TECHNICAL MEMORANDUM

DATE December 22, 2022 **Project No.** 21482114

TO Kyle Kazda, Development Manager
Taggart Realty Management

CC Derek Howe, Vice-President, Development

FROM Etta Gunsolus; Christopher Davidson; Andrew Forbes **EMAIL** etta.gunsolus2@wsp.com; christopher.davidson@wsp.com; andrew.forbes@wsp.com

FLUVIAL GEOMORPHIC ASSESSMENT AT SUBJECT AREA OF THE RIDEAU RIVER TO SUPPORT PROPOSED DEVELOPMENT AT 3930 AND 3960 RIVERSIDE DRIVE

1.0 INTRODUCTION AND SCOPE OF WORK

Golder Associates Ltd. (WSP Golder) was retained by Taggart Realty Management (Taggart) to conduct a fluvial geomorphic assessment at a discrete section of the Rideau River to support the design and permitting of a proposed development property near the intersection of 3930 and 3960 Riverside Drive, Ottawa, Ontario (the Project). The subject area or “reach length” of the watercourse is located adjacent to the Project site and immediately downstream of the West Hunt Club Road bridge crossing (Figure 1). The main objective of the fluvial geomorphic assessment was to address comments by the Rideau Valley Conservation Authority (RVCA) (received by Taggart on April 20, 2022) and the City of Ottawa (received by Taggart on August 11, 2022), specifically to confirm an appropriate geomorphic hazard (erosion) limit between the east bank of the Rideau River and the proposed footprint of the development property. The scope of work to delineate this hazard/erosion setback involved the completion of a field reconnaissance and desktop analysis to identify the characteristic channel morphology and bank stability of the study reach, coupled with the development of an erosion analysis to predict the long-term erosion potential of the watercourse. The results from the fluvial geomorphic assessment will be used to refine, as needed, a preliminary erosion hazard limit for the Project (previously estimated as part of a geotechnical investigation [WSP Golder 2022)].

This technical memorandum presents the methods and results of the fluvial geomorphic assessment at the reach length of the Rideau River. The remaining part of the document is organized into four main sections. This includes additional background for the Project in Section 2.0, a description of the study methods in Section 3.0, a summary of the study results in Section 4.0, and a discussion of the key findings and recommendations in Section 5.0.

2.0 BACKGROUND

The Project site includes an approximate area of 20.08 acres and is located at the northwest corner of West Hunt Club Road and Riverside Drive; bounded by the Rideau River to the west and a residential neighbourhood to the north. The site was historically used for aggregate extraction (i.e., sand extraction that remained active until the 1970s). It has since been reclaimed for development purposes, with the understanding that on the order of 15 metres of fill material has been sequentially placed in the former aggregate mining areas.

The Rideau River (a major tributary to the Ottawa River) represents a large, permanently flowing watercourse that drains a watershed area of approximately 4,000 km^2 in the area upstream (south) of the West Hunt Club Road bridge crossing. The river in the vicinity of the Project site conveys flows from generally south to the north and is located at an elevation of approximately ~10 m below the surrounding tablelands, noting that the west side of the proposed development follows a steep slope to the river edge. These flow volumes are understood to be regulated by the operation of a series of downstream water control dams and lock systems (reflective of the Rideau River waterway), as well as the presence of inline lakes (such as at Mooney's Bay). The majority of the Rideau River watershed is characterized by undeveloped or unmaintained land use (i.e., mostly natural and former agriculture); however, the downstream portion of the catchment, which is where the Project site is located, comprises large areas of urbanization (specific to the urban core of the City of Ottawa).

The proposed development at the Project site involves the construction of approximately 75 serviced residential lots, four serviced lots for future apartment building development, and a service road. This proposed development will utilize approximately 14.80 acres (or 75%) of the total area of the property, while the remaining portion of the land will be designated/maintained as an Environmental Protection Zone (to be undisturbed by the proposed development).

Geotechnical investigations have been conducted at the Project site since 2009 to support the design and permitting of the proposed development property. This includes the completion of the following studies by WSP Golder: preliminary geotechnical assessments (WSP Golder 2009; 2018), a slope stability analysis (WSP Golder 2018), and a hazard land assessment (WSP Golder 2022). The results of the 2022 geotechnical study, in particular, provided preliminary recommendations on the required hazard land allowances at the Project site to account for potential instability at both the valley slope and river bank, with the understanding that the overall erosion hazard limit included three, integrated components, and, where applicable, relied on the Ministry of Natural Resources (MNR) Technical Guidelines for Hazards (2002):

- Toe erosion allowance for the river bank of 15 m (specific to the south end of the property), which was conservatively assumed, given the absence of site-specific geomorphic data, as a "worst case" scenario (using guidance from MNR [2002]);
- Stable slope allowance for the valley slope based on previously completed slope stability analyses; and
- Erosion access allowance for the top of valley slope of 6 m.

