



Lauzon Parkway Improvements Class Environmental Assessment

G.W.P. 3117-09-00

EXISTING CONDITIONS DRAINAGE REPORT FINAL



A member of  **MMM GROUP**

*Global
Transportation
Engineering*

McCORMICK RANKIN CORPORATION

November 2013



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1.0 INTRODUCTION

1.1 Project Description

On behalf of the Ontario Ministry of Transportation, the City of Windsor and the County of Essex, McCormick Rankin Corporation (MRC) is preparing a Class Environmental Assessment Study to address the future requirements for Lauzon Parkway. The study has the following main components:

- The Environmental Assessment Study and Preliminary Design for:
 - Lauzon Parkway from E.C. Row Expressway to County Road 42;
 - Lauzon Parkway extension to Highway 401; and
 - Lauzon Parkway's further extension to Highway 3.
- The Environmental Assessment Study for:
 - County Road 42 from Walker Road to County Road 25; and
 - Future East-West arterial from Walker Road to Essex County Road 17.
- The preparation and approval of a Secondary Plan for the remainder of the lands transferred to the City of Windsor in 2003. These lands are generally bounded by the CPR mainline north of the Windsor International Airport, Lauzon Parkway and the 8th Concession Road, and the City of Windsor boundary.

The purpose of this report is to provide details for the existing drainage system within the study area. The details discussed in this report include:

- Descriptions of the existing drainage patterns;
- Hydrologic assessments for existing conditions; and
- Hydraulic assessments of existing roadway culverts and crossings within the study area.

The Study Area is presented on Exhibit 1 (back of the report). All centreline and side-road culverts, as well as major entrance culverts within the study area were inspected. There are a total of 42 transverse and 14 entrance culverts, as well as three bridges (Little River, Pike River, and Puce River) within the study area. Nineteen of the transverse culverts are located along Lauzon Parkway and 10th Concession Road, and 7 transverse culverts are located along County Road 42. The Culvert Inspection Report prepared by MRC is appended to this report in Appendix A.

1.2 Study Data

The background information provided for this study includes:

- 1:10,000 Ontario Base Maps (OBM) for the study area;
- Aerial photographs;
- Information obtained from the site reconnaissance;
- Numerous reports prepared for other studies;
- Hydrologic and hydraulic model and output data for other studies; and
- Municipal Drain reports for various drains within the Study Area.

Information was provided by the Essex Region Conservation Authority, the City of Windsor, and the County of Essex. Municipal Drain reports were part of this information and included reports for:

- North Townline Road Drain;
- Baseline Drain;
- Watson Drain;
- St. Louis Drain;
- Little 10th Concession Drain;
- Little River Drain;
- 9th Concession Drain;
- Lesperance Road Drain West;
- Lappan and McGill Drain;
- 8th Concession Drain and Demonte Branch;
- Rivard Drain;
- Gouin Drain;
- Ray Road Drain;
- Quick Drain;
- Soulliere Drain;
- Riecher Drain;
- Langlois Drain;
- Hayes Drain;
- Hurley Drain;
- Lachance Drain;
- 6th Concession Drain;
- 7th Concession Drain;
- 7th Street Drain; and
- Desjardins Drain.

Not all of the above municipal drains fall within the study area, therefore only some of the reports were referenced. It should be noted that many of the reports referenced were dated, or contained limited information for the purposes of our study.

In addition to the above, Stantec is currently in the process of preparing the Upper Little River Watershed Master Drainage Plan & Stormwater Management Plan. The Master Plan is being prepared concurrently with this Class EA. Information provided within the Master Plan will be incorporated into this Class EA, including but not limited to drainage and stormwater management methods and locations.

2.0 EXISTING DRAINAGE CONDITIONS

The existing drainage conditions reviewed for this study are shown on Exhibits 2 through 10, which depicts the existing drainage features inspected within the study area, including the location of existing culverts, and the municipal drains. The drainage features were obtained from 1:10,000 Ontario Base Mapping (OBM) and from information provided within the municipal drain reports. The Town of Lakeshore also provided MRC with access to their Municipal Drain mapping which was used to update the mapping.

The land surrounding the roadway within the study area is primarily comprised of agricultural areas. The topography of the Study Area consists of very flat terrain with an average slope of less than 0.5 percent, with overland flow conveyed mainly via municipal drains.

2.1 Site Reconnaissance

A site reconnaissance was carried out in May 2011 to confirm existing culvert locations and sizes, to assess the physical condition of each culvert, and to record characteristics of significant drainage features within the study area.

The following is a list of the field tasks completed during the site reconnaissance:

- Confirmed local drainage patterns and drainage divides;
- Confirmed size, type, location, material, physical condition, and approximate cover depth of each highway culvert crossing;
- Documented channel characteristics upstream and downstream of each culvert;
- Noted sediment accumulation, and checked for signs of erosion; and
- Estimated channel bankfull widths and tailwater conditions.

Prior to the site visit, MRC contacted the MTO Maintenance Supervisor to gain further understanding of drainage related issues within the study area. A photographic inventory and condition summary are presented in the *Culvert Inspection Report* completed by MRC in August 2011, which is included in Appendix A.

2.2 Existing Culvert Locations and Characteristics

The locations and characteristics of the existing culverts within the Study Area are summarized in Table 1. This table provides the following information:

- Culvert identification number;
- Approximate Location;
- Drain conveyed by culvert;
- Culvert size;
- Culvert Type;
- Upstream invert (estimated);
- Downstream invert (estimated);
- Length (if available);
- Slope (if available);

- Municipal Drain Report from which the information was obtained;
- Station (from Municipal Drain reports); and
- Additional information or descriptions from Municipal Drain reports.

The physical condition assessment of the culverts is included in the Culvert Inspection Report (MRC, August 2011), and as noted therein, the majority of the inspected culverts are in good condition. Of the 42 culverts assessed during the site reconnaissance, five (5) were found to be in poor condition:

- LC 2 was corroded at the downstream end, and the culvert barrel was in poor condition;
- LC 3 was deformed/crushed at the upstream and downstream ends;
- LC 9 was crushed, cracked, and the pipe barrel was rusty where visible;
- LC 16 was corroded at the downstream end on the culvert bottom; and
- LC 17 was broken and corroded at the upstream end, and the downstream end had a hole through the bottom of the culvert and was angled upwards.

Four (4) were found to be in poor to fair condition:

- LC 14 inlet CSP pipe from south is connected to the CB, and was in poor condition, downstream end in good condition;
- LC 15 inlet CSP pipe from south is connected to the CB, and was in poor condition (rusty and deformed), and downstream end was rusty,;
- XC 8 culvert barrel was in poor to fair condition; and
- XC 9 was rusty and deformed at both ends, poor to fair conditions.

Culverts DC2 was found to be in fair condition. The remaining culverts are in good condition.

Table 1 - Existing Culvert Summary

| LAUZON PARKWAY (COUNTY ROAD 17 AND COUNTY ROAD 117) – From CN Rail to EC Row Expressway - Centreline Culverts | | | | | | | | | | | |
|---|---|---|---------------------|-------------------------|-------------------------------|---------------------------------|------------|-----------|--|--|---|
| Culvert I.D. | Location | Drain | Culvert Size (mm) | Culvert Type | Estimated Upstream Invert (m) | Estimated Downstream Invert (m) | Length (m) | Slope (%) | Report Name | Station (from Municipal Drain reports) | Description from Municipal Drain Report |
| XC1 | Middle Road | Sullivan Drain | Twin-2000 | CSP (With headwalls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| LC1 | County Road 17/10th Concession Road | Sullivan Drain | 3600 x 1500 | Concrete (Open Footing) | N/A | N/A | N/A | N/A | - | N/A | N/A |
| XC2 | Highway 401 (West side of County Road 17) | Watson Drain | 1500 x 1670 | Concrete | 184.825 | 184.74 | 50 | 0.17 | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 4+201 | 1500 x 1500 concrete box, 50m long ("to be cleaned") |
| LC2 | County Road 17/10th Concession Road | Watson Drain | 450 | CSP | N/A | N/A | N/A | N/A | - | N/A | N/A |
| LC3 | County Road 17/10th Concession Road | Watson Drain | 400 | CSP | N/A | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | - | N/A |
| LC4 | County Road 17/10th Concession Road | Watson Drain | 450 | CSP | 184.3 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 3+310 | 450 CSP (Langlois Drain) |
| LC5 | County Road 17/10th Concession Road | Watson Drain | 350 | CSP | 184.00 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 3+031.5 | 300 CSP |
| LC6 | County Road 17/10th Concession Road | Watson Drain | 250 | HDPF | 183.85 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 2+889 | 250mm dia HDPE from East (Langlois Drain) |
| LC7 | County Road 17/10th Concession Road | Watson Drain | 600 | CSP | 183.50 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 2+750.5 | 600 CSP (listed as Langlois Drain) |
| LC8 | County Road 17/10th Concession Road | Watson Drain | 1600 x 1900 | Concrete | 182.38 | 182.38 | 6.00 | 0.1 | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 2+026.1? | 1800 x 1260 CSP ("to be removed")? |
| LC9 | County Road 17/10th Concession Road | Watson Drain | 500 | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC3 | Baseline road on west side of County Road 17 | Watson Drain | 1970 | CSP | 182.35 | 182.33 | 28.00 | 0.1 | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 2+000 | 28m, ("to be cleaned"), Bridge No. 23 |
| LC10 | County Road 17/10th Concession Road | Watson Drain | 400 | CSP | 182.10 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 1+685.8 | 375 dia CSP, "new 3m long tie end" |
| LC11 | County Road 17/10th Concession Road | Watson Drain | 450 | CSP | 182.20 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 1+533.8 | 450 CSP, "new 3m long end" (listed as Reicher Drain) |
| LC12 | County Road 17/10th Concession Road | Watson Drain | 400 | CSP | 182.40 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 1+232 | 375 CSP |
| LC13 | County Road 17/10th Concession Road | Watson Drain | 300 | PVC | 182.40 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 1+226 | 300 CSP |
| LC14 | County Road 17/10th Concession Road | Watson Drain | 300 & 450 (from CB) | CSPs | 181.80 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 1+060 (1+065) | 300 CSP ("repair"), (listed as Reicher Drain) |
| LC15 | County Road 17/10th Concession Road | Watson Drain | 450 | CSP | 181.50 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 0+775 | 450 CSP ("repair"), (listed as Reicher Drain) |
| LC16 | County Road 17/10th Concession Road | Watson Drain | 250 | CSP | 181.95 | N/A | N/A | N/A | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 0+48 | 250 |
| LB1 | Bridge Structure at Little River | Little River | n/a | n/a | 179.00 | N/A | N/A | N/A | Little River Municipal Drain Report (1953) | N/A | Size not specified, 1983 report, Drain Slope = 0.09%, invert = 179m |
| LC17 | County Road 17/17 (Lauzon Parkway) | Little River | 1350 | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| LC18 | County Road 17/17 (Lauzon Parkway) | McGill Drain | 3100 x 3100 | Concrete (wing walls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| R1 | EC Row Expressway-Y-S Ramp | Russette Drain | Twin-1800 x 1850 | Concrete (wing walls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| LC19 | County Road 17/17 (Lauzon Parkway) | Russette Drain | Twin-1800 x 1900 | Concrete (wing walls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| R2 | EC Row Expressway-W-N Ramp | Russette Drain | Twin-1800 x 1830 | Concrete (wing walls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| R3 | EC Row Expressway-S-E Ramp | Russette Drain | Twin-1800 x 1830 | Concrete (wing walls) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| COUNTY ROAD 42 (DIVISION ROAD) – Walker Road to Puce Road (County Road 25) - Centreline Culverts | | | | | | | | | | | |
| Culvert I.D. | Location | Drain | Culvert Size (mm) | Culvert Type | Estimated Upstream Invert (m) | Estimated Downstream Invert (m) | Length (m) | Slope (%) | Report Name | Station (from Municipal Drain reports) | Description from Municipal Drain Report |
| XC4 | Concession Road 8 | North Townline Highway Drain | 900 | Concrete pipe | 186.70 | N/A | N/A | N/A | N/A | N/A | Profile only, no culvert info in report, values estimated from profile |
| XC5 | Concession Road 9 | North Townline Highway Drain | 6300 x 1300 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | Profile only, no culvert info in report, profile does not extend to outlet XC5 |
| DC1 | County Road 42 | Little River | 6100 x 2450 | Concrete (wing walls) | 179.80 | N/A | N/A | N/A | N/A | N/A | Size not specified, 1983 report, Drain Slope = 0.08%, inv = 179m |
| DC2 | County Road 42 | Watson Drain | 33000 x 1500 | Concrete | 180.93 | 180.89 | 30.00 | 0.12 | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 0+709 | 30m long, 3000 x 1800mm concr. culvert, ("to be cleaned"), Bridge No. 27 |
| XC6 | private entrance | Watson Drain | 2100 x 1500 | CSP, Arch | 180.84 | 180.82 | 18.00 | 0.12 | Watson Drain Reconsidered Municipal Drain Report (24 April 2009) | 0+63.4 | 18m long, 2240 x 1630 CSP, Arch, ("to be cleaned"), Bridge No. 28 |
| DC3 | County Road 42 | Little 10th Concession Drain | 3200 x 900 | Concrete box | 175.10 | 175.05 | 9.50 | 0.53 | Little 10th Conc. Drain Report | 1+214 | 9.5m long, Inv. 175.05ds (175 ft us, approximated from profile), Bridge No. 10 |
| XC7 | Was not found in field | Local Flow | N/A | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DB1 | Banwell Road | Local Flow | 500 | n/a | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DB1 | Bridge Structure at Pike Creek | Pike Creek | n/a | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC9 | Lakeshore Road 101 | 9th Concession Centreline Drain | 900 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DC4 | County Road 42 | 8th Concession Centreline Drain | 3700 x 2560 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DC5 | County Road 42 | 8th Concession Centreline Drain | 5500 x 2850 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC10 | Concession Road 8W (Lakeshore Road 103) | 915 | HDPF | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC11 | Concession Road 7W (Lakeshore Road 105) | 400 | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC12 | Concession Road 8W (Lakeshore Road 107) | Baseline Drain | 1500 | CSP | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DC7 | County Road 42 | Local Flow | 2050 | HDPF | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| DB2 | Bridge Structure at Puce River | Puce River | 200 | n/a | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| XC13 | County Road 25 | River? "lower portion of the Standish D | 4500 x 1650 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| R4 | E.C. ROW Expressway (Highway 2) | Little River | 12100 x 5400 | Concrete | N/A | N/A | N/A | N/A | N/A | N/A | -Structure not assessed in field, information from hydraulic model provided by ERCA |
| LAUZON PARKWAY (COUNTY ROAD 17 AND COUNTY ROAD 117) – From CN Rail to EC Row Expressway - ENTRANCE CULVERTS | | | | | | | | | | | |
| Culvert I.D. | Location | Drain | Culvert Size (mm) | Culvert Type | Estimated Upstream Invert (m) | Estimated Downstream Invert (m) | Length (m) | Slope (%) | Report Name | Station (from Municipal Drain reports) | Description from Municipal Drain Report |
| DW1 | County Road 42-East of 7th Concession Road | North Townline Road Drain | 600 | CSP | N/A | N/A | N/A | N/A | North Townline Road Drain (1980) | N/A | North Townline Road Drain (1980) |
| DW2 | County Road 42-East of 7th Concession Road | North Townline Road Drain | 750 | CSP | N/A | N/A | N/A | N/A | North Townline Road Drain (1980) | (~1.34m from 7th Concession Road) | N/A |
| DW3 | County Road 42-East of 7th Concession Road | North Townline Road Drain | 915 | CSP | N/A | N/A | N/A | N/A | North Townline Road Drain (1980) | (~2.10m from 7th Concession Road) | N/A |
| DW4 | County Road 42-East of 7th Concession Road | North Townline Road Drain | 915 | CSP | N/A | N/A | N/A | N/A | North Townline Road Drain (1980) | (~2.28m from 7th Concession Road) | N/A |
| DM5 | County Road 42 between Lauzon Rd and Conc. 11 | St. Louis Drain | 750 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.70m from 11th Concession Road) | N/A |
| DW6 | County Road 42 between Lauzon Rd and Conc. 12 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.73m from 11th Concession Road) | N/A |
| DW7 | County Road 42 between Lauzon Rd and Conc. 13 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.73m from 11th Concession Road) | N/A |
| DM8 | County Road 42 between Lauzon Rd and Conc. 14 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.71m from 11th Concession Road) | N/A |
| DW9 | County Road 42 between Lauzon Rd and Conc. 15 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.72m from 11th Concession Road) | N/A |
| DW10 | County Road 42 between Lauzon Rd and Conc. 16 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.86m from 11th Concession Road) | N/A |
| DW11 | County Road 42 between Lauzon Rd and Conc. 17 | St. Louis Drain | 450 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.60m from 11th Concession Road) | N/A |
| DW12 | County Road 42 between Lauzon Rd and Conc. 18 | St. Louis Drain | 600 | CSP | N/A | N/A | N/A | N/A | St. Louis Drain Report (2005) | (~0.86m from 11th Concession Road) | N/A |
| DW13 | County Road 42 between Lauzon Rd and Conc. 19 | St. Louis Drain | 600 | CSP | N/A | N/A | | | | | |

3.0 ASSESSMENT CRITERIA

The MTO Highway Drainage Design Standards were applied to this project. The following is a general summary of the MTO Highway Drainage Design Standards that are relevant to this study.

WC-1: Design Flows for Bridges and Culverts: This standard identifies the minimum design flows that should be used for the sizing of roadway bridges and culverts. For an urban arterial (culvert spans less than or equal to 6.0 m) the flow generated by the 50-year storm is used as the design flow. Additionally, there should be no highway overtopping during the check flow event (100-year storm).

WC-7: Culvert Crossings on a Watercourse: This standard identifies the minimum freeboard and the maximum flood depth at culvert crossings.

The desirable freeboard (**Freeboard Criterion**) is measured vertically from the Energy Grade Line (EGL) elevation for the design flow to the edge of the travelled lane at the lowest point in the road profile adjacent to the culvert (spill point). For example, for culverts located at or near a highway sag, the spill elevation would be the lowest edge of travelled lane elevation at the sag. In cases where a culvert is not located at highway sag, the spill point is considered to be the edge of travelled lane elevation at the point at which flows would spill to an adjacent culvert (highpoint along the highway ditch). For design of culverts under freeways this standard indicates the minimum freeboard is 1.0 m (using the design flows, 50 year storm) and that the water level generated by the 100 year design flow should not exceed the edge of the travelled lane at the lowest point in the road profile adjacent to the culvert (spill point).

For culverts with a diameter or rise less than 3.0 m, this standard specifies the ratio of headwater depth to diameter (HW/D) ratio should be less than 1.5.

WC-8: Minimum Culvert Size: This standard identifies minimum culvert sizes for various road types based on maintenance considerations. The minimum culvert size for freeways, urban arterial road transverse culverts and ramp culverts include an 800 mm diameter round culvert and a box culvert with a minimum rise of 900 mm.

WC-12: Fish Passage Through Culverts: This standard identifies requirements to facilitate fish passage through culverts on fish bearing streams. The standard defines the required width of the culvert, embedment depth, substrate materials to be used, and shape of the low flow channel within the culvert. Some key points from this standard include:

- The maximum velocity in the culvert for Fish Passage Design Flow shall not exceed the natural channel velocity, unless otherwise agreed to by DFO;
- The depth of water in a culvert shall be consistent with the average depth immediately upstream and downstream of the culvert;
- The minimum culvert width (span) shall be sufficient to maintain the natural bankfull channel function (width, depth, and velocity) for the Fish Passage Design Flow;

- The Culvert Substrate and Native Substrate within the culvert shall be shaped to form the Low Flow Channel; and
- The primary design objective for the channel within the culvert should be to maintain (or approximate) the slope, dimensions, substrate characteristics of the existing channel, and the related general morphology and physical conditions of the ‘bankfull’ channel.

In some cases the combination of the culvert size and the substrate size may be such that a required low flow channel would not be constructible. In such cases it will be necessary to either increase the culvert size or develop other alternatives to satisfy Agency requirements.

3.1 Assessment of Structures

The hydraulic criteria for the structures are based on the MTO Highway Drainage Design Standards (HDDS) for water crossings. The MTO HDDS for the watercourse and water body crossings are based on the criteria from the Canadian Highway Bridge Design Code. The following performance standards were selected for this study:

Performance Criteria for structures

- design storms used to calculate flood elevations and perform scour calculation;
- desired and minimum top of road freeboard;
- minimum soffit clearance;
- bridge deck drainage;
- maximum depth and velocity of relief flow over the road;
- navigable clearance;
- allowable increase in the flood elevation upstream of the structure; and
- temporary works during construction.

Design Storms for Bridges

MTO HDDS Standard WC-1 specifies the 50-year storm as the design storm for bridges with spans greater than 6 m that are located on rural arterials. The same standard specifies the Check Flow for scour calculations to be 115% of the 100-year storm.

Top of Road Freeboard

MTO HDDS Standard WC-2 specifies that the freeboard at bridge crossings shall be greater than or equal to 1.0 m for freeways, arterials and collectors. The Desirable Freeboard is measured vertically from the Energy Grade Line elevation for the Design Flow to the edge of the travelled lane. The Minimum Freeboard is measured vertically from the High Water Level for the Design Flow to the edge of the travelled lane.

Soffit Clearance

MTO HDDS Standard WC-2 specifies the Bridge Clearance for freeways, arterials and collector roads shall be greater than or equal to 1.0 m for the design flow, in this case 50 year return. The

Clearance is measured vertically from the High Water Level for the Design Flow to the lowest point on the soffit.

Standard WC-2 also states that “where the structure is required to convey the Regulatory Flow, clearance shall be based on the Design Flow...Zero clearance is required for the Regulatory Flow... The freeboard for the Regulatory Flow may be less than the minimum required for the Design Flow”.

Bridge Deck Drainage – Spread

MTO HDDS Standard WC-4 specifies the maximum spread for bridges. This standard specifies the following:

- A Design Storm with a minimum Return Period of 10 years shall be used to calculate Flow Spread. This standard shall be used in conjunction with Standard WC-5: Bridge Deck Drains; and
- For arterial roads the Maximum Lateral Spread Distance shall be such that a minimum of 2.5 m of the lane adjacent to the median barrier or curb remains clear of any flooding.

Relief Flow

MTO HDDS Standard WC-13 specifies that The Regulatory Flow (Hurricane Hazel for this project) shall be used for defining the Relief Flow. Where Relief Flow is provided, the following parameters shall not be exceeded at the cross section of the road for the Regulatory Flood:

- The maximum depth of flow on the roadway shall not exceed 0.3 m; and
- The product of the velocity and depth on the roadway shall not exceed $0.8 \text{ m}^2/\text{s}$.

Navigable Clearance

The MTO HDDS state “the vertical and horizontal Navigational Clearances shall be determined in accordance with the Navigable Waters Protection Act”.

Changes in Upstream Water Levels

The MTO HDDS do not quantify a maximum increase in flood elevations. however the Commentary Section in Standard WC-1 states: “*...any risk to public safety or potential damage to adjacent properties as a result of impact on the flood elevations associated with the Regulatory Flow ...shall be determined in consultation with the Municipality, Conservation Authority or the Ministry of Natural Resources given their responsibilities under the Conservation Authorities Act and Lakes and Rivers Improvement Act.*”

Temporary Works During Construction

The HDDS Standard TW-1 states that the return period depends on the length of the construction period and includes the potential consequences (low, medium, and high) to; public safety, traffic delays, property damage due to flooding, and environmental impacts.

4.0 EXISTING CONDITIONS HYDRAULIC ANALYSIS

As noted in the previous sections, limited information was available to assess the existing hydraulic conditions of the culverts within the study area and along future alignments. The most detailed information was provided for the existing culverts along the Watson Drain along the 10th Concession Road. This drain is no longer on the current proposed alignment, and as such, these culverts were not hydraulically assessed. Limited culvert information was provided for the culverts along County Road 42, specifically on the North Townline Road Drain and the St. Louis Drain. The available information was deemed insufficient to perform a hydraulic assessment for the culverts within the proposed work limits. Limited information was available for three culverts (culverts DC2, DC3, and XC6), however the information, including inverts and slopes, was estimated only and a hydraulic analysis was therefore deemed not feasible at this time. The information provided was limited to culvert size, material, and length for only some of the culverts. Detailed invert and slope information was unavailable. At the detailed design stage, a detailed survey will be required for areas which are to remain rural, to obtain the required culvert information to perform a comprehensive hydraulic assessment.

4.1 Hydraulic Modelling

Hydraulic modelling of the Little River, Pike River, Kerr Drain, Puce River, and 8th Concession Drain was provided by the Essex Region Conservation Authority in PDF format. Table 2 provides a summary of the existing structure characteristics for those culverts with hydraulic models available.

The Hec-2 hard copy printouts were first compared to the available floodplain mapping elevations. Based on this comparison, the model for the 8th Concession Drain appeared to be inconsistent with the floodplain mapping as the elevations did not match. As such, the information was not used to generate a hydraulic model for this watercourse. The Hec-2 paper information for the remaining four models was then scanned and formatted into Hec-2 to create a working model. The Hec-2 model was in turn used to generate Hec-Ras models for the four major crossings. The final Hec-Ras model for each creek system was then compared to the floodline elevations provided on the floodplain mapping as a check, to ensure the models were correct. The differences in the 100-year flood elevations were negligible, and the converted models were thereby confirmed to be converted correctly. Tables 3 through 6 provide a summary of the comparisons of the various stages of the model conversion from PDF format to Hec-Ras format.

The integrity of the sections in the model (i.e. elevations and general geometry of the sections) was not evaluated. Assumptions were made for some of the station information and flow data provided, and some modifications were made to the original data to correspond to modelling input required by Hec-Ras. Discrepancies in the floodplain mapping flood elevations and the PDF flood elevations were noted, and it was assumed that the pdf elevations were correct and were used as boundary conditions, as illustrated in Tables 3 to 6. Exhibit 11 provides a schematic of the floodplain mapping and the Hec-Ras information. Hydraulic modelling output is included in Appendix B.

As presented in the following tables, there are no cases of road overtopping under existing

conditions for the 100-year storm. Only one culvert (DB1 – Pike Creek) currently meets the freeboard criteria. Only 3 of the culverts (R4 – Little River, LB1 – Little River, and DB1 – Pike Creek) currently meet the soffit clearance criteria.

Table 2 - Existing Structure Characteristics (Structures included in modelling provided by ERCA) (100-Year Storm)

| Structure Number | Watercourse Name | Road Crossing | HEC-2 Model | Structure Size Field Measurement (m) | Upstream WSEL (100yr) (m) | Top of Road Elev. (m) | Top of Road Freeboard (1) (m) | Overtopping (2) Yes/No | Road Soffit Elev. (3) (m) | Soffit Clearance (m) |
|------------------|------------------|---------------|-------------|--------------------------------------|---------------------------|-----------------------|-------------------------------|------------------------|---------------------------|----------------------|
| R4 | Little River | Hwy 2 | 12.1x5.4 | na | 180.83 | 181.40 | 0.57 | No | 182.60 | 1.77 |
| LBI | Little River | Lauzon Pkwy | 10.7x3.7 | na | 182.19 | 182.40 | 0.21 | No | 183.60 | 1.41 |
| DC1 | Little River | County Rd 42 | 6.9x2.5 | 6.1x2.45 | 182.65 | 183.10 | 0.45 | No | 182.40 | -0.25 |
| DB1 | Pike Creek | County Rd 42 | 18.3x4.9 | na | 179.22 | 181.78 | 2.56 | No | 181.20 | 1.98 |
| DC4 | Kerr Drain | County Rd 42 | 4.3x2.3 | 3.7x2.5 | 180.23 | 180.72 | 0.49 | No | 180.02 | -0.21 |
| DB2 | Puce River | County Rd 42 | 15.8x4.1 | na | 178.76 | 179.68 | 0.92 | No | 179.25 | 0.49 |

Notes:

1. MTO HDDS Standard WC-2 specifies that the freeboard at bridge crossings shall be greater than or equal to 1.0 m for freeways, arterials and collectors. The Desirable Freeboard is measured vertically from the Energy Grade Line elevation for the Design Flow to the edge of the travelled lane. The Minimum Freeboard is measured vertically from the High Water Level for the Design Flow to the edge of the travelled lane.
2. MTO HDDS Standard WC-13 specifies that The Regulatory Flow (Hurricane Hazel for this project) shall be used for defining the Relief Flow. Where Relief Flow is provided, the following parameters shall not be exceeded at the cross section of the road for the Regulatory Flood:
 - The maximum depth of flow on the roadway shall not exceed 0.3 m; and
 - The product of the velocity and depth on the roadway shall not exceed 0.8m²/s.
3. MTO HDDS Standard WC-2 specifies the Bridge Clearance for freeways, arterials and collector roads shall be greater than or equal to 1.0 m for the design flow, in this case 50 year return. The Clearance is measured vertically from the High Water Level for the Design Flow to the lowest point on the soffit. Standard WC-2 also states that “where the structure is required to convey the Regulatory Flow, clearance shall be based on the Design Flow-Zero clearance is required for the Regulatory Flow. The freeboard for the Regulatory Flow may be less than the minimum required for the Design Flow”.

