Appendix D

Stream Morphology

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NINTH LINE STREAM MORPHOLOGY INTERIM REPORT

137960 - 20947 - 522

Report Prepared for:
AMEC FOSTER WHEELER

Prepared by:
PARISH AQUATIC SERVICES
A DIVISION OF MATRIX SOLUTIONS

June 2016
Mississauga, Ontario

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Report prepared for AMEC Foster Wheeler, June 2016

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DISCLAIMER

We certify that this report is accurate and complete and accords with the information available during the site investigation. Information obtained during the site investigation or provided by third parties is believed to be accurate but is not guaranteed. We have exercised reasonable skill, care and diligence in assessing the information obtained during the preparation of this report.

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APPENDICES

1 SCOPE OVERVIEW

The role of the fluvial geomorphological component is to assess the existing condition (form, function and stability) of the watercourses within the Ninth Line Corridor. The geomorphic component would also provide an integrator role between fisheries, hydrology, and hydraulics. The results will offer guidance with respect to the sensitivity of the channels to potential changes in flow and sediment conveyance.

Given the unique nature of the study area – long, narrow and primarily centered on a branch of east Sixteen Mile Creek that has been subjected to recent alteration – the scope of assessing the channels was refined from the traditional approach. The first component would be the typical desktop assessments for reach delineation, migration rates, and meander belt width corridors. That said, the scope was refined for the historic assessment due to the scale of the channels and extent past alteration, making migration rates difficult to determine and/or misleading. The field component included walks of all the reaches, including downstream sections. Detailed field work was also completed and a monitoring station established.

2 BACKGROUND INFORMATION REVIEW

Before the geomorphic assessment, a background review was conducted to reveal any relevant information that could be considered applicable to this Lisgar area. In addition to the various digital topographic mapping and aerial imagery, reports on the natural heritage and aquatic systems were reviewed for insight on channel function and habitat provided. With respect to the geomorphic data on the watercourses in this area, there were two relevant reports:

- AMEC (2013) Milton Subwatershed Update Study - Fluvial Geomorphology Component
- Water's Edge (2014) Park 459 Development Mississauga, Ontario - Fluvial Geomorphological and Erosion Assessment

2.1 Geology and Physiography

The Ninth Line Corridor is situated within the Peel Plain and South Slope Physiographic Region. The Peel plain features a level-to-undulating clay soil landscape which gradually slopes toward Lake Ontario (Chapman and Putnam 1984). The western most edge of the South Slope Physiographic Region encompasses the downstream portion of the study area. This Physiographic Region forms the southern slope of the Oak Ridges Moraine and characteristic landforms near the study area include ground moraines with irregular knolls and hollows. The downstream portion of the watercourse, outside the Ninth Line Corridor, begins to cut through the clay tills and into the underlying shale bedrock. According to Ontario Geological Survey (OGS) mapping (Chapman and Putnam 2007), the boundary between both

Physiographic Regions is located approximately at the crossing between Highway 407 and the watercourse south of the Lisgar Pond.

Regarding the Ninth Line Corridor specifically, the surficial geology of the area consists predominantly of fine-textured, silty-clay till (Chapman and Putnam 1984; 2007). These findings are further supported by the geotechnical report from AGRA Earth & Environmental Limited (1997) which identified stiff silty-clay till as the dominant surficial material, underlain by interbedded silt and sand as the material transitions from the shale bedrock underneath.

3 DESKTOP ASSESSMENT

The primary product of the desktop work was the delineation of stream reaches. Reaches are lengths of channel, typically 100 m to 2 km in length, that are relatively homogeneous with respect to sinuosity, gradient, geology, physical setting (e.g., relation to valley walls), and surrounding land use/cover. When these key variables change in the downstream direction, the channel will adjust, thus establishing a new reach condition. Given the essentially homogeneous influence of the controlling and modifying factors along a reach, it can be assumed that the form, function, and processes within a reach are consistent.

The desktop work utilized the spatial data provided by the City of Mississauga as well as aerial orthoimagery to delineate appropriate reaches along the east branch of East 16 Mile Creek within and extending downstream of the Ninth Line Corridor (**Figure 3.1**). Reach breaks are generally set at locations where typical channel dimensions, planform and/or physical setting changed, generally occurring at tributary confluences and major road crossings. For this study, reach breaks were delineated based primarily on significant changes in channel planform, floodplain vegetation, major road crossings, and large water body locations. Eighteen (18) reaches were delineated along the watercourse and included two of its tributaries (**Figure 3.2** and **3.3**).

Figure 3.1 The Ninth Line Corridor highlighting the east branch of East 16 Mile Creek