Staff at the RVCA and City of Ottawa were shown to be supportive of the preliminary recommendations for the erosion hazard limit (based on review comments that were received on the 2022 geotechnical study); however, RVCA / the City requested that the toe erosion allowance estimate be further validated (with a plan to consider the incorporation of mitigation measures as needed) by assessing the long-term erosion potential of the subject portion of the Rideau River. To that end, WSP Golder was retained by Taggart to complete a fluvial geomorphic

assessment to further confirm an appropriate geomorphic hazard (erosion) limit between the east bank of the Rideau River and the proposed footprint of the development property.

3.0 METHODOLOGY

The specific work scope for the fluvial geomorphic assessment involved the following tasks:

- Task 1 – Historical air photograph analysis and field reconnaissance of the reach length to characterize channel morphology and assess bank stability, noting that aerial photography/images were obtained for the Project site from 1965, 1976, 1991, 2002, 2011, and 2021.
- Task 2 – Erosion limit analyses of the reach length to determine the long-term erosion potential of the watercourse in the vicinity of the Project site, with consideration of the following two methods:
  - 100-year erosion limit estimate based on protocols from Toronto and Region Conservation Authority (TRCA) (2004), noting that the method relied on the available, historical aerial photography from Task 1 to generate a 100-year migration rate for the channel; and
  - Toe erosion calculations based on protocols from the MNR (2002), with the understanding that this same method was used for WSP Golder (2022), but, as part of the estimates described herein, the calculations were further refined using added site-specific information (including hydraulic characteristic at the channel that were obtained from the RVCA-generated HEC-RAS model for the Rideau River [RVCA, 2015]).

Each of the identified tasks are detailed in the sub-sections below.

3.1 Task 1 – Historical Air Photograph Analysis and Field Reconnaissance

A detailed analysis of maps and historical aerial photographs/orthoimagery was undertaken at the identified reach length to assess lateral stability and changes in historical land use and channel patterns. This considered that the subject portion of the watercourse – a reach length of approximately 700 m – was shown to include similar controls on channel morphology (and hence, could be readily evaluated as a single channel unit). The historical air photograph analysis relied on aerial photography that was obtained from RVCA and the City of Ottawa, specifically aerial photography/images from 1965, 1976, 1991, 2002, 2011, and 2021. Of note, given the prominence of overhanging vegetation along the banks of the subject reach (i.e., the banks were often indiscernible from overhead due to the vegetation cover – present throughout the available period of the air photograph record), a strategy was employed to estimate the typical offset between the bank and the edge of the vegetation canopy. This involved inferring the average radius of 2-3 trees in each air photograph and then using that estimate to inform the assumed offset.

In addition to the historical air photograph analysis, a field reconnaissance was conducted along the length of the study reach on October 14, 2022 to further assess the characteristic channel morphology in the vicinity of the Project site and to identify any areas of instability. This field study involved the completion of walkovers to obtain measurements and observations of the channel under existing conditions. It also involved the completion of Rapid Geomorphic Assessments (RGAs) in accordance with Ministry of Environment and Climate Change (MOECC)

protocols, noting that RGAs were targeted at a total of twenty (22) sample locations at the study reach. The results of the RGAs were used to provide a preliminary indication of channel stability.

The general characterization of channel conditions was further augmented by the review of the RVCA-generated HEC-RAS model for the Rideau River (RVCA, 2015). The input and output data for the model was relied on to assist with the delineation of inferred bankfull dimensions, as well as to evaluate typical flow velocities and characteristic hydraulic controls under various return period flow conditions.

3.2 Task 2 – 100-Year Erosion Limit and Toe Erosion Assessment

A 100-year erosion limit assessment was conducted at the reach length in accordance with procedures outlined in TRCA (2004). The method relied on the available, historical air photographs for the Project site (refer to Section 3.1) to estimate the average annual migration rate of the channel over the available period of record. The specific approach involved the following steps and is based on the expectation that channel planform adjustment/shift (rather than channel widening) represents the overarching influence on lateral stability and associated erosion:

- Selection of two representative meander bend locations to complete the assessment;
- Delineation of the channel centerline in each of the air photographs from the available record;
- Measurement of channel change (i.e., lateral or downvalley shift to the centerline of the channel) from one air photograph to the next, and, in turn, derivation of an average annual migration rate for the full air photograph record; and
- Averaging of the annual migration rates for the two locations and subsequent extrapolation to a 100-year horizon to generate the 100-year erosion limit for the overall study reach.