Table 3 - Flood Elevation Comparison for Little River (100yr Flood)

| Section Number | HEC-2 Mapping (m) | HEC-2 Paper Copy (m) | Diff. (m) | HEC-2 Paper Copy (m) | HEC-2 Digital (m) | Diff. (m) | HEC-2 Digital (m) | HEC-RAS Converted (m) | Diff. (m) |
|----------------|-----------------------------------|----------------------|-----------|----------------------|-------------------|-----------|-------------------|-----------------------|-----------|
| 34001 | 180.26 | 180.43 | 0.17 | 180.43 | 180.43 | 0.00 | 180.43 | 180.43 | 0.00 |
| 35002 | 180.32 | 180.48 | 0.16 | 180.48 | 180.48 | 0.00 | 180.48 | 180.48 | 0.00 |
| 35092.5 | Forrest Glade Drive | | | | | | | | |
| 35183 | na | 180.56 | na | 180.56 | 180.56 | 0.00 | 180.56 | 180.57 | 0.01 |
| 35404 | na | 108.56 | na | 180.56 | 180.56 | 0.00 | 180.56 | 180.57 | 0.01 |
| 36000 | 180.38 | 180.57 | 0.19 | 180.57 | 180.57 | 0.00 | 180.57 | 180.58 | 0.01 |
| 37500 | na | 180.62 | na | 180.62 | 180.62 | 0.00 | 180.62 | 180.63 | 0.01 |
| 39001 | 180.62 | 180.71 | 0.09 | 180.71 | 180.71 | 0.00 | 180.71 | 180.72 | 0.01 |
| 40302 | 180.72 | 180.82 | 0.10 | 180.82 | 180.82 | 0.00 | 180.82 | na | na |
| 40323 | na | 180.82 | na | 180.82 | 180.82 | 0.00 | 180.82 | 180.81 | -0.01 |
| 40573.5 | Hwy 2 | | | | | | | | |
| 40824 | na | 180.83 | na | 180.83 | 180.83 | 0.00 | 180.83 | 180.83 | 0.00 |
| 40845 | na | 180.84 | na | 180.84 | 180.84 | 0.00 | 180.84 | na | na |
| 41106 | na | 180.88 | na | 180.88 | 180.88 | 0.00 | 180.88 | 180.86 | -0.02 |
| 42000 | 180.86 | 180.97 | 0.11 | 180.97 | 180.97 | 0.00 | 180.97 | 180.96 | -0.01 |
| 43501 | 180.89 | 181.00 | 0.11 | 181.00 | 181.00 | 0.00 | 181.00 | 180.98 | -0.02 |
| 44302 | 180.91 | 181.01 | 0.10 | 181.01 | 181.01 | 0.00 | 181.01 | 181.00 | -0.01 |
| 44323 | na | 181.01 | na | 181.01 | 181.01 | 0.00 | 181.01 | 181.00 | -0.01 |
| 44704 | na | 181.02 | na | 181.02 | 181.02 | 0.00 | 181.02 | 181.01 | -0.01 |
| 45100 | na | 181.02 | na | 181.02 | 181.02 | 0.00 | 181.02 | 181.01 | -0.01 |
| 45601 | na | 181.07 | na | 181.07 | 181.07 | 0.00 | 181.07 | 181.06 | -0.01 |
| 46102 | 180.99 | 181.07 | 0.08 | 181.07 | 181.07 | 0.00 | 181.07 | 181.05 | -0.02 |
| 46152.5 | Lauzon Road (may no longer exist) | | | | | | | | |
| 46203 | na | 181.51 | na | 181.51 | 181.51 | 0.00 | 181.51 | 181.50 | -0.01 |
| 46304 | na | 181.52 | na | 181.52 | 181.52 | 0.00 | 181.52 | 181.51 | -0.01 |
| 47100 | na | 181.53 | na | 181.53 | 181.53 | 0.00 | 181.53 | 181.52 | -0.01 |
| 48000 | 181.36 | 181.53 | 0.17 | 181.53 | 181.53 | 0.00 | 181.53 | 181.52 | -0.01 |
| 48500 | na | 181.56 | na | 181.56 | 181.56 | 0.00 | 181.56 | 181.56 | 0.00 |
| 49000 | na | 181.57 | na | 181.57 | 181.57 | 0.00 | 181.57 | 181.57 | 0.00 |
| 50350 | na | 181.60 | na | 181.60 | 181.60 | 0.00 | 181.60 | 181.61 | 0.01 |
| 51701 | 181.54 | 181.63 | 0.09 | 181.63 | 181.63 | 0.00 | 181.63 | 181.65 | 0.02 |
| 52302 | 181.56 | 181.64 | 0.08 | 181.64 | 181.64 | 0.00 | 181.64 | 181.66 | 0.02 |
| 52352.5 | Railway | | | | | | | | |
| 52403 | na | 181.65 | na | 181.65 | 181.65 | 0.00 | 181.65 | 181.66 | 0.01 |
| 52804 | na | 181.73 | na | 181.73 | 181.73 | 0.00 | 181.73 | 181.74 | 0.01 |
| 54000 | na | 181.75 | na | 181.75 | 181.75 | 0.00 | 181.75 | 181.76 | 0.01 |
| 55200 | 181.67 | 181.77 | 0.10 | 181.77 | 181.77 | 0.00 | 181.77 | 181.78 | 0.01 |
| 56150 | na | 181.78 | na | 181.78 | 181.78 | 0.00 | 181.78 | 181.79 | 0.01 |
| 57100 | na | 181.78 | na | 181.78 | 181.78 | 0.00 | 181.78 | 181.79 | 0.01 |
| 59000 | 181.70 | 181.79 | 0.09 | 181.79 | 181.79 | 0.00 | 181.79 | 181.80 | 0.01 |
| 59201 | na | 181.81 | na | 181.81 | 181.81 | 0.00 | 181.81 | 181.82 | 0.01 |
| 59602 | 181.72 | 181.81 | 0.09 | 181.81 | 181.81 | 0.00 | 181.81 | 181.82 | 0.01 |
| 59652.5 | Lauzon Road | | | | | | | | |
| 59703 | na | 181.92 | na | 181.92 | 181.92 | 0.00 | 181.92 | 181.93 | 0.01 |
| 59804 | na | 181.92 | na | 181.92 | 181.92 | 0.00 | 181.92 | 181.93 | 0.01 |
| 61000 | 181.85 | 181.94 | 0.09 | 181.94 | 181.94 | 0.00 | 181.94 | 181.94 | 0.00 |
| 62301 | na | 181.98 | na | 181.98 | 181.98 | 0.00 | 181.98 | 181.98 | 0.00 |
| 62602 | 181.91 | 181.98 | 0.07 | 181.98 | 181.98 | 0.00 | 181.98 | 181.99 | 0.01 |
| 62622.5 | Unknown Structure | | | | | | | | |
| 62643 | na | 182.02 | na | 182.02 | 181.98 | -0.04 | 181.98 | 182.02 | 0.04 |
| 62804 | na | 182.02 | na | 182.02 | 182.01 | -0.01 | 182.01 | 182.05 | 0.04 |
| 66000 | 182.01 | 182.08 | 0.07 | 182.08 | 182.07 | -0.01 | 182.07 | 182.10 | 0.03 |
| 67250 | na | 182.10 | na | 182.10 | 182.09 | -0.01 | 182.09 | 182.12 | 0.03 |
| 68501 | 182.08 | 182.13 | 0.05 | 182.13 | 182.12 | -0.01 | 182.12 | 182.15 | 0.03 |
| 69002 | 182.12 | 182.14 | 0.02 | 182.14 | 182.14 | 0.00 | 182.14 | na | na |
| 69023 | na | 182.14 | na | 182.14 | 182.14 | 0.00 | 182.14 | 182.17 | 0.03 |
| 69118.5 | Lauzon Parkway | | | | | | | | |
| 69214 | na | 182.16 | na | 182.16 | 182.16 | 0.00 | 182.16 | 182.19 | 0.03 |
| 69235 | na | 182.17 | na | 182.17 | 182.16 | -0.01 | 182.16 | na | na |
| 69736 | 182.29 | 182.31 | 0.02 | 182.31 | 182.31 | 0.00 | 182.31 | 182.33 | 0.02 |
| 71000 | 182.34 | 182.34 | 0.00 | 182.34 | 182.34 | 0.00 | 182.34 | 182.36 | 0.02 |
| 72801 | 182.61 | 182.49 | -0.12 | 182.49 | 182.48 | -0.01 | 182.48 | 182.50 | 0.02 |
| 73102 | 182.63 | 182.49 | -0.14 | 182.49 | 182.49 | 0.00 | 182.49 | 182.51 | 0.02 |
| 73162.5 | County Road 42 | | | | | | | | |
| 73223 | na | 182.88 | na | 182.88 | 182.87 | -0.01 | 182.87 | 182.65 | -0.22 |
| 73404 | 182.87 | 182.93 | 0.06 | 182.93 | 182.93 | 0.00 | 182.93 | 182.83 | -0.10 |
| 75800 | na | 183.00 | na | 183.00 | 183.00 | 0.00 | 183.00 | 182.92 | -0.08 |
| 77000 | na | 183.06 | na | 183.06 | 183.06 | 0.00 | 183.06 | 182.99 | -0.07 |
| 78201 | na | 183.18 | na | 183.18 | 183.18 | 0.00 | 183.18 | 183.14 | -0.04 |
| 78502 | 183.19 | 183.24 | 0.05 | 183.24 | 183.24 | 0.00 | 183.24 | 183.20 | -0.04 |
| 78527.5 | Unknown Structure | | | | | | | | |
| 78553 | na | 183.31 | na | 183.31 | 183.31 | 0.00 | 183.31 | 183.27 | -0.04 |
| 78704 | na | 183.33 | na | 183.33 | 183.32 | -0.01 | 183.32 | 183.29 | -0.03 |
| 80600 | na | 183.51 | na | 183.51 | 183.51 | 0.00 | 183.51 | 183.48 | -0.03 |
| 82500 | 183.82 | 183.68 | -0.14 | 183.68 | 183.68 | 0.00 | 183.68 | 183.66 | -0.02 |
| 83950 | na | 183.82 | na | 183.82 | 183.82 | 0.00 | 183.82 | 183.80 | -0.02 |
| 85401 | 184.07 | 183.95 | na | 183.95 | 183.95 | 0.00 | 183.95 | 183.93 | -0.02 |
| 85702 | 184.08 | 183.94 | na | 183.94 | 183.94 | 0.00 | 183.94 | 183.93 | -0.01 |
| 85752.5 | Baseline Road | | | | | | | | |
| 85803 | na | 184.14 | na | 184.14 | 184.14 | 0.00 | 184.14 | 184.19 | 0.05 |
| 86104 | na | 184.39 | na | 184.39 | 184.39 | 0.00 | 184.39 | 184.44 | 0.05 |
| 86400 | 184.35 | 184.40 | 0.05 | 184.40 | 184.40 | 0.00 | 184.40 | 184.45 | 0.05 |
| 87700 | na | 184.43 | na | 184.43 | 184.43 | 0.00 | 184.43 | 184.47 | 0.04 |
| 89500 | 184.54 | 184.52 | -0.02 | 184.52 | 184.49 | -0.03 | 184.49 | 184.52 | 0.03 |
| 94000 | 185.21 | 185.09 | -0.12 | 185.09 | 185.09 | 0.00 | 185.09 | 185.09 | 0.00 |

Table 4 - Flood Elevation Comparison for Pike Creek (100yr Flood)

| Section Number | HEC-2 Mapping (m) | HEC-2 Paper Copy (m) | Diff. (m) | HEC-2 Paper Copy (m) | HEC-2 Digital (m) | Diff. (m) | HEC-2 Digital (m) | HEC-RAS Converted (m) | Diff. (m) |
|----------------|--------------------|----------------------|-----------|----------------------|-------------------|-----------|-------------------|-----------------------|-----------|
| 1 | 586.30 | 586.30 | 0.00 | 586.30 | 586.30 | 0.00 | 178.70 | 178.70 | 0.00 |
| 3 | 587.90 | 587.90 | 0.00 | 587.90 | 587.87 | -0.03 | 179.18 | 179.20 | 0.02 |
| 3.1 | na | 587.93 | na | 587.93 | 587.90 | -0.03 | 179.19 | 179.21 | 0.02 |
| 3.15 | County Road 42 | | | | | | | | |
| 3.2 | na | 587.95 | na | 587.95 | 587.92 | -0.03 | 179.20 | 179.22 | 0.02 |
| 3.3 | 588.00 | 587.98 | -0.02 | 587.98 | 587.95 | -0.03 | 179.21 | 179.22 | 0.01 |
| 4 | 588.90 | 588.93 | 0.03 | 588.93 | 588.91 | -0.02 | 179.50 | 179.51 | 0.01 |
| 4.1 | na | 589.09 | na | 589.09 | 589.07 | -0.02 | 179.55 | 179.56 | 0.01 |
| 4.15 | Manning Road | | | | | | | | |
| 4.2 | na | 589.24 | na | 589.24 | 589.22 | -0.02 | 179.59 | 179.61 | 0.02 |
| 4.3 | 589.70 | 589.73 | 0.03 | 589.73 | 589.72 | -0.01 | 179.75 | 179.76 | 0.01 |
| 5 | 592.50 | 592.53 | 0.03 | 592.53 | 592.52 | -0.01 | 180.60 | 180.60 | 0.00 |
| 5.1 | na | 592.86 | na | 592.86 | 592.76 | -0.10 | 180.67 | 180.68 | 0.01 |
| 5.15 | Concession Road 12 | | | | | | | | |
| 5.2 | na | 592.79 | na | 592.79 | 592.78 | -0.01 | 180.68 | 180.68 | 0.00 |
| 5.3 | 592.80 | 592.78 | -0.02 | 592.78 | 592.77 | -0.01 | 180.68 | 180.68 | 0.00 |
| 6 | 596.20 | 596.21 | 0.01 | 596.21 | 596.20 | -0.01 | 181.72 | 181.72 | 0.00 |
| 6.1 | | 596.34 | 596.34 | 596.34 | 596.35 | 0.01 | 181.77 | 181.77 | 0.00 |
| 6.15 | Concession Road 12 | | | | | | | | |
| 6.2 | na | 596.36 | na | 596.36 | 596.37 | 0.01 | 181.77 | 181.77 | 0.00 |
| 6.3 | 596.40 | 596.37 | -0.03 | 596.37 | 596.38 | 0.01 | 181.78 | 181.78 | 0.00 |
| 7 | 597.00 | 596.99 | -0.01 | 596.99 | 596.99 | 0.00 | 181.96 | 181.97 | 0.01 |
| 9 | 599.00 | 599.02 | 0.02 | 599.02 | 599.02 | 0.00 | 182.58 | 182.58 | 0.00 |
| 9.1 | na | 599.07 | na | 599.07 | 599.07 | 0.00 | 182.60 | 182.60 | 0.00 |
| 9.15 | Baseline Road | | | | | | | | |
| 9.2 | 599.10 | 599.09 | -0.01 | 599.09 | 599.09 | 0.00 | 182.60 | 182.60 | 0.00 |
| 11 | 600.10 | 600.07 | -0.03 | 600.07 | 599.82 | -0.25 | 182.83 | 182.83 | 0.00 |
| 13 | na | 601.90 | na | 601.90 | 601.99 | 0.09 | 183.49 | 183.50 | 0.01 |

Table 5 - Flood Elevation Comparison for Kerr Creek (100yr Flood)

| Section Number | HEC-2 Mapping (m) | HEC-2 Paper Copy (m) | Diff. (m) | HEC-2 Paper Copy (m) | HEC-2 Digital (m) | Diff. (m) | HEC-2 Digital (m) | HEC-RAS Converted (m) | Diff. (m) |
|----------------|-------------------|----------------------|-----------|----------------------|-------------------|-----------|-------------------|-----------------------|-----------|
| 1 | 585.30 | 585.30 | 0.00 | 585.30 | 585.30 | 0.00 | 178.40 | 178.40 | 0.00 |
| 2 | 587.50 | 587.53 | 0.03 | 587.53 | 587.53 | 0.00 | 179.08 | 179.17 | 0.09 |
| 3 | 590.90 | 590.90 | 0.00 | 590.90 | 590.91 | 0.01 | 180.11 | 180.10 | -0.01 |
| 3.1 | na | 590.51 | na | 590.51 | 590.77 | 0.26 | 180.07 | 180.06 | -0.01 |
| 3.15 | County Road 42 | | | | | | | | |
| 3.2 | na | 591.12 | na | 591.12 | 591.41 | 0.29 | 180.26 | 180.23 | -0.03 |
| 3.3 | 591.80 | 591.77 | -0.03 | 591.77 | 592.02 | 0.25 | 180.45 | 180.42 | -0.03 |
| 4 | 593.30 | 593.28 | -0.02 | 593.28 | 593.28 | 0.00 | 180.83 | 180.84 | 0.01 |
| 4.1 | na | 594.49 | na | 594.49 | 594.49 | 0.00 | 181.20 | 181.20 | 0.00 |
| 4.15 | Concession Road 9 | | | | | | | | |
| 4.2 | na | 594.83 | na | 594.83 | 594.84 | 0.01 | 181.31 | 181.30 | -0.01 |
| 4.3 | 595.30 | 595.25 | -0.05 | 595.25 | 595.25 | 0.00 | 181.43 | 181.43 | 0.00 |

Table 6 - Flood Elevation Comparison for Puce River (100yr Flood)

| Section Number | HEC-2 Mapping (m) | HEC-2 Paper Copy (m) | Diff. (m) | HEC-2 Paper Copy (m) | HEC-2 Digital (m) | Diff. (m) | HEC-2 Digital (m) | HEC-RAS Converted (m) | Diff. (m) |
|----------------|-------------------|----------------------|-----------|----------------------|-------------------|-----------|-------------------|-----------------------|-----------|
| 9 | na | 581.50 | na | 581.50 | 581.50 | 0.00 | 177.24 | 177.24 | 0.00 |
| 10 | 581.90 | 581.87 | -0.03 | 581.87 | 581.87 | 0.00 | 177.35 | 177.36 | 0.01 |
| 11 | na | 582.12 | na | 582.12 | 582.12 | 0.00 | 177.43 | 177.44 | 0.01 |
| 11.1 | na | 582.07 | na | 582.07 | 582.07 | 0.00 | 177.41 | 177.42 | 0.01 |
| 11.15 | Railway | | | | | | | | |
| 11.2 | na | 582.06 | na | 582.06 | 582.06 | 0.00 | 177.41 | 177.42 | 0.01 |
| 12 | 581.90 | 582.39 | 0.49 | 582.39 | 582.39 | 0.00 | 177.51 | 177.52 | 0.01 |
| 13 | 584.30 | 584.30 | 0.00 | 584.30 | 584.31 | 0.01 | 178.10 | 178.10 | 0.00 |
| 14 | 586.40 | 586.37 | -0.03 | 586.37 | 586.37 | 0.00 | 178.73 | 178.73 | 0.00 |
| 14.1 | na | 586.42 | na | 586.42 | 586.42 | | 178.74 | 178.74 | 0.00 |
| 14.15 | County Rd 42 | | | | | | | | |
| 14.2 | na | 586.44 | na | 586.44 | 586.44 | 0.00 | 178.75 | 178.76 | 0.01 |
| 14.3 | | 586.51 | na | 586.51 | 586.50 | -0.01 | 178.77 | 178.77 | 0.00 |
| 14.4 | 586.70 | 586.66 | -0.04 | 586.66 | 586.65 | -0.01 | 178.81 | 178.81 | 0.00 |
| 15 | 590.00 | 589.99 | -0.01 | 589.99 | 589.99 | 0.00 | 179.83 | 179.83 | 0.00 |
| 15.1 | na | 590.32 | na | 590.32 | 590.32 | 0.00 | 179.93 | 179.93 | 0.00 |
| 16 | 593.00 | 592.98 | -0.02 | 592.98 | 592.98 | 0.00 | 180.74 | 180.75 | 0.01 |
| 16.1 | 594.10 | 594.09 | -0.01 | 594.09 | 594.09 | 0.00 | 181.08 | 181.09 | 0.01 |
| 16.2 | 595.60 | 595.59 | -0.01 | 595.59 | 595.59 | 0.00 | 181.54 | 181.54 | 0.00 |
| 17 | 597.20 | 597.18 | -0.02 | 597.18 | 597.18 | 0.00 | 182.02 | 182.02 | 0.00 |
| 17.1 | 598.20 | 598.20 | 0.00 | 598.20 | 598.20 | 0.00 | 182.33 | 182.34 | 0.01 |
| 17.2 | 599.60 | 599.63 | 0.03 | 599.63 | 599.63 | 0.00 | 182.77 | 182.78 | 0.01 |
| 18 | 600.50 | 600.46 | -0.04 | 600.46 | 600.46 | 0.00 | 183.02 | 183.03 | 0.01 |

5.0 SUMMARY

This report documents the existing drainage conditions for the Class Environmental Assessment Study to address the future requirements for Lauzon Parkway, prepared by MRC on behalf of the Ontario Ministry of Transportation, the City of Windsor and the County of Essex. The following section provides a summary of the key findings and recommendations.

A site reconnaissance was carried out in May 2011. As noted in the Culvert Inspection Report (MRC, 2011) included in Appendix A, the majority of the inspected culverts are in good condition. Of the 42 culverts assessed during the site reconnaissance, five (5) were found to be in poor condition:

- LC 2 was corroded at the downstream end, and the culvert barrel was in poor condition;
- LC 3 was deformed/crushed at the upstream and downstream ends;
- LC 9 was crushed, cracked, and the pipe barrel was rusty where visible;
- LC 16 was corroded at the downstream end on the culvert bottom; and
- LC 17 was broken and corroded at the upstream end, and the downstream end had a hole through the bottom of the culvert and was angled upwards.

Four (4) were found to be in poor to fair condition:

- LC 14 inlet CSP pipe from south is connected to the CB, and was in poor condition, downstream end in good condition;
- LC 15 inlet CSP pipe from south is connected to the CB, and was in poor condition (rusty and deformed), and downstream end was rusty;
- XC 8 culvert barrel was in poor to fair condition; and
- XC9 was rusty and deformed at both ends.

Culverts DC2 was found to be in fair condition. The remaining culverts are in good condition.

The above assessments are based only on the observations of the site reconnaissance. A comprehensive hydraulic assessment could not be carried out at this time due to limited available information, and as such this report does not include an assessment based on hydraulic capacities.

Hydraulic modelling was carried out for the relevant crossings of the Little River, Pike River, Kerr Drain, and Puce River within the proposed work limits. Hydraulic modelling of the Little River, Pike River, Kerr Drain, Puce River, and 8th Concession Drain was provided by the Essex Region Conservation Authority in PDF format. The Hec-2 hard copy printouts were compared to the available floodplain mapping elevations, and were scanned and ultimately formatted into Hec-Ras working models for four of the major crossings. Assumptions were made for some of the station information and flow data provided, and some modifications were made to the original data to correspond to modelling input required by Hec-Ras. Summaries of the comparisons of the various stages of the model conversion from PDF format to Hec-Ras format are provided in this report. Hydraulic modelling output is included in Appendix B of this report.

As presented in this report, there were no cases of road overtopping under existing conditions for the 100-year storm. Only one culvert (DB1 – Pike Creek) currently meets the freeboard criteria. Only 3 of the culverts (R4 – Little River, LB1 – Little River, and DB1 – Pike Creek) currently meet the soffit clearance criteria.

Exhibit 1 – Key Map

Exhibit 2 – Existing Drainage Conditions – Map 1

Exhibit 3 – Existing Drainage Conditions – Map 2

Exhibit 4 – Existing Drainage Conditions – Map 3

Exhibit 5 – Existing Drainage Conditions – Map 4

Exhibit 6 – Existing Drainage Conditions – Map 5

Exhibit 7 – Existing Drainage Conditions – Map 6

Exhibit 8 – Existing Drainage Conditions – Map 7

Exhibit 9 – Existing Drainage Conditions – Map 8

Exhibit 10 – Existing Drainage Conditions – Map 9

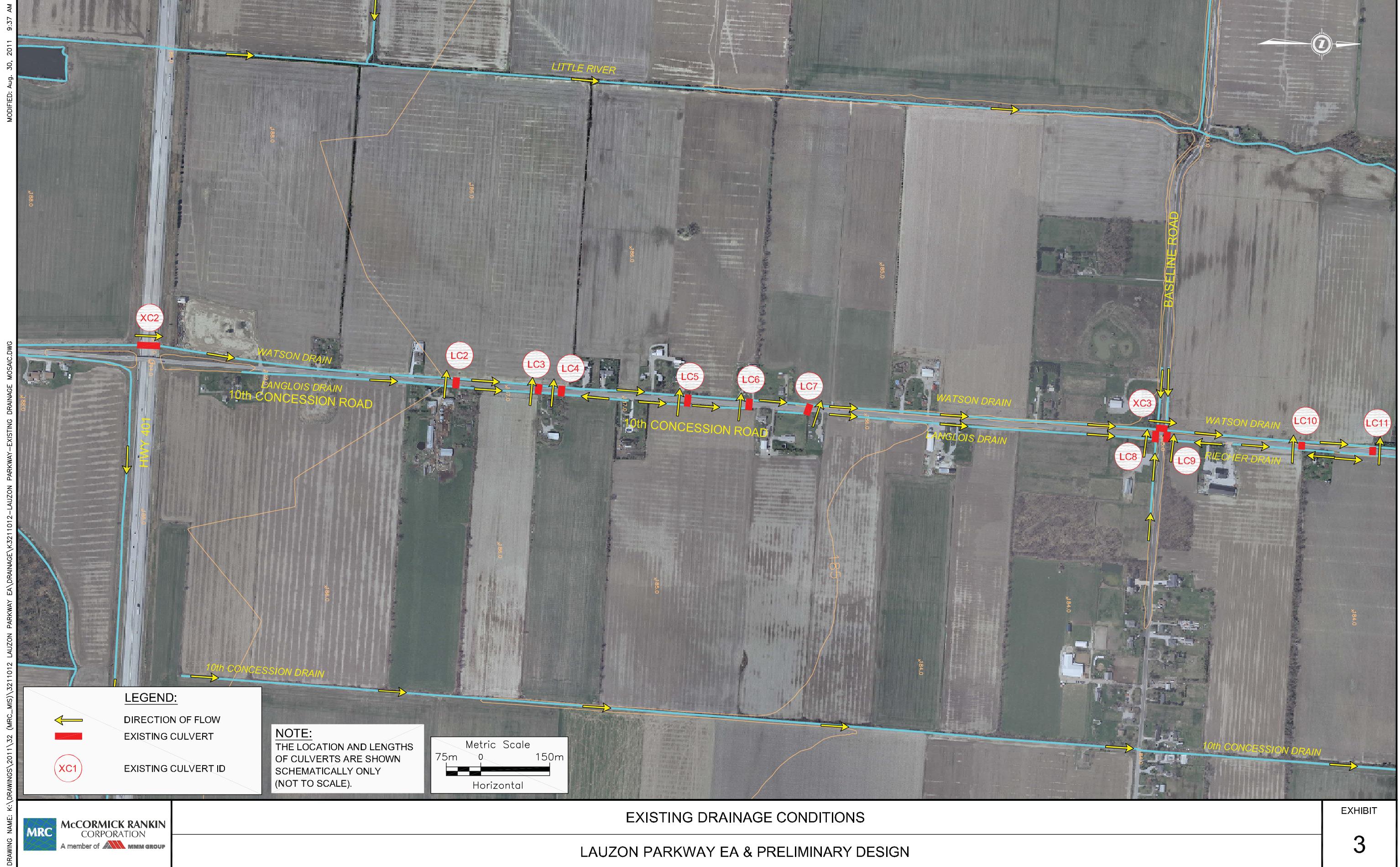
Exhibit 11 – Floodplain Mapping and Hec-2 Information





EXISTING DRAINAGE CONDITIONS

LAUZON PARKWAY EA & PRELIMINARY DESIGN





EXISTING DRAINAGE CONDITIONS

LAUZON PARKWAY EA & PRELIMINARY DESIGN





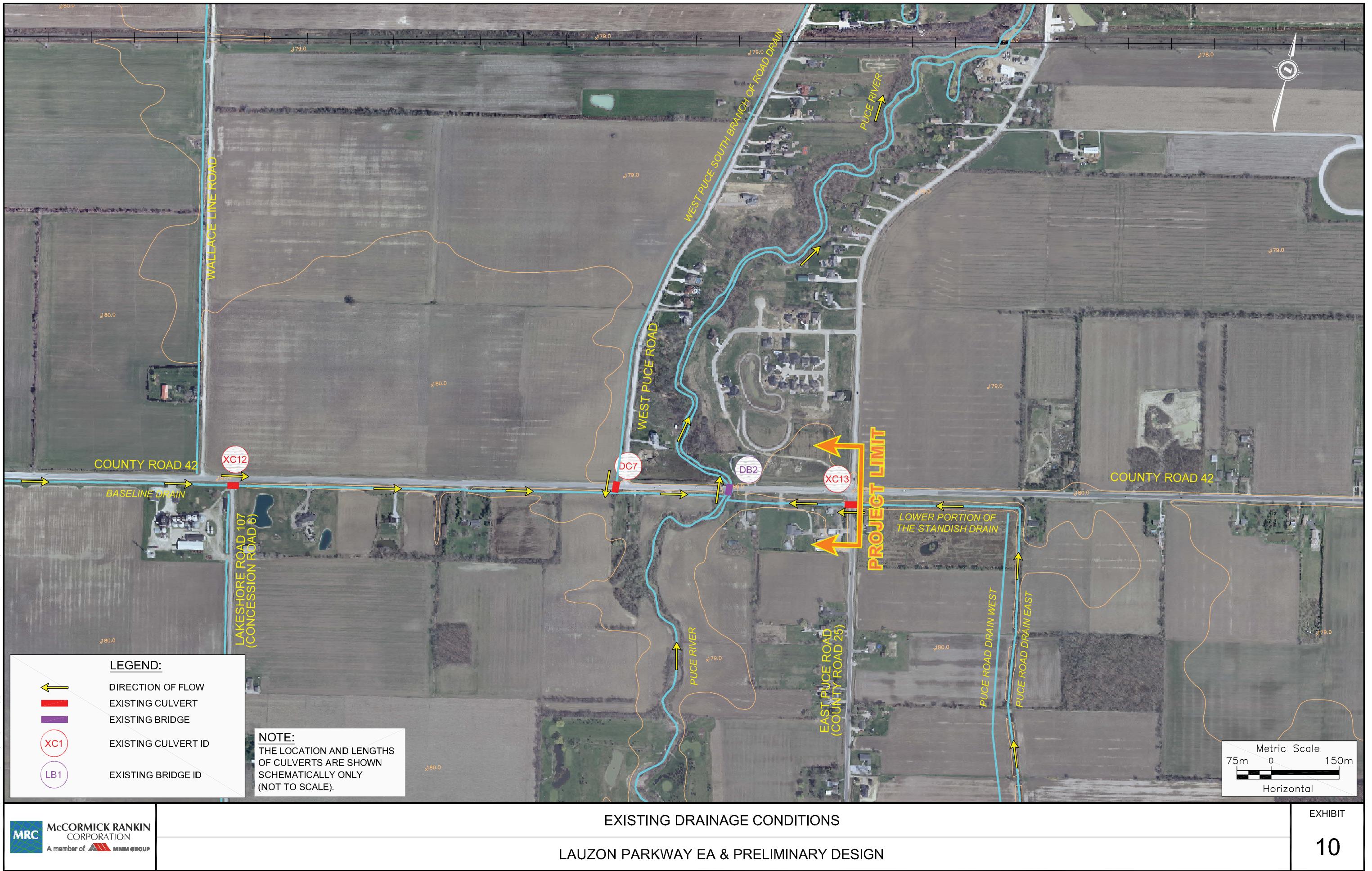
EXISTING DRAINAGE CONDITIONS

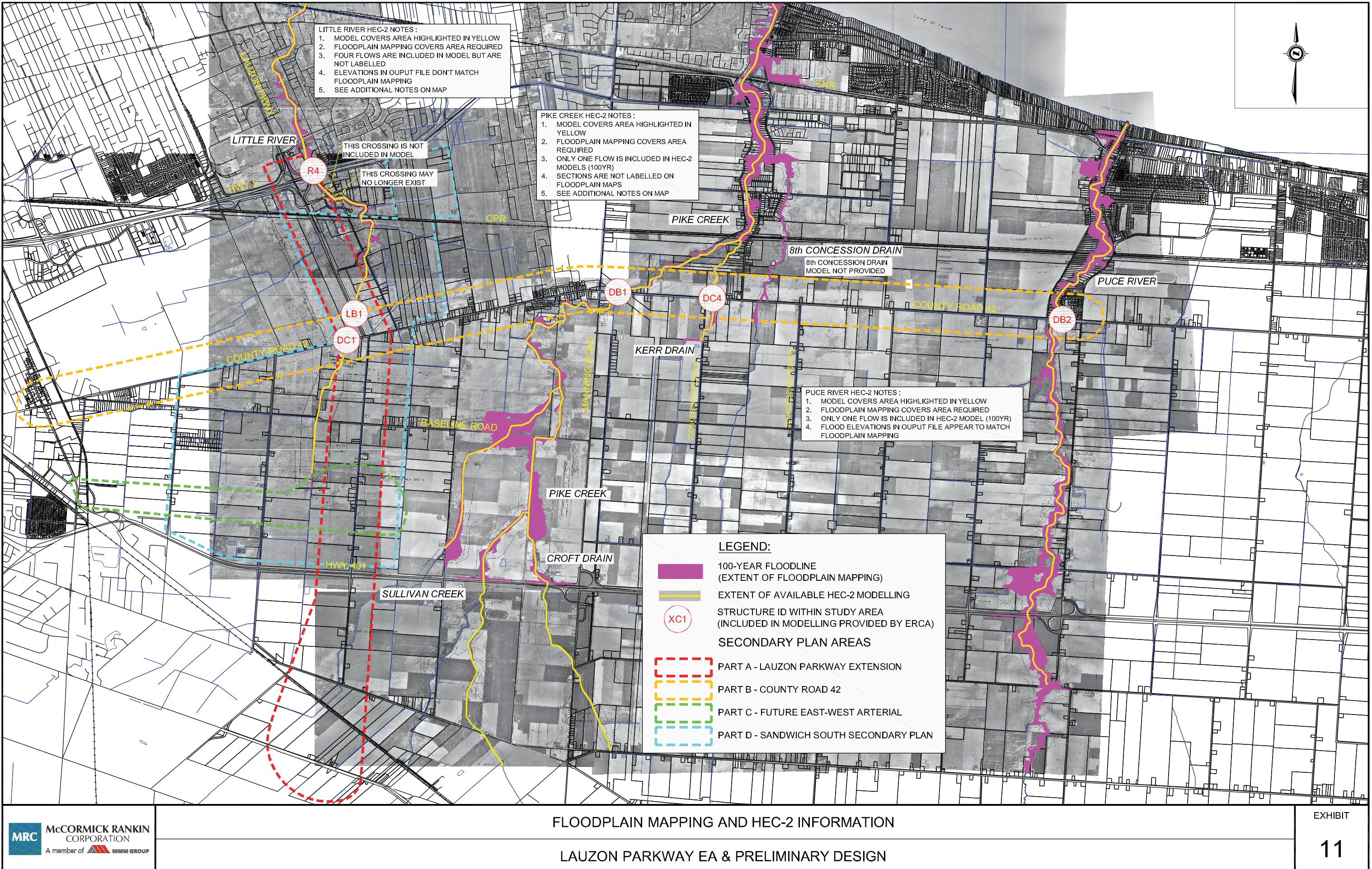
LAUZON PARKWAY EA & PRELIMINARY DESIGN











APPENDIX A

Culvert Inspection Report



LAUZON PARKWAY IMPROVEMENTS CLASS ENVIRONMENTAL ASSESSMENT

G.W.P. 3117-09-00

CULVERT INSPECTION REPORT FINAL



A member of MMM GROUP

Global
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Engineering

McCORMICK RANKIN CORPORATION

November 2013



LAUZON PARKWAY IMPROVEMENTS CLASS ENVIRONMENTAL ASSESSMENT

G.W.P. 3117-09-00

CULVERT INSPECTION REPORT FINAL



A member of **MMM GROUP**

November 2013

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| APPENDIX A | SITE PHOTGRAPHS |
| APPENDIX B | EXHIBITS 1 TO 27 |

1. INTRODUCTION

The Ontario Ministry of Transportation, the City of Windsor and the County of Essex have initiated a Class Environmental Assessment Study to address the future requirements for Lauzon Parkway. The study has the following main components as follows:

- the environmental assessment study for:
 - Lauzon Parkway from E.C. Row Expressway to County Road 42;
 - Lauzon Parkway's extension to Highway 401; and
 - Lauzon Parkway's further extension to Highway 3.
 - County Road 42 from Walker Road to County Road 25; and
 - the future east-west arterial from Walker Road to Essex County Road 17.
- the preparation and approval of a Secondary Plan for the remainder of the lands transferred to the City of Windsor in 2003 (lands are generally bounded by the CPR mainline north of the Windsor International Airport, Lauzon Parkway and the 8th Concession Road, and the City of Windsor boundary).

This culvert inspection report documents the findings of the site reconnaissance carried out by McCormick Rankin Corporation (MRC) and RC Spencer Associates staff from May 4 to 5, 2011. Additionally, the report provides recommendations for culvert rehabilitation or replacement.

The purpose of the site investigation was to determine the physical characteristics and conditions of the transverse and sideroad culverts and to characterize the conditions of the surrounding drainage features. A photographic inventory of the transverse and sideroad culverts along with the characteristics of the drainage systems both upstream and downstream of the culverts was compiled during the site visit.

1.1 Scope of Work

The following tasks were completed in preparing this report:

- Review of existing and relevant background information. This includes consultation with Essex Region Conservation Authority (ERCA) staff to identify any drainage related deficiencies within the study area;
- Confirmation of the size, type, condition, and location of all existing transverse and sideroad culverts within the study limits;
- Photographic inventory of the existing transverse culverts and characteristics of the drainage systems both upstream and downstream of the culverts. This includes photographic inventory of three bridges at Little River, Pike River and Puce River;
- Inspection of road ditches with respect to sedimentation and erosion;

- Confirmation of the location of drainage area divides along the road and side roads were needed to confirm the culvert contributing drainage boundaries;
- Recommendations for each existing culvert based on observed physical conditions; and
- Identification of any required remedial drainage works along Lauzon Parkway and County Road 42.

1.2 Background Information

Several municipal drain reports and MTO contract drawings (WP No. 259-66-25) were consulted to review and/or confirm the existing culvert locations, their physical characteristics and drainage area divides along the roads. Other relevant background information reviewed during the preparation of this report includes:

- Drainage features from the Ontario Base Maps (OBMs) data base for the study area; and
- Aerial photographs.

MRC staff contacted the Essex Region Conservation Authority (ERCA) to enquire about identified drainage related issues within the study area. ERCA staff indicated that the only issue was related to the occurrence of ice jams and blockages at various locations (usually at the bridge crossings) of the north shore watercourses which are located outside of the study area. ERCA also indicated that flooding has taken place at low lying areas as characterized by the ERCA floodline mapping.

Staff from the Town of Lakeshore noted that for their section of County Road 42, surface water drainage along the roadway has been an issue; and that overland flows overtopped the existing road on numerous occasions in the past.

2. CULVERT INSPECTION

The culverts were visually inspected by MRC and RC Spencer Associates staff on May 4 to 5, 2011. [Appendix A](#) provides the photographic inventory for each inspected culvert and related drainage characteristics.

The overall intent of the culverts inspection was to carry out an assessment of the existing drainage infrastructure (culverts, ditches, catchbasins, scour/erosion at bridge locations, etc.) along Lauzon Parkway and County Road 42 within the project limits, to identify drainage related deficiencies, and prioritize remedial drainage works. The culvert inspection included, but was not limited to, culvert location, type, size, physical condition, erosion sites and relevant drainage characteristics surrounding the culvert.

As shown in [Exhibits 1 to 27 \(provided in Appendix B\)](#), a total of twenty-six (26) transverse culverts and sixteen (16) sideroad culverts were inspected within the study area. In addition, three bridges (Little River, Pike River and Puce River) were inspected for scour and/or erosion.

Nineteen (19) of the twenty-six (26) transverse culverts are located beneath Lauzon Parkway, and seven (7) transverse culverts are located beneath County Road 42. The transverse and sideroad culvert locations are described in [Table 1](#).

[Table 1](#) also summarizes the physical characteristics of the transverse and sideroad culverts along with a description and location of the erosion sites.

Several of the inspected circular culverts located beneath 10th Concession Road, south of County Road 42, (particularly the pipe outlet to Watson Drain from the Langlois and Riecher Drains) were observed to have significant sediment build-up and/or blockages, poor structural condition, and/or potential drainage deficiencies. The majority of the inspected concrete box culverts, located beneath Lauzon Parkway, are in good condition. In general, the majority of the inspected concrete box culverts, located beneath County Road 42, are in fair to good condition although a number of culverts exhibit spalling and scaling at the culvert ends.

There is a severe scour hole under a catchbasin (deck drainage) located on the west end of the County Road 17 (10th Concession Road) bridge over Highway 401. This catchbasin outlets to Watson Drain. The catchbasin and wooden guardrail are exposed. The outlet pipe is detached from the catchbasin. Standing water was observed at the bottom of the scour hole beside the catchbasin.

The culvert ends and upstream and downstream ditches of the concrete box culverts located at the interchange between Lauzon Parkway and EC Row Expressway are covered/obstructed by dense stands of cattails with the exception of the culvert under the S-E Ramp. These culverts convey flows easterly along the Russette Drain which discharges to the Little River.

Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations – Lauzon Parkway EA

| LAUZON PARKWAY (COUNTY ROAD 17 AND COUNTY ROAD 117) – From Canada South Railway to EC Row Expressway | | | | | | | |
|--|--|----------------------------------|----------------------------|--|--|--|--|
| Culvert I.D. | Location | Culvert Size (mm) ⁽¹⁾ | Culvert Type | Observations from Site Reconnaissance: Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | | | |
| <i>Culverts Conveying Flows along Sullivan Drain</i> | | | | | | | |
| | | | | | | | |
| XC1 | Under Middle Road (approximately 60m west of County Rd 17) Photographs PXCL1 – 1 thru 2 | Twin-2000 | CSP (With headwalls) | <ul style="list-style-type: none"> • Visible portion of culverts barrel in good conditions • 0.36m water depth at downstream end of culvert • Water flowing north • No erosion was observed | | | |
| LC1 | Under County Road 17 (approximately 570m north of Middle Road) Photographs PLC1 – 1 thru 2 | 3600 x 1500 | Concrete (Open footing) | <ul style="list-style-type: none"> • Visible portion of culvert pipe from east at downstream side • 0.20m water depth upstream of culvert • Water flowing northerly • No erosion was observed • 600mm and 750mm CSP outlet pipes from south at the upstream and downstream sides | | | |
| <i>Culverts Discharging to and Conveying Flows along Watson Drain</i> | | | | | | | |
| | | | | | | | |
| XC2 | Under Highway 401 (West side of County Road 17) Photographs PXCL2 – 1 thru 2 | 1500 x 1670 | Concrete | <ul style="list-style-type: none"> • Visible portion of culvert barrel in good conditions • 0.10m water depth at downstream end of culvert • Water flowing north • No erosion was observed | | | |
| LC2 | Under County Road 17 (south of House #4776 entrance) Photographs PLC2 – 1 thru 4 | 450 | CSP | <ul style="list-style-type: none"> • Culvert barrel in poor conditions. Perched culvert • Downstream end of culvert is corroded • Road embankment slumped on culvert at the upstream end • Erosion was observed around pipe at the upstream end • Bank erosion adjacent to pipe at downstream end • Insufficient erosion blanket protection on the opposite bank | | | |
| LC3 | Under County Road 17 (approximately 175m north of Culvert LC2) Photographs PLC3 – 1 thru 4 | 400 | CSP | <ul style="list-style-type: none"> • Downstream and upstream ends of culvert barrel is deformed/crushed • Perched culvert • At the downstream side, erosion was observed on channel slope just north of pipe • Insufficient riprap protection around pipe at the downstream side • Insufficient erosion blanket protection on the opposite bank | | | |
| LC4 | Under County Road 17 (approximately 45m north of Culvert LC3) Photographs PLC4 – 1 thru 4 | 450 | CSP | <ul style="list-style-type: none"> • Downstream end of culvert is slightly crushed • Upstream end of culvert barrel in fair to good conditions • Perched culvert • At the downstream side, erosion was observed on channel slope around pipe • At the downstream side, erosion blanket failure on the opposite bank | | | |
| LC5 | Under County Road 17 (approximately 275m north of Culvert LC4) Photographs PLC5 – 1 thru 3 | 350 | CSP | <ul style="list-style-type: none"> • Visible portion of pipe barrel in good conditions • Upstream end of pipe was not found. Pipe may be the outlet of a tiled system • Perched pipe • At the downstream side, erosion was observed on channel slope north of pipe | | | |
| LC6 | Under County Road 17 (approximately 140m north of Culvert LC5) Photographs PLC6 – 1 thru 2 | 200 | Solid Big 'O' | <ul style="list-style-type: none"> • Pipe in good conditions • Upstream end of pipe was not found. Pipe may be the outlet of a tiled system • Perched pipe | | | |

Notes:

1 - Measured culvert size during site reconnaissance

Notes:
1- Measured culvert size during site reconnaissance

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Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations (Cont'd) – Lauzon Parkway EA

| Culvert I.D. | Location | Culvert Size (mm) ⁽¹⁾ | Culvert Type | Observations from Site Reconnaissance: Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | |
|--------------|---|----------------------------------|--------------|---|--|
| | | | | • Downstream end of culvert is slightly crushed | • Upstream end of culvert barrel in fair to good conditions |
| LC7 | Under County Road 17 (approximately 133m north of Culvert LC6) Photographs PLC7 – 1 thru 6 | 600 | CSP | • At the downstream side, erosion was observed on channel slope north of pipe | • At the downstream side, erosion blanket failure on the opposite bank. Localized channel slope failure north of pipe (adjacent to field entrance) |
| LC8 | Under County Road 17 (south side of Baseline Road) Photographs PLC8 – 1 thru 2 | 1600 x 1900 | Concrete | • Culvert in good conditions | • Downstream end connected to 1950mm CSP pipe (Culvert XC3) • Flowing water entering the culvert from east • Road embankment slumped on south side culvert bottom • Culvert LC8 is one of the outlet of Langlois Drain |
| LC9 | Under County Road 17 (north side of Baseline Road) Photographs PLC9 – 1 thru 2 | 500 | CSP | • Visible portion of culvert in poor conditions. Crushed, cracked and rusty pipe barrel | • Downstream end connected to 1950mm CSP pipe (Culvert XC3) • No flow observed • Culvert LC9 is one of the outlet of Riecher Drain |
| XC3 | Under Baseline Road on west side of County Road 17 Photographs PXC3 – 1 thru 3 | 1970 | CSP | • Upstream and downstream bottom of culvert barrel slightly rusty | • Water flowing northerly • 500mm and 525mm diameter CSP inlet pipes. These pipes convey flows easterly to Culvert XC3 from the ditches located on both sides of Baseline Road • Erosion on east channel slope at the upstream side • Erosion blanket failure/deteriorated on west channel slope at the upstream side |
| LC10 | Under County Road 17 (approximately 310m north of Baseline Road) Photographs PLC10 – 1 thru 4 | 400 | CSP | • Pipe barrel in good condition | • Perched pipe • Slight channel slope erosion above pipe • Upstream end of pipe barrel in fair to good conditions |
| LC11 | Under County Road 17 (approximately 155m north of Culvert LC10) Photographs PLC11 – 1 thru 4 | 450 | CSP | • Large and severe channel bank failure/collapsed just south of Culvert LC10 | • Large and severe channel bank failure/collapsed just south of Culvert LC10 • Upstream end of pipe is crushes and cracked • Perched pipe • Slight channel slope erosion above pipe • Erosion blanket failure/deteriorated on west channel slope at the downstream side |
| LC12 | Under County Road 17 (approximately 300m north of Culvert LC11) Photographs PLC12 – 1 thru 2 | 400 | CSP | • Downstream end of pipe barrel in good condition | • Old style "CB" without cover at upstream side. Concrete tiles stacked around top of "CB" • Perched pipe (downstream end) • Slight channel slope erosion above pipe |
| LC13 | Under County Road 17 (approximately 60m north of Culvert LC12) Photographs PLC13 – 1 thru 2 | 300 | PVC | • Downstream end of pipe barrel in good condition | • Upstream end of pipe was not found. Pipe may be the outlet of a tiled system • Perched pipe (downstream end) • Slight erosion under pipe |

Notes:

1- Measured culvert size during site reconnaissance

Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations (Cont'd) – Lauzon Parkway EA

| Culvert I.D. | Location | Culvert Size (mm) (^①) | Culvert Type | Observations from Site Reconnaissance: Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | | | |
|---|---|---------------------------------------|--------------------------|--|--|--|--|
| | | | | | | | |
| <i>Culverts Discharging to and Conveying Flows along Watson Drain</i> | | | | | | | |
| LC14 | Under County Road 17 (approximately 110m north of Culvert LC13) Photographs PLC14 – 1 thru 4 | 300 & 450 (from CB) | CSP's | <ul style="list-style-type: none"> Downstream end of 300mm pipe barrel in good condition Downstream end of 450mm pipe barrel slightly deformed The two 300mm and 450mm CSP pipes are connected to a CB located on the other side of road 300mm inlet CSP pipe from south is connected to the CB. This pipe is in poor conditions | | | |
| LC15 | Under County Road 17 (approximately 290m north of Culvert LC14) Photographs PLC15 – 1 thru 3 | 450 | CSP | <ul style="list-style-type: none"> Downstream pipe bottom is rusty Upstream side of pipe connected to a CB 400mm inlet CSP pipe from south is connected to the CB. This pipe is in poor conditions (rusty and deformed) | | | |
| LC16 | Under County Road 17 (approximately 23m north of Culvert LC16) Photographs PLC16 – 1 thru 2 | 250 | CSP | <ul style="list-style-type: none"> Downstream pipe bottom is corroded Perched pipe (downstream side) Upstream side of pipe connected to a CB | | | |
| <i>Culvert Discharging to Little River</i> | | | | | | | |
| LB1 | Bridge Structure at Little River Photographs PLB1 – 1 thru 4 | n/a | n/a | <ul style="list-style-type: none"> No erosion or scour was observed | | | |
| LC17 | Under County Road 17 (approximately 50m north of Bridge LB1) Photographs PLC17 – 1 thru 2 | 1350 | CSP | <ul style="list-style-type: none"> Upstream end of culvert barrel is in poor conditions. Broken and corroded bottom. Upstream end of culvert barrel is in poor conditions. Hole in bottom. End of pipe tilted up. Beveled ends (upstream and downstream) Culvert conveys flows along Rivard Drain to Little River | | | |
| <i>Culvert Conveying Flows along McGill Drain</i> | | | | | | | |
| LC18 | Under County Road 117 (approximately 300m south of railway tracks) Photographs PLC18 – 1 thru 4 | 3100 x 3100 | Concrete (wing walls) | <ul style="list-style-type: none"> Culvert in good conditions Downstream channel is 6.5m wide, 2.8m bottom width 1.6m deep 0.25m water depth at downstream end 1800mm iron pipe located just upstream of culvert Water flowing northerly CB on west side of Lauzon Parkway is full of sediment | | | |
| <i>Culvert Conveying Flows along Russette Drain</i> | | | | | | | |
| R1 | Under EC Row Expressway W-S Ramp Photographs PR1 – 1 thru 2 | Twin-1800 x 1850 | Concrete (wing walls) | <ul style="list-style-type: none"> Culvert barrels in good conditions. Upstream and downstream sides of culvert covered by a dense stands of cattails 0.25m water depth Culvert conveys flows along Russette Drain to Little River | | | |
| LC19 | Under County Road 117 (south side of EC Row Expressway) Photographs PLC19 – 1 thru 2 | Twin-1800 x 1900 | Concrete (wing walls) | <ul style="list-style-type: none"> Culvert barrels in good conditions 0.25m water depth Water flowing easterly Upstream and downstream sides of culvert covered by a dense stands of cattails Culvert conveys flows along Russette Drain to Little River | | | |
| Notes: | | | | | | | |
| 1 - Measured culvert size during site reconnaissance | | | | | | | |
| n/a = Not applicable | | | | | | | |

Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations (Cont'd) – Lauzon Parkway EA

| Culvert I.D. | Location | Culvert Size (mm) (1) | Culvert Type | Observations from Site Reconnaissance: Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | |
|---|---|--------------------------|--------------------------|--|--|
| | | | | • Culvert barrels in good conditions | • Upstream and downstream sides of culvert covered by a dense stands of cattails |
| R2 | Under EC Row Expressway W-N Ramp Photographs PR2 – 1 thru 2 | Twin-1800 x 1830 | Concrete (wing walls) | • 0.15m water depth • Water flowing easterly | • Culvert conveys flows along Russette Drain to Little River |
| R3 | Under EC Row Expressway S-E Ramp Photographs PR3 – 1 thru 4 | Twin-1800 x 1830 | Concrete (wing walls) | • Culvert barrels in good conditions • 0.15m water depth • Water flowing easterly | • Culvert conveys flows along Russette Drain to Little River |
| COUNTY ROAD 42 (DIVISION ROAD) – Walker Road to Puce Road (County Road 25) | | | | | |
| <i>Culverts Conveying Flows along North Townline Highway Drain</i> | | | | | |
| XC4 | Under Concession Road 8 Photographs PXC4 – 1 thru 2 | 900 | Concrete pipe | • Culvert in good conditions • Water flowing easterly to Little River | |
| XC5 | Under Concession Road 9 Photographs PXC5 – 1 thru 2 | 6300 x 1300 | Concrete | • Culvert in good conditions • Water flowing easterly to Little River | • 600mm outlet pipe from eastern ditch of Concession Road 9 |
| <i>Culvert Conveying Flows along Little River</i> | | | | | |
| DC1 | Under County Road 42 Photographs PDC1 – 1 thru 2 | 6100 x 2450 | Concrete (wing walls) | • Overall conditions of culvert are good. Spalding in some areas • Exposed footings • 0.3m water depth • Water flowing northerly • Sand bar inside culvert (on western side) | |
| <i>Culverts Conveying Flows along Watson Drain</i> | | | | | |
| DC2 | Under County Road 42 (west side of Concession Road 10 and east side of County Road 117) Photographs PDC2 – 1 thru 2 | 3300 x 1500 | Concrete | • Upstream end of culvert in good conditions • Downstream end of culvert is cracked at the top. Spalding and scaling. • 0.25m water depth • Water flowing northerly | |
| XC6 | Under private entrance (50m east of Culvert DC2) Photographs PXC6 – 1 thru 2 | 2100 X 1500 | CSP Arch | • Culvert in good conditions • 0.5m water depth • Water flows easterly | |
| <i>Culvert Conveying Flows along Little 10th Concession Drain</i> | | | | | |
| DC3 | Under County Road 42 (east side of Lauzon Road) Photographs PDC3 – 1 thru 4 | 3200 x 900 | Concrete | • Culvert in good conditions • 0.15m water depth. Water flowing northerly • 750mm CSP outlet pipe from east (St Louis Drain) | |
| <i>Culverts Conveying Local Flows</i> | | | | | |
| XC7 | Was not found in field (keep number for sequence order purposes) | - | - | - | |
| Notes: | | | | | |
| 1 - Measured culvert size during site reconnaissance | | | | | |

Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations (Cont'd) – Lauzon Parkway EA

| | | | | Observations from Site Reconnaissance: | | | |
|--|---|-------------------------------------|--------------|--|--|--|--|
| | | | | Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | | | |
| Culvert I.D. | Location | Culvert Size (mm) ⁽¹⁾ | Culvert Type | | | | |
| XC8 | Under Banwell Road (north side of County Road 42) Photographs PXC8 – 1 thru 2 | 500 | CSP | <ul style="list-style-type: none"> • Culvert barrel in poor to fair conditions • No water flowing was observed | | | |
| Bridge Conveying Flows along Pike Creek | | | | | | | |
| DB1 | Bridge Structure at Pike Creek Photographs PDB1 – 1 thru 6 | n/a | n/a | <ul style="list-style-type: none"> • Sand bar inside bridge • Erosion in approaching ditch located on the south side of County Road 42 | | | |
| Culverts Discharging to or Conveying Flows along 9th Concession Centreline Drain | | | | | | | |
| XC9 | Under Lakeshore Road 101 (south side of County Road 42) Photographs PXC9 – 1 thru 2 | 900 | CSP | <ul style="list-style-type: none"> • Culvert barrel in poor conditions. Both ends are rusty and deformed • Culvert conveys flows easterly to 9th Concession Drain • Water flow was observed | | | |
| DC4 | Under County Road 42 Photographs PDC4 – 1 thru 2 | 3700 x 2500 | Concrete | <ul style="list-style-type: none"> • Scaling, cracking and spalling at upstream end • Erosion at upstream end on both side of culvert • Erosion at downstream end of culvert. Exposed footing • 0.1m water depth • Water flowing northerly | | | |
| Culvert Discharging to and Culvert Conveying Flows along 8th Concession Centreline Drain | | | | | | | |
| DC5 | Under County Road 42 (at 8 th Concession Centreline Drain) Photographs PDC5 – 1 thru 4 | 5500 x 2850 | Concrete | <ul style="list-style-type: none"> • Scaling and spalling at upstream end of culvert • Erosion adjacent to east culvert footing at downstream side (see Photo PDC5-2) • Sediment deposition at the outlet of culvert on west side • 300mm CSP pipes in poor conditions (rusty) along approaching ditches at the downstream side • 500mm CSP pipe outlet from west (see Photos PDC5-3 and PDC5-4) • 0.3m water depth • Water flowing northerly | | | |
| DC6 | Under County Road 42 (approximately 123m east of Culvert DC5) Photographs PDC6 – 1 thru 2 | 900 (915) | | <ul style="list-style-type: none"> • Exposed rebar and spalling at upstream end of culvert • Small exposed rebar at downstream end • Erosion on road side ditches on south side of County Road 42 (upstream side) • Erosion on west bank at downstream side • 500mm and 300mm CSP pipes in poor conditions (rusty/corroded) convey flows along road side ditches on north side of County Road 42 • 0.3-0.5m water depth • Water flowing northerly | | | |
| Notes: | | | | | | | |
| 1- Measured culvert size during site reconnaissance | | | | | | | |

Table 1: Summary of Site Reconnaissance Observations at Transverse and Sideroad Culvert Locations (Cont'd) – Lauzon Parkway EA

| Culvert I.D. | Location | Culvert Size (mm) (¹) | Culvert Type | Observations from Site Reconnaissance: Physical Characteristics of Existing Culverts and Observed Drainage Deficiencies | |
|---|---|---------------------------------------|--------------|---|--|
| | | | | | |
| <i>Culverts Conveying Local Flows</i> | | | | | |
| XC10 | Under Concession Road 8W (Lakeshore Road 103) Photographs PXC10 – 1 thru 2 | 400 | HDPE | <ul style="list-style-type: none"> Culvert in good conditions Perched pipe at downstream end Road embankment slumped on culvert at upstream side Debris and sediment at upstream end of culvert No water flowing was observed Culvert conveys flows easterly to Puce River | |
| XC11 | Under Concession Road 7W (Lakeshore Road 105) Photographs PXC11 – 1 thru 2 | 1500 | CSP | <ul style="list-style-type: none"> Culvert barrel in good conditions 0.15m water depth Water flowing easterly 1000mm CSP pipe connected to culvert at upstream side. This pipe convey flow from ditch on the west side of Concession Road 7W 500mm CSP pipe outlets at the downstream end of culvert. This pipe convey flow from ditch on the east side of Concession Road 7W Rock protection around both the upstream and downstream ends of culvert | |
| XC12 | Under Concession Road 6W (Lakeshore Road 107) Photographs PXC12 – 1 thru 4 | 2050 | CSP | <ul style="list-style-type: none"> Culvert barrel in good conditions 0.2m water depth Water flowing easterly 800mm CSP pipe connected to culvert at upstream side. This pipe convey flow from ditch on the west side of Concession Road 6W 600mm CSP pipe outlets at the downstream end of culvert. This pipe convey flow from ditch on the east side of Concession Road 6W Rock protection around both the upstream and downstream ends of culvert A pond is located to the east of Culvert XC12 (see Photos Pond-1 and Pond-2) | |
| DC7 | Under County Road 42 (west side of W Puce Road) Photographs PDC7 – 1 thru 4 | 200 | HDPE | <ul style="list-style-type: none"> Road embankment slumped on culvert at upstream side. Sediment/embankment material deposition at inlet Road embankment eroded Perched pipe at downstream end At downstream side, the bottom of north bank is eroded/cut No water flowing was observed. Culvert conveys flows from western side road ditch of W Puce Road | |
| <i>Bridge Conveying Flows along Puce River</i> | | | | | |
| DB2 | Bridge Structure at Puce River Photographs PDB2 – 1 thru 4 | n/a | n/a | <ul style="list-style-type: none"> Severe erosion/cut on east bank at downstream side of the bridge structure (see Photos PDB2-2 and PDB2-3) | |
| <i>Culvert Conveying Flows Easterly to Puce River</i> | | | | | |
| XC13 | Under County Road 25 Photographs PXC13 – 1 thru 4 | 4500 x 1650 | Concrete | <ul style="list-style-type: none"> Culvert in good conditions 750mm concrete pipe outlets at the upstream end of culvert. This pipe convey flow from the ditch on the east side of Puce Road (County Road 25) 0.2m water depth Water flowing westerly to Puce River | |
| <i>Notes:</i> | | | | | |
| 1 - Measured culvert size during site reconnaissance | | | | | |
| n/a = Not applicable | | | | | |

APPENDIX A
(from Culvert Inspection Report)
SITE PHOTOGRAPHS
(Taken on May 4 & 5, 2011)



PXC1-1 Downstream Elevation (Sullivan Drain)



PXC1-2 Upstream Elevation (Sullivan Drain)



PLC1-1 Downstream Elevation (Sullivan Drain)



PLC1-2 Upstream Elevation (Sullivan Drain)



PXC2-1 Downstream Elevation (Watson Drain)



PXC2-2 Upstream Elevation (Watson Drain)



PS-1 Looking East



PS-2 Looking at Exposed CB, CSP Pipe and Wood Guardrail Post



PLC2-1 Downstream Elevation (Erosion on channel slope)



PLC2-2 Upstream Elevation (Erosion above pipe)



PLC2-3 Insufficient Blanket Protection on West Channel Bank



PLC2-4 Erosion on Channel Slope (Just north of Culvert LC2)



PLC3-1 Downstream Elevation (Erosion on channel slope)



PLC3-2 Upstream Elevation



PLC3-3 Erosion on Channel Slope Just North of Culvert



PLC3-4 Insufficient Blanket Protection on West Channel Bank (Looking south)



PLC4-1 Downstream Elevation (Erosion on channel slope)



