NIAGARA FALLS THUNDERING WATERS DEVELOPMENT

FUNCTIONAL SERVICING STUDY
PHASE 1: BACKGROUND REVIEW AND EXISTING CONDITIONS CHARACTERIZATION

GR INVESTMENTS GROUP

CITY OF NIAGARA FALLS

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1. INTRODUCTION

GR (CAN) Investment Co. Ltd. has acquired approximately 480 acres (195 ha) of land adjacent to the Thundering Waters Golf Course (the "Thundering Waters" Lands). It is currently proposed to develop the lands with a mix of commercial (retail shops, nursing homes, sports complexes and fields, a school and hotels), residential (single family homes, townhouses, and apartment building/condo units both low and high rise), park lands (green space) and other employment uses.

In order to develop the lands, a Secondary Plan for the development is required. As part of the Secondary Plan, among other requirements, a Functional Servicing Study is required to determine the preferred approach to servicing the Thundering Waters Lands based on existing infrastructure capacity and related upgrades, to support development. Terms of Reference for the preparation of a Functional Servicing Plan were prepared consultatively with the City of Niagara Falls, Region of Niagara and Niagara Peninsula Conservation Authority (NPCA) (ref. Appendix E).

The study area is located in the City of Niagara Falls, bounded by Oldfield Road to the north, Dorchester Road to the west and south, and by the existing industrial developments to the east. Figure 1.1 shows the subject area in its current state.

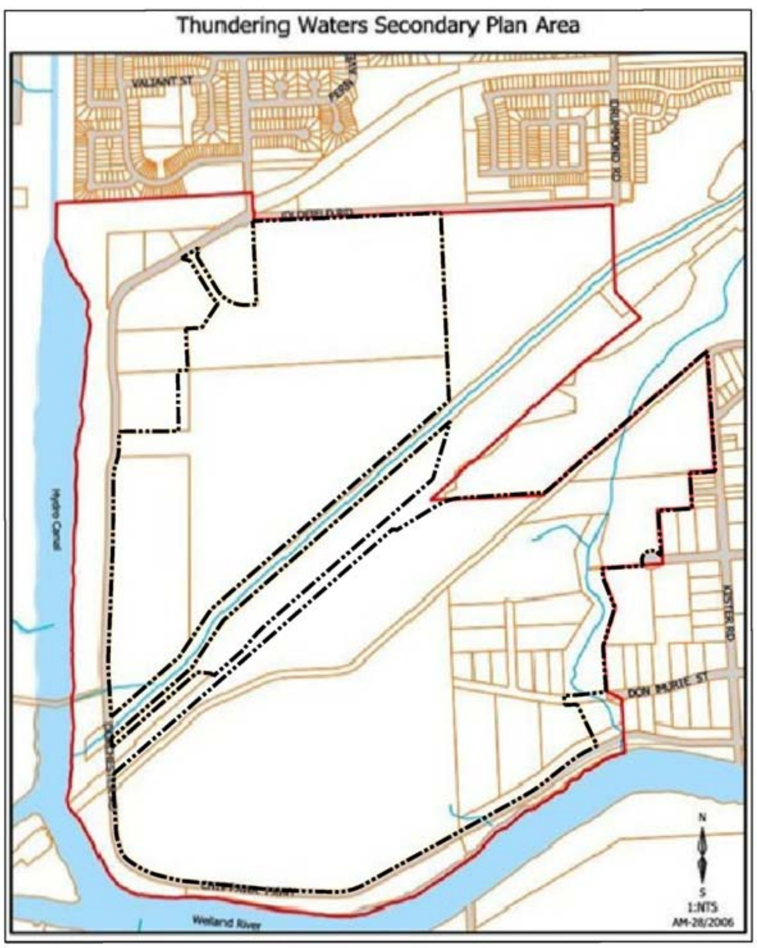

Figure 1.1. Study Area

The purpose and objectives of the Functional Servicing Plan in support of the Niagara Falls Thundering Waters Development Secondary Plan area is to document existing service conditions and capacities, and prepare a conceptual servicing master plan for the proposed development with order of magnitude costs to address the ultimate build out of the area as per the proposed area land use. The Functional Servicing Plan is intended to satisfy the joint requirements of the Environmental Assessment and Planning Acts.

The specific objectives include:

i. *Assess the existing servicing capacities of the water, wastewater and stormwater systems.*
ii. *Analyze the impact of the proposed development on the existing systems using current MOECC, Region of Niagara, and City of Niagara Falls standards for development.*
iii. *Determine site servicing feasibility and requirements for new infrastructure and any necessary upgrades to the existing infrastructure systems (linear and treatment).*
iv. *Consider the potential opportunities and needs of other utility servicing such as gas, hydro, and communications.*
v. *Establish management and servicing strategies consistent with the recommendations of the Environmental Impact Study (under separate cover).*
vi. Address the requirements of the MEA Class Environmental Assessment process (2011).

Per the approved Terms of Reference, this first report constitutes a summary of existing information serving as background to establishing an understanding of the area's services specific to water, wastewater and storm, as well as other utilities. Once this information is received by the City, Region and Conservation Authority, it is expected to serve as the basis for evaluating proposed future development scenarios and determining required servicing (Phase 2).

2. BACKGROUND INFORMATION REVIEWED

As part of the process involved in establishing the Terms or Reference for preparation of the Functional Servicing Plan, Amec Foster Wheeler staff met with City of Niagara Falls, Niagara Region, and NPCA staff on a number of occasions to pre-consult on municipal servicing requirements and develop an improved understanding of available background information. In terms of the Functional Servicing Plan, the available information is specific to water, wastewater, stormwater, and related utilities. The City of Niagara Falls has provided information related to the following:

- Con Rail Drain
  - 12 tif images and geotechnical report
- Master Drainage Plan Update Study
- Culvert plans depicting locations
- Various other Reports and Plans including:
  - Review of Municipal Servicing Requirements Thundering Waters, Warren Woods, NCLG, R.V. Anderson,
  - Thundering Waters Estates Stormwater Management Plan
  - related OLS surveys

- Plan and Profile images of various infrastructure
- Storm District maps, excerpts from Storm Drainage Report Volume 1 December 1981, Storm Drainage Report Volume 2 December 1981
- Storm drainage maps
- Plans of watermains
- Area Geotechnical investigations
- GIS Shape files for:
  - contours
  - parcels
  - road centre lines
  - sanitary mains
  - sanitary maintenance holes
  - storm inlet structures
  - storm maintenance holes
  - watermains
- Thundering Waters UEM Site Servicing Feasibility Study
- 2011 Municipal Bridge Appraisals

Further information has been requested and received from the Region of Niagara, including the water and wastewater models and as-builts for Regional trunk systems, specifically existing water and wastewater infrastructure.

In addition, NPCA has provided base mapping (2010) and other mapping depicting its Regulatory Limit on the Welland River and Power Canal. The Niagara Peninsula Conservation Authority has also provided information related to the following:

- NPCA Stormwater Management Guidelines
- Aerial Mapping
- Natural environment information screening maps
- GIS Shape files for:
  - watershed planning areas
  - conservations areas
  - regulated floodplains
  - regulation lands
  - regulated wetlands and allowance
  - top of slope and allowance
  - intake protection zones, vulnerable aquifers, groundwater recharge areas

3. STORMWATER SERVICING

3.1 Introduction

As part of the preparation of the Functional Servicing Plan, it is required to establish an understanding of the existing storm drainage systems comprised of local catchment areas, open water features, municipal drains, municipal storm systems, and receiving watercourses. By defining these existing features and establishing the design capacity through hydrologic and hydraulic assessments, the existing system can be characterized so that the impact of future planned urbanization can be assessed and appropriate management plans developed accordingly. The sections which follow outline existing information and the related analyses to develop this understanding.

3.2 Background Information Review

As noted in Section 2, various parties have provided data/information related to the stormwater systems including the City of Niagara Falls, Region of Niagara, and the NPCA, (ref. Appendix A), including:

Mapping:

- Storm Servicing Map (Regional Municipality of Niagara, 2015).
- Thundering Waters – Flood Plain (Niagara Peninsula Conservation Authority, 2015)
- LiDAR information of Thundering Waters and surrounding area. (Leading Edge Geomatics, 2015).
- GIS Mapping from Natural Areas Inventory Report. (Niagara Peninsula Conservation Authority, 2011).
- Niagara Natural Environment Information Screening Maps. (Niagara Peninsula Conservation Authority, 2011).
- Thundering Waters Aerial Mapping (Niagara Peninsula Conservation Authority, 2011).
- Shapefiles (from the City of Niagara Falls): Storm maintenance holes and inlets, parcels, road centerlines, and 1 m contours.
- Shapefiles (from the Niagara Peninsula Conservation Authority): Watershed Planning Areas, Hunting Areas Conservation Areas, Trails, HydroNet-related shapefiles, NNEI Screening Layer, Riverine Floodplain Mapping, NNEI Screening Layer, Wetland Allowance, Top of Slope Allowance, Top of Slope, Regulated Wetlands, Regulated Shoreline Area, Regulated Floodplains, Regulation Lands, Shoreline Mapping, Surface Water Intake Protection zones, highly vulnerable aquifers, significant groundwater recharge areas.

Drawings:

- Conrail Drainage Channel. (City of Niagara Falls, 1979).
- Plan and Profile Drawings, Storm Drainage Maps. (from the City of Niagara Falls).
    - Drummond Road Watermain (2003)
    - Dorchester Road (1999)
    - 1982 Operating Budget Watermain Drummond Road (1982)
    - Kister Road (1981)
    - Drummond Park Village Subdivision (1979)
    - Falls Industrial Subdivision Extension (1978)
    - Reg. Plan M-67 (1976)
    - Dorchester Road Plan & Profile (1974)
    - Drummond Road Sanitary Sewer
    - Local Improvement Program Dorchester Road (1973)

  - Proposed Watermain Construction Drummond Road (1971)
  - Reg. Plan 243 (1969)
  - Langendoem Subdivision (1968)
  - Existing Conditions (1960)
  - Future Services on Oldfield Road (undated)
- Digital Elevation Model 1 m contours (Niagara Peninsula Conservation Authority, 2010).

Documents:

- *Preliminary Stormwater Management Plan for Thundering Waters Estates.* (Upper Canada Consultants, 2012).

This report provides a preliminary stormwater management plan for a proposed site (immediately north of Oldfield Road and west of Drummond Road) and associated external lands. The report provides relevant soil information. It also indicates that existing drainage is towards the Conrail Drainage Channel, and that proposed stormwater management will address quality control but not quantity or erosion control.

- *2011 Municipal Bridge Appraisal.* (City of Niagara Falls, 2011).

Five (5) inspection/maintenance reports of culverts within the Thundering Waters Study Area.

- *Stormwater Management Guidelines.* (Niagara Peninsula Conservation Authority, 2010).

- *Review of Municipal Servicing Requirements.* (R.V. Anderson Associates Ltd., 2007).

This report provides a review of municipal servicing requirements for Thundering Waters and Warren Woods. It also references the Site Servicing Feasibility Study by Urban & Environmental Management Inc., for site drainage patterns and stormwater management requirements.

- *Site Servicing Feasibility Study.* (Urban & Environmental Management Inc., 2006).

The report specifies existing drainage patterns for the Thundering Waters site. Quality control is required for outlet into the Power Canal or the Welland River, at a Normal (Level 2) treatment level, based upon fish habitat requirements. The report makes recommendations for proposed stormwater management. This report estimates approximately 46.2 ha contribute to the Conrail Drain.

- *Storm Drainage Report Volumes 1 and 2*. (R.V. Anderson Associates Ltd., 1981).

This report is an update to the “1968 Report on Flood Control and Pollution Abatement” indicating storm sewers and channels constructed between 1968 and 1980 and recommends proposed storm sewers and channels for the City of Niagara Falls.

Other:

- Master Drainage Plan Update Study PIC #1 Slides (Aquafor Beech, Undated)

3.3 Field Reconnaissance

A field reconnaissance was undertaken by Amec Foster Wheeler staff on October 1, 2015 (ref. Appendix A for photographic inventory), with a focus on reviewing existing drainage patterns and hydraulic structures. The following have been noted from the field reconnaissance:

- Between Stanley Avenue and Oldfield Road, Dorchester Road and Chippawa Parkway are two-lane roads with a rural cross-section, running generally parallel to the Power Canal and Welland River, respectively. The roads bound the subject property to the west and south.
- Dense vegetation was observed along the full extent of Dorchester Road and Chippawa Parkway surrounding the site (ref. Photo 11).
- The northwest corner of the Dorchester Road - Oldfield Road intersection is supported by gabion baskets. (ref. Photo 29).
- A 1200 mm diam. concrete culvert, located approximately 300 m west of Stanley Avenue, has been identified in the field (ref. Culvert #1). The inlet invert of the culvert is sunk beneath the invert of the channel by approximately 0.3m (ref. Photo 1). The culvert was partially submerged at the time of the field reconnaissance as it is under the influence of backwater from the Welland River; the depth of water at the downstream end of the culvert is approximately 0.4 m (ref. Photo 7). A separation has been noted at the inlet of the culvert, where the most upstream length of pipe is disconnected from the remainder of the culvert (ref. Photo 6). The outlet of this pipe is damaged. (ref. Photo 8).
- Immediately upstream of the 1200 mm diam. concrete culvert, the creek has a bankfull depth and width of approximately 0.2 m and 2.3 m, respectively. The creek has a rocky bottom with little vegetation growing out of the water, while the overbanks have thick vegetation consisting of trees and brush. (ref. Photos 2, 3, 4, and 5).
- A 900 mm diam. corrugated steel culvert, located approximately 700 m west of Stanley Avenue, was identified in the field (ref. Culvert # 3). The culvert was partially submerged at the time of the field reconnaissance as it is under the influence of backwater from the Welland River; the depth of water at the upstream end of the culvert is approximately 0.3 m (ref. Photo 9). The portions of the pipe which are visible are rusted. (ref. Photo 9 and 10).
- Near the southwest corner of the subject property, a 450 mm diam. Corrugated steel culvert was identified (ref. Culvert # 4). The pipe appears to be in good condition with no visible deficiencies (ref. Photo 12 and 13).
- Located approximately 100 m north of the CNR tracks at Dorchester Road, the Conrail Drain has an accumulation of vegetation and debris (ref. Culvert # 5). The inlet of the culvert crossing at Dorchester Road has a build-up of debris against the safety grate. (ref. Photo 14). The invert of the Conrail Drain corridor, immediately east of Dorchester Road, is lined with tall grass and the entire drain is covered with light brush and young tree growth. (ref. Photo 15). The culvert crossing at Dorchester Road was not measured during the field reconnaissance. The outlet is inaccessible, secured by a chain link fence and barbed wire. (ref. Photo 16).
- A road crossing culvert located approximately 100 m north of the Con Rail Drain, within a defined valley, was identified. (ref. Culvert # 9). The 1200 mm diam. smooth steel pipe, is heavily corroded, with holes located in the pipe wall (ref. Photo 18). At the outlet, the bottom half (approximate) of the pipe is filled with rocks and debris (ref. Photo 17).

- A road crossing culvert located approximately 1050 m north of the Con Rail Drain, was identified. (ref. Culvert # 10). The 850 mm diam. corrugated steel pipe appears to be in good condition with no visible defects at the inlet (ref. Photo 19). The outlet was located in a stand of thick brush and was difficult to view (ref. Photo 20).
- At the intersection of Dorchester Road and Oldfield Road as well as along Dorchester Road immediately west of Oldfield Road, flow is directed west through roadside ditches and various driveway culverts. (ref. Photos 21, 22, 23, 24, 30, and 32). Road crossing culverts (ref. Culverts 12, 13, 14, 15, and 16) direct flow from south of Dorchester Road to north of Dorchester Road where the roadside ditch is deeper, with greater flow capacity (ref. Photos 21, 23, 28, and 31). The ditch along the north side of Dorchester Road outlets through a 900 mm by 650 mm elliptical corrugated steel driveway culvert (ref. Culvert 11) flowing west towards the Power Canal. (ref. Photos 25, 26, and 27).

3.4 Baseline Assessment

The study area is located near the confluence of the Welland River and the Power Canal within the City of Niagara Falls in the Welland River Watershed. The site is bounded by Dorchester Road toward the west, Chippawa Parkway to the south hydro corridor to the north, and an open unnamed watercourse to the east.

The site measures 195.8 ha (+/-) (ref. Figure 1.1) and is densely vegetated with forests and wetlands. Soils information from the Canadian Soil Information Service (CANSIS) indicates that majority of soils within the site are of Hydrologic Soil Class C, D indicating an *imperfect* to *poor* soil infiltration characterization for the site. Available topographic information indicates that the site generally drains from north to south, although grades across the site are quite low (i.e. approximately 0.1 %) and is relatively flat, with low points and pools throughout.

The following provides the key findings of the Baseline Assessment based upon a review of available background information and the field reconnaissance.

Drainage boundaries of the Thundering Waters site (ref. Drawing 3.2):

- The western limit of the site is bounded by Dorchester Road, which runs adjacent to the Power Canal.
- The southern limit of the site is bounded by Chippawa Parkway, which runs adjacent to the Welland River.
- The eastern limit is west of Kister Road. Drainage from Don Murie Street, Progress Street, Kister Road, Ramsey Road is predominantly directed south or east, away from the Thundering Waters site based on plan and profile drawings provided (City of Niagara Falls).
- The north / northwest limit is represented by subdivisions north of the hydro corridor. Stormsewers within these subdivisions direct flow north and away from the Thundering Waters Site based on plan and profile drawings provided (City of Niagara Falls). Major flows, from portions of this area are directed south and intercepted by roadside ditches along Dorchester Road, west of Oldfield Road and ultimately outleting to the Power Canal.

- The north / northeast portion of the site is adjacent to the Thundering Waters Golf Course, as well as the headwaters of the Conrail Drain Channel, which drains through the Thundering Waters site.

In Summary:

i. The Thundering Waters site drains to two notable watercourses and numerous on-site culverts (ref. Drawings 3.1 and 3.5): the southern portion of the site drains to the Welland River through culverts crossing Chippawa Parkway, with the most pronounced drainage feature being a creek which runs along the eastern edge of the Thundering Waters property.
ii. The northern portion of the site drains to the Power Canal via culverts crossing Dorchester Road, with the most pronounced water feature being the Conrail Drain Channel.
iii. The Conrail Drain Channel drainage feature splits the site, running northeast to southwest alongside the C.N.R. tracks which also span the Thundering Waters site. The City of Niagara Falls has confirmed that the Conrail Drain Channel is not a Municipal Drain and the NPCA has indicated that it is not a fish habitat feature [ref. EIS, 2015 (Draft), Dougan & Associates].

The Conrail Drain, which traverses the site, represents the most significant drainage feature on the property. The Conrail Drain received and conveys runoff from 67.0 ha within the site, as well as runoff from some 298 ha of predominantly urbanized lands upstream of the site (ref. Drawing 3.2 and Drawing 80-CA-1 in Appendix A).

The unnamed watercourse along the east limit of the subject property receives runoff from 40.2 ha of the site, as well as runoff from 75.2 ha of industrial lands and the Thundering Waters Golf Club to the east (ref. Drawing 3.2).

A hydraulic structure inventory has been developed based upon a desktop review of information provided, as well as findings from the field reconnaissance conducted as part of this study. The hydraulic structure location plan is provided in Drawing 3.1, and the size and type of structures is presented in Table 3.1.