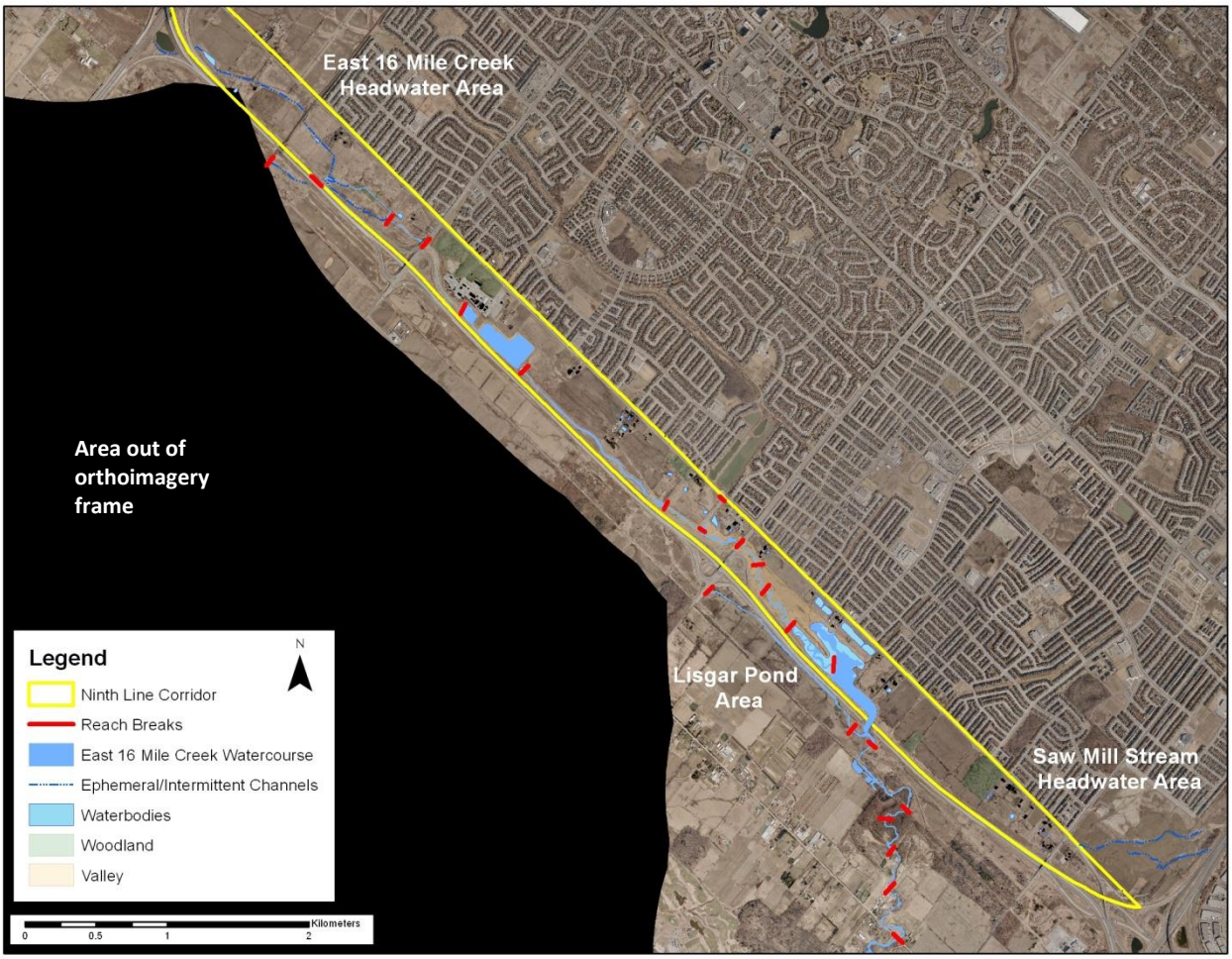


Figure 3.2 Delineated reaches within the upstream area of the Ninth Line Corridor

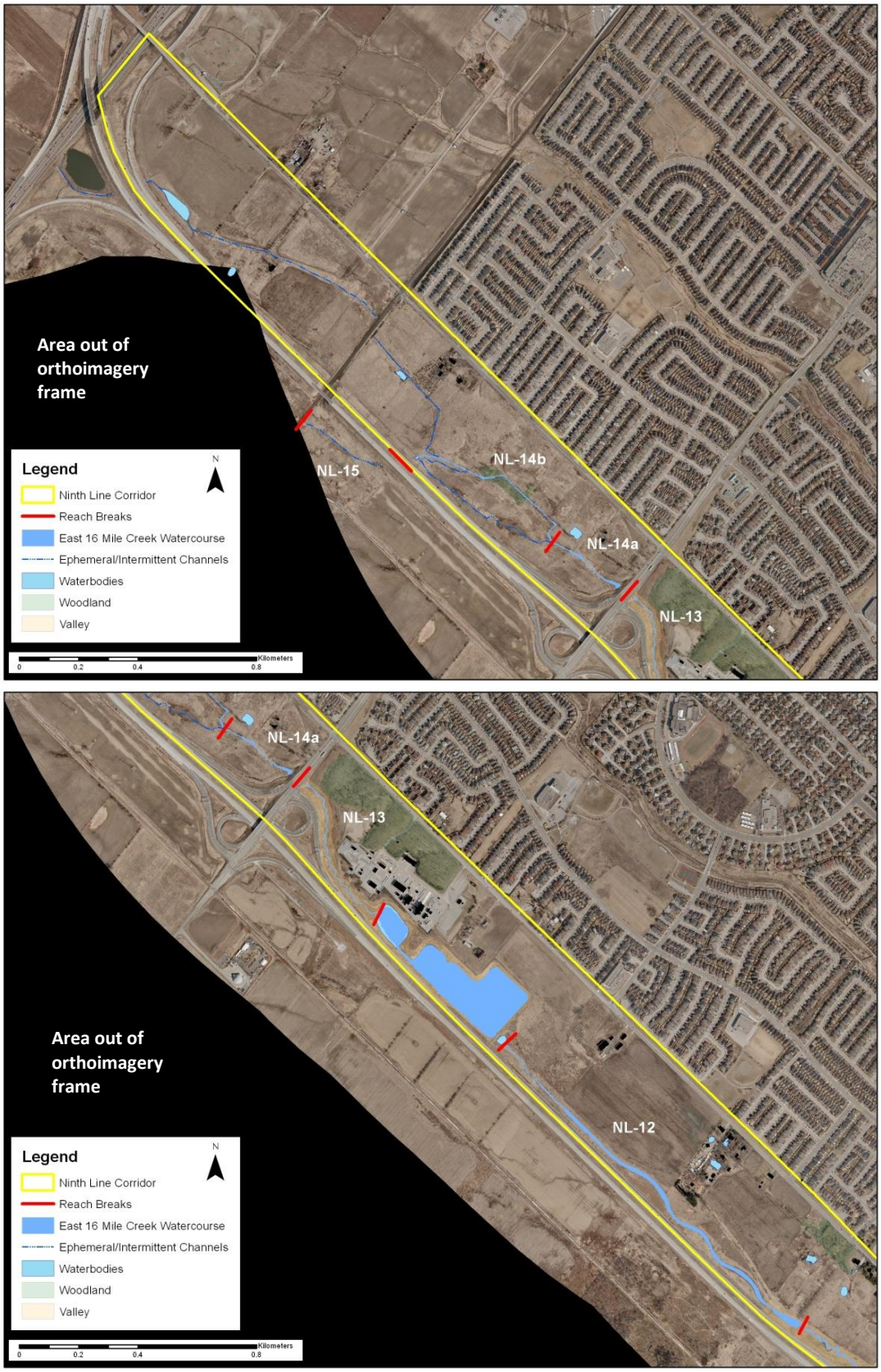
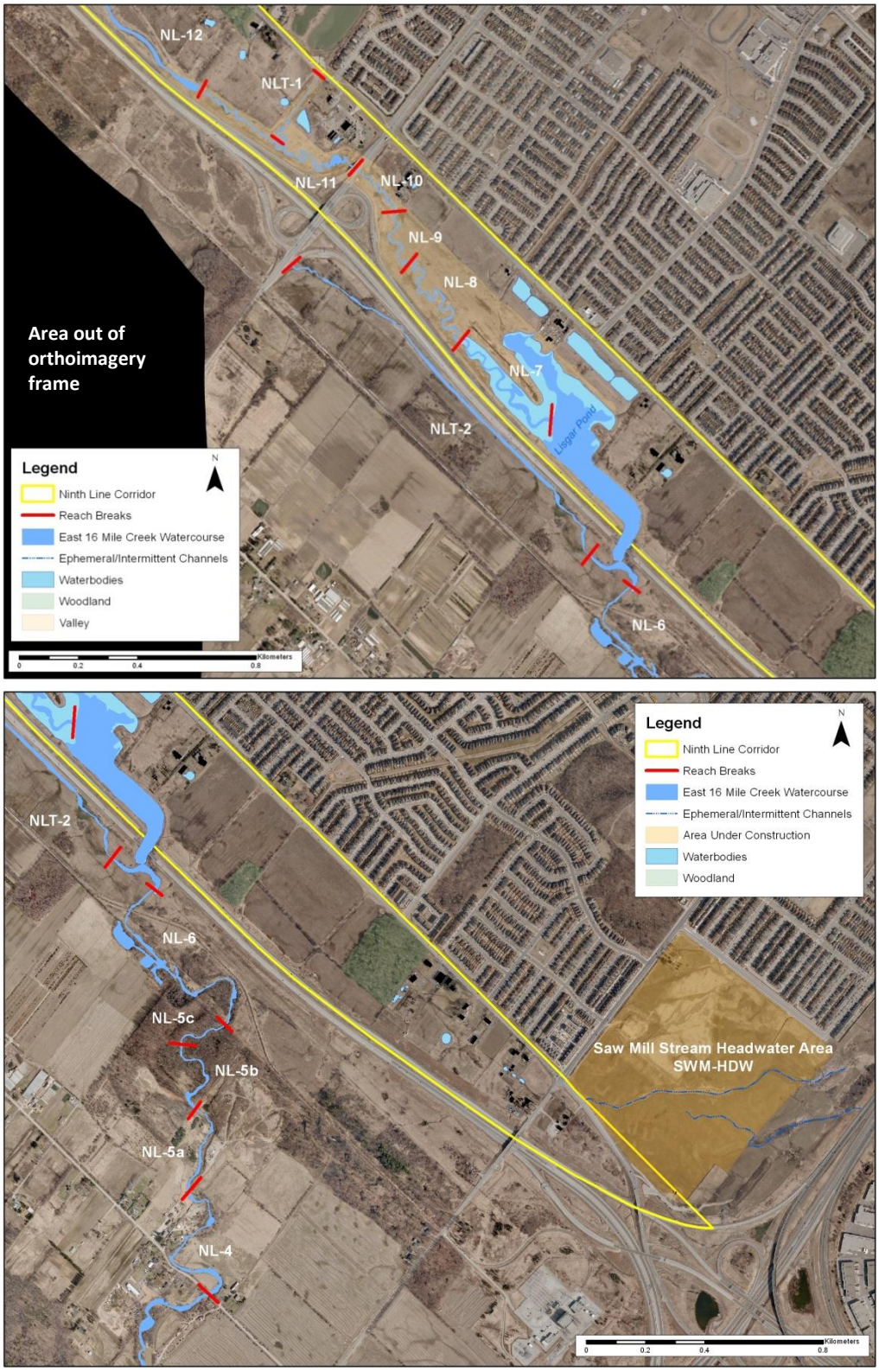