For comparison with the 100-year erosion limit assessment, a toe erosion calculation was undertaken based on the protocols in MNR (2002), recognizing that this particular approach is understood to be well-suited to estimate channel erosion rates for confined systems (indicative of the study reach at the Rideau River where the meander pattern of the channel was shown to be confined to the valley walls – refer to Section 4.1.1 for details). As previously mentioned, the estimated toe erosion allowance from WSP Golder (2022) was developed using the same method, but, as part of the estimates described herein, the calculations were further refined using added site-specific information. This included the use of the following input parameters:

- An inferred, dominant bank substrate of very fine sand (D_{50} = 0.1 mm) based on a review of borehole information from WSP Golder (2009) and publicly available geologic mapping, coupled with observations at the time of the field reconnaissance, noting that substrate at the bed and bank of the channel were shown to generally range from silt- to gravel-sized materials; and
- Inferred hydraulic characteristics at the channel, including an average bank slope of roughly 1.7:1 and an average bankfull flow velocity of 0.68 m/s, based on topographic surveys at the time of the field visit and a review of the RVCA-generated HEC-RAS model for the Rideau River (RVCA, 2015).

4.0 RESULTS

4.1 Task 1 – Historical Air Photography Analysis and Field Reconnaissance

4.1.1 Field Reconnaissance

The results of the field reconnaissance, coupled with a review of the available background information, included the following key observations, noting that photographs from the walkovers are presented in Appendix A:

- The channel included the following general characteristics:
  - Well-defined bed and bank (i.e., incised conditions);
  - Moderate sinuosity;
  - Muted bed morphology (mostly flat) with some examples of ill-defined pool-riffle sequences;
  - Bed and bank substrate of mostly fine-grained materials (dominated by very fine sand with substrate ranging from silt- to gravel-sized materials);
  - Slight to moderate entrenchment;
  - Bankfull widths of 80 to 110 m (increasing in the downstream direction); and
  - Mostly alluvial controls.
- Erosion-sedimentation patterns at the channel included evidence of active bank erosion at several discrete locations (i.e., high, over-steepened banks with examples of undercut and/or exposure), with the understanding that this observed erosion likely reflects one or both of the following considerations (rather than a broad scale channel adjustment in response to land use changes or other in the contributing watershed):
  - The majority of the subject area of active erosion is located at the outside of a meander bend (particularly where the channel runs adjacent to the south end of the Project site), recognizing that the outer boundary of this type of channel feature is known to support higher flow velocities and shear stresses, and, in turn, increased erosion potential (relative to other parts of the channel cross-section in the immediate area, as well as at comparatively straighter sections of channel in upstream and downstream areas).
  - The subject portion of the channel itself is located immediately downstream of a bridge crossing, noting that areas downstream of crossing structures can be characterized by higher flow velocities and shear stresses, and, in turn, increased erosion potential (compared to areas upstream or further downstream and specific to instances where hydraulic restrictions are present at the opening of the crossing structure).
- Meander pattern at the channel supported confined conditions on both sides of the valley (i.e., the banks of the channel were shown to be in contact with the valley wall).
- Riparian/overbank zones included a dense cover of vegetation (mostly trees with some shrubs and grasses).

The results of the RGAs are presented in Appendix B. RGA scores were shown to range from 0.07 to 0.35, with an average stability index of 0.20, meaning that the channel is largely in regime (albeit with some examples of transition or stress).

The review of the RVCA-generated HEC-RAS model for the Rideau River (RVCA, 2015) showed that, not only do the downstream water control dams along the Rideau River (including the Hogs Back Dam) function to attenuate flow velocities and shear stress values at the reach length, downstream features such as the CN Rail Bridge and Mooney's Bay (essentially an inline lake) also serve as key hydraulic controls on the system.

