PARSONS

Project File Report

Tutela Heights Road Slope Stabilization

Class Environmental Assessment Study

Contract # 2-15

Prepared for:

The Corporation of the County of Brant
26 Park Avenue
Burford, Ontario N0E 1A0

June 2017

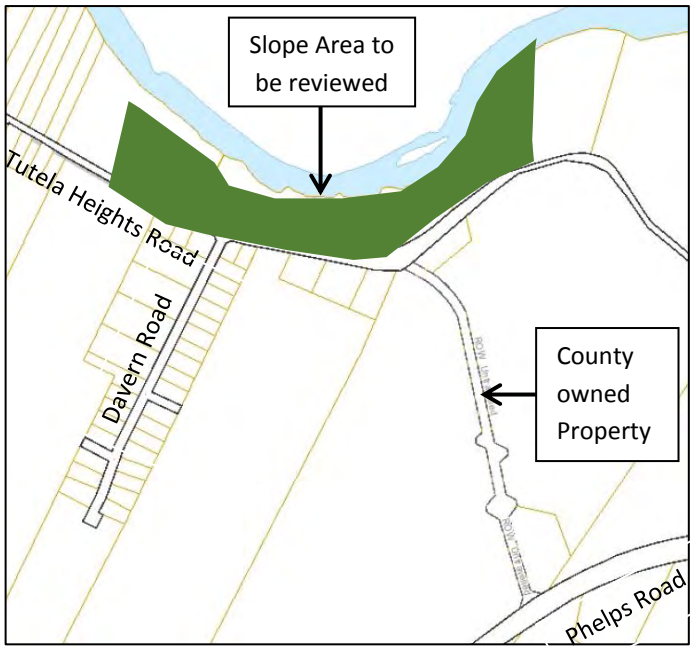
delivering a better world

NOTICE OF STUDY COMPLETION
TUTELA HEIGHTS ROAD SLOPE STABILITY
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

The County of Brant has completed a Municipal Class Environmental Assessment Study to identify and address impacts on Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, due to unstable conditions in the slope area between the roadway and the Grand River.

The Process

The Study was initiated as a Schedule "C" project in October 2015, in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA) process. Based on a review of the Schedule in light of the study findings and identified alternative solutions, the Study has been conducted and completed as a Schedule "B" project, including the development of a Preferred Solution to address the study requirements.



Preferred Solution

The Preferred Solution is to ultimately close the subject section of Tutela Heights Road, when ongoing monitoring measures indicate that road closure is warranted. The Preferred Solution also includes recommendations for the Slope Area and the Road Right-of-Way:

The Slope Area Recommendations include priority measures for: (1) **Public Safety** by providing warning signs throughout the slope area and preventing access to unsafe slope areas; (2) **Drainage-Mitigation** to protect the slope area from surface runoff; and (3) **Slope-Monitoring** involving frequent observations of surface and in-depth movements; geotechnical inspection; and the monitoring of the condition of the remaining gryones.

Roadway Recommendations include: 1) **Road Closure** with the timing and the limits of road closure guided by periodical monitoring and observations; 2) **Property Access** provided where road closure will impact driveways to existing properties; 3) **Underground Services** replaced/relocated outside the EHL limit; and 4) **Truck Traffic Prohibition** on Tutela Heights Road, except for local deliveries.

Next Steps

Along with the issuing of this Notice, a Project File documenting the EA process and the recommendations will be made available for public review from Monday, June 5 to Wednesday, July 5, 2017 (30 calendar days) at:

County of Brant, Administration Office 26 Park Avenue, Burford, ON N0E 1A0	**Paris Customer Service Office** 66 Grand River Street North, Paris, ON N3L 2M2
Scotland Library 281 Oakland Road, Scotland, ON N0E 1R0	**Brantford City Hall, Engineering Counter** 100 Wellington Square, Brantford, ON N3T 2M2

All locations open Monday to Friday, 8:30 a.m. to 4:30 p.m., except Scotland Library. Please see County of Brant Website for branch hours at www.brant.ca.

A copy of the Project File and the Notice of Completion are also posted on the County Website at http://www.brant.ca/en/explore-our-services/Public-Works-Notices.asp under "Environmental Assessment".

During the 30-day review period you are encouraged to contact the County of Brant and/or Parsons Inc. if you have any questions or concerns about this project. If after consulting with the County and/or Parsons, you feel your concerns remain unresolved, you may ask the Minister of the Environment and Climate Change to make an order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order).

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For a Part II Order, you must submit a written request to the Minister of the Environment and Climate Change and send a copy to the County of Brant before the end of the thirty calendar-day review period (Wednesday, July 5, 2017).

Minister of the Environment and Climate Change
77 Wellesley Street West, 11th Floor, Ferguson Block, Toronto ON M7A 2T5

For More Information

Please contact the either one of the following project team members if you have any questions or comments or wish to obtain more information on the project:

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Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

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1.0 INTRODUCTION AND BACKGROUND

The County of Brant is undertaking a Municipal Class Environmental Assessment (EA) study to identify and address impacts on Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, due to unstable conditions of the slope area between the roadway and the Grand River. Figure 1.0 illustrates the subject roadway section, the abutting slope area, and the surrounding lands. The slope area has had a history of deteriorating slopes, and geotechnical investigations have indicated that the slope area is not in a stable condition to support the subject section of the existing Tutela Heights Road. The purpose of the EA is to identify slope stabilization alternatives, roadway alternatives, and combinations of slope stabilization and roadway alternatives and select a preferred solution for the subject roadway section. As part of the EA process, assessments of existing conditions, and identification and evaluation of alternative solutions were undertaken to determine the preferred solution. This Report summarizes the study process and its findings, including recommendations for the preferred solution and associated measures for implementation.

1.1 The Class Environmental Assessment Process

The Class EA process for Municipal Road Projects was established by the Municipal Engineers Association (MEA) and embodies a planning process that can be applied to projects that display important common characteristics (i.e. projects that are similar in nature and/or limited in scale; exhibit a predictable range of environmental effects; and responsive to mitigating measures). The Class EA process provides municipalities with a procedure approved under the EA Act to plan and undertake municipal road projects that exhibit such characteristics.

Under the Class EA process, municipal road projects are categorized according to their environmental significance and the effects they may impose on the environment. These categories, described by specific Class EA "schedules", prescribe planning methodologies for each category. At present, there are three schedule classification types including Schedule A, B and C. The main difference between each of the schedule types is the degree to which each project may adversely affect the existing environment. Schedule A projects have minimal adverse effects while Schedule C projects have the potential for significant environmental affects and must proceed under the full planning and documentation procedures specified under the Class EA document. Projects are also classed according to their relative financial costs in addition to their significant environmental impacts. For example, some types of road projects by their very nature may be relatively large in terms of their total cost, whereas their environmental impact may or may not be significant.

In addition to providing municipalities with a planning procedure approved under the EA Act for municipal road projects, the Class EA also serves as a public statement of the decision making process under which municipalities plan and implement road projects. The Class EA process provides various opportunities for public involvement and review. Public consultation is a key feature of environmental assessment planning.

In developing a recommended solution for the subject portion of Tutela Heights Road consideration was given to existing conditions including the transportation role and function of Tutela Heights Road, and the determination of the Erosion Hazard Limit for the slope area.

Classified as a Schedule "C" undertaking at the commencement of the study, the project components and their overall impacts were reviewed by the Project Team and the study was subsequently reclassified as a Schedule "B" undertaking. In accordance with the Municipal Class Environmental Assessment, October

Figure 1.0 Key Plan of Study Area

2000, as Amended in 2007, Schedule "B" process requirements are warranted since significant impacts to the environment are not anticipated as a result of the recommended solution identified through the study.

1.2 Project Team Organization

The County of Brant retained Parsons Inc. as their Prime Consultant to undertake this Class EA Study on their behalf. The "Project Team" consisted of members from the County of Brant and Parsons Inc. (Prime Consultant). The following subconsultants were involved in the study for specialist work:

Englobe - Geotechnical Investigation
Aquafor Beech – Geomorphic and Erosion Assessment
Archaeological Research Associates – Archaeological Assessment
J.H. Cohoon - Survey

2.0 Existing Conditions

As illustrated in Figure 1.0, the study area is part of the Tutela Heights Settlement Area, and is located to the south of the Grand River and between Mount Pleasant Road to the west, and Cockshutt Road to the east. Mount Pleasant Road and Cockshutt Road are oriented north-south, while Tutela Heights Road and Phelps Road are east-west roads within the study area. There is also a Municipally owned north-south corridor connecting Tutela Heights Road and Phelps Road, between Davern Road and Cockshutt Road.

The municipal boundary between the County of Brant and the City of Brantford has recently been shifted to the south, from along the Grand River in the study area, to include the westerly half of Tutela Heights Road, within the City of Brantford.

Land uses in the area include a mix of residential, agricultural, institutional, and open space uses. Existing residential properties include both older homes and new developments, generally comprising larger homes on larger lots. A new plan of residential subdivision has been proposed to the south of Tutela Heights Road, between Davern Road and Rue Chateau Terrace. An assessment of existing conditions, in regard to the natural environment, cultural heritage, transportation, and geomorphic and geotechnical conditions, was undertaken through the following component studies:

1. Transportation and Corridor Assessment – prepared by Parsons Inc., October 2016 (included in Appendix A)
2. Preliminary Environmental Investigations Summary – by Parsons Inc., September 2015 (included in Appendix B)
3. Stage 1 Archaeological Assessment – by Archaeological Research Associates Limited, March 2016 (included in Appendix C)
4. Grand River Geomorphic and Erosion Hazard Assessment – by Aquafor Beech Limited, March 2016 (included in Appendix D)
5. Geotechnical Investigation Report, Tutela Heights Slope Stabilization – by Englobe, March 2016 (included in Appendix E)

Archaeologically, Tutela Heights Road is a historic roadway with abutting historic properties including the Bell Homestead (a National Historic site) located on the north side, at the westerly project limit. The Grand River and adjacent slopes in the study area are known for their natural heritage significance. Significant vegetation and wildlife presence were also identified in the vacant lands to the north of Phelps Road including the north-south corridor.

The Transportation and Corridor Assessment confirmed the role and function of Tutela Heights Road as a Rural Local/Urban Residential roadway, as identified in the Official Plan. It primarily provides property access while carrying low traffic volumes under current and future conditions. The underground services include a watermain and a limited storm sewer system.

Geo-technical investigation and Geomorphic assessment were undertaken to assess slope stability and toe erosion, respectively, and to determine the Erosion Hazard Limit (EHL) in the study area. The findings of the Geotechnical and Geomorphic investigations and the EHL determination were presented to the Grand River Conservation Authority (GRCA), prior to finalizing the Geotechnical and Geomorphic reports.

Erosion Hazard Limit (EHL)

The determination of the Erosion Hazard Limit (EHL) is described in the Geotechnical Investigation Report (Appendix E). Figure 2.0 illustrates the delineation of the EHL for the subject section of Tutela Heights Road. The EHL is based on (a) 100-year erosion allowance from the river ranging from 30 metres to 75 metres, from the westerly project limit to the easterly limit; and (b) stable slope allowance (3.5 Horizontal to 1.0 Vertical). As shown in Figure 2.0, the EHL encompasses all of the road right-of-way from west of Davern Road to east of the north-south corridor. Based on the EHL delineation, three Slope Stabilization Alternatives were identified in regard to addressing tableland stability for Tutela Heights Road (Appendix E):

1) Do Nothing: This alternative refers to no action being taken to eliminate toe erosion and/or slope stabilization. It is noted that if left in the existing condition, the slope will continue to erode and slope failures will continue to occur.

Corresponding to the DO Nothing scenario, ten specific measures (listed in Appendix E) are recommended for implementation. Two of these measures suggest developing "a plan for the future of Tutela Heights Road"; and prohibiting "new development within the setback limits along Tutela Heights Road as provided in this report" (i.e. Geotechnical Investigation Report. Note: 'Setback Limits' include EHL as shown in Figure 2.0, plus an additional access allowance of 6 to 15 metres as required by GRCA policy). Other eight measures involve safety-warning measures and slope-monitoring measures to under a Do Nothing scenario.

2) Mechanical Slope Reinforcement: This refers to complex mechanical reinforcing of the slope area, which along with measures to reduce toe erosion could prevent tableland loss.

3) Combined Geometric and Mechanical Stabilization: This will include cutting back the slope to a more stable angle, limited mechanical reinforcement measures and toe-erosion reduction measures. This combination of measures could be used to reduce, not prevent, tableland loss.

Drainage Mitigation: The recommendations also include drainage mitigation measures that would be applicable to all of the above-noted alternatives. Under existing conditions, surface run-off on the slope area contributes to slope instability and the following measures are recommended to mitigate surface run-off:

a) redirect existing sources of surface runoff away from the slope area
b) establish swales to direct water away from affected areas
c) enhance grading and vegetation in specific locations to avoid ponding and minimize infiltration

3.0 Class Environmental Assessment Phase 1: Problem Statement

Under Phase 1 of the Municipal Class EA planning process, a "Problem Statement" is prepared which identifies, in detail, the various issues needing to be addressed by the Class EA study. In essence, the Problem Statement outlines the need and justification for the overall project and establishes the general parameters, or scope, of the study.

Based on a review of various background documents and works previously completed, the EA Terms of Reference, site visits, and consultation with various agencies and the public, the Project Team has developed the following problem statement for the Class EA study:

The section of Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, is located on top of a slope area between the road right-of-way and the Grand River to the north. The slope area has had a history of deteriorating slopes affecting the stability of the tableland supporting the roadway. This has created the need to address the stability and safety of the subject section of Tutela Heights Road through the EA process, involving the identification and evaluation of slope stabilization alternatives, roadway alternatives, and combinations of slope stabilization and roadway alternatives, and the selection of a preferred solution. The identification of roadway alternatives and the selection of the preferred alternative is based on the determination of Erosion Hazard Limit (EHL), which is defined as the limit (setback from the Grand River) on the tableland, within which it would be unsafe to allow development, infrastructure and site alteration activities.

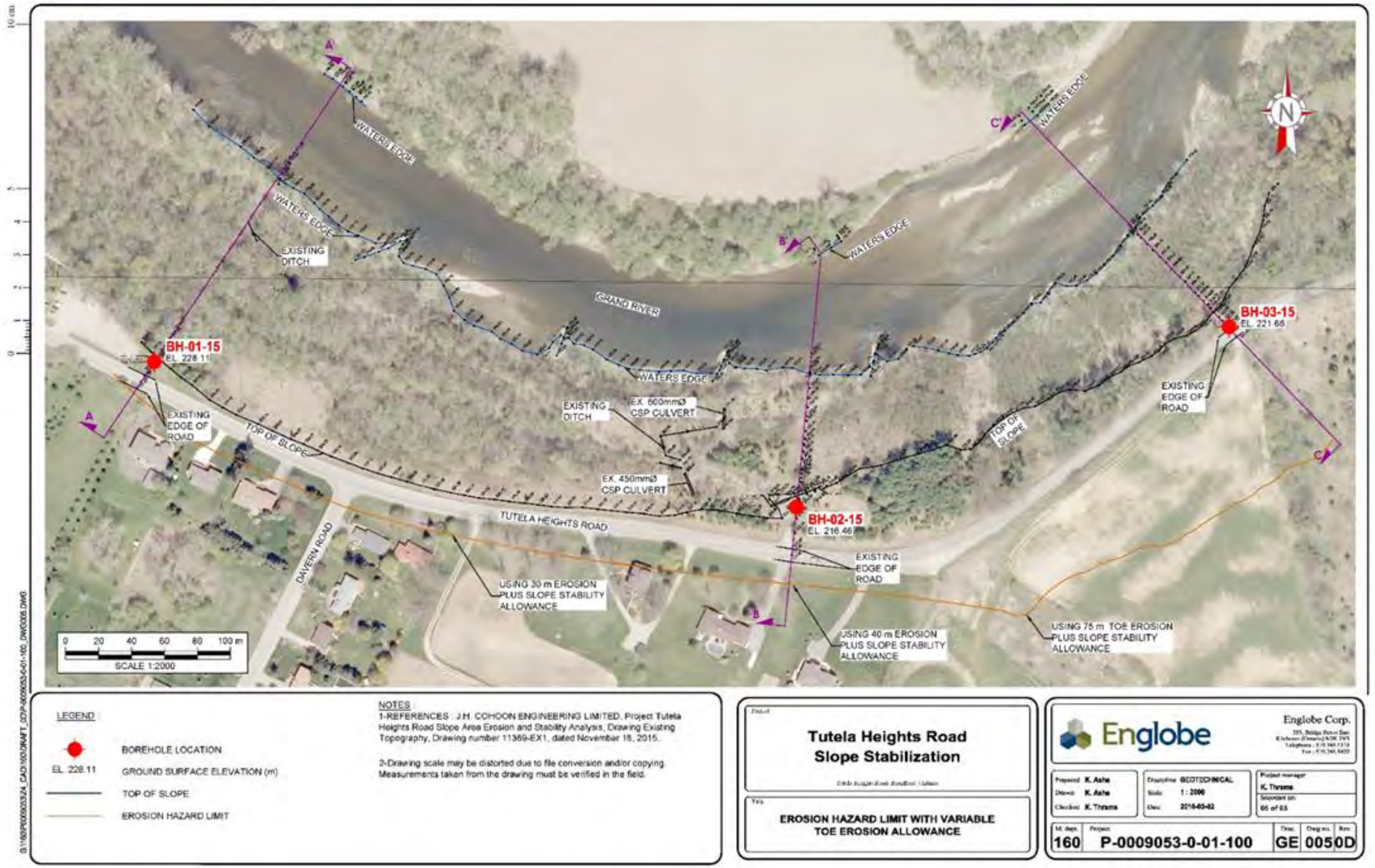


Figure 2.0 Delineation of the Erosion Hazard Limit

4.0 CLASS ENVIRONMENTAL ASSESSMENT PHASE 2: ALTERNATIVE SOLUTIONS

Under Phase 2 of the Class EA process, all reasonable alternative solutions to the problem are identified and evaluated, considering the impacts to the surrounding natural, social and economic environments. The Environmental Assessment Act requires that all reasonable alternatives to the undertaking be considered during the decision making process. Consultation with review agencies and the public is a key element at this Phase of the Class EA process.

4.1 Alternative Solutions

Based on the Erosion Hazard Limit and the three slope stabilization alternatives, four roadway alternatives were identified for the subject section of Tutela Heights Road:

a. Do Nothing (Note: Do Nothing on the slope area would trigger the implementation of safety-warning, drainage-mitigation and slope-monitoring measures as noted earlier and as described in Appendix E)
b. Close the section of Tutela Heights Road where tableland is impacted by slope instability
c. Re-align Tutela Heights Road outside the EHL Limit, plus the access allowance as required by GRCA policy, on the tableland, while closing the impacted roadway section
d. Develop a new road alignment, while closing the impacted roadway section

Appendix F describes potential re-alignment and new alignment alternatives for Tutela Heights Road.

The four roadway alternatives are paired with the three slope stabilization alternatives to identify twelve combination alternatives, as illustrated in Table 1 below:

Table 1: Combination Alternatives

Roadway Alternatives	Slope Stabilization Alternatives		
	Do Nothing	Geometric & Mechanical Slope Stabilization	Mechanical Slope Reinforcement
Do Nothing	Not a viable Alternative	Not a viable Alternative	*Alternative-4*
Road Closure	*Alternative-1*	Not a viable Alternative	No need to close road
Road Closure + Realignment	*Not a viable Alternative*	*Alternative-3*	No need to close/realign road
Road Closure + New Alignment	*Alternative-2*	*Not a viable Alternative*	No need for road closure/ new alignment

Of the twelve pairs of combination alternatives, the Do-Nothing pair is not a viable alternative, considering the risk to public safety.

But with Do Nothing on the slope, road closure becomes a viable alternative for consideration (i.e. Alternative – 1). In addition, a new road alignment becomes a potentially viable alternative, while closing the impacted road section corresponding to DO Nothing on the slope (i.e. Alternative-2).

Geometric and Mechanical Slope Stabilization (which will reduce, but not prevent, tableland loss) involves cutting back the slope into the road right-of-way and making the road inoperable. The only viable road alternative for consideration is re-aligning Tutela Heights Road just outside the EHL plus access allowance (i.e. Alternative-3) as part of slope modifications. Also, there will be no purpose in stabilizing the slope corresponding to the fourth roadway alternative, namely, Road Closure + New Alignment.

With appropriate Mechanical Slope Reinforcement measures, tableland loss could be prevented thereby supporting the existing road alignment. DO Nothing on the road, therefore, becomes a viable alternative (i.e. Alternative-4). And there will not be a need for road closure, re-alignment or new alignment.

The four combination alternatives for evaluation, are described below:

Alternative-1 - combines Do Nothing on the slopes with closing the road, while providing alternative access to properties and relocating underground services and utilities in the road corridor. As noted earlier (and described in Appendix E), DO Nothing on the slope area would involve undertaking safety-warning, drainage-mitigation and slope-monitoring measures).

Alternative-2 - envisages closing the impacted section of Tutela Heights Road and developing a new road alignment, while doing nothing on the slopes. Potential new alignment alternatives are described in Appendix F. As noted already, DO Nothing on the slope area would involve undertaking safety-warning, drainage-mitigation and slope-monitoring measures).

Alternative-3 - involves realigning the road while undertaking slope stabilization measures to reduce, but not prevent, tableland loss. The slope protection measures include cutting back on the slope into the existing road right-of-way, and presents the opportunity for considering an alternative road realignment outside the EHL plus access allowance requirement. Appendix F describes the realignment option for Alternative 3.

Alternative-4 - is predicated on preventing tableland loss, which would allow Do Nothing on the roadway, and using the existing road alignment.

4.2 Evaluation of the Alternatives

The evaluation of the four alternatives takes into account the role and function of Tutela Heights Road; the impacts involving property frontage, natural heritage and cultural heritage; the costs of roadway and slope stabilization alternatives; and effectiveness of slope protection and erosion control measures. These considerations are incorporated in the evaluation criteria listed and described below:

- *Role and Function of Tutela Heights Road*: As discussed in the Transportation and Corridor Assessment, Tutela Heights Road primarily provides property access and has no significant external traffic. Its role and function are, therefore, measured by the following indicators:
  - *local traffic service*
  - *property access*
  - *underground services*
- *Property Frontage Impacts*: This criterion compares the impacts on property frontage due to roadway alternatives.
- *Environmental Impacts*: Both roadway and slope stabilization alternatives will have different impacts on the natural environment, and are compared under this criterion.
- *Archaeological Impacts*: The archaeological impacts arising from roadway and slope stabilization alternatives are compared under this criterion.
- Slope Area Costs and Slope Stabilization Costs: Slope Area costs are costs of safety-warning, monitoring and drainage mitigation measures associated with the Do Noting scenario in the slope area. A breakdown of these costs are tabulated in Appendix G. Slope stabilization costs are costs associated with the two stabilization scenarios. The cost of slope stabilization will depend on the scope and specific stabilization measures that will have to be identified through detailed investigation and analysis. Only order-of-magnitude costs are used in the evaluation. The cost of mechanical slope reinforcement to prevent tableland loss is expected to be in the order of $10M, and the cost of geometric and mechanical stabilization to reduce tableland loss is expected to be in the order of $5M.
- Roadway Costs: Roadway costs are considered separately for road realignment and new road alignment alternatives (Appendix F), and for the Road Closure alternative involving alternative access and watermain connection to affected properties (Appendix G). These costs are preliminary cost estimates based on conceptual alignments.
- ***The effectiveness of potential Slope Stabilization measures***: Slope stabilization measures include both mechanical/geometric slope protection measures and toe erosion control measures. The long term effectiveness of erosion control measures cannot be assured given the natural geomorphic processes causing toe erosion and contributing to slope instability, and the failure of three of the seven angular-rock groynes installed in 1973. This criterion captures the uncertainty of erosion control and slope protection measures as well as the unpredictability of sudden failure.

As can be seen in Table 1, Alternative-1 and Alternative-2 are roadway alternatives corresponding to Do Nothing on the slope area. On the other hand, Alternative-3 and Alternative-4 are essentially slope stabilization alternatives with different implications for the road corridor. The four alternatives are evaluated through 'pair-wise' comparison undertaken in three steps. Alternative-1 and Alternative-2 are evaluated in Step 1, and Alternative-3 and Alternative-4 are evaluated in Step 2. The superior alternatives from Step 1 and Step 2 are evaluated in Step 3 to select the preferred alternative.

Step 1 Evaluation: Table 2 summarizes the evaluation of Alternative-1 and Alternative-2, and is based on the consideration of the two new alignment options as described in Appendix F. Between the two alternatives, Alternative-1 is the preferred alternative based on its low impacts and cost. More importantly, as discussed in Appendix F, existing and projected traffic conditions do not justify the need for road alignment to replace Tutela Heights Road.

Table 2: Step 1 - Evaluation of Alternative 1 and Alternative 2

Evaluation Criteria	Alternative-1 (Road Closure)	Alternative-2 (Road Closure + New Alignment)
Local Traffic Service	Yes	Yes
Property Access	Will require modifications	Will require modifications
Underground Services	Will require modifications	Will require modifications
Property Frontage Impacts	Driveway Impacts	Driveway Impacts
Environmental Impacts	None	Yes
Archaeological Impacts	None	Yes
Slope Area Costs	$390,000	$390,000
Roadway Costs	$2.2M	$2.2M + $3.2 to $4.6M
Step 1 - Selected Alternative	**Yes**	**No**

Step 2 Evaluation: Table 3 summarizes Step 2 evaluation of Alternative-3 and Alternative-4. Alternative-4 is the preferred of the two. Although the cost of Alternative-4 is higher, it has fewer impacts and will prevent tableland loss, whereas under Alternative-3 the impacts are greater and there is greater uncertainty about the effectiveness of stabilization measures.

Table 3: Step 2 - Evaluation of Alternative 3 and Alternative 4

Evaluation Criteria	Alternative-3 (Realignment + Geometric & Mechanical Measures)	Alternative-4 (Do Nothing + Mechanical Slope Reinforcement)
Local Traffic Service	Yes	No Change
Property Access	Will require modifications	No Change
Underground Services	Will require modifications	No Change
Property Frontage Impacts	Significant Frontage Impacts	None
Environmental Impacts	Significant Impacts on the Slope Area	Significant Impacts on the Slope Area
Archaeological Impacts	Potentially Significant Impacts	Potentially Significant Impacts
Slope Stabilization Costs	$5.0M	$10M
Roadway Costs	$4.0M	Nil
Long-term Effectiveness	More Uncertain	Less Uncertain
Step 2 - Selected Alternative	**No**	**Yes**

Step 3 Evaluation: Table 4 summarizes Step 3 evaluation of Alternative-1 and Alternative-4, the selected alternatives from Step 1 and Step 2 evaluations.

Table 4: Step 3 - Evaluation of Alternative 1 and Alternative 4		
Evaluation Criteria	**Alternative 1 (Road Closure)**	**Alternative 4 (Do Nothing + Mechanical Slope Reinforcement)**
Local Traffic Service	Yes	No Change
Property Access	Will require modifications	No Change
Underground Services	Will require modifications	No Change
Property Frontage Impacts	Driveway Impacts	None
Environmental Impacts	None	Significant Impacts on the Slope Area
Archaeological Impacts	None	Potentially Significant Impacts
Slope Area Costs / Slope Stabilization Costs	$390,000	$10M
Roadway Costs	$2.2M	Nil
Long-term Effectiveness	Not Applicable	Not Assured
Step 3 - Recommended Alternative	**Yes**	**No**

4.3 Recommended Solution

Alternative 1 is selected as the overall recommended alternative. It is significantly lower in cost and avoids significant natural environmental and archaeological impacts associated with slope stabilization measures. The property and infrastructure impacts can be mitigated at modest costs. The potential cost of slope stabilization would be disproportionately high for a transportation corridor whose primary function is providing property access. Further, slope stabilization measures involve both mechanical slope protection and erosion control measures and there is uncertainty about the long term effectiveness of erosion control measures given the natural geomorphic processes causing bank erosion at the subject slope area location.

5.0 Description of the Recommended Solution

The Recommended Alternative Solution is to ultimately close the subject section of Tutela Heights Road without undertaking significant soil stabilization measures, when ongoing monitoring measures indicate that road closure is warranted. The Recommended Solution also includes the undertaking of appropriate safety-warning, drainage-mitigation and slope-monitoring measures in the slope area on a priority basis. In addition, closing the subject section of the roadway would involve determining the timing and extent of closing, as well mitigating attendant impacts on abutting properties and underground services. The timing and extent of road closure will be determined by on-going slope monitoring measures. The following recommendations identify the steps that need to be taken in regard to the slope area and in regard to closing the road, in implementing the recommended alternative solution. Preliminary Cost-estimates for the recommended measures for the Slope Area and the Roadway are included in Appendix G.

Slope Area Recommendations:

The following safety-warning, mitigating and monitoring measures should be undertaken on a priority basis:

1) **Safety-Warning**: Close all trails along the slope east of the lookout and below the Bell Homestead; install fencing to prevent pedestrian access to unsafe slope areas; and placing warning signs throughout the slope area to alert the public.
2) **Drainage-Mitigation**: Drainage improvement measures to protect the slope area from surface runoff by: redirecting existing sources of surface runoff away from the slope area; providing swales to direct water away from affected areas; and grading and vegetation in specific locations to avoid ponding and minimize infiltration.

3) **Slope-Monitoring**: Periodical monitoring of the slope area involving frequent observations of surface and in-depth movements through Standard Iron Bars (SIB) and inclinometers respectively; geotechnical inspection; and the monitoring of the condition of the remaining gryones.

Roadway Recommendations:

The following roadway recommendations address the timing and staging of road closure and the mitigation of associated impacts:

1) **Road Closure**: The timing of road closure should be guided by periodical monitoring and observations. The easterly and westerly limits of road closure will depend on the extent and location of deterioration in the slope area. The limits of road closure should be established by slope-monitoring and through additional investigation as appropriate.
2) **Property Access**: Where road closure will impact driveways to existing properties, driveway modifications would need to be undertaken, potentially through a cul-de-sac arrangement, outside the EHL limit plus the access allowance requirement.
3) **Underground Services**: The existing storm outlet should be replaced as part of drainage mitigation measures to avoid surface runoff in the slope area. Existing watermain and utilities should be relocated to an easement outside the EHL limit plus the access allowance requirement.
4) **Truck Traffic Prohibition**: Truck traffic should be prohibited on Tutela Heights Road, except for local deliveries.

