25-year	8.51	518
1	0.626	50-year	8.97	570
1	0.626	100-year	9.49	676
1	0.398	2-year	5.42	273
1	0.398	10-year	7.29	466
1	0.398	25-year	7.79	518
1	0.398	50-year	8.25	570
1	0.398	100-year	8.89	676

Table 6c. Tributary 1 Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	0.250	2-year	4.87	273
1	0.250	10-year	6.84	466
1	0.250	25-year	7.40	518
1	0.250	50-year	7.90	570
1	0.250	100-year	8.50	676
1	0.046	2-year	4.87	273
1	0.046	10-year	6.85	466
1	0.046	25-year	7.41	518
1	0.046	50-year	7.91	570
1	0.046	100-year	8.51	676

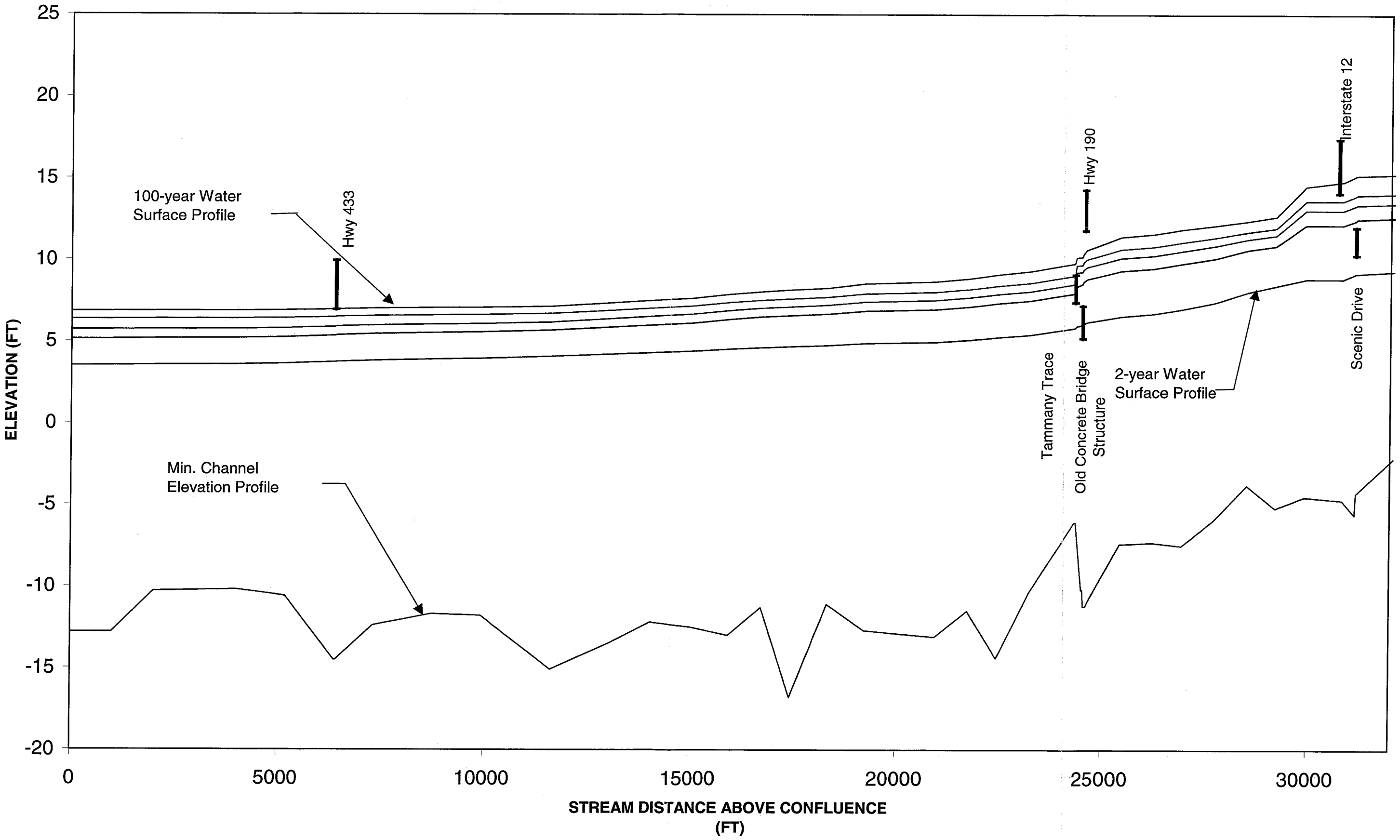
Table 6d. Tributary 2 Existing Conditions

REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	1.333	2-year	20.24	164
1	1.333	10-year	21.76	300
1	1.333	25-year	22.11	347
1	1.333	50-year	22.41	394
1	1.333	100-year	22.90	489
1	1.146	2-year	19.65	164
1	1.146	10-year	21.17	300
1	1.146	25-year	21.49	347
1	1.146	50-year	21.75	394
1	1.146	100-year	22.18	489
1	0.958	2-year	19.30	164
1	0.958	10-year	20.86	300
1	0.958	25-year	21.16	347
1	0.958	50-year	21.41	394
1	0.958	100-year	21.82	489
1	0.840	2-year	19.12	164
1	0.840	10-year	20.68	300
1	0.840	25-year	20.99	347
1	0.840	50-year	21.25	394
1	0.840	100-year	21.66	489
1	0.835	**Bellaire Boulevard**		
1	0.815	2-year	19.08	164
1	0.815	10-year	20.66	300
1	0.815	25-year	20.99	347
1	0.815	50-year	21.24	394
1	0.815	100-year	21.65	489
1	0.756	2-year	18.47	347
1	0.756	10-year	19.92	604
1	0.756	25-year	20.25	692
1	0.756	50-year	20.52	781
1	0.756	100-year	20.98	960
1	0.576	2-year	14.87	347
1	0.576	10-year	16.39	604
1	0.576	25-year	16.80	692
1	0.576	50-year	17.19	781
1	0.576	100-year	17.99	960
1	0.414	2-year	14.06	347
1	0.414	10-year	15.36	604
1	0.414	25-year	15.68	692
1	0.414	50-year	16.03	781
1	0.414	100-year	16.86	960
1	0.411	**Royal 18 Road**		

Table 6d. Tributary 2 Existing Conditions

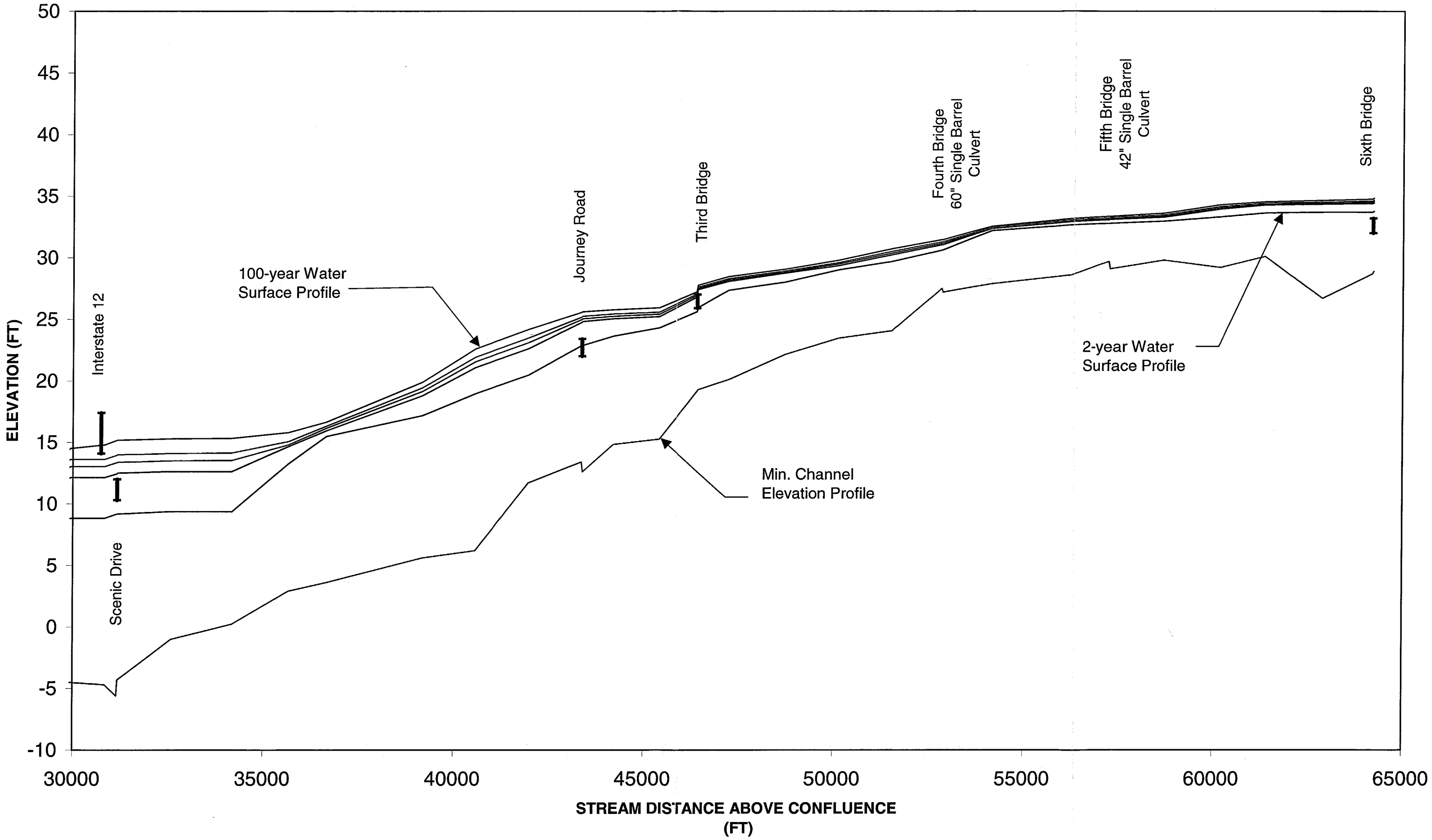
REACH	STA.	PROFILE	PEAK WSEL	PEAK FLOW RATE (CFS)
1	0.408	2-year	14.03	347
1	0.408	10-year	15.32	604
1	0.408	25-year	15.57	692
1	0.408	50-year	15.87	781
1	0.408	100-year	16.58	960
1	0.201	2-year	13.77	347
1	0.201	10-year	14.95	604
1	0.201	25-year	15.13	692
1	0.201	50-year	15.39	781
1	0.201	100-year	16.06	960
1	0.018	2-year	13.70	347
1	0.018	10-year	14.86	604
1	0.018	25-year	15.03	692
1	0.018	50-year	15.29	781
1	0.018	100-year	15.96	960