Table 3.1 Hydraulic Structure Inventory		
Culvert #	**Configuration (Size, Shape, Material)**	**Comments / Source**
1	1200 mm diam. Circ. Conc.	
2	CSPPA (Approximate rise of 1000 mm)	2011 Municipal Bridge Appraisal ID Number: S053C (City of Niagara Falls, 2011). Not viewed during field reconnaissance.
3	900 mm diam. CSP	
4	450 mm diam. CSP	
5	5500 mm X 3500 mm CSPPA	Culvert is located within the Conrail Drain Channel and crosses Dorchester Road. 2011 Municipal Bridge Appraisal ID Number: S049C (City of Niagara Falls, 2011).
6	5500 mm X 3500 mm CSPPA	Culvert is located within the Conrail Drain Channel. 2011 Municipal Bridge Appraisal ID Number: S050C (City of Niagara Falls, 2011). Not viewed during field reconnaissance.
7	5500 mm X 3500 mm CSPPA	Culvert is located within the Conrail Drain Channel. 2011 Municipal Bridge Appraisal ID Number: S148C (City of Niagara Falls, 2011). Not viewed during field reconnaissance.
8	5100 mm X 3300 mm CSPPA	Culvert is located within the Conrail Drain Channel. 2011 Municipal Bridge Appraisal ID Number: S149C (City of Niagara Falls, 2011). This document indicates a slightly larger culvert with a rise of approximately 3700 mm. Not viewed during field reconnaissance.
9	1200 mm diam. SSP	
10	850 mm diam. CSP	
11	900 mm X 650 mm diam. Elliptical CSP	Driveway culvert (does not cross Dorchester Road) acts as outlet for a roadside ditch ultimately draining to the power canal.
12	650 mm diam. CSP	
13	350 mm diam. CSP	Not viewed during field reconnaissance.
14	650 mm diam. CSP	
15	525 mm diam. CSP	
16	450 mm diam. CSP	

3.5 Hydrology and Hydraulics

3.5.1 Hydrology

Hydrologic analyses have been completed in order to establish return period peak flow rates for the 2 year through 100 year events at the outlets of the site to the Power Canal and the Welland River, under existing land use conditions. The hydrologic analyses have been completed using the Visual OTTHYMO hydrologic model, Version 2.4.

Subcatchment boundaries within the site have been established based upon the topographic mapping provided for use in this study, and to obtain peak flows at key points of interest and the drainage outlets from the site to the Power Canal and the Welland River, as well as at hydraulic structures along the Conrail Drain and confluences along the watercourse at the east boundary of the site. The subcatchment boundary plan is provided in Drawing 3.2. In addition, the Visual OTTHYMO model has been developed to include the contributing drainage areas to the Conrail Drain upstream of the site based upon the information provided by the City of Niagara Falls (ref. Drawing 80-CA-1 in Appendix A), as well as the external drainage areas contributing to the watercourse along the east limit of the site. The existing conditions hydrologic model schematic is provided on Drawing 3.4.

Subcatchment areas have been measured from the base mapping and topography provided by the City and the NPCA. The areas for the external subcatchments discharging to the Conrail Drain have been determined based upon the information provided on Drawing 80-CA-1 of Appendix A.

Impervious coverages for the urban subcatchments have been determined based upon a review of available aerial photographs and Drawing 80-CA-1 to determine land use composition. Applying a 50 % impervious coverage has been adopted for residential areas based on a review of mapping and an 85 % impervious coverage for commercial and industrial lands based upon a similar review.

The SCS Soil Class and the curve number (CN) for the pervious areas have been estimated based on the mapping from the Canadian Soil Information Service (CANSIS) database. The surficial soils within the study area are presented in Drawing 3.3. As noted earlier, the information in the CANSIS database indicates that majority of soils within the study area are of Hydrologic Soil Class C, D, or a mixture of C-D, indicating an imperfect to poor drainage characterization for the site.

For the rural catchments, time to peak has been determined using the Airport Equation due to the largely undeveloped nature of these subcatchments, and applying runoff coefficients calculated in accordance with the approach outlined in the 1998 MTO Drainage Manual. Length and slope of the catchments have been measured from the base mapping provided for use in this study.

All remaining parameters for the hydrologic model have applied the default parameters in accordance with the Visual OTTHYMO methodology. The resulting subcatchment parameters which have been established for the hydrologic model are summarized in Tables 3.2 and 3.3 for the rural (non-urban) and urban subcatchments respectively.

Routing elements have been incorporated into in the model to represent the hydrologic influence of routing through the Conrail Drain and the watercourse along the east limit of the site. The cross-section and slope of the routing elements representing the Conrail Drain have been established based upon the information provided in the available design drawings for that system and verified by a review of the base mapping and contour data. The cross-section and slope for the routing elements representing the watercourse at the east limit of the site have been established based upon the contour data and base mapping provided for use in this study.

Table 3.2 Hydrologic Model Parameterization (Rural / Non-Urban Catchments)

VO2 Subcatchment Name (NHYD)	Contributing Drainage Area (ha)	CN (AMC II)	TP (hr)
101	36.6	89	2.35
102	31.4	77	1.60
103	74.0	77	2.71
105	17.8	77	1.18
106	3.9	70	0.60
107	58.1	80	1.87
108	12.8	77	1.24
109	11.7	77	0.93
110	14.9	70	1.08
111	12.5	73.5	0.95
112	5.4	70	0.88
113	60.7	73.5	1.12
114	15.8	70	0.92
207	22.0	84	1.71

Table 3.3 Hydrologic Model Parameterization (Urban Catchments)

VO2 Subcatchment Name (NHYD)	Contributing Drainage Area (ha)	CN (AMC II)	Impervious Coverage (%)
104	6.0	80	85
201	28.5	80	57
202	14.5	80	53
203	56.1	80	58
204	11.5	80	77
205	36.5	80	71
206	50.4	80	50

Synthetic design storms have been developed for the hydrologic analyses. The 12 hour SCS distribution has been selected due to the size of the study area, as well as the rural (non-urban) land use throughout the site. Intensity-duration-frequency (IDF) equations have been furnished by NPCA for use in determining the 2 year through 100 year synthetic design storms. Upon closer review and inspection of the relationships, it was noted that the depth of rainfall for the 10 year storm, as calculated using the IDF relationships provided by NPCA, is less than the depth of rainfall for the 5 year storm, which is contrary to anticipated trends. Consequently, rainfall depths for the 2 through 100 year storm events have been established based upon the IDF relationships applied by the Ministry of Transportation within the local region. Recognizing that the 100 year storm event represents the Regulatory storm for the NPCA, the IDF relationship, as provided by NPCA, has been used to develop the 12 hour SCS storm for the 100 year event; this is in addition to the 100 year storm as determined based upon the IDF relationships applied by MTO. The resulting synthetic design storms are provided in Appendix A.

Peak flows for the various return periods at key points in the study area (ref. Drawing 3.4) have been determined using the hydrologic model and associated synthetic design storms. The resulting peak flows are presented in Table 3.4.

Table 3.4 VO2 Existing Conditions Simulated Peak Frequency Flows (m^3/s)

Flow Node / Subcatchment Number	Frequency Storm Events						
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year (MTO)	100 Year (NPCA)
501	9.30	14.16	17.55	22.03	25.49	28.91	23.31
502	9.25	14.07	17.44	21.89	25.34	28.73	23.16
503	12.89	19.32	23.79	29.48	33.92	38.46	31.14
504	16.61	24.66	30.08	37.74	43.19	49.27	39.83
505	16.58	24.60	29.99	37.62	43.03	49.08	39.69
506	0.98	1.69	2.23	2.94	3.5	4.09	3.14
507	0.95	1.62	2.14	2.83	3.35	3.91	3.01
508	0.85	1.46	1.92	2.53	2.99	3.48	2.69
509	0.76	1.29	1.69	2.22	2.62	3.05	2.37
510	0.65	1.10	1.44	1.88	2.22	2.57	2.00
104	0.83	1.16	1.39	1.66	1.86	2.07	1.74
105	0.20	0.35	0.46	0.61	0.72	0.84	0.65
107	0.52	0.89	1.16	1.51	1.78	2.06	1.61
113	0.63	1.10	1.46	1.95	2.32	2.71	2.08
114	0.16	0.29	0.39	0.52	0.62	0.73	0.55

The results in Table 3.4 indicate that the routing influence of the Conrail Drain decreases the peak flows from upstream to downstream for all events between the 2 year and 100 year return period storms. This is considered attributable to the low gradient and large hydraulic cross-section within the Conrail Drain, which provides an attenuative effect, as flows are routed through the system.

For all other nodes of interest, the peak flows are consistent with anticipated trends based upon drainage area size and land use.

Validation of design flows has been conducted by comparing unitary flow rates in Table 3.5 from various studies and watercourse systems in similar physiographic regions. Unitary flows for standalone subcatchments 105, 113, and 114 compare well with one another and subcatchment 104 produces higher unitary flows characteristic of a relatively small drainage area. The results indicate that the flow rates at watercourse outlets 501 and 506 are above the range of most watercourse systems for all design storms. It had been noted previously that rainfall volume data provided by the MTO is higher than the NPCA rainfall data, producing more conservative peak flows for all storm events. This comparison also does not differentiate between factors such as soil permeability and routing attenuation. Based on the consistency of unitary peak flows from individual subcatchments, the hydrologic modelling results are considered to be reasonable for the purposes of this study and generally conservative.

Table 3.5 Unitary Peak Flow Comparison ($m^3/s/ha$)

Flow Node / Subcatchment Number/ Location	Frequency Storm Events							
	Area (ha)	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year (MTO)	100 Year (NPCA)
501	365.3	0.025	0.039	0.048	0.060	0.070	0.079	0.064
506	115.4	0.008	0.015	0.019	0.025	0.030	0.035	0.027
104	6.0	0.139	0.194	0.232	0.277	0.311	0.346	0.290
105	17.8	0.011	0.020	0.026	0.034	0.041	0.047	0.037
113	60.7	0.010	0.018	0.024	0.032	0.038	0.045	0.034
114	15.4	0.010	0.019	0.025	0.034	0.040	0.047	0.036
Battlefield Creek at escarpment	487.1	0.004	0.008	0.011	0.015	0.019	0.022	0.022
North Waterdown	466.9	0.006	0.011	0.014	0.018	0.021	0.023	0.023
Unnamed Grand River Tributary	57.8	0.025	0.040	0.052	0.067	0.089	0.109	0.109
Sixteen Mile Creek	444.4	0.003	0.006	0.009	0.012	0.016	0.019	0.019

3.5.2 Hydraulics

As noted previously, the Conrail Drain and the unnamed watercourse along the east limit of the property receive flows from external properties and convey the flows through the site. As such, hydraulic analyses have been completed for these systems, in order to characterize the hydraulic function of these features with respect to conveyance capacity to the top of slope.

The hydraulic analyses have applied the HEC-RAS methodology to determine the water surface elevations along the Conrail Drain and the unnamed watercourse along the east limit of the site.

The cross-section geometry and elevations for the sections along the Conrail Drain Channel have been established based upon the information in the design drawings provided by the City of Niagara Falls, and verified based upon a review of the base mapping provided for this study. Manning's roughness coefficients of 0.05 and 0.06 have been applied for the base and side slopes of the Conrail Drain respectively, based upon the conditions observed during field reconnaissance (ref. Appendix A). The culverts along the Conrail Drain have been simulated based upon the structure sizes and dimensions noted in Table 3.1, and as verified during the field reconnaissance.

Similarly, the cross-section geometry and elevations of the eastern watercourse have been established based upon the base mapping provided for use in this study. The low flow channel width and depth of the eastern creek has been represented in the model based upon field measurements taken upstream of Culvert #1 during field reconnaissance, and has been applied throughout the balance of the reach. Manning's roughness coefficients of 0.045 and 0.10 have been applied for the low flow channel and the overbanks respectively, based upon the observed condition of the channel and overbanks during field reconnaissance. At the upstream-most limit of the model, the roughness coefficient has been set to 0.03 for the channel and overbank to represent the manicured grass conditions within the golf course. The hydraulic structure at the watercourse outlet at Chippawa Parkway has been incorporated into the model based upon the size and type of structure measured during field reconnaissance; the structure invert has been simulated based upon measured cover at the structure during field reconnaissance, and top of road elevations provided in the base mapping.

The simulated peak flows from the hydrologic analyses (ref. Table 3.4) have been incorporated into the HEC-RAS hydraulic models, and the model has been executed conservatively under subcritical flow conditions to determine the flood characteristics of the Conrail Drain and the unnamed eastern watercourse related to conveyance of runoff for all events up to and including the 100 year design storm. The simulated water surface elevations are presented in Tables 3.6 and 3.7. As discussed in the previous section, *Hydrology,* two (2) 100 year storm events have been assessed: the NPCA 100 year storm event representing the Regulatory storm, and the MTO 100 year storm event with the greatest rainfall volume of all storms assessed in this report. Floodlines for the two (2) 100 year storm events within the Conrail Drain and the eastern watercourse are provided in Drawing 3.5.

Table 3.6 Conrail Drain Channel HEC-RAS Existing Conditions Simulated Water Surface Elevations (m)							
HEC-RAS Cross Section Number	Frequency Storm Events						
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	100 Year (NPCA)
Culvert #8							
2099.77	178.32	178.76	179.01	179.31	179.51	179.72	179.39
2029	178.19	178.64	178.90	179.22	179.44	179.67	179.30
1765	177.66	178.09	178.35	178.67	178.91	179.17	178.76
1484	176.76	177.25	177.55	177.93	178.25	178.59	178.04
1437.13	176.59	177.06	177.35	177.70	178.01	178.34	177.81
Culvert #7							
1373.13	176.54	176.96	177.20	177.47	177.65	177.83	177.54
1308	176.43	176.85	177.10	177.37	177.57	177.76	177.45
1001	175.90	176.32	176.56	176.84	177.03	177.22	176.91
659	175.28	175.68	175.92	176.20	176.41	176.61	176.28
429	174.64	175.05	175.31	175.63	175.87	176.11	175.72
381	174.53	174.93	175.18	175.48	175.71	175.94	175.57
Culvert #6							
332.24	174.49	174.86	175.08	175.35	175.54	175.72	175.42
286	174.40	174.78	175.01	175.28	175.48	175.67	175.36
212	174.25	174.63	174.86	175.15	175.35	175.55	175.23
97.53	173.79	174.15	174.37	174.64	174.83	175.01	174.71
Culvert #5							
35.06	173.75	174.06	174.25	174.45	174.60	174.72	174.51
0	173.61	173.93	174.12	174.34	174.49	174.63	174.39

Table 3.7 Eastern Creek HEC-RAS Existing Conditions Simulated Water Surface Elevations (m)							
HEC-RAS Cross Section Number	Frequency Storm Events						
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	100 Year (NPCA)
9	178.09	178.19	178.24	178.32	178.36	178.40	178.33
8	177.32	177.41	177.46	177.48	177.52	177.55	177.50
7	177.09	177.14	177.16	177.24	177.27	177.30	177.26
6	176.07	176.10	176.13	176.09	176.10	176.11	176.10
5	175.08	175.12	175.15	175.24	175.29	175.32	175.28
4	174.13	174.19	174.22	174.17	174.13	174.14	174.12
3	173.07	173.10	173.12	173.28	173.59	173.94	173.37
2	172.32	172.64	172.86	173.16	173.54	173.91	173.29
Culvert #1							
1	171.90	172.01	172.07	172.14	172.19	172.23	172.16

The results of the analyses indicate that the reach of the Conrail Drain through the subject property, as well as the watercourse at the eastern boundary of the site, generally to convey all events up to and including the 100 year storm event (based upon both the MTO and the NPCA IDF relationships) below the top of bank for each system. As such, the 100 year floodplain associated with each system is entirely contained within the feature, and does not extend onto the adjacent property.

3.5.3 Regulatory Mapping

The location of the Regulatory floodplain of the Welland River has been provided by the NPCA and can be seen on Drawing 3.5, HEC-RAS Cross-Section Location Plan. No Regulatory mapping has been provided regarding the Power Canal.

3.6 Summary

The Thundering Waters site is currently undeveloped, with dense vegetation and some wetlands. Soils exhibit a low permeability, and grades across the site are low. The Conrail Drain and an unnamed watercourse at the east limit of the property receive and convey runoff from external properties through or along the site. All runoff from events up to and including the 100 year design storm is contained within the features, and does not breach the top of bank and extend onto the site.

During the next phase of the servicing study, the baseline information will be used to evaluate stormwater management alternatives and to establish a preferred stormwater management plan for the site. Additional analyses will be completed to assess the impacts of the proposed development on the site, as well as to establish criteria for the sizing of stormwater management infrastructure to mitigate impacts.

4. WASTEWATER SERVICING

4.1 Purpose

The purpose of the wastewater servicing assessment is to determine the current conditions of the sanitary sewage collection system, and establish the potential need for additional capacity in the system. As new developments are introduced to the system, they can consume available capacity of the existing infrastructure downstream to the wastewater treatment plant, reducing the capability of future development to be serviced. By establishing the flows that will be generated by the Thundering Waters development, the Region can assess the influence in the master collection system model, and determine the short term and long term effects of the development. Working with the Region and the City of Niagara Falls, the sanitary flow generated by the Thundering Waters site can be coordinated with the local and regional master planning.

4.2 Background Information

The Thundering Waters Developments falls within the collection area of the Niagara Falls Wastewater Treatment Plant. The capacity of the WWTP is 145.5 MLD or 1,684 L/s. All flows generated within the development area would be collected and distributed to the South Side High Lift SPS, which has a firm capacity of 760L/s. The Region has confirmed that current baseline, or measured, flow at the South Side SPS is approximately 150 L/s (20% of capacity). Flows from the Grassybrook SPS are also pumped directly to the South Side high lift SPS. Complete buildout for the Grassybrook SPS would have a capacity of 138L/s, and is anticipated to be at complete buildout by 2020. There are no plans identified for expansion to the South Side High lift SPS.

Table 4.1 Proposed Wastewater Capital Projects in the Area or in the Adjacent Area

Project Description	Year in Service and Class EA	Total Estimated Cost (2011)
Process Improvements at Niagara Falls WWTP	TBD	$40,000,000
Increase firm capacity of Grassy Brook pumping station	2020 Schedule A+	$695,000
Increase capacity of Grassy Brook Forcemain	2020 Schedule B	$1,815,000

The existing sanitary sewer collection system drawing is provided in Appendix B. It shows the existing collection system surrounding the proposed development, including the associated force mains. The piping along Don Murie Street, Progress Street, and Kister Road all drain east to the South Side Low Lift SPS, which is pumped north along Stanley Avenue, crosses the Conrail Drain, under the train tracks and discharges to the 1200 mm diameter trunk sewer on Oldfield Road. Both the 825 mm diameter concrete trunk on Dorchester Road, and 1200 mm diameter concrete trunk on Oldfield Road discharge to the 1375 mm gravity main, and eventually to the South Side High Lift SPS. The 825 mm diameter sewer dead ends at the extent of the existing industrial development on Dorchester Road. The 825 mm diameter size suggests that this was oversized for future development along Dorchester Road, and limits the number of future connections to be made to the trunk sewer on Oldfield Road.

Also to be considered is the potential development of the Vedic lands to the south of the Welland River. During earlier consultation, the City has suggested that servicing of this potential development may impact the design requirements of the Thundering Waters development. There are potentially an additional 192 ha of developable land on the south of the Welland River that would require servicing. To date, limited data has been made available for this area. The Vedic Lands Ownership Group provided a basic map of its lands, which is provided in Appendix B. Assuming that all lands were developed for residential use, the complete development could generate as much as 170L/s. It is expected upon confirmation from the City and Region, that this amount may have to be considered in further analysis, and as part of the overall design.

4.3 Methodology

In order to establish the flows generated by the proposed development, MOECC guidelines have been used in conjunction with the design standards for the City of Niagara Falls, as well as the information gathered from the Region of Niagara, Master Servicing Plan (2011). The proposed land use plan will be provided by GR (CAN), as part of the next phase and anticipated flows will be generated based on various land uses. Sanitary flows will need to be applied based on the specific land uses, and peaking factors used accordingly to develop an average day flows. It is expected that a Harmon peaking factor of 3.0 will need to be used to develop a peak flow rate due to the expected population. Inflow and infiltration will need to be considered, at a rate of 0.286L/s/Ha based on the area of the land to be developed, and included in the generation of a total flow.

4.4 Design Criteria

The planning and design of water and wastewater facilities follows recognized standards and planning documents, including:

- Design Guidelines for Sewage Works, MOE, 2008
- Design Guidelines for Drinking Water Systems, MOE, 2008
- Region of Niagara Design Guidelines
- City of Niagara Falls Engineering Design Criteria
- Niagara Region Water and Wastewater Master Servicing Plan, AECOM, 2011
- The City of Niagara Falls Official Plan, Amended to January 2015

Amec Foster Wheeler has identified the design criteria for the wastewater servicing (Table 4.1) as follows.

Table 4.2 Design Criteria – Wastewater Collection

	Criteria	Source
Planning Basis[1]		
To Be Determined		
Flow Generation		
Average Generation: Residential	275 l/cap/day	Region
Average Generation: Employment	275 l/cap/day	Region
Average persons per unit	2.7 persons/unit	Region
Sanitary Flow Peaking Factor	Harmon Formula (2.0-4.0)	Region
I/I Allowance	90 /cap/day 0.286 l/s/hectare	Region
Pipe Design		
Minimum Depth of Cover	2.8m – Residential 2.15m - Industrial	City
Minimum Pipe Size	200mm – residential	City
Minimum Velocity	0.60 m/s	City
Maximum Velocity	3.0 m/s	City
Manning's factor (n value)	0.013	City

Note 1: Unavailable at the Background report stage.