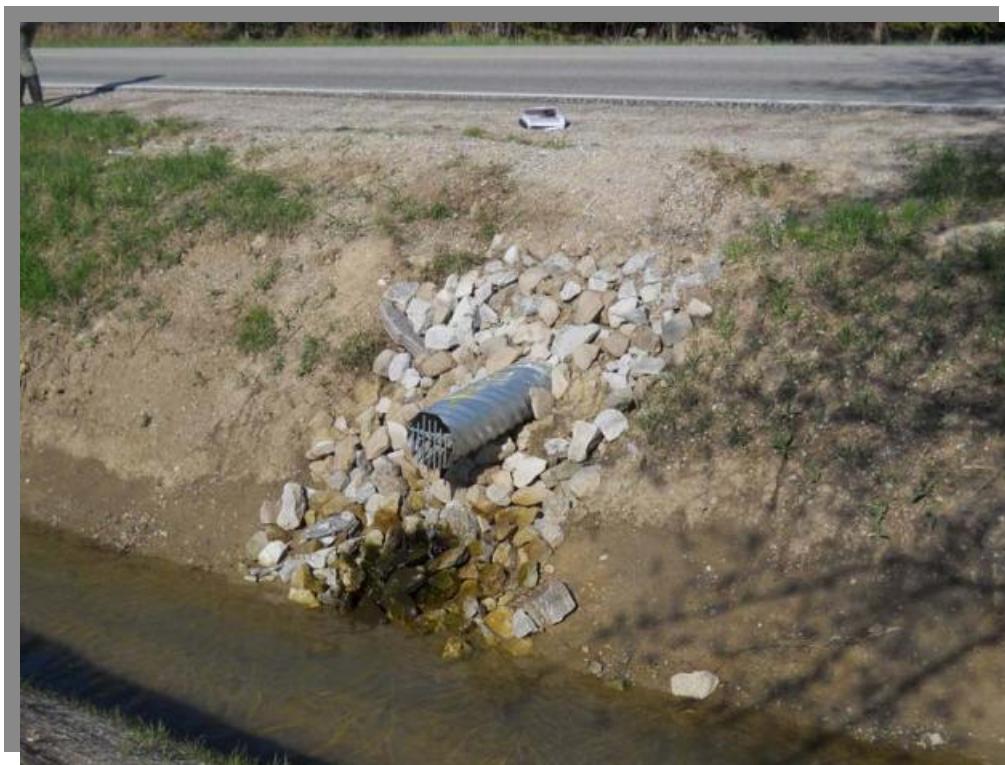
PLC4-2 Upstream Elevation



PLC4-3 Erosion on East Channel Slope and Erosion Blanket Failure (Looking north)



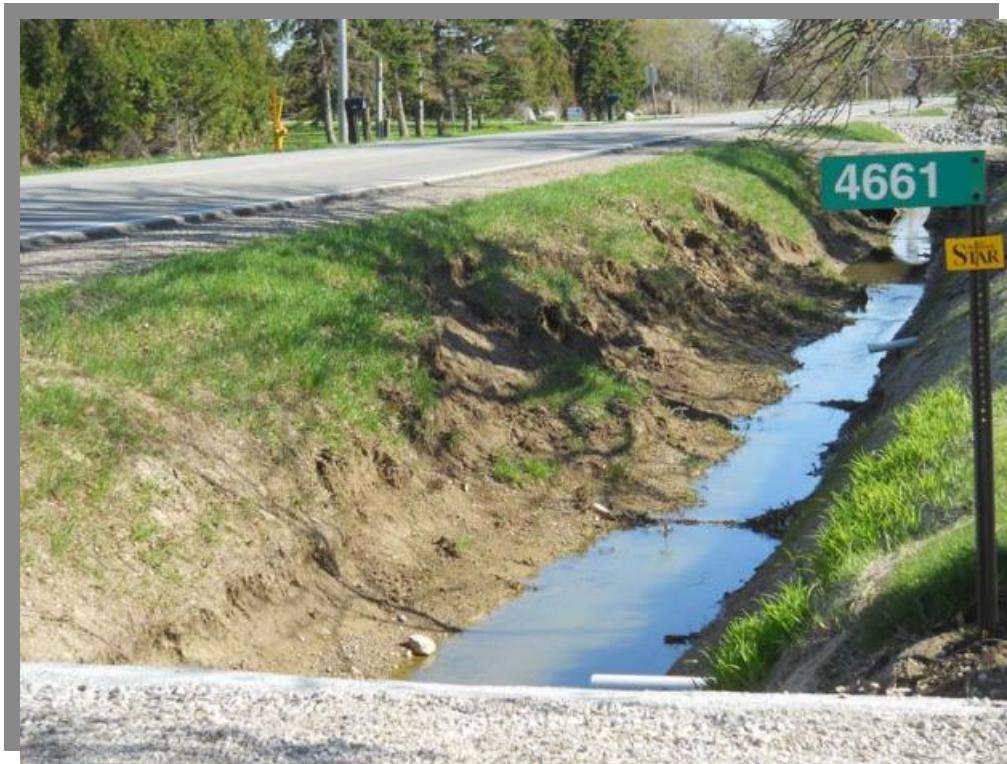
PLC4-4 Erosion Blanket Failure (West channel slope)



PLC5-1 Downstream Elevation



PLC5-2 Upstream Side (Looking North)



PLC5-3 Erosion on East Channel Slope (Looking south)



PLC6-1 Downstream Elevation



PLC6-2 Upstream End



PLC7-1 Downstream Elevation



PLC7-2 Upstream Elevation



PLC7-3 Erosion on East Channel Slope



PLC7-4 Erosion Blanket Failure (West channel slope)



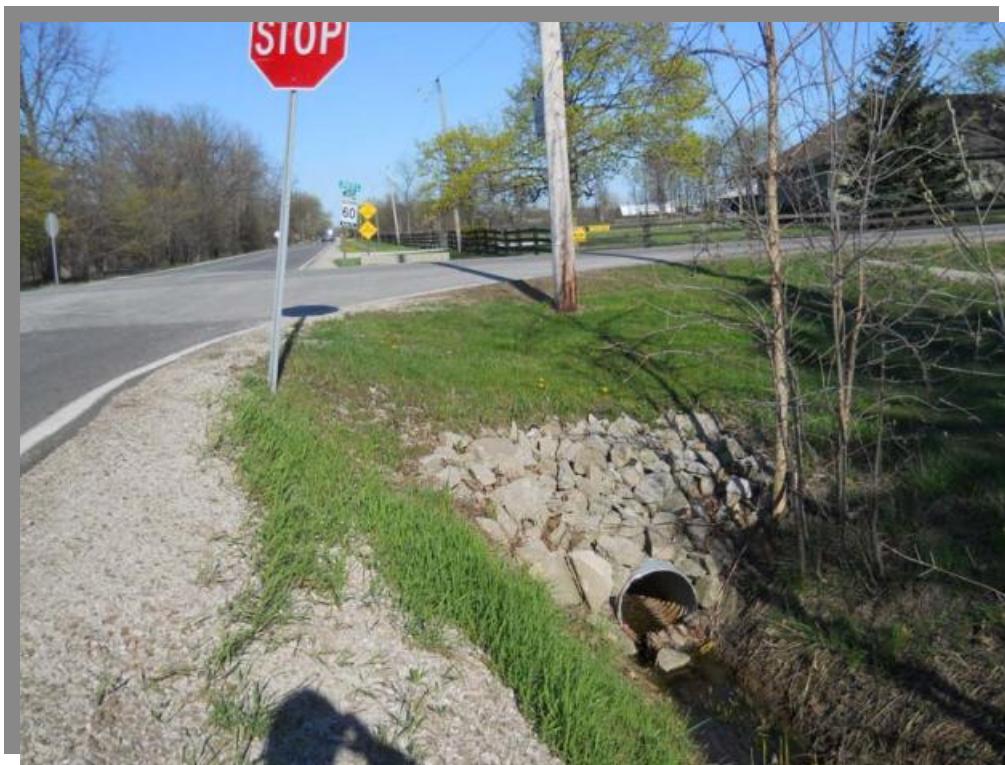
PLC7-5 Erosion on East Channel Slope Upstream of 1800mm CSP (65m± north of Culvert LC7)



LC7-6 Erosion on East Channel Slope (Opposite side of tiled system outlet pipe)



PLC8-1 Upstream Elevation (South side of Baseline Road)



PLC8-2 Downstream Side (Looking East at 500mm CSP Inlet Pipe)



PLC9-1 Upstream Elevation (North side of Baseline Road)



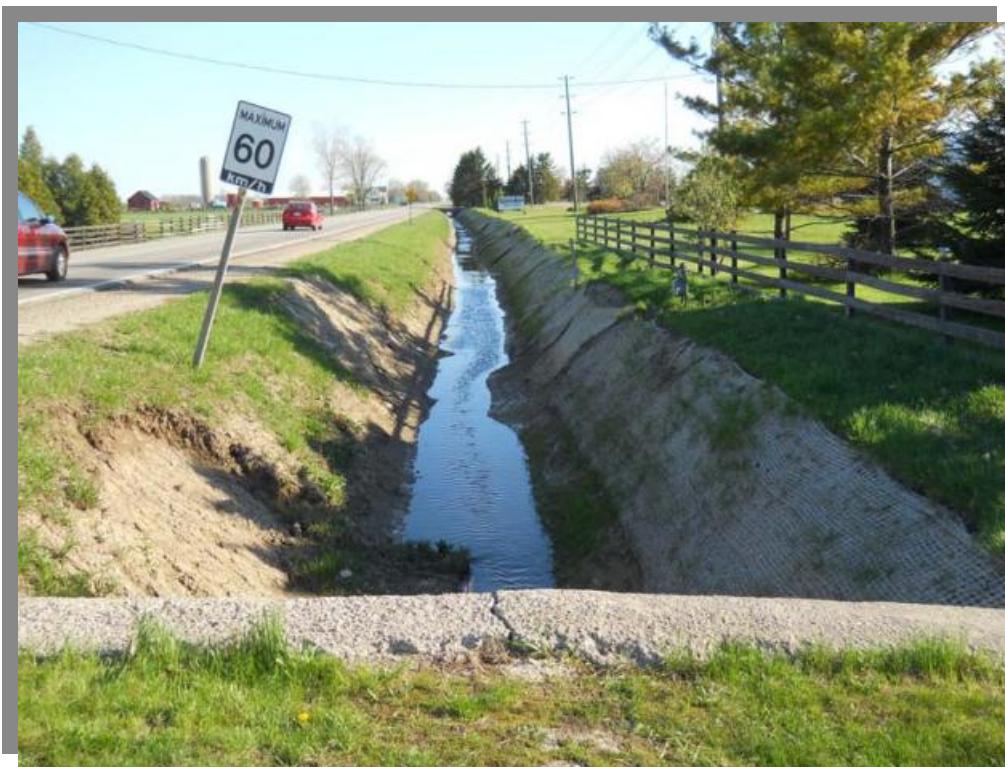
PLC9-2 Downstream Side (Looking East at 525mm CSP Inlet Pipe)



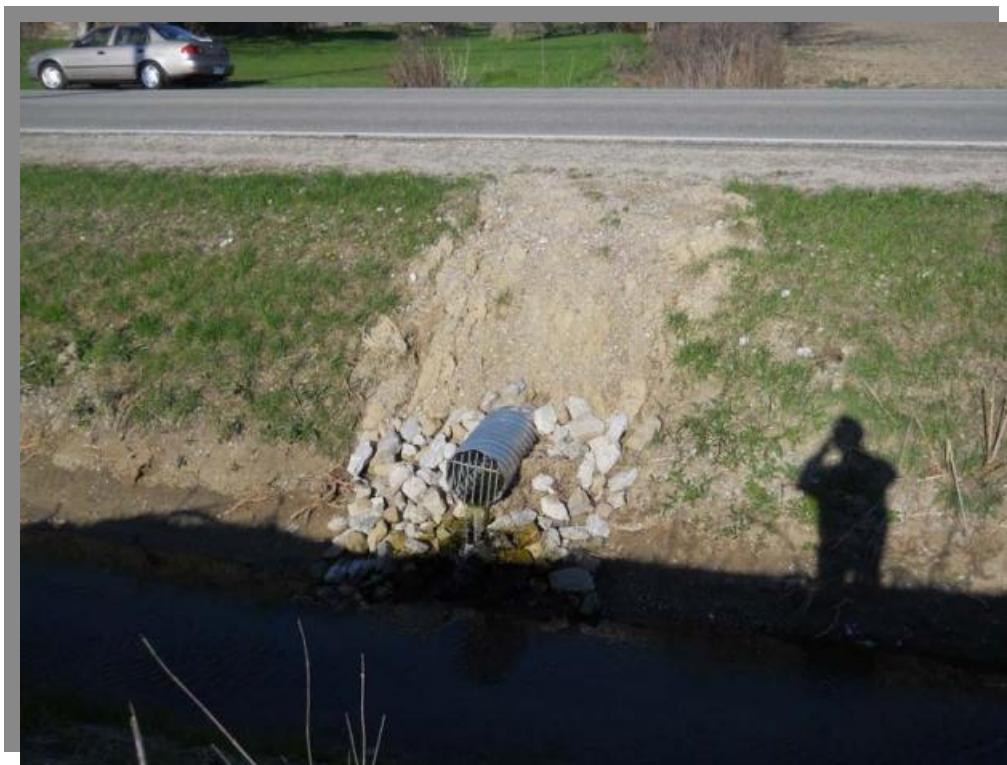
PXC3-1 Downstream Elevation (Watson Drain)



PXC3-2 Upstream Elevation (Watson Drain)



PXC3-3 Erosion on East Channel Slope and Erosion Blanket Failure on West Channel Slope (Watson Drain)



PLC10-1 Downstream Elevation



PLC10-2 Upstream Elevation



PLC10-3 West Channel Bank Failure (Watson Drain)



PLC10-4 West Channel Bank Failure (Watson Drain - Looking North)



PLC11-1 Downstream Elevation



PLC11-2 Upstream Elevation



PLC11-3 Deteriorated Erosion Blanket on West Channel Slope (Watson Drain)



PLC11-4 Watson Drain (Looking South)



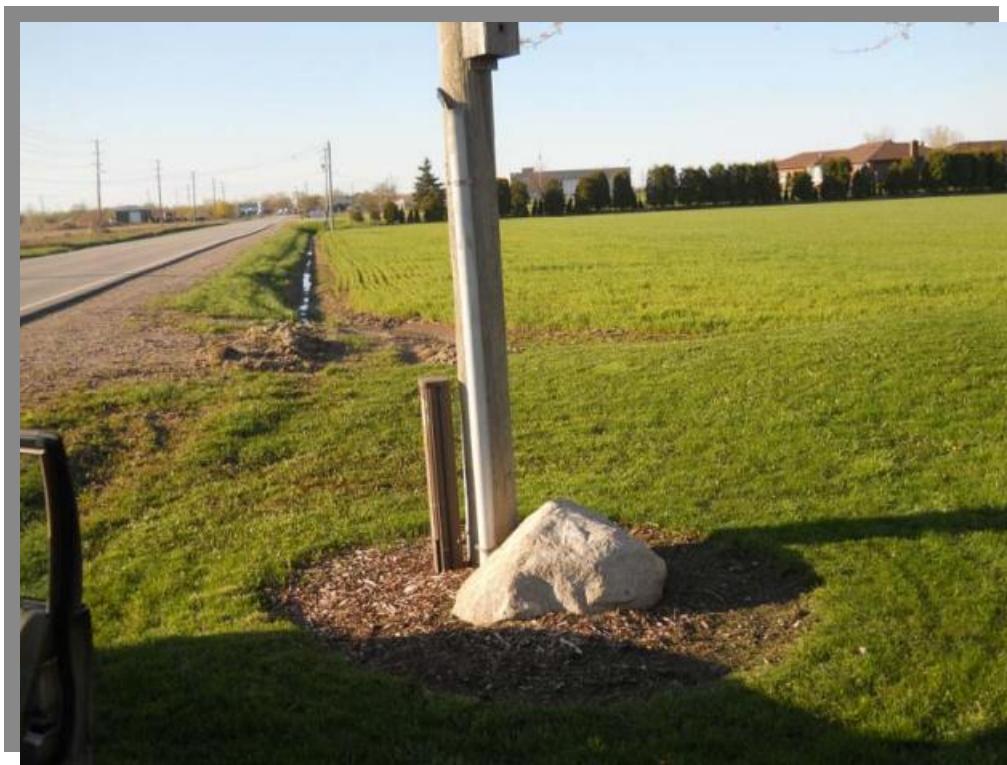
PLC12-1 Downstream Elevation (Watson Drain)



PLC12-2 - Upstream End (Old Style "CB")



PLC13-1 Downstream Elevation



PLC13-2 Upstream End (Pipe end was not found – Looking north)



PLC14-1 Downstream End (Watson Drain)



PLC14-2 Upstream End (CB – Looking north)



PLC14-3 Upstream End (CB – Looking south)



PLC14-4 300mm CSP Inlet Pipe to CB (Looking north)



PLC15-1 Downstream Elevation



PLC15-2 Upstream End (CB – Looking north)



PLC15-3 Inlet Pipe to CB (Looking north)



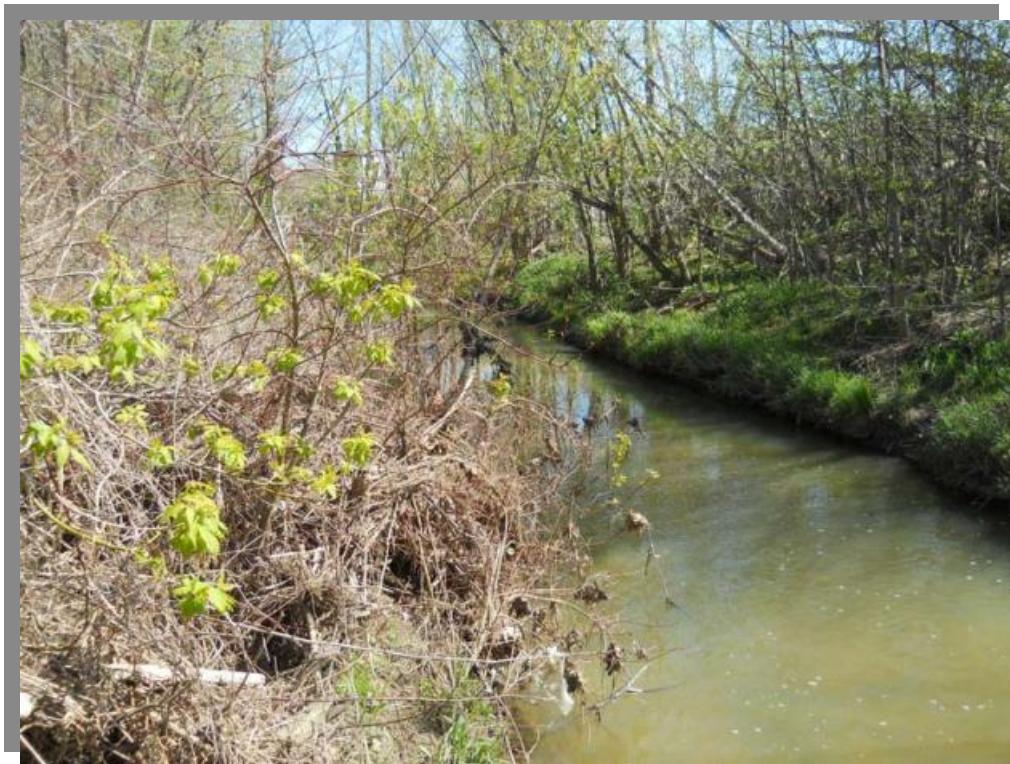
PLC16-1 Downstream End



PLC16-2 Upstream End (CB)



PLB1-1 Downstream Elevation (Looking west)



PLB1-2 Downstream Side (Little River - Looking east)



PLB1-3 Upstream Elevation (Looking east)



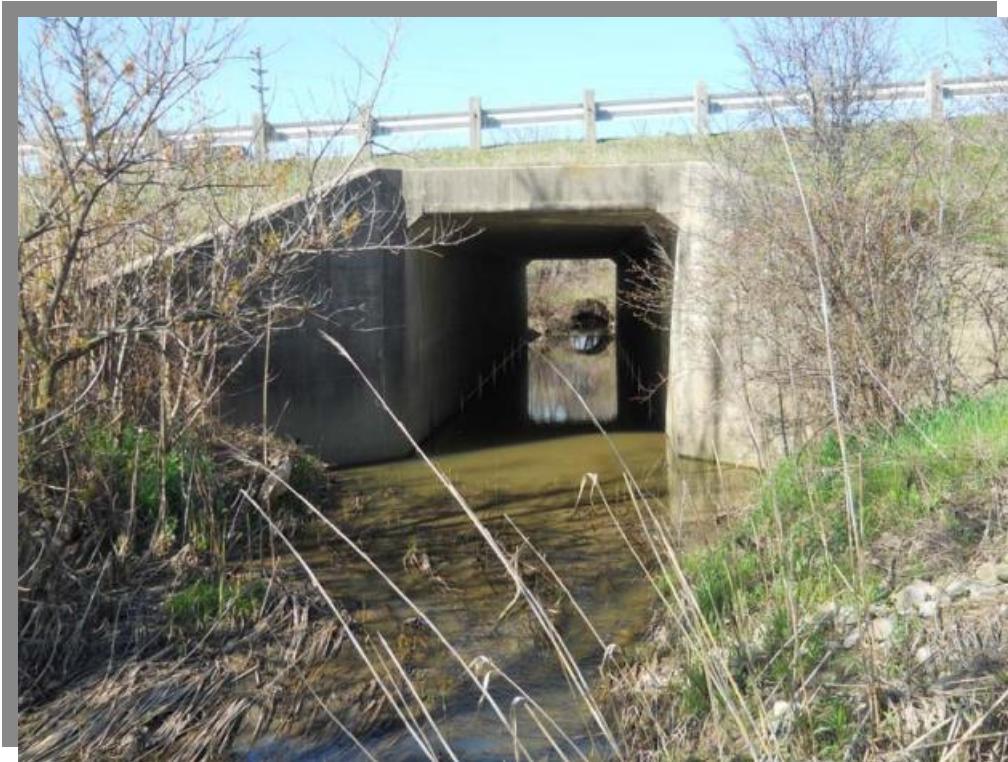
PLB1-4 Upstream Side (Little River - Looking west)



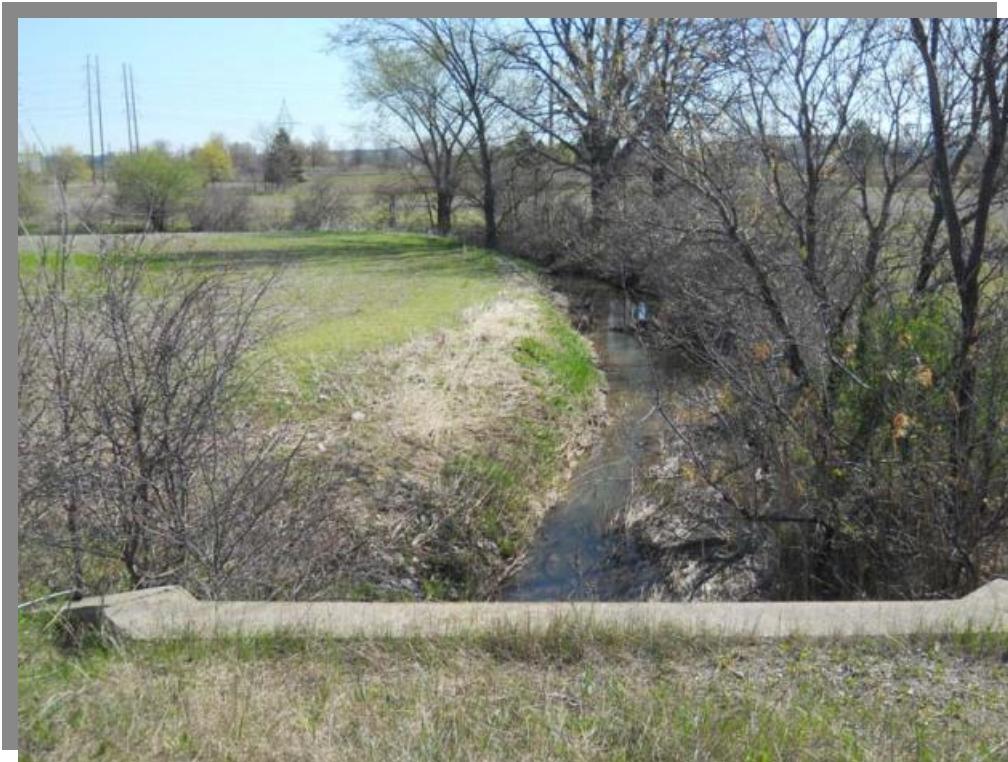
LC17-1 Downstream Elevation (Rivard Drain)



LC17-2 Upstream Elevation (Rivard Drain)



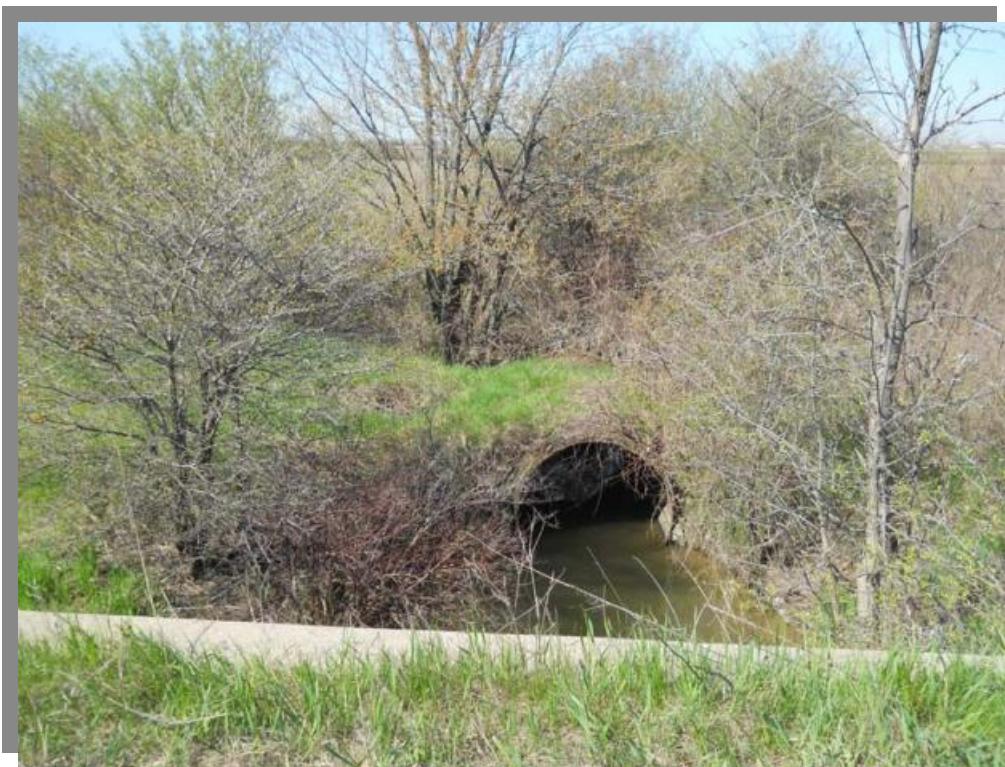
PLC18-1 Downstream Elevation (McGill Drain)



PLC18-2 Downstream Side (McGill Drain - Looking east)



PLC18-3 Upstream Elevation (McGill Drain)



PLC18-4 Upstream Side (McGill Drain - Looking west to 1800mm iron pipe)



PLC19-1 Downstream Elevation (Covered by dense stands of cattail - Russette Drain)



PLC19-2 Upstream Elevation (Russette Drain)



PR1-1 Downstream Elevation (Russette Drain)



PR1-2 Upstream Elevation (Russette Drain)



PR2-1 Downstream Elevation (Russette Drain)



PR2-2 Upstream Elevation (Russette Drain)



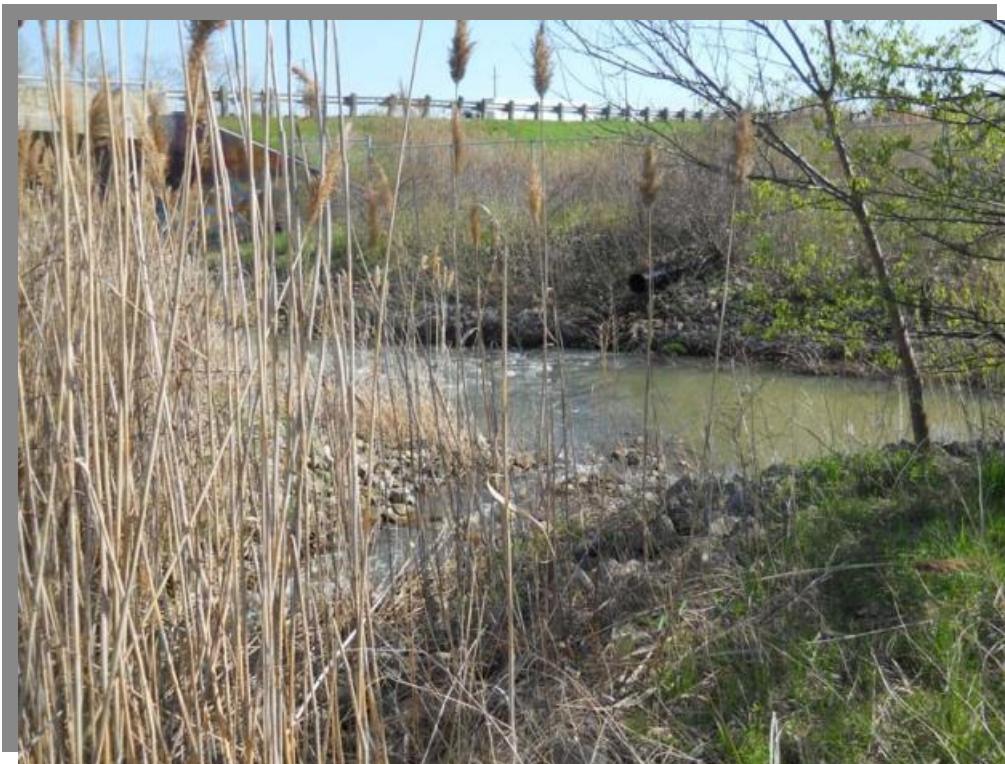
PR3-1 Upstream Elevation (Russette Drain)