6.0 PUBLIC AND AGENCY CONSULTATION

Consultation with the public, external agencies and other stakeholders was conducted in accordance with the requirements of the Schedule "B" Class EA process. Throughout the study, residents and stakeholders were contacted via newspaper advertisements, mail deliveries, and information posted on the County of Brant's website. Copies of study notifications, Public Information Centre documentations, and Agency correspondence are provided in Appendix H.

6.1 Consultation with the Public and Review Agencies

Notice of Study Commencement

A Notice of Study Commencement (included in Appendix H) was mailed out to area residents, businesses, property owners, external agencies, and interest groups on September 29, 2015. The Notice was also placed in the Brantford Expositor and Paris Star on October 1 and October 8, 2015, as well as on the County website. The Notice, which also served as notification for the first Public Information Centre, described the project, outlined the Municipal Class Environmental Assessment process, requested public involvement, identified the details of the first Public Information Centre and identified contact persons for the Project.

Public Information Centre No. 1

Public Information Centre (PIC) No. 1 was held on October 14, 2015, at the Mount Pleasant Community Centre, to provide background information on the project and receive input and comments from area residents and interested stakeholders.

The PIC was set up as an open-house style information centre in which participants were encouraged to view the boards on display and to address their questions and concerns to members of the project team. 20 people attended and signed-in at PIC No. 1. Only one written comment was received by email and is summarized in Table 9.1.

The PIC No. 1 display materials, sign-in sheets and the email comment received are included in Appendix H.

Table 9.1 – Public Information Centre No. 1 Comment Summary

Key Issues	Comment Summary	Project Team's Consideration of Comments
Continuing erosion; increasing traffic; proposed new development in the area.	The comment was provided by two residents on Tutela Heights Road. Support closing the road, and potentially converting it into a 'trail head'.	Closing the road is part of the recommended solution.

Public Information Centre No. 2

PIC No. 2 was held on January 12, 2017, also at the Mount Pleasant Community Centre. The second PIC was set up in the same format as PIC No.1, and notifications were carried out in the same manner as well.

The purpose of the second PIC was to provide study updates and summaries, and to present the identification and evaluation of alternative solutions as well as the recommended solutions identified by the Project Team.

32 people attended and signed-in at PIC No. 2. Nine comments were received from eight people, including two email comments. A summary of the comments received at the PIC and the Project Team's consideration of those comments are provided in Table 9.2.

The PIC No. 2 Notice, display materials, sign-in sheets, comments received, and letters sent in response to specific comments are included in Appendix H.

Table 9.2 – Public Information Centre No. 2 Comment Summary

Key Issues	Comment Summary	Project Team's Consideration of Comments
Impact of closing Tutela Heights Road; positive outcome from closing.	The comment was provided by the same residents as in PIC No. 1, suggesting there would be minimal impact on residents, due to road closing, and a positive outcome for walking and cycling.	Closing the road is part of the recommended solution presented at PIC No. 2. Similar comments were made verbally by a number of attendees at the PIC.
Monitoring of the slope area.	One comment emphasized the importance of monitoring.	Monitoring is included in the recommended/preferred solution.
Restriction of Truck Traffic	Three comments emphasized the need to restrict truck traffic on Tutela Heights Road.	Truck traffic restriction was not included in the recommended solution presented at PIC No. 2. It has since been added to the recommended/preferred solution.
Potential impact on the slope area due to future construction work for a proposed new development south of Tutela Heights Road.	Three comments were received from residents on Davern Road, concerned with the potential impact on the slope area, due to future construction of a proposed new subdivision on the side of Tutela Heights Road and west of Davern Road.	Review of potential slope impacts due to future development is outside of the project scope.

Create a new channel. Realign the river to the north.	Two comments were received suggesting the realignment of the Grand River as a solution to erosion.	The Project Team considered the suggested option to realign the Grand River as a 'New Alternative', and evaluated it in comparison to Alternative 1 (Road Closure) and Alternative 4 (Do Nothing on the Road + Mechanical Slope Reinforcement) that were presented at PIC #2. The results of the evaluation are tabulated below. The Roads Closure option (Alternative 1) is confirmed to be the Preferred Alternative in terms of relative magnitudes of impacts including cost.

Evaluation of Alternatives: Road Closure; Mechanical Slope Reinforcement; River Realignment

Evaluation Criteria		**Road Closure (Alternative 1)**	**Do Nothing + Mechanical Slope Reinforcement (Alternative 4)**	**Grand River Realignment (New Alternative)**
Local Traffic Service		Yes	No Impacts	Minimal Impacts
Property Access		Will require modifications	No Impacts	Minimal Impacts
Underground Services		Will require modifications	No Impacts	Minimal Impacts
Property Frontage Impacts		Driveway Impacts	No Impacts	Minimal Impacts
Environmental Impacts		None	Significant Impacts on the Slope Area	Significant Impacts on the River System Ecology; changes to floodplain area; and potential erosion impacts upstream and downstream
Archaeological Impacts		None	Significant Impacts	Significant Impacts
EHL Impacts	Stable Slope	Not Applicable	Improved Slope Stability	Slope stability not addressed by this alternative. Slope stability requires either mechanical reinforcement at a cost of $10M; or, stable incline of 3.5:1 as determined by slope stability analysis
	Toe Erosion	Not Applicable	Toe Erosion will continue subject to protection by remaining groynes	Toe Erosion caused by the rive is potentially eliminated
Costs Comparison	Slope Area Costs	$390,000	None (included in slope stabilization costs)	$390,000
	Roadway Costs	$2.2M	None	$500,000 to address potential minimal impacts
	Slope Stabilization Costs	None	$10M	None
	River Realignment Costs	None	None	Estimated to be in the order of $20M, given the energy and the complexity of the River. Actual cost estimate will require at least preliminary investigation.
	Total Costs	$2.59M	$10M	$20M
Evaluation of Alternatives		**Recommended**	**Not Recommended**	**Not Recommended**

6.2 Comments Received from Technical Agencies

Throughout the Study, the Project Team shared information with Grand River Conservation Authority (GRCA) and met with the GRCA on January 12, 2016 to finalize the determination of the Erosion Hazard Limit. The Minutes of the January 2016 meeting and copies of correspondence are included in Appendix I. The correspondence (copies) from the Ministry of Cultural Affairs and Tourism are also included in Appendix I.

Notice of Study Completion

A Notice of Study Completion has been advertised in the Brantford Expositor and Brant News on Thursday, June 1 and Thursday, June 8, 2017. The newspaper Notice of Study Completion identified main features of the recommended design, the Class EA process undertaken (including the "Part II Order" request process), and details on the Project File Report which is available for review from Monday, June 5 to Wednesday, July 5, 2017. Concurrent with the newspaper Notice of Study Completion, area residents, property owners, external agencies and other stakeholders were sent a copy of the Notice of Completion. A copy of the Notice of Completion is included in the Project File Report Summary.

7.0 Submission of Project File

The Project File Report will be placed on the public record for a 30-day review period. During this time, stakeholders will be encouraged to review outstanding issues with the study team.

7.1 Resolution of Outstanding Issues

In the event there are major issues which cannot be resolved, stakeholders may request the Minister of the Environment by order to require a proponent to comply with Part II of the EA Act before proceeding with a proposed undertaking which has been subject to Class EA requirements. This is called a "Part II Order". The Minister will make one of the following decisions:

1. Deny the request (with or without conditions);
2. Refer the matter to mediation; or
3. Require the proponent to comply with Part II of the EA Act, ordering a full Environmental Assessment.

All stakeholders are urged to try to resolve issues since it is preferable for them to be resolved by the municipality in which a project is located, rather than at the provincial level. To request a Part II Order, a person must send a written request to:

Minister of the Environment

77 Wellesley Street West, 11th Floor

Ferguson Block, Toronto, ON M7A 2T5

The request must address the following with respect to the identified concerns:

- Environmental Impacts and specific concerns;
- Adequacy of the planning and public consultation process;
- Involvement of the person in the planning process; and
- Details of discussions held between the person and the proponent.

APPENDIX A

Transportation and Corridor Assessment

Parsons Inc.

October 2016

PARSONS

MEMORANDUM

SUBJECT: Tutela Heights Road Slope Stabilization Class EA Study
Transportation and Corridor Assessment

DATE: October 31, 2016

Background

The County of Brant is undertaking a Municipal Class Environmental Assessment to identify and address impacts on Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, arising from potential stability issues in the slope area between the roadway and the Grand River. The purpose of the Environmental Assessment is to select a preferred solution to the undertaking based on considering slope stabilization alternatives, roadway alternatives, and combinations of slope stabilization and roadway alternatives. The identification of roadway alternatives is based on the determination of the Erosion Hazard Limit, defined as the limit (setback from the Grand River) within which it would be unsafe to allow development, infrastructure, or site alteration activities. The alternative solutions will be evaluated to determine a preferred solution using evaluation criteria that will include:

- Slope Stabilization Costs
- Roadway Costs
- Long-term effectiveness of Slope Stabilization
- Role and Function of Tutela Heights Road in providing traffic service, property service and linear infrastructure service
- Need for New Road Alignment
- Property Impacts
- Environmental Impacts
- Archaeological Impacts

The purpose of this Memo is to assess the role and function of Tutela Heights Road in considering roadway alternatives based on their implications for providing traffic service, property (access) service and linear infrastructure service in the Study Area.

Study Area and Road Network

Figure 1.0 illustrates the location of subject section of Tutela Heights Road under Class EA Study, the abutting Slope Area, and the surrounding lands and road network. The study area is part of the Tutela Heights Settlement Area, and is located to the south of the Grand River and between Mount Pleasant Road to the west, and Cockshutt Road to the east. Mount Pleasant Road and Cockshutt Road are oriented north-south, while Tutela Heights Road and Phelps Road are east-west roads within the study area.

Land uses in the area include a mix of residential, agricultural, institutional, and open space uses. Existing residential properties include both older homes and new developments, generally comprising larger homes on larger lots. A new Plan of Subdivision consisting of 210 to 215 lots/units, located to the west of Davern Road and south of Tutela Heights Road is currently in the Planning Application process. Archaeologically, Tutela Heights Road is a historic roadway with abutting historic properties including the Bell Homestead (a National Historic site) located on the north side, at the westerly project limit. The Grand River and adjacent slopes in the study area are also known for their natural heritage significance.

The existing municipal boundary between the County of Brant and the City of Brantford is along the Grand River in the study area. An annexation process is currently underway to extend the municipal boundary to the south and include parts of the study area including the westerly half of Tutela Heights Road within the City of Brantford.

Figure 1.0: Key Plan

Role and Function of Tutela Heights Road

The four main study area roads are of two-lane cross-section, and are classified as follows in Schedule B of the County's Official Plan:

- Tutela Heights Road: Rural Local / Urban Residential Road
- Mount Pleasant Road: Rural Collector Road
- Phelps Road: Rural Arterial Road
- Cockshutt Road: Rural Arterial Road

Davern Road, Rue Chateaux Terrace, Rosehill Avenue and Belholme Avenue are north-south residential streets with double-loaded residential properties and providing access to Tutela Heights Road at four Tee-intersections. To the east of Davern Road, the County owns a north-south corridor linking Tutela Heights Road and Phelps Road.

The 2008 Brant County Transportation Master Plan (TMP) Report identified the need for the following intersection improvements and new road construction in the Tutela Heights Settlement Area:

- *Intersection Improvements*: at Phelps Road and Mount Pleasant Road; and at Phelps Road and Cockshutt Road.

- *New Road Connection*: a short road connection between Tutela Heights Road and Phelps Road utilizing the vacant north-south corridor "for a possible realignment of Tutela Heights Road should riverbank slope instability make the existing road unsafe for public use.

The TMP Report also identified the primary roadway function according to road classification:

- Rural Local Road: Individual Property Access
- Rural Collector Road: Traffic Movement and Access are equally important
- Rural Arteria: Traffic Movement

It is noted that an update to the 2008 TMP study was undertaken in 2016, and the 2016 TMP Update does not include additional considerations in regard to the above-noted intersection improvements and the new road connection.

Traffic Service on Tutela Heights Road:

As part of the proposed new Subdivision west of Daven Road, The Tutela Heights Scoped Area Study was undertaken in 2011. The Area Study included a Traffic Impact Study (TIS) undertaken by Stantec. The TIS assessed five year (2016) and ten year (2021) traffic conditions on Tutela Heights Road including the intersections at Mount Pleasant Road and at Cockshutt Road. The traffic conditions correspond to the following scenarios:

a) Existing Background Traffic (2011)
b) Future Background Traffic, projected at 2% traffic growth, in 2016 and 2021
c) Total Traffic (Background + New Development) in 2016 and 2021

Traffic information from the 2011 TIS is illustrated in the attached Figures, as described below:

- Figure 2.0: Lane Configuration and Traffic Control
- Figure 3.0: 2011 (Existing) Traffic Volumes
- Figure 4.0: 2016 Background Traffic Volumes
- Figure 5.0: 2021 Background Traffic Volumes
- Figure 6.0: 2021 Total Traffic Volumes

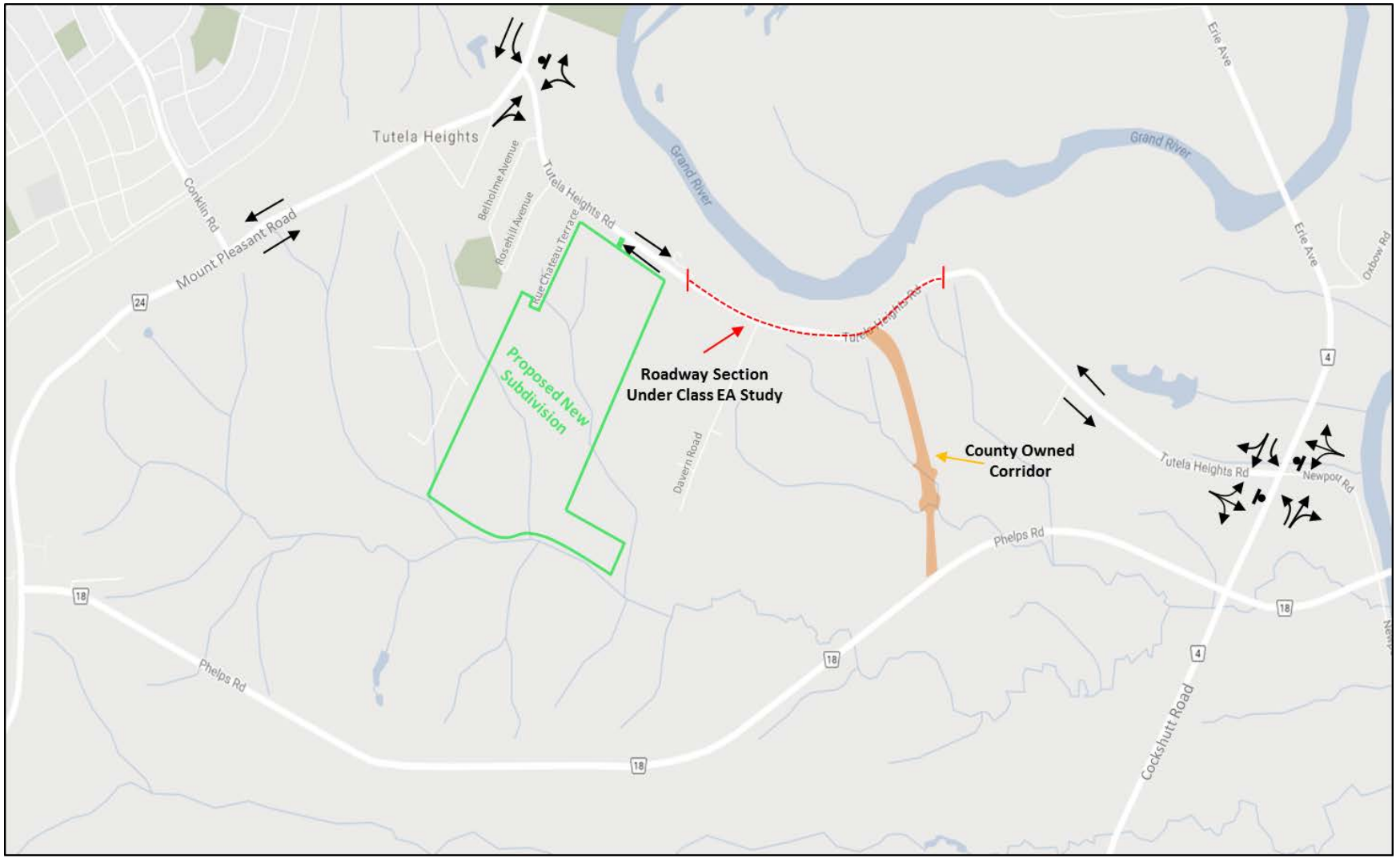


Figure 2.0: Lane Configuration and Traffic Control

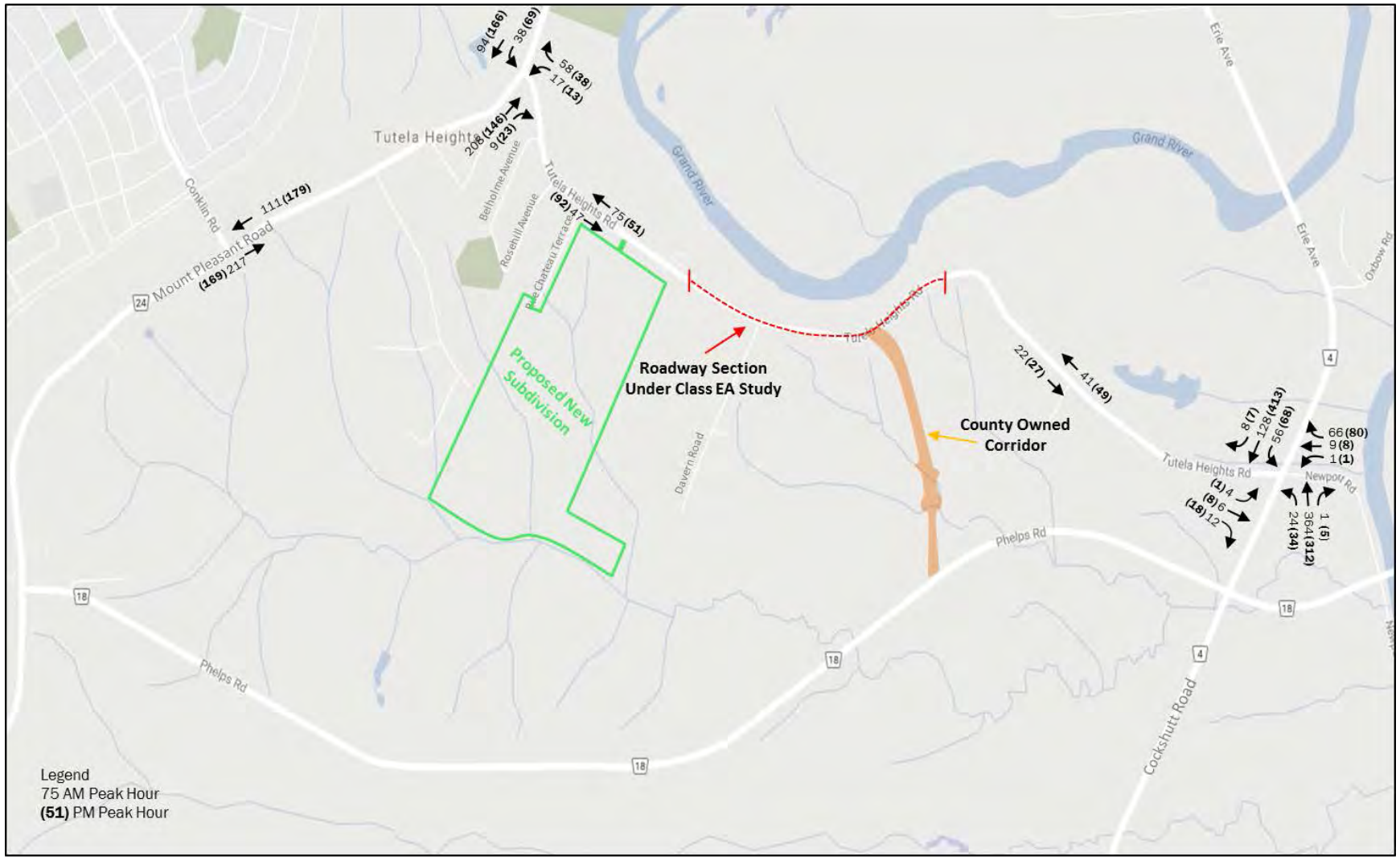


Figure 3.0: 2011 (Existing) Traffic Volumes

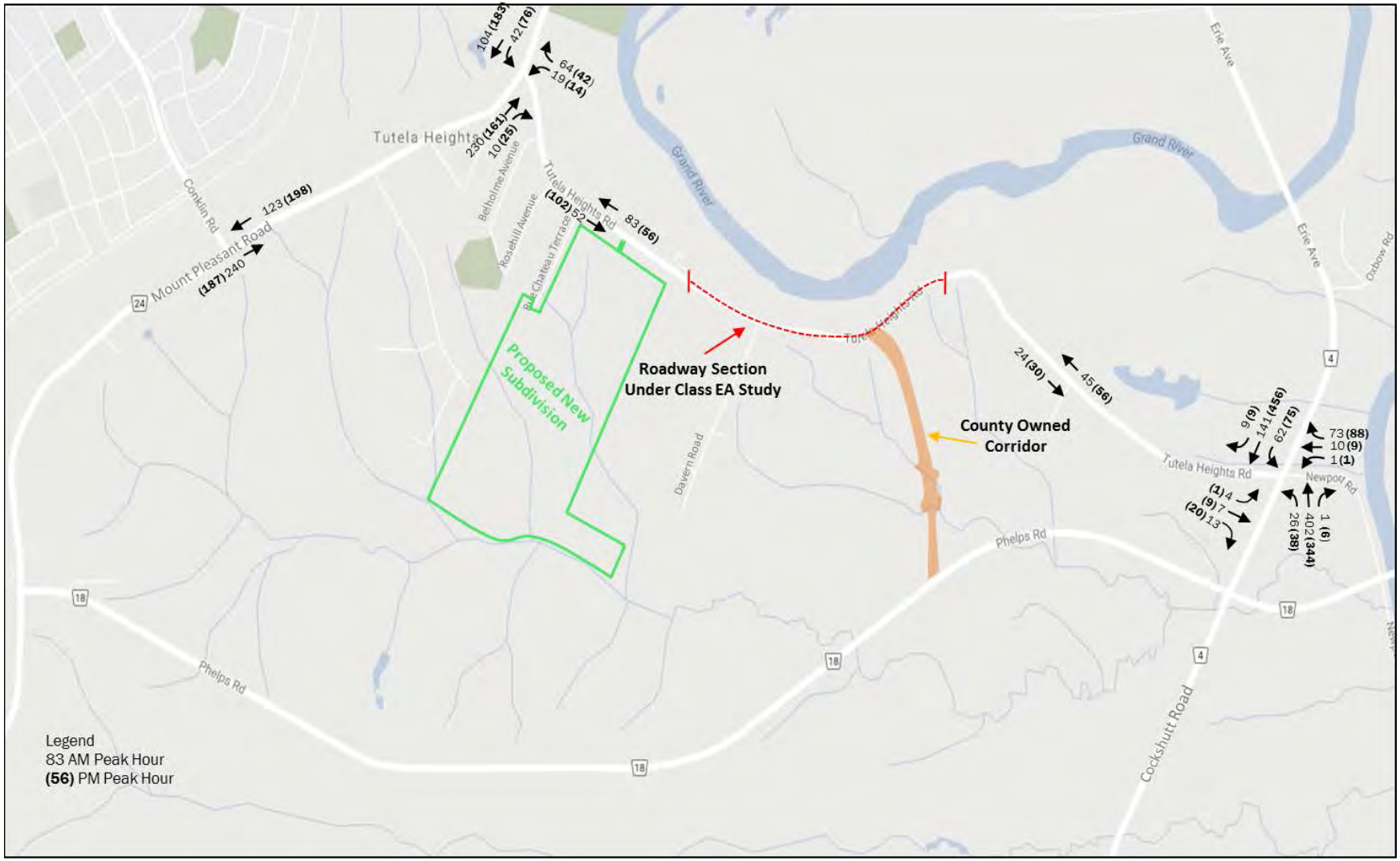


Figure 4.0: 2016 Background Traffic Volumes

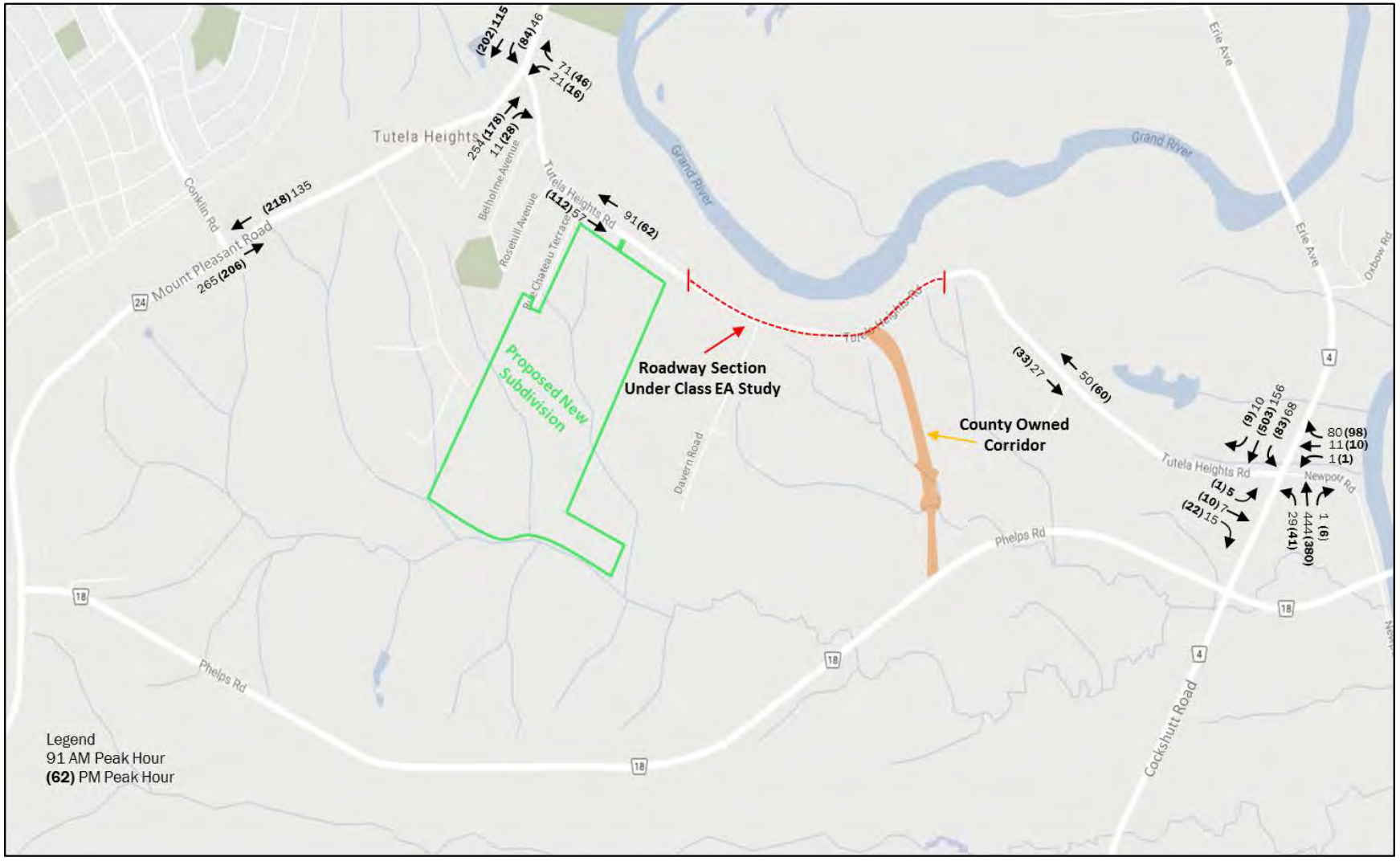


Figure 5.0: 2021 Background Traffic Volumes

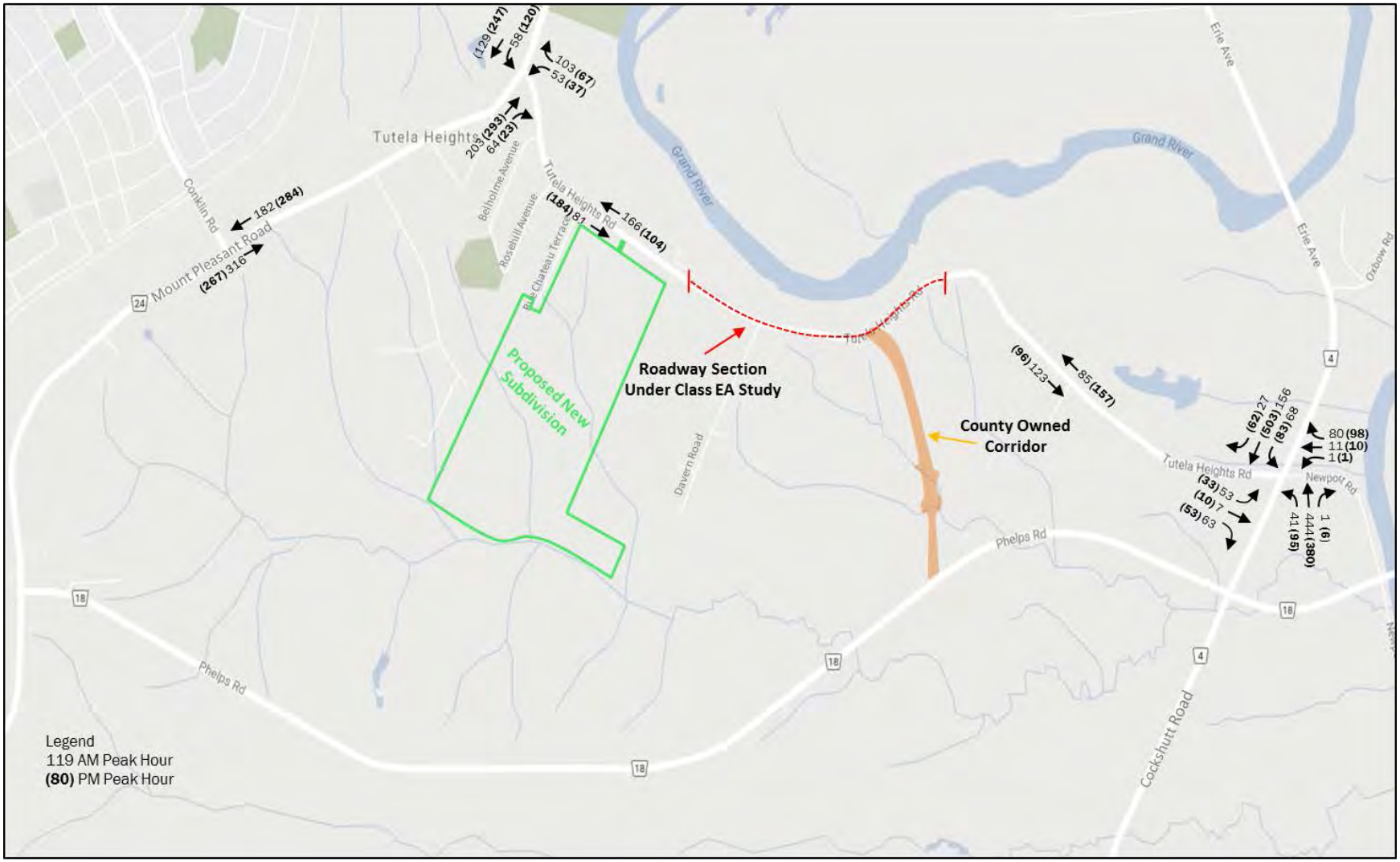


Figure 6.0: 2021 Total Traffic Volumes

The lane configurations (Figure 2.0) indicate one lane in each direction on Tutela Heights Road. The intersection of Tutela Heights Road and Mount Pleasant Road is a Tee intersection with an exclusive southbound Left-Turn lane and a Through-lane on Mount Pleasant Road; the northbound and westbound movements are accommodated on shared Through/Right and shared Left/Right lanes, respectively.