Figure 5a. Bayou Liberty Existing Conditions Water Surface Profiles



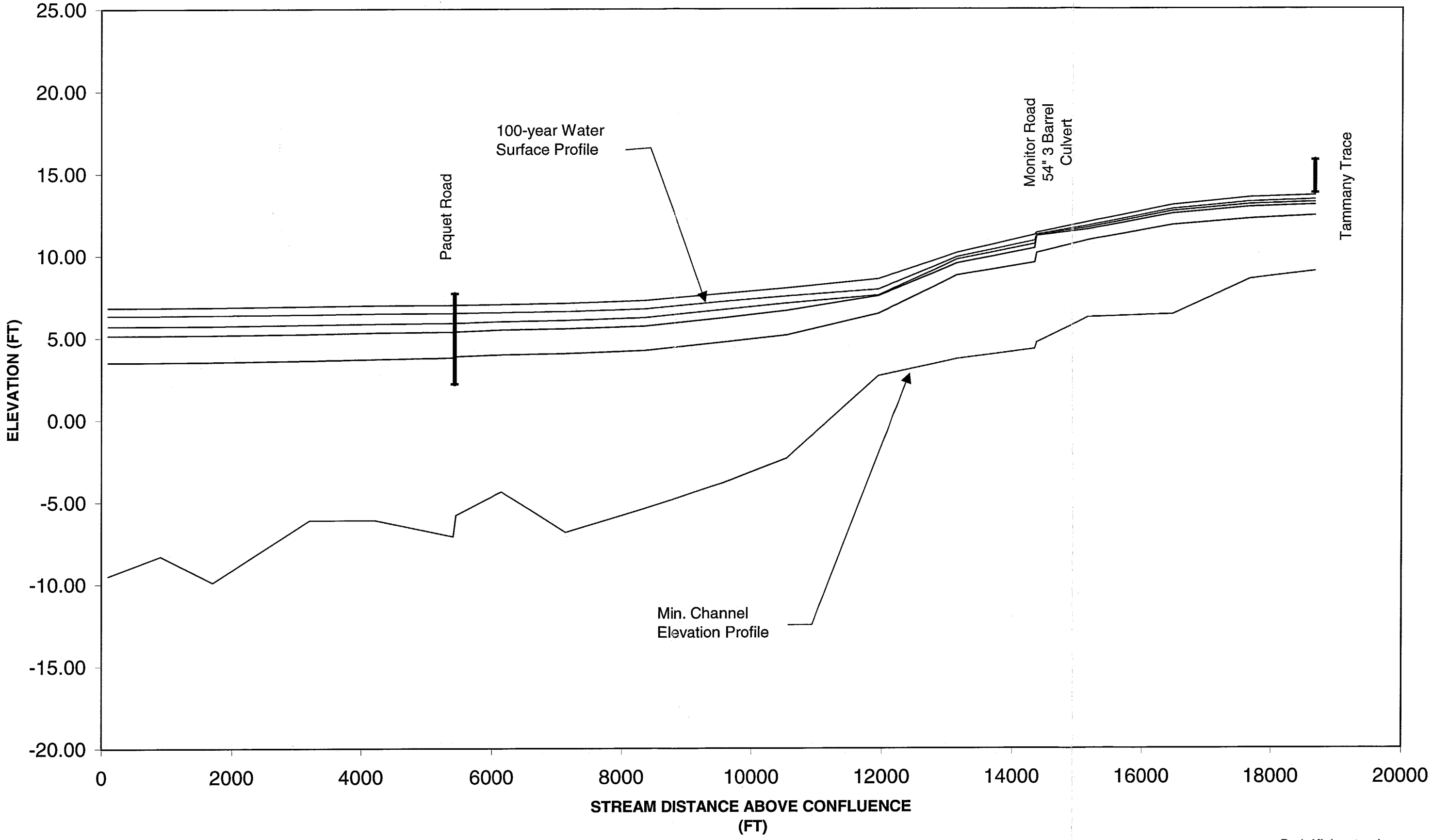
Burk-Kleinpeter, Inc.