For the preliminary calculation of flow generation, a value of 2.7 persons per unit is proposed. This is a conservative estimate, as planning figures project that the number of persons/unit is decreasing in Niagara Falls, and by 2031 could be as low as 2.5. More detailed planning information for the Thundering Waters development will provide an estimate of persons per unit for each land use type.

4.5 Topographic Constraints

Existing contour mapping indicates that the proposed development is relatively flat, and there is a separation in grade created by the Conrail Drain. Grades slope slightly to the south, towards the Welland River. This indicates that in order to convey flows to the trunk sewer on Oldfield Road, a pumping station will be required in order to service this development. Some of the flows generated on the northwest portion of the development, north of the Conrail Drain, could be directed to the 825 mm trunk sewer along Dorchester Road. While to the southeast, grades may allow for drainage to the existing development; these flows would need to be pumped from the South Side low lift pumping station, back to the Regional trunk sewer and eventually flow back to the South Side High Lift SPS. In order to prevent pumping the flows twice, this option should be screened.

4.6 Required Analysis

In order to establish an average day flow generated by the development, all of the various land uses present must be assigned a flow rate. Depending on the land use, the manner in which the flow rate is calculated will vary. For residential units, a population equivalent is calculated, and a flow assigned based on a per person flow rate, while ICI flows are area based. Once the land use plan is finalized, the following criteria will have to be established:

- Average day flow
- Total Peak Flow (3.0)
- Inflow and Infiltration Allowance
- Total Flow Generated

At this time, the locations and sizing of the piping on the interior of the development area cannot be determined. It is presumed that all of the flow generated will have to be collected in one common pumping station, and pumped to either the 825mm diameter gravity main along Dorchester, or directly to the 1200mm diameter trunk main along Oldfield Road. The feasibility of a pumping station and discharge points will be assessed as part of the analysis. Both the 825mm, and 1200mm have been oversized with considerations for future development, and have sufficient capacity for a typical development the size of Thundering Waters. The Region would like to reduce the number of connections to the trunk mains as possible, so future analysis will consider one common point of discharge to the trunk main. This would include one potential connection directly from a force main.

The results from preliminary analysis will be presented to the Region in order for them to verify that the flows generated are acceptable. The Region will need to confirm that the South Side High Lift SPS can receive the peak flow generated by the Thundering Waters development, while considering other proposed developments. The increased flows expected due to the planned upgrades to the Grassybrook SPS will be taken into consideration by the region, as well as flow from the South Side High Lift SPS, and other potential developments within the sewershed. Once the detailed plans are available, further analysis can be conducted, and an estimated flow rates from the development can be determined.

5. WATER SERVICING

5.1 Purpose

The purpose of the water servicing assessment is to determine the current conditions of the distribution system, and establish the need for additional capacity and pressure in the existing system. The Thundering Waters development will draw a significant amount of water from the system, and the increased demands will potentially create decreases in pressure throughout the distribution system. By establishing the flows that are going to be generated by the Thundering Waters development, the Region can consider the requirements as part of its distribution system and determine the short term and long term effects of the proposed development.

5.2 Background Information

The proposed Thundering Waters development currently does not have any internal water servicing, however it does have access to servicing to the north, and to the east of the property. The Regional 1050 mm diameter trunk watermain runs along Oldfield Road and connects the Niagara Falls system to the communities of Thorold and Welland. A 300 mm PVC water main extends south along Dorchester Road and dead ends at the extent of the existing industrial development. Progress Street, and Don Murie Street to the east of the development also have 300mm diameter water mains which dead end, and would act as excellent connection points for the new development.

The Niagara Falls W.T.P is located approximately 5 km to the east along the Niagara River, and would be the main source of water for the development. The capacity of the WTP is 145.5 MLD or 1,684 L/s. The previous master plan projected that flows in 2016 would be 79.60 MLD (921 L/s), 55% of the overall capacity of the WTP. The existing Region of Niagara Master Plan does not indicate any planned upgrades to the WTP, or any of its water mains in the immediate vicinity of the proposed development. The Region is currently in the process of having the Master Plan updated, which will provide updated flows and pressures around the development. At this time though based on consultation with Region staff, it is not anticipated that the update of the Master Plan will be completed in time for fulsome analysis of the Thundering Waters development's impacts on the overall system.

As for the wastewater system, the Region and City wish to consider the potential development of the Vedic lands to the South of the Welland River as part of this assessment. The City has suggested that servicing of this potential development may impact the design requirements of the Thundering Waters development. As noted, there are potentially an additional 192 ha of developable land on the south of the Welland River would require servicing. Assuming that all lands were developed for residential use, the development could see peak hourly demands of 167L/s. This amount may have to be considered in further analysis, and as part of the overall design subject to concurrence with Region and City staff.

5.3 Methodology

In order to establish the demands that are to be expected from the proposed development, MOECC guidelines will be used in conjunction with design standards for the City of Niagara, as well as information gathered from the Region of Niagara Master Servicing Plan. Anticipated demands will be estimated based on the various land uses to develop an average day flow. The Region of Niagara uses a peaking factor of 4.0 to account for peak hour demand in residential development. The development is primarily a residential development, and so a peak hour factor of 4.0 is considered applicable to the entire development to establish a preliminary estimate of the peak hour flow.

5.4 Design Criteria

Based on the background information reviewed and listed in Section 2, Amec Foster Wheeler has identified the design criteria for the potable water servicing (Table 5.1) as follows.

Table 5.1. Design Criteria – Water Distribution

	Criteria	Source
Planning Basis[1]		
To Be Determined		
Flow Demands		
Average Day Demand	300 l/cap/day	Region
Maximum Day Factor	Calculated from historical max day factors 2.0	Region MOECC
Peak Hour Demand Factor – Residential Peak Hour Demand Factor – Industrial	4.0 2.0	Region
Fire Flow		
Equalization storage at 25% of the maximum day demands for the lower pressure zone at the reservoir's HGL		
For Development area (Equivalent population 10,000) – 189 l/s for 3 hours		
Emergency storage at 25% of the equalization plus fire flow		
Fire flow allowance should not be less than 80.0 L/s		
Pipe Design		
Residential Area Minimum Size Industrial/Commercial Area Minimum Size High Density Residential	150mm for mainline 300mm for mainline 300mm for mainline	City
Minimum Cover	No less than 1.50m	City
Operation Pressure		
Pressure Range (Min-Max)	275-700 kPa (40-100 psi)	City
Normal Operating	350-480 kPa (50-70 psi)	MOECC
Minimum Pressure Under Fire Flow Conditions	149 kPa (21.6 psi)	City

Note 1: Unavailable at the background report stage.

As noted in the wastewater section, the preliminary calculation of expected demand uses a value of 2.7 persons per unit in order to be conservative. Regional population projections indicate that the number of person per unit is decreasing and could be as low as 2.5 by 2031. Once more detailed planning information is available, including a prediction of the long term persons per unit, the estimate of demand can be established.

The 2011 Region of Niagara Master Servicing Plan provides the most recent pressure map for the development area. The pressure map indicates that to the north, and to the west of the property, expected pressures are greater than 700 kpa (100psi), which is at the maximum end of the allowable pressures range. Typically, when pressures exceed the maximum end of the allowable range, it is recommended that pressure reducing valves be installed at each water service. The pressures and fire flows required for this development site will have to be verified by both the City and Region in order to confirm if the 2011 pressure mapping is still valid. As part of ensuring that pressures are verified, Amec Foster Wheeler has been requested by the Region that hydrant flow, and pressure tests will be required as the updated Master Plan is not anticipated to be completed within the schedule for this project.

5.5 Required Analysis

The analysis of the average daily water demand will be calculated by applying the design standards previously mentioned with the land use plans provided by GR(Can). Each unit within the various proposed land uses will be assigned an equivalent population, and a unit demand will be applied to determine the average day demand. Once the final land use plan is determined, the information from Table 5.1 can be used to establish the following:

- Average day flow
- Peak Hour Flow (4.0)

From the results of the 2011 Regional master plan, there is potentially 763 L/s of capacity available of the total 1684L/s capacity of the Niagara Falls WTP.

Both the City, and the Region require that looping of the water main be implemented wherever possible. Once demands are established, a pipe network throughout the development will be determined, including pipe sizing to meet demands. Ensuring that looping within the development, and connecting the north water main at Dorchester with the eastern mains on Don Murie Street and Progress Street will be an important part of this design, in order to greatly improve the ability of the system to meet the development demands. The Region would prefer to avoid any connections directly to the 1050mm trunk water main, so the existing 300mm diameter pipe at the north and east will have to be utilized where possible. The results, once generated, will be presented to the Region and the City so that they can apply them to their respective models. Once they have analyzed the impact of this development on the entire system, they will determine the allowable peak hour flow of the proposed development. These results will be added to the new master planning, and included in all future planning. Also, once more detailed planning data becomes available, a servicing plan can be established

6. OTHER UTILITIES

Over the course of this first phase investigations, various utility providers have been contacted and requested to provide maps and drawings of their existing utility services. The drawings from each of the utility providers is included in Appendix C and details are discussed in the following.

6.1 Bell (Telecommunications)

Bell currently provides minimal servicing to the proposed development site. Existing development to the southeast is serviced with buried cable along Progress Street, Don Murie Street, and Kister Road. Overhead service is provided along Dorchester Road, extending as far as the current industrial development limit. A service extension would have to be provided in order to service the site. Further consultation over the course of the Secondary Plan process will be required to define the nature of the upgrades.

6.2 Cogeco

Cogeco's existing services extend south from Dorchester Road, and terminate at the limit of the current development boundary on Dorchester Road. The current Oldfield development, which lies to the north of the proposed development site, is being serviced from the east along Drummond Road. These upgrades are ongoing. Cogeco also has service along Kister which ends just north of Progress Street, and a service extension would have to be provided in order to service the site.

6.3 Enbridge (Natural Gas)

Local servicing exists along Progress Street, Don Murie Street, and Kister Road. Dorchester Road is serviced as far south as the existing industrial development boundary. To the west of the Power Canal, Enbridge provides services along the Queen Elizabeth Way (east and west side), and show plans for a future crossing of the canal which could service the southwest portion of the development.

6.4 Hydro Electricity

Niagara Peninsula Energy Inc. (NPEI) currently provides services to the north, and to the east of the proposed development. Along Dorchester Road, a 3-phase / 13,800 volt hydro line extends to the existing industrial development. At this point a 1-phase / 8,000 volt, primary overhead distribution pole line continues south along Dorchester Road, terminating at the railway crossing. Along Don Murie Street and Progress Street, 3-phase / 13,800 volt, primary overhead distribution lines are provided and terminate at the development limits.

7. SUMMARY

In summary, the proposed development site has been in its existing condition since before the previous Region of Niagara Master Plan (2011), hence the information from that master plan are still considered valid. The site is densely vegetated with some wetland areas that have to be considered during future servicing. The soils on the subject property generally exhibit low infiltration, have a high generation of runoff can be expected. The property is relatively flat, with a mild grade (ie. Less than 0.1%) sloping towards the Welland River, or towards the Power Canal. The Conrail Drain runs north east to southwest through the subject property, creating a separation in grade, and acts as a significant drainage feature for the property. The Conrail Drain is capable of containing the flows generated during the 100 year storm, preventing any potential floodplain limitations in developing final land uses. The level terrain in combination with the Conrail Drain will have design implications for sanitary servicing, and with the water servicing design to a lesser extent.

The proposed development site has a well serviced perimeter providing good access to existing services. Oldfield Road acts a major artery for all of the required services for development. The proximity to Oldfield Road will provide the Thundering Waters development with:

- Sufficient water pressure and supply (>100 psi, 218 L/s)
    - Water services may require pressure reducing valves.
- South Side High Lift SPS and trunk sewer connection has sufficient capacity to receive wastewater flows
- Conrail Drain and water feature at eastern boundary can convey the equivalent of the 100 year storm in their existing state.
- Cogeco, Bell, and NPEI utility services can be extended to provide required service for development. The proposed site is not currently serviced.

The Oldfield Estates development which is located to the north of Oldfield Road will have no direct impact on the Thundering Waters development, as it shares major servicing from the trunk water main, and trunk sanitary sewer along Oldfield Road.

8. NEXT STEPS

At this stage of the planning process, Amec Foster Wheeler has established the existing conditions of the current services and drainage system in and around available at the proposed Thundering Waters development. The next phase of the planning assessment will be to develop a functional servicing plan for the study area based on the proposed land uses. As part of the functional servicing phase, there are several important points of input required:

- Verification that the Thundering Waters development has been, or is going to be included in the future scenarios presented in the 2016 Master Plan update.
- Indication from the Region as to the amount of developable land to the South of the Welland River that must be considered in the development of the study area.

Once the Team receives feedback from the City, Region and NPCA and a land use plan is established the functional servicing plan will be prepared; it is expected to include:

- Water main sizing and layout based on land use, demand and population density.
- Sanitary sewer sizing and layout.
- Sanitary pumping station discussion:
  - Location, size, contributing area and potential locations for outlet.
- Storm sewer sizing and layout.
- Stormwater management facilities and Low Impact Development Best Management Practices (LID BMPs)
- Watercourse / floodplain mapping

In order to prepare the functional servicing plan, it will be necessary to collaborate with the City and Region to confirm that the infrastructure proposed meets their requirements, and that the Thundering Waters development fits into the ongoing 2016 Region of Niagara Master Plan.

Report prepared by,

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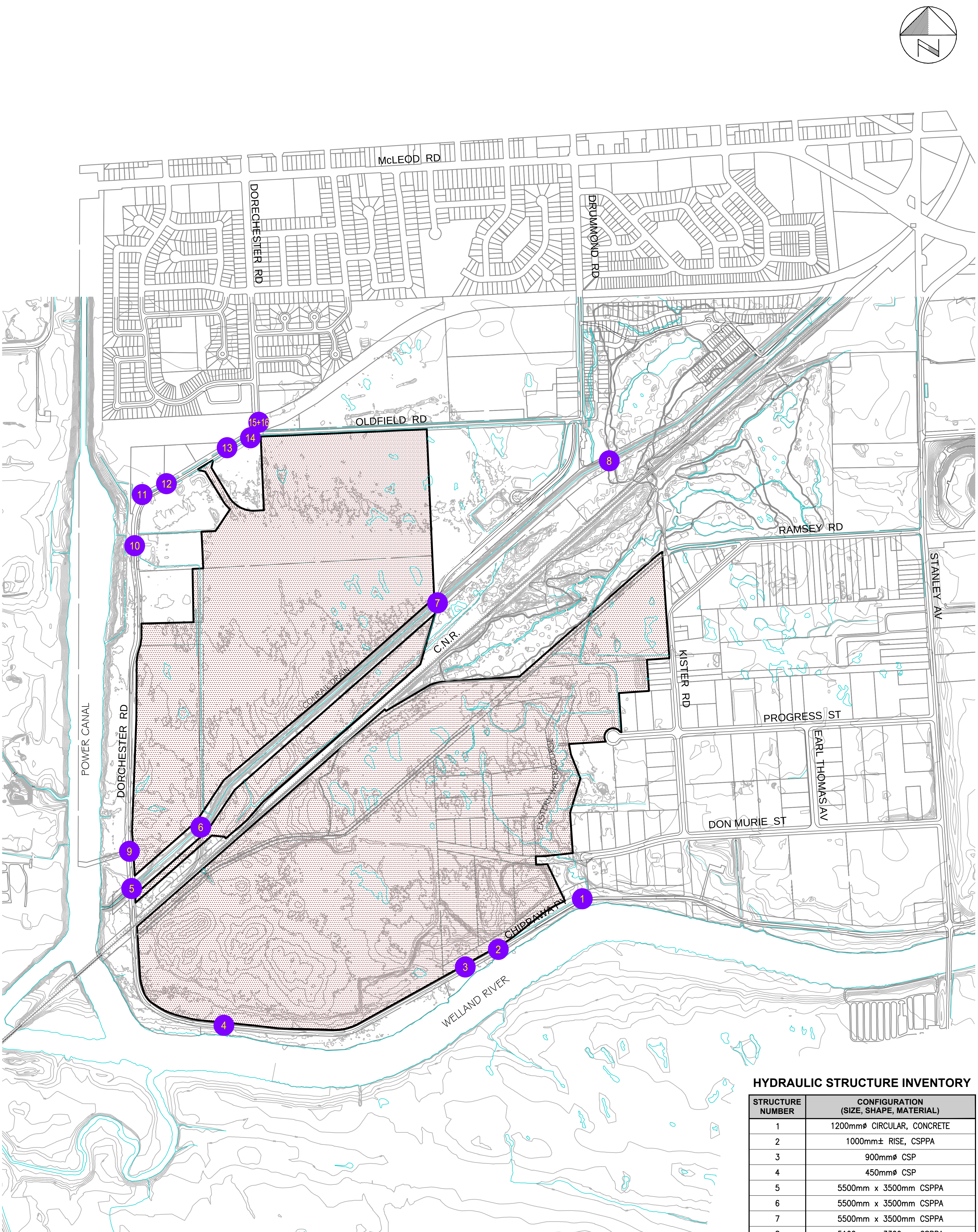

HYDRAULIC STRUCTURE INVENTORY

STRUCTURE NUMBER	CONFIGURATION (SIZE, SHAPE, MATERIAL)
1	1200mmø CIRCULAR, CONCRETE
2	1000mm± RISE, CSPPA
3	900mmø CSP
4	450mmø CSP
5	5500mm x 3500mm CSPPA
6	5500mm x 3500mm CSPPA
7	5500mm x 3500mm CSPPA
8	5100mm x 3300mm CSPPA
9	1200mmø SSP
10	850mmø CSP
11	900mm x 650mm ELLIPTICAL CSP
12	650mmø CSP
13	350mmø CSP
14	650mmø CSP
15	525mmø CSP
16	450mmø CSP

SCALE VALID ONLY FOR 24"x36" VERSION

LEGEND

- PROPERTY FABRIC
- WATERCOURSE
- CONTOUR (1m)
- LANDS OWNED BY GR(CAN) INVESTMENTS
- 6 HYDRAULIC STRUCTURE LOCATION AND REFERENCE ID#

THUNDERING WATERS SECONDARY PLAN

CITY OF NIAGARA FALLS

HYDRAULIC STRUCTURE INVENTORY

amec foster wheeler

Scale 1:6000 (0 75 150 300)

Consultant File No. TP115026

Drawing No. 3.1

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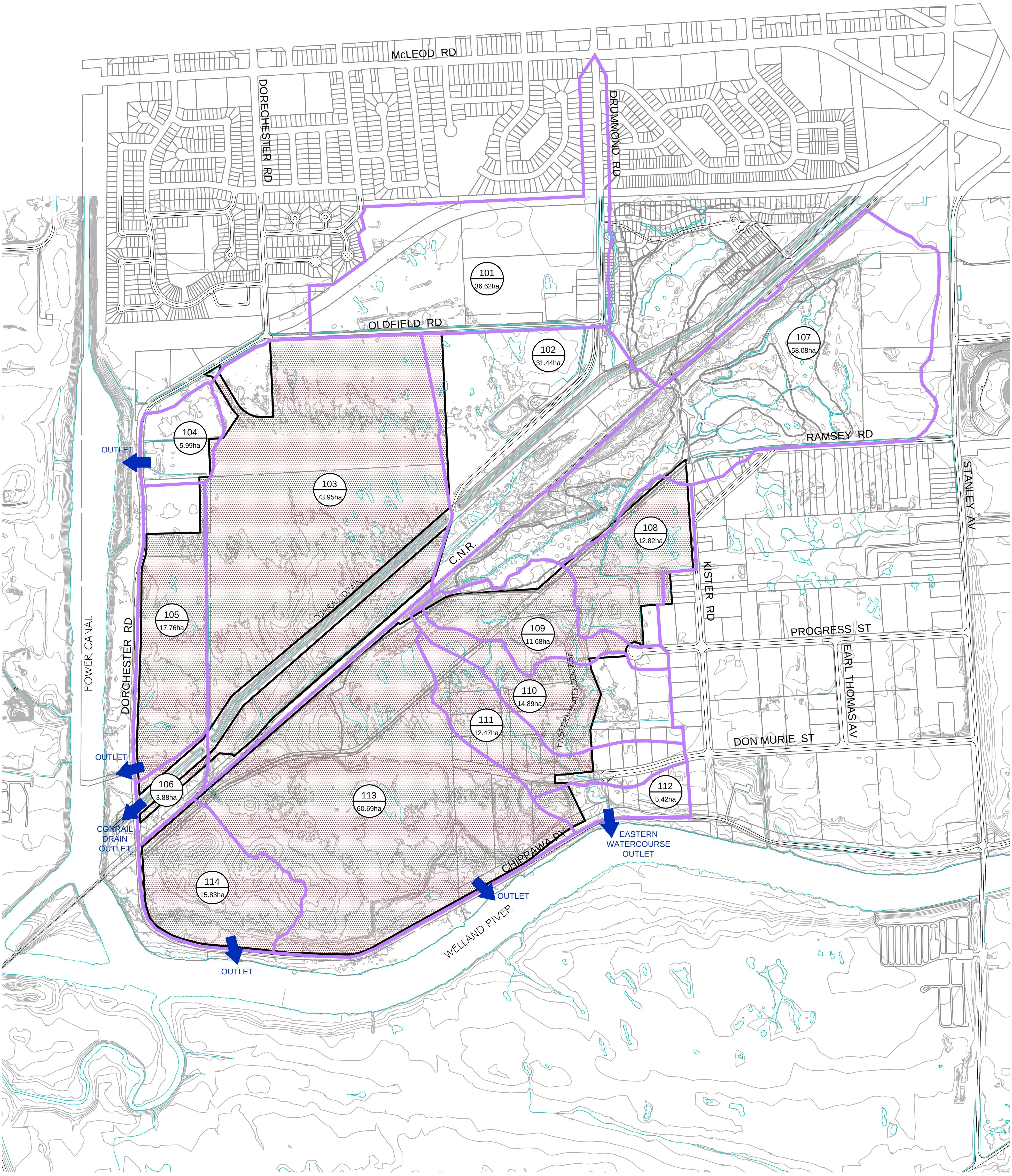