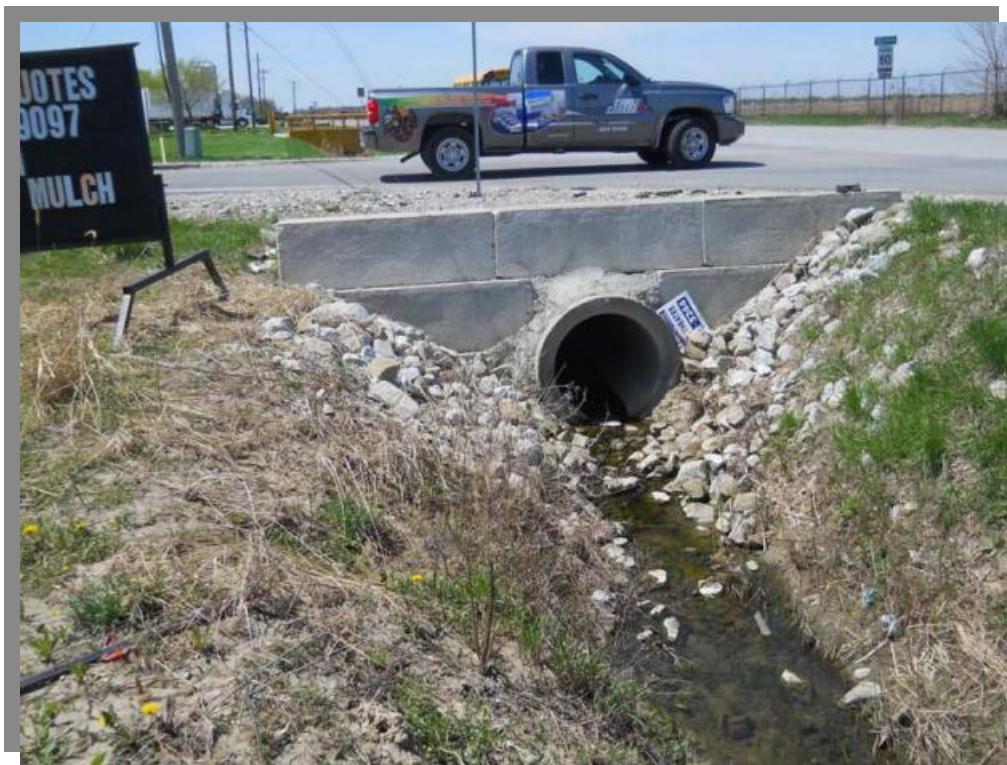
PR3-2 Downstream Elevation (Russette Drain)



PR3-3 Downstream Channel (Russette Drain - Looking east)



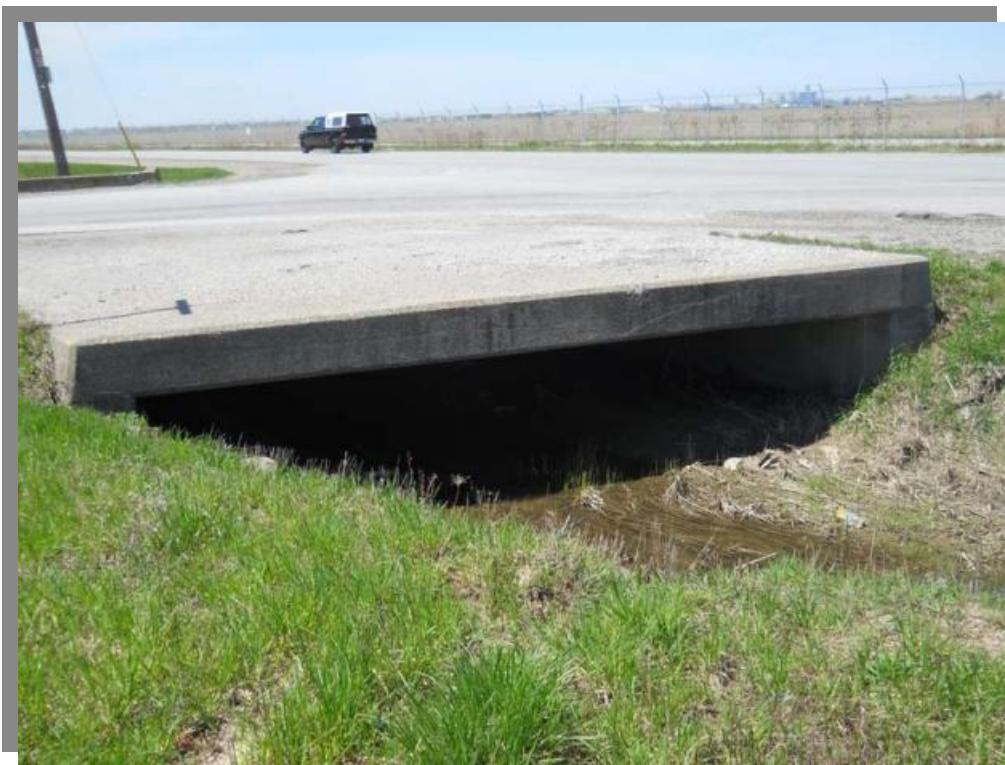
PR3-4 Russette Drain Outlet at Little River (Looking east)



PXC4-1 Downstream Elevation (North Townline Highway Drain)



PXC4-2 Upstream Elevation (North Townline Highway Drain)



PXC5-1 Downstream Elevation (North Townline Highway Drain)



PXC5-2 Upstream Elevation (North Townline Highway Drain)



PDC1-1 Downstream Elevation (Little River)



PDC1-2 Upstream Elevation (Little River)



PDC2-1 Downstream Elevation (Spalling at top of culvert-Watson Drain)



PDC2-2 Upstream Elevation (Watson Drain)



PXC6-1 Downstream Elevation (Watson Drain)



PXC6-2 Upstream Elevation (Watson Drain)



PDC3-1 Downstream Elevation (Little 10th Concession Drain)



PDC3-2 Upstream Elevation (Little 10th Concession Drain)



PDC3-3 750mm CSP Outlet Pipe (St Louis Drain - Looking east)



PDC3-4 Little 10th Concession Drain (Looking south)



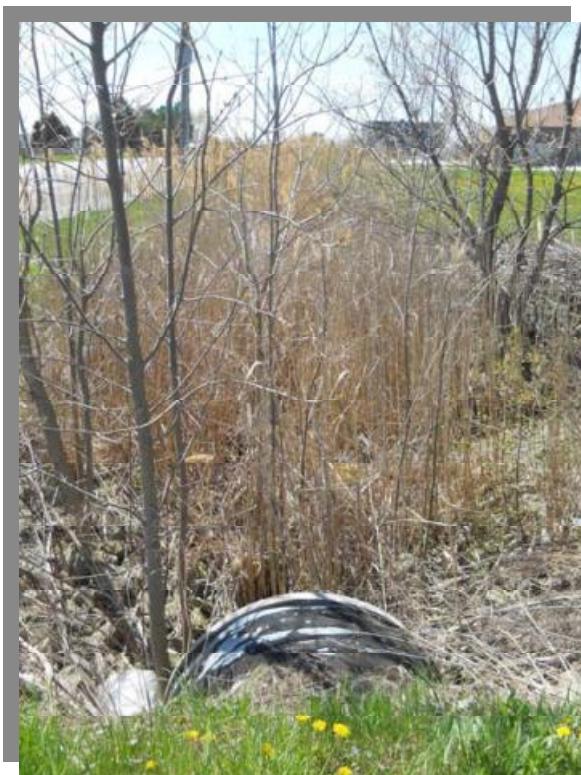
PXC8-1 East End



PXC8-2 West End



PKD-1 1200mm Inlet Pipe (Klondyke Drain - Looking east)



PKD-2 1200mm Inlet Pipe (Klondyke Drain - Looking west)



PDB1-1 Downstream Elevation



PDB1-2 Looking inside Bridge Structure



PDB1-3 Pike Creek (Looking east from bridge structure)



PDB1-4 Upstream Elevation



PDB1-5 Pike Creek (Looking west from bridge structure)



PDB1-6 Erosion in Approaching Ditch from West (South side of County Road 42)



PXC9-1 Downstream Elevation



PXC9-2 Upstream Elevation



PDC4-1 Downstream Elevation



PDC4-2 Upstream Elevation



PDC5-1 Downstream Elevation



PDC5-2 Erosion Adjacent to East Culvert Footing (Downstream side)



PDC5-3 Upstream Elevation (Spalling on top of culvert left corner)



PDC5-4 Upstream Elevation (Spalling at east end of top beam)



PDC6-1 Downstream Elevation



PDC6-2 Upstream Elevation (Spalling and exposed rebar on top of culvert)



PXC10-1 Downstream Elevation



PXC10-2 Upstream Elevation



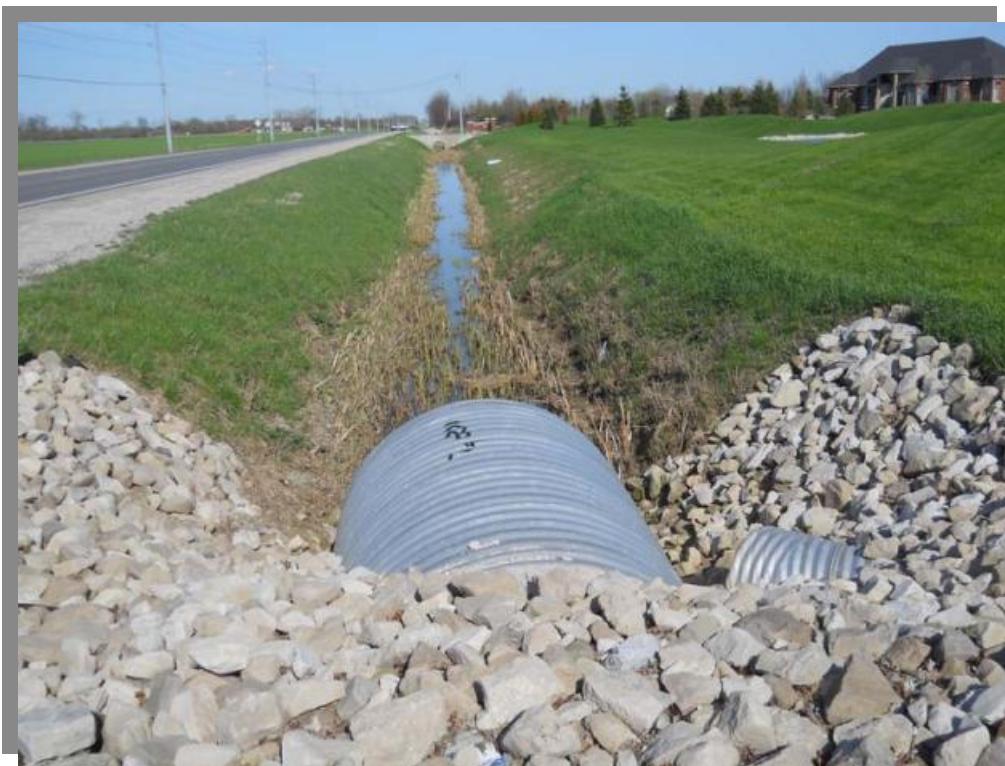
PXC11-1 Downstream Elevation



PXC11-2 Upstream Elevation



PXC12-1 Downstream Elevation



PXC12-2 Downstream Channel and 600mm CSP Inlet Pipe (Looking east)



PXC12-3 Upstream Elevation



PXC12-4 800mm CSP Inlet Pipe from South (Looking north)



POND-1 Looking South



POND-2 200mm PVC Outlet Pipe (Looking east)



PDC7-1 Downstream Elevation



PDC7-2 Erosion on Bottom of Channel Bank (Looking west)



PDC7-3 Erosion on Bottom of Channel Bank (Looking east)



PDC7-4 Upstream Elevation



PDB2-1 Downstream Elevation



PDB2-2 Erosion on East Bank (Downstream side – Looking north)



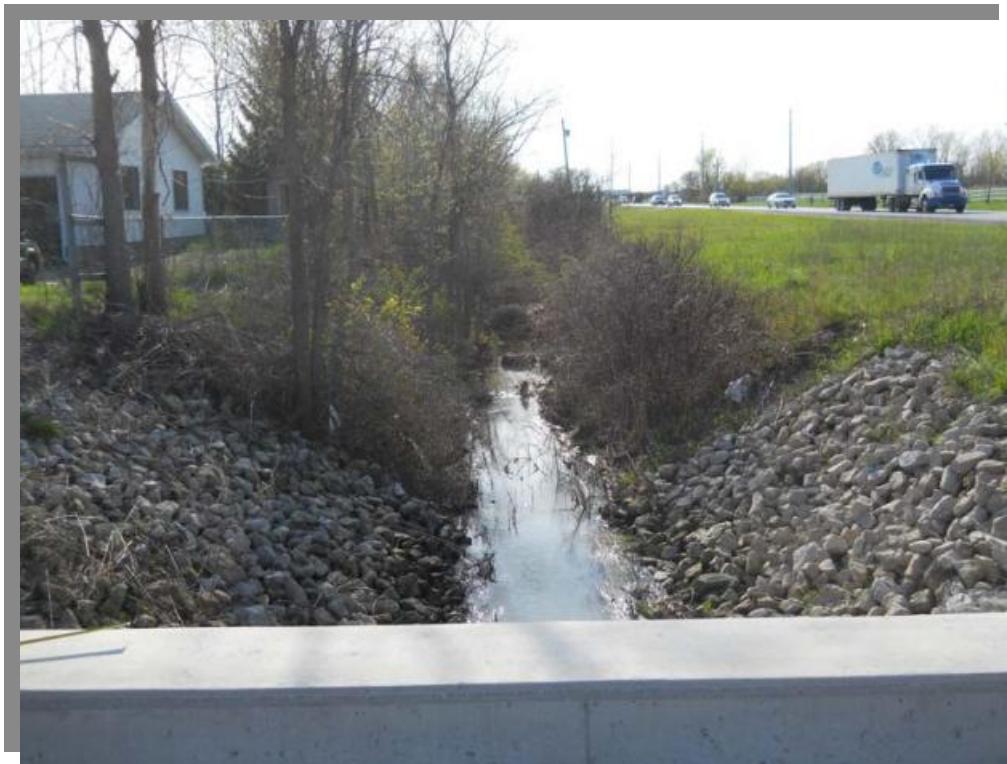
PDB2-3 Erosion on East Bank (Downstream side – Looking north)



PDB2-4 Upstream Elevation



PXC13-1 Downstream Elevation



PXC13-2 Downstream Channel (Looking west)



PXC13-3 Upstream Elevation



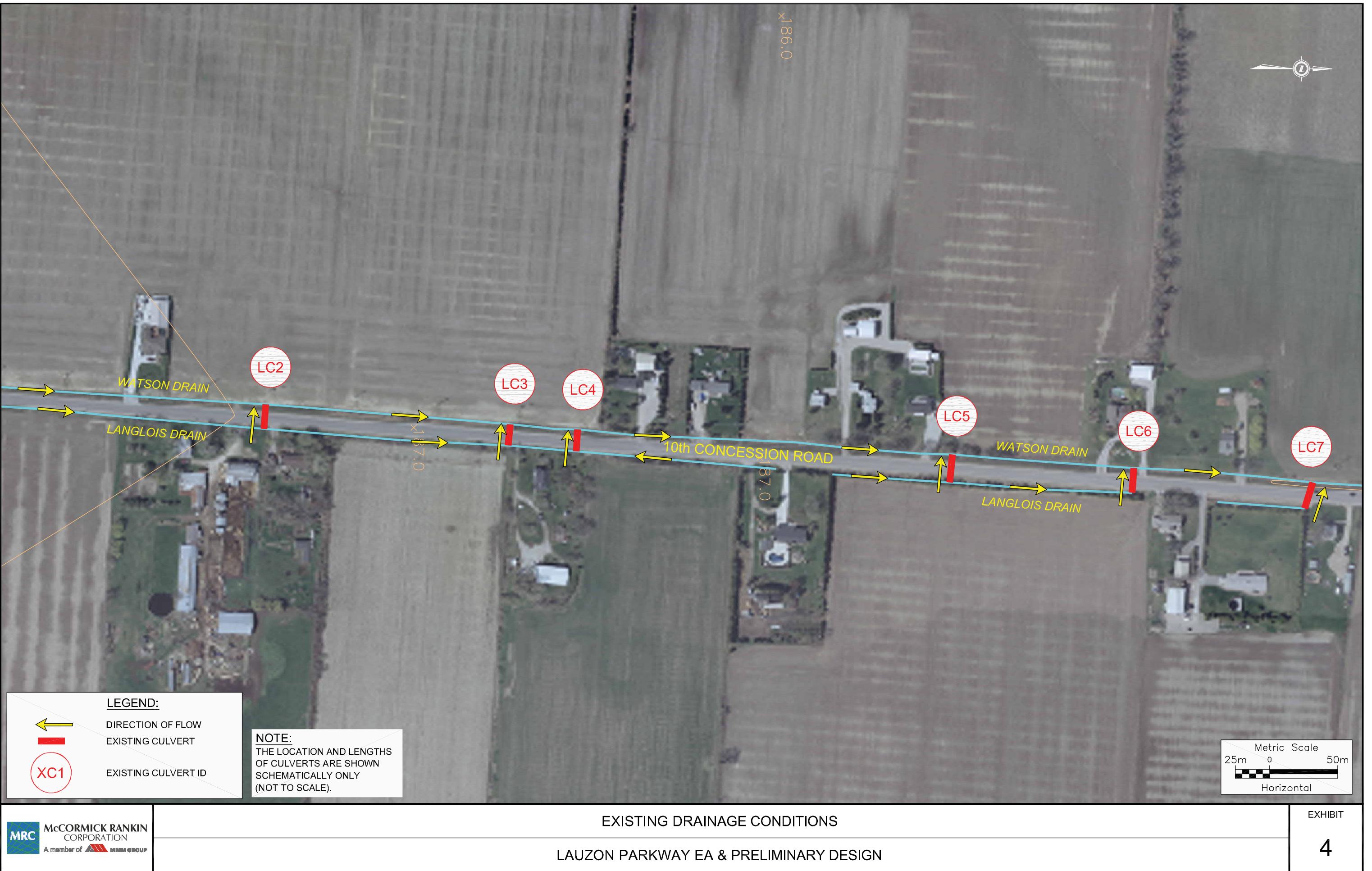
PXC13-4 MH on the South Side of Culvert (Outlets to upstream of culvert)

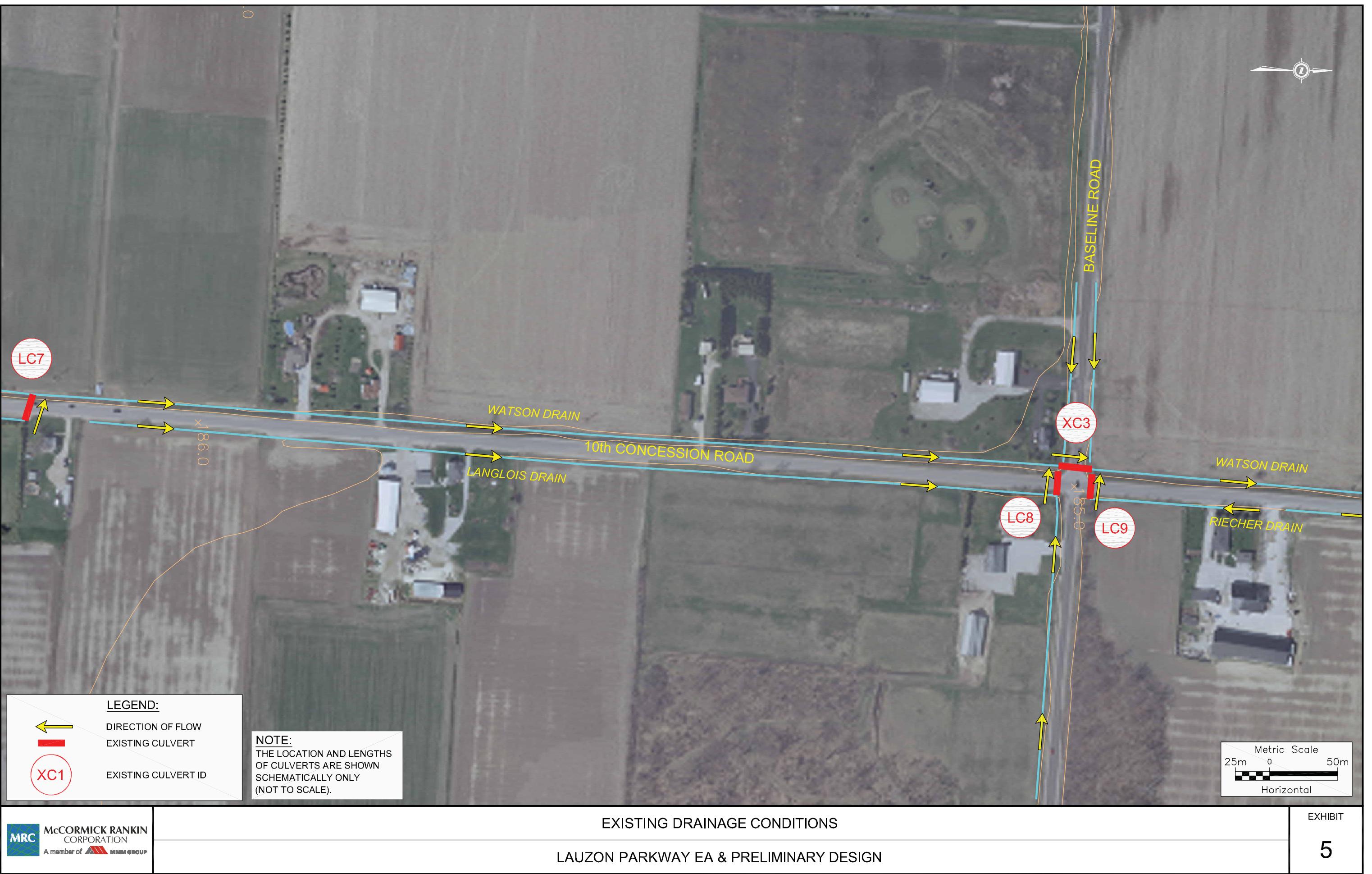
APPENDIX B
(from Culvert Inspection Report)
EXHIBITS 1 TO 27