The Tutela Heights Road and Cockshutt Road intersection is a four-legged intersection with exclusive northbound and southbound Left-Turn lanes and shared lanes for all of the other movements.

The two intersections operate under stop-sign control on Tutela Heights Road, with free movement on Mount Pleasant Road and Cockshutt Road.

The traffic volumes for the different horizon years include morning (AM) and afternoon (PM) peak hour volumes. The total directional volumes on Tutela Heights Road at the two intersections, for the different horizon years, are summarized in Table 1, below. Development Traffic volumes are also shown as the difference between 2021 Total Traffic volumes and 2021 Background Traffic volumes. Development Traffic volumes includes traffic generated from the proposed new subdivision, as well as from adjacent new developments in the Study Area, as identified in the 2011 TIS. It is noted that the development traffic assigned to Tutela Heights Road at the intersection at Cockshutt Road is significantly higher in comparison to the existing and projected background traffic volumes

Table 1: Tutela Heights Road AM & PM Peak Hour Traffic Volumes (vph)

Horizon Year	Tutela Heights Road & Mount Pleasant Road				Tutela Heights Road and Cockshutt Road			
	Eastbound Traffic		Westbound Traffic		Eastbound Traffic		Westbound Traffic	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
2011 (Existing)	47	92	75	51	22	27	41	49
2016 (Background)	52	102	83	56	24	30	45	56
2021 (Background)	57	112	91	62	27	33	50	60
Development Traffic	24	72	77	42	96	61	35	97
2021 (Total Traffic)	81	184	166	104	123	96	85	157

Based on the traffic volumes shown in Table 1, the highest two-way traffic volumes on Tutela Heights Road just east of the intersection at Mount Pleasant Road, corresponding to 2021 Total Traffic, are 247 vph during the AM Peak Hour, and 288 vph in the PM Peak Hour. Similarly, the two-way traffic volumes just west of the Cockshutt Road intersection are: 208 vph (AM Peak Hour) and 253 vph (PM Peak Hour).

The AADT volumes on Tutela Heights Road based on 3-year ATR counts from 2006 to 2015, and 2021 projections are summarized in Table 2

Table 2: AADT Volumes on Tutela Heights Road

Year	ATR at 0.2 km east of Mount Pleasant Road	ATR at 0.2 km west of Cockshutt Road
2006	1900	1100
2009	2000	1200
2012	1950	1300

2015	2050	1400
2021 (Projected at 2% annual growth rate)	2300	1600

Two-way PM Peak Hour roadway traffic volumes at a given road location are generally considered to be 10% of the AADT at that location. The 2021 two-way PM Peak Hour (Total Traffic) volumes on Tutela Heights Road are about 12.5% of the projected AADT volumes east of Mount Pleasant Road and 18% west of Cockshutt Road.

The above-noted traffic volumes are consistent with the Official Plan classification of Tutela Heights Road as a Rural Local Road, with property access, and not traffic movement, as its primary purpose, as indicated in the County of Brant Transportation Master Plan Road Classification Guidelines.

Property Service:

Residential properties with driveway access to Tutela Heights Road are located north and south of the road between Mount Pleasant Road and the north-south corridor owned by the Count of Brant. Tutela Heights also serves residential properties abutting the four north-south streets: Davern Road, Rue Chateaux Terrace, Rosehill Avenue and Belholme Avenue. Large farm properties, with access to Tutela Heights Road, are located between the north-south corridor and Cockshutt Road.

Infrastructure Service:

There is an existing 200mm watermain on Tutela Heights Road from Mount Pleasant Road easterly to a north-south easement located to the west of Cockshutt Road. In addition, there are short lengths of storm sewer and catch basins collecting road and property runoff and out-letting to the slope area.

Implications of EA Alternatives

As part of the EA Study, three categories of alternatives are being identified: (1) slope stabilization alternatives; (2) roadway alternatives; and (3) a combination of slope stabilization and roadway alternatives. In broad terms, potential roadway alternatives include:

a) Do Nothing
b) Re-align Tutela Heights Road
c) Close a section of Tutela Heights Road between Mount Pleasant Road and Cockshutt Road

Of the three roadway alternatives, re-aligning or closing Tutela Heights Road will have implications for the traffic, property and infrastructure services currently available in the Tutela Heights Road corridor. Figure 7 illustrates the potential closing of the roadway section to address slope stability concerns. The implications of closing Tutela Heights Road between Mount Pleasant Road and Cockshutt Road are reviewed herein. The extent and timing of potential road closure are discussed as part of the EA recommendations.

Traffic Implications:

Closing Tutela Heights Road, as shown in Figure 7, will cut off through traffic on Tutela Heights Road between Mount Pleasant Road and Cockshutt Road. The traffic from existing and planned residential developments on Tutela Heights Road will be directed to/from Mount Pleasant Road. The intersection at Cockshutt Road will become a virtual Tee intersection, with only vehicles from the easterly farm properties using the westerly leg of the intersection.

Figure 7 also illustrates the redistributed traffic volumes at the two intersections, corresponding to 2021 Total Traffic volumes (Figure 6). As can be seen, the turning movements at the Mount Pleasant Road intersection (not northbound and southbound through volumes) are higher with Tutela Heights disconnected between the two

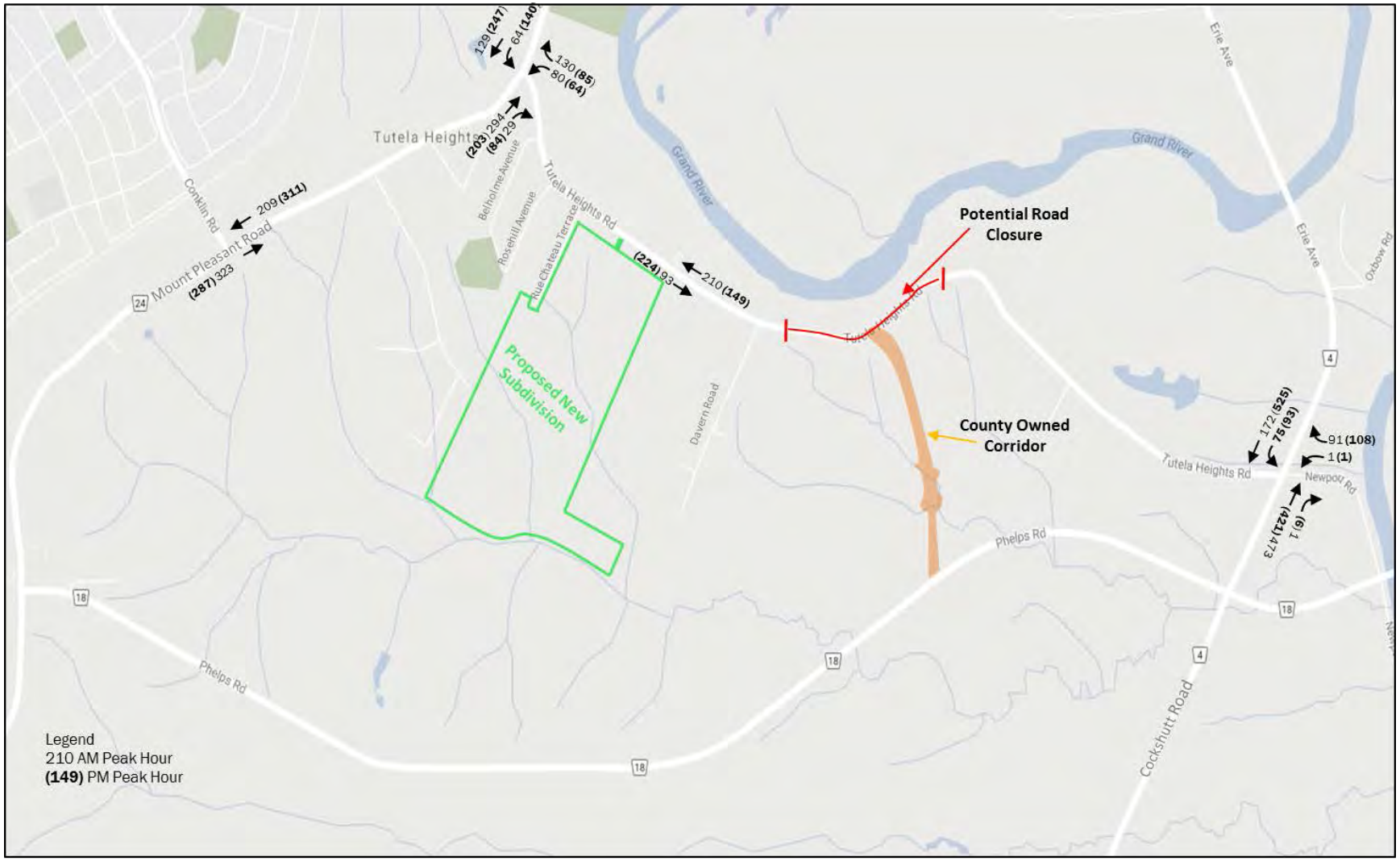


Figure 7.0: Disconnecting Tutela Heights Road

intersections. On the other hand, the intersection at Cockshutt Road has all movements increasing, except for the eastbound traffic which will be virtually eliminated.

However, the increases in traffic volumes are not significant to affect the Levels of Service identified in the 2011 Stantec TIS, considering that the Mount Pleasant Road intersection will remain a Tee intersection and the Cockshutt Road intersection will become a virtual Tee intersection. The TIS identified high Levels of Service for the two intersections and all of the individual turning movements with the exception of the eastbound approach at the Cockshutt Road intersection. The TIS did not identify the need for intersection modifications to accommodate 2021 Total Traffic volumes, except for recommending future monitoring of the Cockshutt Road intersection for potential traffic signal warrant requirements.

The TIS concluded that "there are no road capacity and/or traffic control improvement measures required to accommodate the proposed development," and went on to note that "this conclusion would be unchanged in the event that Tutela Heights Road becomes discontinuous to the east of the site as a consequence of erosion issues."

These TIS conclusions are consistent with the traffic assessment undertaken as part of the current EA Study. It should also be noted that closing Tutela Heights Road will virtually eliminate the eastbound traffic at the Cockshutt Road intersection. Also, as the proposed new subdivision is still in its planning stages, it would be prudent to have the 2011 TIS updated to specifically analyze a potential 'discontinuous Tutela Heights Road' scenario, which could also consider providing separate Left-turn and Right-turn lanes for westbound traffic at the Mount Pleasant Road intersection.

Similarly, future redevelopment of lands to the east of the north-south corridor will have to be supported by transportation studies that would assess the potential of the intersection at Cockshutt Road to accommodate such redevelopment.

As well, given the current and future traffic volumes on Tutela Heights Road, as described earlier, it would be difficult to justify a new road alignment based on the traffic service function of Tutela Heights Road. However, new road alignments in the study may become justifiable in the future depending on future growth and development opportunities.

Property Access Implications:

Closing Tutela Heights Road as shown in Figure 7 will affect access to residential properties currently fronting on Tutela Heights Road. However, as identified in the EA recommendations, the timing of closure will be guided by the monitoring of the stability of the abutting slope area, and alternative access to properties outside the Erosion Hazard Limit (EHL) would need to be provided prior to road closing.

Infrastructure / Utility Implications:

The existing watermain on Tutela Heights Road, as well as underground utilities, should be relocated to a new easement outside the EHL limit.

The existing system of storm sewers and catch basins out-letting to the affected slope area has been identified as a concern for slope protection in Geotechnical studies undertaken as part of this EA Study and previously. An alternative storm system should be provided to divert runoff from Tutela Heights Road and abutting properties from out-letting to the slope area.

Conclusions

The conclusions from the Transportation and Corridor Assessment undertaken as part of the EA Study are summarized below.

1) Closing a section of Tutela Heights Road between Mount Pleasant Road and Cockshutt Road will not create any significant impact on the road network serving the Tutela Heights Settlement Area. The impact on through traffic will be minimal, and local traffic at present can be served by the intersection at Mount Pleasant Road at satisfactory Levels-of-Service. The intersection at Cockshutt Road will function primarily as a Tee intersection.

2) Future developments in the vicinity of Mount Pleasant Road or Cockshutt Road could potentially be served by the respective intersections with appropriate modifications as required.

3) Existing and future traffic volumes on Tutela Heights Road do not warrant a new road alignment to address the impacts of disconnecting Tutela Heights Road. This does not preclude considering new road alignments in the Tutela Heights Settlement Area to accommodate future growth and development needs.

4) The timing of road closure will be guided by the monitoring of the stability of the abutting slope area. Alternative access to properties outside the EHL limit would need to be provided prior to road closing.

5) The existing watermain and underground utilities should be relocated to a new easement outside the EHL limit.

6) The existing system of storm sewers and catch basins out-letting to the affected slope area has been identified as a concern for slope protection in Geotechnical studies undertaken as part of this EA Study and previously. An alternative storm sewer system should be provided to divert runoff from Tutela Heights Road and abutting properties from out-letting to the slope area.

APPENDIX B

Environmental Investigations Summary

Parsons Inc.

September 2015

PARSONS

Memorandum

To: Rajan Philips
Copy: Tisha Doucette; Julie Scott
From: Will Van Hemessen

Date: October 5, 2015
Project:

Re: Tutela Heights Road Environmental Assessment – September 30th Environmental Investigations Summary

The following memo summarizes the results of preliminary environmental investigations for the Tutela Heights Road environmental assessment (EA). This memo replaces the memo dated September 12th, 2015. An additional memo will be prepared following the receipt of background information and comments from the Grand River Conservation Authority (GRCA) and Ministry of Natural Resources and Forestry (MNRF).

Initial field investigations were conducted on September 9th, 2015. Following these investigations, the environmental study area was expanded and additional field work was conducted on September 30th to capture environmental conditions in the additional areas. The study area is located in the County of Brant and includes an area of approximately 0.6 square kilometers bounded by Tutela Heights Road to the north, Phelps Road to the south, Davern Road to the west, and a county-owned right-of-way (ROW) to the east (see Map 1 in Appendix A). The proposed work includes the potential realignment of Tutela Heights Road southwards away from the slope above the Grand River and potential construction of a new bypass road between Tutela Heights Road and Phelps Road. Environmental investigations included collection of background materials related to environmental features located in the study area; review of species at risk that have the potential to occur in the area; and field work to determine existing conditions. The results of these investigations are summarized below. A photographic record of field investigations can be found in Appendix D.

Existing Conditions

Vegetation

Vegetation communities were mapped based on orthoimagery and characterized in the field using the Ecological Land Classification (ELC) system for Southern Ontario (see Map 2 in Appendix A). These vegetation communities are described below. A full list of plant species identified during field investigations can be found in Appendix B.

Cultural Meadow (CUM1)

Cultural meadow is the dominant vegetation community throughout the study area. This vegetation community is generally dominated by grasses and forbs such as Field Brome, Reed Canary Grass, and Canada Goldenrod. A variety of native species such as Asters and Milkweeds are abundant.

Cultural Thicket (CUT1)

The county-owned ROW is primarily a cultural meadow succeeding in places towards a cultural thicket community. Areas of cultural thicket are dominated by Staghorn Sumac, Russian Olive, Manitoba Maple, and Black Oak. The understory in these areas consists mainly of Canada Goldenrod. Other species present in thickets included Slippery Elm, Black Cherry, Eastern Redcedar, and Shagbark Hickory.

There is also a small area of cultural thicket located to the north of Tutela Heights Road. This area of thicket is dominated by Black Locust.

White Pine Coniferous Plantation (CUP3-2)

There is a mature Eastern White Pine plantation located immediately to the north of Tutela Heights Road. This vegetation community is composed almost entirely of Eastern White Pine with sparse groundcover.

Mineral Cultural Woodland (CUW1)

There are large areas of cultural woodland throughout the study area. The largest area is located at roughly the centre of the study area. It is notable that this vegetation unit surrounds an abandoned homestead which may have cultural value. This is discussed in more detail below. This vegetation community is dominated by Black Walnut and the understory consists of Canada Goldenrod, Field Brome, and Asters.

Small areas of cultural woodland at the far southwestern and northeastern corners of the study area are dominated by Black Walnut with scattered other trees such as Northern Catalpa, Sycamore, Eastern Cottonwood, Redbud, and Northern Hackberry. The understory in these areas consists mainly of Canada Goldenrod and Asters.

Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)

There are small areas of oak-hickory forest located in the southeastern corner of the study area. This vegetation community is dominated by Red Oak, Black Oak, and Shagbark Hickory. Other species such as Sugar Maple, Basswood, and Hop-hornbeam are also present. Groundcover is composed of common forest species such as Zig-zag Goldenrod, Bloodroot, and False Solomon's-seal. There are some very large Red Oaks and Black Oaks with diameters of over 80 centimetres.

Fresh-Moist Black Walnut Lowland Deciduous Forest (FOD7-4)

This vegetation community is located at the eastern end of the study area behind the Black Walnut-dominated cultural woodland (CUW1). It is dominated by Black Walnut with occasional Northern Hackberries.

Dry Oak-Pine Mixed Forest (FOM1)

The area to the north of Tutela Heights Road at the eastern end of the study area consists of mixed forest with abundant Eastern White Pine, White Oak, Red Oak, and Black Oak. There is a high diversity of tree species in this area and there are several large trees located in close

proximity to the road. The area could potentially be considered "old growth" as most trees fall into a large size class. Groundcover is composed of common forest species but there are also a number of weedy roadside species owing to its location immediately adjacent to the road.

Hedgerows (HED)

There are numerous hedgerows throughout the study area, mainly located within agricultural fields and along roadsides. Hedgerows composed of Black Walnut, Oaks, Hickories, and Northern Catalpa were identified in the study area. Two provincially rare tree species were identified in hedgerows in the study area: Northern Pin Oak and Pignut Hickory. Many hedgerows contain large, old-growth trees.

Mineral Meadow Marsh (MAM2)

There are large areas of mineral meadow marsh throughout the study area, mainly following the intermittent watercourse and low-lying swales in agricultural fields. These areas are dominated by Reed Canary Grass and Broad-leaved Cattail with few other species present. There was no standing water present in September, 2015, but the areas are almost certainly flooded in the spring and early summer.

Willow Mineral Thicket Swamp (SWT2-2)

There is a small area of willow mineral thicket swamp located along the intermittent watercourse in the southeastern corner of the study area. This vegetation community is dominated by Willow species and other shrubs such as Grey Dogwood and Silky Dogwood.

Silky Dogwood Mineral Thicket Swamp (SWT2-8)

This very small vegetation community is located along a stream which runs through the north-south ROW. Silky Dogwood is the most abundant species but Ninebark also occurs quite frequently along with Black Ash and Manitoba Maple. Groundcover consists mainly of Spotted Jewelweed, Currants, and Sedges. Note that this is a provincially rare vegetation community with a provincial conservation status of S3S4.

Other

Other vegetation in the study area includes agricultural fields (soy), horse pasture, mowed lawns and gardens. These areas are generally actively managed by humans and highly disturbed and therefore contain little natural vegetation.

Significant Wildlife Habitat

A variety of significant wildlife habitat was identified in the study area during field investigations (Map 3 in Appendix A). These are summarized below.

Amphibian Breeding Habitat

Amphibian breeding habitat consists of areas that amphibian species such as frogs, toads, and salamanders use for breeding. Any wet areas are potentially amphibian breeding habitat

and therefore all wetland vegetation communities are considered potential habitat at this time. Because field surveys were conducted late in the season, only one amphibian species, American Toad, was observed in the study area.

Snake Hibernacula

A notable observation during field investigations was the presence of a group of abandoned structures located at roughly the centre of the study area. There are two abandoned buildings and a variety of abandoned vehicles and other items scattered throughout this area. Abandoned buildings, vehicles, and other objects often provide winter shelter for snakes and other wildlife. Therefore, these objects were classified as potential snake hibernacula and it is recommended that they not be disturbed, particularly because a snake species at risk, Eastern Milksnake, may occur in the area.

Deer Bedding Areas

Deer bedding areas are locations where deer have laid down to rest. They can indicate areas where deer feed and congregate and can also help to identify major wildlife movement corridors. They are recognizable by an area where grasses and other vegetation has been pushed down along with other evidence such as tracks and scat. Deer bedding areas were observed at two locations in the study area. In one instance, a White-tailed Deer was directly observed lying down and was subsequently frightened away by the observer.

Old-growth Trees

A number of very large trees are present in the study area. Some individuals with diameters around 100 cm were observed and are likely well over 100 years old. These trees are valuable as habitat for birds and other wildlife. Tree cavities, for example, can provide shelter for wildlife such as Raccoons, Bats, and cavity-nesting birds. Large trees probably also have cultural value for area residents.

Wildlife Movement Corridors

The county-owned ROW is probably a significant corridor for wildlife movement between the forests along the Grand River and natural areas to the south. The use of this area by wildlife is evidenced by the presence of White-tailed Deer. The wetlands along the watercourse in the southern section of the study area are probably also used by wildlife. Hedgerows can also be considered wildlife corridors.

Tutela Heights Road and other roads in the study area are obstacles to wildlife movement as evidenced by the dead Raccoon observed during field work.

Migratory Birds

Field surveys were carried out late in the field season in September, 2015. This was after the typical bird nesting season which runs from April 1st to August 31st, therefore many birds had already migrated south and it was not possible to produce a comprehensive list of bird species that occur in the area.

There are a variety of habitats throughout the study area that could be used by nesting birds. Cattail and grass marshes could be used by birds such as Red-winged Blackbird, while meadows and other open areas are potential habitat for species at risk such as Eastern Meadowlark and Bobolink. Wild Turkeys were observed in the study area in September, 2015, and there is a variety of habitat present where this species could nest. Large trees are important nesting habitat for a variety of birds.

An abandoned building located roughly at the centre of the study area is potentially nesting habitat for Barn Swallow, a species at risk in Ontario. This structure was not checked for nests during field work in September, 2015, due to safety concerns. However, an inspection of this structure for Barn Swallow nests may be advisable if the preferred alignment of the potential bypass road would affect the structure.

Twelve bird species were observed during field investigations in September, 2015, and these are listed in Appendix B.

Other Wildlife

Other wildlife observed during field investigations included Eastern Chipmunk, Eastern Gray Squirrel, and White-tailed Deer. A dead Raccoon was found along the south side of Tutela Heights Road. Several species of Lepidoptera were also seen, including Monarch and Question Mark. Monarchs lay eggs and feed on Milkweed plants while Question Marks feed on plants in the Nettle and Elm families. Food plants for both species are abundant throughout the study area.

The only amphibian seen in the study area during field investigations was American Toad. However, because field investigations were carried out relatively late in the season, it is probable that other reptiles and amphibians are present in the area at other times of year.

Designated Areas and Features

Wetlands in the southeastern section of the study area are listed as significant wetlands in the County of Brant Official Plan. These wetlands include Meadow Marsh, Willow Thicket Swamp, and Silky Dogwood Thicket Swamp.

There are some very large trees located throughout the study area, particularly in hedgerows and in the area of Oak-Hickory forest. These trees can be considered heritage trees due to their age, value as wildlife habitat, and probable cultural value for area residents. Exceptionally large trees in the study area include White Oak, Red Oak, Black Oak, and Shagbark Hickory.

The Bell Homestead National Historic Site is located to the west of the study area.

Species at Risk

Parsons reviewed existing Species at Risk (SAR) occurrence records for the area using the MNRF's Natural Heritage Information Centre (NHIC) online mapping and information service. The full list of SAR with occurrence records for the study area can be found in Appendix C. Additional SAR (Eastern Meadowlark, Bobolink, and Barn Swallow) were also determined to potentially occur in the area due to the presence of suitable habitat.

Eastern Milksnake

Eastern Milksnake is listed as 'Special Concern' in Ontario and lives in a wide range of habitats including farmlands, meadows and open woodland. Much of the study area can be considered suitable habitat for this species and there are recent occurrences of the species nearby. In particular, the group of abandoned buildings and other items located at the centre of the study area could provide hibernacula for this species. Therefore, Eastern Milksnake should be assumed to occur in the area and mitigation strategies developed accordingly. Note that because Eastern Milksnake is listed as 'Special Concern', it does not receive the same regulatory protection under the *Endangered Species Act* (ESA) as species listed as 'Threatened' or 'Endangered'. Nonetheless, mitigation measures to prevent impacts to this species are highly recommended.

Eastern Meadowlark, Bobolink

Eastern Meadowlark and Bobolink are bird species which are listed as Threatened in Ontario. These species share similar habitat affinities and therefore are both discussed here. The county-owned ROW represents a large area of meadow habitat which is potentially nesting habitat for Eastern Meadowlark and Bobolink. Neither of these species was observed during field investigations but this may have been due to the late timing of surveys.

Barn Swallow

Barn Swallow is a species of bird which is listed as Threatened in Ontario. These birds nest almost exclusively in human-made structures, such as barns, sheds, garages, or other buildings which are open to the exterior. An abandoned structure located in the centre of the study area was noted as being potential nesting habitat for Barn Swallow. The building was not inspected for nests due to safety concerns, but it is conceivable that Barn Swallows could nest there.

Provincially Rare Species

Provincially rare species (species that have a provincial conservation status rank of S3 or lower) are considered species of conservation concern. These species receive no regulatory protection but are still considered significant.

Northern Pin Oak

Northern Pin Oak is a species of tree with a provincial conservation status rank of S3. A large oak located along a hedgerow in the northeastern section of the study area was identified as Northern Pin Oak. This tree should be retained due to its ecological significance and because it is located directly behind a residential property and likely has aesthetic importance for area residents.

Pignut Hickory

Pignut Hickory is a species of tree with a provincial conservation status rank of S3. Three large Pignut Hickories were identified in the study area. Two are located along Tutela Heights Road and one is located in a hedgerow in the southeastern corner of the study area. These

trees should be retained due to their ecological significance and because they likely have cultural significance for area residents.

Fish & Fish Habitat

There is an intermittent watercourse in the study area which was dry in September, 2015. However, the watercourse is visible as a well-defined channel and probably provides fish habitat at certain times of year. Swales through agricultural fields can also provide seasonal fish habitat. It is recommended that fisheries assessments of watercourses in the study area be conducted in the spring of 2016 to determine if fish are present. Local regulatory agencies have been contacted for information pertaining to fish and fish habitat in the area and an additional memo will be prepared once their comments have been received.

Cultural Heritage Features

In addition to the environmental features identified in the study area, a number of features which may have cultural significance were noted during field investigations in September, 2015 (see Map 4 in Appendix A). Most notably, a collection of abandoned structures is present at roughly the centre of the study area and may be the remains of an old homestead. Two of these structures are visible only as stone and cement foundations while one wooden structure remains standing but is highly decayed. These structures were not inspected closely due to safety concerns. The history of these structures is unknown at this time.

Old-growth trees and hedgerows can also have cultural heritage value. A number of trees in the area are likely well over 100 years old and several exceptionally large trees may be over 200 years old which would make them older than European settlement of the area. These trees should be retained if possible.

The Bell Homestead National Historic Site is located to the northwest of the study area.

Preliminary Assessment of Impacts

Specific information about the potential realignment of Tutela Heights Road and potential alignment of the new bypass road is unavailable at this time. Therefore, it is not possible to determine all potential impacts of this project. A preliminary assessment of potential impacts based on current information is presented below.

Removal of Vegetation

Because this study was conducted late in the season, it was not possible to develop a comprehensive list of plant species which occur in the study area. Given the relatively large areas of vegetation that could be impacted by realignment of the existing road or construction of a new bypass road, it is recommended that more detailed vegetation studies be conducted once the proposed road alignments are finalized. These studies should be conducted in the spring and mid-summer in order to capture as many species as possible.