Figure 5b. Bayou Liberty Existing Conditions Water Surface Profiles



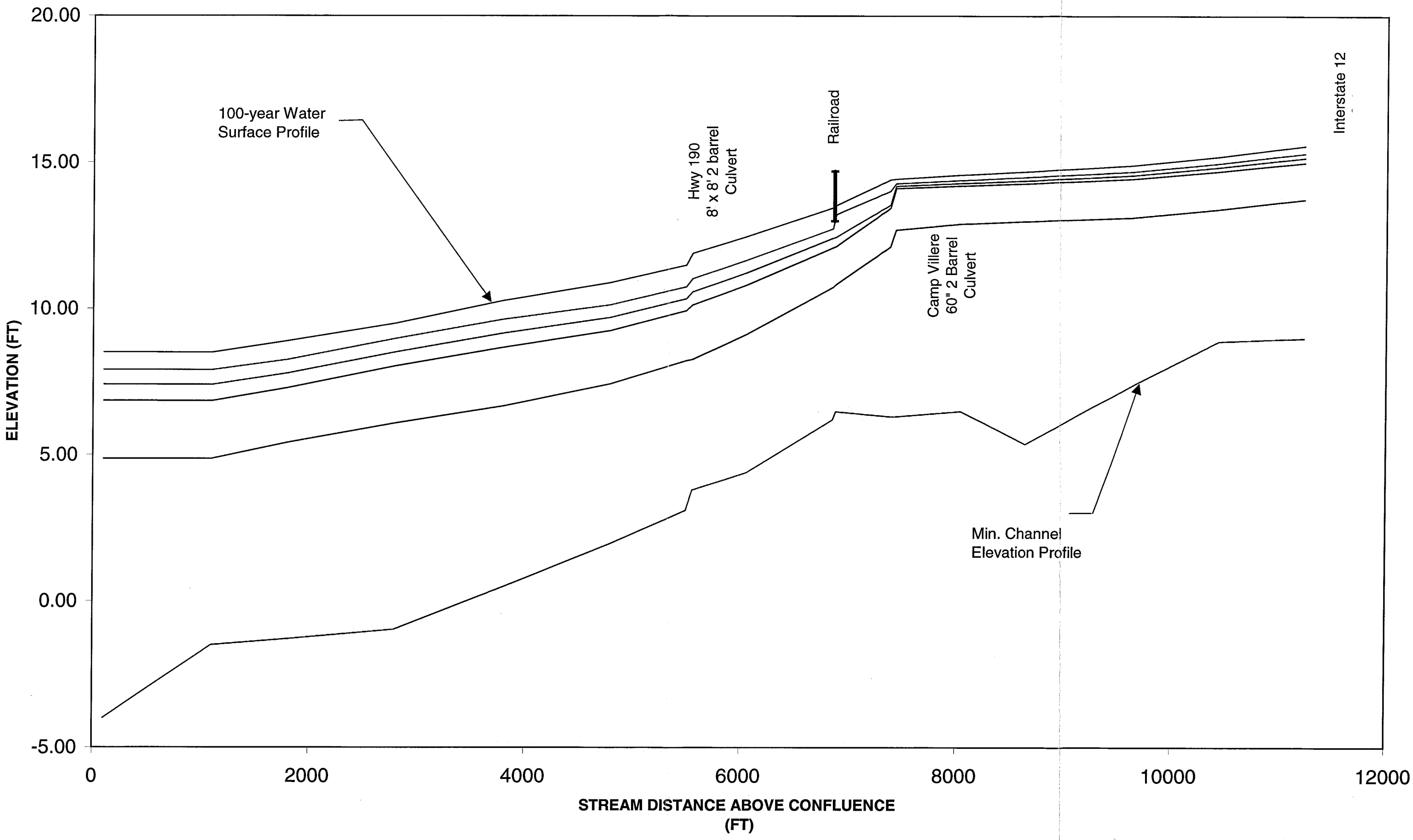
Burk-Kleinpeter, Inc.