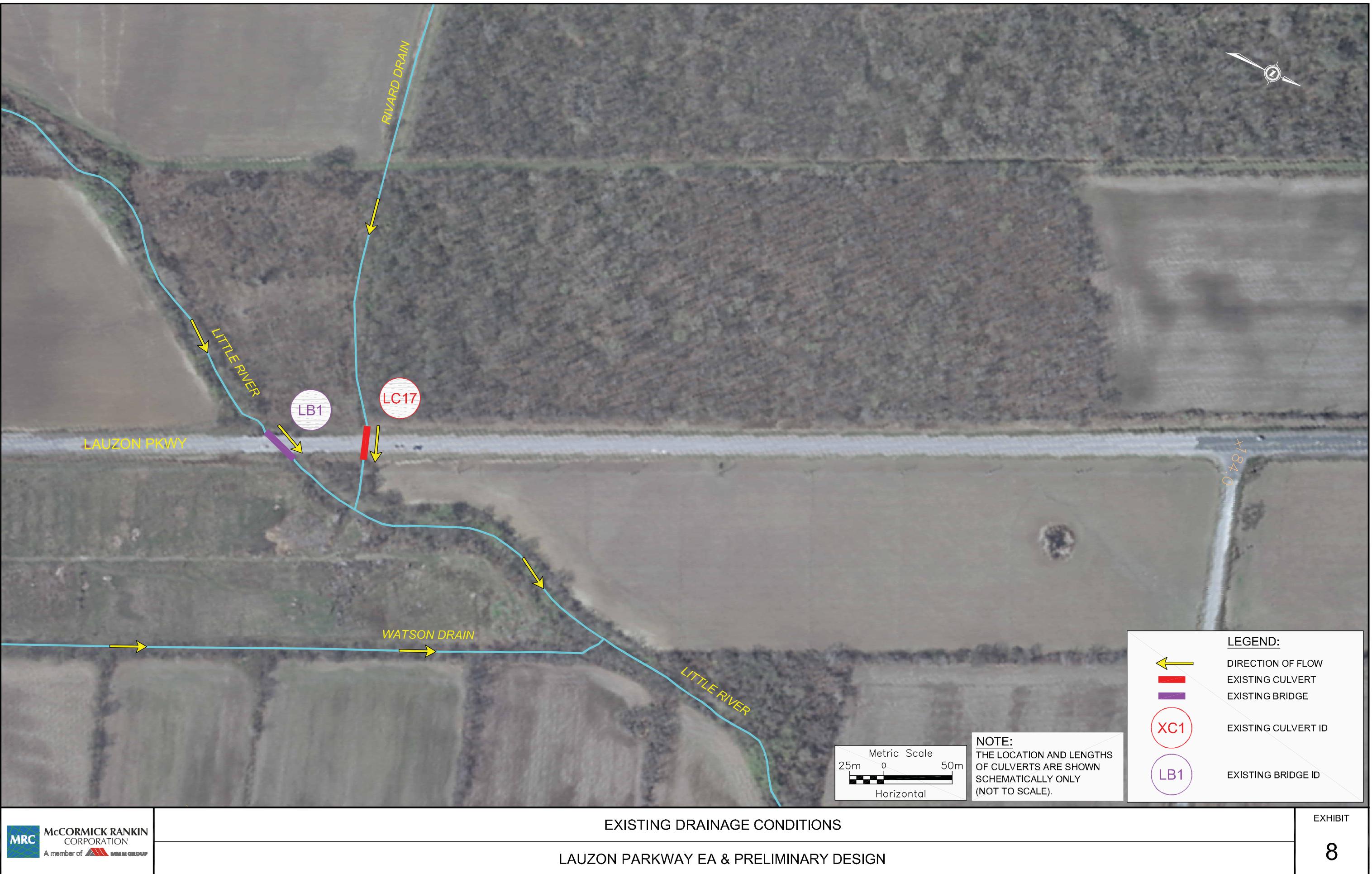




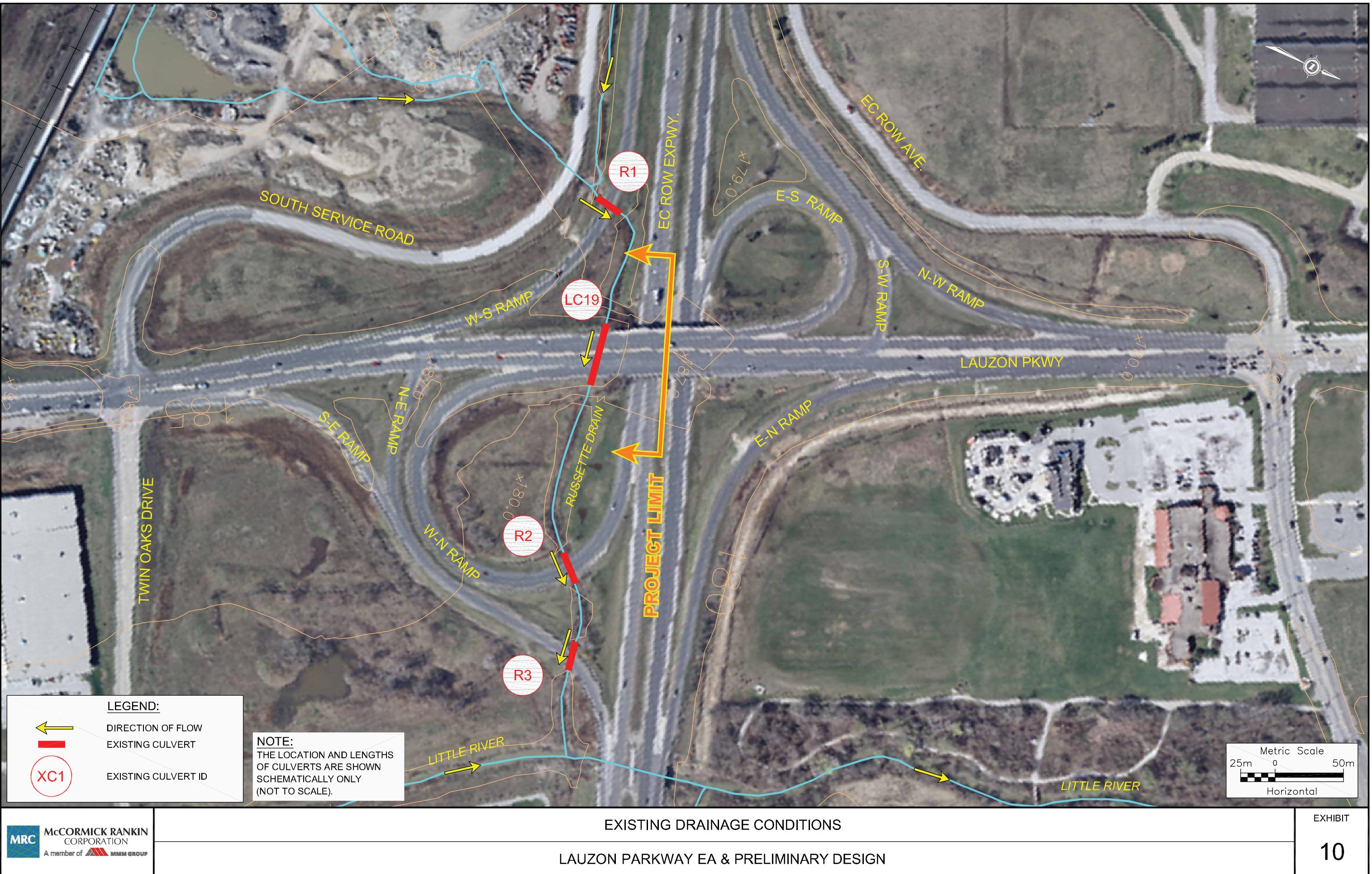


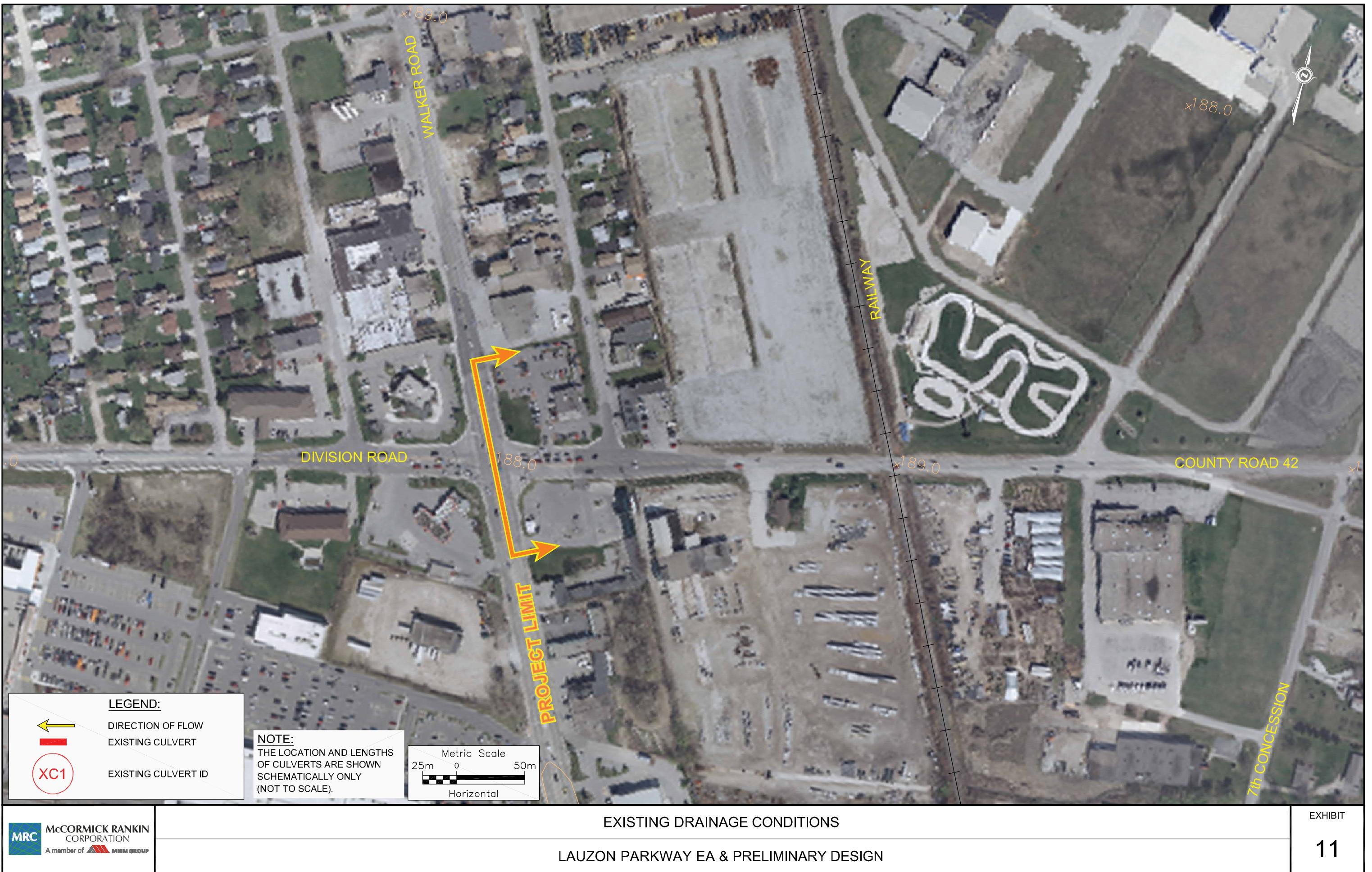






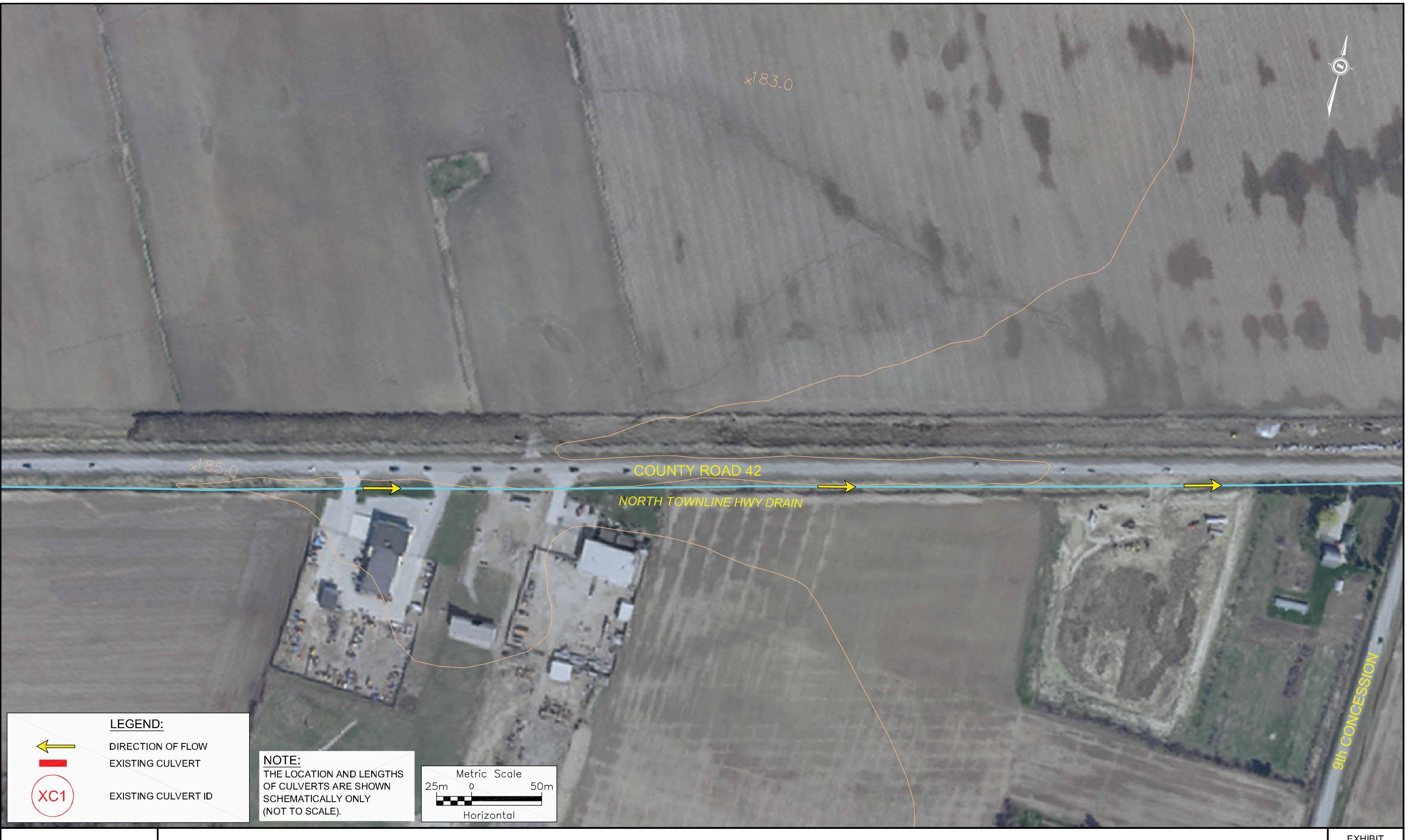




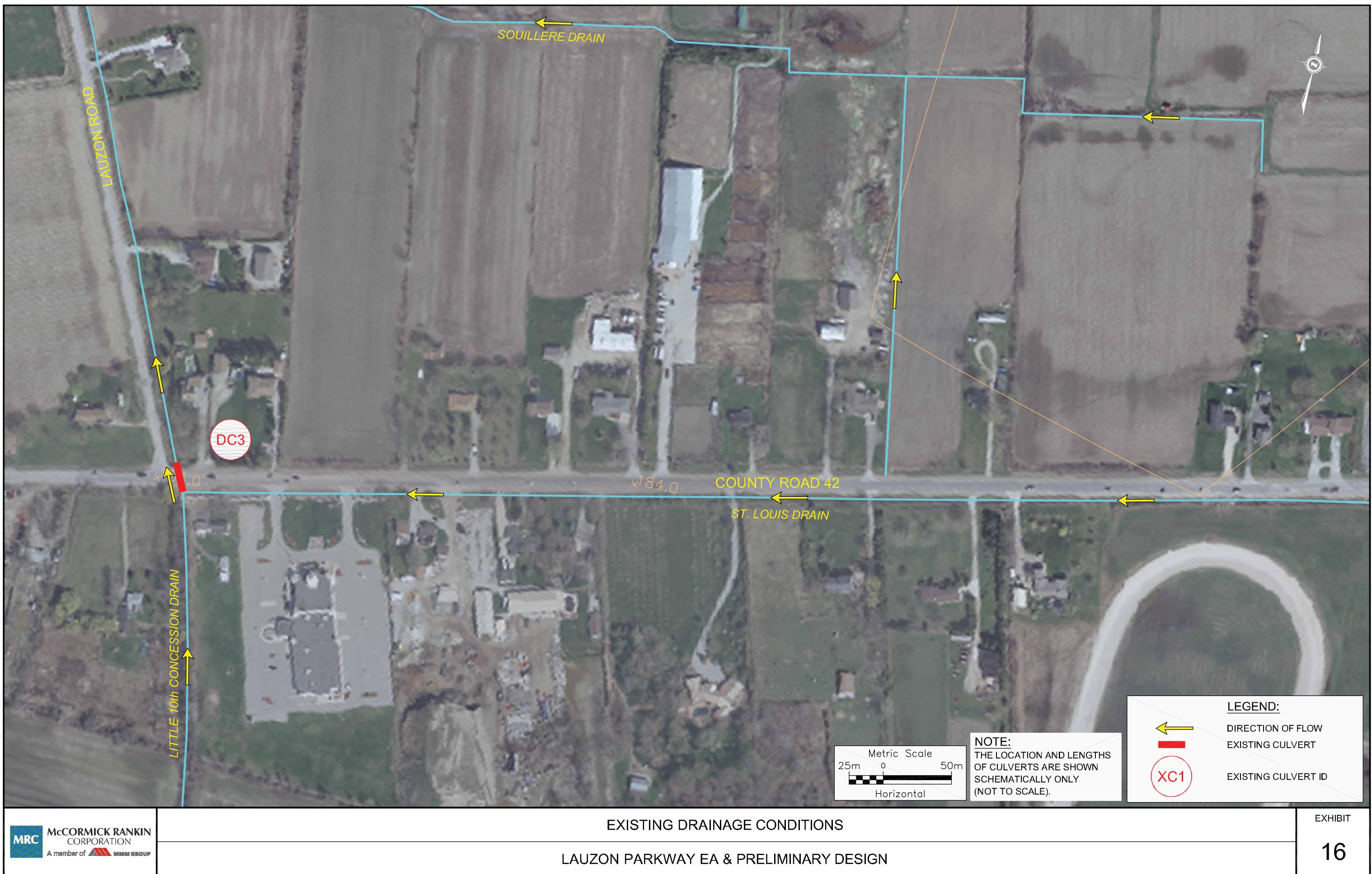










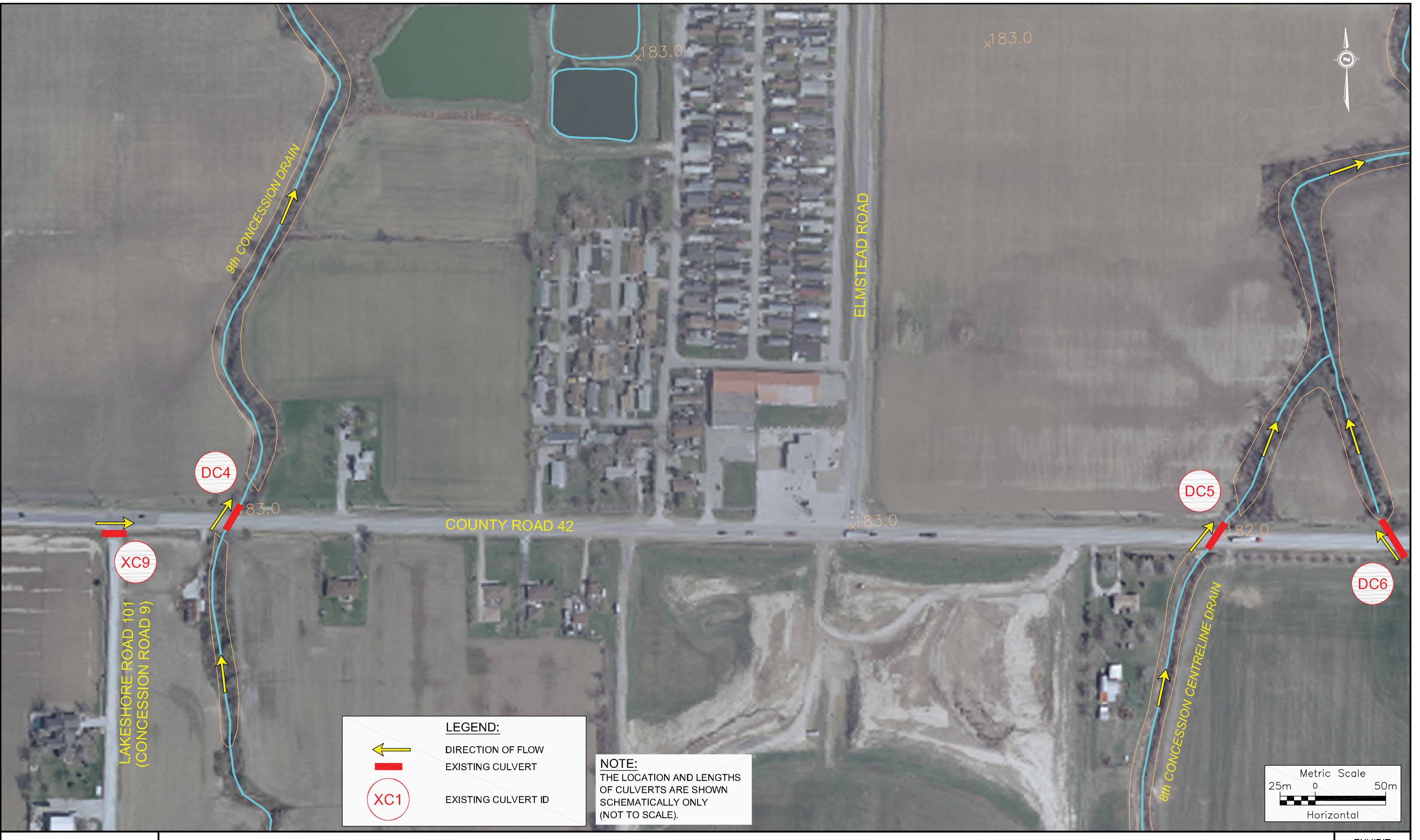












EXISTING DRAINAGE CONDITIONS

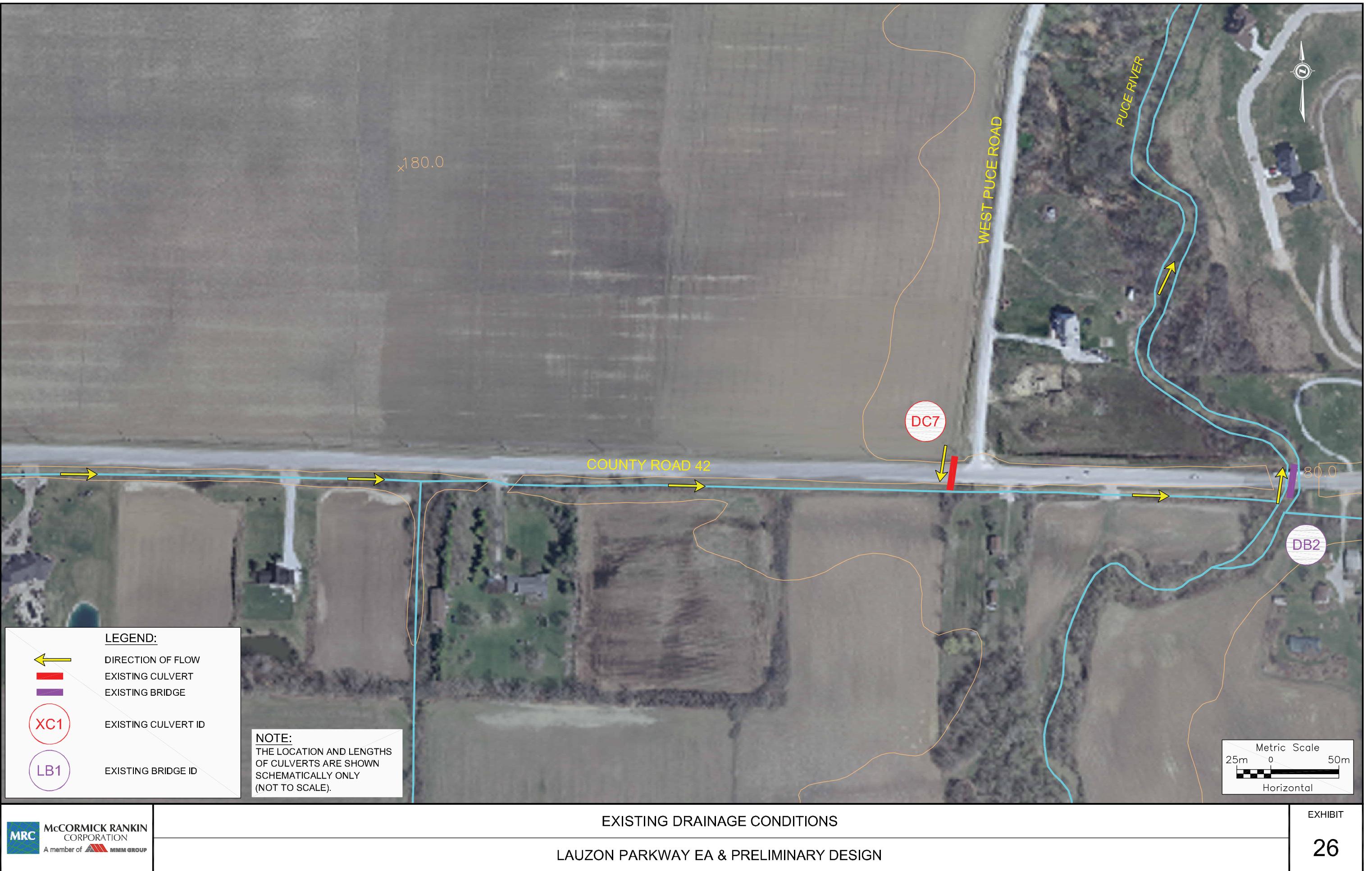
LAUZON PARKWAY EA & PRELIMINARY DESIGN













APPENDIX B

Hec-Ras Output Files for Little River, Pike River, Kerr Drain, and Puce River

Little River Existing Conditions HEC-RAS Summary Output

HEC-RAS Plan: LTRiv-ExCond1 River: RIVER-1 Reach: Reach-1

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope | |
|---------|-----------|--------------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|------------|----------|
| | | | (m) | (m³/s) | (m) | (m) | (m/s) | (m/s) | (m²) | (m) | (m) | (m) | (m) | (m/m) | | | |
| Reach-1 | 34001 | Max Observed | 180.81 | 92.50 | 179.10 | 180.88 | 0.27 | 1.33 | 339.73 | 636.89 | 176.70 | | | 4.11 | 0.25 | 0.000428 | |
| Reach-1 | 34001 | 100yr | 180.43 | 66.10 | 178.74 | 180.49 | 0.37 | 1.18 | 177.23 | 286.75 | 176.70 | | | 3.73 | 0.24 | 0.000412 | |
| Reach-1 | 34001 | PF 3 | 179.42 | 37.60 | 178.22 | 179.50 | 1.28 | 1.28 | 29.38 | 17.60 | 176.70 | | | 2.72 | 0.32 | 0.000804 | |
| Reach-1 | 34001 | PF 4 | 180.01 | 51.90 | 178.50 | 180.08 | 0.67 | 1.22 | 77.66 | 167.38 | 176.70 | | | 3.31 | 0.27 | 0.000568 | |
| Reach-1 | 35002 | Max Observed | 180.86 | 92.50 | 178.43 | 180.92 | 0.20 | 1.20 | 473.64 | 744.25 | 176.80 | 100.00 | | 4.06 | 0.0010 | 0.19 | 0.000214 |
| Reach-1 | 35002 | 100yr | 180.48 | 66.10 | 178.10 | 180.53 | 0.26 | 1.04 | 251.10 | 310.27 | 176.80 | 100.00 | | 3.68 | 0.0010 | 0.17 | 0.000182 |
| Reach-1 | 35002 | PF 3 | 179.52 | 37.60 | 177.71 | 179.56 | 0.95 | 0.95 | 39.68 | 95.98 | 176.80 | 100.00 | | 2.72 | 0.0010 | 0.18 | 0.000229 |
| Reach-1 | 35002 | PF 4 | 180.07 | 51.90 | 177.92 | 180.13 | 1.09 | 1.09 | 47.76 | 202.05 | 176.80 | 100.00 | | 3.27 | 0.0010 | 0.19 | 0.000235 |
| Reach-1 | 35092.5 | Bridge | | | | | | | | | | | | | | | |
| Reach-1 | 35183 | Max Observed | 180.86 | 92.50 | 178.43 | 180.92 | 0.20 | 1.20 | 473.60 | 744.22 | 176.80 | 0.10 | | 4.06 | 0.0000 | 0.19 | 0.000214 |
| Reach-1 | 35183 | 100yr | 180.57 | 66.10 | 178.11 | 180.61 | 0.23 | 1.02 | 282.21 | 462.21 | 176.80 | 0.10 | | 3.77 | 0.0000 | 0.17 | 0.000171 |
| Reach-1 | 35183 | PF 3 | 179.53 | 37.60 | 177.71 | 179.57 | 0.94 | 0.94 | 39.79 | 97.58 | 176.80 | 0.10 | | 2.73 | 0.0000 | 0.18 | 0.000227 |
| Reach-1 | 35183 | PF 4 | 180.08 | 51.90 | 177.92 | 180.14 | 1.08 | 1.08 | 47.99 | 206.12 | 176.80 | 0.10 | | 3.28 | 0.0000 | 0.19 | 0.000231 |
| Reach-1 | 35404 | Max Observed | 180.87 | 92.50 | | 180.93 | 0.23 | 1.23 | 406.81 | 700.81 | 176.80 | 22.00 | | 4.07 | 0.0000 | 0.22 | 0.000314 |
| Reach-1 | 35404 | 100yr | 180.57 | 66.10 | | 180.63 | 0.31 | 1.12 | 214.11 | 578.24 | 176.80 | 22.00 | | 3.77 | 0.0000 | 0.21 | 0.000293 |
| Reach-1 | 35404 | PF 3 | 179.53 | 37.60 | | 179.59 | 1.06 | 1.07 | 35.47 | 24.23 | 176.80 | 22.00 | | 2.73 | 0.0000 | 0.24 | 0.000453 |
| Reach-1 | 35404 | PF 4 | 180.09 | 51.90 | | 180.15 | 0.82 | 1.14 | 63.59 | 122.68 | 176.80 | 22.00 | | 3.29 | 0.0000 | 0.23 | 0.000387 |
| Reach-1 | 36000 | Max Observed | 180.88 | 92.50 | | 180.96 | 0.27 | 1.32 | 348.36 | 666.03 | 176.90 | 60.00 | | 3.98 | 0.0017 | 0.24 | 0.000373 |
| Reach-1 | 36000 | 100yr | 180.58 | 66.10 | | 180.65 | 0.40 | 1.19 | 166.02 | 543.37 | 176.90 | 60.00 | | 3.68 | 0.0017 | 0.22 | 0.000344 |
| Reach-1 | 36000 | PF 3 | 179.56 | 37.60 | | 179.62 | 1.11 | 1.11 | 33.83 | 20.29 | 176.90 | 60.00 | | 2.66 | 0.0017 | 0.25 | 0.000508 |
| Reach-1 | 36000 | PF 4 | 180.11 | 51.90 | | 180.18 | 0.94 | 1.18 | 55.30 | 89.76 | 176.90 | 60.00 | | 3.21 | 0.0017 | 0.24 | 0.000433 |
| Reach-1 | 37500 | Max Observed | 180.93 | 92.50 | | 181.06 | 0.37 | 1.72 | 251.10 | 515.70 | 177.00 | 150.00 | | 3.93 | 0.0007 | 0.31 | 0.000678 |
| Reach-1 | 37500 | 100yr | 180.63 | 66.10 | 178.91 | 180.74 | 0.61 | 1.54 | 109.11 | 416.57 | 177.00 | 150.00 | | 3.63 | 0.0007 | 0.29 | 0.000622 |
| Reach-1 | 37500 | PF 3 | 179.64 | 37.60 | | 179.74 | 1.41 | 1.41 | 26.73 | 15.32 | 177.00 | 150.00 | | 2.64 | 0.0007 | 0.32 | 0.000862 |
| Reach-1 | 37500 | PF 4 | 180.17 | 51.90 | | 180.29 | 1.24 | 1.51 | 41.77 | 59.06 | 177.00 | 150.00 | | 3.17 | 0.0007 | 0.31 | 0.000753 |
| Reach-1 | 39001 | Max Observed | 181.04 | 92.50 | | 181.18 | 0.32 | 1.92 | 288.46 | 743.73 | 177.10 | 150.00 | | 3.94 | 0.0007 | 0.34 | 0.000888 |
| Reach-1 | 39001 | 100yr | 180.72 | 66.10 | 179.21 | 180.86 | 0.45 | 1.76 | 145.50 | 378.43 | 177.10 | 150.00 | | 3.62 | 0.0007 | 0.33 | 0.000859 |
| Reach-1 | 39001 | PF 3 | 179.77 | 37.60 | | 179.92 | 1.68 | 1.68 | 22.33 | 11.22 | 177.10 | 150.00 | | 2.67 | 0.0007 | 0.38 | 0.001282 |
| Reach-1 | 39001 | PF 4 | 180.28 | 51.90 | | 180.45 | 1.18 | 1.81 | 43.87 | 93.43 | 177.10 | 150.00 | | 3.18 | 0.0007 | 0.37 | 0.001126 |
| Reach-1 | 40323 | Max Observed | 181.08 | 92.50 | 179.00 | 181.27 | 1.94 | 1.94 | 47.74 | 580.35 | 177.20 | 132.00 | | 3.88 | 0.0008 | 0.31 | 0.000246 |
| Reach-1 | 40323 | 100yr | 180.81 | 66.10 | 178.63 | 180.92 | 1.49 | 1.49 | 44.36 | 411.24 | 177.20 | 132.00 | | 3.61 | 0.0008 | 0.25 | 0.000161 |
| Reach-1 | 40323 | PF 3 | 179.94 | 37.60 | 178.18 | 180.00 | 1.12 | 1.12 | 33.70 | 26.13 | 177.20 | 132.00 | | 2.74 | 0.0008 | 0.22 | 0.000130 |
| Reach-1 | 40323 | PF 4 | 180.45 | 51.90 | 178.42 | 180.53 | 1.30 | 1.30 | 39.95 | 129.39 | 177.20 | 132.00 | | 3.25 | 0.0008 | 0.23 | 0.000140 |
| Reach-1 | 40573.5 | Bridge | | | | | | | | | | | | | | | |
| Reach-1 | 40824 | Max Observed | 181.12 | 92.50 | 179.00 | 181.31 | 1.92 | 1.92 | 48.21 | 592.00 | 177.20 | 0.10 | | 3.92 | 0.0000 | 0.31 | 0.000238 |
| Reach-1 | 40824 | 100yr | 180.83 | 66.10 | 178.63 | 180.94 | 1.48 | 1.48 | 44.63 | 418.47 | 177.20 | 0.10 | | 3.63 | 0.0000 | 0.25 | 0.000157 |
| Reach-1 | 40824 | PF 3 | 179.96 | 37.60 | 178.18 | 180.02 | 1.11 | 1.11 | 33.89 | 29.28 | 177.20 | 0.10 | | 2.76 | 0.0000 | 0.21 | 0.000127 |
| Reach-1 | 40824 | PF 4 | 180.47 | 51.90 | 178.42 | 180.55 | 1.29 | 1.29 | 40.17 | 133.09 | 177.20 | 0.10 | | 3.27 | 0.0000 | 0.23 | 0.000138 |
| Reach-1 | 41106 | Max Observed | 181.20 | 92.50 | 179.39 | 181.34 | 0.64 | 1.71 | 144.05 | 412.52 | 177.30 | 28.00 | | 3.90 | 0.0036 | 0.30 | 0.000572 |
| Reach-1 | 41106 | 100yr | 180.86 | 66.10 | | 180.96 | 0.90 | 1.38 | 73.06 | 66.41 | 177.30 | 28.00 | | 3.56 | 0.0036 | 0.25 | 0.000429 |
| Reach-1 | 41106 | PF 3 | 179.96 | 37.60 | | 180.03 | 1.04 | 1.15 | 36.16 | 28.66 | 177.30 | 28.00 | | 2.66 | 0.0036 | 0.25 | 0.000483 |
| Reach-1 | 41106 | PF 4 | 180.48 | 51.90 | | 180.56 | 0.96 | 1.26 | 54.30 | 40.98 | 177.30 | 28.00 | | 3.18 | 0.0036 | 0.25 | 0.000429 |
| Reach-1 | 42000 | Max Observed | 181.36 | 81.60 | | 181.40 | 0.27 | 0.97 | 304.32 | 685.69 | 177.30 | 90.00 | | 4.06 | 0.0000 | 0.16 | 0.000165 |
| Reach-1 | 42000 | 100yr | 180.96 | 59.50 | | 181.00 | 0.52 | 0.84 | 114.58 | 112.26 | 177.30 | 90.00 | | 3.66 | 0.0000 | 0.15 | 0.000146 |
| Reach-1 | 42000 | PF 3 | 180.04 | 32.60 | | 180.06 | 0.59 | 0.67 | 55.10 | 43.68 | 177.30 | 90.00 | | 2.74 | 0.0000 | 0.15 | 0.000150 |
| Reach-1 | 42000 | PF 4 | 180.57 | 46.10 | | 180.60 | 0.56 | 0.76 | 82.81 | 61.49 | 177.30 | 90.00 | | 3.27 | 0.0000 | 0.15 | 0.000142 |
| Reach-1 | 43501 | Max Observed | 181.38 | 81.60 | | 181.43 | 0.24 | 1.03 | 339.27 | 829.59 | 177.50 | 150.00 | | 3.88 | 0.0013 | 0.18 | 0.000205 |
| Reach-1 | 43501 | 100yr | 180.98 | 59.50 | | 181.03 | 0.48 | 0.93 | 123.84 | 176.96 | 177.50 | 150.00 | | 3.48 | 0.0013 | 0.17 | 0.000197 |
| Reach-1 | 43501 | PF 3 | 180.07 | 32.60 | | 180.10 | 0.76 | 0.76 | 42.74 | 23.14 | 177.50 | 150.00 | | 2.57 | 0.0013 | 0.17 | 0.000218 |
| Reach-1 | 43501 | PF 4 | 180.59 | 46.10 | | 180.63 | 0.67 | 0.85 | 69.20 | 100.07 | 177.50 | 150.00 | | 3.09 | 0.0013 | 0.17 | 0.000202 |
| Reach-1 | 44302 | Max Observed | 181.40 | 81.60 | | 181.45 | 0.23 | 1.01 | 354.79 | 854.71 | 177.50 | 80.00 | | 3.90 | 0.0000 | 0.18 | 0.000198 |
| Reach-1 | 44302 | 100yr | 181.00 | 59.50 | | 181.04 | 0.47 | 0.94 | 126.63 | 360.01 | 177.50 | 80.00 | | 3.50 | 0.0000 | 0.17 | 0.000200 |
| Reach-1 | 44302 | PF 3 | 180.08 | 32.60 | | 180.11 | 0.76 | 0.76 | 43.16 | 23.89 | 177.50 | 80.00 | | 2.58 | 0.0000 | 0.17 | 0.000212 |
| Reach-1 | 44302 | PF 4 | 180.61 | 46.10 | | 180.64 | 0.65 | 0.85 | 70.91 | 103.35 | 177.50 | 80.00 | | 3.11 | 0.0000 | 0.17 | 0.000198 |
| Reach-1 | 44323 | Max Observed | 181.40 | 81.60 | | 181.45 | 0.23 | 1.01 | 355.22 | 855.43 | 177.50 | 22.00 | | 3.90 | 0.0000 | 0.18 | 0.000198 |
| Reach-1 | 44323 | 100yr | 181.00 | 59.50 | | 181.04 | 0.47 | 0.94 | 126.80 | 360.31 | 177.50 | 22.00 | | 3.50 | 0.0000 | 0.17 | 0.000200 |
| Reach-1 | 44323 | PF 3 | 180.08 | 32.60 | | 180.11 | 0.76 | 0.76 | 43.17 | 23.91 | 177.50 | 22.00 | | 2.58 | 0.0000 | 0.17 | 0.000212 |
| Reach-1 | 44323 | PF 4 | 180.61 | 46.10 | | 180.64 | 0.65 | 0.85 | 70.96 | 103.44 | 177.50 | 22.00 | | 3.11 | 0.0000 | 0.17 | 0.000197 |
| Reach-1 | 44704 | Max Observed | 181.41 | 81.60 | | 181.47 | 0.38 | 1.15 | 214.52 | 590.61 | 177.70 | 38.00 | | 3.71 | 0.0053 | 0.21 | 0.000276 |
| Reach-1 | 44704 | 100yr | 181.01 | 59.50 | | 181.06 | 0.62 | 1.00 | 95.61 | 142.52 | 177.70 | 38.00 | | 3.31 | 0.0053 | 0.19 | 0.000250 |
| Reach-1 | 44704 | PF 3 | 180.09 | 32.60 | | 180.13 | 0.83 | 0.83 | 39.12 | 20.10 | 177.70 | 38.00 | | 2.39 | 0.0053 | 0.19 | 0.000281 |
| Reach-1 | 44704 | PF 4 | 180.61 | 46.10 | | 180.66 | 0.82 | 0.92 | 55.99 | 54.43 | 177.70 | 38.00 | | 2.9 | | | |