Figure 3.3 Delineated reaches within the downstream area of the Ninth Line Corridor



4 FIELD PROGRAM

In order to assess the potential impacts of future development on the watercourse within the Ninth Line Corridor, a focused field data collection program was undertaken. The study inventories and characterizes the watercourse within the Ninth Line Corridor and also extending downstream to provide a comprehensive assessment of existing conditions. The objective of the field work was to assess the stability of the channel, evaluate hydraulic parameters and determine the drivers of channel form and function.

4.1 Rapid Field Assessments

In order to obtain all necessary data, various channel reaches were delineated throughout the entirety of the watercourse. Rapid geomorphic and stream assessments were completed for the delineated reaches and consisted of a synoptic-level survey which qualitatively assessed any reach-specific problems and provided an estimate of overall reach stability and sensitivity. By walking each reach in its entirety, areas of active erosion and/or deposition can be documented, basic channel dimensions can be measured and an understanding of the active channel processes affecting a reach can be gained. The rapid field assessments completed followed two rapid field assessment protocols – Rapid Geomorphic Assessment (RGA) and Rapid Stream Assessment Technique (RSAT). These assessments offer a quick qualitative evaluation of the reach providing insight into active geomorphic processes and overall channel stability, as well as an estimate of the ecological integrity. Details regarding each protocol are presented in the subsequent sections and results of the rapid field assessments are summarized in Section 4.1.3.

4.1.1 Rapid Geomorphic Assessment

An RGA documents observed indicators of channel instability within a watercourse to assess its existing geomorphic stability and sensitivity to an alteration in the sediment-flow regime (MOE, 2003). Observations are quantified using a stability index that identifies channel sensitivity based on evidence of channel widening, degradation, aggradation, and planimetric form adjustment.

Table 4 Rapid Geomorphic Assessment Classification

Factor Value	Classification	Interpretation
≤0.20	In Regime or Stable (Least Sensitive)	The channel morphology is within a range of variance for streams of similar hydrographic characteristics – evidence of instability is isolated or associated with normal river meander propagation processes
0.21-0.40	Transitional or Stressed (Moderately Sensitive)	Channel morphology is within the range of variance for streams of similar hydrographic characteristics but the evidence of instability is frequent
≥0.41	In Adjustment (Most Sensitive)	Channel morphology is not within the range of variance and evidence of instability is wide spread

The RGA protocol produces a stability index value which classifies the channel as being in regime (score <0.20), stressed/transitional (score 0.21 to 0.40), or in adjustment (score >0.41). The various classifications (Table 4) indicate whether evidence of instability observed is isolated and/or the result of normal river function or wide spread and resulting from a change in the sediment-flow regime of the system.

4.1.2 Rapid Stream Assessment Technique

The RSAT provides a broader view of the system by considering the ecological function of the stream through observations of instream habitat, water quality, riparian conditions, and biological indicators (Galli, 1996). The RSAT approach integrates semi quantitative measures of bankfull channel dimensions, type of substrate, vegetative cover, and channel disturbance to provide a broader assessment of the overall health and functions of a river reach. This includes observations of channel stability, scour/deposition, instream habitat, water quality, riparian conditions, and biological indicators such as abundance of benthic invertebrates. Each indicator was ranked numerically, with lower values indicating poorer stream health and higher values representing rich, healthy streams. Specifically RSAT scores rank the channel as maintaining a low (<20), moderate (20 to 35), or high (>35) degree of stream ecological health.