4.1.2 Historical Air Photograph Analysis

The results of the air photograph analysis are illustrated in Figure 2. The key findings are as follows:

- Changes in Land Use – The review of the historical air photographs showed that land use in the vicinity of the reach length, as well as in the upstream catchment area, has been predominated by agriculture (i.e., cleared land) with some residential development since at least 1965. However, based on the general understanding of settlement patterns in the Rideau and Ottawa River Valleys, agriculture and associated land clearing has likely been the dominant land use in these catchments well before that time (over the past approximately 100 to 150 years). From 1965 onward, the air photos/images showed that land use in the local area continued to progressively transition to mostly urban development (residential with some commercial and light industry). This included the development of West Hunt Club Road and the associated bridge crossing at the river between 1965 and 1976.
- Changes in Channel Planform – The examination of the historical air photograph record demonstrated that the planform of the subject channel has been relatively stable for the past 40+ years (i.e., lateral movement of the channel has been relatively minimal). The most pronounced change in the channel pattern was limited to modest examples of planform shift between 1965 and 1975 and then again between 2011 and 2021 (e.g., modest straightening of the channel immediately downstream of the bridge crossing, slight widening and minor translation of the channel at the downstream-most meander bend). This suggests that the channel morphology has largely adjusted to past changes in land use (i.e., agriculture and associated land clearing followed by progressive urbanization) and reached a quasi-stable equilibrium (Annable & Watson, 2012). The analysis of the historical air photographs also identified the following examples of erosion-sedimentation processes:
    - Well-sorted, longitudinal, depositional features (i.e., point bars) were identified at the river in the air photograph from 1965, noting that these features were shown to be progressively eroded away in subsequent air photographs; and
    - Each of the available air photographs included instances of overhanging vegetation at the right (east) bank of the river, with the understanding that these observations are typically indicative of active bank erosion.

4.2 Task 2 – 100-Year Erosion Limit and Toe Erosion Assessment

The results of the 100-year erosion limit estimates are presented in Table 1, while the corresponding results of the refined toe erosion calculations are shown in Table 2.

Table 1: Results of 100-Year Erosion Analysis

Reach	Average Bankfull Width (m)	Estimated Meander Bend Migration Rate (cm/yr)		Average Migration Rate (m/100 yr)	Estimated 100-Year Erosion Limit (m)
		Bend #1	Bend #2		
Rideau River	82	19.84	0.00(1)	9.92	10

(1) The channel planform at this location was observed, over time, to be widening at both banks (albeit slightly) and/or shifting laterally toward each side (by an equally marginal amount), meaning that the centerline of the channel remained largely unchanged (and yielded an approximate migration rate of 0 cm/yr).

Table 2: Results of Toe Erosion Assessment

Reach	Inferred Bank Material	Competent Flow Velocity for Inferred Bank Substrate (m/s)	Bankfull Flow Velocity (m/s)	Minimum Toe Erosion Allowance (m)
Rideau River	Very Fine Sand	0.2(1)	0.7	8-15(2)

(1) Permissible flow velocities for a fine sand material were determined based on literature values from Hjulstrom (1935).
(2) The elevated range of minimum toe erosion allowance was selected, given that the estimated flow velocity under bankfull (assumed channel forming) flow conditions was shown to exceed the permissible flow velocity for the inferred bank material type.

5.0 DISCUSSION AND RECOMMENDATIONS

Based on the results of the fluvial geomorphology assessment at the study reach of the Rideau River, WSP Golder is of the opinion that the proposed development property should include a minimum geomorphic (erosion) setback of 15 m to accommodate the potential for long-term channel migration/movement. This recommended setback combines the estimated 100-year migration rate for the river of ~ 10 m with a safety factor of 50% or 5 m (to account for the potential of added channel movement via widening processes) and generally aligns with the previously inferred toe erosion allowance from WSP Golder (2022), as well as the upper limit of the toe erosion estimate for the current study. The recommended erosion setback at the study reach of the Rideau River is expected to be sufficiently conservative, given the following considerations:

- Observations at the time of the field reconnaissance confirmed the presence of active bank erosion at several discrete locations along the length of the channel reach (i.e., high, over-steepened banks with examples of undercut and/or exposure); however, the results of the air photograph analysis demonstrated that the planform of the subject channel has been relatively stable for the past 40+ years (i.e., lateral movement of the channel has been relatively minimal), and, because of that, it suggests that the channel morphology has largely adjusted to the past changes in land use.
- The meander pattern of the channel was shown to be confined on both sides of the valley (i.e., the banks of the channel were observed to be in contact with the valley wall), with the understanding that these confining conditions inherently reduces the opportunity for further lateral movement of the channel.