Construction of a new bypass road will require removal of trees and other vegetation regardless of the final alignment of the road. Realignment of Tutela Heights Road also has the potential to affect several large trees. Of particular concern are old-growth trees and

provincially rare trees (Pignut Hickory and Northern Pin Oak). These trees should be retained if possible because of their ecological and cultural value. A restoration and planting plan may need to be developed in order to compensate for vegetation losses, particularly if natural vegetation communities (i.e. forests and wetlands) are impacted. Note also that any removal of vegetation can impact bird nesting habitat and therefore should be completed outside of the bird nesting season (April 1st to August 31st).

Impacts to Nesting Birds

As with vegetation, because this study was conducted late in the season, it was not possible to develop a comprehensive list of bird species which occur in the study area. Given the relatively large amount of vegetation, and therefore bird nesting habitat, which would be impacted by realignment of the existing road and construction of a new bypass road, it is recommended that more detailed migratory bird studies be conducted once the proposed road alignments are finalized. These studies will need to be conducted in the spring or early summer when birds are nesting and are at their most active.

The *Migratory Birds Convention Act* prohibits the killing or destruction of birds and active bird nests. Any vegetation can be considered suitable nesting habitat for birds, and any removal of vegetation has the potential to damage existing bird nests. For this reason, removal of vegetation should be conducted outside of the bird nesting season (April 1st to August 31st).

General Impacts to Wildlife

Construction of a new bypass road would create a new barrier to wildlife movement in the area regardless of the final alignment of the road. However, these impacts can be minimized by avoiding key movement corridors, through passive measures such as signage for motorists, and potentially through more advanced measures such as constructing culverts and other passages to allow wildlife to safely travel beneath the road. More specific mitigation measures for minimizing impacts to wildlife movement can be recommended once the proposed road alignments are finalized.

Mitigation measures to prevent impacts to wildlife during construction should also be implemented. Wildlife commonly strays into work areas. This can include smaller animals such as frogs, snakes, and small mammals, but larger animals such as deer or turtles have also been known to wander into construction areas. In general, any wildlife that is observed in work areas should be allowed to leave without being harmed or harassed. If animals are observed in proximity to construction equipment or activities, work in the vicinity should stop until the animal has vacated the area or until a qualified individual provides direction on how to proceed.

Impacts to Snakes

Because there is potential for Eastern Milksnake and other snake species to occur in the area, it is recommended that mitigation measures to prevent harm to snakes be implemented. In particular, the group of abandoned structures at the centre of the study area is potentially an important snake refuge. This area should be avoided by the proposed bypass road and should be made off limits during construction.

During construction, snakes could potentially seek refuge underneath or inside vehicles and other equipment and could stray into active construction areas. Snake exclusion fencing is recommended to be installed around construction areas, laydown areas, and other areas of activity. ESC fencing can be used for this purpose but should be installed in a way that directs snakes away from activity areas. More specific recommendations on the placement and installation of snake protection fencing can be provided once the proposed road alignments are finalized.

Impacts to Amphibian Breeding Habitat

There are a variety of low, wet areas in the study area which can be considered amphibian breeding habitat. These generally consist of watercourses and swales in agricultural fields. Culverts of appropriate size should be constructed where the proposed bypass road crosses these areas. Filling in these areas is highly discouraged. Construction in these areas should be completed later in the season when they are dry in order to prevent impacts to breeding amphibians.

Species at Risk

Because of the potential that Eastern Milksnake occurs in the study area, snake protection measures as outlined previously are recommended. Because it is listed as 'Special Concern', these snakes and their habitat do not receive the same regulatory protection under the ESA as 'Threatened' or 'Endangered' species. However, it is still recommended that mitigation measures be implemented.

Impacts to Old-growth and Provincially Rare Trees

Old-growth trees throughout the study area are significant both as wildlife habitat and because they likely have cultural value for area residents. Exceptionally large trees should be retained and protected during construction.

Two provincially rare trees are present in the study area – Pignut Hickory and Northern Pin Oak. These trees should be retained due to their ecological value and because they likely have cultural value to area residents.

Fish & Fish Habitat

As discussed previously, there is potential for the intermittent watercourse and agricultural swales in the area to provide seasonal fish habitat. Fisheries assessments should be conducted in these areas in the spring of 2016. Local regulatory agencies have been contacted for information pertaining to fish and fish habitat in the area and an additional memo will be prepared once their comments have been received.

Erosion and Sediment Control

During construction, exposed soil will be vulnerable to erosion until vegetation is re-established. Mitigation measures will be necessary in order to prevent sediment from flowing into watercourses and impacting downstream habitats. The Grand River, located to the north and east of the study area, is highly sensitive because it is considered critical habitat for a number of aquatic SAR by the Department of Fisheries and Oceans (DFO). Because all

watercourses in the project area flow into the Grand River, any sediment that is allowed to enter watercourses has the potential to impact sensitive habitats. Therefore, erosion and sediment control (ESC) measures should be implemented during construction as required. The purpose of ESC measures is stop the flow of sediment and direct it away from watercourses and sensitive habitats. More specific recommendations for ESC measures will be provided as the project develops.

Construction Noise and Materials

Construction noise has the potential to impact birds and other wildlife at any time of year. Noise impacts to birds and other wildlife are generally not significant as long as noise levels are temporary and kept within reasonable limits. In order to minimize noise, it is recommended that idling of construction vehicles and other equipment be avoided. Vehicles and equipment should also be kept properly maintained in order to reduce excess noise. The presence of deleterious substances associated with construction equipment (e.g. gasoline, oil, other fuels) is unavoidable. These materials can have a variety of toxic and damaging effects on the natural environment.

Memo prepared by:

Will Van Hemessen
Environmental Scientist
Parsons

Appendix A

-

Maps

Legend

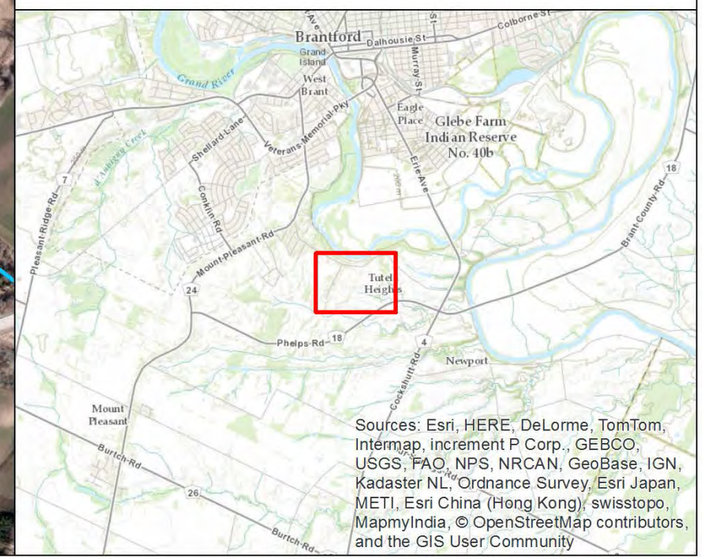
- Environmental Study Area
- Wetlands
- Roads
- Watercourses

1 centimeter = 44 meters

0 75 150 300 Meters

N

Parsons Job #



Map created by Will Van Hemessen
1069 Wellington Rd S Suite 214
London, ON N6E 2H6

Data Source: Parsons Inc, Ontario Ministry of Natural Resources and Forestry; ESRI Canada

Map 1: Environmental Study Area

PARSONS

Legend

Environmental Study Area
Vegetation Communities
Wetlands
Roads
Watercourses

CUM1	Cultural Meadow
CUP3-2	White Pine Coniferous Plantation
CUT1	Cultural Thicket
CUW1	Cultural Woodland
FOD2-2	Dry-Fresh Oak-Hickory Deciduous Forest
FOD7-4	Fresh-Moist Black Walnut Lowland Deciduous Forest
FOM1	Dry Oak-Pine Mixed Forest
HED-c	Catalpa Hedgerow
HED-h	Hickory Hedgerow
HED-o	Oak Hedgerow
HED-w	Black Walnut Hedgerow
HED-wo	Black Walnut-Oak Hedgerow
MAM2	Mineral Meadow Marsh
MAM2-1	Reed Canary Grass Mineral Meadow Marsh
SWT2-2	Willow Mineral Thicket Swamp
SWT2-8	Silky Dogwood Mineral Thicket Swamp

1 centimeter = 44 meters

0 75 150 300 Meters

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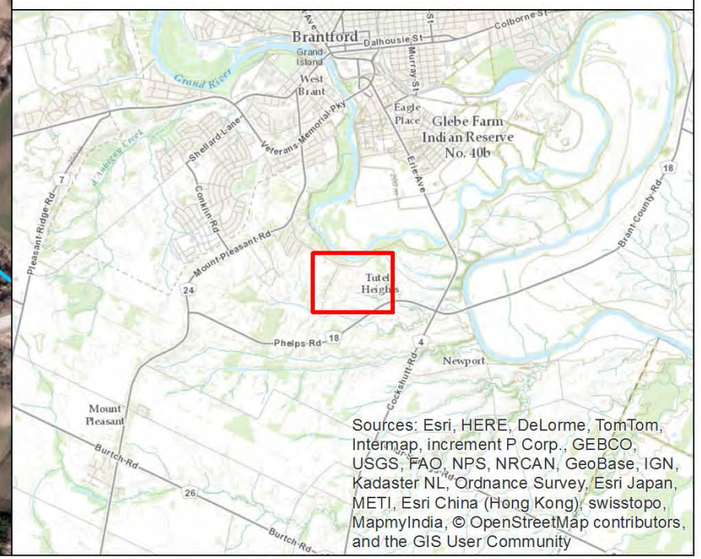
Parsons Job #



Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Map created by Will Van Hemessen
1069 Wellington Rd S Suite 214
London, ON N6E 2H6

Data Source: Parsons Inc, Ontario Ministry of Natural Resources and Forestry; ESRI Canada

Map 2: Vegetation Communities

PARSONS

Grand River

TUTELA HEIGHTS

DAYTON ROAD

PHELPS ROAD

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- Environmental Study Area
- Wetlands
- Roads
- Watercourses

Significant Wildlife Habitat

- Rare Vegetation Community
- Amphibian Breeding Habitat
- Old-growth Hedgerows
- Snake Hibernaculum
- Deer Bedding Area

Provincially Rare Trees

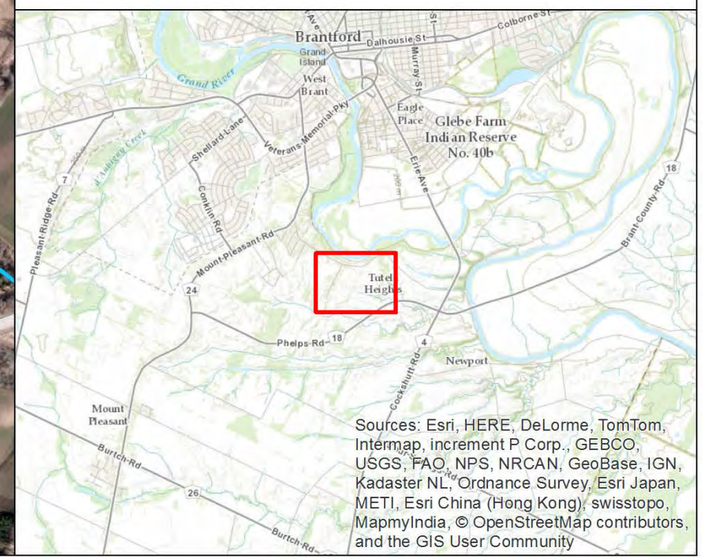
- Northern Pin Oak
- Pignut Hickory

1 centimeter = 44 meters

0 75 150 300 Meters

N

Parsons Job #



Map created by Will Van Hemessen
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Data Source: Parsons Inc, Ontario Ministry of Natural Resources and Forestry; ESRI Canada

Map 3: Significant Wildlife Habitat

PARSONS

Legend

- Environmental Study Area
- Wetlands
- Roads
- Watercourses

Cultural Heritage Features

- Bell Homestead National Historic Site
- Abandoned Structures
- Old-growth Hedgerows

Provincially Rare Trees

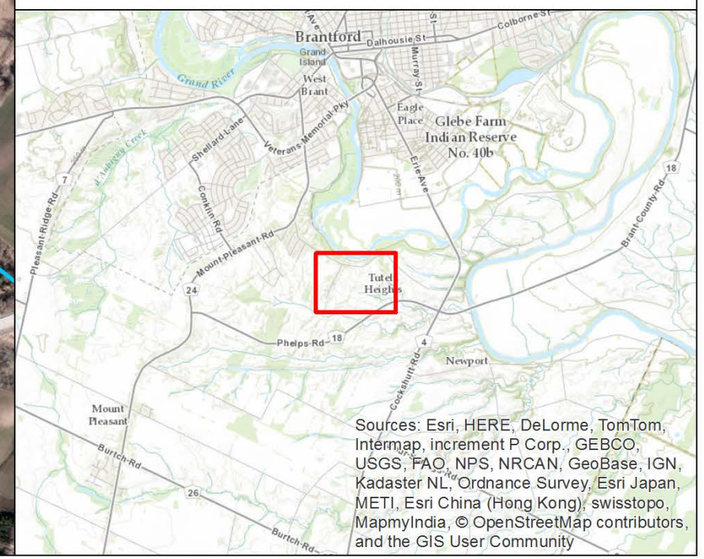
- Northern Pin Oak
- Pignut Hickory

1 centimeter = 44 meters

0 75 150 300 Meters

N

Parsons Job #



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Data Source: Parsons Inc, Ontario Ministry of Natural Resources and Forestry; ESRI Canada

Map 4: Cultural Heritage Features

PARSONS

Appendix B
-
Plant Species List

Definitions

S-Rank – An indicator of provincial rarity based on the estimated number of species occurrences, the estimated community extent, and the estimated range of the community within the province. S-Rank does not necessarily indicate protected status under provincial or federal SAR legislation.

S1: Extremely rare in Ontario; usually 5 or fewer occurrences in the province, or very few remaining hectares

S2: very rare in Ontario; usually between 5 and 20 occurrences in the province, or few remaining hectares

S3: Rare to uncommon in Ontario; usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with some extensive examples remaining

S4: Considered common in Ontario; denotes a species that is generally secure, with over 100 occurrences in the province

S5: Widespread in Ontario; demonstrably secure in the province.

SNA: No rarity ranking applies; typically associated with non-native species.

SARA/ESA Status – Species that are listed on the schedules of the federal Species at Risk Act (SARA) or the Ontario Endangered Species Act (ESA) are protected by these pieces of legislation, as are their habitats.

END: Endangered
THR: Threatened
SC: Special Concern

Plants

Scientific Name	Common Name	Exotic	Status	Comments
Cultural Meadow (CUM1)/Cultural Thicket (CUT1)/Cultural Woodland (CUW1)				
Acer negundo	Manitoba Maple	N	S5	
Acer rubrum	Red Maple	N	S5	
Acer saccharum	Sugar Maple	N	S5	
Aesculus hippocastanea	Horsechestnut	Y	SNA	
Ambrosia trifida	Giant Ragweed	N	S5	
Asclepias syriacus	Common Milkweed	N	S5	
Asparagus officinalis	Asparagus	Y	SNA	
Bromus arvensis	Field Brome	Y	SNA	
Bromus inermis	Smooth Brome	Y	SNA	
Carya ovata	Shagbark Hickory	N	S5	
Catalpa bignonioides	Northern Catalpa	Y	SNA	
Celtis occidentalis	Northern Hackberry	N	S5	Two very old trees next to Tutela Heights Road
Centaurea sp.	unidentified knapweed	Y	SNA	
Cercis canadensis	Redbud	N	SX	Planted specimens
Cirsium arvense	Canada Thistle	Y	SNA	
Clematis virginiana	Virgin's-bower	N	S5	
Conium maculatum	Poison Hemlock	Y	SNA	
Cornus sericea	Red-osier Dogwood	N	S5	
Daucus carota	Wild Carrot	Y	SNA	
Dipsacus fullonum	Teasel	Y	SNA	
Echinocystis lobata	Wild Cucumber	N	S5	
Elaeagnus angustifolia	Russian Olive	Y	SNA	
Euthamia graminifolia	Grass-leaved Goldentop	N	S5	
Fragaria virginiana	Field Strawberry	N	S5	
Fraxinus pennsylvanica	Green Ash	N	S4	
Juglans nigra	Black Walnut	N	S5	Dominant in CUW
Juniperus virginiana	Eastern Redcedar	N	S5	
Lonicera maackii	Amur Honeysuckle	Y	SNA	
Lonicera tatarica	Tartarian Honeysuckle	Y	SNA	
Malus domestica	Apple	Y	SNA	
Melilotus alba	White Sweet-clover	Y	SNA	
Oenothera biennis	Biennial Evening-primrose	N	S5	
Parthenocissus vitacea	Woodbine	N	S5	
Phalaris arundinacea	Reed Canary Grass	N	S5	
Pinus strobus	Eastern White Pine	N	S5	
Platanus occidentalis	Sycamore	N	S4	
Populus deltoides	Eastern Cottonwood	N	S5	
Prunus serotina	Black Cherry	N	S5	
Prunus virginiana	Choke Cherry	N	S5	
Quercus rubra	Red Oak	N	S5	

Scientific Name	Common Name	Exotic	Status	Comments
Quercus velutina	Black Oak	N	S5	
Ranunculus acris	Field Buttercup	Y	SNA	
Rhamnus cathartica	European Buckthorn	Y	SNA	
Rhus typhina	Staghorn Sumac	N	S5	
Robinia pseudoacacia	Black Locust	Y	SNA	
Rubus idaeus	Red Raspberry	N	SNA	
Solanum dulcamara	Bittersweet Nightshade	Y	SNA	
Solidago Canadensis	Canada Goldenrod	N	S5	
Solidago nemoralis	Grey Goldenrod	N	S5	
Sonchus arvensis	Sow Thistle	Y	SNA	
Symphyotrichum cordifolium	Heart-leaved Aster	N	S5	
Symphyotrichum ericoides	Heath Aster	N	S5	
Symphyotrichum leave	Smooth Aster	N	S5	
Symphyotrichum lanceolatum	Panicled Aster	N	S5	
Symphyotrichum lateriflorum	Calico Aster	N	S5	
Symphyotrichum novae-angliae	New England Aster	N	S5	
Symphyotrichum oolentangiense	Sky Blue Aster	N	S4	In county-owned ROW near Tutela Heights Road
Symphyotrichum puniceum	Purple-stemmed Aster	N	S5	
Tanacetum vulgare	Tansy	Y	SNA	
Tilia americana	Basswood	N	S5	
Toxicodendron radicans	Poison Ivy	N	S5	
Ulmus rubra	Slippery Elm	N	S5	
Verbena stricta	Hoary Vervain	N	S4	
Verbena urticifolia	White Vervain	N	S5	
Vicia cracca	Cow Vetch	Y	SNA	
Vitis riparia	Riverbank Grape	N	S5	
Zanthoxylum americanum	Northern Prickly-ash	N	S5	
Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)				
Acer saccharum	Sugar Maple	N	S5	
Carya ovata	Shagbark Hickory	N	S5	
Cornus alternifolia	Alternate-leaved Dogwood	N	S5	
Cornus racemosa	Grey Dogwood	N	S5	
Crataegus sp.	Hawthorn			
Geranium maculatum	Spotted Geranium	N	S5	
Geum aleppicum	Spring Avens	N	S5	
Geum laciniatum	Slashed Avens	N	S5	
Maianthemum racemosum	False Solomon's-seal	N	S5	
Muehlenbergia frondosa	Tufted Muhly	N	S5	
Ostrya virginiana	Hop-hornbeam	N	S5	
Parthenocissus vitacea	Virginia-creeper	N	S5	
Prunus serotina	Black Cherry	N	S5	
Prunus virginiana	Choke Cherry	N	S5	
Quercus alba	White Oak	N	S5	

Scientific Name	Common Name	Exotic	Status	Comments
Quercus rubra	Red Oak	N	S5	
Quercus velutina	Black Oak	N	S5	
Ribes americanum	American Red Currant	N	S5	
Rosa sp.	Rose			
Sanguinaria canadensis	Bloodroot	N	S5	
Sicyos angulatus	Bur Cucumber	N	S5	
Solidago flexicaulis	Zig-zag Goldenrod	N	S5	
Symphyotrichum lateriflorum	Calico Aster	N	S5	
Thalictrum dioicum	Early Meadowrue	N	S5	
Tilia americana	Basswood	N	S5	
Ulmus rubra	Slippery Elm	N	S5	
Viburnum trilobum	Cranberry Viburnum	N	S5	
Dry Oak-Pine Mixed Forest (FOM1)				
Acer negundo	Manitoba Maple	N	S5	
Acer saccharum	Sugar Maple	N	S5	
Carya ovata	Shagbark Hickory	N	S5	
Celtis occidentalis	Northern Hackberry	N	S5	
Cornus alternifolia	Alternate-leaved Dogwood	N	S5	
Cornus racemosa	Grey Dogwood	N	S5	
Corylus americana	American Hazel	N	S5	
Crataegus sp.	Unidentified Hawthorn			
Elaeagnus angustifolia	Russian Olive	Y	SNA	
Geranium maculatum	Spotted Geranium	N	S5	
Maianthemum racemosum	False Solomon's-seal	N	S5	
Parthenocissus vitacea	Virginia-creeper	N	S5	
Prunus serotina	Black Cherry	N	S5	
Prunus virginiana	Choke Cherry	N	S5	
Quercus alba	White Oak	N	S5	
Quercus rubra	Red Oak	N	S5	
Quercus velutina	Black Oak	N	S5	
Sicyos angulatus	Bur Cucumber	N	S5	
Solidago flexicaulis	Zig-zag Goldenrod	N	S5	
Symphyotrichum lateriflorum	Calico Aster	N	S5	
Tilia americana	Basswood	N	S5	
Ulmus rubra	Slippery Elm	N	S5	
Viburnum lentago	Nannyberry	N	S5	
Hedgerows (HED)				
Acer negundo	Manitoba Maple	N	S5	
Acer saccharum	Sugar Maple	N	S5	
Carya glabra	Pignut Hickory	N	S3	Provincially rare
Carya ovata	Shagbark Hickory	N	S5	
Catalpa bignonioides	Northern Catalpa	Y	SNA	
Celtis occidentalis	Northern Hackberry	N	S5	

Scientific Name	Common Name	Exotic	Status	Comments
Crataegus sp.	Unidentified Hawthorn			
Elaeagnus angustifolia	Russian Olive	Y	SNA	
Juglans nigra	Black Walnut	N	S5	
Malus domestica	Apple	Y	SNA	
Prunus serotina	Black Cherry	N	S5	
Quercus alba	White Oak	N	S5	Some very large trees
Quercus ellipsoidalis	Northern Pin Oak	N	S3	Provincially rare. Can be difficult to distinguish from Black Oak and can form hybrids with that species…need a lens and fresh acorns to identify with certainty but most features point to Northern Pin
Quercus rubra	Red Oak	N	S5	Some very large trees
Quercus velutina	Black Oak	N	S4	Some very large trees
Rhamnus cathartica	European Buckthorn	Y	SNA	
Mineral Meadow Marsh (MAM2)				
Carex lacustris	Lake Sedge	N	S5	
Euthamia graminifolia	Grass-leaved Goldentop	N	S5	
Phalaris arundiancea	Reed Canary Grass	N	S5	
Solidago canadensis	Canada Goldenrod	N	S5	
Symphyotrichum lanceolatum	Panicled Aster	N	S5	
Symphyotrichum puniceum	Purple-stemmed Aster	N	S5	
Typha latifolia	Broad-leaved Cattail	N	S5	
Verbena hastata	Blue Vervain	N	S5	
Verbena stricta	Hoary Vervain	N	S4	
Verbena urticifolia	White Vervain	N	S5	
Willow Mineral Thicket Swamp (SWT2-2)				
Acer negundo	Manitoba Maple	N	S5	
Cornus racemosa	Grey Dogwood	N	S5	
Echinocystis lobata	Wild Cucumber	N	S5	
Rhamnus cathartica	European Buckthorn	Y	SNA	
Salix eriocephala	Woolly-headed Willow	N	S5	
Salix purpurea	Basket Willow	Y	SNA	Dominant; non-native species suggests cultural origin of this community type
Silky Dogwood Mineral Thicket Swamp (SWT2-8)				
Acer negundo	Manitoba Maple	N	S5	
Cornus amomum	Silky Dogwood	N	S5	Just barely dominant over Ninebark
Equisetum palustre	Water Horsetail	N	S5	
Fraxinus nigra	Black Ash	N	S4	
Impatiens capensis	Spotted Jewelweed	N	S5	
Physocarpus opulifolius	Ninebark	N	S5	
Ranunculus pensylvanicus	Pennsylvania Buttercup	N	S5	
Ribes americana	American Red Currant	N	S5	
Ribes cynosbati	Prickly Gooseberry	N	S5	
Viburnum lentago	Nannyberry	N	S5	

Wildlife

Common Name	Scientific Name	Status	Comments
Birds			
Corvus brachyrhynchos	American Crow	S5B	
Carduelis tristis	American Goldfinch	S5B	
Icterus galbula	Baltimore Oriole	S4B	
Poecile atricapillus	Black-capped Chickadee	S5	
Cyanocitta cristata	Blue Jay	S5	
Bombycilla cedrorum	Cedar Waxwing	S5B	
Geothlypis trichas	Common Yellowthroat	S5B	In buckthorn shrubs near MAM2
Picoides pubescens	Downy Woodpecker	S5	
Sturnus vulgaris	European Starling	SNA	
Picoides villosus	Hairy Woodpecker	S5	
Melospiza melodia	Song Sparrow	S5B	
Cathartes aura	Turkey Vulture	S5B	Flying above study area
Meleagris gallopavo	Wild Turkey	S5	Along hedgerow in southern part of study area
Mammals			
Tamias striatus	Eastern Chipmunk	S5	In oak-hickory forest
Sciurus carolinensis	Eastern Gray Squirrel	S5	Only seen in residential areas
Procyon lotor	Raccoon	S5	Dead on shoulder of Tutela Heights Road
Odocoileus virginianus	White-tailed Deer	S5	One was lying down in county-owned ROW and was scared away
Reptiles & Amphibians			
Bufo americanus	American Toad	S5	In oak-hickory woods near intermittent watercourse
Lepidoptera			
Danaus plexippus	Monarch	SC, S3	In county-owned ROW; host plants (Milkweed) are abundant throughout study area
Polygonia interrogationis	Question Mark	S5	Edge of oak-hickory woods; host plants (Ulmaceae, Urticaceae) are abundant throughout study area.

Appendix C
-
Species at Risk Review

Definitions

Status:
S-Rank is an indicator of how common a species is in Ontario. **S1** means extremely rare, **S2** means very rare, **S3** means rare to uncommon, **S4** means common and **S5** means very common. Migratory birds may have a **B** or **N** appended to their rank to indicate whether the rank applies to their breeding or non-breeding (overwintering) range. A rank of **SNA** indicates that no rarity ranking is available, and is typically applied to non-native species.

Species that are Special Concern (**SC**), Threatened (**THR**) or Endangered (**END**) are protected by legislation at a national or provincial level.

PIF Status:
North America is divided into Bird Conservation Regions (BCRs). Southern Ontario lies in BCR 13. Partners in Flight [PIF] priority species for BCR 13 are those that are declining on a continental or regional scale and, yet at the same time, may still be relatively common in a given BCR. Priority levels are expressed as follows: **CC** (of Continental Concern); **RC** (of Regional Concern); **RS** (candidate for Regional Stewardship); and **MI** (of management interest).

Area Sensitive:
Area sensitive (**AS**) species are those that breed most successfully in large patches of their preferred breeding habitat.

***Conservation Priority*:**
Conservation Priority status for birds indicates a degree of "significance" within Dufferin County based on factors such as area sensitivity (Couturier, 1999). Level one (**CP1**) species have the highest priority, and level four (**CP4**) the lowest.

Species	Species	Status	Habitat Requirements	Discussion
NHIC 1km SquareS # 17MH6251				
Ammocrypta pellucida	Eastern Sand Darter	END, S2	Clear, fast moving watercourses with sandy bottoms.	The Grand River is listed as critical habitat by the DFO. However, this is outside the project study area.
Frasera caroliniensis	American Columbo	END, S2	Woodlands on sandy and clay soils.	Dated 1930 and is therefore a "historical" observation. Not observed in study area.
Lampropeltis triangulum	Eastern Milksnake	SC, S3	Farmlands, meadows, hardwood or aspen stands; pine forest with brushy or woody cover; river bottoms or bog woods; hides under logs, stones, or boards or in outbuildings; often uses communal nest sites.	Listed as "1984-Present" in NHIC database so probably still occurs here. The abandoned structures at the centre of the study area could provide important refuge habitat for this species.
Phegopteris hexagonoptera	Broad Beech Fern	SC, S3	Rich, moist soil in mature deciduous forests.	Dated 1977 and is therefore a "historical" observation. Requires larger areas of forest than are present in the study area.
Aureolaria pedicularia	Fern-leaved Yellow False-foxglove	S2?	Dry, open pine and oak woods and thickets; often on sand and along disturbed woodland margins; hosts frequently include woody species other than pines and oaks.	Dated 1888 and is therefore a "historical" observation. There is suitable habitat in the study area but this species was not observed during field surveys.
Lithospermum parviflorum	Soft-hairy False Gromwell	S2	Woods, fields, thickets, alvars; often on floodplains.	Dated 1864 and is therefore a "historical" observation. There is suitable habitat in the study area but this species was not observed during field surveys
Oenothera pilosella	Meadow Evening Primrose	S2	Moist edges of woods and waste ground, prairie.	Dated 1973 and is therefore a "historical" observation. There is suitable habitat in the study area but this species was not observed during field surveys.
Carya glabra	Pignut Hickory	S3	Dry to dry-mesic deciduous forests and savannahs.	Three large trees are located in the study area: two along Tutela Heights Road and one in a hedgerow in the southeastern corner of the study area.
Moxostoma valenciennesi	Greater Redhorse	S3	Large rivers in the Great Lakes watershed.	Dated 1995. Could occur in the Grand River but not within the study area.