4.1.3 Rapid Field Assessment Results

The results of the rapid field assessment are summarized in **Table 4.1.** The results clearly indicate the channel displays reasonable stability and relatively poor geomorphic function. It is noted that a large percentage of the channel within the study area has been subjected to natural channel design and/or flows through on-line ponds. Overall, the study area exhibited low topographic relief resulting in a low gradient system fragmented by several on-line ponds. As a result, the system lacks diversity in channel form and tends to exhibit evidence of poor geomorphic function, specifically with regards to sediment transport. The RGA scores suggest that most reaches examined are relatively stable exhibiting signs of poor channel function through aggradation as evidenced through the invariable, soft unconsolidated beds typically observed. Evidence of channel widening was also commonly noted throughout the watercourse as basal scouring and steep bank angles were often observed. Although these results would suggest that the channel was widening due to changes in its flow regime, bank erosion and basal scour was more often related to the presence of vegetation colonizing the center channel.

Table 4.1 Summary of rapid field assessment results

RGA Summary							RSAT Summary	
Reach	Factor Value				Stability Index	Condition	Ecological Health Ranking	Condition
	Aggrad-ation	Degrad-ation	Widening	Planimetric Adjustment				
NL-4	0.56	0.00	0.50	0.14	**0.30**	Transitional	**22**	Moderate
NL-5a	0.56	0.00	0.25	0.14	**0.24**	Transitional	**22**	Moderate
NL-5b	0.00	0.43	0.25	0.00	**0.17**	In Regime	**22**	Moderate
NL-5c	0.11	0.29	0.25	0.00	**0.16**	In Regime	**23**	Moderate
NL-6	0.22	0.14	0.25	0.14	**0.19**	In Regime	**17**	Low
NL-7	0.44	0.29	0.00	0.14	**0.22**	Transitional	**26**	Moderate
NL-8	0.44	0.14	0.25	0.00	**0.21**	Transitional	**25**	Moderate
NL-9	0.22	0.00	0.38	0.00	**0.15**	In Regime	**22**	Moderate
NL-10	0.33	0.29	0.50	0.14	**0.32**	Transitional	**21**	Moderate
NL-11	0.22	0.14	0.50	0.00	**0.22**	Transitional	**21**	Moderate
NL-12	0.22	0.14	0.00	0.00	**0.09**	In Regime	**23**	Moderate
NL-13	0.11	0.14	0.25	0.00	**0.13**	In Regime	**21**	Moderate
NL-14a	0.00	0.14	0.00	0.00	**0.03**	In Regime	**21**	Moderate
NL-14b	0.11	0.14	0.13	0.14	**0.13**	In Regime	**25**	Moderate
NL-15	0.00	0.14	0.00	0.00	**0.04**	In Regime	**20**	Moderate
Tributaries								
NLT-1	0.22	0.00	0.38	0.29	**0.22**	Transitional	**16**	Low
NLT-2	0.22	0.29	0.25	0.43	**0.30**	Transitional	**14**	Low
Sawmill Stream Headwater Area								
SWM-H DW	N/A Area being developed, no defined channel present. Landcover bare un-vegetated and reworked						N/A	

4.2 Detailed Field Survey

To gain further insight into the geomorphic processes operating within Ninth Line Corridor, detailed field sites were established in November 2014 along Reach NL-4 and NL-10. Reach NL-10 is representative of the area within the Ninth Line Corridor while NL-4 better represents the area downstream of the corridor. These reaches were selected for detailed assessment as they were deemed to be most sensitive through the rapid assessment process receiving the highest RGA stability index values – 0.32 and 0.30 for reach NL-10 and NL-4, respectively. Areas that are most vulnerable to change need to be characterized in order to inform development planning.

As shown in **Table 4.2**, the summary data from these two sites are relatively similar, with the main differences attributable to change in upstream drainage area. Together the selected reaches provide an overall representation of the watershed from a geomorphic perspective. It should also be noted that the dominance of the pond features in the study area elicit a noticeable influence on flows in these sites. While the assessment was 'scoped', there was not a high degree of variability and diversity in the study area to warrant additional detailed assessment sites to ensure adequate representation of the overall study area.

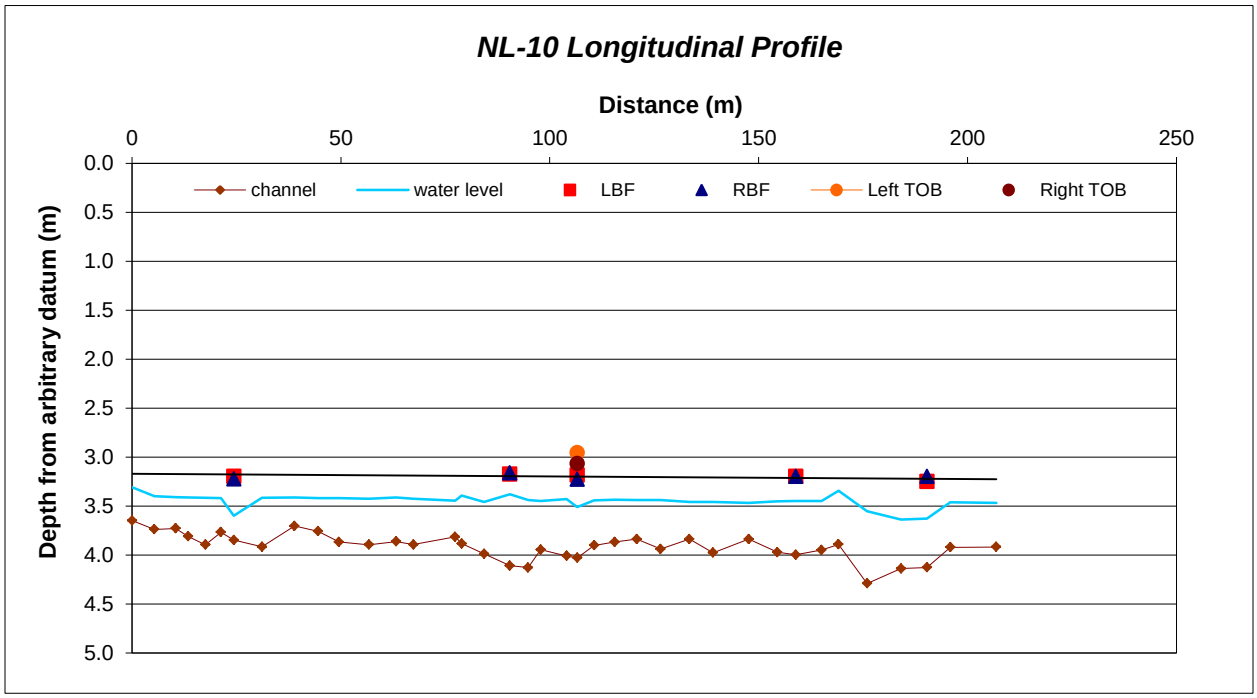
Table 4.1 Summary of reach characteristics collected during detailed field survey