- The longitudinal profile/slope of the channel is known to be controlled by downstream water control dams, as well as other downstream features (such as the CN Rail Bridge and the inline lake at Mooney's Bay), recognizing that these controls on hydraulic conditions function to limit the opportunity for further vertical degradation of the channel.

The identified setback recommendations are based on the results of the fluvial geomorphology assessment alone. It is understood that the overall erosion hazard limit for the Project will also need to account for added geotechnical setbacks (i.e., stable slope allowance and erosion access allowance).

In the event that the proposed development property is required to encroach within the overall erosion hazard limit, one or more mitigation measures could be implemented at the study reach to minimize the risk of bank / valley slope erosion on the planned infrastructure. This may include the installation of targeted armouring works at the banks of the river in the form of a rip-rap or river stone revetment or a vegetated buttress (via geogrid material or other), with a plan to extend the armouring works vertically from the toe of the river bank to an elevation above the inferred flood level of the design flow event. Where appropriate, the specific configuration and design basis for these type of mitigation measures could be advanced under a separate scope of work.

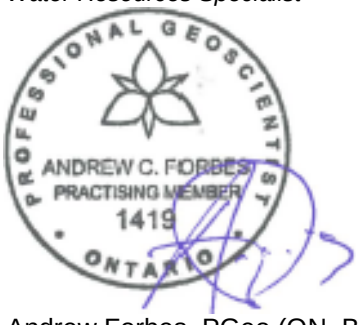
6.0 CLOSURE

We trust that this technical memorandum provides sufficient information for your current purposes. However, please do not hesitate to contact the undersigned if you have any questions regarding the contents of this report or require additional information.

Golder Associates Ltd.

Etta Gunsolus, M(Eng)Sc
Water Resources Specialist

Christopher Davidson, PEng
Surface Water Engineer



Andrew Forbes, PGeo (ON, BC)
Director - Water Resources Group, Earth & Environment Ontario

EG/CD/AF/mp

Attachments: Figure 1 – Location Plan
Figure 2 – Summary of Observed Changes to Channel Platform at Subject Reach Based on Historical Air Photograph Analysis
Appendix A – Photo Log
Appendix B – RGA Forms

LIMITATIONS

This report was prepared for the exclusive use of Taggart Realty Management. The report, which specifically includes all tables, figures and appendices, is based on (1) data and information that was obtained during the completion of the fluvial geomorphic assessment, (2) the conditions of the property at the time of the assessment, and (3) our professional judgement.

The services described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. WSP Golder accepts no responsibility for damages, if any, suffered by any third party (other than as noted above) as a result of decisions made or actions based on this report.

This report provides a professional opinion and therefore no warranty is expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings or other studies, WSP Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