Figure 5c. Bayou Paquet Existing Conditions Water Surface Profiles



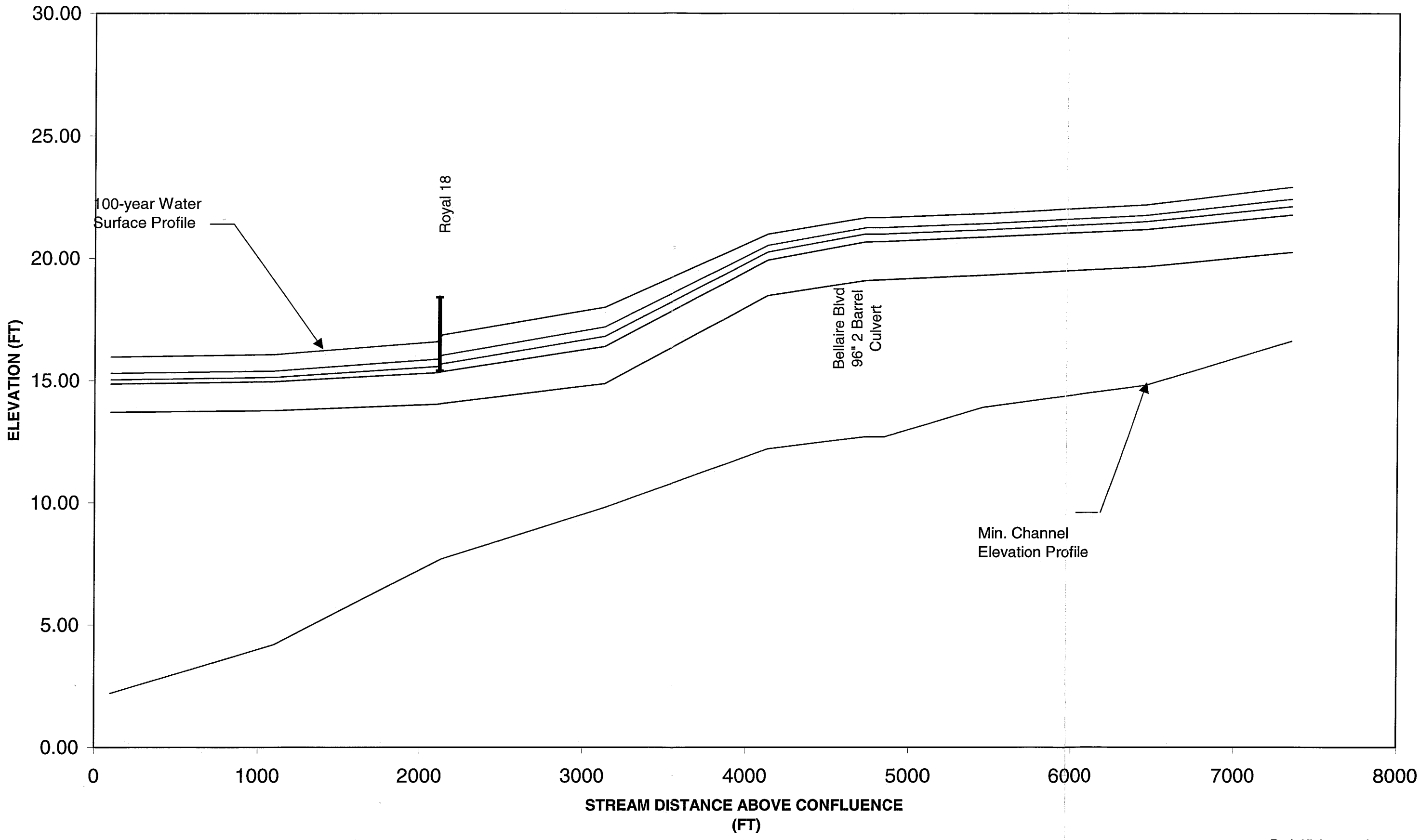
Burk-Kleinpeter, Inc.

Figure 5d. Tributary 1 Existing Conditions Water Surface Profiles



Burk-Kleinpeter, Inc.

Figure 5e. Tributary 2 Existing Conditions Water Surface Profiles



Burk-Kleinpeter, Inc.