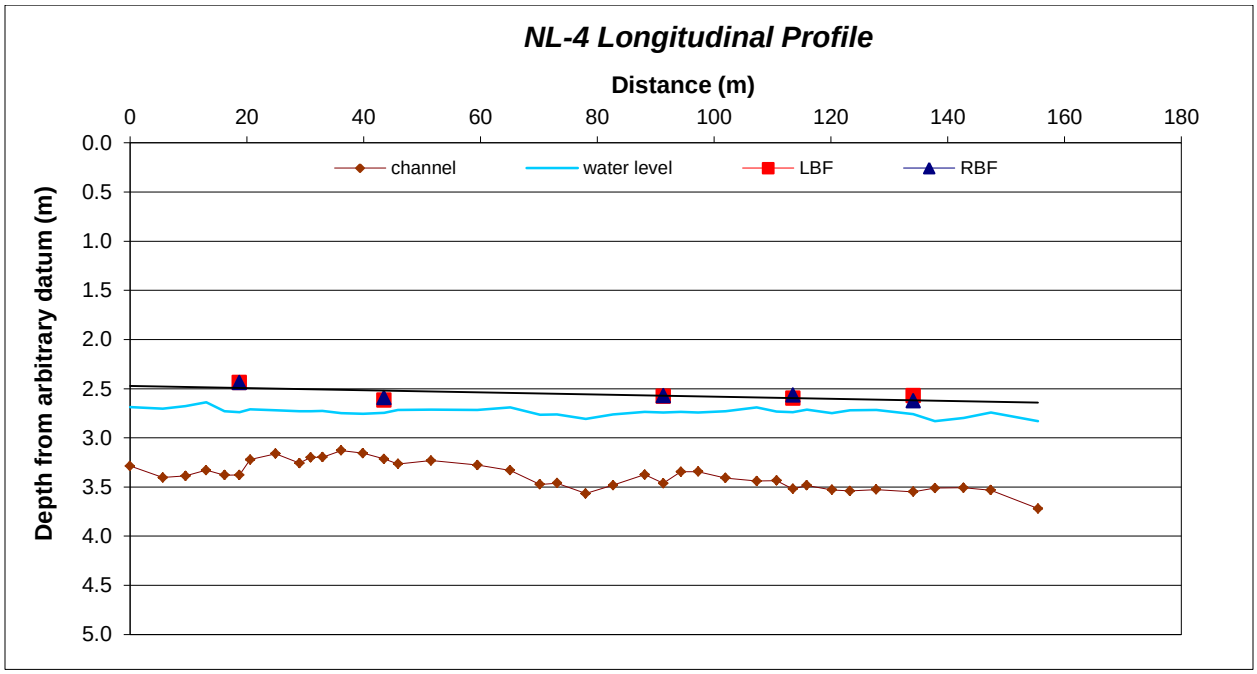
Parameter	NL-10	NL-4
Average Bankfull Width (m)	4.56	5.85
Average Bankfull Depth (m)	0.55	0.89
Average W/D Ratio	8.41	7.12
Bed Gradient (%)	0.14	0.23
Energy Gradient (%)	0.03	0.11
Bed Substrate	Silt, clay and fine sand with coarse sand, pebbles and small gravel inclusions	High organic content mixed with silt, clay, fine and coarse sands.
Bank Height (m)	0.8-1.2	1.1-3.2
Bank Angle (degrees)	30-45	20-40
Bank Material	Silty-clay till	Silty-clay till with fine sand inclusions. Some shale fragments noted along valley wall

A detailed field site consists of a minimum of 5 cross-sections and a longitudinal profile survey of the local channel gradient. At each cross-section bankfull widths and depths are measured, banks are characterized (height, angle, composition, degree of vegetative cover), and bed substrate is sampled using a modified Wolman pebble count. With the collected data and subsequent analyses, evaluation of hydraulic parameters was undertaken to gain a more comprehensive understanding of the physical processes that are controlling the geomorphic condition of the watercourse. A monumental monitoring cross-section was established and erosion pins were installed within reach NL-10 to obtain further insight on channel migration and form adjustments should future visits be undertaken. The longitudinal profiles illustrated in **Figure 4.1** indicate the overall lack of channel gradient and in the case of NL-4, the lack of any variability in the bed morphology. The lack of diversity in bed structure and substrates is the

result of the overall low energy condition, and the imbalance between sediment supply and transport. The results are channels with limited function and would contribute in a negative manner to water quality and aquatic habitat.

Figure 3.1 Longitudinal Profiles for Reaches NL-10 and NL-4





5 EROSION THRESHOLDS

5.1 Erosion Threshold Analysis

The critical discharge, or erosion threshold, is evaluated through a quantitative analysis of site conditions within the Ninth Line lands and specifically the locations of detailed data collection on the Sixteen Mile Creek tributary (NL-10 and NL-4). The detailed field assessment provides preliminary parameters that quantify channel geometry, substrate, and energy gradient necessary for the evaluation of hydraulic properties under bankfull conditions specific to the site including, discharge, flow velocity, shear stress, and stream power. The threshold limit defines instream hydraulic conditions during which sustained flows will initiate particle entrainment and instigate sediment transport.

5.1.1 Methodology

Critical values for channel boundary material (i.e., permissible velocity and critical shear stress) were evaluated for substrate distributions using various approaches derived from recognized sources examining sediment mobility of boundary material (Dunn 1959; Chow 1959; Fischenich 2001). An iterative approach using existing channel conditions was applied to evaluate the critical discharge, or erosion threshold. Erosion thresholds are determined by modelling a “dry” channel and increasing water levels in small increments (1 mm) until the average velocities or shear stresses exceed the critical values defined. The discharge under which the critical values are generated within each cross-section defines the critical discharge of the transect. Results of the analysis are then generally averaged across the entire detailed site but individual transects can be isolated or excluded from the modelling process as desired.