HEC-RAS Plan: LTRiv-ExCond1 River: RIVER-1 Reach: Reach-1 (Continued)

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope |
|---------|-----------|--------------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|------------|
| | | | (m) | (m³/s) | (m) | (m) | (m/s) | (m/s) | (m²) | (m) | (m) | (m) | (m) | | | (m/m) |
| Reach-1 | 46304 | PF 3 | 180.22 | 25.10 | | 180.30 | 1.20 | 1.20 | 20.94 | 14.14 | 178.40 | 10.00 | 1.82 | 0.0000 | 0.31 | 0.000861 |
| Reach-1 | 46304 | PF 4 | 180.93 | 36.60 | | 180.99 | 1.17 | 1.17 | 31.40 | 15.73 | 178.40 | 10.00 | 2.53 | 0.0000 | 0.26 | 0.000563 |
| Reach-1 | 47100 | Max Observed | 181.60 | 62.50 | | 181.61 | 0.08 | 0.79 | 793.61 | 1264.13 | 178.30 | 80.00 | 3.30 | -0.0012 | 0.15 | 0.000191 |
| Reach-1 | 47100 | 100yr | 181.52 | 48.10 | | 181.53 | 0.07 | 0.69 | 699.78 | 1229.72 | 178.30 | 80.00 | 3.22 | -0.0012 | 0.13 | 0.000149 |
| Reach-1 | 47100 | PF 3 | 180.29 | 25.10 | | 180.41 | 1.54 | 1.54 | 16.29 | 10.16 | 178.30 | 80.00 | 1.99 | -0.0012 | 0.39 | 0.001411 |
| Reach-1 | 47100 | PF 4 | 180.96 | 36.60 | 179.72 | 181.07 | 0.44 | 1.49 | 83.40 | 973.88 | 178.30 | 80.00 | 2.66 | -0.0012 | 0.33 | 0.000960 |
| Reach-1 | 48000 | Max Observed | 181.60 | 62.50 | | 181.66 | 0.20 | 1.28 | 306.54 | 1186.35 | 178.30 | 90.00 | 3.30 | 0.0000 | 0.26 | 0.000471 |
| Reach-1 | 48000 | 100yr | 181.52 | 48.10 | | 181.57 | 0.22 | 1.09 | 220.54 | 1120.95 | 178.30 | 90.00 | 3.22 | 0.0000 | 0.22 | 0.000355 |
| Reach-1 | 48000 | PF 3 | 180.45 | 25.10 | | 180.51 | 1.13 | 1.13 | 22.12 | 14.59 | 178.30 | 90.00 | 2.15 | 0.0000 | 0.29 | 0.000728 |
| Reach-1 | 48000 | PF 4 | 181.08 | 36.60 | | 181.15 | 0.86 | 1.14 | 42.42 | 137.16 | 178.30 | 90.00 | 2.78 | 0.0000 | 0.26 | 0.000507 |
| Reach-1 | 48500 | Max Observed | 181.65 | 62.50 | | 181.69 | 0.12 | 1.02 | 509.57 | 1383.01 | 178.20 | 50.00 | 3.45 | -0.0020 | 0.20 | 0.000277 |
| Reach-1 | 48500 | 100yr | 181.56 | 48.10 | | 181.59 | 0.12 | 0.89 | 389.05 | 1269.21 | 178.20 | 50.00 | 3.36 | -0.0020 | 0.18 | 0.000224 |
| Reach-1 | 48500 | PF 3 | 180.50 | 25.10 | | 180.55 | 1.03 | 1.03 | 24.30 | 15.18 | 178.20 | 50.00 | 2.30 | -0.0020 | 0.26 | 0.000562 |
| Reach-1 | 48500 | PF 4 | 181.12 | 36.60 | | 181.17 | 0.52 | 1.04 | 70.68 | 280.65 | 178.20 | 50.00 | 2.92 | -0.0020 | 0.23 | 0.000391 |
| Reach-1 | 49000 | Max Observed | 181.66 | 62.50 | | 181.72 | 0.19 | 1.14 | 322.31 | 1232.84 | 178.20 | 50.00 | 3.46 | 0.0000 | 0.23 | 0.000362 |
| Reach-1 | 49000 | 100yr | 181.57 | 48.10 | | 181.61 | 0.22 | 0.98 | 215.81 | 1087.74 | 178.20 | 50.00 | 3.37 | 0.0000 | 0.20 | 0.000283 |
| Reach-1 | 49000 | PF 3 | 180.53 | 25.10 | | 180.58 | 0.95 | 0.95 | 26.45 | 16.09 | 178.20 | 50.00 | 2.33 | 0.0000 | 0.24 | 0.000456 |
| Reach-1 | 49000 | PF 4 | 181.14 | 36.60 | | 181.19 | 0.78 | 0.98 | 46.91 | 147.51 | 178.20 | 50.00 | 2.94 | 0.0000 | 0.22 | 0.000366 |
| Reach-1 | 50350 | Max Observed | 181.71 | 62.50 | | 181.76 | 0.16 | 1.06 | 390.20 | 1306.49 | 178.20 | 135.00 | 3.51 | 0.0000 | 0.21 | 0.000305 |
| Reach-1 | 50350 | 100yr | 181.61 | 48.10 | | 181.65 | 0.18 | 0.93 | 261.93 | 1163.42 | 178.20 | 135.00 | 3.41 | 0.0000 | 0.19 | 0.000251 |
| Reach-1 | 50350 | PF 3 | 180.59 | 25.10 | | 180.64 | 0.91 | 0.91 | 27.47 | 16.35 | 178.20 | 135.00 | 2.39 | 0.0000 | 0.23 | 0.000411 |
| Reach-1 | 50350 | PF 4 | 181.19 | 36.60 | | 181.24 | 0.66 | 0.96 | 55.34 | 183.42 | 178.20 | 135.00 | 2.99 | 0.0000 | 0.21 | 0.000334 |
| Reach-1 | 51701 | Max Observed | 181.76 | 62.50 | | 181.80 | 0.14 | 1.00 | 447.72 | 1365.78 | 178.20 | 135.00 | 3.56 | 0.0000 | 0.19 | 0.000265 |
| Reach-1 | 51701 | 100yr | 181.65 | 48.10 | | 181.68 | 0.16 | 0.89 | 304.50 | 1212.78 | 178.20 | 135.00 | 3.45 | 0.0000 | 0.18 | 0.000225 |
| Reach-1 | 51701 | PF 3 | 180.65 | 25.10 | | 180.69 | 0.88 | 0.88 | 28.40 | 16.58 | 178.20 | 135.00 | 2.45 | 0.0000 | 0.22 | 0.000375 |
| Reach-1 | 51701 | PF 4 | 181.24 | 36.60 | | 181.28 | 0.57 | 0.93 | 64.63 | 216.03 | 178.20 | 135.00 | 3.04 | 0.0000 | 0.20 | 0.000306 |
| Reach-1 | 52302 | Max Observed | 181.76 | 62.50 | 179.99 | 181.87 | 1.44 | 1.44 | 43.49 | 1425.28 | 178.20 | 60.00 | 3.56 | 0.0000 | 0.27 | 0.000474 |
| Reach-1 | 52302 | 100yr | 181.66 | 48.10 | 179.77 | 181.72 | 1.15 | 1.15 | 41.86 | 1260.06 | 178.20 | 60.00 | 3.45 | 0.0000 | 0.22 | 0.000319 |
| Reach-1 | 52302 | PF 3 | 180.67 | 25.10 | 179.30 | 180.72 | 0.92 | 0.92 | 27.22 | 17.05 | 178.20 | 60.00 | 2.47 | 0.0000 | 0.22 | 0.000365 |
| Reach-1 | 52302 | PF 4 | 181.26 | 36.60 | 179.56 | 181.31 | 1.02 | 1.02 | 35.94 | 227.57 | 178.20 | 60.00 | 3.06 | 0.0000 | 0.21 | 0.000307 |
| Reach-1 | 52352.5 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 52403 | Max Observed | 181.88 | 62.50 | 179.99 | 181.97 | 1.38 | 1.38 | 45.17 | 1557.14 | 178.20 | 0.10 | 3.68 | 0.0000 | 0.25 | 0.000418 |
| Reach-1 | 52403 | 100yr | 181.66 | 48.10 | 179.77 | 181.73 | 1.15 | 1.15 | 41.93 | 1268.82 | 178.20 | 0.10 | 3.46 | 0.0000 | 0.22 | 0.000317 |
| Reach-1 | 52403 | PF 3 | 180.68 | 25.10 | 179.30 | 180.72 | 0.92 | 0.92 | 27.26 | 17.06 | 178.20 | 0.10 | 2.47 | 0.0000 | 0.22 | 0.000363 |
| Reach-1 | 52403 | PF 4 | 181.26 | 36.60 | 179.56 | 181.31 | 1.02 | 1.02 | 35.99 | 229.95 | 178.20 | 0.10 | 3.06 | 0.0000 | 0.21 | 0.000306 |
| Reach-1 | 52804 | Max Observed | 182.02 | 62.50 | | 182.03 | 0.07 | 0.69 | 852.38 | 1730.85 | 178.20 | 40.00 | 3.82 | 0.0000 | 0.13 | 0.000111 |
| Reach-1 | 52804 | 100yr | 181.74 | 48.10 | | 181.76 | 0.11 | 0.79 | 419.76 | 1337.29 | 178.20 | 40.00 | 3.54 | 0.0000 | 0.15 | 0.000168 |
| Reach-1 | 52804 | PF 3 | 180.70 | 25.10 | | 180.74 | 0.86 | 0.86 | 29.19 | 16.77 | 178.20 | 40.00 | 2.50 | 0.0000 | 0.21 | 0.000348 |
| Reach-1 | 52804 | PF 4 | 181.29 | 36.60 | | 181.33 | 0.48 | 0.90 | 76.71 | 252.16 | 178.20 | 40.00 | 3.09 | 0.0000 | 0.19 | 0.000278 |
| Reach-1 | 54000 | Max Observed | 182.03 | 57.50 | | 182.04 | 0.07 | 0.60 | 846.12 | 1925.61 | 178.30 | 120.00 | 3.73 | 0.0008 | 0.11 | 0.000086 |
| Reach-1 | 54000 | 100yr | 181.76 | 45.10 | | 181.78 | 0.12 | 0.69 | 382.15 | 1474.52 | 178.30 | 120.00 | 3.46 | 0.0008 | 0.14 | 0.000129 |
| Reach-1 | 54000 | PF 3 | 180.75 | 22.90 | | 180.77 | 0.67 | 0.67 | 34.06 | 19.89 | 178.30 | 120.00 | 2.45 | 0.0008 | 0.16 | 0.000212 |
| Reach-1 | 54000 | PF 4 | 181.34 | 34.00 | | 181.36 | 0.44 | 0.72 | 76.61 | 256.15 | 178.30 | 120.00 | 3.04 | 0.0008 | 0.16 | 0.000180 |
| Reach-1 | 55200 | Max Observed | 182.05 | 57.50 | | 182.05 | 0.05 | 0.47 | 1189.49 | 1783.18 | 178.40 | 120.00 | 3.64 | 0.0008 | 0.09 | 0.000053 |
| Reach-1 | 55200 | 100yr | 181.78 | 45.10 | | 181.79 | 0.06 | 0.50 | 790.28 | 1341.31 | 178.40 | 120.00 | 3.38 | 0.0008 | 0.10 | 0.000070 |
| Reach-1 | 55200 | PF 3 | 180.78 | 22.90 | | 180.81 | 0.82 | 0.82 | 28.05 | 17.02 | 178.40 | 120.00 | 2.38 | 0.0008 | 0.20 | 0.000333 |
| Reach-1 | 55200 | PF 4 | 181.37 | 34.00 | | 181.38 | 0.11 | 0.69 | 308.50 | 995.87 | 178.40 | 120.00 | 2.97 | 0.0008 | 0.15 | 0.000167 |
| Reach-1 | 56150 | Max Observed | 182.05 | 57.50 | | 182.05 | 0.05 | 0.47 | 1194.94 | 1789.27 | 178.50 | 95.00 | 3.55 | 0.0011 | 0.09 | 0.000054 |
| Reach-1 | 56150 | 100yr | 181.79 | 45.10 | | 181.80 | 0.06 | 0.50 | 795.90 | 1346.47 | 178.50 | 95.00 | 3.29 | 0.0011 | 0.10 | 0.000071 |
| Reach-1 | 56150 | PF 3 | 180.81 | 22.90 | | 180.84 | 0.84 | 0.84 | 27.37 | 17.12 | 178.50 | 95.00 | 2.31 | 0.0011 | 0.21 | 0.000363 |
| Reach-1 | 56150 | PF 4 | 181.38 | 34.00 | | 181.40 | 0.11 | 0.69 | 321.96 | 1005.83 | 178.50 | 95.00 | 2.88 | 0.0011 | 0.15 | 0.000171 |
| Reach-1 | 57100 | Max Observed | 182.05 | 57.50 | | 182.06 | 0.05 | 0.46 | 1201.48 | 1795.20 | 178.50 | 95.00 | 3.55 | 0.0000 | 0.09 | 0.000054 |
| Reach-1 | 57100 | 100yr | 181.79 | 45.10 | | 181.80 | 0.06 | 0.50 | 802.73 | 1351.60 | 178.50 | 95.00 | 3.29 | 0.0000 | 0.10 | 0.000070 |
| Reach-1 | 57100 | PF 3 | 180.84 | 22.90 | | 180.88 | 0.82 | 0.82 | 27.98 | 17.28 | 178.50 | 95.00 | 2.34 | 0.0000 | 0.21 | 0.000341 |
| Reach-1 | 57100 | PF 4 | 181.40 | 34.00 | | 181.41 | 0.10 | 0.67 | 337.13 | 1016.02 | 178.50 | 95.00 | 2.90 | 0.0000 | 0.15 | 0.000162 |
| Reach-1 | 59000 | Max Observed | 182.06 | 57.50 | | 182.08 | 0.08 | 0.74 | 729.81 | 1453.62 | 178.70 | 190.00 | 3.36 | 0.0011 | 0.14 | 0.000142 |
| Reach-1 | 59000 | 100yr | 181.80 | 45.10 | | 181.83 | 0.12 | 0.86 | 382.78 | 1197.87 | 178.70 | 190.00 | 3.10 | 0.0011 | 0.18 | 0.000220 |
| Reach-1 | 59000 | PF 3 | 180.91 | 22.90 | | 180.96 | 0.93 | 0.93 | 24.62 | 15.64 | 178.70 | 190.00 | 2.21 | 0.0011 | 0.24 | 0.000463 |
| Reach-1 | 59000 | PF 4 | 181.42 | 34.00 | | 181.47 | 0.46 | 1.00 | 73.92 | 274.00 | 178.70 | 190.00 | 2.72 | 0.0011 | 0.22 | 0.000380 |
| Reach-1 | 59201 | Max Observed | 182.07 | 47.20 | | 182.08 | 0.06 | 0.60 | 743.16 | 1462.58 | 178.70 | 20.00 | 3.37 | 0.0000 | 0.12 | 0.000093 |
| Reach-1 | 59201 | 100yr | 181.82 | 37.70 | | 181.84 | 0.09 | 0.70 | 402.07 | 1221.78 | 178.70 | 20.00 | 3.12 | 0.0000 | 0.14 | 0.000146 |
| Reach-1 | 59201 | PF 3 | 180.94 | 18.10 | | 180.97 | 0.72 | 0.72 | 25.09 | 15.77 | 178.70 | 20.00 | 2.24 | 0.0000 | 0.18 | 0.000275 |
| Reach-1 | 59201 | PF 4 | 181.45 | 27.90 | | 181.48 | 0.34 | 0.90 | 82.25 | 293.78 | 178.70 | 20.00 | 2.75 | 0.0000 | 0.18</td | |

HEC-RAS Plan: LTRiv-ExCond1 River: RIVER-1 Reach: Reach-1 (Continued)

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope | |
|---------|-----------|--------------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|------------|----------|
| | | | (m) | (m³/s) | (m) | (m) | (m/s) | (m/s) | (m²) | (m) | (m) | (m) | (m) | (m) | (m/m) | | |
| Reach-1 | 62301 | 100yr | 181.98 | 37.70 | | 182.00 | 0.09 | 0.79 | 399.10 | 1062.69 | 179.00 | 130.00 | 2.98 | 0.0015 | 0.16 | 0.000207 | |
| Reach-1 | 62301 | PF 3 | 181.07 | 18.10 | | 181.11 | 0.94 | 0.94 | 19.28 | 11.79 | 179.00 | 130.00 | 2.07 | 0.0015 | 0.23 | 0.000487 | |
| Reach-1 | 62301 | PF 4 | 181.64 | 27.90 | | 181.68 | 0.29 | 1.00 | 95.58 | 610.20 | 179.00 | 130.00 | 2.64 | 0.0015 | 0.22 | 0.000400 | |
| Reach-1 | 62602 | Max Observed | 182.34 | 47.20 | 180.65 | 182.35 | 0.06 | 0.75 | 791.75 | 1173.27 | 179.00 | 30.00 | 3.34 | 0.0000 | 0.13 | 0.000102 | |
| Reach-1 | 62602 | 100yr | 181.99 | 37.70 | 180.42 | 182.02 | 0.09 | 1.07 | 403.28 | 1064.41 | 179.00 | 30.00 | 2.99 | 0.0000 | 0.20 | 0.000238 | |
| Reach-1 | 62602 | PF 3 | 181.08 | 18.10 | 179.87 | 181.15 | 1.23 | 1.23 | 14.74 | 11.81 | 179.00 | 30.00 | 2.08 | 0.0000 | 0.27 | 0.000513 | |
| Reach-1 | 62602 | PF 4 | 181.64 | 27.90 | 180.16 | 181.73 | 0.28 | 1.37 | 98.63 | 618.97 | 179.00 | 30.00 | 2.64 | 0.0000 | 0.27 | 0.000459 | |
| Reach-1 | 62622.5 | Bridge | | | | | | | | | | | | | | | |
| Reach-1 | 62643 | Max Observed | 182.35 | 47.20 | 180.65 | 182.36 | 0.06 | 0.74 | 806.91 | 1181.63 | 179.00 | 0.10 | 3.35 | 0.0000 | 0.13 | 0.000097 | |
| Reach-1 | 62643 | 100yr | 182.02 | 37.70 | 180.42 | 182.05 | 0.09 | 1.00 | 440.57 | 1075.88 | 179.00 | 0.10 | 3.02 | 0.0000 | 0.18 | 0.000206 | |
| Reach-1 | 62643 | PF 3 | 181.09 | 18.10 | 179.87 | 181.16 | 1.22 | 1.22 | 14.81 | 11.84 | 179.00 | 0.10 | 2.09 | 0.0000 | 0.27 | 0.000504 | |
| Reach-1 | 62643 | PF 4 | 181.67 | 27.90 | 180.16 | 181.75 | 0.23 | 1.31 | 119.41 | 675.86 | 179.00 | 0.10 | 2.67 | 0.0000 | 0.26 | 0.000418 | |
| Reach-1 | 62804 | Max Observed | 182.36 | 47.20 | | 182.36 | 0.06 | 0.56 | 815.50 | 1186.34 | 179.00 | 16.00 | 3.36 | 0.0000 | 0.11 | 0.000084 | |
| Reach-1 | 62804 | 100yr | 182.05 | 37.70 | | 182.06 | 0.08 | 0.71 | 467.31 | 1062.47 | 179.00 | 16.00 | 3.05 | 0.0000 | 0.14 | 0.000161 | |
| Reach-1 | 62804 | PF 3 | 181.15 | 18.10 | 181.19 | 180.89 | 0.89 | 0.89 | 20.28 | 12.00 | 179.00 | 16.00 | 2.15 | 0.0000 | 0.22 | 0.000422 | |
| Reach-1 | 62804 | PF 4 | 181.76 | 27.90 | | 181.79 | 0.16 | 0.85 | 179.29 | 805.09 | 179.00 | 16.00 | 2.76 | 0.0000 | 0.18 | 0.000272 | |
| Reach-1 | 66000 | Max Observed | 182.38 | 47.20 | | 182.39 | 0.05 | 0.54 | 885.68 | 1520.28 | 179.40 | 320.00 | 2.98 | 0.0013 | 0.12 | 0.000107 | |
| Reach-1 | 66000 | 100yr | 182.10 | 37.70 | | 182.12 | 0.08 | 0.77 | 474.59 | 1402.09 | 179.40 | 320.00 | 2.70 | 0.0013 | 0.18 | 0.000260 | |
| Reach-1 | 66000 | PF 3 | 181.32 | 18.10 | 181.39 | 180.57 | 1.14 | 31.81 | 158.70 | 179.40 | 320.00 | 1.92 | 0.0013 | 0.30 | 0.000836 | | |
| Reach-1 | 66000 | PF 4 | 181.85 | 27.90 | | 181.88 | 0.12 | 0.86 | 227.09 | 641.86 | 179.40 | 320.00 | 2.45 | 0.0013 | 0.21 | 0.000370 | |
| Reach-1 | 67250 | Max Observed | 182.39 | 38.70 | | 182.40 | 0.06 | 0.58 | 673.44 | 1460.45 | 179.55 | 125.00 | 2.84 | 0.0012 | 0.13 | 0.000136 | |
| Reach-1 | 67250 | 100yr | 182.12 | 33.10 | | 182.14 | 0.11 | 0.85 | 312.87 | 823.84 | 179.55 | 125.00 | 2.57 | 0.0012 | 0.20 | 0.000345 | |
| Reach-1 | 67250 | PF 3 | 181.44 | 14.20 | | 181.48 | 0.54 | 0.93 | 26.44 | 134.15 | 179.55 | 125.00 | 1.89 | 0.0012 | 0.25 | 0.000565 | |
| Reach-1 | 67250 | PF 4 | 181.89 | 23.70 | | 181.92 | 0.15 | 0.87 | 161.70 | 508.91 | 179.55 | 125.00 | 2.34 | 0.0012 | 0.21 | 0.000400 | |
| Reach-1 | 68501 | Max Observed | 182.40 | 38.70 | | 182.42 | 0.08 | 0.77 | 474.59 | 1401.71 | 179.70 | 125.00 | 2.70 | 0.0012 | 0.18 | 0.000262 | |
| Reach-1 | 68501 | 100yr | 182.15 | 33.10 | | 182.19 | 0.14 | 0.99 | 228.64 | 643.62 | 179.70 | 125.00 | 2.45 | 0.0012 | 0.24 | 0.000489 | |
| Reach-1 | 68501 | PF 3 | 181.51 | 14.20 | | 181.55 | 0.76 | 0.96 | 18.61 | 82.86 | 179.70 | 125.00 | 1.81 | 0.0012 | 0.26 | 0.000633 | |
| Reach-1 | 68501 | PF 4 | 181.93 | 23.70 | | 181.97 | 0.21 | 0.98 | 114.86 | 384.70 | 179.70 | 125.00 | 2.23 | 0.0012 | 0.25 | 0.000529 | |
| Reach-1 | 69023 | Max Observed | 182.41 | 38.70 | 181.08 | 182.43 | 0.07 | 0.82 | 529.49 | 1468.38 | 179.90 | 52.00 | 2.51 | 0.0038 | 0.17 | 0.000188 | |
| Reach-1 | 69023 | 100yr | 182.17 | 33.10 | 180.97 | 182.27 | 1.40 | 1.40 | 23.72 | 882.52 | 179.90 | 52.00 | 2.27 | 0.0038 | 0.30 | 0.000632 | |
| Reach-1 | 69023 | PF 3 | 181.55 | 14.20 | 180.55 | 181.60 | 0.83 | 0.83 | 17.07 | 17.97 | 179.90 | 52.00 | 1.66 | 0.0000 | 0.21 | 0.000348 | |
| Reach-1 | 69023 | PF 4 | 181.95 | 23.70 | | 182.02 | 1.11 | 1.11 | 21.37 | 518.03 | 179.90 | 52.00 | 2.05 | 0.0038 | 0.25 | 0.000459 | |
| Reach-1 | 69118.5 | Bridge | | | | | | | | | | | | | | | |
| Reach-1 | 69214 | Max Observed | 182.58 | 38.70 | 181.08 | 182.59 | 0.05 | 0.58 | 807.56 | 1829.13 | 179.90 | 0.10 | 2.68 | 0.0000 | 0.12 | 0.000088 | |
| Reach-1 | 69214 | 100yr | 182.19 | 33.10 | 180.97 | 182.29 | 1.38 | 1.38 | 23.98 | 922.83 | 179.90 | 0.10 | 2.29 | 0.0000 | 0.30 | 0.000609 | |
| Reach-1 | 69214 | PF 3 | 181.56 | 14.20 | 180.55 | 181.60 | 0.83 | 0.83 | 17.07 | 17.97 | 179.90 | 0.10 | 1.66 | 0.0000 | 0.21 | 0.000348 | |
| Reach-1 | 69214 | PF 4 | 181.97 | 23.70 | | 180.78 | 182.03 | 1.10 | 1.10 | 21.54 | 544.25 | 179.90 | 0.10 | 2.07 | 0.0000 | 0.25 | 0.000447 |
| Reach-1 | 69736 | Max Observed | 182.58 | 38.70 | | 182.59 | 0.05 | 0.58 | 816.58 | 1831.67 | 179.90 | 52.00 | 2.68 | 0.0000 | 0.11 | 0.000086 | |
| Reach-1 | 69736 | 100yr | 182.33 | 33.10 | | 182.35 | 0.08 | 0.79 | 427.31 | 1256.83 | 179.90 | 52.00 | 2.43 | 0.0000 | 0.16 | 0.000182 | |
| Reach-1 | 69736 | PF 3 | 181.58 | 14.20 | | 181.61 | 0.66 | 0.81 | 21.57 | 18.11 | 179.90 | 52.00 | 1.68 | 0.0000 | 0.20 | 0.000320 | |
| Reach-1 | 69736 | PF 4 | 182.03 | 23.70 | | 182.07 | 0.16 | 0.90 | 147.64 | 648.22 | 179.90 | 52.00 | 2.13 | 0.0000 | 0.20 | 0.000284 | |
| Reach-1 | 71000 | Max Observed | 182.58 | 38.70 | | 182.67 | 1.33 | 1.33 | 29.13 | 16.87 | 179.90 | 127.00 | 2.68 | 0.0000 | 0.31 | 0.000748 | |
| Reach-1 | 71000 | 100yr | 182.36 | 33.10 | | 182.45 | 1.26 | 1.26 | 25.78 | 14.54 | 179.90 | 127.00 | 2.46 | 0.0000 | 0.31 | 0.000780 | |
| Reach-1 | 71000 | PF 3 | 181.63 | 14.20 | | 181.67 | 0.89 | 0.89 | 16.03 | 12.13 | 179.90 | 127.00 | 1.73 | 0.0000 | 0.25 | 0.000539 | |
| Reach-1 | 71000 | PF 4 | 182.08 | 23.70 | | 182.14 | 1.09 | 1.09 | 21.81 | 13.61 | 179.90 | 127.00 | 2.18 | 0.0000 | 0.27 | 0.000636 | |
| Reach-1 | 72801 | Max Observed | 182.72 | 38.70 | 181.31 | 182.80 | 0.52 | 1.22 | 74.73 | 369.99 | 179.90 | 180.00 | 2.82 | 0.0000 | 0.27 | 0.000583 | |
| Reach-1 | 72801 | 100yr | 182.50 | 33.10 | | 182.58 | 1.21 | 1.21 | 27.34 | 16.24 | 179.90 | 180.00 | 2.60 | 0.0000 | 0.29 | 0.000668 | |
| Reach-1 | 72801 | PF 3 | 181.73 | 14.20 | | 181.76 | 0.85 | 0.85 | 16.69 | 12.39 | 179.90 | 180.00 | 1.83 | 0.0000 | 0.23 | 0.000484 | |
| Reach-1 | 72801 | PF 4 | 182.19 | 23.70 | | 182.25 | 1.04 | 1.04 | 22.85 | 13.97 | 179.90 | 180.00 | 2.29 | 0.0000 | 0.26 | 0.000562 | |
| Reach-1 | 73102 | Max Observed | 182.73 | 38.70 | 181.35 | 182.86 | 0.36 | 1.71 | 108.90 | 387.35 | 179.90 | 30.00 | 2.83 | 0.0000 | 0.32 | 0.000659 | |
| Reach-1 | 73102 | 100yr | 182.51 | 33.10 | 181.20 | 182.67 | 1.22 | 1.78 | 27.13 | 351.31 | 179.90 | 30.00 | 2.61 | 0.0000 | 0.35 | 0.000796 | |
| Reach-1 | 73102 | PF 3 | 181.74 | 14.20 | 180.64 | 181.80 | 1.09 | 1.09 | 13.04 | 10.28 | 179.90 | 30.00 | 1.84 | 0.0000 | 0.26 | 0.000475 | |
| Reach-1 | 73102 | PF 4 | 182.20 | 23.70 | | 180.95 | 182.31 | 1.45 | 1.45 | 16.34 | 11.08 | 179.90 | 30.00 | 2.30 | 0.0000 | 0.31 | 0.000623 |
| Reach-1 | 73162.5 | Bridge | | | | | | | | | | | | | | | |
| Reach-1 | 73223 | Max Observed | 182.96 | 38.70 | 181.35 | 183.13 | 1.78 | 1.78 | 21.75 | 425.51 | 179.90 | 0.10 | 3.06 | 0.0000 | 0.32 | 0.000640 | |
| Reach-1 | 73223 | 100yr | 182.65 | 33.10 | 181.20 | 182.80 | 1.69 | 1.69 | 19.56 | 375.18 | 179.90 | 0.10 | 2.75 | 0.0000 | 0.33 | 0.000668 | |
| Reach-1 | 73223 | PF 3 | 181.75 | 14.20 | 180.64 | 181.81 | 1.08 | 1.08 | 13.15 | 10.31 | 179.90 | 0.10 | 1.85 | 0.0000 | 0.25 | 0.000462 | |
| Reach-1 | 73223 | PF 4 | 182.23 | 23.70 | | 180.95 | 182.33 | 1.43 | 1.43 | 16.54 | 11.13 | 179.90 | 0.10 | 2.33 | 0.0000 | 0.30 | 0.000598 |
| Reach-1 | 73404 | Max Observed | 183.19 | 38.70 | | 183.22 | 0.11 | 0.78 | 343.61 | 671.83 | 179.90 | 18.00 | 3.29 | 0.0000 | 0.15 | 0.000181 | |
| Reach-1 | 73404 | 100yr | 182.83 | 33.10 | | 182.87 | 0.22 | 0.99 | 148.32 | 403.58 | 179.90 | 18.00 | 2.93 | 0.0000 | 0.20 | 0.000352 | |
| Reach-1 | 73404 | PF 3 | 181.79 | 14.20 | | 181.83 | 0.86 | 0.86 | 16.56 | 10.38 | 179.90 | 18.00 | 1.89 | 0.0000 | 0.22 | 0.000438 | |
| Reach-1 | 73404 | PF 4 | 182.31 | 23.70 | | 182.37 | 1.07 | 1.07 | 22.18 | 11.28 | 179.90 | 18.00 | 2.41 | 0.0000 | 0.24 | 0.000532 | |
| Reach-1 | 75800 | Max Observed | 183.24 | 38.70 | | 183.28 | 0.20 | 1.03 | 194.93 | 422.00 | 180.20 | 240.00 | 3.04 | 0.0012 | 0.21 | 0.000353 | |
| Reach-1 | 75800 | 100yr | 182.92 | 33.10 | | | | | | | | | | | | | |