LEGEND

- PROPERTY FABRIC
- WATERCOURSE
- CONTOUR (1m)
- LANDS OWNED BY GR(CAN) INVESTMENTS
- SUBCATCHMENT BOUNDARY
- 100 — SUBCATCHMENT ID#
- 25.0ha — SUBCATCHMENT AREA

THUNDERING WATERS SECONDARY PLAN

CITY OF NIAGARA FALLS

SUBCATCHMENT BOUNDARY PLAN

amec foster wheeler

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:6000

0 75 150 300

Consultant File No. TP115026

Drawing No. 3.2

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Plotted: 2015-10-29

Last Saved By: richard.bartolo

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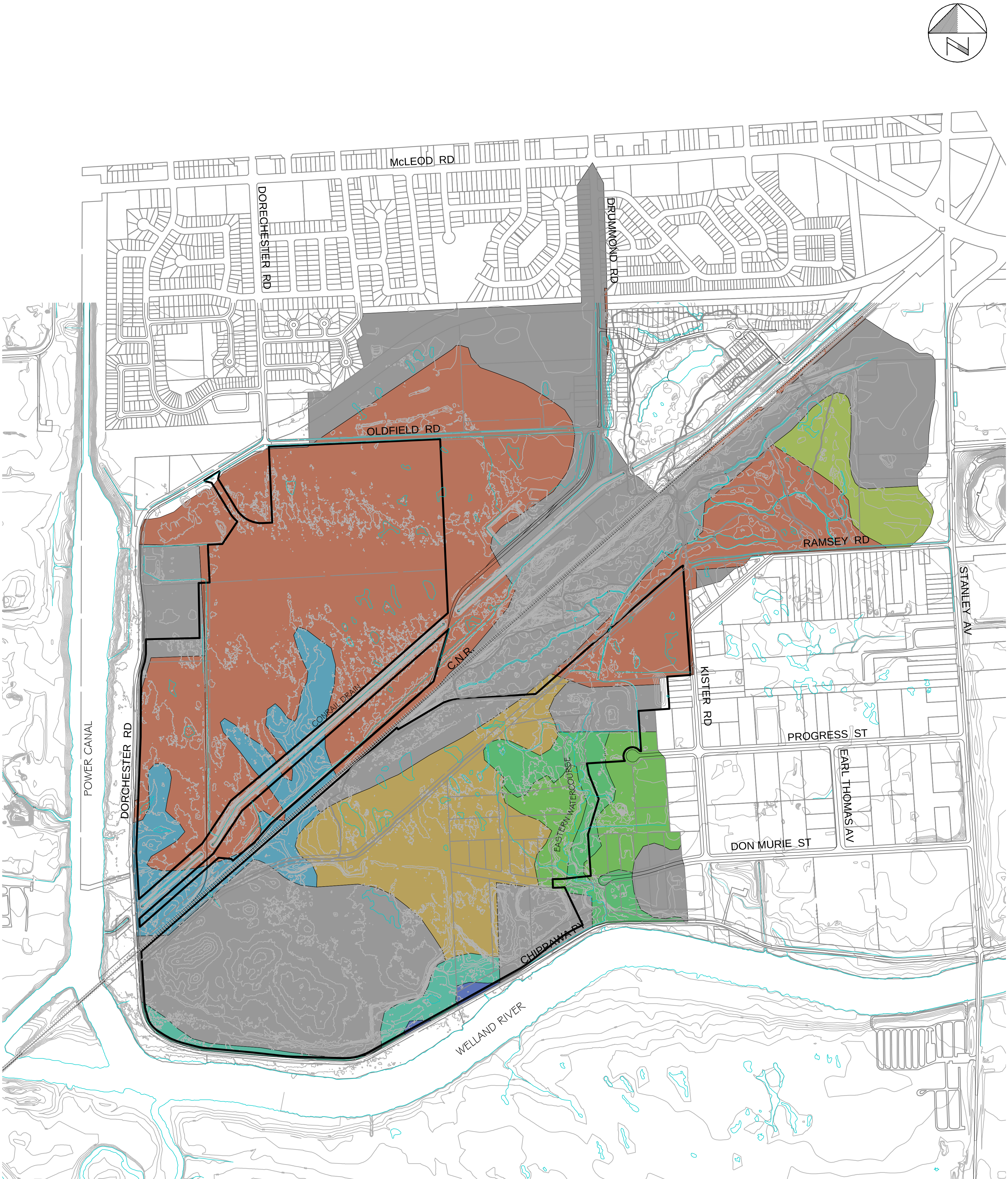


LEGEND

- PROPERTY FABRIC
- WATERCOURSE
- CONTOUR (1m)
- LANDS OWNED BY GR(CAN) INVESTMENTS
- LINCOLN CLAY
- WELLAND SILT–CLAY
- HALDIMAND SILT–CLAY + LINCOLN CLAY
- NIAGARA SILT–CLAY–LOAM
- ONTARIO SILT–CLAY + ALLUVIUM SILT–CLAY–LOAM
- ONTARIO SILT–CLAY
- NIAGARA SILT–CLAY–LOAM + ALLUVIUM SILT–CLAY–LOAM
- ALLUVIUM SILT–CLAY–LOAM
- UNCLASSIFIED

SCALE VALID ONLY FOR 24"x36" VERSION

THUNDERING WATERS SECONDARY PLAN
CITY OF NIAGARA FALLS

SOILS MAPPING

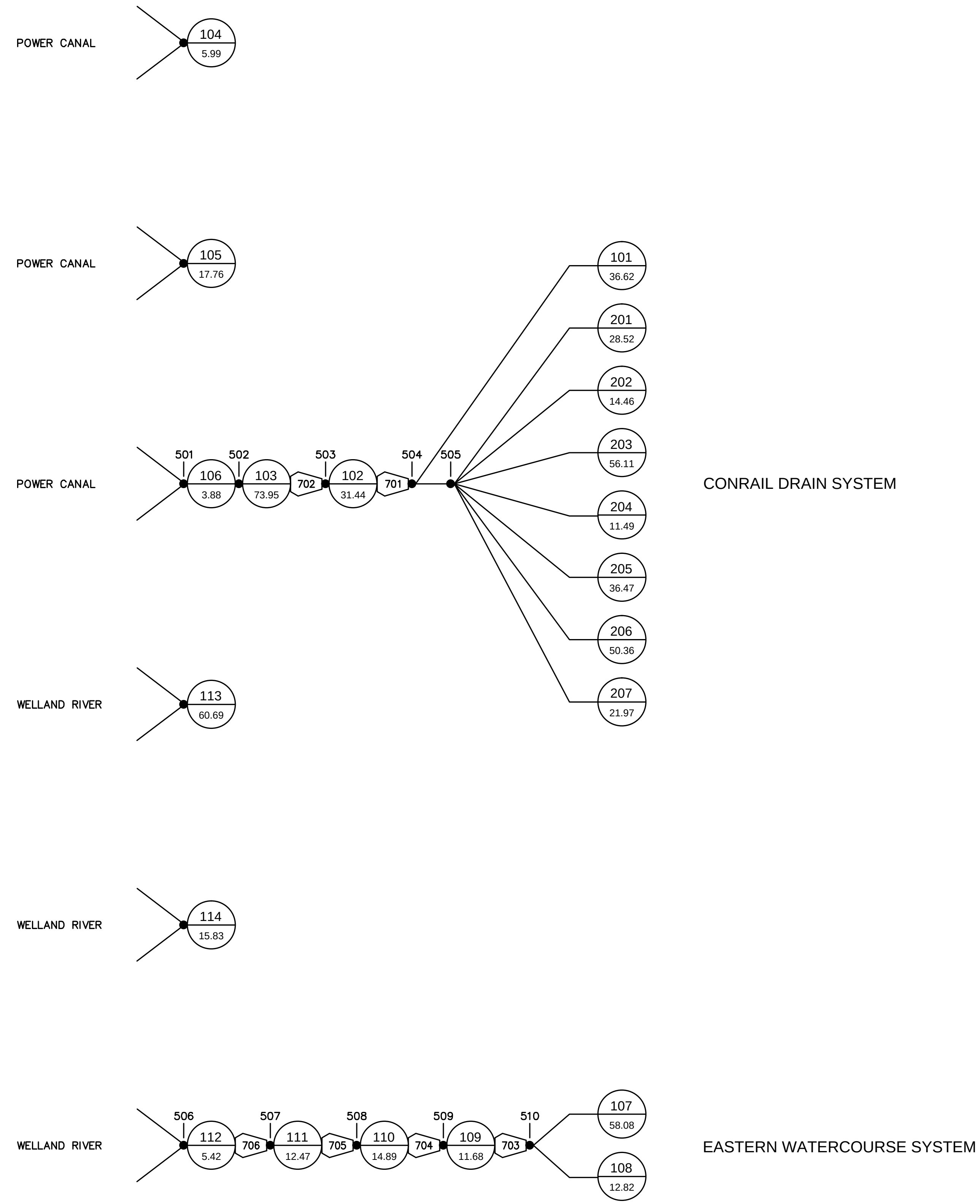
amec foster wheeler

Scale 1:6000 (0 75 150 300)

Consultant File No. TP115026

Drawing No. 3.3

Path: P:\Work\TP115026\water\dwg\2015-10(Report)\Dwg3-3 Soils.dwg
Plotted By: richard.bartolo
Plotted: 2015-10-29
Last Saved By: richard.bartolo
Last Saved: 2015-10-28



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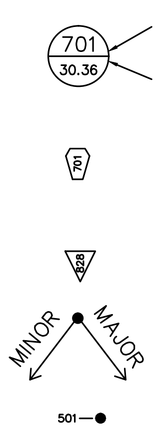


SUBCATCHMENT NUMBER

DRAINAGE AREA (ha)

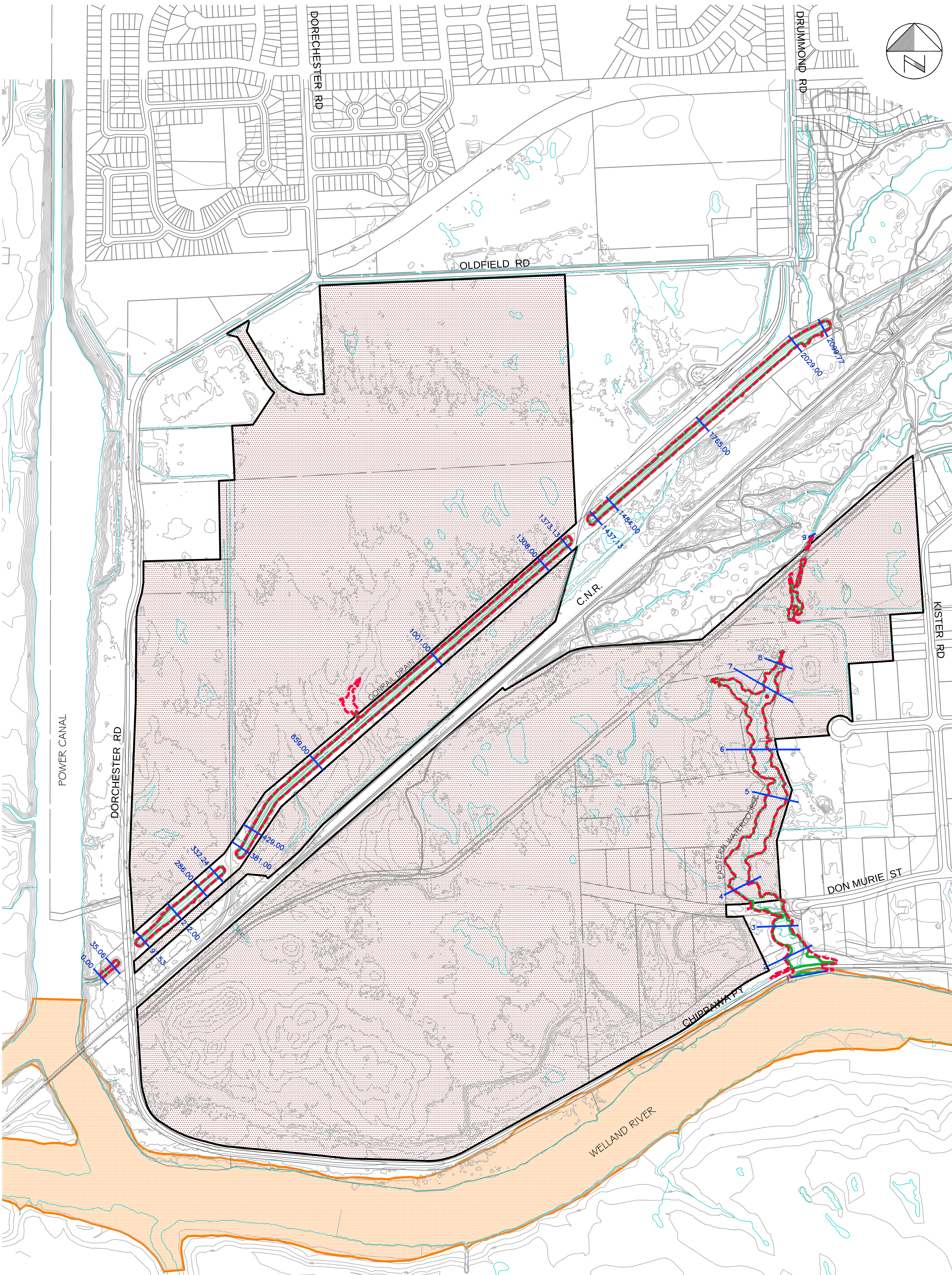
CHANNEL ROUTING ELEMENT REFERENCE NUMBER

RESERVOIR ROUTING ELEMENT REFERENCE NUMBER

SPLIT FLOW ELEMENT

FLOW NODE

THUNDERING WATERS SECONDARY PLAN CITY OF NIAGARA FALLS	EXISTING LAND USE CONDITION HYDROLOGIC MODEL SCHEMATIC	amec foster wheeler	Scale: N.T.S. Consultant File No.: TP115026 Drawing No.: 3.4



LEGEND

PROPERTY FABRIC

WATERCOURSE

CONTOUR (1m)

LANDS OWNED BY GR(CAN) INVESTMENTS

8212.49 HEC-RAS CROSS-SECTION LOCATION

100 YEAR FLOOD LINE

100 YEAR FLOOD LINE (REGULATORY-NPCA)

WELLAND RIVER REGULATED FLOOD PLAIN (NPCA)

SCALE VALID ONLY FOR 24"x36" VERSION

THUNDERING WATERS SECONDARY PLAN

CITY OF NIAGARA FALLS

HEC-RAS CROSS-SECTION LOCATION PLAN

amec foster wheeler

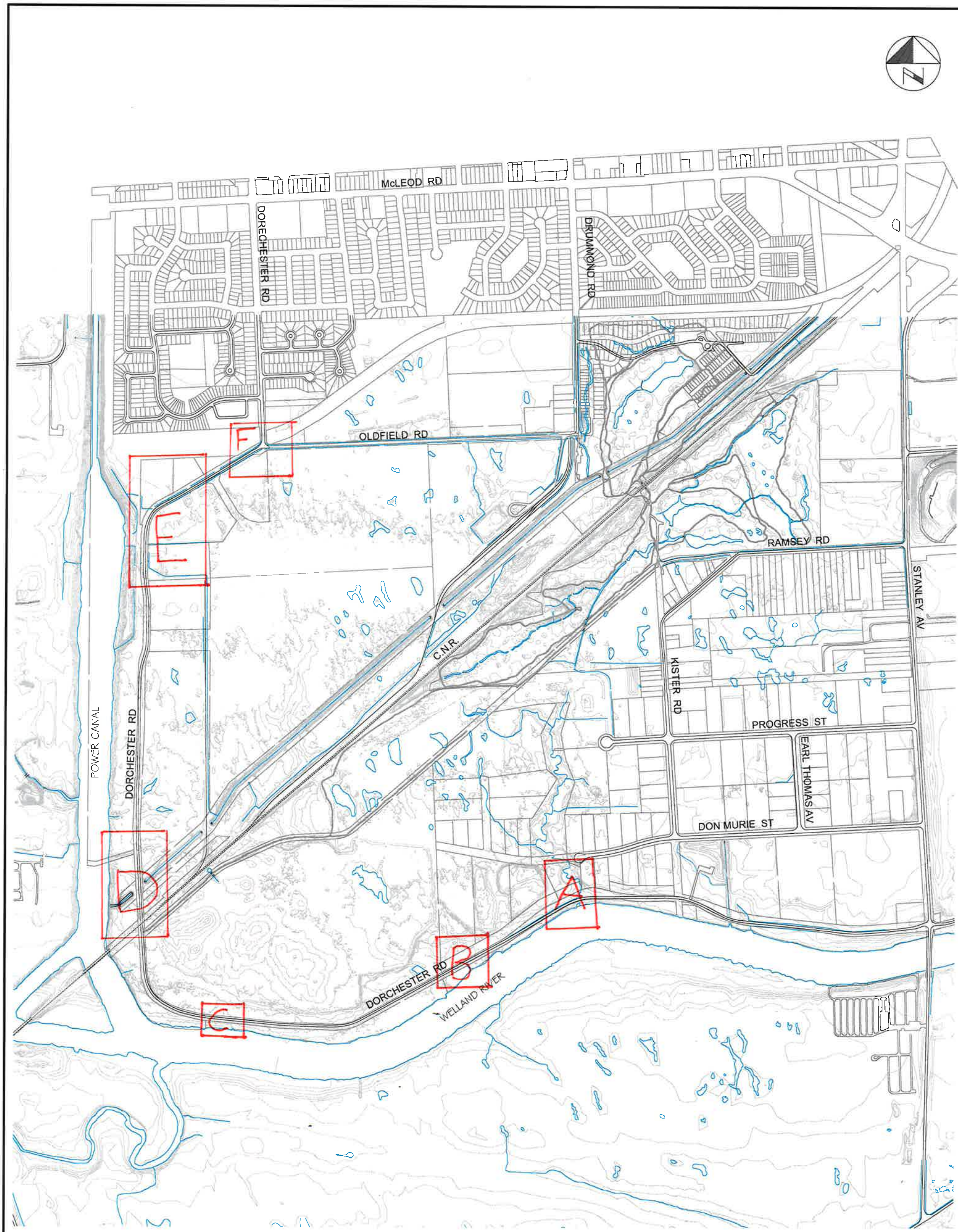
Scale 1:4000 (0 50 100 200)

Consultant File No. TP115026

Drawing No. 3.5

APPENDIX A

HYDROLOGY AND HYDRAULICS



LEGEND

PROPERTY FABRIC

WATERCOURSE

CONTOUR (1m)

Z Sheet Identifier

THUNDERING WATERS SECONDARY PLAN

CITY OF NIAGARA FALLS

PHOTOGRAPHIC INVENTORY

amec foster wheeler

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:6000

0 75 150 300

Consultant File No. TP115026

Drawing No.