5.1.2 Results

The erosion threshold analysis determined that the critical discharge reaches or exceeds the bankfull discharge in each of the detailed sites indicating that significant sediment transport is not frequently initiated coinciding with our field observations. The existing channel dimensions are capable of conveying flows up to approximately 1.09 m^3/s. Flows which exceed this discharge, as those determined to instigate significant sediment transport, over top the banks and dissipate energy within channels broad floodplain. The fragmented and low gradient nature of the watercourse inhibits the development of hydraulic conditions adequate enough to properly convey its fine sediment load. The tractive forces exhibited by the watercourse are considered to be insufficient to initiate and effectively sustain sediment transport within the watercourse.

Table 5.1 Summary of erosion threshold values and metrics

Parameter	NL-10	NL-4
Average Bankfull Discharge (m^3/s)	0.93	2.33
Average Bankfull Velocity (m/s)	0.30	0.47
Average Shear Stress (N/m^2)	1.44	5.59
Stream Power (W/m)	2.73	25.13
Stream Power per Unit Width (W/m^2)	0.58	4.32
Critical Particle	Loose sandy material	Clay-silt content
Critical Shear for bed material (N/m^2)	2.40	--
Critical Discharge (m^3/s)	**1.09**	**1.98**
Critical Discharge/Bankfull Discharge (%)	117	85
Maximum Velocity (m/s)	0.45	0.80
Maximum Depth (m)	0.90	0.80
Method	Chang (1959)	Dunn (1959)

6 DISCUSSION

The study area is generally fairly flat, with little gradient and instream energy. Overall, the watercourse fails to display any type of bed form features and offers much little habitat variability. The study area has several large ponds which elicit an influence on the flows in the channel system. The following discussion is provided to address specific aspects of the geomorphic analyses, specifically sediment budgets and headwater drainage function.

6.1 Sediment Budget

Evidence of significant sediment production within the system was not identified within the study area. The low gradient and fragmented nature of the system attenuates the overall potential energy within the system deterring sediment production and efficient transport of fine materials. As supported by the erosion threshold assessment, the tractive forces exhibited by the watercourse are insufficient to initiate and effectively sustain sediment transport. As a result the watercourse within the Ninth Line Corridor essentially stores sediment consequently resulting in insignificant production and transport of materials through the system and thus providing poor geomorphic function.

6.2 Headwater Drainage Function

Headwater features were only identified within the north portion of the Ninth Line Corridor, south of HWY 401 and north of Derry Road. The features were ill-defined, low gradient topographic depressions typically lined with terrestrial grasses and/or cattails. These features appeared to be ephemeral or intermittent in nature showing little evidence of active flow. Shallow, stagnant water along the base of the depression is common, hence supporting the establishment of wetland vegetation and accumulation of fine sediment and organic material. These features may provide suitable wetland habitat to support small communities of aquatic and terrestrial species.

7 REFERENCES

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APPENDIX A
Detailed Geomorphic Survey Summary

DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-4 Ninth Line Corridor Subwatershed Study 01-14-02**

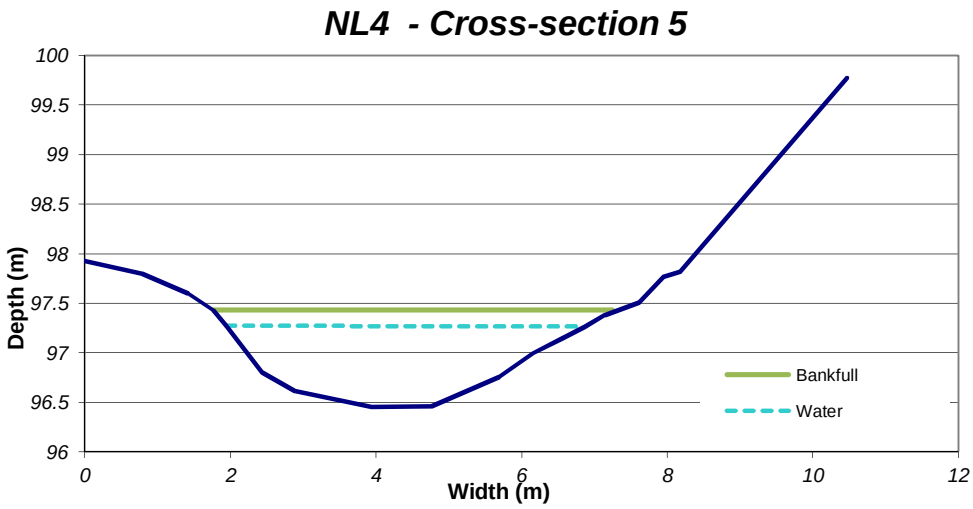
Site Location:	Ninth Line Corridor, Mississuaga, Ontario
Reach:	NL-4
Length surveyed:	160 m
Number of cross-sections:	5
Date of Survey:	13-Nov-14

Modifying Factors

Surrounding Land Use:	Deciduous Woodlot, Private Lot
General Riparian Vegetation:	Deciduous Trees, shrubs, short grasses
Existing Channel Disturbances:	Concrete crossing causing disruption to proper conveyance
Woody Debris:	Some large pieces found in channel, minor debris on banks

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	5.07 - 6.75	5.86
Bankfull Depth (m)	0.69 - 0.98	0.89
Width / Depth	5.39 - 9.25	6.74
Wetted Width (m)	4.26 - 6.11	5.12
Water Depth (m)	0.32 - 0.51	0.43
Manning's n		0.033



DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-4 Ninth Line Corridor Subwatershed Study 01-14-02**

Bank Characteristics

	Range	Average	
Bank Height (m)	1.1 - 3.2	1.77	
Bank Angle (degrees)	15 - 40	31	
Root Density ***(1=Low - 5=High)***	1 - 1	1.0	Low
Protected by vegetation (%)	2 - 40	15.2	
Amount of undercut (cm)		0	
Banks with undercuts (%)		0%	