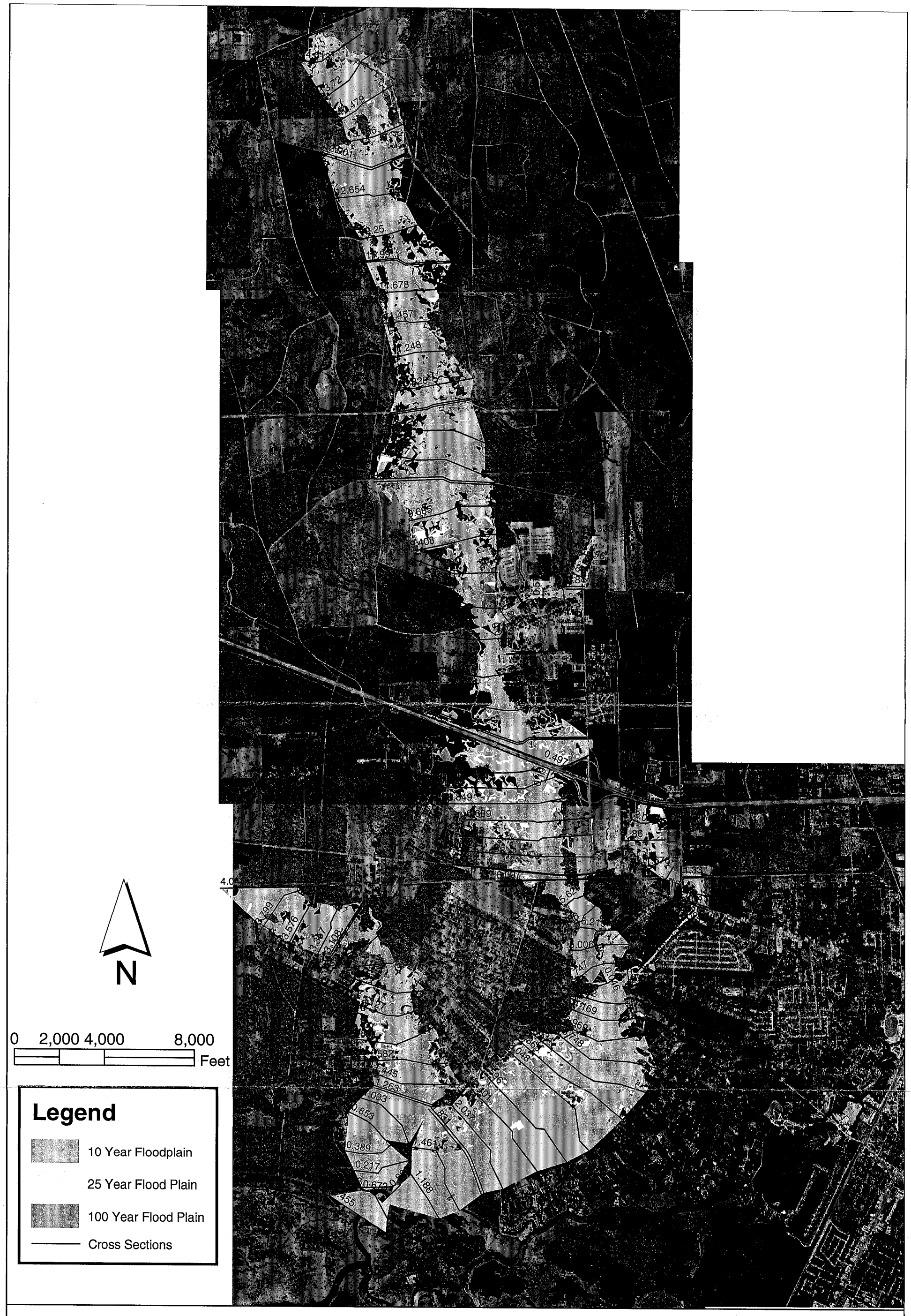


Figure 6 Existing Conditions

10, 25, 100 Year Floodplain

5. Analysis of Improved Conditions:

The Bayou Liberty Watershed Management Plan considered two methods to reduce flood impacts. Detention ponds and channel improvements were the proposed improvement methods.

Detention ponds were considered as an improvement strategy to reduce flooding impacts. Regional ponds were considered to solve generalized flooding within the watershed and site specific ponds were considered to mitigate localized flooding conditions. The utilization of detention ponds will remove storm water runoff from the channel before the time of concentration and release the storm water back to the channel at a later time thus dampening the peak flow in the channel. This was modeled in the HEC-HMS and HEC-RAS models by removing the affected subbasin areas.

Channel improvements were also considered to reduce flooding impacts. In general, channel improvements consist of channel straightening, channel widening, and clearing of overbank areas. These methods were not considered in this management plan. Previous watershed management plans for Bayou Liberty prepared by the U.S. Army Corps of Engineers incorporated these methodologies and the plans met stiff and vocal resistance from neighborhood and community groups who desired to maintain the Bayou's esthetic and scenic charm. The channel improvements considered within this master plan consist of "snagging" the channels. "Snagging" a channel consists of removing natural and man-made obstructions within the channel limits. Examples of these obstructions would include but not be limited to trees fallen into the channel from tree death or channel erosion, underwater obstructions, natural debris piles (especially at bridge and culvert locations), and man-made debris and refuse. The existing stream alignment would not be altered and the overbank areas would not be cleared.