REFERENCES

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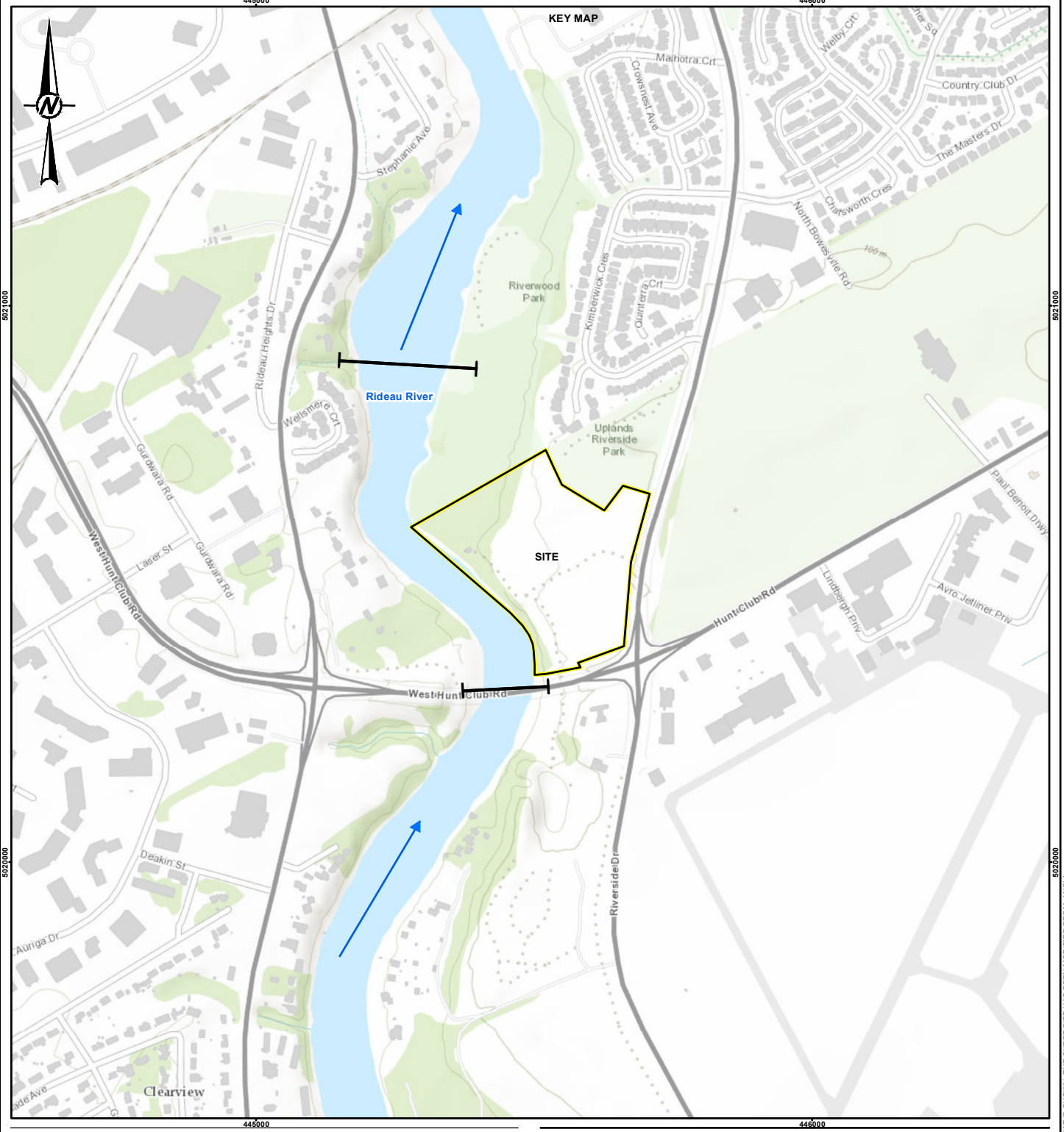
WSP Golder (WSP Golder Associates Ltd.). Updated Limit of Hazard Lands Assessment Along the Northern Section of the Site, St. Mary's Lands, Hunt Club Road and Riverside Drive, Ottawa, Ontario. March 2022.

FIGURES



LEGEND

- PROPOSED DEVELOPMENT
- REACH BOUNDARY

0 100 200 400

1:10,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N

CLIENT
TAGGART REALTY MANAGEMENT

PROJECT
ST. MARY'S RIVERSIDE HUNT CLUB,
OTTAWA, ONTARIO

TITLE
LOCATION PLAN

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-12-20
DESIGNED	EG
PREPARED	SD
REVIEWED	EG/CD
APPROVED	AF

PROJECT NO.	CONTROL	REV.	FIGURE
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LEGEND

- REACH BOUNDARY
- CHANNEL CENTRELINE
  - 1965
  - 1976
  - 1991
  - 2002
  - 2011
  - 2021
- PROPOSED DEVELOPMENT

0 25 50 100

1:2,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. SERVICE CREDITS: CITY OF OTTAWA IMAGERY 2021, CITY OF OTTAWA, PROVINCE OF ONTARIO, ESRI CANADA, ESRI, HERE, GARMIN, INCREMENT P, USGS, METI/NASA, NGA, EPA, USDA, AAFC, NRCAN
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N

CLIENT
TAGGART REALTY MANAGEMENT

PROJECT
ST. MARY'S RIVERSIDE HUNT CLUB, OTTAWA, ONTARIO

TITLE
SUMMARY OF OBSERVED CHANGES TO CHANNEL PLANFORM AT SUBJECT REACH BASED ON HISTORICAL AIR PHOTOGRAPH ANALYSIS

CONSULTANT

WSP GOLDER

YYYY-MM-DD	2022-12-20
DESIGNED	EG
PREPARED	AM
REVIEWED	EG/CD
APPROVED	AF

PROJECT NO.	CONTROL	REV.	FIGURE
21482114	0004	0	2

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APPENDIX A

Photo Log

Photo 1: View looking upstream at S1 on October 14, 2022.

Photo 2: View looking at S2 (perpendicular to bank) on October 14, 2022.

Photo 3: View looking upstream at S3 on October 14, 2022.