Appendix A
-
Photographic Record

Tutela Heights Road Existing Conditions

Cultural Meadow/Cultural Thicket/Cultural Woodland


Left: *Cultural woodland dominated by Black Walnut at far northeastern corner of the study area;* ***Right:*** *Cultural woodland in the centre of the study area.*


Left: *Cultural woodland at the centre of the study area;* ***Right:*** *Cultural meadow at the centre of the study area.*


Left: *Cultural meadow in county-owned right-of-way;* ***Right:*** *Different view of the same.*

Dry-Fresh Oak-Hickory Deciduous Forest

Meadow Marsh

Left: *Typical naturalized swale dominated by Reed Canary Grass and Broad-leaved Cattail;* ***Right:*** *A small corrugated steel pipe (CSP) culvert in one of the swales.*

Willow Mineral Thicket Swamp

Silky Dogwood Mineral Thicket Swamp

Above: *View of the swamp showing well-defined intermittent stream channel.*

Cultural Heritage Features

Left: *Foundation of structure, possibly a house or barn;* ***Right:*** *Overgrown but still standing wooden structure*

Above: *Remains of another structure, possibly a silo.*

Provincially Rare Trees

Left: *Pignut Hickory in hedgerow at southeastern corner of study area;* ***Right:*** *Provincially rare Pignut Hickory located where the N-S corridor ROW meets Tutela Heights Road.*

APPENDIX C

Stage 1 Archaeological Assessment

Archaeological Research Associates Limited

September 2016

ARCHAEOLOGY | HERITAGE | OUTREACH | EDUCATION

Stage 1 Archaeological Assessment
Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment
Stewart & Ruggles Tract, Hiram Phelps Tract
Geographic Township of Brantford
Brant County

Prepared for
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&
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Licenced under
P.J. Racher, M.A., CAHP
MTCS Licence #P007
Project #P007-0707
PIF #P007-0707-2015

13/09/2016

Original Report

EXECUTIVE SUMMARY

Under a contract awarded by Parsons Inc. in September 2015, Archaeological Research Associates Ltd. carried out a Stage 1 archaeological assessment of lands with the potential to be impacted by the proposed Tutela Heights Road Slope Stability project in Brant County, Ontario. The purpose of the project is to review the slope stability along a section of Tutela Heights Road extending easterly from the Bell Homestead National Historic Site for approximately 1 km. A new road option may be considered through the farmlands bounded by Tutela Heights Road, a County-owned property, Phelps Road and Davern Road. This report documents the background research and fieldwork involved in the assessment, and presents conclusions and recommendations pertaining to archaeological concerns within the project lands. The assessment was completed as a component of a Municipal Class Environmental Assessment, in compliance with the *Environmental Assessment Act*.

The Stage 1 assessment was conducted in October 2015 under licence #P007, PIF #P007-0707-2015. At the time of assessment, the study area comprised a mixture of wooded areas, grassed areas, maintained lawns, agricultural fields, extant structures (e.g., residential housing), municipal roadways (i.e., Tutela Heights Road, Phelps Road and Davern Road) and various driveways/pathways. All field observations were made from accessible public lands; accordingly, no permissions were required for property access.

The Stage 1 assessment determined that the study area currently comprises a mixture of areas of archaeological potential and areas of no archaeological potential. Archaeological Research Associates Ltd. recommends that all identified areas of archaeological potential that could be impacted by the project be subject to a Stage 2 property assessment in advance of construction. The identified areas of no archaeological potential are not recommended for further assessment. It is requested that this report be entered into the *Ontario Public Register of Archaeological Reports*, as provided for in Section 65.1 of the *Ontario Heritage Act.*

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GLOSSARY OF ABBREVIATIONS

ARA – Archaeological Research Associates Ltd.
CHVI – Cultural Heritage Value or Interest
MTC – (Former) Ministry of Tourism and Culture
MTCS – Ministry of Tourism, Culture and Sport
PIF – Project Information Form
ROW – Right-of-Way
S&Gs – Standards and Guidelines for Consultant Archaeologists

PERSONNEL

Project Director: P.J. Racher, M.A. (#P007)
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Technical Writers: P. Epler (#R418), C.J. Gohm

1.0 PROJECT CONTEXT

1.1 Development Context

Under a contract awarded by Parsons Inc. in September 2015, ARA carried out a Stage 1 archaeological assessment of lands with the potential to be impacted by the proposed Tutela Heights Road Slope Stability project in Brant County, Ontario. The purpose of the project is to review the slope stability along a section of Tutela Heights Road extending easterly from the Bell Homestead National Historic Site for approximately 1 km. A new road option may be considered through the farmlands bounded by Tutela Heights Road, a County-owned property, Phelps Road and Davern Road. This report documents the background research and fieldwork involved in the assessment, and presents conclusions and recommendations pertaining to archaeological concerns within the project lands. The assessment was completed as a component of a Municipal Class Environmental Assessment, in compliance with the *Environmental Assessment Act*.

The subject study area consists of an irregularly-shaped 30.1 ha parcel located south of the City of Brantford in the central part of Brant County (see Map 1–Map 2). This parcel is bounded by the Grand River to the north, agricultural fields and wooded areas to the east, residential properties, agricultural fields, wooded areas and Phelps Road to the south, and residential properties, agricultural fields and wooded areas to the west. The northwestern part of the study area traverses part of the Bell Homestead National Historic Site. At the time of assessment, the study area comprised a mixture of wooded areas, grassed areas, maintained lawns, agricultural fields, extant structures (e.g., residential housing), municipal roadways (i.e., Tutela Heights Road, Phelps Road and Davern Road) and various driveways/pathways. In legal terms, the study area falls on part of the Stewart & Ruggles Tract and part of the Hiram Phelps Tract in the Geographic Township of Brantford.

The Stage 1 assessment was conducted in October 2015 under licence #P007, PIF #P007-0707-2015. The study area was subject to a property inspection, and a corpus of available satellite imagery, topographic mapping and digital environmental data also provided information concerning current land conditions. All field observations were made from accessible public lands; accordingly, no permissions were required for property access. In compliance with the objectives set out in Section 1.0 of the *S&Gs* (MTC 2011:13–23), this investigation was carried out in order to:

- Provide information concerning the geography, history, previous archaeological fieldwork and current land condition of the study area;
- Determine the presence of known archaeological sites in the study area;
- Present strategies to mitigate project impacts to such sites, if they are located;
- Evaluate in detail the archaeological potential of the study area; and
- Recommend appropriate strategies for Stage 2 archaeological assessment, if some or all of the study area has archaeological potential.

The assessment was conducted in accordance with the provisions of the *Ontario Heritage Act*, R.S.O. 1990, c. O.18. All notes, photographs and records pertaining to the project are stored at ARA's processing facility located at 154 Otonabee Drive, Kitchener. Subsequent long-term storage will occur at ARA's secure storage facility located in Ancaster. The MTCS is asked to review the results and recommendations presented in this report and express their satisfaction with the fieldwork and reporting through a *Letter of Review and Entry into the Ontario Public Register of Archaeological Reports*.

1.2 Historical Context

After a century of archaeological work in southern Ontario, scholarly understanding of the historic usage of lands in Brant County has become very well-developed. What follows is a detailed summary of the archaeological cultures that have settled in the vicinity of the study area over the past 11,000 years; from the earliest Palaeo-Indian hunters to the most recent Euro-Canadian farmers.

1.2.1 Pre-Contact

1.2.1.1 Palaeo-Indian Period

The first documented evidence of occupation in southern Ontario dates to around 9000 BC, after the retreat of the Wisconsinan glaciers and the formation of Lake Algonquin, Early Lake Erie and Early Lake Ontario (Karrow and Warner 1990; Jackson et al. 2000:416–419). At that time (or perhaps even earlier) small Palaeo-Indian bands moved into the region, leading mobile lives based on the communal hunting of large game and the collection of plant-based food resources (Ellis and Deller 1990:38; MCL 1997:34). Current understanding suggests that Palaeo-Indian peoples ranged over very wide territories in order to live sustainably in a post-glacial environment with low biotic productivity. This environment changed considerably during this period, developing from a sub-arctic spruce forest to a boreal forest dominated by pine (Ellis and Deller 1990:52–54, 60).

An Early Palaeo-Indian period (ca. 9000–8400 BC) and a Late Palaeo-Indian period (ca. 8400–7500 BC) are discernable amongst the lithic spear and dart points. Early points are characterized by grooves or 'flutes' near the base while the later examples lack such fluting. All types would have been used to hunt caribou and other 'big game'. Archaeological sites from both time-periods typically served as small campsites or 'way-stations' (occasionally with hearths or fire-pits), where tool manufacture/maintenance and hide processing would have taken place. For the most part, these sites tend to be small (less than 200 sq. m) and ephemeral (Ellis and Deller 1990:51–52, 60–62). Many parts of the Palaeo-Indian lifeway remain unknown.

1.2.1.2 Archaic Period

Beginning in the early 8th millennium BC, the biotic productivity of the environment began to increase as the climate warmed and southern Ontario was colonized by deciduous forests. This caused the fauna of the area to change as well, and ancient peoples developed new forms of tools and alternate hunting practices to better exploit both animal and plant-based food sources. These new archaeological cultures are referred to as 'Archaic'. Thousands of years of gradual change in

stone tool styles allows for the recognition of Early (7500–6000 BC), Middle (6000–2500 BC) and Late Archaic periods (2500–900 BC) (MCL 1997:34).

The Early and Middle Archaic periods are characterized by substantial increases in the number of archaeological sites and a growing diversity amongst stone tool types and exploited raw materials. Notable changes in Archaic assemblages include a shift to notched or stemmed projectile points, a growing prominence of net-sinkers (notched pebbles) and an increased reliance on artifacts like bone fish hooks and harpoons. In addition to these smaller items, archaeologists also begin to find evidence of more massive wood working tools such as ground stone axes and chisels (Ellis et al. 1990:65–67).

Towards the end of the Middle Archaic (ca. 3500 BC), the archaeological evidence suggests that populations were 1) increasing in size, 2) paying more attention to ritual activities, 3) engaging in long distance exchange (e.g. in items such as copper) and 4) becoming less mobile (Ellis et al. 1990:93; MCL 1997:34). Late Archaic peoples typically made use of shoreline/riverine sites located in rich environmental zones during the spring, summer and early fall, and moved further inland to deer hunting and fruit-gathering sites during late fall and winter (Ellis et al. 1990:114).

During the Late Archaic these developments continued, and new types of projectile points appeared along with the first true cemeteries. Excavations of burials from this time-frame indicate that human remains were often cremated and interred with numerous grave goods, including items such as projectile points, stone tools, red ochre, materials for fire-making kits, copper beads, bracelets, beaver incisors, and bear maxilla masks (Ellis et al. 1990:115–117). Interestingly, these true cemeteries may have been established in an attempt to solidify territorial claims, linking a given band or collection of bands to a specific geographic location.

From the tools unearthed at Archaic period sites it is clear that these people had an encyclopaedic understanding of the environment that they inhabited. The number and density of the sites that have been found suggest that the environment was exploited in a successful and sustainable way over a considerable period of time. The success of Archaic lifeways is attested to by clear evidence of steady population increases over time. Eventually, these increases set the stage for the final period of Pre-Contact occupation—the Woodland Period (Ellis et al. 1990:120).

1.2.1.3 Early and Middle Woodland Periods

The beginning of the Woodland period is primarily distinguished from the earlier Archaic by the widespread appearance of pottery. Although this difference stands out prominently amongst the archaeological remains, it is widely believed that hunting and gathering remained the primary subsistence strategy throughout the Early Woodland period (900–400 BC) and well into the Middle Woodland (400 BC–AD 600) and Middle to Late Woodland transition (AD 600–900). In addition to adopting ceramics, communities also grew in size during this period and participated in developed and widespread trade relations (Spence et al. 1990; MCL 1997:34).

The first peoples to adopt ceramics in the vicinity of the study area are associated with the Meadowood archaeological culture. This culture is characterized by distinctive Meadowood preforms, side-notched Meadowood points and Vinette 1 ceramics (thick and crude handmade pottery with cord-marked decoration). Meadowood peoples are believed to have been organized

in bands of roughly 35 people, and some of the best documented sites are fall camps geared towards the hunting of deer and the gathering of nuts (Spence et al. 1990:128–137).

Ceramic traditions continued to develop during the subsequent Middle Woodland period, and three distinct archaeological cultures emerged in southern Ontario: 'Point Peninsula' north and northeast of Lake Ontario, 'Couture' near Lake St. Clair and 'Saugeen' in the rest of southwestern Ontario (see Map 3). These cultures all shared a similar method of decorating pottery, using either dentate or pseudo-scallop shell stamp impressions, but they differed in terms of preferred vessel shape, zones of decoration and surface finish (Spence et al. 1990:142–43).

The local Saugeen complex, which appears to have extended from Lake Huron to as far east as the Humber River and the Niagara Peninsula, is characterized by stamped pottery, distinctive projectile points, cobble spall scrapers and a lifeway geared towards the exploitation of seasonally-available resources such as game, nuts and fish (Spence et al. 1990:147–156). Although relatively distant from the study area, the Donaldson site along the Saugeen River may be representative of a typical Saugeen settlement; it was occupied in the spring by multiple bands that came to exploit spawning fish and bury members who had died elsewhere during the year (Finlayson 1977:563–578). The archaeological remains from this site include post-holes, hearth pits, garbage-dumps (middens), cemeteries and even a few identifiable rectangular structures (Finlayson 1977:234–514).

During the Middle to Late Woodland transition (AD 600–900), major developments took place at the western end of Lake Ontario as maize (corn) horticulture was introduced and settled agriculturalists emerged (Fox 1990:171, Figure 6.1). This shift is linked to the development of the Princess Point complex, which is characterized by distinctively decorated ceramic vessels (combining cord roughening, impressed lines and punctuate designs), triangular projectile points, T-based drills, steatite and ceramic pipes and ground stone chisels and adzes (Fox 1990:174–188).

The Grand Banks site near Cayuga is one of the best known Princess Point sites, and a calibrated radiocarbon date of AD 406–586 indicates that it was home to the first maize horticulturalists in northeastern North America (Warrick 2000:427). Generally, Princess Point sites consist of what are called 'incipient' longhouses, circular or square houses and even rudimentary palisades. Excavated evidence suggests that a typical village would have contained upwards of five contemporary houses at any one time, serving a population of roughly 75 people for perhaps 40–50 years. The evidence also indicates that many of these villages were reoccupied repeatedly over the centuries (Warrick 2000:429–434).

Intriguingly, approximately half of the documented Princess Point sites in Ontario have been discovered along the Grand River, but examples have also been found in the vicinity of the Credit and Humber Rivers (see Map 4). The distinctive artifacts and horticultural practices of Princess Point peoples have led to the suggestion that they were the ancestors of the later Iroquoian-speaking populations of southern Ontario (Warrick 2000:427).

1.2.1.4 Late Woodland Period

In the Late Woodland period (ca. AD 900–1600), the practice of maize horticulture spread beyond the western end of Lake Ontario, allowing for population increases which in turn led to larger settlement sizes, higher settlement density and increased social complexity among the peoples involved. These developments are believed to be linked to the spread of Iroquoian-speaking populations in the area; ancestors of the historically-documented Huron, Petun, Neutral and Haudenosaunee Nations. Other parts of southern Ontario, including the Georgian Bay littoral, the Bruce Peninsula and the vicinity of Lake St. Clair, were inhabited by Algonkian-speaking peoples, who were much less agriculturally-oriented.

Late Woodland archaeological remains from the greater vicinity of the study area show three major stages of cultural development prior to European contact: 'Early Iroquoian', 'Middle Iroquoian' and 'Late Iroquoian' (Dodd et al. 1990; Lennox and Fitzgerald 1990; Williamson 1990).

Early Iroquoians (AD 900–1300) lived in small villages (ca. 0.4 ha) of between 75 and 200 people, and each settlement consisted of four or five longhouses up to 15 m in length. The houses contained central hearths and pits for storing maize (which made up 20–30% of their diet), and the people produced distinctive pottery with decorative incised rims (Warrick 2000:434–438). The best documented Early Iroquoian culture in the local area is the Glen Meyer complex, which is characterized by well-made and thin-walled pottery, ceramic pipes, gaming discs, and a variety of stone, bone, shell and copper artifacts (Williamson 1990:295–304).

Over the next century (AD 1300–1400), Middle Iroquoian culture became dominant in southern Ontario, and distinct 'Uren' and 'Middleport' stages of development have been identified. Both houses and villages dramatically increased in size during this time: longhouses grew to as much as 33 m in length, settlements expanded to 1.2 ha in size and village populations swelled to as many as 600 people. Middle Iroquoian villages were also better planned, suggesting emerging clan organization, and most seem to have been occupied for perhaps 30 years prior to abandonment (Dodd et al. 1990:356–359; Warrick 2000:439–446).

During the Late Iroquoian period (AD 1400–1600), the phase just prior to widespread European contact, it becomes possible to differentiate between the archaeologically-represented groups that would become the Huron and the Neutral Nations. The study area itself lies within the territorial boundaries of the Pre-Contact Neutral Nation, documented in lands as far west as Chatham and as far east as New York State.

The Neutral Nation is well represented archaeologically: typical artifacts include ceramic vessels and pipes, lithic chipped stone tools, ground stone tools, worked bone, antler and teeth, and exotic goods obtained through trade with other Aboriginal (and later European) groups (Lennox and Fitzgerald 1990:411–437). The population growth so characteristic of earlier Middleport times appears to have slowed considerably during the Late Iroquoian period, and the Pre-Contact Neutral population likely stabilized at around 20,000 by the early 16th century (Warrick 2000:446).

Pre-Contact Neutral villages were much larger than Middleport villages, with average sizes in the neighbourhood of 1.7 ha. Exceptional examples of these could reach 5 ha in size, containing longhouses over 100 m in length and housing 2,500 individuals. This seemingly rapid settlement growth is thought to have been linked to Middleport 'baby boomers' starting their own families and needing additional living space (Warrick 2000:446–449).

It has been suggested that the size of these villages, along with the necessary croplands to sustain them, may have had some enduring impacts on the landscapes that surrounded them. In particular, there has been a correlation postulated between Pre-Contact era corn fields and modern stands of white pine (Janusas 1987:69–70, Figure 7). Aside from these villages, the Pre-Contact Neutral also made use of hamlets, agricultural field cabins, specialized camps (e.g., fishing camps) and cemeteries (MCL 1997:35; Warrick 2000:449).

For the most part, Pre-Contact Neutral archaeological sites occur in isolated clusters defined by some sort of geographic region, usually within a watershed or another well-defined topographic feature (see Map 5). It is believed that these clusters represent distinct tribal units, which may have been organized as a larger confederacy akin to the historic Five Nations Iroquois (Lennox and Fitzgerald 1990:410). Nineteen main clusters of villages have been identified, the closest manifestation of which is known simply as the 'Fairchild-Big Creeks Cluster'. This cluster, which includes the Knight-Tucker, Main, Henderson, Mannen and Cleveland sites, appears to have flourished primarily in the 16th and 17th centuries (Lennox and Fitzgerald 1990:Table 13.1).

The end of the Late Woodland period can be conveniently linked to the arrival and spread of European fur traders in southern Ontario, and a terminus of AD 1600 effectively serves to demarcate some substantial changes in Aboriginal material culture. Prior to the establishment of the fur trade, items of European manufacture are extremely rare on Pre-Contact Neutral sites, save for small quantities of reused metal scrap. With the onset of the fur trade ca. AD 1580, European trade goods appear in ever-increasing numbers, and glass beads, copper kettles, iron axes and iron knives have all been found during excavations (Lennox and Fitzgerald 1990:425–432).

1.2.2 Early Contact

1.2.2.1 Exploration and Trade

One of the first Europeans to venture into what would become Ontario was Étienne Brûlé, who was sent by Samuel de Champlain in Summer 1610 to accomplish three goals: 1) to consolidate an emerging friendship between the French and the First Nations, 2) to learn their languages, and 3) to better understand their unfamiliar customs. Other Europeans would subsequently be sent by the French to train as interpreters. These men became *coureurs de bois*, "living Indian-style ... on the margins of French society" (Gervais 2004:182). Such 'woodsmen' played an essential role in all later communications with the First Nations.

Champlain himself made two trips to Ontario: in 1613, he journeyed up the Ottawa River searching for the North Sea, and in 1615/1616, he travelled up the Mattawa River and descended to Lake Nipissing and Lake Huron to explore Huronia (Gervais 2004:182–185). He learned about many First Nations groups during his travels, including prominent Iroquoian-speaking

peoples such as the Wendat (Huron), Petun (Tobacco) and '*la nation neutre*' (the Neutrals), and a variety of Algonkian-speaking Anishinabeg bands.

Champlain's *Carte de la Nouvelle France* (1632) encapsulates his accumulated knowledge of the area (see Map 6). Although the distribution of the Great Lakes is clearly an abstraction in this early map, important details concerning the terminal Late Woodland occupation of southern Ontario are discernable. Numerous Aboriginal groups are identified throughout the area, for example, and prolific Neutral village sites can be seen 'west' and 'south' of *Lac St. Louis* (Lake Ontario).

The first half of the 17th century saw a marked increase in trading contacts between the First Nations and European colonists, especially in southern Ontario. Archaeologically, these burgeoning relations are clearly manifested in the widespread appearance of items of European manufacture by AD 1630, including artifacts such as red and turquoise glass beads, scissors, drinking glasses, keys, coins, firearms, ladles and medallions. During this time, many artifacts such as projectile points and scrapers began to be manufactured from brass, copper and iron scrap, and some European-made implements completely replaced more traditional tools (Lennox and Fitzgerald 1990:432–437).

Nicholas Sanson's *Le Canada, ou Nouvelle France* (1656) provides an excellent representation of southern Ontario at this time of heightened contact. Here the lands of the Neutral Nation are clearly labelled with the French rendering of their Huron name, '*Attawandaron*' (see Map 7). Unfortunately, this increased contact had the disastrous consequence of introducing European diseases into First Nations communities. These progressed from localized outbreaks to much more widespread epidemics (MCL 1997:35; Warrick 2000:457). Archaeological evidence of disease-related population reduction appears in the form of reduced longhouse sizes, the growth of multi-ossuary cemeteries and the loss of traditional craft knowledge and production skills (Lennox and Fitzgerald 1990:432–433).

1.2.2.2 Five Nations Invasion

The importance of European trading contacts eventually led to increasing factionalism and tension between the First Nations, and different groups began to vie for control of the lucrative fur trade (itself a subject of competition between the French and British). In what would become Ontario, the Huron, the Petun, and their Anishinabeg trading partners allied themselves with the French. In what would become New York, the League of the Haudenosaunee (the Five Nations Iroquois at that time) allied themselves with the British. The latter alliance may have stemmed from Champlain's involvement in Anishinabeg and Huron attacks against Iroquoian strongholds in 1609 and 1615, which engendered enmity against the French (Lajeunesse 1960:xxix). Interposed between the belligerents, the members of the Neutral Nation refused to become involved in the conflict.

Numerous military engagements occurred between the two opposing groups during the first half of the 17th century, as competition over territories rich in fur-bearing animals increased. These tensions boiled over in the middle of the 17th century, leading to full-scale regional warfare (MNCFN 2010:5). In a situation likely exacerbated by epidemics brought by the Europeans and the decimation of their population, a party of roughly 1,000 Mohawk and Seneca warriors set

upon Huronia in March 1649. The Iroquois desired to remove the Huron Nation altogether, as they were a significant obstacle to controlling the northern fur trade (Hunt 1940:91–92).

The Huron met their defeat in towns such as Saint Ignace and Saint Louis (Sainte-Marie was abandoned and burned by the Jesuits in the spring of 1649). Those that were not killed were either adopted in the Five Nations as captives or dispersed to neighbouring regions and groups (Ramsden 1990:384). The Petun shared a similar fate, and the remnants of the affected groups formed new communities outside of the disputed area, settling in Quebec (Wendake), in the area of Michilimackinac and near Lake St. Clair (where they were known as the Wyandot).

Anishinabeg populations from southern Ontario, including the Ojibway, Odawa, and Pottawatomi, fled westward to escape the Iroquois (Schmalz 1977:2). The Neutral were targeted in 1650 and 1651, and the Iroquois took multiple frontier villages (one with over 1,600 men) and numerous captives (Coyne 1895:18). The advance of the Iroquois led to the demise of the Neutral Nation as a distinct cultural entity (Lennox and Fitzgerald 1990:456).

For the next four decades, southern Ontario remained an underpopulated wilderness (Coyne 1895:20). This rich hunting ground was exploited by the Haudenosaunee to secure furs for trade with the Dutch and the English, and settlements were established along the north shore of Lake Ontario at places like Teiaiagon on the Humber River and Ganatswekwyagon on the Rouge River (Williamson 2008:51). The Haudenosaunee are also known to have traded with the northern Anishinabeg during the second half of the 17th century (Smith 1987:19).

Due to their mutually violent history, the Haudenosaunee did not permit French explorers and missionaries to travel directly into southern Ontario for much of the 17th century. Instead, they had to journey up the Ottawa River to Lake Nipissing and then paddle down the French River into Georgian Bay (Lajeunesse 1960:xxix). New France was consequently slow to develop in southern Ontario, at least until the fall of several Iroquoian strongholds in 1666 and the opening of the St. Lawrence and Lake Ontario route to the interior (Lajeunesse 1960:xxxii).

In 1669, the Haudenosaunee allowed an expedition of 21 men to pass through their territory. This expedition, which included François Dollier de Casson (a Sulpician priest) and René Bréhant de Galinée, managed to reach and explore the Grand River, which they named *le Rapide* after the swiftness of its current. These men descended the Grand to reach Lake Erie, and they wintered at the future site of Port Dover (Coyne 1895:21). Galinée's map is one of the earliest documented representations of the interior of southwestern Ontario (see Map 8). In it, he notes the locations of several former Neutral villages at the western end of Lake Ontario, likely consisting of abandoned ruins.

1.2.2.3 Anishinabeg Influx

The fortunes of the Five Nations began to change in the 1690s, as disease and casualties from battles with the French took a toll on the formerly-robust group (Smith 1987:19). On July 19, 1701, the Haudenosaunee ceded lands in southern Ontario to King William III with the provision that they could still hunt freely in their former territory (Coyne 1895:28). However, judging from the many land cessions to follow, this agreement appears to have lacked any immediate binding formality.

According to the traditions of the Algonkian-speaking Anishinabeg, Ojibway, Odawa and Potawatomi bands began to mount an organized counter-offensive against the Iroquois in the late 17th century (MNCFN 2010:5). Around the turn of the 18th century, the Anishinabeg of the Great Lakes expanded into Haudenosaunee lands, and attempted to trade directly with the French and the English (Smith 1987:19). This led to a series of battles between the opposing groups, in which the Anishinabeg were more successful (Coyne 1895:28).

Haudenosaunee populations subsequently withdrew into New York State, and Anishinabeg bands established themselves in southern Ontario. Many of these bands were mistakenly grouped together by the immigrating Europeans under the generalized designations of 'Chippewa/ Ojibway' and 'Mississauga'. 'Mississauga', for example, quickly became a term applied to many Algonkian-speaking groups around Lake Erie and Lake Ontario (Smith 1987:19), despite the fact that the Mississaugas were but one part of the larger Ojibway Nation (MNCFN 2010:3).

The Anishinabeg are known to have taken advantage of the competition between the English and French over the fur trade, and they were consequently well-supplied with European goods. The Mississaugas, for example, traded primarily with the French and received "everything from buttons, shirts, ribbons to combs, knives, looking glasses, and axes" (Smith 1987:22). The British, on the other hand, were well-rooted in New York State and enjoyed mutually beneficial relations with the Haudenosaunee.

As part of this influx, many members of the Algonkian-speaking Ojibway, Potawatomi and Odawa First Nations came back to Lake Huron littoral. Collectively, these people came to be known as the Chippewas of Saugeen Ojibway Territory (also Saugeen Ojibway Nation). These Algonkian-speakers established themselves in the Bruce Peninsula, all of Bruce and Grey Counties, and parts of Huron, Dufferin, Wellington, and Simcoe Counties (Schmalz 1977:233).

Throughout the 1700s and into the 1800s, Anishinabeg populations hunted, fished, gardened and camped along the rivers, floodplains and forests of southern Ontario (Warrick 2005:2). However, their 'footprint' was exceedingly light, and associated archaeological sites are both rare and difficult to detect. Around 1720, French traders are known to have established a trading post at the western end of Lake Ontario, and the Mississaugas were actively involved in the regional fur trade (MNCFN 2010:09). In September 1750, construction began on another trading post in the vicinity of present-day Toronto, which was called Fort Rouillé, or Fort Toronto. Fort Rouillé was completed in Spring 1751 and served as an outstation for the larger Fort Niagara until it was abandoned and burned in 1759 (Williamson 2008:56).

Historical maps from the 18th century shed valuable light on the cultural landscape of what would become southern Ontario. H. Popple's *A Map of the British Empire in America* (1733), for example, shows the Neutral, Huron and Petun Nations destroyed by the Haudenosaunee ca. 1650, and also demonstrates the ephemeral environmental impact of the mobile Anishinabeg (see Map 9).

1.2.2.4 Relations and Ambitions

The late 17th and early 18th centuries bore witness to the continued growth and spread of the fur trade across all of what would become the Province of Ontario. The French, for example, established and maintained trading posts along the Upper Great Lakes, offering enticements to attract fur traders from the First Nations. Even further north, Britain's Hudson Bay Company dominated the fur trade. Violence was common between the two parties, and peace was only achieved with the Treaty of Utrecht in 1713 (Ray 2015). Developments such as these resulted in an ever-increasing level of contact between European traders and local Aboriginal communities.

As the number of European men living in Ontario increased, so too did the frequency of their relations with Aboriginal women. Male employees and former employees of French and British companies began to establish families with these women, a process which resulted in the ethnogenesis of a distinct Aboriginal people: the Métis. Comprising the descendants of those born from such relations (and subsequent intermarriage), the Métis emerged as a distinct Aboriginal people during the 1700s. Métis settlements developed along freighting waterways and watersheds, and were tightly linked to the spread and growth of the fur trade. These settlements were part of larger regional communities, connected by "the highly mobile lifestyle of the Métis, the fur trade network, seasonal rounds, extensive kinship connections and a shared collective history and identity" (MNO 2015).