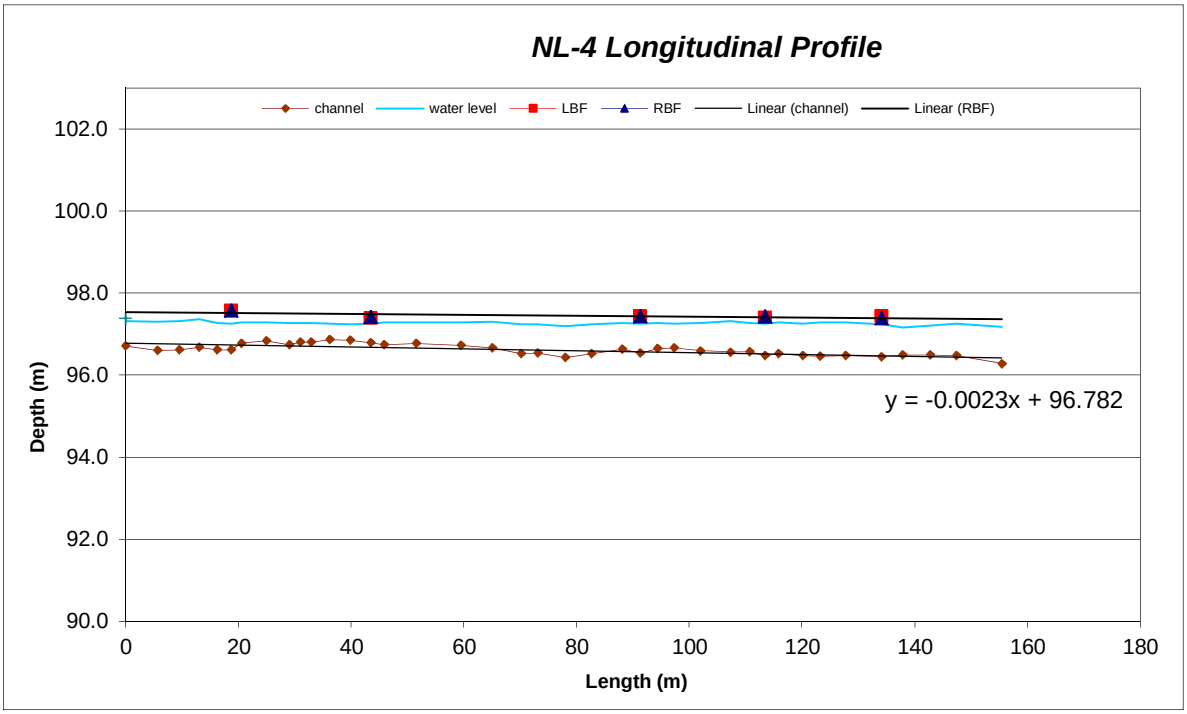
Bank Materials:		**Torvane values (kg/cm2)**
cl/fs/ms	*	0.35
cl/si/fs		0.30

* - Dominant Material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient: 0.11 %
Bed Gradient: 0.23 %



DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-4 Ninth Line Corridor Subwatershed Study 01-14-02**

Field Observations

Notes:

Channel was wide and deep flowing through a deciduos woodlot with medium to high banks. Typical banks consisted of silty-clay till while others, more noticably the left bank in the upstream area, contained shale fragments. Some unnatural particles, (i.e. fragements of concrete) were also observed along the right bank as a large private lot was located on the upper bank (5m from channel). Banks were vegetated with short herbs, deciduous trees, and shrubs. While deciduous trees and shrubs were abundant, banks had substantial bare areas. Fallen and leaning trees were observed with the reach creating debris jams in some areas.
High flow was observed during the field visit and water appeared brown and turbid. Although flow was high due to recent rainfall event, water movement was minimal indicative of the low channel slope. As a result, the channel bed was soft and unconsolidated conprised of fine textured materials with high organic content (black to dark grey in colour). Fine textured material consisted of silt, clay, fine sand and coarse sand with traces of small gravel. A small storage pond was located on the left floodplain at the mid reach area. It appears as though the pond becomes active during high flow periods as water levels are higher allowing for water transfer between the pond and channel. This condition was observed at the time of visit. A small conceret crossing, most likely for adjacent private lot, appeared to inhibit proper flow and sediment conveyance at the downstream survey area.

NL-4 Detailed Survey Photo Summary

Fallen & leaning trees in channel often seen along channel boundaries.

Private lot adjacent to channel contained piles of sand & other material near the channel. Traces of this material was found within the channel.

Concrete Fragments observed on private lot adjacent to channel. Traces of this material was found within the channel.

Shale Fragments observed on left bank in upstream reach area evidence of the underlying bedrock found within the area.

Typical substrate found within reach was soft and unconsolidated with high organic content. Substrate consisted of fine textured material, typically silt, clay, fine sand and coarse sand.

Small storage pond located on the left floodplain at mid reach. Pond becomes active during high flow events as observed during detailed field survey.

Backwatering & poor flow/sediment conveyance resulting from the small concrete crossing at the downstream survey extent.

DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-10 Ninth Line Corridor Subwatershed Study 01-14-02**

Site Location:	Ninth Line Corridor, Mississauga, Ontario
Reach:	NL-10
Length surveyed:	205m
Number of cross-sections:	5
Date of Survey:	12-Nov-14

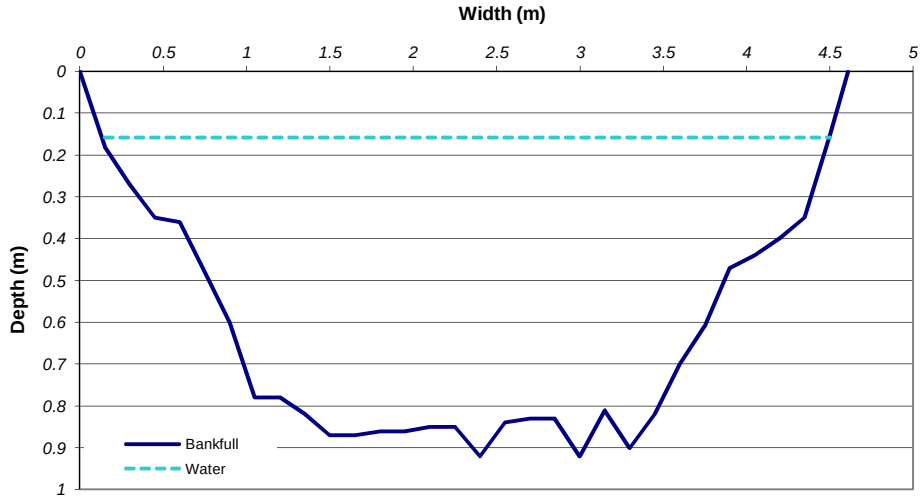
Modifying Factors

Surrounding Land Use:	Agricultural Meadow Field
General Riparian Vegetation:	Tall and short grasses, instream wetland vegetation (cattails, wet meadow grasses)
Existing Channel Disturbances:	None
Woody Debris:	None