A total of five individual improved conditions and one combined improvement condition were considered for the Bayou Liberty Watershed Management Plan. In order to mitigate general flooding problems as well as address specific points of concern (Huntwyck Village), the following alternatives were considered. Alternatives 1 and 2 attempt to control peaks by use of upstream regional detention ponds, Alternative 3 removes a frequently flooding area from the model by development of a site specific detention pond, Alternative 4 allows flow to proceed more freely by raising a bridge obstruction, and Alternative 5 attempts to remove channel obstructions in order to decrease the Manning "n" coefficient and reduce water surface elevations. The final Alternative 6 is a mixture of the above remedies.

It should be noted that any future development of the watershed will likely counteract to a degree the benefits of any of these alternatives. As previously mentioned, the Parish has enacted ordinances to regulate increased runoff created by land development. Despite the fact that future developments will not produce a greater flow rate, they will still likely produce runoff flow faster based upon the shortened time of concentration,

with less lag time. Thus should a detention pond be employed, it is likely that future development may necessitate an increase in storage volume.

5.1 Alternative 1 Camp Villere Detention Pond.

This alternative considers the effects of installing a regional detention pond in the area just west of Camp Villere Road and north of Interstate Highway 12. The improved conditions flows were computed by eliminating HEC-HMS subareas 16, 17 and a portion of 101 from the drainage system to simulate the detention pond. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 0.5 feet. The proposed pond location, 100-year flood profile, and flow data are shown in Appendix H.

5.2 Alternative 2 Upper Watershed Detention Pond.

This alternative considers the effects of installing a regional detention pond in the area east of Airport Road and north of Interstate Highway 12 in the existing wetland area. An outflow control structure would be constructed at the southern channel exit of the wetland area. This alternative considers the effects of eliminating HEC-HMS subareas 501-507 from the system to simulate the detention pond. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 3.9 feet. The 100-year flood profile and flow data are shown in Appendix I.

5.3 Alternative 3 Huntwyck Village Detention Pond.

This alternative considers the effects of installing a site specific detention pond in the area upstream of the Huntwyck Village subdivision. This alternative considers the effects of eliminating HEC-HMS subarea 107 from the drainage system to simulate the detention pond. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 0.1 foot. The 100-year flood profile and flow data are shown in Appendix J.

5.4 Alternative 4 Tammany Trace Bridge Improvements and Obstruction Removal

This alternative considers the effects of improving the Tammany Trace Bridge by reducing the number of piers in the channel, raising the low chord of the Tammany Trace Bridge structure above flood levels, and eliminating the partially demolished abandoned structure. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 0.4 foot. The improved bridge geometry, 100-year flood profile and flow data are shown in Appendix K.

5.5 Alternative 5 Snag the Channels

This alternative considers the effects of snagging the channels of Bayou Liberty below I-12, Tributary 1 below I-12, and Bayou Paquet below Tammany Trace. This was accomplished in the HEC-RAS model by reducing the Manning's "n" value for the channel only. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 1.4 feet for Bayou Liberty, 0.6 foot for Bayou Paquet, and 1.5 feet for Tributary 1. The 100-year flood profile and flow data are shown in Appendix L.

5.6 Alternative 6 (Master Plan 01)

This alternative combines all the improvements under Alternatives 1, 4 and 5. The computed maximum reduction in the 100-year water profile (compared to existing conditions) is 2.0 feet for Bayou Liberty, 0.6 foot for Bayou Paquet, and 1.5 feet for Tributary 1. The 100-year flood profile and flow data are shown in Appendix M.

6. Improved Conditions Cost Analysis

The Bayou Liberty Watershed Management Plan analyzed five individual improvement projects. For each improvement project costs have been developed. Project costs include construction cost, engineering costs, construction administration and inspection costs. Right-of-way costs were not included in these estimated project costs due to the variation of right-of -way cost per location and the uncertainty of proposed locations.

In order to evaluate the alternatives on a comparative basis, right-of-way costs were estimated. We have estimated right-of-way costs from local real estate advertisements. For large tract undeveloped wooded property with limited access, purchase costs would be $10,000.00 per acre; for long term lease (100 year with renewal option) of existing non-developable wetland, lease costs would be $5.00 per year per acre; and for long term lease purchase (100 year) of existing non-developable wetland, lease purchase cost would be $15.00 per year per acre. Cost/Benefit Ratios (Thousand Dollars per Reduction Foot) were developed utilizing these land cost assumptions and the reduction of water surface elevation.