In 1754, hostilities over trade and the territorial ambitions of the French and the British led to the Seven Years' War (often called the French and Indian War in North America), in which many Anishinabeg bands fought on behalf of the French. After the French surrender in 1760, these bands adapted their trading relationships accordingly, and formed a new alliance with the British (Smith 1987:22). In addition to cementing British control over the Province of Quebec, the Crown's victory over the French also proved pivotal in catalyzing the Euro-Canadian settlement process. The resulting population influx caused the demographics of many areas to change considerably.

R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776) provides an excellent view of the ethnic landscape of southern Ontario prior to the widespread arrival of European settlers (see Map 10). This map clearly depicts the Grand and Humber Rivers, the territory of the Ojibway and the virtually untouched lands of southern Ontario.

1.2.3 The Euro-Canadian Era

1.2.3.1 British Colonialism

With the establishment of absolute British control came a new era of land acquisition and organized settlement. In the *Royal Proclamation* of 1763, which followed the Treaty of Paris, the British government recognized the title of the First Nations to the land they occupied. In essence, the 'right of soil' had to be purchased by the Crown prior to European settlement (Lajeunesse 1960:cix). Numerous treaties and land surrenders were accordingly arranged by the Crown, and great swaths of territory were acquired from the Ojibway and other First Nations. These first purchases established a pattern "for the subsequent extinction of Indian title" (Gentilcore and Head 1984:78).

The first land purchases in Ontario took place along the shores of Lake Ontario and Lake Erie, as well as in the immediate 'back country'. Such acquisitions began in August 1764, when a 3.0 km strip of land on the west side of the Niagara River was surrendered by the Seneca First Nation (Surtees 1994:97; NRC 2010). Although many similar territories were purchased by the Crown in subsequent years, it was only with the conclusion of the American Revolutionary War (1775–1783) that the British began to feel a pressing need for additional land. In the aftermath of the conflict, waves of United Empire Loyalists came to settle in the Province of Quebec, driving the Crown to seek out property for those who had been displaced. This influx had the devastating side effect of sparking the slow death of the fur trade, which was a primary source of income for many First Nations groups.

By the mid-1780s, the British recognized the need to 1) secure a military communication route from Lake Ontario to Lake Huron other than the vulnerable passage through Niagara, Lake Erie and Lake St. Clair; 2) acquire additional land for the United Empire Loyalists; and 3) modify the administrative structure of the Province of Quebec to accommodate future growth. The first two concerns were addressed through the negotiation of numerous 'land surrenders' with Anishinabeg groups north and west of Lake Ontario, and the third concern was mitigated by the establishment of the first administrative districts in the Province of Quebec.

In response to the second need, the 'Between the Lakes Purchase' of 1784 (a.k.a. the Haldimand Tract Purchase) was orchestrated by the Governor of the Province of Quebec, Sir Frederick Haldimand. This purchase was completed to obtain land for those members of the Haudenosaunee (now Six Nations) who supported the Loyalist/British cause. In 1779, two years after joining the American Revolutionary War as allies of the British, many Seneca, Onondaga and Cayuga towns were targeted by American forces and destroyed. This caused the Iroquois Confederacy to seek retribution, and under the leadership of the Mohawk captain Joseph Brant, Haudenosaunee forces attacked and burned rebel forts and settlements as far east as Schenectady, New York (Ramsden 2015).

After the war ended, the Haudenosaunee were forced to leave New York State, and Governor Haldimand purchased a tract of land from the Mississaugas in 1784 for the Six Nations Loyalists to settle (Johnston 1964:xxxviii–xli; NRC 2010). Approximately 384,750 ha were discussed in this agreement (see Map 11), extending for 9.6 km on either side of the Grand River from its source to its mouth (Six Nations Council 2010:2).

Due to the fact that the colonial British 'government' at this time was largely nominal, rather than legislatively effective and decisive, the question was left open as to whether the Six Nations could dispose of their land directly to whomever they chose. Regardless of this significant hurdle, Brant moved quickly to lease some of the Six Nations' holdings to raise investment income for the Confederacy. In 1787, a number of European families were issued rough land titles with the condition that they could never be transferred to another individual. With less than 2,000 Six Nations members living in the Haldimand Tract and the imminent death of the fur trade, Brant realized that he would need the assistance of European settlers to bring new technologies to his people and transform them into successful agriculturalists (Johnston 1964:xlii–xliii).

On July 24, 1788, Sir Guy Carleton, Baron of Dorchester and Governor-General of British North America, divided the Province of Quebec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (AO 2011). The vicinity of the study area fell within the Hesse District at this time, which consisted of a massive tract of land encompassing all of the western and inland parts of the province extending due north from the tip of Long Point on Lake Erie in the east. According to early historians, "this division was purely conventional and nominal, as the country was sparsely inhabited … the necessity for minute and accurate boundary lines had not become pressing" (Mulvany et al. 1885:13).

Further change came in December 1791, when the Parliament of Great Britain's *Constitutional Act* created the Provinces of Upper Canada and Lower Canada from the former Province of Quebec. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada, and he became responsible for governing the new province, directing its settlement and establishing a constitutional government modelled after that of Britain (Coyne 1895:33).

Simcoe initiated several schemes to populate and protect the newly-created province, employing a settlement strategy that relied on the creation of shoreline communities with effective transportation links between them. These communities, inevitably, would be composed of lands obtained from the First Nations, and many more purchases were subsequently arranged. For example, on December 7, 1792 another 'Between the Lakes Purchase' was completed to enhance Governor Haldimand's original purchase from 1784. In this transaction, the Mississaugas received goods worth 1,180.74 Quebec pounds as compensation for approximately 1,215,000 ha (NRC 2010).

In July 1792, Simcoe divided the province into 19 counties consisting of previously settled lands, new lands open for settlement and lands not yet acquired by the Crown. These new counties stretched from Essex in the west to Glengarry in the east. Three months later, in October 1792, an Act of Parliament was passed whereby the four districts established by Lord Dorchester were renamed as the Western, Home, Midland and Eastern Districts. The vicinity of the study area nominally fell within the boundaries of Norfolk County in the Western District at this time, as the Grand River was used as a natural boundary line between Norfolk, York and Lincoln (AO 2011).

In 1793, the Lieutenant-Governor issued a patent confirming Six Nations' title to the Haldimand Tract, but at the same time he reduced the size of the grant by 111,292 ha (the 'Source Lands' of the Grand River), arguing that the Crown could not grant lands that they did not own (Cumming 1972:2). Simcoe further specified that 'Tract' land could only be sold to the Crown, as he was concerned that 'land jobbers' (speculators) might take advantage of Six Nations (Johnston 1964:xliv–xlvi). Brant was in favour of such sales, and in 1796 he was granted Power of Attorney to surrender "In Trust" four blocks of the Haldimand Tract (Blocks 1–4) in exchange for 999 annual payments for the "perpetual care and maintenance" of Six Nations. On February 5, 1798, Brant exceeded his Power of Attorney and surrendered Blocks 1–6 (142,845 ha) "In Trust" to the Crown (Six Nations Council 2010:Insert 1).

The eastern part of what would become Brant County consisted of part of Block 1 (South Dumfries) and the Six Nations' territory obtained in the 'Between the Lakes Purchase' of 1784, whereas the western part was obtained in the 'Between the Lakes Purchase' of 1792.

D.W. Smyth's *A Map of the Province of Upper Canada* (1800) clearly shows the extent of the Six Nations' territory, and Mohawk, Cayuga and 'Ougonga' villages are noted on the north side of the Grand River (see Map 12).

1.2.3.2 Brant County

Shortly after the creation of Upper Canada, the original arrangement of the province's districts and counties was deemed inadequate. As population levels increased, smaller administrative bodies became desirable, resulting in the division of the largest units into more 'manageable' component parts. The first major changes in the vicinity of the study area took place in 1798, when an Act of Parliament called for the realignment of the Home and Western Districts and the formation of the London and Niagara Districts. Many new counties and townships were subsequently created (AO 2011).

The vicinity of the study area became part of Haldimand County in the newly-created Niagara District at this time, the latter of which also included Lincoln County (AO 2011). Haldimand County was named after Sir Frederick Haldimand, who served as the Governor of the Province of Quebec from 1777 to 1789. The county lands stretched from the mouth of the Grand River to the southern limits of the Township of Dumfries (Block No. 1 of the Haldimand Tract). J. Purdy's *A Map of Cabotia* (1814) provides an excellent view of the vicinity of the study area during these early years, as well as the first thoroughfares (see Map 13).

Eventually, as even smaller units of government became desirable, the Home and Niagara Districts were further divided. In 1816, large parts of York County and Haldimand County were reincorporated as the newly-formed Halton and Wentworth Counties in the Gore District. The vicinity of the study area became part of the newly-formed Wentworth County at this time, which comprised the Townships of Ancaster, Barton, Glanford, Binbrook and Saltfleet, as well as the remnants of the Haldimand Tract (see Map 14). By 1817, the Gore District had a population of 6,684 (the majority of which were United Empire Loyalists), 18 grist mills and 41 saw mills (Cumming 1971:54). The southern townships of the Gore District were the best settled (Smith 1846:213).

Although many townships were added to Halton County in 1821, Wentworth County remained unchanged for the majority of the early 19th century (see Map 15). According to the records of Rev. Robert Lugger from 1828, approximately 2,000 Six Nations members resided within the Haldimand Tract at that time (see Map 16). This population appears to have lived primarily in log houses along the Grand River, and only a handful of villages are depicted in Lugger's map (Gentilcore and Head 1984:84). The unsold portions of the Haldimand Tract continued to be "dismembered by surrenders and detachments" in later years (Gentilcore and Head 1984:98).

In 1832, a treaty was concluded between the First Nations and the Crown that allowed for the remaining lands within the Haldimand Tract to be sold. Only the Township of Tuscarora and a small portion of the Township of Oneida were reserved from this surrender, and the newly-acquired territory subsequently became available for Euro-Canadian settlement (Phelps 1972:3). In 1833, the Grand River Navigation Company initiated improvements along the Grand River between Brantford and Indiana; this, too, resulted in local population growth as company employees settled along the river banks (Phelps 1972:5).

In the late 1830s and early 1840s, the layout of what would become southern Ontario was significantly altered through the creation of the Huron, Brock, Wellington, Talbot and Simcoe Districts (AO 2011). The Townships of Wilmot, Puslinch, Guelph, Eramosa, Erin and Garafraxa were transferred from Halton County in the Gore District to the newly-formed Wellington District at this time, as were Blocks 2–4 of the Haldimand Tract (Waterloo, Woolwich, Pilkington and Nichol). Block 1 of the Haldimand Tract (Dumfries) remained part of Halton County, whereas the Townships of Brantford, Onondaga and Tuscarora comprised part of Wentworth County (see Map 17). Wentworth County became part of Canada West in the new United Province of Canada in February 1841. In 1845, the Townships of Seneca and Oneida were also added to Wentworth County (AO 2011).

Following the abolition of the district system in 1849, the counties of Canada West were reconfigured once again. Brant County was created from parts of Wentworth, Halton, Oxford and Norfolk Counties, comprising the Townships of Burford, Oakland, Brantford, South Dumfries (North Dumfries became part of Waterloo County), Onondaga and Tuscarora (see Map 18). Brant, Wentworth and Halton Counties were initially united for municipal and judicial purposes, but Brant emerged as an independent administrative body in 1853 (Reville 1920:275). The layout of Brant County remained constant for the remainder of the Euro-Canadian era (see Map 19).

1.2.3.3 Township of Brantford

In historic times, the Township of Brantford was bounded on the east by the Townships of Ancaster, Onondaga and Tuscarora, on the north by the Township of Dumfries (later South Dumfries), on the west by the Township of Burford and on the south by the Township of Oakland. The township contained good agricultural land that was well-watered, and was accordingly an ideal location for early settlers (Smith 1846:19; Irwin & Burnham 1867:46). The Grand River bisected the township, and the eastern, southwestern and western parts contained Hynd's Creek and Fairchild's Creek, Mount Pleasant Creek, and Horner's Creek (a.k.a. 'Whiteman's Creek'), respectively. 'Whiteman's Creek' was reportedly named after a youth who was taken prisoner by Six Nations during the American Revolutionary War, and who later married a Mohawk woman and settled by the Grand River (Sutherland 1896:17).

The Township of Brantford remained in the hands of Six Nations for the majority of the late 18th and early 19th centuries, save for several areas leased by Joseph Brant to early settlers. The township's first settlers settled along Fairchild's Creek in the east, and included Isaac Fairchild, John Filer, Isaac Whiting and Major Westbrook. In 1810, only John Stalts and Enos Burrell lived in the area that would become the Town of Brantford. Thomas Perrin was the first pioneer in the western part of the township (Mika 1972:xv).

Numerous thoroughfares served the Township of Brantford, which contributed greatly to its successful settlement (see Map 20). According to Eliakim Malcolm, the first County Warden, the Town of Brantford was particularly well-situated in this regard, as "the main thoroughfare from the eastern to the western sections of the Province, passes through Brantford, and leading roads intersect it from all parts of the surrounding country" (Mika 1972:v). The Hamilton Road (i.e., Colborne Street) was opened through the township in 1810, and it was rehabilitated as a corduroy road to facilitate the transportation of troops and supplies in 1812. Parts of this road would subsequently be either planked or gravelled (Mika 1972:xv). Other roads of importance

included the Brantford and Paris Road, the Mount Pleasant Road and Cockshutt's Road, the latter of which was gravelled and led through Oakland to Port Dover (Sutherland 1869:17).

In April 1830, a 326 ha parcel of land east of the Grand River was surrendered to the Crown for the future Town of Brantford. This plot represented the first significant area of land surrendered for sale and settlement by Six Nations since Brant's time, and it was surveyed by L. Burwell in Summer 1830 (Sutherland 1869:66). Part of the northern part of the Township of Brantford was also obtained by the Crown at that time, and the remaining lands were surrendered for sale and settlement in subsequent years (Sutherland 1869:17). The principal settlements of Mt. Pleasant, Mt. Vernon, Paris, Cainsville, Langford and the Town of Brantford began to develop soon after these purchases were finalized.

Much of the Township of Brantford was settled through leases organized by Joseph Brant; as a result, its overall plan was very irregular (see Map 21–Map 22). When the township was formally surveyed, particular attention had to be paid to these leased tracts. The remainder of the land was organized with regular concession numbers from north to south, and the lots were numbered from west to east (Sutherland 1869:18). By 1841, nearly all of the lands of the Haldimand Tract had been sold, save for isolated small reserves and the large reserve known as the Township of Tuscarora (Gentilcore and Head 1984:84).

Despite being settled and surveyed relatively late in this part of Upper Canada, local population levels rose quickly in the Township of Brantford, and the population reached 5,199 in 1841. By 1846, a total of 23,504 ha had been taken up, 17,121 ha of which were under cultivation. There were six grist mills and six saw mills in operation at that time (Smith 1846:19). The township was organized as a municipality in 1850 (Mika 1972:xv), and the population reached 6,904 by 1861 (Sutherland 1869:18).

The Town of Brantford, named after Joseph Brant and the historic river crossing (Brant's Ford), was one of the most thriving commercial and manufacturing towns in the province during the 19th century. It benefited greatly from its position on the Buffalo and Detroit section of the Grand Trunk Railway, had direction communication with the Great Western Railway via a branch line to Harrisburg, and was linked to Lake Erie via the Brantford, Norfolk & Port Burwell Railway (Mika 1972:xii).

By 1824, there were already a few settlers living on the town site, and stores were kept by John Wilkes, S.V.R. Douglas, Nathan Gage, William Dutton and A. Huntington. The first mills in the area were erected by Henry Sage and Marshal Lewis, which were taken over by Jedediah Jackson in 1830. After the surrender of the town plot in April 1830, the lots laid out by Burwell were sold "to actual settlers at an upset price of ten pounds per lot" (Mika 1872:xii). Tanneries, hotels, distilleries, breweries and grist mills were quick to follow. The Grand River Navigation Company was chartered by an Act of Parliament in 1832, and the canal was laid out in 1840 to facilitate the shipping of produce and goods (Mika 1872:xii; Irwin & Burnham 1867:116).

By 1846, the population of the Town of Brantford was roughly 2,000, and a wide variety of industries were flourishing. The town had 3 physicians and surgeons, 4 lawyers, 3 grist mills, 1 carding machine and fulling mill, 1 foundry, 2 surveyors, 2 breweries, 4 distilleries, 21 stores,

1 soap and candle factory, 14 taverns, 2 druggists, 1 printer, 12 groceries and many other businesses at that time (Smith 1846:18–19). Brantford also contained eight churches and chapels, a Fire Company with an engine, and a weekly newspaper (the 'Brantford Courier'). The town was incorporated in July 1847, and it had a population of approximately 10,000 by 1875 (Mika 1972:xii).

1.2.3.4 The Study Area

The study area is located within a part of the Township of Brantford known historically as Tutela Heights. In Reverend R. Lugger's *Plan of the Grand River & Location of 6 Nations of Indians* (1828), for example, a group of 'Upper Cayugas' are shown to have occupied an area known as 'Tatulis Heights', just south of Brantford and the Grand River (see Map 16). The origin of the name 'Tutela Heights' is directly tied to the Tutelo tribe, whose members settled in the area after the completion of the Haldimand Tract Purchase (see Map 23).

The Tutelo were a Siouan tribe first documented near Salem, Virginia, and their principal village was visited by Fallam and Batts in 1671 (Swanton 1953:73). After years of conflict with the Iroquois and other First Nations, the Tutelo abandoned their traditional territory and sought the protection of Six Nations to the north. They were attested at Shamokin, Pennsylvania in 1745, and were admitted to the League ca. 1753. Tutelo chiefs, as well as those of the Nanticoke and Delaware, sat on the Council of the League beginning in 1756, but the migration of the people to the proper territory of the Iroquois was gradual. The Cayuga were particularly beneficent towards the Tutelo, allowing them to maintain their own traditions, language and culture, and giving them a site for their town (south of Cayuga Lake) along with hunting and fishing privileges. The town was destroyed in 1779 by General Sullivan during the Revolutionary War, and the Mohawks, the greater part of the Cayugas, roughly half of the Onondagas, many of the Oneidas, and a few Senecas and Tuscarora followed Brant to Canada (Hale 1884:2–8).

Many Tutelo accompanied the League of Six Nations when they migrated to the Grand River, and they settled at 'Tutela Heights'—"the 'a' having been substituted for the final 'o' by current local custom" (Reville 1920:350). Hale provides the following description of the community:

> They built their town on a pleasant elevation, which stretches along the western bank of the Grand River, and still bears the name of Tutelo Heights. Under this name it now forms a suburb of the city of Brantford. Fifty years ago, when the present city was a mere hamlet, occupied by a few venturous Indian traders and pioneers, the Tutelo cabins were scattered over these heights, having in the midst their 'long-house' in which their tribal councils were held, and their festivals celebrated. They are said to have numbered then about two hundred souls (Hale 1884:8).

The proximity of the town to Brantford resulted in the rampant spread of disease within the community. In 1832, Asiatic cholera decimated the Tutelo tribe, and a second round of the plague resulted in the destruction of the community in 1848. The few survivors fled from the Heights and took refuge among their Cayuga friends, and by intermarriage they were soon absorbed (Hale 1884:8–9). The last attested Tutelo included Nikhonha, who died in America in 1871, and Nastabon (John Key), who died in Brant County in 1898 (Reville 1920:349–350).

As discussed in Section 1.1, the study area for this assessment falls on part of the Stewart & Ruggles Tract and part of the Hiram Phelps Tract in the Geographic Township of Brantford. As discussed above, these lands were first settled by the Tutela and began to be patented to Euro-Canadian settlers in the 1830s. The vicinity of the study area was well-settled for the remainder of the Euro-Canadian period.

In an attempt to reconstruct the historic land use of the study area, ARA examined three historical maps that documented past residents, structures (e.g., homes, businesses and public buildings) and features during the mid- and late 19th century. Specifically, the following maps were consulted:

- L. Burwell's *Plan of the Township of Brantford in the County of Wentworth in the District of Gore* (1839) at a scale of 40 chains to 1 inch (Gentilcore and Head 1984:Map 4.24);
- G.R. and G.M. Tremaine's *Tremaine's Map of the County of Brant, Canada West* (1858) at a scale of 40 chains to 1 inch (Brock University 2010); and
- *Brantford Township West of River* from Page and Smith's *Illustrated Historical Atlas of the County of Brant* (1875) at a scale of 50 chains to 1 inch (McGill University 2001).

The limits of the study area are shown on 1) georeferenced versions of the consulted historical maps and 2) a georeferenced aerial image from 1954 in Map 24–Map 27. The content of these maps and the visible features in the aerial image are referenced throughout the following historic land use summary.

In order to facilitate the discussion of the historic land use of each individual property, the parcels were assigned an identifier based on 1) whether it was north or south of Tutela Heights Road and 2) how far from the westernmost edge of the study area the parcel was located. For example, N1 identifies the northwestern property, whereas S3 identifies the third property from the western edge of the study area, south of Tutela Heights Road.

These maps indicate that the majority of the surrounding lots were settled by mid-19th century, and numerous Euro-Canadian owners are depicted on the township maps. These maps also provide useful information concerning structures and prominent natural features in the area. These data are summarized in Table 1.

Table 1: Euro-Canadian Residents within the Study Area

Parcel	Source		
	Burwell (1839)	**Tremaine (1858)**	**Page and Smith (1875)**
N1	Jemima Stewart and Sarah Ruggles	W.B. Jarvis	A.B.
N2	Jemima Stewart and Sarah Ruggles	'Craven Heights' Subdivision	Ignatius Cockshutt and R. Greenwood
N3	Jemima Stewart and Sarah Ruggles; Hiram Phelps	Unknown	James Wye
S1	Jemima Stewart and Sarah Ruggles	J. Stewart	J. Stewart
S2	Jemima Stewart and Sarah Ruggles	Robert Leeming	A. Mitchell
S3	Jemima Stewart and Sarah Ruggles	Ignatius Cockshutt	Ignatius Cockshutt
S4	Jemima Stewart and Sarah Ruggles	Jas. Cockshutt	R. Greenwood

Parcel	Source		
	Burwell (1839)	**Tremaine (1858)**	**Page and Smith (1875)**
S5	Hiram Phelps	Ignatius Cockshutt	I. Cockshutt
S6	Hiram Phelps	John Smith, Esq.	W. Swaisland

L. Burwell's *Plan of the Township of Brantford in the County of Wentworth in the District of Gore* (1839) depicts the two subject tracts, the westernmost of which was owned by Jemima Stewart and Sarah Ruggles (678 ha) and the easternmost of which was owned by Hiram Phelps (278 ha). The early alignment of Tutela Heights Road is illustrated, and 'Indian Farms' are shown on the opposite bank of the Grand River at 'Eagles Nest'.

Tremaine's Map of the County of Brant, Canada West (1858) shows what appears to be a small subdivision at 'Craven Heights' (property N2), north of the Leeming and Cockshutt properties (S2 and S3, respectively). There also appears to be a driveway or access road between the properties of James and Ignatius Cockshutt (S4 and S5). No other structures are depicted on this map (see Map 26).

In the *Illustrated Historical Atlas* (1875), a number of new features and historical occupants are depicted. Homesteads are shown on the properties of A. Mitchell (S2), I. Cockshutt (S3) and R. Greenwood (S4), all of which fall within the southwestern part of the study area. The small subdivision that was previously represented on property N2 is no longer present, and the lot was clearly owned by I. Cockshutt. James Wye also appears as the owner of the northeastern property (N3), and 'A.B.' is sown as the owner of the northwestern property (N1). This represents Alexander Melville Bell, and the illustrated homestead comprises part of the Bell Homestead National Historic Site (see Map 27).

When Alexander Melville Bell, father of Alexander Graham Bell, and his family immigrated to Canada in 1870, he purchased a property at Tutela Heights from Mr. Robert Morton "containing ten acres of land and complete house and good orchard situated on Mount Pleasant Road some two miles from Brantford" (Brantford Expositor 1870). The house, which would become known as Melville House (see Image 1), is best known as the location where Alexander Graham Bell grasped the principle upon which his invention of the telephone would work on July 26, 1874. Starting in 1910, the homestead was restored to its original condition and became a tourist attraction. The Henderson Home building was moved to the homestead property in 1969, and it was officially designated a National Historic Site in 1996 (City of Brantford 2015).

The historic aerial image from 1954 demonstrates that the property boundaries, land uses and housing and road locations remained largely the same as they were at the time of the *Illustrated Historical Atlas* (1875). The only new feature appears to be an access road/farmer's laneway stretching from Tutela Heights Road to the southeastern limit of the study area (see Map 27).

1.2.4 Summary of Past and Present Land Use

During Pre-Contact and Early Contact times, the vicinity of the study area would have comprised a mixture of coniferous trees, deciduous trees and open areas. It seems clear that the First Nations managed the landscape to some degree, but the extent of such management is unknown. During the early 19th century, Euro-Canadian settlers arrived in the area and began to clear the forests for agricultural and settlement purposes. Over the course of the Euro-Canadian era, this locality would have comprised primarily agricultural lands located north and south of Tutela Heights Road. At the time of assessment, the study area comprised a mixture of wooded areas, grassed areas, maintained lawns, agricultural fields, extant structures (e.g., residential housing), municipal roadways (i.e., Tutela Heights Road, Phelps Road and Davern Road) and various driveways/pathways.

1.2.5 Additional Background Information

In the course of previous archaeological work conducted in the greater vicinity of the study area, additional research concerning local settlement history and land use was carried out. In accordance with the requirements set out in Section 7.5.7 of the *S&Gs* (MTC 2011:125), the title, author and PIF number of two related works appear below:

- Title: *Stage 1 and 2 Archaeological Assessment of Tutela Heights Phase 1, Stuart & Ruggles Tract, County of Brant, Ontario*. Author: ASI. PIF #P049-512-2010 (ASI 2010); and
- Title: *Stage 3 Site-Specific Archaeological Assessment, Tutela Heights (AgHb-413), Blacker I (AgHb-416), Blacker II (AgHb-417), Blacker's Brickworks (AgHb-415), AgHb-418, AgHb-421, AgHb-432, AgHb-434, AgHb-440, AgHb-442, AgHb-443, AgHb-446, AgHb-449, AgHb-450, AgHb-473, AgHb-477 and AgHb-479. Tutela Heights Phase 1, Stewart & Ruggles Tract, County of Brant, Ontario*. Author: ASI. PIF #P049-584-2010 (ASI 2011).

The research included in these reports was considered during the archaeological potential modelling and the formulation of recommendations pertaining to archaeological concerns within the study area.

1.3 Archaeological Context

1.3.1 Previous Archaeological Work

The MTCS's Ontario Archaeological Sites Database and ARA's archive of past reports were consulted to determine whether any archaeological assessments had been previously conducted within the limits of, or immediately adjacent to the study area. As a result of this investigation, it was determined that there are no reports on record documenting previous archaeological fieldwork within a 50 m radius. Two archaeological assessments were conducted within 250 m of the study area, however, and a description of these past assessments and their associated recommendations are summarized below.

In May and June 2010, ASI conducted Stage 1 and 2 archaeological assessments for the proposed Tutela Heights Phase I subdivision under PIF #P049-512-2010 (ASI 2010). The assessed area fell within part of the Stewart & Ruggles Tract, and is located approximately 250 m west of the subject lands. The Stage 1 assessment determined that the study area exhibited high archaeological potential (ASI 2010:4–5), and the Stage 2 assessment resulted in the identification of 155 locations of archaeological materials (P1–P148, H1–H5 and Blacker's Brickworks). A total of 64 sites were recommended for Stage 3 site-specific assessment, and the remainder of the property was not recommended for further assessment (ASI 2010:97–101).

In November 2010, ASI conducted Stage 3 site-specific assessments for 17 sites located within the Phase 1 project area (ASI 2011). The assessed sites included Tutela Heights (AgHb-413), Blacker I (AgHb-416), Blacker II (AgHb-417), Blacker's Brickworks (AgHb-415), AgHb-418, AgHb-421, AgHb-432, AgHb-434, AgHb-440, AgHb-442, AgHb-443, AgHb-446, AgHb-449, AgHb-450, AgHb-473, AgHb-477 and AgHb-479. The following recommendations were made:

1. The Tutela Heights site (AgHb-413) is deemed to have significant cultural value and should be subjected to Stage 4 mitigative excavation if the site cannot be avoided within the proposed development plan.
2. The Blacker I (AgHb-416) and Blacker II (AgHb-417) sites are deemed to not be significant heritage resources and may be considered clear of further archaeological concern.
3. The following pre-contact Aboriginal sites are deemed to be significant heritage resources and should be subjected to Stage 4 mitigative excavation if they cannot be avoided within the proposed development plan: AgHb-418, AgHb-421, AgHb-442, AgHb-443, and AgHb-446.
4. The following pre-contact Aboriginal sites are deemed to not be significant heritage resources and may be considered clear of further archaeological concern: AgHb-434, AgHb-440, AgHb-449, AgHb-450, AgHb-477 and AgHb-479.
5. The Blacker's Brickworks (AgHb-415) site should be subjected to additional Stage 3 assessment.
6. Pre-contact sites AgHb-432 and AgHb-473 should be subjected to additional Stage 3 assessment (ASI 2011:83).

It is ARA's understanding that the addition Stage 3 assessments and any Stage 4 mitigations of development impacts are ongoing for the project.

1.3.2 Summary of Registered or Known Archaeological Sites

The MTCS's Ontario Archaeological Sites Database and ARA's archive of past reports were consulted to determine whether any registered or known archaeological resources occur in the greater vicinity of the study area. As a result of this investigation, it was determined that there are 161 registered or known archaeological sites located either 1) within a 1 km radius of the study area or 2) on the adjacent Tutela Heights Phase 1 property (slightly more than 1 km away in some areas). The excavation results from these sites are summarized in Appendix A.