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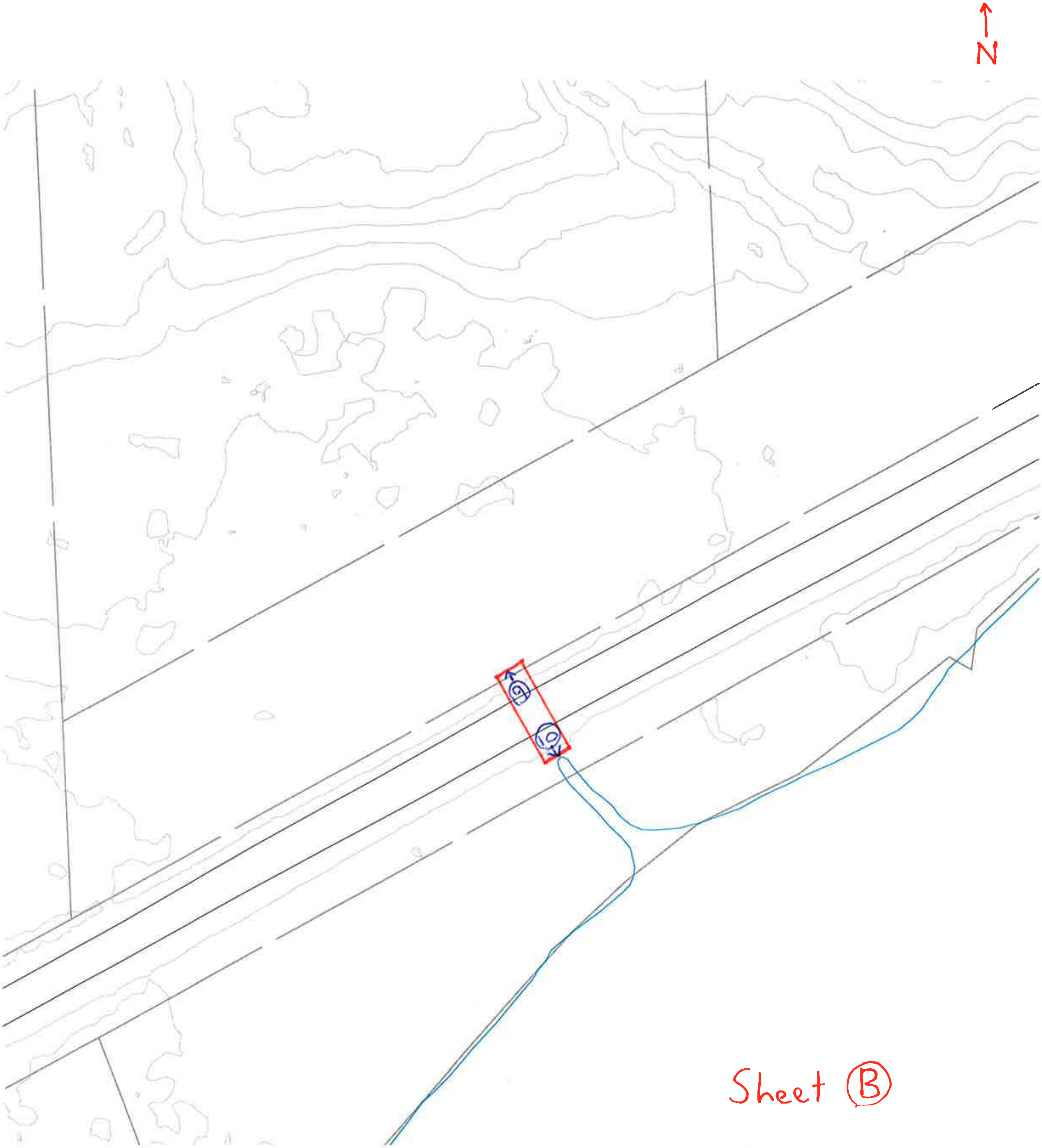
Sheet A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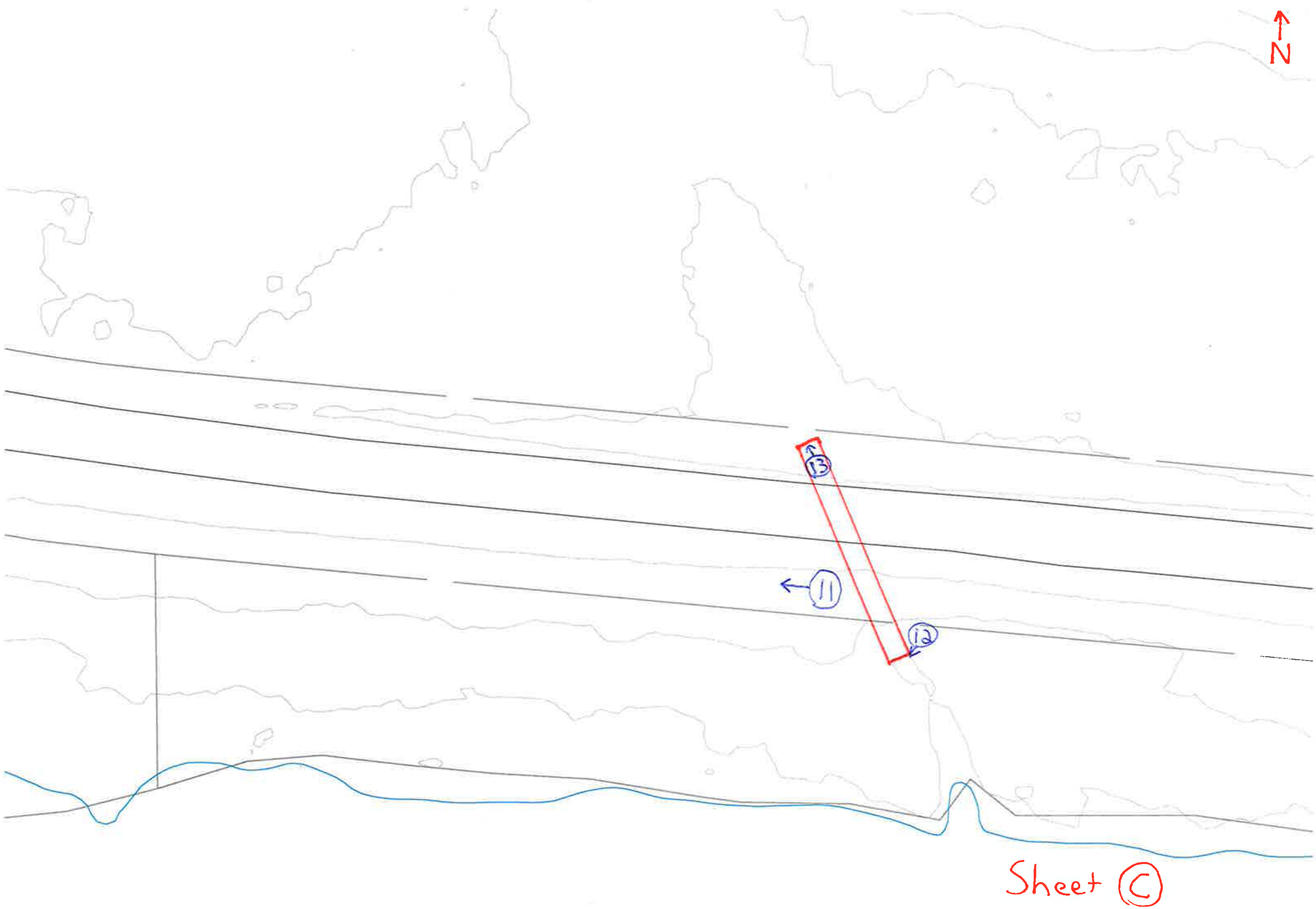
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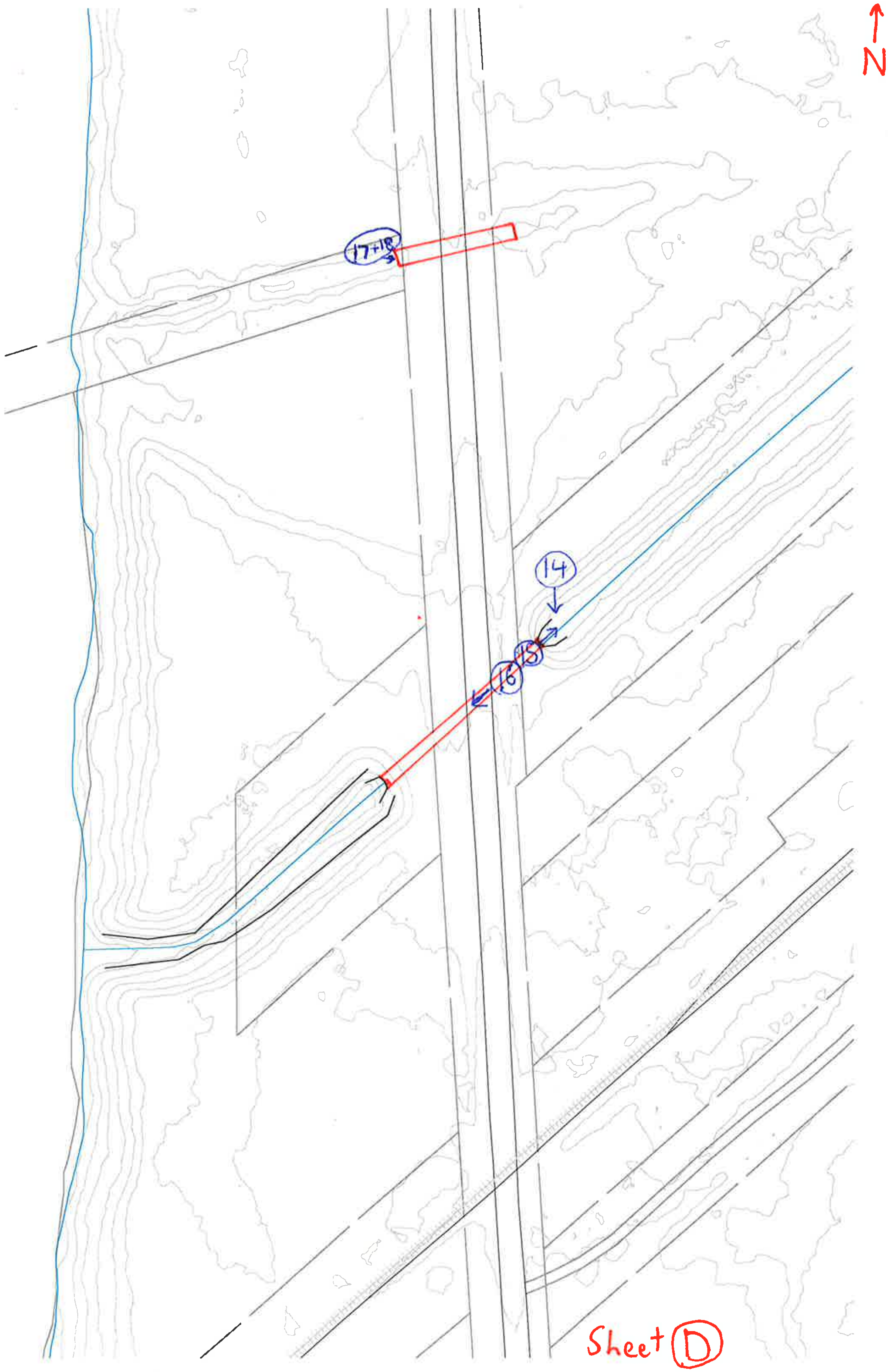
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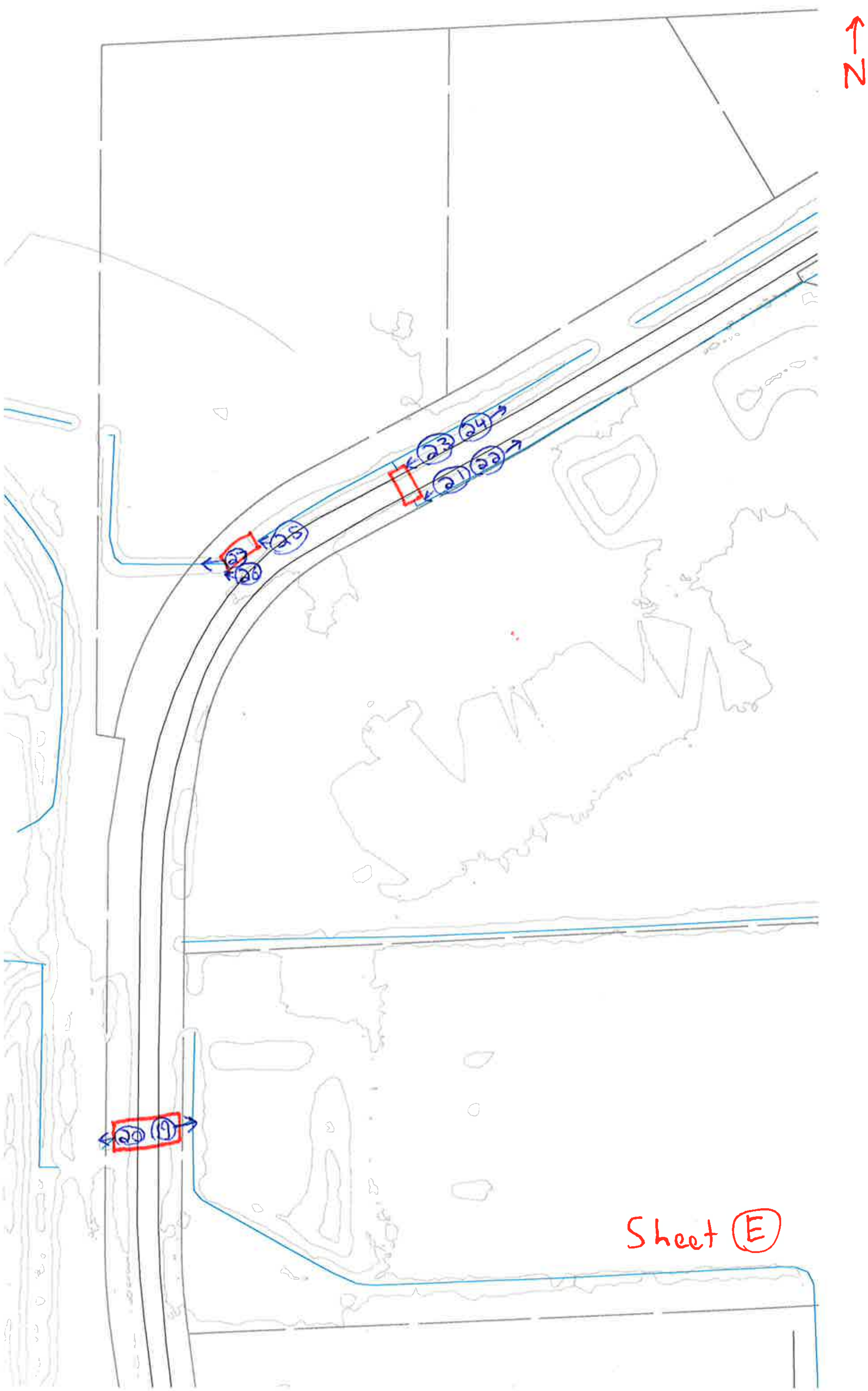
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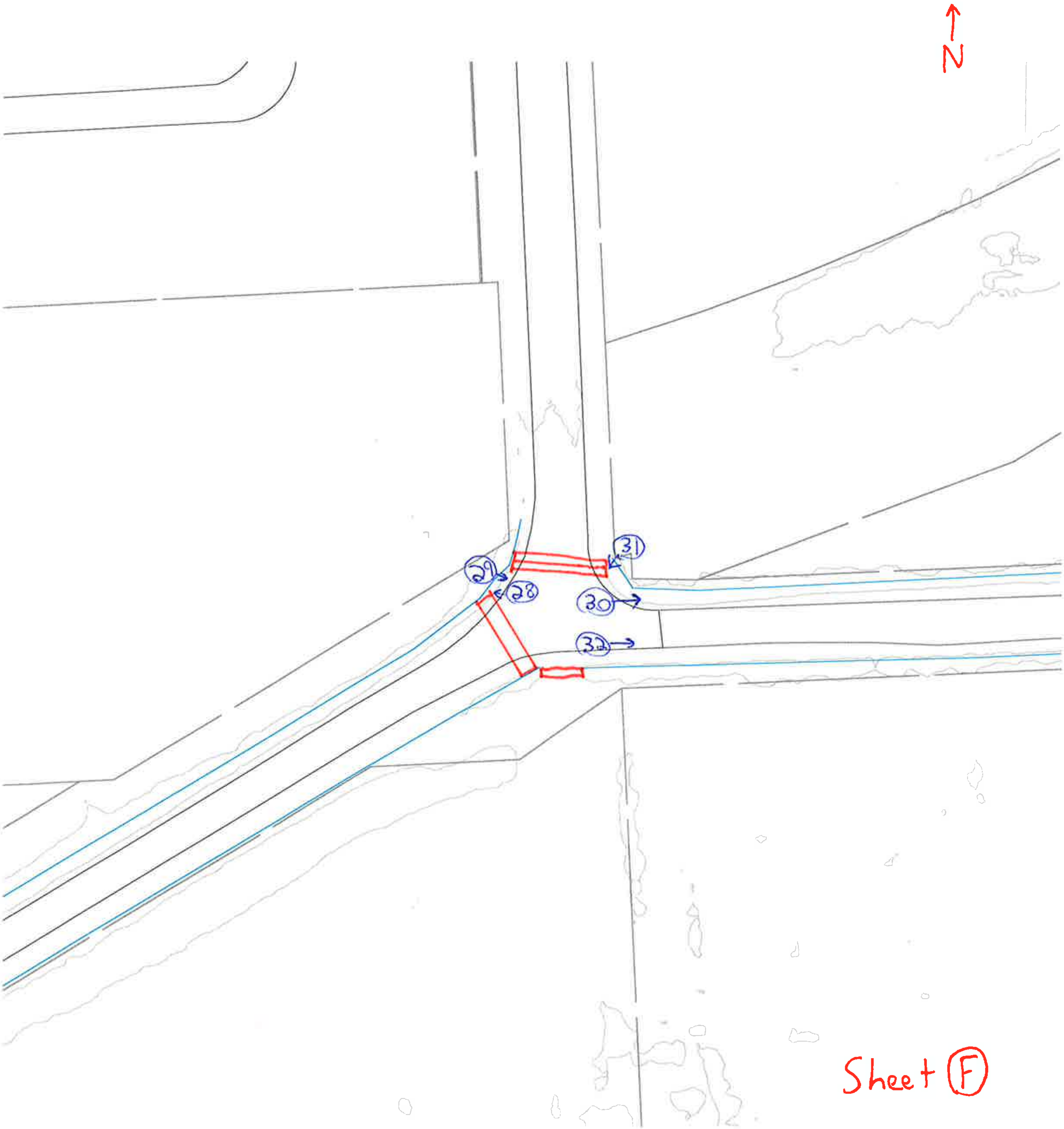
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Sheet F

Thundering Waters

Photo 1: Culvert inlet under the influence of backwater from the Welland River.

Photo 2: Creek banks upstream of culvert.

Photo 3: Main channel of creek - looking upstream.

Photo 4: West overbank of creek - looking upstream. Dense vegetation present.

Photo 5: East overbank of creek - looking upstream. Dense vegetation present.

Photo 6: Upstream length of pipe, separated from remainder of culvert.

Photo 7: Culvert outlet under the influence of backwater from the Welland River.

Photo 8: Culvert outlet in state of disrepair.

Photo 9: Culvert inlet under the influence of backwater from the Welland River. Culvert rusted.

Photo 10: Culvert outlet under the influence of backwater from the Welland River. Culvert rusted.

Photo 11: Dense vegetation present along Dorchester Road and Chippawa Parkway.

Photo 12: Culvert outlet in good condition.

Photo 13: Culvert inlet in good condition.

Photo 14: Conrail Drain inlet with safety grate and debris blockage.

Photo 15: Conrail Drain Channel - looking upstream. Vegetation growth within channel.

Photo 16: Conrail Drain outlet inaccessible due to chain link fence.


Photo 17: Culvert outlet partially blocked by large rocks.


Photo 18: Culvert outlet heavily corroded with holes in the pipe wall.