6.1 Alternative 1 Camp Villere Detention Pond.

From the model analysis, an excavated detention pond with the volume of 291acre-feet or 12.7 million cubic feet would be required with an outflow structure. Assuming a six feet deep detention pond, a 50 acre pond would be developed with an overall site of approximately 65 acres. Project costs include excavation, seeding, concrete outflow structure. The estimated project costs were $2,450,00.00 without right-of-way and

$3,100,000.00 with right-of-way. Cost/Benefit Ratios for the alternative without right-of-way and with right-of-way were 4,900 and 6,200 respectively.

6.2 Alternative 2 Upper Watershed Detention Pond.

From the model analysis, a detention pond with the volume of 3800 acre-feet or 164 million cubic feet would be required with an outflow structure. Assuming a three feet deep detention area, a 1300 acre area would be required. This pond would use the existing wetland area as the storage volume but will require a longer outflow structure to contain the runoff. Right-of-way would be prohibitively expensive to purchase the necessary flooded area. Establishment of drainage servitudes through long term lease or lease-purchase agreements would be more cost effective. The estimated project costs were $1,150,000.00 without right-of-way, $1,800,000.00 with long term lease, and $3,100,000.00 with lease purchase. Cost/Benefit Ratios for the alternative without right-of-way, with long term lease, and with lease purchase were 295, 462 and 795 respectively.

6.3 Alternative 3 Huntwyck Village Detention Pond.

From the model analysis, a detention pond with the volume of 80 acre-feet or 3.5 million cubic feet would be required with an outflow structure. Assuming a six feet deep detention pond, a 15 acre pond would be developed with an overall site of approximately 20 acres. Project costs include excavation, seeding, concrete outflow structure. The estimated project costs were $730,000.00 without right-of-way and $930,000.00 with right-of-way. Cost/Benefit Ratios for the alternative without right-of-way and with right-of-way were 7,300 and 9,300 respectively.

6.4 Alternative 4 Tammany Trace Bridge Improvements and Obstruction Removal

In order to remove the existing restriction to the flow of Bayou Liberty, a light duty bridge approximately 16 feet wide would replace the existing structure. No right-of-way costs would be associated with this improvement since the current structure exists within existing Parish right-of-way. The bridge would consist of pre-cast concrete piles, pre-cast concrete slabs, and pre-cast concrete railings. The estimated project cost was $260,000.00 without right-of-way. Cost/Benefit Ratio for the alternative without right-of-way was 650.

6.5 Alternative 5 Snag the Channels

If the portions of Bayou Liberty and Bayou Paquet below Interstate-12, Tributary 1, and Tributary 2 were snagged, there would be 11 miles of channel to be snagged. Right-of-way costs for this alternative would be minimal. Access to portions of the bayous and tributaries would need land access if they were not accessible directly from the water. This could be accomplished through the purchase of permanent right-of-way or

temporary access agreements. Permanent right-of-way would be prudent for future snagging operations. For the 11 miles of channel, twenty access sites of one-half acre were estimated for a total of 10 acres. Snagging operations will include debris removal and disposal. The estimated project costs were $560,000.00 without right-of-way and $660,000.00 with right-of-way. Cost/Benefit Ratios for the alternative without right-of-way and with right-of-way are 400 and 471 respectively.

6.6 Alternative 6 (Master Plan 01)

This alternative combines all the improvements under Alternatives 1, 4 and 5 as described above. The right-of-way requirements and the construction items would remain as previously described. The estimated project costs were $3,270,000.00 without right-of-way and $3,760,000.00 with right-of-way. Cost/Benefit Ratios for the alternative without right-of-way and with right-of-way were 1,635 and 1,880 respectively.

7. Recommendations

By reviewing the Cost/Benefit Ratios for the proposed alternatives, Alternative 5 Snag the Channels, Alternative 2 Upper Watershed Detention Pond and Alternative 4 Tammany Trace Bridge Improvements and Obstruction Removal were the most cost effective improvements. Alternatives 4 and 5 could be implemented in relatively short period due to the need for little to no required right-of-way while Alternative 2 could be require a longer period of time for the establishment of leases. Alternative 3 Huntwyck Village Detention Pond had the highest cost/benefit ratio. Since Alternative 3 was a site specific detention pond to solve a specific inundation problem in a developed area, it was anticipated to have a high cost/benefit ratio. Prior to the implementation of the proposed alternatives, each alternative should be analyzed in more detail, more detailed construction costs should be developed ,and site specific right-of-way costs should be developed.

It should be noted that the five independent alternatives analyzed in the Bayou Liberty Watershed Management Plan are not all the potential improvements possible for this watershed. These alternatives are representative of improvement schemes that can be implemented within the watershed. There are many more potential improvements that could be included in the improvement schemes of channel improvements and detention ponds. Any new improvement alternatives considered should be input into the HEC-HMS and HEC-RAS models for rigorous review and scrutinized with similar construction and right-of-way costs.