HEC-RAS Plan: LTRiv-ExCond1 River: RIVER-1 Reach: Reach-1 (Continued)

| Reach | River Sta | Profile | W.S. Elev (m) | Q Total (m³/s) | Crit W.S. (m) | E.G. Elev (m) | Vel Total (m/s) | Vel Chnl (m/s) | Flow Area (m²) | Top Width (m) | Min Ch El (m) | Length Chnl (m) | Max Chl Dpth (m) | Invert Slope | Froude # Chl | E.G. Slope (m/m) |
|---------|-----------|--------------|------------------|-------------------|------------------|------------------|--------------------|-------------------|-------------------|------------------|------------------|--------------------|---------------------|--------------|--------------|---------------------|
| Reach-1 | 78553 | 100yr | 183.27 | 33.10 | 182.02 | 183.38 | 1.43 | 1.43 | 23.16 | 12.45 | 180.40 | 0.10 | 2.87 | 0.0000 | 0.33 | 0.000941 |
| Reach-1 | 78553 | PF 3 | 182.21 | 14.20 | 181.41 | 182.28 | 1.23 | 1.23 | 11.51 | 9.24 | 180.40 | 0.10 | 1.81 | 0.0000 | 0.35 | 0.001179 |
| Reach-1 | 78553 | PF 4 | 182.76 | 23.70 | 181.75 | 182.86 | 1.39 | 1.39 | 17.09 | 11.00 | 180.40 | 0.10 | 2.36 | 0.0000 | 0.36 | 0.001123 |
| Reach-1 | 78704 | Max Observed | 183.51 | 38.70 | 182.19 | 183.63 | 1.48 | 1.54 | 26.17 | 97.20 | 180.40 | 15.00 | 3.11 | 0.0000 | 0.35 | 0.001009 |
| Reach-1 | 78704 | 100yr | 183.29 | 33.10 | 183.40 | 183.40 | 1.48 | 1.48 | 22.39 | 12.02 | 180.40 | 15.00 | 2.89 | 0.0000 | 0.35 | 0.001031 |
| Reach-1 | 78704 | PF 3 | 182.22 | 14.20 | 182.30 | 182.30 | 1.26 | 1.26 | 11.29 | 8.88 | 180.40 | 15.00 | 1.82 | 0.0000 | 0.36 | 0.001210 |
| Reach-1 | 78704 | PF 4 | 182.77 | 23.70 | 182.88 | 183.43 | 1.43 | 1.43 | 16.63 | 10.51 | 180.40 | 15.00 | 2.37 | 0.0000 | 0.36 | 0.001179 |
| Reach-1 | 80600 | Max Observed | 183.70 | 38.70 | 182.34 | 183.82 | 1.24 | 1.50 | 31.30 | 145.71 | 180.55 | 190.00 | 3.15 | 0.0008 | 0.33 | 0.000937 |
| Reach-1 | 80600 | 100yr | 183.48 | 33.10 | 183.59 | 183.59 | 1.44 | 1.44 | 22.95 | 12.15 | 180.55 | 190.00 | 2.93 | 0.0008 | 0.34 | 0.000965 |
| Reach-1 | 80600 | PF 3 | 182.45 | 14.20 | 182.52 | 182.52 | 1.19 | 1.19 | 11.96 | 9.10 | 180.55 | 190.00 | 1.90 | 0.0008 | 0.33 | 0.001036 |
| Reach-1 | 80600 | PF 4 | 183.00 | 23.70 | 183.09 | 183.09 | 1.36 | 1.36 | 17.40 | 10.72 | 180.55 | 190.00 | 2.45 | 0.0008 | 0.34 | 0.001044 |
| Reach-1 | 82500 | Max Observed | 183.88 | 38.70 | 183.98 | 183.98 | 0.53 | 1.44 | 72.73 | 256.63 | 180.70 | 190.00 | 3.18 | 0.0008 | 0.31 | 0.000790 |
| Reach-1 | 82500 | 100yr | 183.66 | 33.10 | 182.36 | 183.77 | 1.06 | 1.45 | 31.16 | 115.42 | 180.70 | 190.00 | 2.96 | 0.0008 | 0.33 | 0.000915 |
| Reach-1 | 82500 | PF 3 | 182.64 | 14.20 | 182.71 | 182.71 | 1.17 | 1.17 | 12.12 | 8.98 | 180.70 | 190.00 | 1.94 | 0.0008 | 0.32 | 0.000984 |
| Reach-1 | 82500 | PF 4 | 183.19 | 23.70 | 183.29 | 183.29 | 1.35 | 1.35 | 17.49 | 10.53 | 180.70 | 190.00 | 2.49 | 0.0008 | 0.34 | 0.001013 |
| Reach-1 | 83950 | Max Observed | 184.01 | 38.70 | 184.10 | 184.10 | 0.36 | 1.36 | 108.76 | 331.73 | 180.90 | 145.00 | 3.11 | 0.0014 | 0.29 | 0.000683 |
| Reach-1 | 83950 | 100yr | 183.80 | 33.10 | 182.53 | 183.90 | 0.64 | 1.40 | 51.80 | 203.06 | 180.90 | 145.00 | 2.90 | 0.0014 | 0.32 | 0.000832 |
| Reach-1 | 83950 | PF 3 | 182.79 | 14.20 | 182.86 | 182.86 | 1.18 | 1.18 | 12.02 | 9.24 | 180.90 | 145.00 | 1.89 | 0.0014 | 0.33 | 0.001031 |
| Reach-1 | 83950 | PF 4 | 183.34 | 23.70 | 183.43 | 183.43 | 1.35 | 1.35 | 17.61 | 10.92 | 180.90 | 145.00 | 2.44 | 0.0014 | 0.34 | 0.001020 |
| Reach-1 | 85401 | Max Observed | 184.12 | 38.70 | 184.19 | 184.19 | 0.25 | 1.20 | 153.32 | 473.55 | 181.10 | 145.00 | 3.02 | 0.0014 | 0.25 | 0.000491 |
| Reach-1 | 85401 | 100yr | 183.93 | 33.10 | 184.00 | 184.00 | 0.39 | 1.22 | 85.20 | 283.54 | 181.10 | 145.00 | 2.83 | 0.0014 | 0.26 | 0.000565 |
| Reach-1 | 85401 | PF 3 | 182.94 | 14.20 | 182.99 | 182.99 | 1.03 | 1.03 | 13.82 | 10.25 | 181.10 | 145.00 | 1.84 | 0.0014 | 0.28 | 0.000733 |
| Reach-1 | 85401 | PF 4 | 183.49 | 23.70 | 183.57 | 183.57 | 1.19 | 1.19 | 19.93 | 11.68 | 181.10 | 145.00 | 2.39 | 0.0014 | 0.29 | 0.000733 |
| Reach-1 | 85702 | Max Observed | 184.13 | 38.70 | 182.81 | 184.25 | 0.25 | 1.72 | 155.77 | 483.01 | 181.10 | 30.00 | 3.03 | 0.0000 | 0.32 | 0.000648 |
| Reach-1 | 85702 | 100yr | 183.93 | 33.10 | 182.65 | 184.13 | 1.98 | 1.98 | 16.74 | 281.28 | 181.10 | 30.00 | 2.83 | 0.0000 | 0.38 | 0.000942 |
| Reach-1 | 85702 | PF 3 | 182.95 | 14.20 | 182.04 | 183.04 | 1.33 | 1.33 | 10.67 | 10.29 | 181.10 | 30.00 | 1.85 | 0.0000 | 0.32 | 0.000777 |
| Reach-1 | 85702 | PF 4 | 183.50 | 23.70 | 182.37 | 183.65 | 1.68 | 1.68 | 14.10 | 13.28 | 181.10 | 30.00 | 2.40 | 0.0000 | 0.36 | 0.000856 |
| Reach-1 | 85752.5 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 85803 | Max Observed | 184.58 | 38.70 | 182.81 | 184.60 | 0.07 | 0.96 | 535.30 | 1226.42 | 181.10 | 0.10 | 3.48 | 0.0000 | 0.17 | 0.000167 |
| Reach-1 | 85803 | 100yr | 184.19 | 33.10 | 182.66 | 184.36 | 1.80 | 1.80 | 18.37 | 600.03 | 181.10 | 0.10 | 3.09 | 0.0000 | 0.33 | 0.000691 |
| Reach-1 | 85803 | PF 3 | 182.98 | 14.20 | 182.04 | 183.06 | 1.31 | 1.31 | 10.83 | 10.36 | 181.10 | 0.10 | 1.88 | 0.0000 | 0.32 | 0.000739 |
| Reach-1 | 85803 | PF 4 | 183.57 | 23.70 | 182.37 | 183.71 | 1.63 | 1.63 | 14.51 | 57.83 | 181.10 | 0.10 | 2.47 | 0.0000 | 0.34 | 0.000777 |
| Reach-1 | 86104 | Max Observed | 184.60 | 38.70 | 184.61 | 184.61 | 0.07 | 0.68 | 562.51 | 1273.59 | 181.10 | 30.00 | 3.50 | 0.0000 | 0.13 | 0.000122 |
| Reach-1 | 86104 | 100yr | 184.44 | 33.10 | 184.45 | 184.45 | 0.09 | 0.71 | 383.14 | 967.32 | 181.10 | 30.00 | 3.34 | 0.0000 | 0.14 | 0.000147 |
| Reach-1 | 86104 | PF 3 | 183.06 | 14.20 | 183.11 | 183.11 | 0.94 | 0.94 | 15.16 | 10.58 | 181.10 | 30.00 | 1.96 | 0.0000 | 0.25 | 0.000565 |
| Reach-1 | 86104 | PF 4 | 183.72 | 23.70 | 183.77 | 183.77 | 0.62 | 1.03 | 38.24 | 152.39 | 181.10 | 30.00 | 2.62 | 0.0000 | 0.24 | 0.000469 |
| Reach-1 | 86400 | Max Observed | 184.61 | 38.70 | 184.62 | 184.62 | 0.06 | 0.61 | 659.86 | 1176.00 | 181.40 | 30.00 | 3.21 | 0.0100 | 0.12 | 0.000126 |
| Reach-1 | 86400 | 100yr | 184.45 | 33.10 | 184.46 | 184.46 | 0.07 | 0.73 | 466.84 | 1176.00 | 181.40 | 30.00 | 3.05 | 0.0100 | 0.15 | 0.000196 |
| Reach-1 | 86400 | PF 3 | 183.07 | 14.20 | 183.16 | 183.16 | 1.35 | 1.35 | 10.52 | 7.84 | 181.40 | 30.00 | 1.67 | 0.0100 | 0.37 | 0.001392 |
| Reach-1 | 86400 | PF 4 | 183.71 | 23.70 | 182.64 | 183.82 | 1.48 | 1.48 | 15.97 | 9.02 | 181.40 | 30.00 | 2.31 | 0.0100 | 0.36 | 0.001215 |
| Reach-1 | 87700 | Max Observed | 184.63 | 38.70 | 184.64 | 184.76 | 0.08 | 0.81 | 503.84 | 1176.00 | 181.60 | 130.00 | 3.03 | 0.0015 | 0.16 | 0.000223 |
| Reach-1 | 87700 | 100yr | 184.47 | 33.10 | 184.50 | 184.50 | 0.10 | 0.92 | 333.76 | 978.17 | 181.60 | 130.00 | 2.87 | 0.0015 | 0.19 | 0.000315 |
| Reach-1 | 87700 | PF 3 | 183.25 | 14.20 | 183.34 | 183.57 | 1.33 | 1.33 | 10.71 | 8.20 | 181.60 | 130.00 | 1.65 | 0.0015 | 0.37 | 0.001357 |
| Reach-1 | 87700 | PF 4 | 183.88 | 23.70 | 182.83 | 183.98 | 0.69 | 1.41 | 34.27 | 139.42 | 181.60 | 130.00 | 2.28 | 0.0015 | 0.34 | 0.001059 |
| Reach-1 | 89500 | Max Observed | 184.66 | 38.70 | 183.46 | 184.76 | 0.31 | 1.45 | 126.20 | 808.65 | 182.00 | 180.00 | 2.66 | 0.0022 | 0.32 | 0.000889 |
| Reach-1 | 89500 | 100yr | 184.52 | 33.10 | 183.33 | 184.63 | 0.96 | 1.47 | 34.52 | 545.99 | 182.00 | 180.00 | 2.52 | 0.0022 | 0.34 | 0.000999 |
| Reach-1 | 89500 | PF 3 | 183.49 | 14.20 | 183.57 | 183.57 | 1.23 | 1.23 | 11.52 | 9.41 | 182.00 | 180.00 | 1.49 | 0.0022 | 0.36 | 0.001215 |
| Reach-1 | 89500 | PF 4 | 184.07 | 23.70 | 184.17 | 184.17 | 1.37 | 1.37 | 17.32 | 10.72 | 182.00 | 180.00 | 2.07 | 0.0022 | 0.34 | 0.001065 |
| Reach-1 | 94000 | Max Observed | 185.17 | 38.70 | 184.48 | 185.31 | 0.26 | 1.78 | 146.18 | 1037.77 | 182.70 | 450.00 | 2.47 | 0.0016 | 0.44 | 0.001657 |
| Reach-1 | 94000 | 100yr | 184.09 | 33.10 | 184.33 | 185.25 | 0.45 | 1.80 | 73.52 | 794.63 | 182.70 | 450.00 | 2.39 | 0.0016 | 0.45 | 0.001807 |
| Reach-1 | 94000 | PF 3 | 184.21 | 14.20 | 183.71 | 184.35 | 1.61 | 1.61 | 8.84 | 8.18 | 182.70 | 450.00 | 1.51 | 0.0016 | 0.49 | 0.002401 |
| Reach-1 | 94000 | PF 4 | 184.71 | 23.70 | 184.06 | 184.87 | 1.79 | 1.79 | 13.24 | 9.70 | 182.70 | 450.00 | 2.01 | 0.0016 | 0.49 | 0.002220 |

Pike Creek Existing Conditions HEC-RAS Summary Output

HEC-RAS Plan: PkCkExCond1 River: RIVER-1 Reach: Reach-1 Profile: 100-Year

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope (m/m) |
|---------|-----------|----------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|---------------------|
| Reach-1 | 1 | 100-Year | 178.70 | 56.63 | 176.51 | 178.73 | 0.55 | 0.91 | 102.98 | 66.36 | 174.65 | | 4.05 | | 0.15 | 0.000218 |
| Reach-1 | 3 | 100-Year | 179.20 | 56.63 | | 179.26 | 1.10 | 1.10 | 51.45 | 18.29 | 176.24 | 1554.48 | 2.97 | 0.0010 | 0.21 | 0.000570 |
| Reach-1 | 3.1 | 100-Year | 179.21 | 56.63 | 177.38 | 179.27 | 1.10 | 1.10 | 51.61 | 18.29 | 176.24 | 15.24 | 2.97 | 0.0000 | 0.21 | 0.000564 |
| Reach-1 | 3.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 3.2 | 100-Year | 179.22 | 56.63 | 177.41 | 179.28 | 1.11 | 1.11 | 51.17 | 18.29 | 176.27 | 0.10 | 2.95 | 0.0000 | 0.21 | 0.000579 |
| Reach-1 | 3.3 | 100-Year | 179.22 | 56.63 | | 179.29 | 1.12 | 1.12 | 50.77 | 18.29 | 176.30 | 15.24 | 2.93 | 0.0020 | 0.21 | 0.000593 |
| Reach-1 | 4 | 100-Year | 179.51 | 55.78 | | 179.62 | 1.44 | 1.44 | 38.66 | 16.81 | 175.93 | 396.24 | 3.58 | -0.0009 | 0.30 | 0.001085 |
| Reach-1 | 4.1 | 100-Year | 179.56 | 55.78 | 178.24 | 179.76 | 1.96 | 1.96 | 28.48 | 10.36 | 175.93 | 60.96 | 3.63 | 0.0000 | 0.38 | 0.002227 |
| Reach-1 | 4.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 4.2 | 100-Year | 179.61 | 55.78 | 178.25 | 179.80 | 1.93 | 1.93 | 28.95 | 10.36 | 175.93 | 0.10 | 3.68 | 0.0000 | 0.37 | 0.002126 |
| Reach-1 | 4.3 | 100-Year | 179.76 | 55.78 | 179.84 | 1.32 | 1.32 | 42.30 | 17.51 | 175.96 | 15.24 | 3.80 | 0.0020 | 0.27 | 0.000851 | |
| Reach-1 | 5 | 100-Year | 180.60 | 55.78 | | 180.72 | 1.48 | 1.48 | 37.66 | 15.14 | 176.81 | 899.16 | 3.79 | 0.0009 | 0.30 | 0.001081 |
| Reach-1 | 5.1 | 100-Year | 180.68 | 55.78 | 178.79 | 180.75 | 1.22 | 1.22 | 45.68 | 15.24 | 176.85 | 30.48 | 3.83 | 0.0010 | 0.23 | 0.000670 |
| Reach-1 | 5.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 5.2 | 100-Year | 180.68 | 55.78 | 178.79 | 180.76 | 1.22 | 1.22 | 45.79 | 15.24 | 176.85 | 0.10 | 3.84 | 0.0000 | 0.22 | 0.000665 |
| Reach-1 | 5.3 | 100-Year | 180.68 | 55.78 | | 180.79 | 1.44 | 1.44 | 38.80 | 15.51 | 176.85 | 15.24 | 3.84 | 0.0000 | 0.29 | 0.001006 |
| Reach-1 | 6 | 100-Year | 181.72 | 55.78 | | 181.80 | 1.11 | 1.27 | 50.18 | 66.75 | 178.06 | 1167.38 | 3.66 | 0.0010 | 0.26 | 0.000754 |
| Reach-1 | 6.1 | 100-Year | 181.77 | 55.78 | 179.49 | 181.83 | 1.08 | 1.08 | 51.69 | 27.57 | 178.00 | 30.48 | 3.77 | -0.0020 | 0.19 | 0.000473 |
| Reach-1 | 6.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 6.2 | 100-Year | 181.77 | 55.78 | 179.48 | 181.83 | 1.08 | 1.08 | 51.77 | 27.92 | 178.00 | 0.10 | 3.77 | 0.0000 | 0.19 | 0.000471 |
| Reach-1 | 6.3 | 100-Year | 181.78 | 55.78 | | 181.85 | 1.05 | 1.22 | 53.07 | 67.67 | 178.09 | 15.24 | 3.68 | 0.0060 | 0.24 | 0.000665 |
| Reach-1 | 7 | 100-Year | 181.97 | 55.78 | | 182.06 | 1.21 | 1.36 | 46.10 | 62.74 | 177.91 | 256.03 | 4.05 | -0.0007 | 0.28 | 0.000917 |
| Reach-1 | 9 | 100-Year | 182.58 | 55.78 | | 182.65 | 0.90 | 1.20 | 62.13 | 128.75 | 179.07 | 752.86 | 3.51 | 0.0015 | 0.24 | 0.000669 |
| Reach-1 | 9.1 | 100-Year | 182.60 | 55.78 | 180.62 | 182.68 | 1.23 | 1.23 | 45.51 | 142.12 | 179.07 | 30.48 | 3.53 | 0.0000 | 0.22 | 0.000642 |
| Reach-1 | 9.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 9.2 | 100-Year | 182.60 | 55.78 | 180.62 | 182.68 | 1.22 | 1.22 | 45.59 | 147.11 | 179.07 | 0.10 | 3.53 | 0.0000 | 0.22 | 0.000639 |
| Reach-1 | 11 | 100-Year | 182.83 | 55.78 | | 182.86 | 0.48 | 0.92 | 115.22 | 217.97 | 179.13 | 310.90 | 3.70 | 0.0002 | 0.19 | 0.000437 |
| Reach-1 | 13 | 100-Year | 183.50 | 55.78 | | 183.61 | 1.45 | 1.47 | 38.52 | 40.39 | 179.89 | 1066.80 | 3.61 | 0.0007 | 0.31 | 0.001135 |

Kerr Drain Existing Conditions HEC-RAS Summary Output

HEC-RAS Plan: KerrDrExCond1 River: RIVER-1 Reach: Reach-1 Profile: 100yr

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope (m/m) |
|---------|-----------|---------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|---------------------|
| Reach-1 | 1 | 100yr | 178.40 | 17.84 | 177.54 | 178.51 | 0.87 | 1.82 | 20.52 | 78.45 | 175.87 | | 2.53 | | 0.36 | 0.002254 |
| Reach-1 | 2 | 100yr | 179.17 | 17.84 | | 179.23 | 0.85 | 1.47 | 20.88 | 34.95 | 177.39 | 316.99 | 1.77 | 0.0048 | 0.35 | 0.002150 |
| Reach-1 | 3 | 100yr | 180.10 | 17.84 | 178.96 | 180.13 | 0.40 | 1.02 | 44.30 | 246.92 | 177.67 | 609.60 | 2.43 | 0.0005 | 0.21 | 0.001066 |
| Reach-1 | 3.1 | 100yr | 180.06 | 17.84 | 178.96 | 180.23 | 1.81 | 1.81 | 9.84 | 197.66 | 177.67 | 15.24 | 2.39 | 0.0000 | 0.38 | 0.003442 |
| Reach-1 | 3.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 3.2 | 100yr | 180.23 | 17.84 | 178.96 | 180.37 | 1.69 | 1.69 | 10.56 | 419.30 | 177.67 | 0.10 | 2.56 | 0.0000 | 0.34 | 0.002725 |
| Reach-1 | 3.3 | 100yr | 180.42 | 17.84 | | 180.42 | 0.11 | 0.31 | 164.69 | 511.85 | 177.70 | 15.24 | 2.72 | 0.0020 | 0.06 | 0.000086 |
| Reach-1 | 4 | 100yr | 180.84 | 17.84 | 180.84 | 181.27 | 2.92 | 2.92 | 6.12 | 7.09 | 179.59 | 505.97 | 1.25 | 0.0037 | 1.00 | 0.015922 |
| Reach-1 | 4.1 | 100yr | 181.20 | 17.84 | 180.70 | 181.48 | 2.36 | 2.36 | 7.57 | 4.57 | 179.47 | 15.24 | 1.73 | -0.0080 | 0.58 | 0.007913 |
| Reach-1 | 4.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 4.2 | 100yr | 181.30 | 17.84 | 180.70 | 181.55 | 2.21 | 2.21 | 8.06 | 4.57 | 179.47 | 0.10 | 1.84 | 0.0000 | 0.53 | 0.006670 |
| Reach-1 | 4.3 | 100yr | 181.43 | 17.84 | | 181.66 | 2.10 | 2.10 | 8.50 | 4.57 | 179.50 | 15.24 | 1.93 | 0.0020 | 0.49 | 0.005761 |

Puce River Existing Conditions HEC-RAS Summary Output

HEC-RAS Plan: PuceExCond1 River: RIVER-1 Reach: Reach-1 Profile: 100yr

| Reach | River Sta | Profile | W.S. Elev | Q Total | Crit W.S. | E.G. Elev | Vel Total | Vel Chnl | Flow Area | Top Width | Min Ch El | Length Chnl | Max Chl Dpth | Invert Slope | Froude # Chl | E.G. Slope (m/m) |
|---------|-----------|---------|-----------|---------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-------------|--------------|--------------|--------------|---------------------|
| Reach-1 | 9 | 100yr | 177.24 | 80.99 | 175.77 | 177.29 | 0.61 | 1.10 | 132.12 | 197.05 | 174.25 | | 2.99 | | 0.22 | 0.000530 |
| Reach-1 | 10 | 100yr | 177.36 | 80.99 | | 177.38 | 0.42 | 0.80 | 194.03 | 246.81 | 174.56 | 213.36 | 2.80 | 0.0015 | 0.16 | 0.000285 |
| Reach-1 | 11 | 100yr | 177.44 | 80.99 | | 177.47 | 0.57 | 0.93 | 141.80 | 164.52 | 174.62 | 243.84 | 2.82 | 0.0002 | 0.19 | 0.000426 |
| Reach-1 | 11.1 | 100yr | 177.42 | 80.99 | 175.91 | 177.51 | 1.29 | 1.29 | 62.64 | 162.39 | 174.62 | 15.24 | 2.80 | 0.0000 | 0.26 | 0.000825 |
| Reach-1 | 11.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 11.2 | 100yr | 177.42 | 80.99 | 175.98 | 177.52 | 1.40 | 1.40 | 57.89 | 220.09 | 174.62 | 0.10 | 2.80 | 0.0000 | 0.28 | 0.001295 |
| Reach-1 | 12 | 100yr | 177.52 | 80.99 | | 177.55 | 0.52 | 0.90 | 155.50 | 174.58 | 174.62 | 15.24 | 2.90 | 0.0000 | 0.18 | 0.000376 |
| Reach-1 | 13 | 100yr | 178.10 | 81.84 | | 178.24 | 1.57 | 1.70 | 52.02 | 45.94 | 174.89 | 1005.84 | 3.21 | 0.0003 | 0.33 | 0.001270 |
| Reach-1 | 14 | 100yr | 178.73 | 82.12 | | 178.84 | 1.51 | 1.51 | 54.52 | 15.84 | 175.14 | 548.64 | 3.59 | 0.0005 | 0.26 | 0.000923 |
| Reach-1 | 14.1 | 100yr | 178.74 | 82.12 | 176.68 | 178.86 | 1.50 | 1.50 | 54.83 | 26.91 | 175.14 | 15.24 | 3.60 | 0.0000 | 0.26 | 0.000909 |
| Reach-1 | 14.15 | Bridge | | | | | | | | | | | | | | |
| Reach-1 | 14.2 | 100yr | 178.76 | 82.12 | 176.71 | 178.87 | 1.51 | 1.51 | 54.50 | 15.84 | 175.17 | 0.10 | 3.59 | 0.0000 | 0.26 | 0.000924 |
| Reach-1 | 14.3 | 100yr | 178.77 | 82.12 | | 178.89 | 1.51 | 1.51 | 54.24 | 15.84 | 175.20 | 15.24 | 3.57 | 0.00020 | 0.26 | 0.000937 |
| Reach-1 | 14.4 | 100yr | 178.81 | 77.87 | | 178.92 | 1.41 | 1.42 | 55.06 | 29.89 | 175.20 | 30.48 | 3.61 | 0.0000 | 0.24 | 0.000809 |
| Reach-1 | 15 | 100yr | 179.83 | 77.87 | | 180.01 | 1.28 | 2.02 | 60.62 | 120.22 | 176.85 | 853.44 | 2.98 | 0.0019 | 0.41 | 0.002104 |
| Reach-1 | 15.1 | 100yr | 179.93 | 77.87 | | 180.08 | 1.12 | 1.86 | 69.79 | 135.03 | 176.88 | 30.48 | 3.05 | 0.0010 | 0.38 | 0.001738 |
| Reach-1 | 16 | 100yr | 180.75 | 73.62 | | 180.78 | 0.66 | 1.02 | 110.74 | 106.19 | 177.76 | 853.44 | 2.99 | 0.0010 | 0.20 | 0.000439 |
| Reach-1 | 16.1 | 100yr | 181.09 | 70.79 | | 181.19 | 1.01 | 1.54 | 69.93 | 111.59 | 178.16 | 548.64 | 2.93 | 0.0007 | 0.33 | 0.001212 |
| Reach-1 | 16.2 | 100yr | 181.54 | 70.79 | | 181.67 | 1.24 | 1.67 | 57.28 | 79.17 | 178.37 | 365.76 | 3.17 | 0.0006 | 0.35 | 0.001362 |
| Reach-1 | 17 | 100yr | 182.02 | 67.96 | | 182.08 | 0.68 | 1.23 | 99.44 | 151.39 | 178.61 | 396.24 | 3.41 | 0.0006 | 0.26 | 0.000720 |
| Reach-1 | 17.1 | 100yr | 182.34 | 67.96 | | 182.41 | 0.77 | 1.34 | 88.19 | 157.81 | 179.04 | 411.48 | 3.30 | 0.0010 | 0.28 | 0.000840 |
| Reach-1 | 17.2 | 100yr | 182.78 | 63.71 | | 182.81 | 0.53 | 1.04 | 121.29 | 219.73 | 179.56 | 609.60 | 3.22 | 0.0009 | 0.22 | 0.000507 |
| Reach-1 | 18 | 100yr | 183.03 | 60.88 | | 183.05 | 0.35 | 0.86 | 172.01 | 409.89 | 180.08 | 548.64 | 2.95 | 0.0009 | 0.18 | 0.000371 |