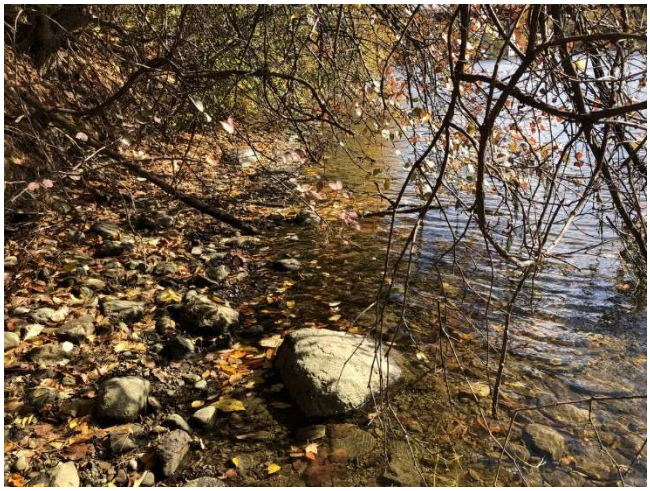

Photo 4: View looking upstream at S4 on October 14, 2022

Photo 5: View looking upstream at S5 on October 14, 2022

Photo 6: View looking at S6 (perpendicular to bank) on October 14, 2022.

Photo 7: View looking at S7 (perpendicular to bank) on October 14, 2022.

Photo 8: View looking at S8 (perpendicular to bank) on October 14, 2022.

Photo 9: View looking at S9 (perpendicular to bank) on October 14, 2022.

Photo 10: View looking at S10 (downslope to bank) on October 14, 2022.

Photo 11: View looking upstream at S11 on October 14, 2022

Photo 12: View looking at S12 (perpendicular to bank) on October 14, 2022, noting evidence of runoff pathways.

Photo 13: View looking at S13 (perpendicular to bank) on October 14, 2022.

Photo 14: View looking at S14 (perpendicular to bank) on October 14, 2022.

Photo 15: View looking at S15 (perpendicular to bank) on October 14, 2022.

Photo 16: View looking upstream at S16 on October 14, 2022

Photo 17: View looking at S17 (perpendicular to bank) on October 14, 2022.

Photo 18: View looking at S18 (perpendicular to bank) on October 14, 2022.

Photo 19: View looking at S19 (perpendicular to bank) on October 14, 2022.

Photo 20: View looking upstream at S20 on October 14, 2022

Photo 21: View looking at S21 (perpendicular to bank) on October 14, 2022.

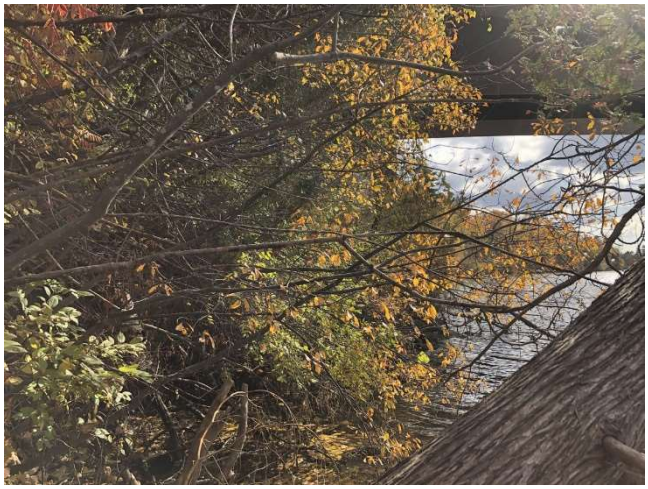

Photo 22: View looking upstream at S22 on October 14, 2022.

APPENDIX B

RGA Forms

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S1 (445314E, 5020590N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded	1	
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank	1	
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.24 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S2 (445319E, 5020570N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.		1
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	2/10 = 0.20	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.19 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S3 (445329E, 5020562N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	2/7 = 0.29	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.18 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S4 (445345E, 5020553N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded	1	
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.22 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S5 (445350E, 5020548N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.		1
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots		1
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.17 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S6 (445354E, 5020529N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	2/7 = 0.29	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.		1
	2	Occurrence of large organic debris		1
	3	Exposed tree roots		1
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed		1
		RATIO OF INDICES [1]	0/7 = 0.00	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.07 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S7 (445378E, 5020529N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded	1	
	3	Siltation in pools	1	
	4	Medial bars	1	
	5	Accretion on point bars	1	
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	6/7 = 0.86	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank	1	
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.35 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S8 (445371E, 5020510N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded	1	
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.22 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S9 (445394E, 5020528N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded	1	
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank	1	
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.24 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S10 (445413E, 5020484N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	1/7 = 0.14	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots		1
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	2/10 = 0.20	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)	1	
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	2/7 = 0.29	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.16 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S11 (445412E, 5020502N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars	1	
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material	1	
	9	Suspended armor layer visible in bank	1	
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	2/10 = 0.20	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.27 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S12 (445426E, 5020485N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	1/7 = 0.14	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris		1
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	2/10 = 0.20	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]				