None of these previously identified sites are located within the subject study area, and the closest site (AgHb-450) is approximately 250 m to the northwest. Regardless, the presence of 161 registered or known sites in the vicinity of the study area demonstrates the desirability of this locality for early settlement and resource exploitation.

1.3.3 Natural Environment

Environmental factors played a substantial role in shaping early land-use and site selection processes, particularly in small Pre-Contact societies with non-complex, subsistence-oriented economies. Euro-Canadian settlers also gravitated towards favourable environments, particularly those with agriculturally-suitable soils. In order to fully comprehend the archaeological context of the study area, the following four features of the local natural environment must be considered: 1) forests; 2) drainage systems; 3) physiography; and 4) soil types.

The study area lies within the deciduous forest, which is the southernmost forest region in Ontario and is dominated by agricultural and urban areas. This region generally has the greatest diversity of tree species, while at the same time having the lowest proportion of forest. It has most of the tree and shrubs species found in the Great Lakes–St. Lawrence forest (e.g., eastern white pine, red pine, eastern hemlock, white cedar, yellow birch, sugar and red maple, basswood, red oak, black walnut, butternut, tulip, magnolia, black gum, and many types of oaks and hickories), and also contains black walnut, butternut, tulip, magnolia, black gum, many types of oaks, hickories, sassafras and red bud. The deciduous forest region has the most diverse forest life in Ontario, including rare species such as the southern flying squirrel, red-bellied woodpecker, black rat snake, milk snake and gray tree frog (MNRF 2015).

With an area of almost 3,000,000 ha, the deciduous forest region has largely been cleared, and only scattered woodlots remain on sites too poor for agriculture (MNRF 2015). In Pre-Contact times, however, these dense forests would have been particularly bountiful. It is believed that the First Nations of the Great Lakes region exploited close to 500 plant species for food, beverages, food flavourings, medicines, smoking, building materials, fibres, dyes and basketry (Mason 1981:59–60). Furthermore, this diverse vegetation would have served as both home and food for a wide range of game animals, including white tailed deer, turkey, passenger pigeon, cottontail rabbit, elk, muskrat and beaver (Mason 1981:60).

In terms of local drainage systems, the subject lands fall entirely within the Lower Middle Grand major basin, which comprises part of the Grand River Watershed (GRCA 2015). Specifically, the northern portion of the study area traverses the Grand River, the northeastern portion traverses an unnamed wetland, and the southeastern portion traverses several unnamed tributaries of the Grand River and an unnamed wetland.

Physiographically, the study area lies within the region known as the Norfolk Sand Plain, which is a wedge-shaped plain stretching from the Niagara Escarpment southwesterly to the north shore of Lake Erie. The sands and silts of this region were deposited as a delta in glacial Lakes Whittlesey and Warren, which was built from west to east as the glacier withdrew (Chapman and Putnam 1984:153–154). These physiographic elements have accumulated over dolostone, shale, gypsum, sandstone and salt bedrocks belonging to the Upper Silurian Salina formations (Davidson 1989:42).

A variety of soil types occur within the study area, including Alluvium (ALU) in the north and southeast, Beverley (BVY) soils in the southwest, Brantford (BFO) soils in the south-centre and east, and Plainfield (PFD) soils in the west. Lands classified as Escarpment (ESC) also occur along the southern bank of the Grand River. The specific characteristics of these soil types are summarized in Table 2 (Acton 1989:Sheet 3).

Table 2: Summary of Soil Types

Soil Code	Soil Type	Soil Materials	Drainage	Topography
ALU15	Alluvium	Mainly medium-textured loamy floodplain deposits	Variable	Level
ALU17	Alluvium	Mainly fine-textured clayey floodplain deposits	Variable	Level
BVY1	Beverly	Lacustrine silty clay loam and silty clay	Imperfect	Level
BFO6	Brantford	Lacustrine silty clay loam and silty clay	Moderately well	Gently Sloping
ESC	Escarpment	Very steep valley sides of variable texture	Rapid	N/A
PFD3	Plainfield	Lacustrine and eolian modified sand	Rapid and Well	Steeply Sloping

In summary, the study area possesses a number of environmental characteristics which would have made it attractive to both Pre-Contact and Euro-Canadian populations. The rich deciduous forest and the nearby waterways would have attracted a wide variety of game animals, and consequently, early hunters. The areas of well-drained soils would have been ideal for the maize horticulture of Middle to Late Woodland peoples and the mixed agriculture practiced by later Euro-Canadian populations. The proximity of the study area to the Grand River—a principal transportation route in both Pre-Contact and Euro-Canadian times—would have significantly influenced its settlement and land-use history.

1.3.4 Archaeological Fieldwork and Property Conditions

The Stage 1 property inspection was carried out on October 2, 2015 under licence #P007, PIF #P007-0707-2015. The assessment involved visual inspection to evaluate archaeological potential, and a corpus of satellite imagery, topographic mapping and digital environmental data was also consulted for information concerning current land conditions. All field observations were made from accessible public areas; accordingly, no permissions were required for property access. The limits of the study area were estimated in the field based on the aerial imagery and natural formations (i.e., GPS could not be used to confirm the extents within private property).

At the time of assessment, the study area comprised a mixture of wooded areas, grassed areas, maintained lawns, agricultural fields, extant structures (e.g., residential housing), municipal roadways (i.e., Tutela Heights Road, Phelps Road and Davern Road) and various driveways/pathways. The specific weather and lighting conditions for the day of assessment are summarized in Section 2.2. No unusual physical features were encountered during the property inspection that affected the results of the Stage 1 assessment.

2.0 STAGE 1 BACKGROUND STUDY

2.1 Summary

The Stage 1 assessment involved an examination of the archaeology, history, geography and current land condition of the vicinity of the study area. This background study was carried out using archival sources (e.g., historical publications and records) and current academic and archaeological publications (e.g., archaeological studies and reports). It also included the analysis of modern topographic maps (at a 1:50,000 scale), recent satellite imagery, digital environmental data and historical maps/atlases of the most detailed scale available (i.e., 40 chains to 1 inch and 50 chains to 1 inch).

With occupation beginning approximately 11,000 years ago, the greater vicinity of the study area comprises a complex chronology of Pre-Contact and Euro-Canadian histories (see Section 1.2). Artifacts associated with Palaeo-Indian, Archaic, Woodland and Early Contact traditions are well-attested in Brant County, and Euro-Canadian archaeological sites dating to pre-1900 and post-1900 contexts are likewise common. The presence of 161 registered and known archaeological sites in the vicinity of the study area demonstrates the desirability of this locality for early settlement and resource exploitation (see Section 1.3.2).

As mentioned in Section 1.3.3, the natural environment of the study area would have been attractive to both Pre-Contact and Euro-Canadian populations as a result of proximity to the Grand River and its tributaries. The areas of well-drained soils and the diverse local vegetation would also have encouraged settlement throughout Ontario's lengthy history. Euro-Canadian populations would have been particularly drawn to Tutela Heights Road, which was a historically-surveyed thoroughfare.

In summary, the Stage 1 assessment included an up-to-date listing of sites from the MTCS's Ontario Archaeological Sites Database (within at least a 1 km radius), the consideration of previous local archaeological fieldwork (within at least a 50 m radius), the analysis of topographic and historic maps (at the most detailed scale available), and the study of aerial photographs/satellite imagery. In this manner, the standards for background research set out in Section 1.1 of the *S&Gs* (MTC 2011:14–15) were met.

2.2 Field Methods (Property Inspection)

In order to gain first-hand knowledge of the geography, topography and current condition of the study area, a property inspection was conducted on October 2, 2015. Although optional, Section 1.2 of the *S&Gs* (MTC 2011:15–17) outlines the appropriateness of such an option when detailed maps might be needed to determine whether portions of the project area have no archaeological potential and can be eliminated from further assessment. All field observations were made from accessible public lands; accordingly, no permissions were required for property access.

Environmental conditions were ideal during the property inspection, with partly cloudy skies, a high of 5 °C and excellent lighting. ARA therefore confirms that fieldwork was carried out under weather and lighting conditions that met the requirements set out in Section 1.2 Standard 2 of the *S&Gs* (MTC 2011:16).

Given the size and irregular shape of the study area, the lands were subjected to random spot checking in accordance with the requirements set out in Section 1.2 of the *S&Gs* (MTC 2011:15–17). Specifically, spot checking was conducted along Tutela Heights Road from east to west, along Davern Road from north to south, and at the termination point of the southeastern corridor at Phelps Road. The visually inspected areas were examined under ideal weather and lighting conditions with high ground surface visibility.

The visual inspection confirmed that all features of archaeological potential (e.g., waterways, historically-surveyed roadways, etc.) were present where they were previously identified, and did not result in the identification of any additional features of archaeological potential not visible on mapping (e.g., relic water channels, patches of well-drained soils, etc.). One culturally-significant property was identified: the Bell Homestead National Historic Site at 94 Tutela Heights Road, designated by the Government of Canada on July 1, 1996 (City of Brantford 2015). No other culturally-significant structures or built features (e.g., heritage structures, landscapes, plaques, monuments, cemeteries, etc.) that would affect assessment strategies were identified (MTC 2011:16–17). The property inspection documented wet areas and disturbance in several parts of the study area, but no other features that would affect assessment strategies were identified (e.g., overgrown vegetation, heavier soils than expected, etc.).

2.3 Analysis and Conclusions

In addition to the relevant historical sources and the results of past excavations and surveys (see Section 1.2–Section 1.3), the archaeological potential of a property can be assessed using its soils, hydrology and landforms as considerations. What follows is an in-depth analysis of the archaeological potential of the study area, which incorporates the results of the property inspection conducted in October 2015.

Throughout southern Ontario, scholars have noted a strong association between site locations and waterways. Young, Horne, Varley, Racher and Clish, for example, state that "either the number of streams and/or stream order is always a significant factor in the positive prediction of site presence" (1995:23). They further note that certain types of landforms, such as moraines, seem to have been favoured by different groups throughout prehistory (Young et al. 1995:33). According to Janusas (1988:1), “the location of early settlements tended to be dominated by the proximity to reliable and potable water resources”. Site potential modeling studies (Peters 1986; Pihl 1986) have found that most prehistoric archaeological sites are located within 300 m of either extant water sources or former bodies of water, such as post-glacial lakes.

While many of these studies do not go into detail as to the basis for this pattern, Young, Horne, Varley, Racher and Clish (1995) suggest that the presence of streams would have been a significant attractor for a host of plant, game and fish species, encouraging localized human exploitation and settlement. Additionally, lands in close proximity to streams and other water courses were highly valued for the access they provided to transportation and communication

routes. Primary water sources (e.g., lakes, rivers, streams and creeks) and secondary water sources (e.g., intermittent streams and creeks, springs, marshes and swamps) are therefore of pivotal importance for identifying archaeological potential (MTC 2011:17).

Section 1.3.1 of the *S&Gs* (MTC 2011:17–18) emphasizes the following six features and characteristics as being additional indicators of positive potential for Pre-Contact archaeological materials: 1) features associated with extinct water sources (glacial lake shorelines, relic river channels, shorelines of drained lakes, etc.); 2) the presence of pockets of well-drained soils (for habitation and agriculture); 3) elevated topography (e.g. drumlins, eskers, moraines, knolls, etc.); 4) distinctive landforms that may have been utilized as spiritual sites (waterfalls, rocky outcrops, caverns, etc.); 5) proximity to valued raw materials (quartz, ochre, copper, chert outcrops, medicinal flora, etc.); and 6) accessibility of plant and animal food sources (spawning areas, migratory routes, prairie lands, etc.).

Conversely, it must be understood that non-habitational sites (e.g., burials, lithic quarries, kill sites, etc.) may be located anywhere. Potential modeling appears to break down when it comes to these idiosyncratic sites, many of which have more significance than their habitational counterparts due to their relative rarity. The Stage 1 archaeological assessment practices outlined in Section 1.4.1 of the *S&Gs* (MTC 2011:20–21) ensure that these important sites are not missed, as no areas can be exempt from test pit survey unless both a background study and property inspection have been completed.

With the development of integrated 'complex' economies in the Euro-Canadian era, settlement tended to become less dependent upon local resource procurement/production and more tied to wider economic networks. As such, proximity to transportation routes (roads, canals, etc.) became the most significant predictor of site location, especially for Euro-Canadian populations. In the early Euro-Canadian era (pre-1850), when transport by water was the norm, sites tended to be situated along major rivers and creeks—the 'highways' of their day. With the opening of the interior of the province to settlement after about 1850, sites tended to be more commonly located along historically-surveyed roads. Section 1.3.1 of the *S&Gs* (MTC 2011:18) recognizes trails, passes, roads, railways and portage routes as examples of such early transportation routes.

In addition to transportation routes, Section 1.3.1 of the *S&Gs* (MTC 2011:18) emphasizes three other indicators of positive potential for Euro-Canadian archaeological materials: 1) areas of early settlement (military outposts, pioneer homesteads or cabins, early wharfs or dock complexes, pioneer churches, early cemeteries, etc.); 2) properties listed on a municipal register, designated under the *Ontario Heritage Act* or otherwise categorized as a federal, provincial or municipal historic landmark/site; and 3) properties identified with possible archaeological sites, historical events, activities or occupations, as identified by local histories or informants.

The Stage 1 assessment resulted in the identification of numerous features of archaeological potential that would directly affect Stage 2 survey interval requirements within the study area (see Image 1–Image 2). These local indicators of archaeological potential include multiple primary water sources (the Grand River and several unnamed tributaries), one historic roadway (Tutela Heights Road), one National Historic Site (94 Tutela Heights Road) and three historic

homestead localities visible in *Brantford Township West of River* from Page and Smith's *Illustrated Historical Atlas of the County of Brant* (1875).

ARA's visual inspection, coupled with the analysis of recent aerial imagery, topographic mapping and digital environmental data, resulted in the identification of several areas of no archaeological potential within the assessed lands. Section 2.1 of the *S&Gs* (MTC 2011:28) states that lands that 1) are permanently wet, 2) consist of exposed bedrock, 3) are sloped > 20° or 4) have been subject to extensive and deep land alterations can be considered as having no archaeological potential, and are therefore exempt from requiring Stage 2 survey. The identified areas of no archaeological potential can be summarized as follows:

- Permanently wet areas were identified along the Grand River in the northern part of the study area; and
- Deep land alterations have resulted in the removal of archaeological potential from the platforms, ditches and embankments of Tutela Heights Road, Davern Road and Phelps Road, the footprint and environs of the existing residential housing along Tutela Heights Road and Davern Road, as well as the parking lot for the Bell Homestead National Historic Site. These areas had all clearly been impacted by past earth-moving/construction activities, resulting in the disturbance of the original soils to a significant depth (see Image 3–Image 8).

The remainder of the assessed area either has potential for Pre-Contact and Euro-Canadian archaeological materials or requires test pit survey to confirm the presence/extent of any subsurface disturbances (see Image 9–Image 12). Although there are clearly areas of slope located on the north side of Tutela Heights Road, there are also testable flat areas that have archaeological potential. This area should be systematically examined during a more intensive Stage 2 survey to properly identify the limits of any areas sloped > 20°.

The Stage 1 assessment determined that the study area currently comprises a mixture of areas of archaeological potential and areas of no archaeological potential. At the time of assessment, 25.74% (7.75 ha) of the study area had archaeological potential and fell within agricultural or plough-accessible areas, 58.50% (17.61 ha) of the study area had archaeological potential and fell within wooded or grassed areas located < 300 m from a feature of archaeological potential, 7.51% (2.26 ha) was found to be permanently wet and 8.25% (2.48 ha) was identified as disturbed. The identified areas of archaeological potential and areas of no archaeological potential (separated by class or category) are depicted in Map 28.

3.0 RECOMMENDATIONS

The Stage 1 assessment determined that the study area currently comprises a mixture of areas of archaeological potential and areas of no archaeological potential (see Map 28). ARA recommends that all identified areas of archaeological potential that could be impacted by the project be subject to a Stage 2 property assessment in advance of construction.

In accordance with the requirements set out in Section 2.1 of the *S&Gs* (MTC 2011:28–39), the following assessment strategies should be utilized:

- For recently cultivated or actively cultivated lands, the assessment must be conducted using the pedestrian survey method at an interval of ≤ 5 m. All ground surfaces must be recently ploughed, weathered by one heavy rainfall, and provide at least 80% visibility. If archaeological materials are encountered in the course of the pedestrian survey, the transect interval must be closed to 1 m and a close inspection of the ground must be conducted for 20 m in all directions.
- For lands where ploughing is not possible or viable (e.g., wooded areas; pasture with high rock content; abandoned farmland with heavy brush and weed growth; and gardens, parkland or lawns which will remain in use for several years after the survey), the assessment must be conducted using the test pit survey method. A test pit survey interval of ≤ 5 m will be required due to the proximity of the lands to the identified features of archaeological potential. Each test pit must be excavated into the first 5 cm of subsoil, and the resultant pits must be examined for stratigraphy, cultural features and/or evidence of fill. The soil from each test pit must be screened through mesh with an aperture of no greater than 6 mm and examined for archaeological materials.

The identified areas of no archaeological potential are not recommended for further assessment. It is requested that this report be entered into the *Ontario Public Register of Archaeological Reports*, as provided for in Section 65.1 of the *Ontario Heritage Act.*

4.0 ADVICE ON COMPLIANCE WITH LEGISLATION

Section 7.5.9 of the *S&Gs* requires that the following information be provided for the benefit of the proponent and approval authority in the land use planning and development process (MTC 2011:126–127):

- This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.
- It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.
- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.
- The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

5.0 IMAGES

Image 1: Feature of Archaeological Potential – Bell Homestead National Historic Site
(Photo Taken on October 2, 2015; Facing North)

Image 2: Feature of Archaeological Potential – Historic Roadway
(Photo Taken on October 2, 2015; Facing Southwest)

Image 3: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing Southeast)

Image 4: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing East)

Image 5: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing Northeast)

Image 6: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing West)

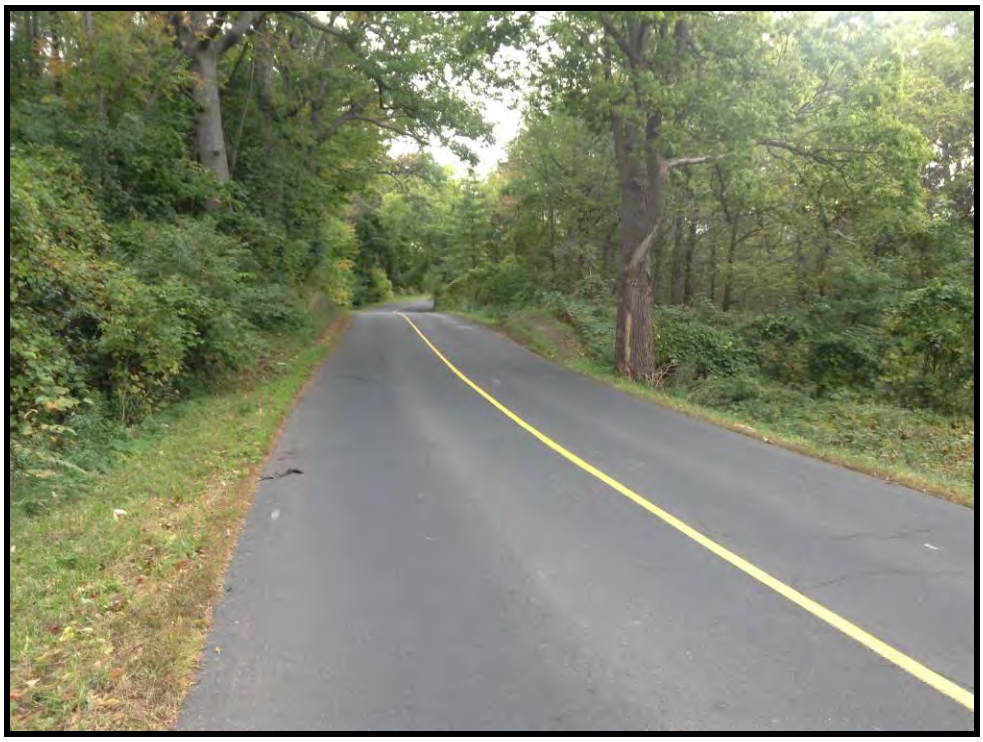


Image 7: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing Southwest)

Image 8: Area of No Archaeological Potential – Disturbed
(Photo Taken on October 2, 2015; Facing Northwest)

Image 9: Field Conditions
(Photo Taken on October 2, 2015; Facing North)

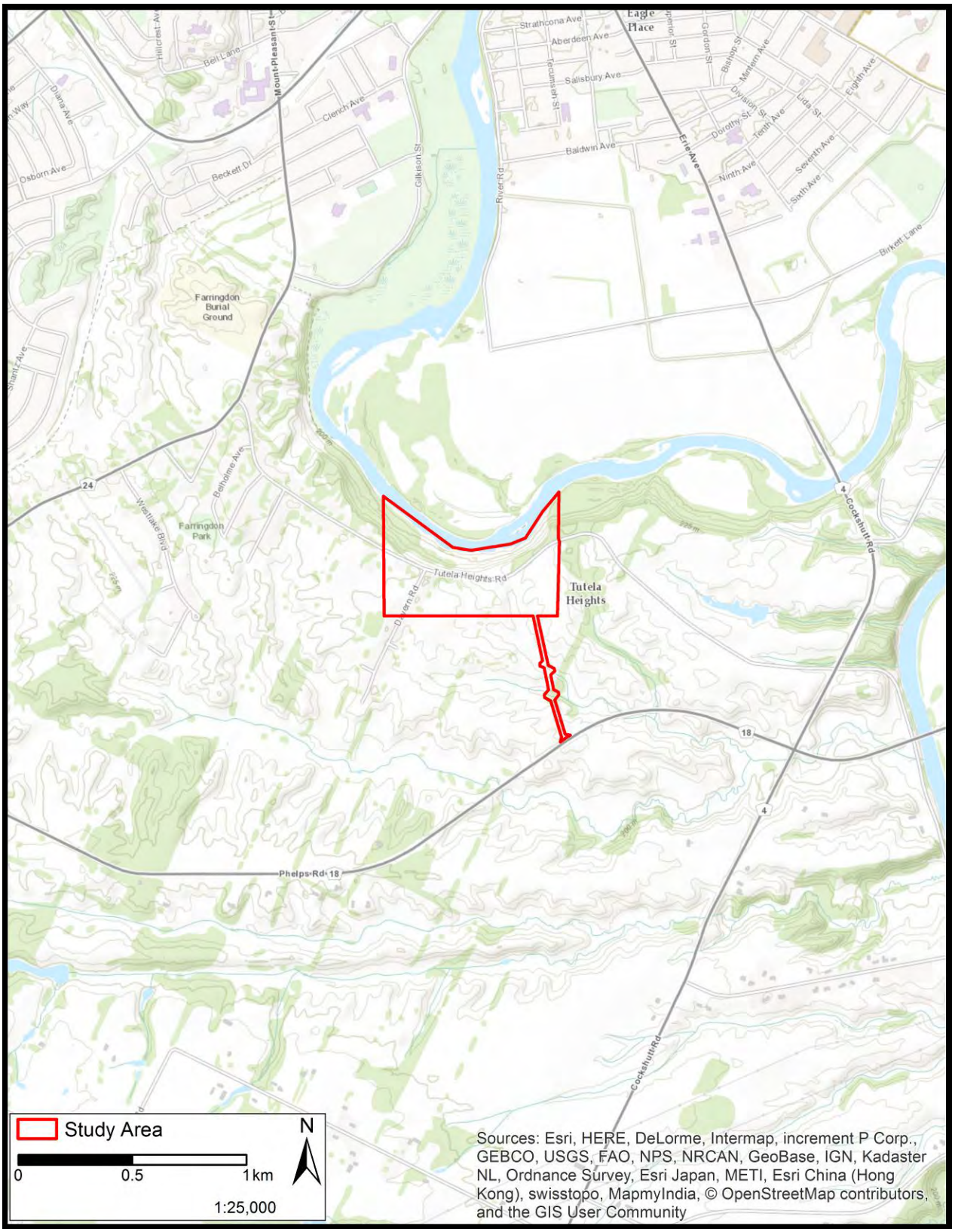
Image 10: Field Conditions
(Photo Taken on October 2, 2015; Facing Southeast)

Image 11: Field Conditions
(Photo Taken on October 2, 2015; Facing South)

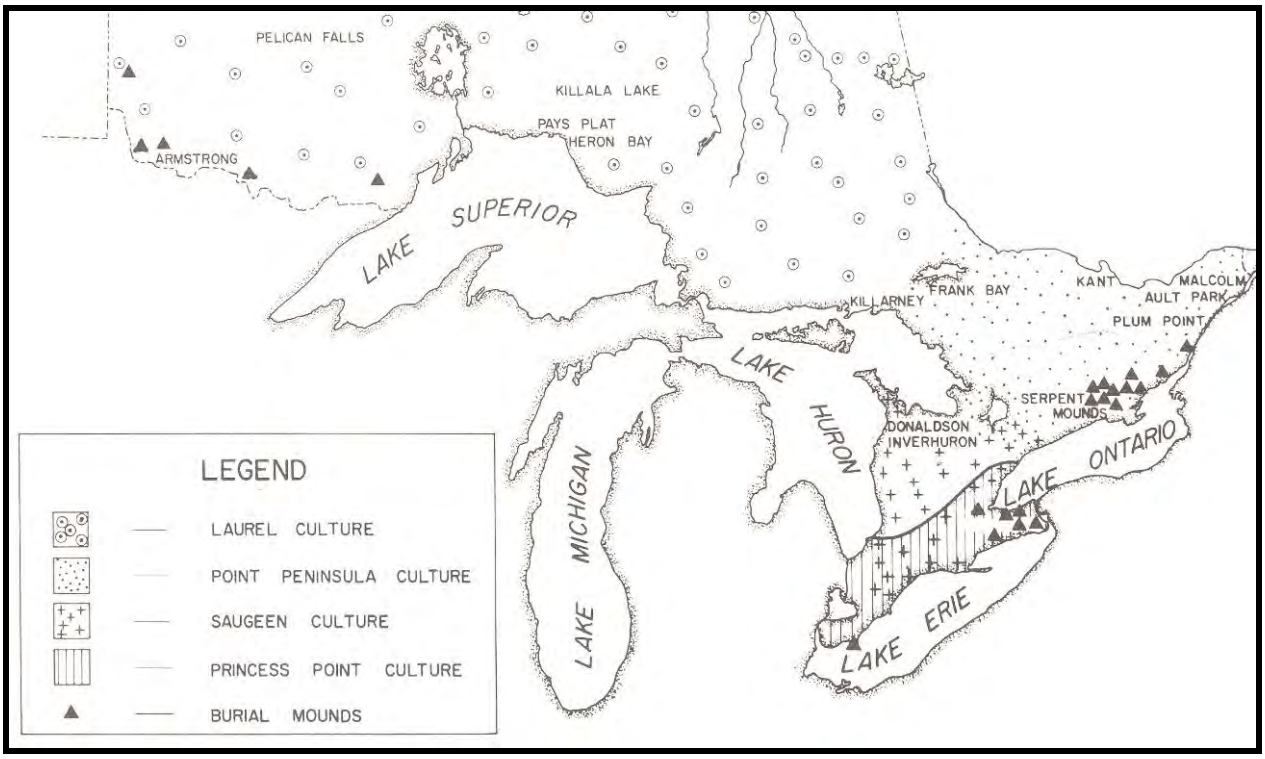
Image 12: Field Conditions
(Photo Taken on October 2, 2015; Facing Northeast)

6.0 MAPS

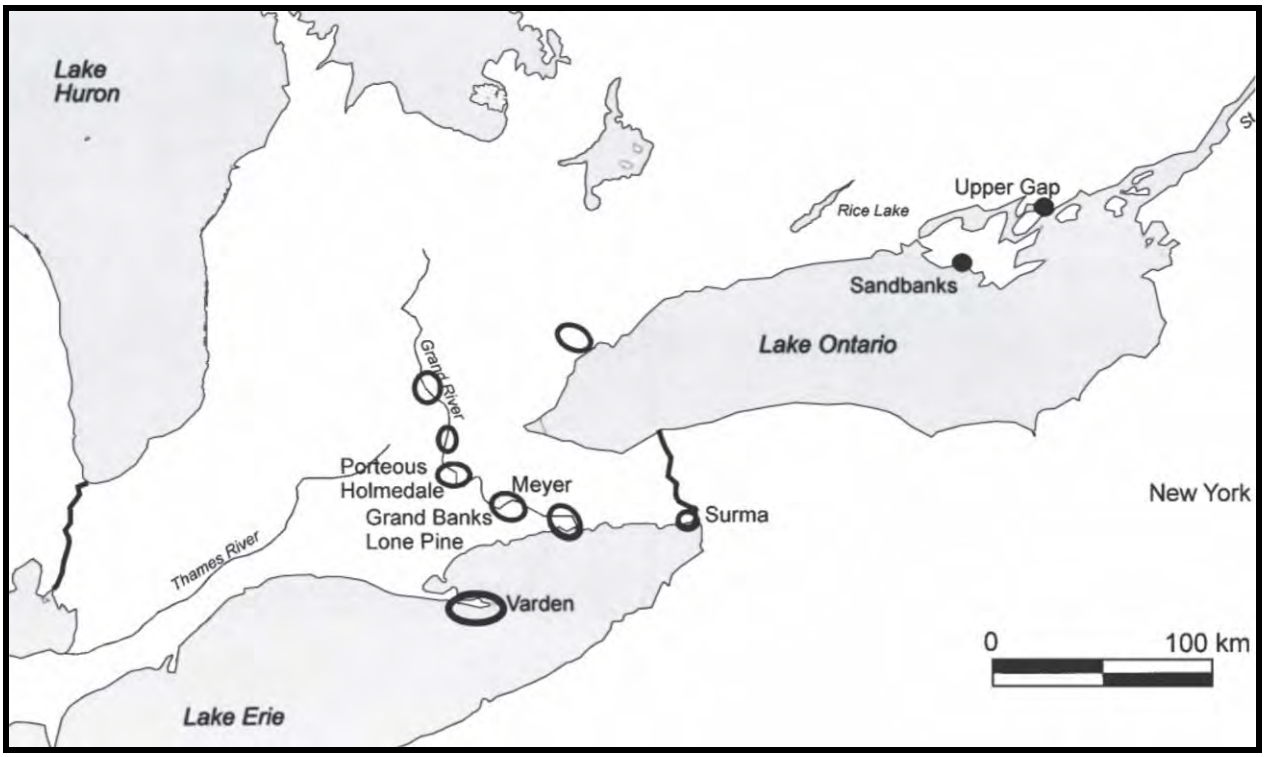
Map 1: Location of the Study Area in the Province of Ontario
(NRC 2002)