Photo 19: Culvert inlet in good condition.


Photo 20: Culvert outlet in stand of thick brush.

Photo 21: South ditch - with CSP culvert in good condition.

Photo 22: South ditch - shallow and regularly maintained.

Photo 23: North ditch - with CSP culvert in good condition.

Photo 24: North ditch - deep with vegetation growth.


Photo 25: Driveway culvert inlet.


Photo 26: Driveway culvert outlet.


Photo 27: Drainage outlet to power canal.

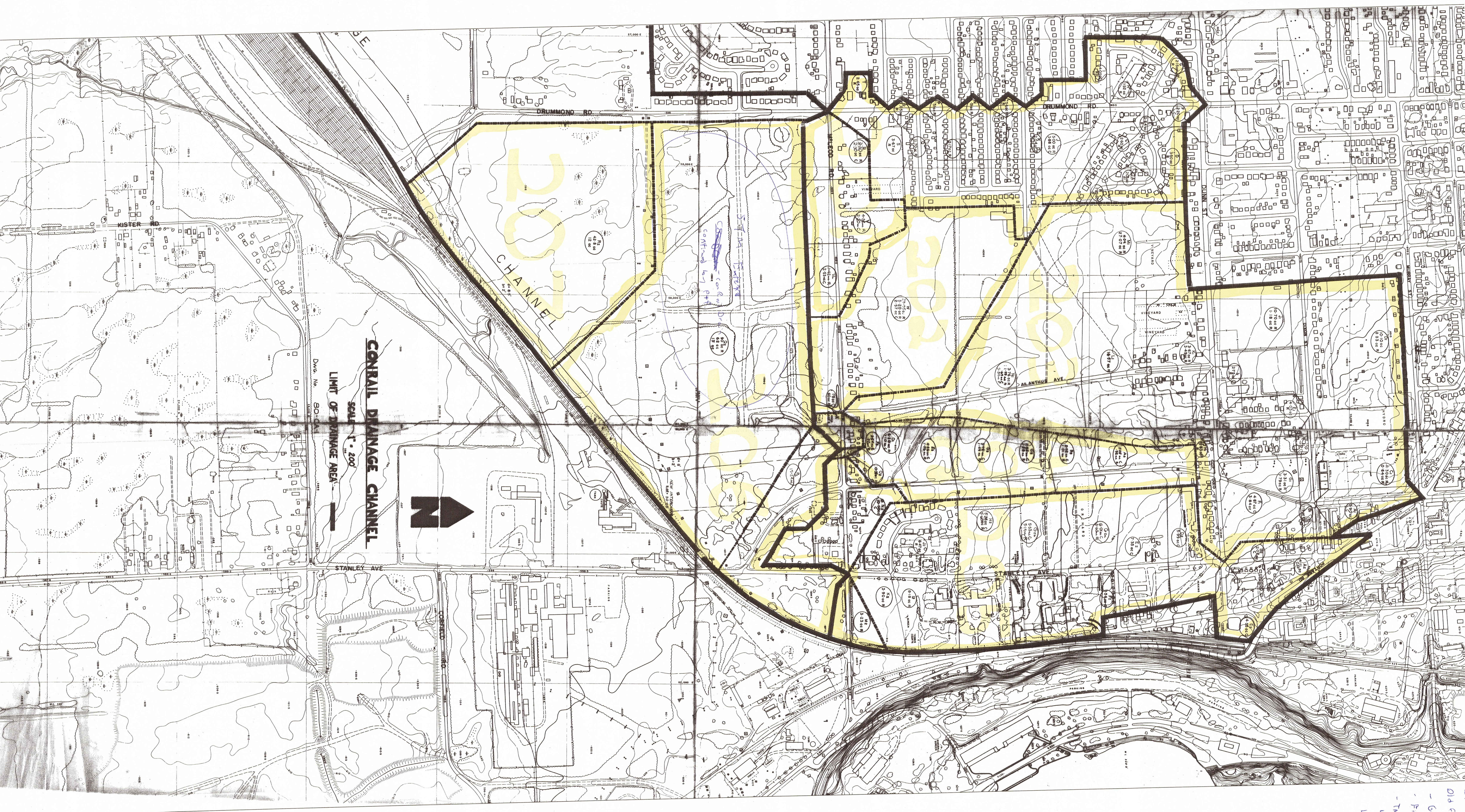
Photo 28: Culvert outlet to north ditch with thick vegetation.

Photo 29: Gabion baskets supporting road surface.

Photo 30: Oldfield Road north ditch.

Photo 31: Twin culvert inlets.

Photo 32: Oldfield Road south ditch.



Old Field Road and Mcleod Road.
- Google Earth: ~828m
- Figure 2 (1:5000): ~828m
- This drawing (using 1:5000 scale): ~900m
↳ 1:5000 measurement × 828m/900m = Actual length
↳ Estimated scale of drawing ≅ 1:4583

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IDF CURVE LOOKUP
Coordinate Selection | Terms of Use | About

Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:45:33 UTC

Map options: Modify selection | Show/hide gauging stations | Re-center selection

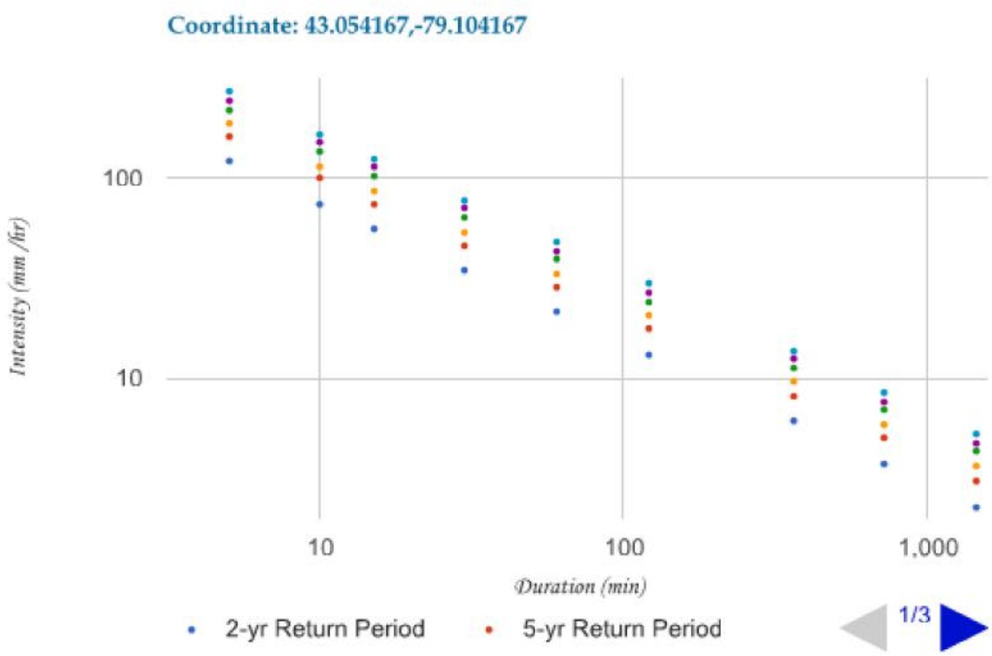
Coordinate summary

These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.



Coefficient summary

Notes

Click a return period in the table header for more detail.

Return period	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
A	21.6	28.8	33.6	39.6	44.0	48.5
B	-0.700	-0.697	-0.695	-0.694	-0.694	-0.694

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
2-yr	123.0	75.7	57.0	35.1	21.6	13.3	6.2	3.8	2.3
5-yr	162.8	100.4	75.7	46.7	28.8	17.8	8.3	5.1	3.1
10-yr	189.0	116.7	88.1	54.4	33.6	20.8	9.7	6.0	3.7
25-yr	222.2	137.3	103.6	64.1	39.6	24.5	11.4	7.1	4.4
50-yr	246.8	152.6	115.2	71.2	44.0	27.2	12.7	7.8	4.8
100-yr	272.1	168.2	126.9	78.5	48.5	30.0	14.0	8.6	5.3

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IDF CURVE LOOKUP
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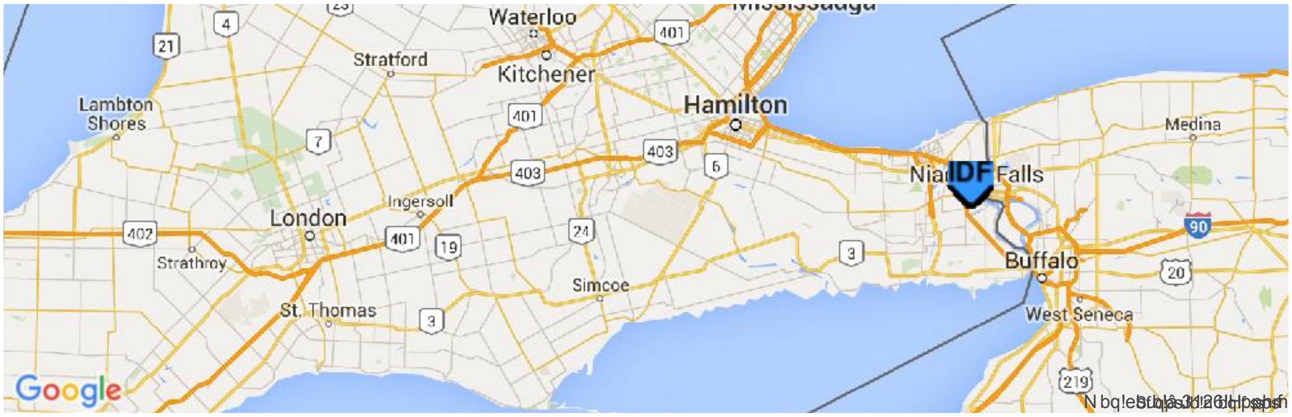
Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:49:59 UTC



Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

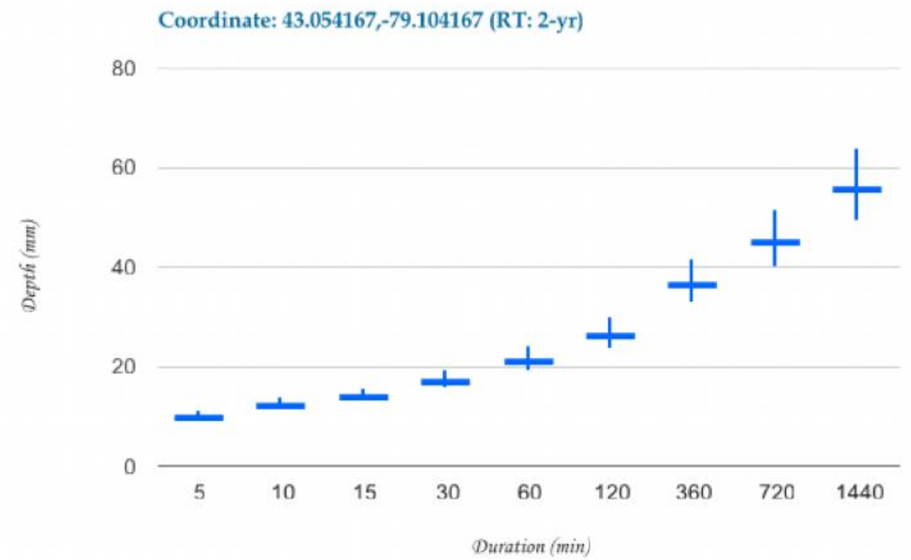
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 2-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 21.6 (+2.6, -2.3)

B: -0.7 (+0.006, -0.006)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Intensity (mm hr^{-1})	123.0	+12.8	75.7	+8.2	57.0	+6.3	35.1	+4.1	21.6	+2.6	13.3	+1.7	6.2	+0.8	3.8	+0.5	2.3	+0.3
		-11.4		-7.3		-5.6		-3.6		-2.3		-1.5		-0.7		-0.5		-0.3

Rainfall depth (mm)

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Depth (mm)	10.2	+1.1	12.6	+1.4	14.3	+1.6	17.5	+2.0	21.6	+2.6	26.6	+3.3	37.0	+4.9	45.5	+6.2	56.0	+8.0
		-1.0		-1.2		-1.4		-1.8		-2.3		-2.9		-4.3		-5.4		-6.9

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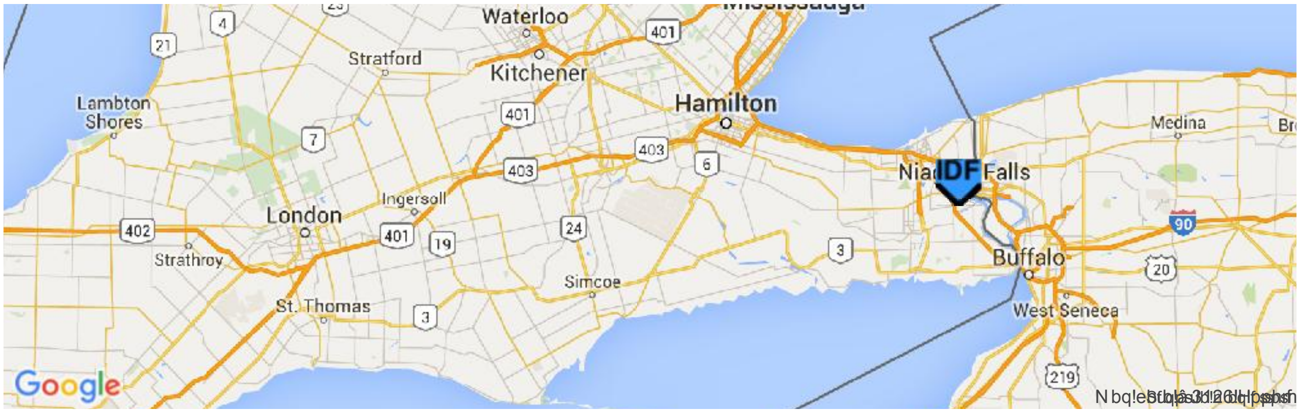
Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:51:03 UTC



Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

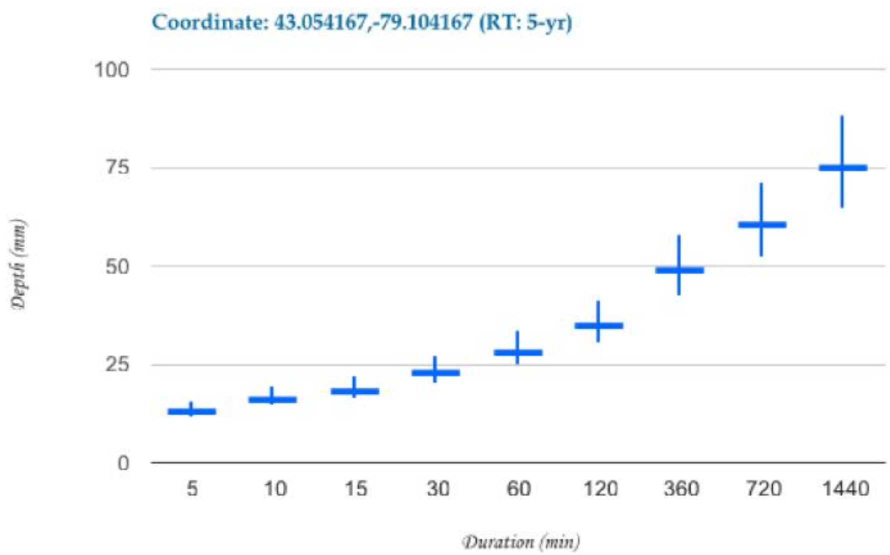
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 5-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 28.8 (+4.8, -4.1)

B: -0.697 (+0.001, -0.001)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Intensity (mm hr^{-1})	162.8	+26.7	100.4	+16.5	75.7	+12.5	46.7	+7.7	28.8	+4.8	17.8	+3.0	8.3	+1.4	5.1	+0.9	3.1	+0.5
		-22.8		-14.1		-10.7		-6.6		-4.1		-2.5		-1.2		-0.7		-0.5

Rainfall depth (mm)

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Depth (mm)	13.6	+2.2	16.7	+2.8	18.9	+3.1	23.3	+3.9	28.8	+4.8	35.5	+6.0	49.6	+8.4	61.1	+10.4	75.4	+12.9
		-1.9		-2.4		-2.7		-3.3		-4.1		-5.1		-7.1		-8.8		-10.9

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IDF CURVE LOOKUP
Coordinate Selection | Terms of Use | About

Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:51:52 UTC

Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

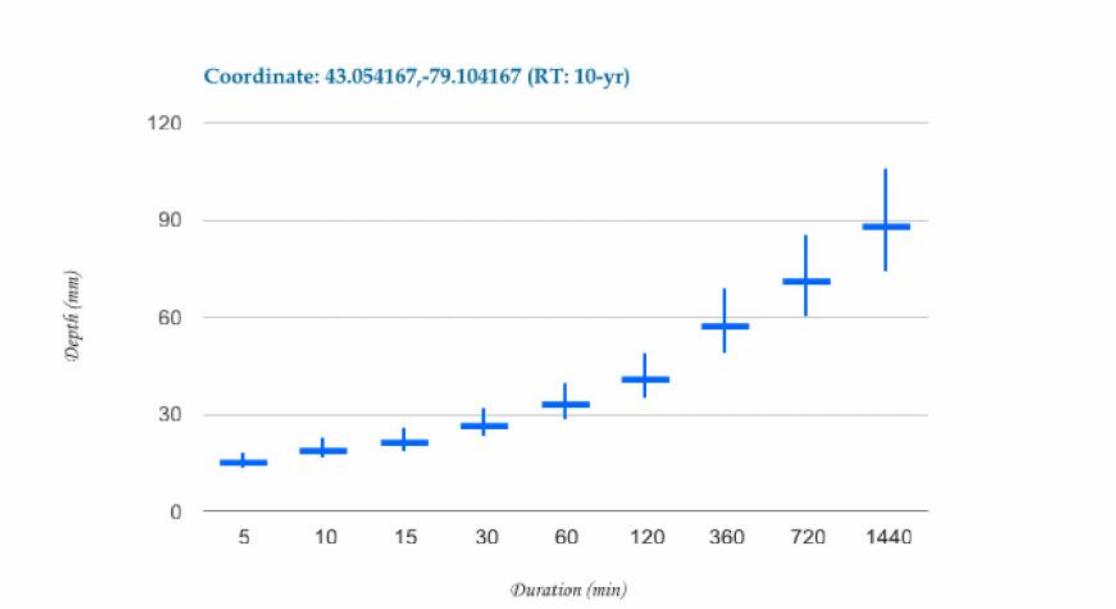
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 10-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 33.6 (+6.4, -5.4)

B: -0.695 (+0.002, -0.002)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr

Intensity (mm hr^{-1})	189.0	+34.9	116.7	+21.7	88.1	+16.5	54.4	+10.3	33.6	+6.4	20.8	+4.0	9.7	+1.9	6.0	+1.2	3.7	+0.7
		-29.6		-18.4		-13.9		-8.7		-5.4		-3.4		-1.6		-1.0		-0.6

Rainfall depth (mm)

Duration	**5-min**		**10-min**		**15-min**		**30-min**		**1-hr**		**2-hr**		**6-hr**		**12-hr**		**24-hr**	
Depth (mm)	15.7	+2.9	19.5	+3.6	22.0	+4.1	27.2	+5.1	33.6	+6.4	41.5	+8.0	58.0	+11.3	71.7	+14.1	88.6	+17.5
		-2.5		-3.1		-3.5		-4.3		-5.4		-6.7		-9.5		-11.8		-14.7

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IDF CURVE LOOKUP

Coordinate Selection | Terms of Use | About

Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

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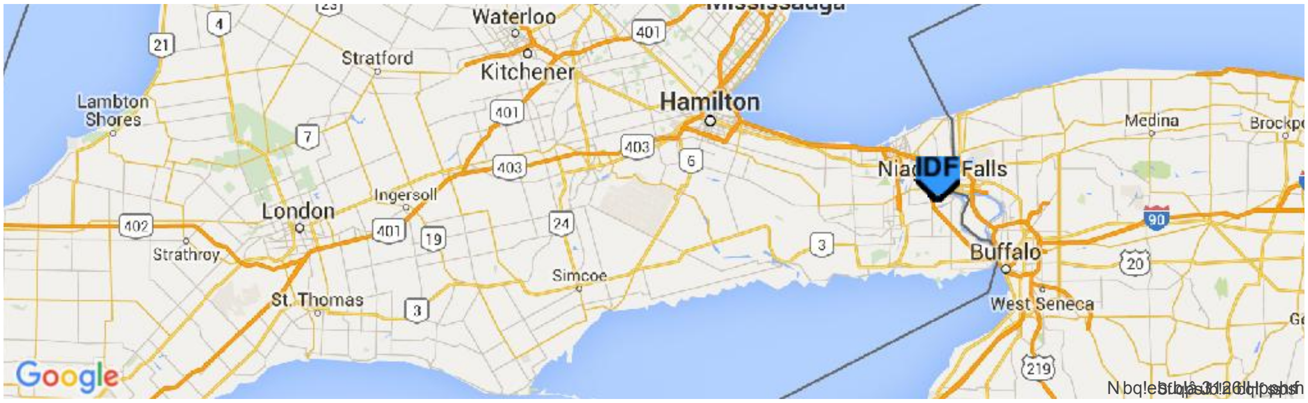


Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

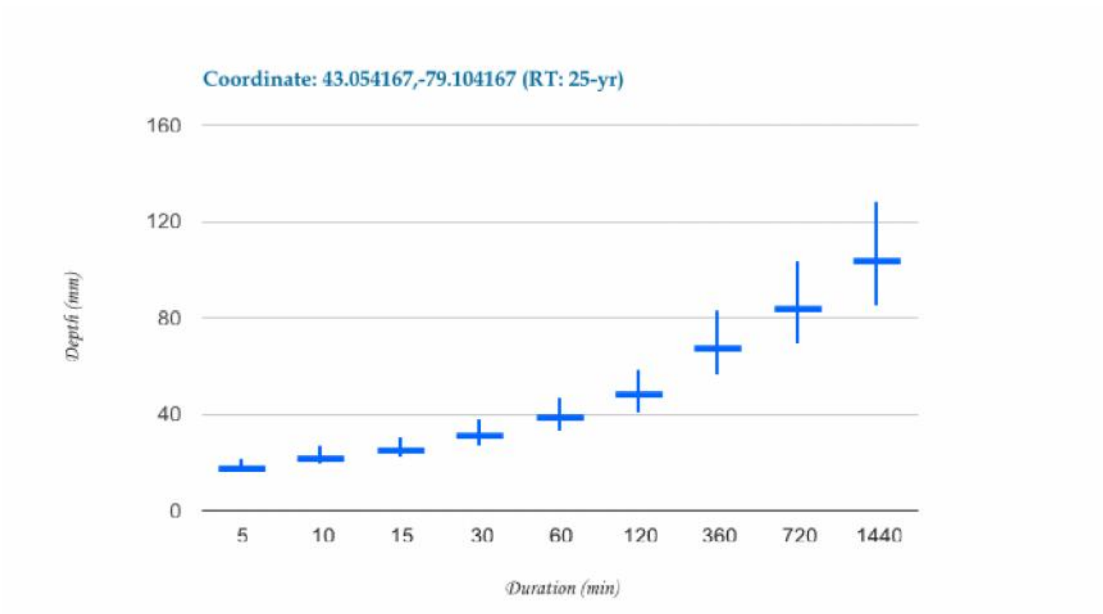
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 25-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 39.6 (+7.9, -6.6)

B: -0.694 (+0.008, -0.008)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr

Intensity (mm hr^{-1})	222.2	+39.1	137.3	+25.1	103.6	+19.3	64.1	+12.4	39.6	+7.9	24.5	+5.0	11.4	+2.5	7.1	+1.6	4.4	+1.0
		-33.3		-21.2		-16.3		-10.4		-6.6		-4.2		-2.0		-1.3		-0.8

Rainfall depth (mm)

Duration	**5-min**		**10-min**		**15-min**		**30-min**		**1-hr**		**2-hr**		**6-hr**		**12-hr**		**24-hr**	
Depth (mm)	18.5	+3.3	22.9	+4.2	25.9	+4.8	32.0	+6.2	39.6	+7.9	49.0	+10.1	68.5	+14.9	84.7	+18.9	104.7	+24.1
		-2.8		-3.5		-4.1		-5.2		-6.6		-8.4		-12.2		-15.5		-19.6

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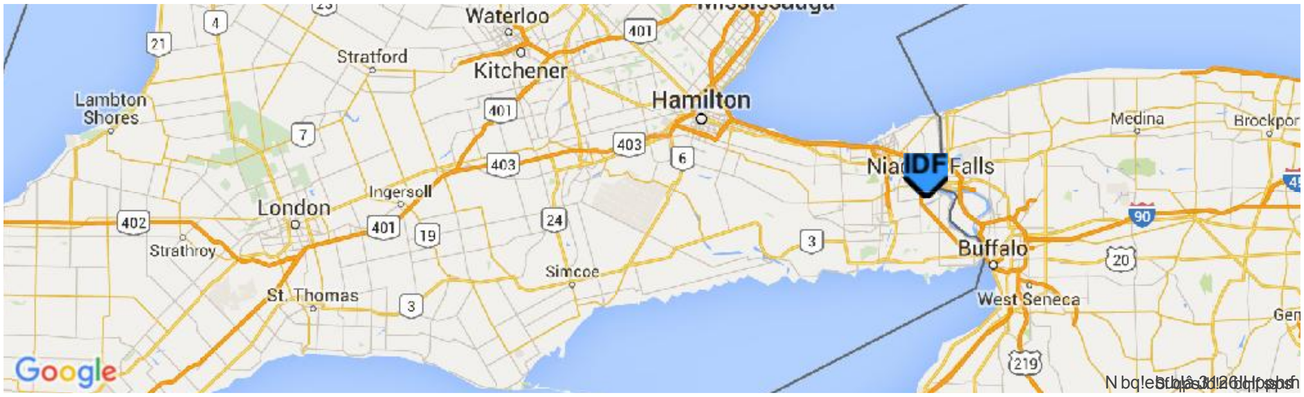
IDF CURVE LOOKUP

Coordinate Selection | Terms of Use | About

Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:53:04 UTC



Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

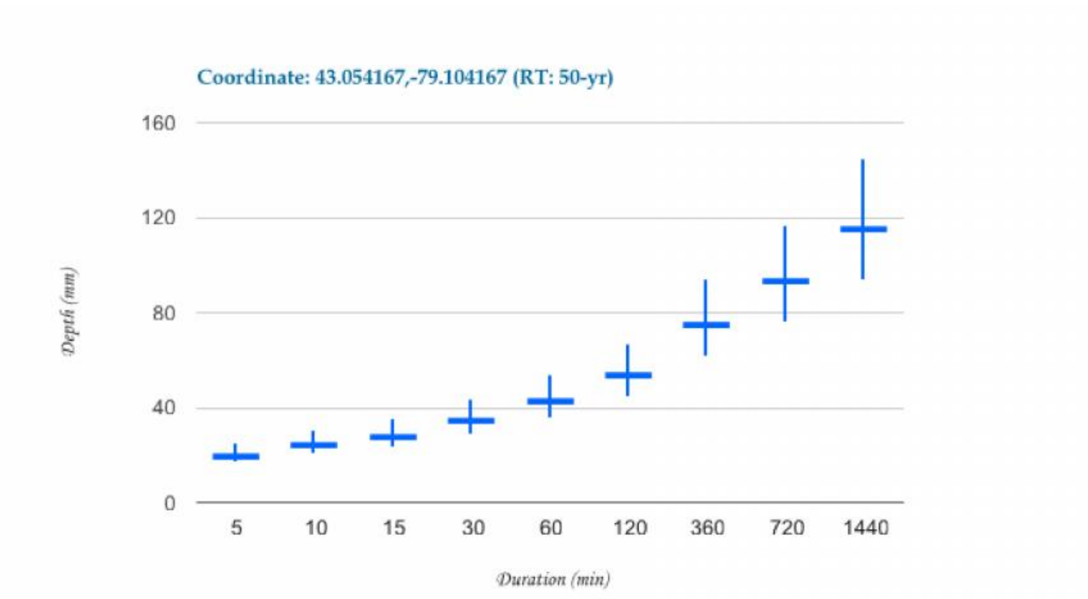
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 50-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 44 (+10.2, -8.2)

B: -0.694 (+0.004, -0.003)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min	10-min	15-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr
Intensity									

(mm hr^{-1})	246.8	+54.2	152.6	+34.0	115.2	+25.9	71.2	+16.3	44.0	+10.2	27.2	+6.4	12.7	+3.1	7.8	+1.9	4.8	+1.2
		-44.5		-27.8		-21.1		-13.1		-8.2		-5.1		-2.4		-1.5		-0.9

Rainfall depth (mm)

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Depth (mm)	20.6	+4.5	25.4	+5.7	28.8	+6.5	35.6	+8.1	44.0	+10.2	54.4	+12.8	76.1	+18.3	94.1	+23.0	116.4	+28.8
		-3.7		-4.6		-5.3		-6.6		-8.2		-10.2		-14.5		-18.1		-22.6

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IDF CURVE LOOKUP

Coordinate Selection | Terms of Use | About

Active coordinate

43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)Modify selection

Retrieved: Fri, 9 Oct 2015 18:53:40 UTC

Map options: Modify selection | Show/hide gauging stations | Re-center selection

Coordinate summary

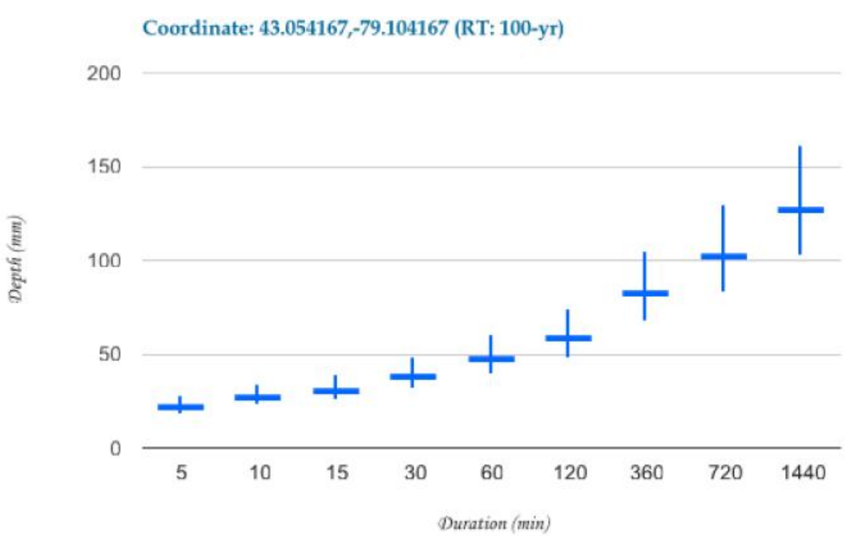
These are the coordinates in the selection.

IDF Curve: 43° 3' 15" N, 79° 6' 14" W (43.054167,-79.104167)

Results

An IDF curve was found for this set of coordinates.

Return period: 100-yr Choose another return period



MTO Switch variable: Intensity or Depth

Coefficient summary

Notes

A: 48.5 (+11.8, -9.5)

B: -0.694 (+0.004, -0.003)

Statistics

Rainfall intensity (mm hr^{-1})

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Intensity	272.1	+62.9	168.2	+39.4	126.9	+30.0	78.5	+18.8	48.5	+11.8	30.0	+7.4	14.0	+3.5	8.6	+2.2	5.3	+1.4

(mm hr^{-1})		-51.7		-32.2		-24.4		-15.2		-9.5		-5.9		-2.8		-1.7		-1.1

Rainfall depth (mm)

Duration	5-min		10-min		15-min		30-min		1-hr		2-hr		6-hr		12-hr		24-hr	
Depth (mm)	22.7	+5.2	28.0	+6.6	31.7	+7.5	39.2	+9.4	48.5	+11.8	60.0	+14.8	83.9	+21.2	103.7	+26.5	128.3	+33.2
		-4.3		-5.4		-6.1		-7.6		-9.5		-11.8		-16.8		-20.9		-26.1

Terms of Use

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12 HOUR SCS II DESIGN STORM

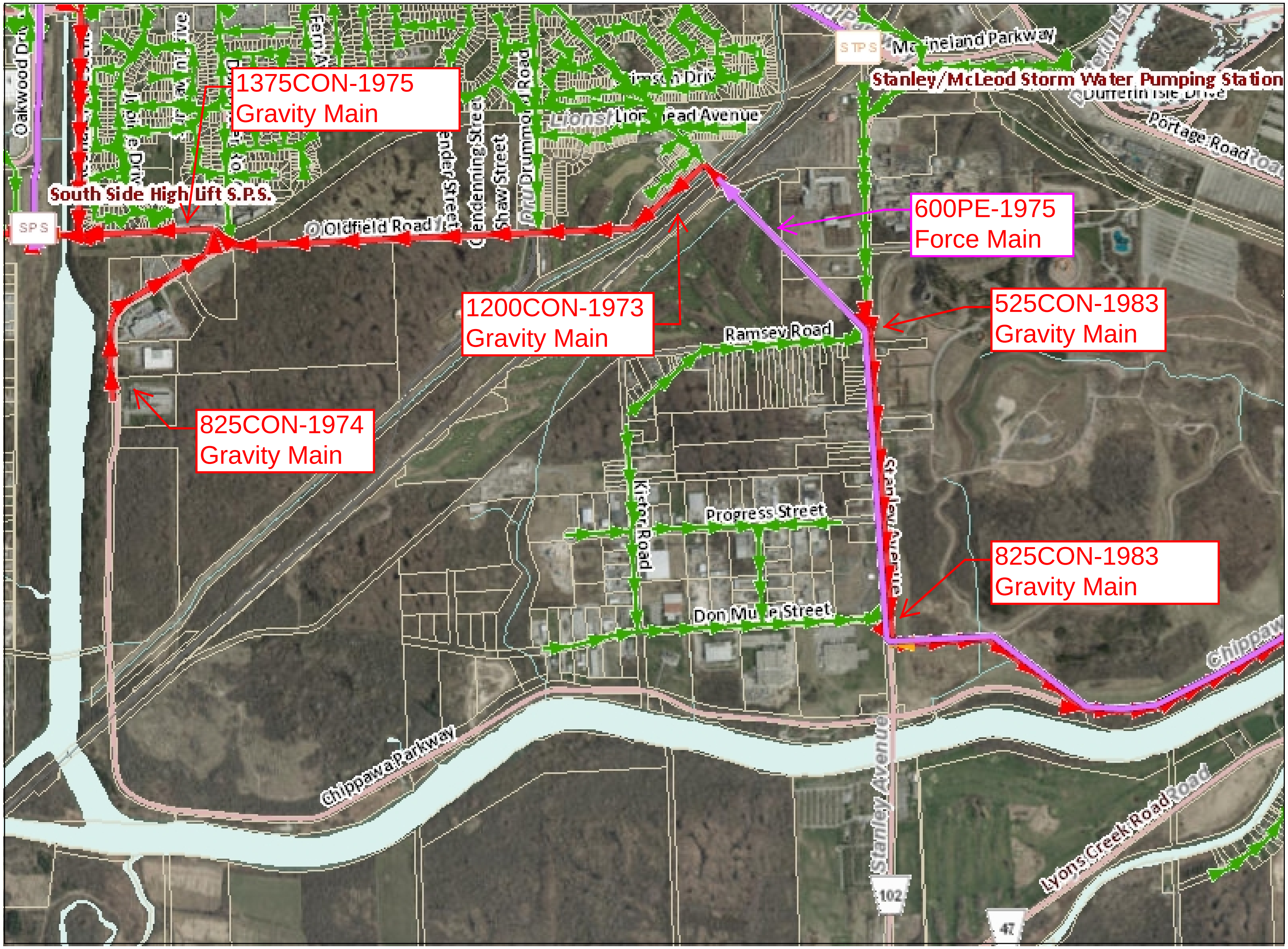
	*Time Ending	*% Inc	Depth/Increment						
			2	5	10	25	50	100	100 - NPCA
	Total Depth		45.5	61.1	71.7	84.7	94.1	103.7	88.1
	0	0	0						
120	2	0.05	2.275	3.055	3.585	4.235	4.705	5.185	4.405
180	3	0.03	1.365	1.833	2.151	2.541	2.823	3.111	2.643
210	3.5	0.02	0.91	1.222	1.434	1.694	1.882	2.074	1.762
240	4	0.02	0.91	1.222	1.434	1.694	1.882	2.074	1.762
270	4.5	0.03	1.365	1.833	2.151	2.541	2.823	3.111	2.643
300	5	0.04	1.82	2.444	2.868	3.388	3.764	4.148	3.524
330	5.5	0.06	2.73	3.666	4.302	5.082	5.646	6.222	5.286
345	5.75	0.12	5.46	7.332	8.604	10.164	11.292	12.444	10.572
360	6	0.33	15.015	20.163	23.661	27.951	31.053	34.221	29.073
390	6.5	0.09	4.095	5.499	6.453	7.623	8.469	9.333	7.929
420	7	0.04	1.82	2.444	2.868	3.388	3.764	4.148	3.524
450	7.5	0.03	1.365	1.833	2.151	2.541	2.823	3.111	2.643
480	8	0.03	1.365	1.833	2.151	2.541	2.823	3.111	2.643
600	10	0.07	3.185	4.277	5.019	5.929	6.587	7.259	6.167
720	12	0.04	1.82	2.444	2.868	3.388	3.764	4.148	3.524

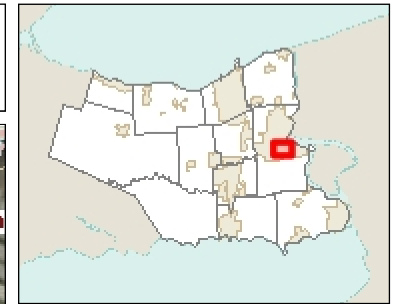
* ref Design Chart 1.05 MTO Drainage Manutal

APPENDIX B

EXISTING AND FUTURE SANITARY COLLECTION

Thundering Waters- Sanitary Servicing





Legend

RMoN Sanitary Facility Point

- Wastewater Treatment Plant
- Sewage Pumping Station
- Odour Control Facility
- Flume
- Lagoon
- Biosolids Storage Facility
- Combined Sewage Detention Facili
- Sewage Detention Facility
- Diversion Chamber
- Storm Water Pumping Station

RMoN Sanitary Force Main

- Force Main
- Force Main Under Construction

RMoN Sanitary Gravity Main

- Sanitary Gravity Pipe
- Sanitary Gravity Pipe Under Constr
- Combined Sewer Overflow
- Combined Sewer Overflow Under C
- Sanitary Siphon
- Sanitary Siphon Under Constructio
- Wastewater Effluent
- Wastewater Effluent Under Constru
- Sanitary Inline Storage
- Sanitary Inline Storage Under Cons