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S13 (445433E, 5020480N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars	1	
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.22 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S14 (445441E, 5020460N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)	1	
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	2/7 = 0.29	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.26 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S15 (445454E, 5020464N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	2/7 = 0.29	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.18 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S16 (445465E, 5020437N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials		1
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	0/7 = 0.00	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed		1
		RATIO OF INDICES [1]	0/7 = 0.00	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.1 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S17 (445474E, 5020426N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials		1
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	0/7 = 0.00	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank	1	
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	4/10 = 0.40	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.14 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S18 (445478E, 5020417N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools		1
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials		1
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank	1	
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle	1	
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	4/10 = 0.40	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.20 = In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S19 (445500E, 5020405N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars	1	
	6	Poor longitudinal sorting of bed materials		1
	7	Deposition in the overbank zone	1	
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material	1	
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.		1
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	2/10 = 0.20	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.22 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S20 (445502E, 5020382N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars	1	
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	3/7 = 0.43	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material	1	
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	1/10 = 0.10	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle		1
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	3/10 = 0.30	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.24 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S21 (445508E, 5020370N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials		1
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	1/7 0.14	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle	1	
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	4/10 = 0.40	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.17 --> In Regime	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*

RAPID GEOMORPHIC ASSESSMENT (RGA)

Date: 14-Oct-22 Location: S22 (445487E, 5020346N)

Field Staff: Robert Ireland Project #: 21482114

FORM/ PROCESS	GEOMORPHIC INDICATOR		PRESENT OR ABSENT	
	#	DESCRIPTION	Yes	No or N/A
Evidence of Aggradation (AI)	1	Lobate bar		1
	2	Coarse material in riffles embedded		1
	3	Siltation in pools	1	
	4	Medial bars		1
	5	Accretion on point bars		1
	6	Poor longitudinal sorting of bed materials	1	
	7	Deposition in the overbank zone		1
		RATIO OF INDICES [1]	2/7 = 0.29	
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		1
	2	Exposed sanitary/storm sewer/pipeline/etc.		1
	3	Elevated storm sewer outfall(s)		1
	4	Undermined gabion baskets/concrete aprons/etc.		1
	5	Scour pools d/s of culverts/stormsewer outlets		1
	6	Cut face on bar forms		1
	7	Head cutting due to knick point migration		1
	8	Terrace cut through older bar material		1
	9	Suspended armor layer visible in bank		1
	10	Channel worn into undisturbed overburden/bedrock		1
		RATIO OF INDICES [1]	0/10 = 0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	1	
	2	Occurrence of large organic debris	1	
	3	Exposed tree roots	1	
	4	Basal scour on inside meander bends		1
	5	Basal scour on both sides of channel through riffle	1	
	6	Gabion baskets/concrete walls/etc. out flanked		1
	7	Length of basal scour > 50% through subject reach		1
	8	Exposed length of previously buried pipe/cable/etc.		1
	9	Fracture lines along top of bank		1
	10	Exposed building foundation		1
		RATIO OF INDICES [1]	4/10 = 0.40	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		1
	2	Single thread channel to multiple channel		1
	3	Evolution of pool-riffle form to low bed relief form		1
	4	Cutoff channel(s)		1
	5	Formation of island(s)		1
	6	Thalweg alignment out of phase meander form		1
	7	Bar forms poorly formed/reworked/removed	1	
		RATIO OF INDICES [1]	1/7 = 0.14	
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4 [2]			0.21 --> Transitional	

Notes:

[1] Ratio of Indices or Factor = Number of Indices Present / Total Number of Indices.

[2] Stability Index or SI values inferred as follows: 0.20 or lower = In Regime; 0.21 to 0.40 = Transitional or Stressed; and 0.41 or higher = In Adjustment.

Sourced and adapted from: *Ontario Ministry of the Enviroment, 2003. Stormwater Management Planning and Design Manual.*