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	3.52 - 5.42	4.56
Bankfull Depth (m)	0.45 - 0.66	0.55
Width / Depth	7.23 - 10.55	8.41
Wetted Width (m)	3.10 - 4.35	3.76
Water Depth (m)	0.33 - 0.54	0.42
Manning's n		0.033

NL-4 Bankfull Cross-section - XS 4



DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-10 Ninth Line Corridor Subwatershed Study 01-14-02**

Bank Characteristics

	Range	Average
Bank Height (m)	0.8 - 1.4	1.19
Bank Angle (degrees)	30 - 50	39.5
Root Depth (cm)	8.0 - 10	9.0
Root Density ***(1=Low - 5=High)***	2 - 3	2.1
Protected by vegetation (%)	5 - 40	12.5
Amount of undercut (cm)		12
Banks with undercuts (%)		10%

Bank Materials:		**Torvane values (kg/cm2)**
cl/cs/p	*	0.33
cl/cs/si		0.40
cl/ms/cs		0.31
cl/ms		0.29

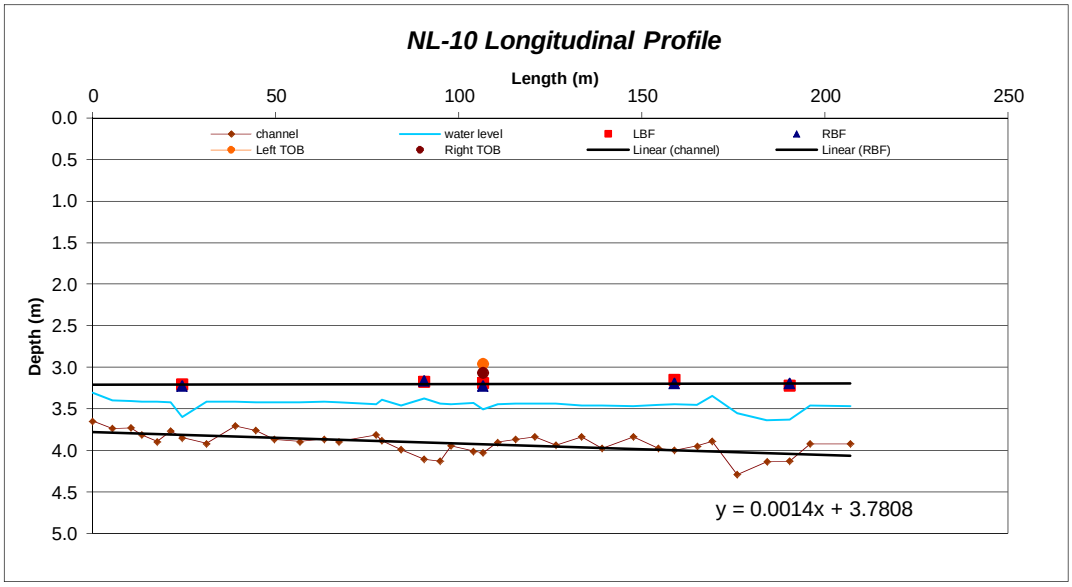
* - Dominant Material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient: 0.01 %

Bed Gradient: 0.14 %



DETAILED GEOMORPHOLOGICAL FIELD DATA SUMMARY

Project: **NL-10 Ninth Line Corridor Subwatershed Study 01-14-02**

Field Observations

Notes

This reach is sinuous and displayed a low channel slope flowing through an argicultural meadow grass area. Channel banks are typically shallow and prone to frequent overtopping events. The sloped bank (channel boundary) was predominantly bare with silty-clay till exposed,while the top of bank area and floodplain is typically flat and densely vegetated by short and tall grasses.
At the time of visit,water level was high due to recent rainfall event. The water was turbid but showed little to no signs of flow, indicative of the channels low slope. The channel bed was soft and unconsolidated with evidence of high organic content (black to dak grey in colour). The substrate consists predominantly of fine textured materials, silt, clay, and fine sand, but coarser inclusions (coarse sand, pebbles, and small gravel) were also commonly found within the unconsolidated mix. The subpavement material is representative of the areas underlying geology consisting of stiff silty-clay till while also including traces of coarse sand, pebbles and small gravels.
Instream vegetation was common throughout the watercourse. This instream vegetation is comprised primarily of wet meadow grasses and cattails. These areas were typically associated with slumping of channel banks as the instream vegetation forced flows around the patches. A monitoring cross-section was established (XS-3) in the mid reach area. Erosion Pins were installed to monitor channel migration. DoD rod was also installed DS of XS 3 to monitor sediment accumulation.

Erosion Pins

5 Erosion Pins were installed to monitor channel migration at outer bends
Initial Erosion Pin Measurements and Approximate Location

EP 1 = 15cm	RB of meander bend US of XS5, approx. 8m US of XS5
EP 2 = 15 cm	LB of meander bend DS of XS5, approx. 10m DS of XS5
EP 3 = 15cm	LB of meander bend DS of XS3, approx. 10m DS of XS3
EP 4 = 15cm	RB of meander bend US of XS2, approx. 20m US of XS2
EP 5 = 14cm	LB of meander bend DS of XS 2, approx. 5m DS of XS 2

Deph of Disturbance (DoD)

A Depth of DoD rod was installed at XS 3 to monitor sediment accumulation at the monitoring cross-section
DoD Rod installed 1m DS of cross-section centre channel
Washer was measured at 0.5m from top of rod

NL-10 Detailed Survey Photo Summary

Typical channel cross-section displaying shallow banks which frequently overtop onto the broad, flat floodplain. The floodplain is vegetated with short to long grasses and some shrubs. Note the Britannia Bridge crossing in the bottom photo delineating the upstream reach extent. Ninth Line and HWY 407 confine the watercourse to the east and west delineating the Ninth Line Corridor.

The presence of instream vegetation was typically observed within the watercourse, commonly found in mid channel areas. Wet meadow grasses and cattails were the dominant types of instream vegetation noted.

Channel bed substrate was soft and unconsolidated with high organic content. The substrate consists of fine textured materials (silt, clay, fine sand) with inclusions of coarser materials (coarse sand, pebbles and small gravels) found within the mix. The subpavement is representative of the typical geology of the area consisting of stiff silty-clay till.