RMoN WMT Sanitary Facility F

1,016.0 | 0 | 508.00 | 1,016.0 Meters

N

Notes

Vedic Resort Infrastructure

External Servicing

N

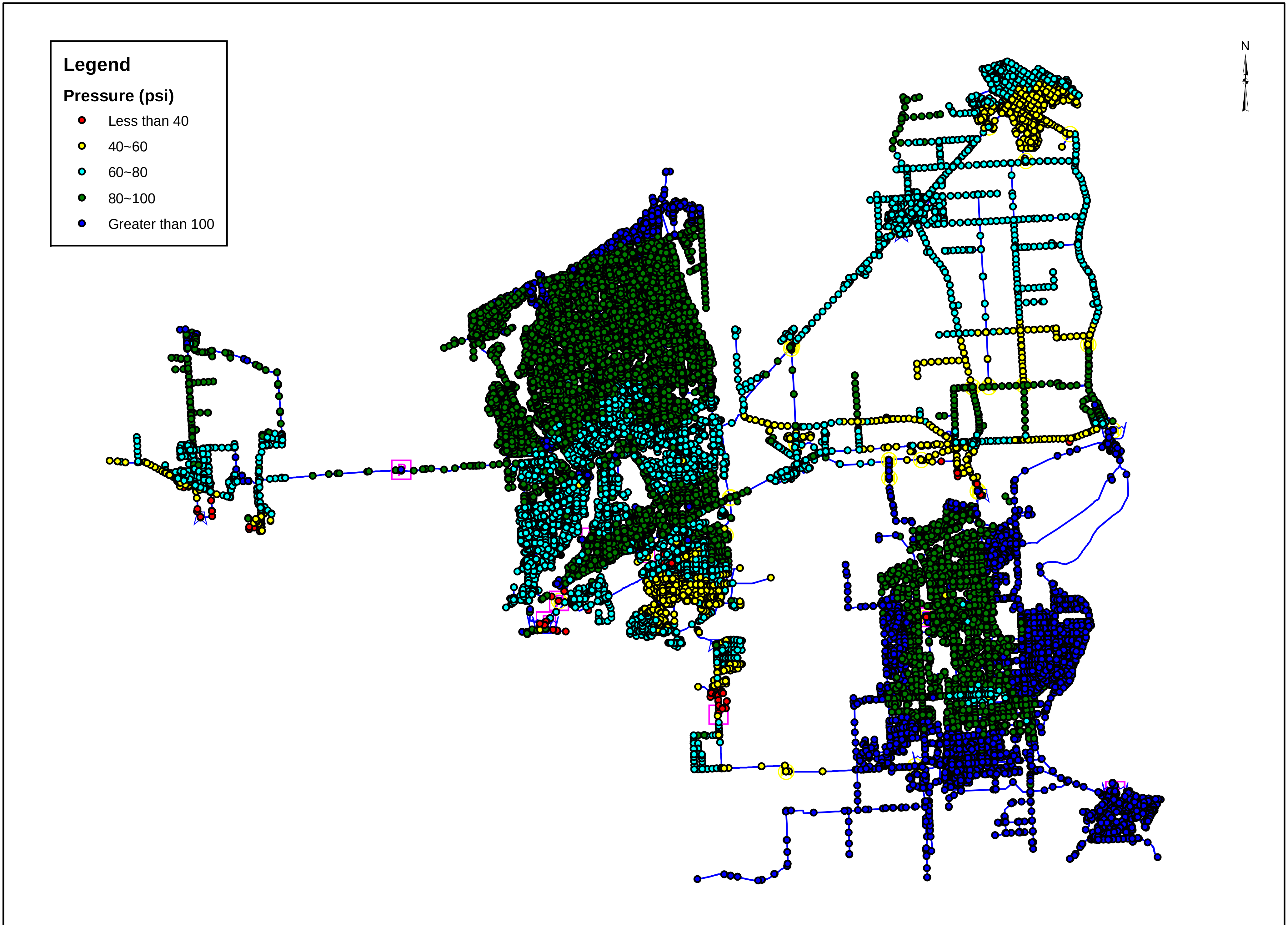
Niagara Region

gis@niagararegion.ca
Printed: Apr 16, 2012

Approximate Developable Area on south side of Welland River

APPENDIX C

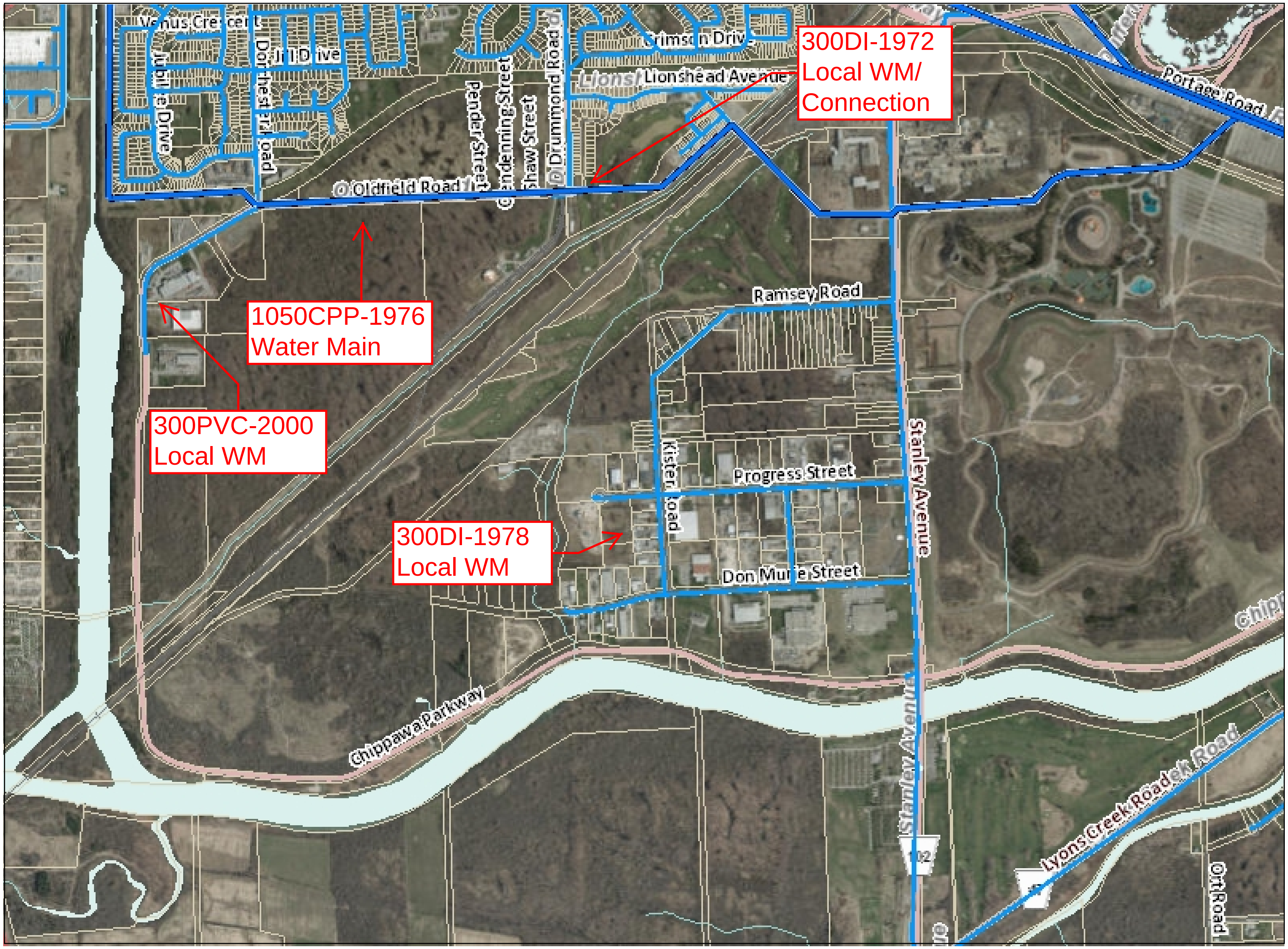
EXISTING AND FUTURE WATER DISTRIBUTION

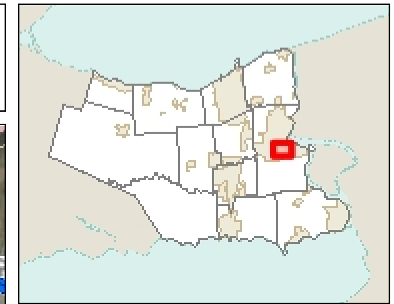


DeCew and Niagara Service Area - 2031 System Pressure

AECOM

Thundering Waters- Water Servicing





Legend

RMoN Water Facility Point

- Water Treatment Plant
- Pumping Station
- Chlorine Facility
- Elevated Tank
- Reservoir
- Standpipe

RMoN Water Main

- Transmission
- Transmission Under Construction
- Intake

LAM Water Facility Point

LAM Water Main

Streets Labels

1,016.0 | 0 | 508.00 | 1,016.0 | Meters

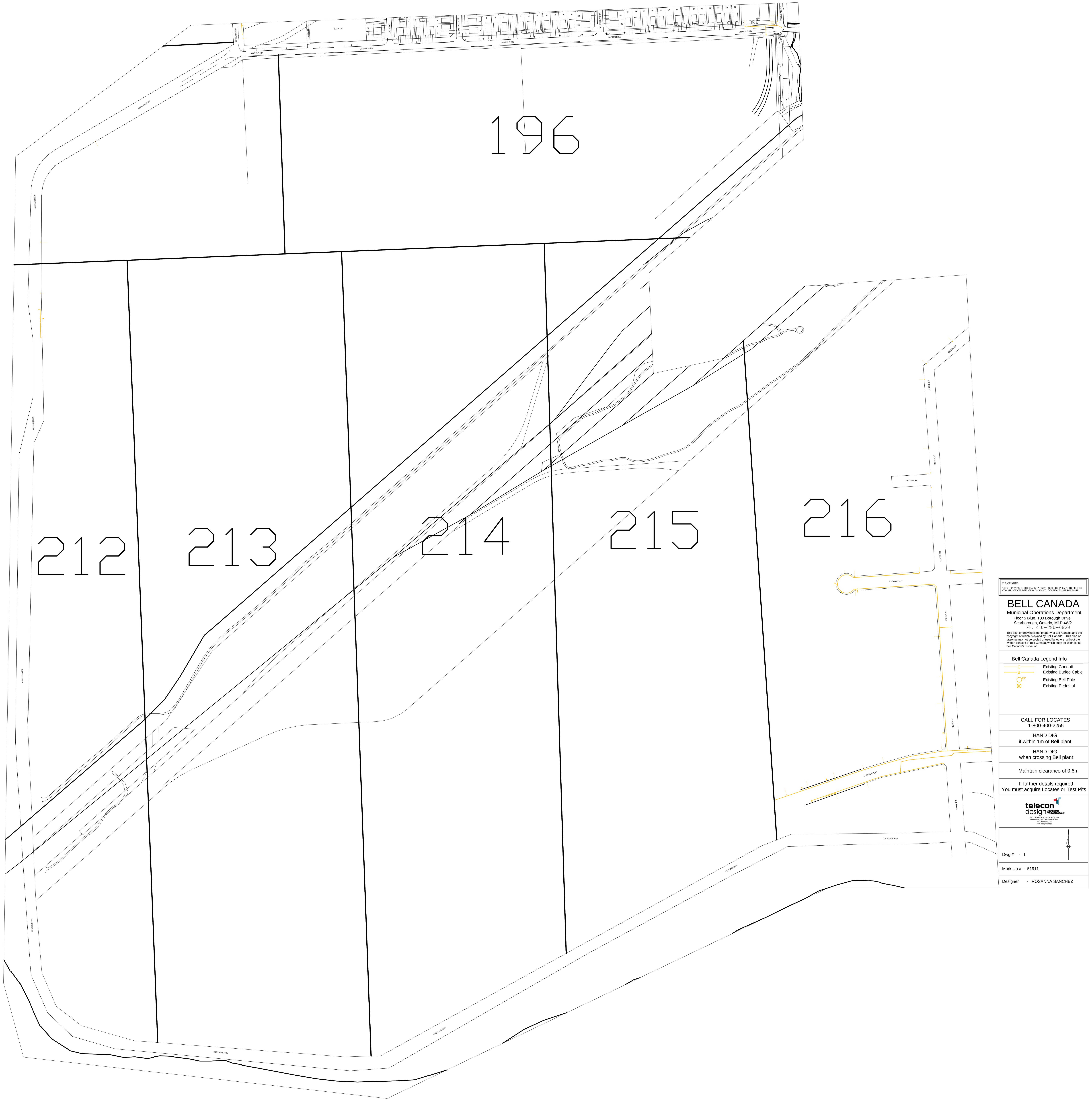
N

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. This map is not to be used for navigation.

Notes

APPENDIX D

EXISTING UTILITY PROVIDER MAPS



PLEASE NOTE:

THIS DRAWING IS FOR MARKUP ONLY - NOT FOR PERMIT TO PROCEED CONSTRUCTION. BELL CANADA PLANT LOCATION IS APPROXIMATE.

BELL CANADA

Municipal Operations Department
Floor 5 Blue, 100 Borough Drive
Scarborough, Ontario, M1P 4W2
Ph. 416–296–6929

Bell Canada Legend Info

—C—	Existing Conduit
—B—	Existing Buried Cable
○BP	Existing Bell Pole
⊠	Existing Pedestal

CALL FOR LOCATES
1-800-400-2255

HAND DIG
if within 1m of Bell plant

HAND DIG
when crossing Bell plant

Maintain clearance of 0.6m

If further details required
You must acquire Locates or Test Pits

telecon design MEMBER OF TELECON GROUP
200 TOWN CENTRE BLVD, SUITE 300
MARKHAM, ONT, CANADA L3R 8G5
TEL: (905) 470-2112
FAX: (905) 470-8956

Dwg # - 1

Mark Up # - 51911

Designer - ROSANNA SANCHEZ

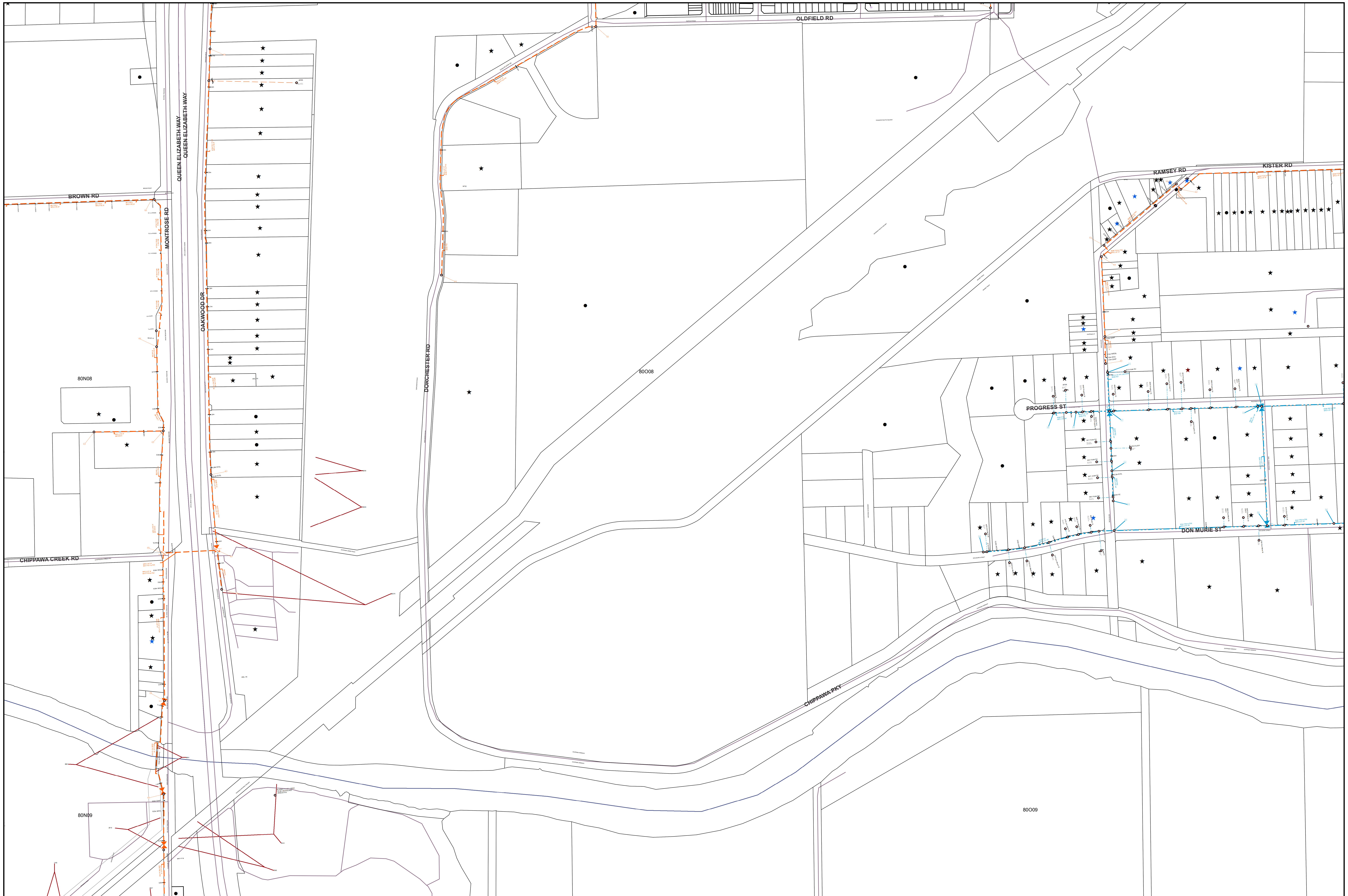
LEGEND

- WATER MAIN
- SANITARY SEWER
- PROPERTY LINE
- STORM MANHOLE
- SANITARY MANHOLE
- STORM CATCHBASIN

SCALE VALID ONLY FOR 24"x36" VERSION

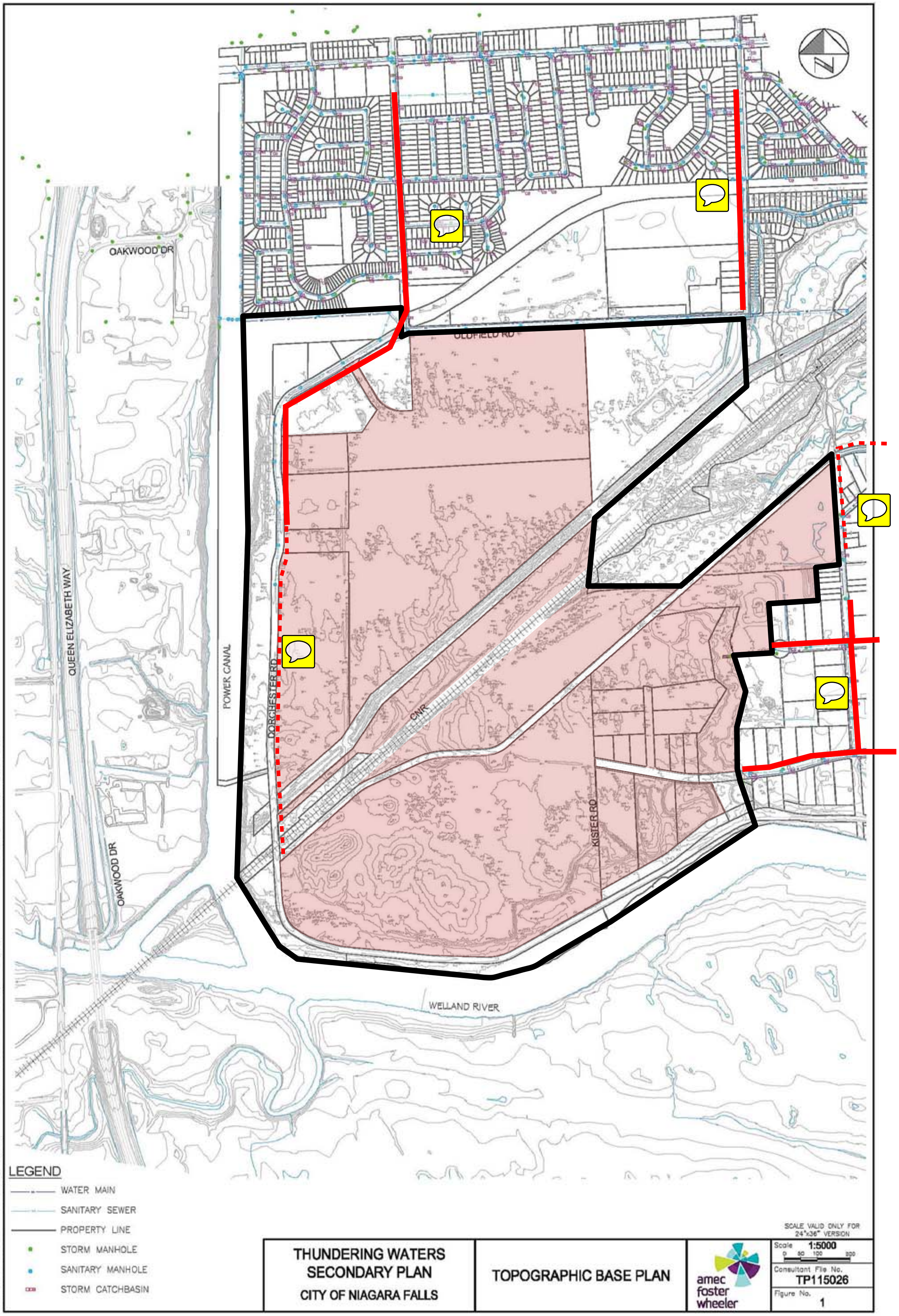
THUNDERING WATERS SECONDARY PLAN CITY OF NIAGARA FALLS	STUDY AREA	amec foster wheeler	Scale 1:5000 (0 50 100 200) Consultant File No. TP115026 Figure No. 1

Path: P:\Work\TP115026\water\study Area.dwg Plotted: 2015-09-02 Plotted By: mary.kelly Last Saved By: mary.kelly Last Saved: 2015-09-02



N	ENBRIDGE	Plotted By: Robert D'Onofrio	Date Plotted: 9/17/2015 7:52:51 AM

Note : Map is not to scale.



Proposed Secondary Plan Study Area

Lands Owned by GR(CAN) Investments