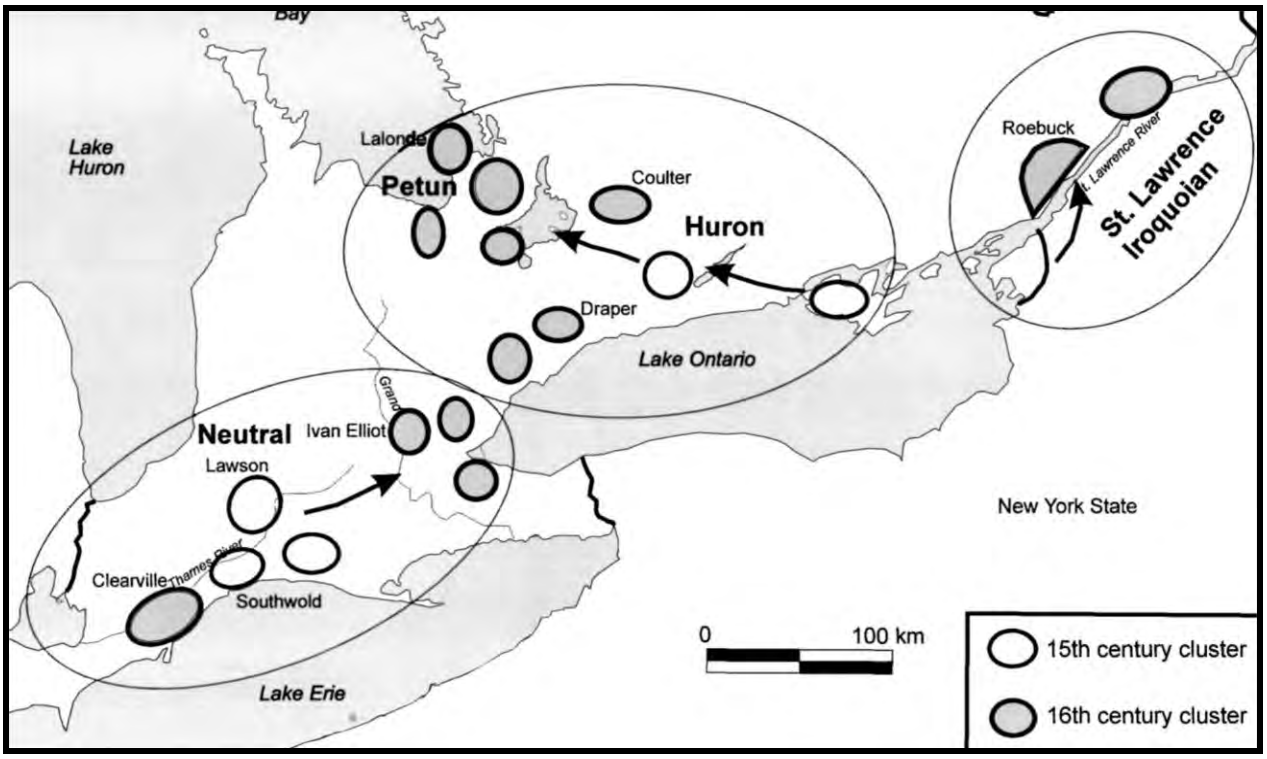
Map 2: Location of the Study Area in Brant County
(Produced by ARA under licence using ArcGIS® software by Esri, © Esri)



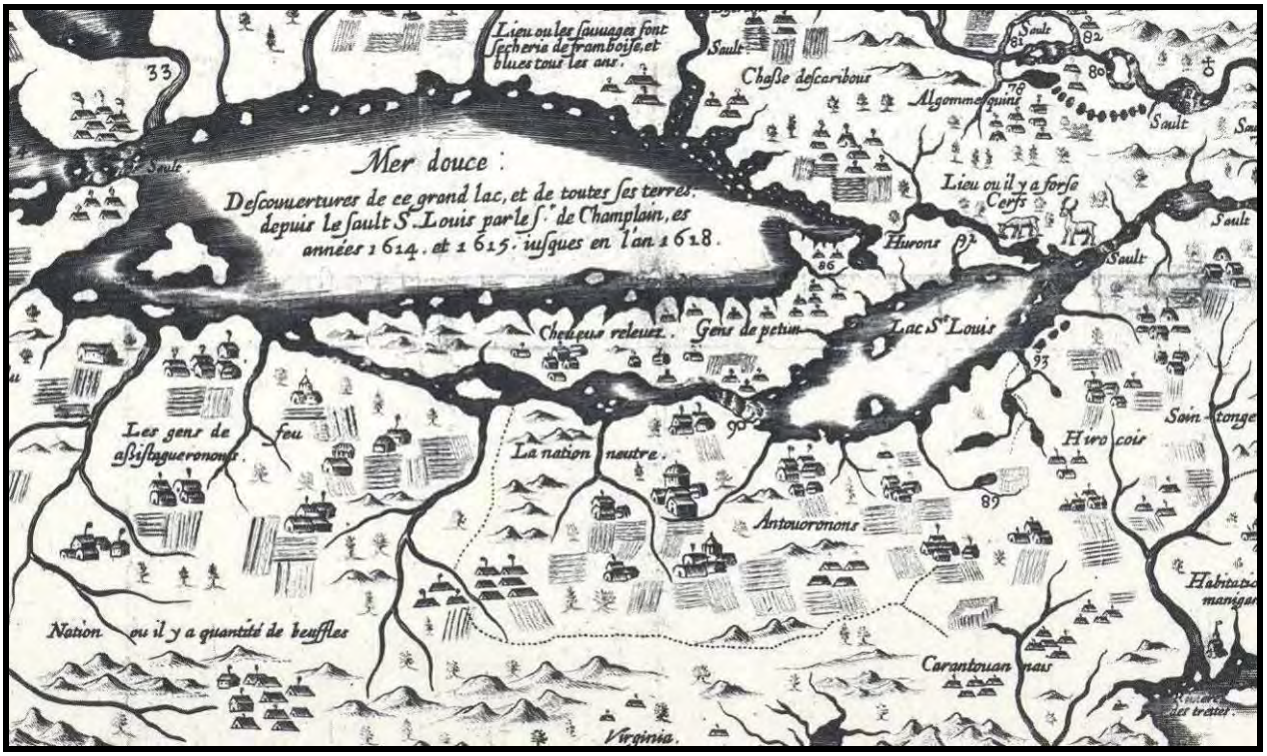
Map 3: Middle Woodland Period Cultures
(Wright 1972:Map 4)



Map 4: Princess Point Site Clusters
(Warrick 2000:Fig. 3)

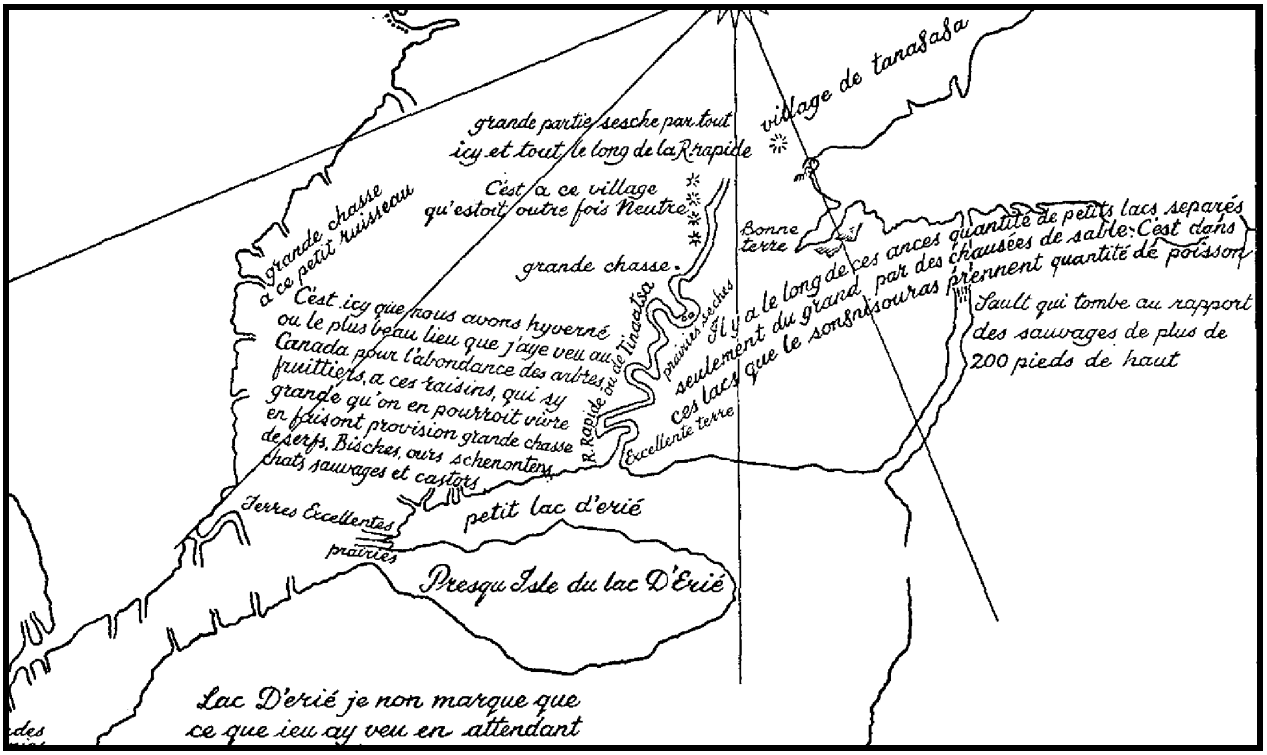


Map 5: Pre-Contact Iroquoian Site Clusters
(Warrick 2000:Figure 10)



Map 6: Detail from S. de Champlain's *Carte de la Nouvelle France* (1632)
(Gentilcore and Head 1984:Map 1.2)

Map 7: Detail from N. Sanson's *Le Canada, ou Nouvelle France* (1656)
(Gentilcore and Head 1984:Map 1.10)



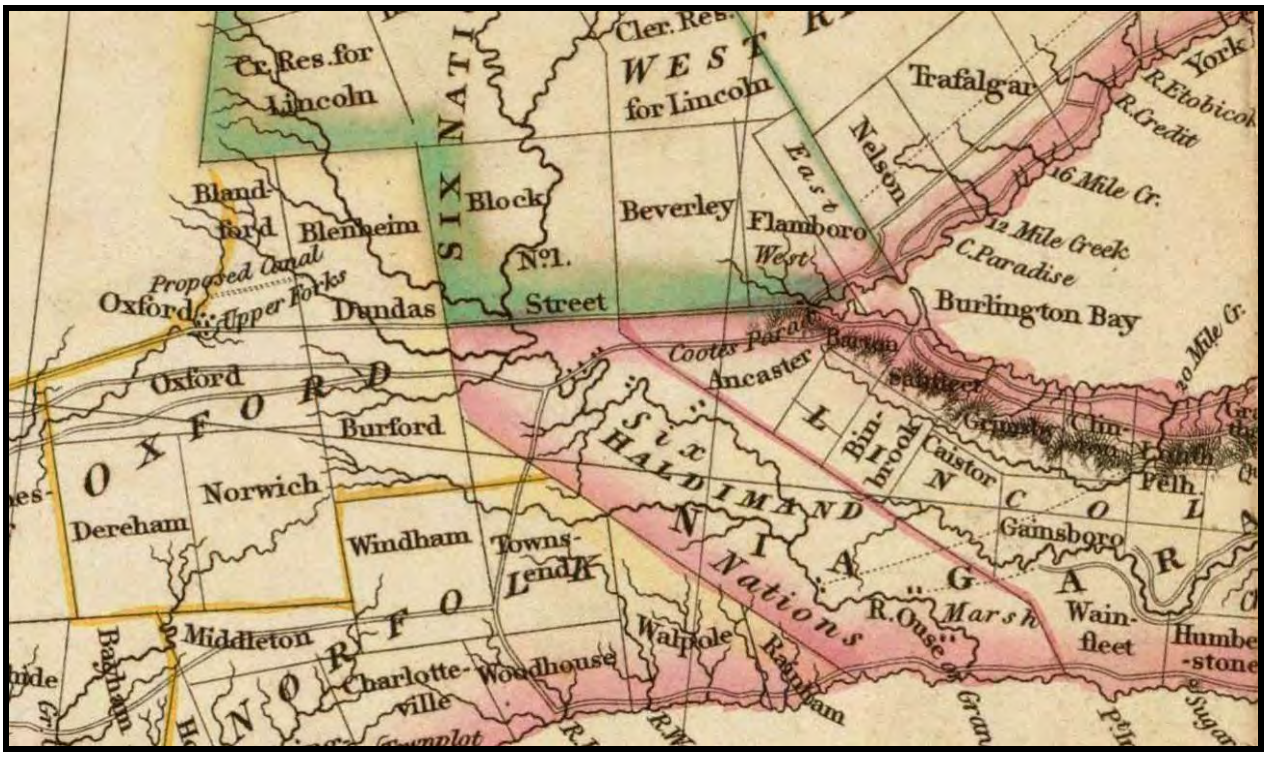
Map 8: Detail from the Map of Galinée's Voyage (1670)
(Lajeunesse 1960:Map 2)

Map 9: Detail from H. Popple's *A Map of the British Empire in America* (1733)
(Cartography Associates 2009)

Map 10: Detail from R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776)
(Cartography Associates 2009)

Map 11: The Haldimand Tract (Left) and the Haldimand Proclamation (Right)
(Six Nations Council 2010:2)

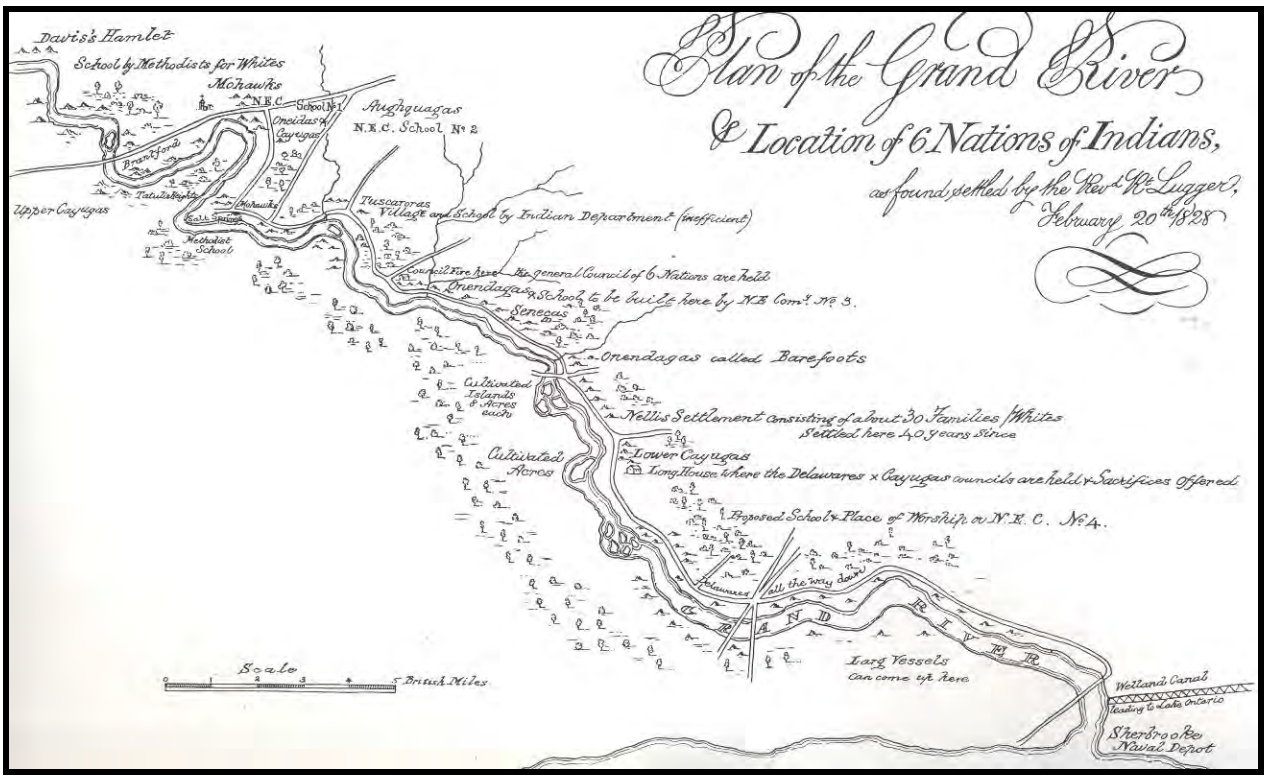
Map 12: Detail from D.W. Smyth's *A Map of the Province of Upper Canada* (1800)
(Cartography Associates 2009)



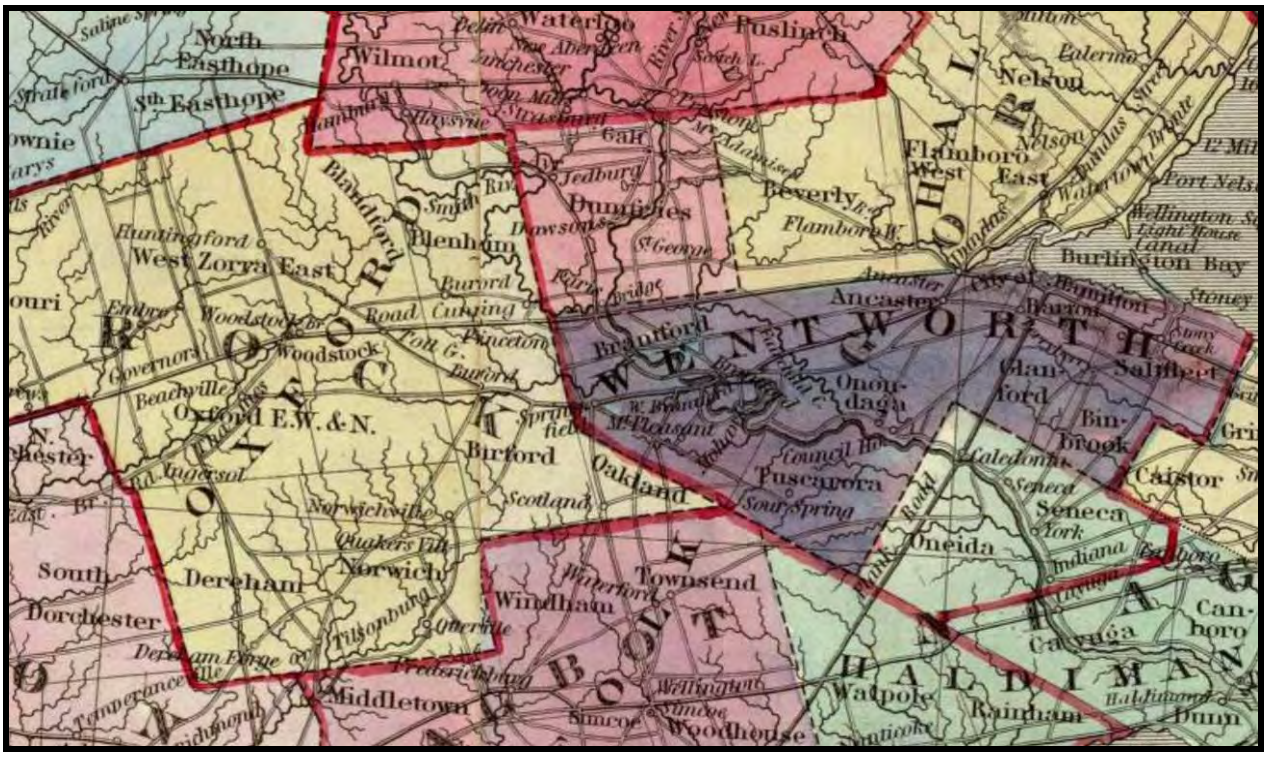
Map 13: Detail from J. Purdy's *A Map of Cabotia* (1814)
(Cartography Associates 2009)

Map 14: Detail from D.W. Smyth's *A Map of the Province of Upper Canada, 2nd Edition* (1818)
(Cartography Associates 2009)

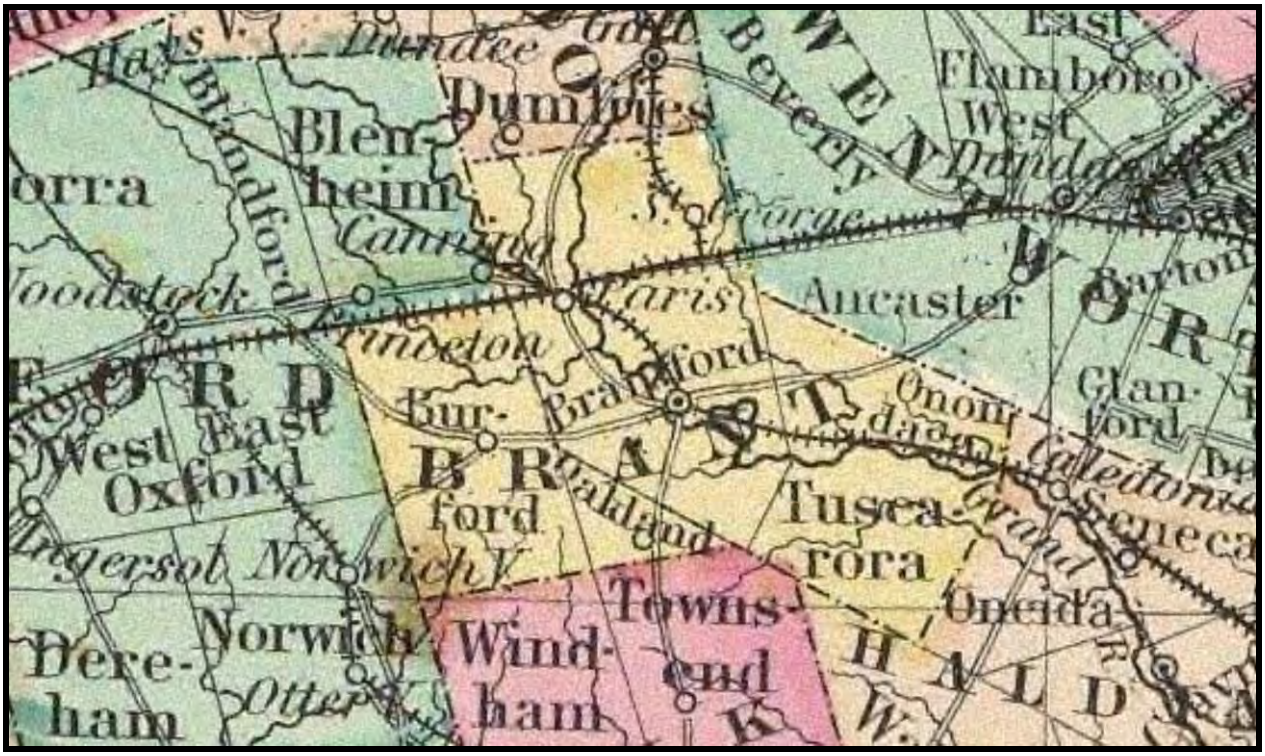
Map 15: Detail from J. Arrowsmith's *Upper Canada* (1837)
(Cartography Associates 2009)



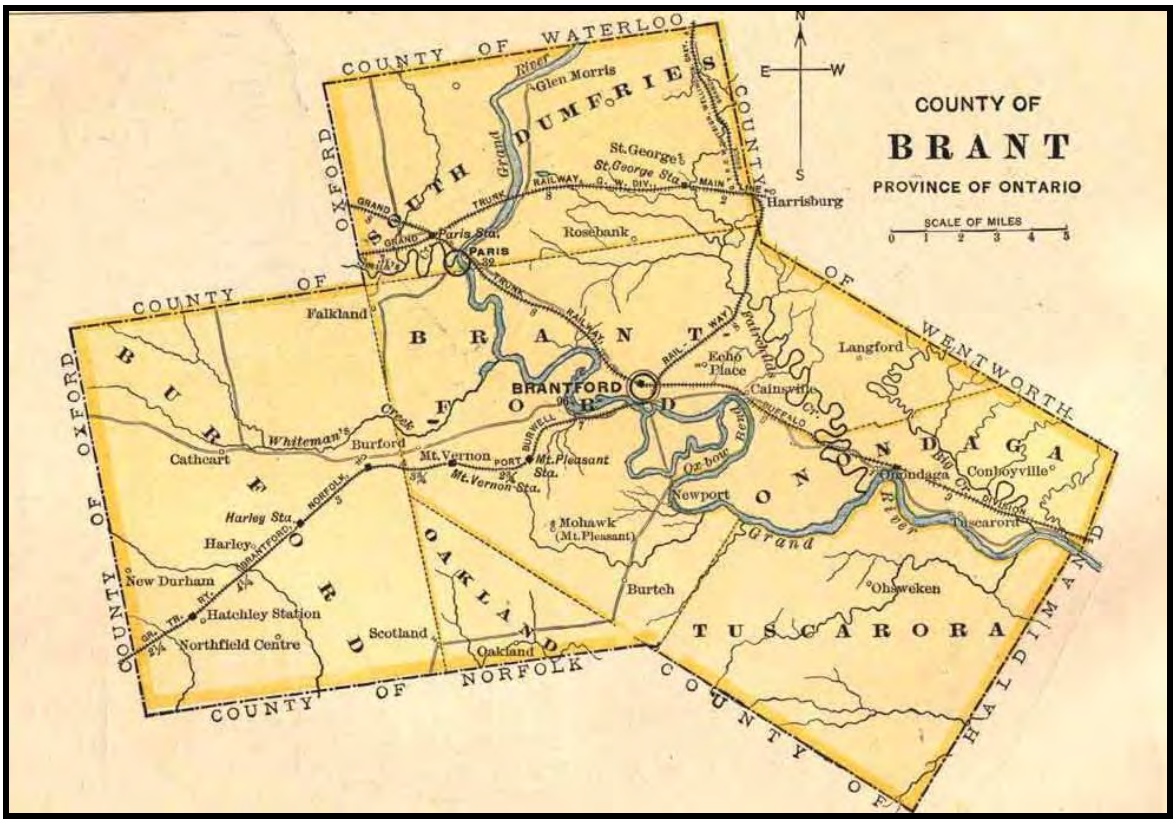
Map 16: G. Matthew's Reproduction of Rev. R. Lugger's *Plan of the Grand River & Location of 6 Nations of Indians* (1828)
(Johnston 1964:Figure 2)



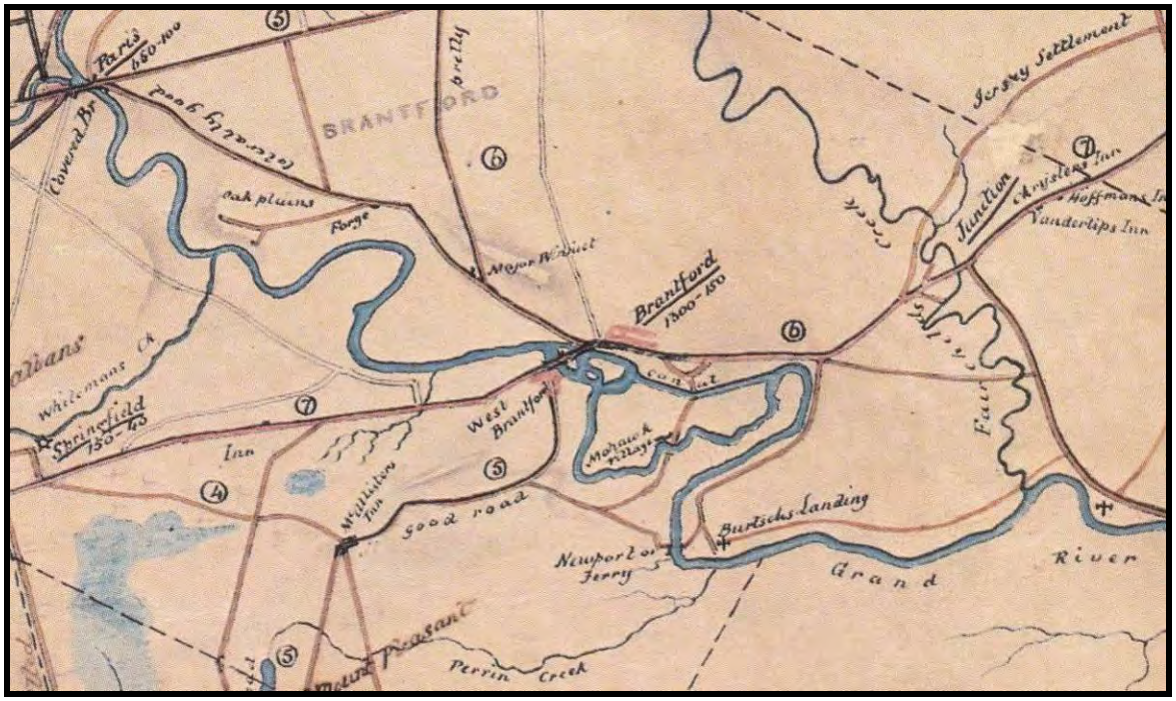
Map 17: Detail from J. Bouchette's *Map of the Provinces of Canada* (1846)
(Cartography Associates 2009)



Map 18: Detail from G.W. Colton's *Canada West* (1856)
(Cartography Associates 2009)



Map 19: *County of Brant* from W.J. Gage and Co.'s *County Atlas* (1886)
(W.J. Gage and Co. 1886)

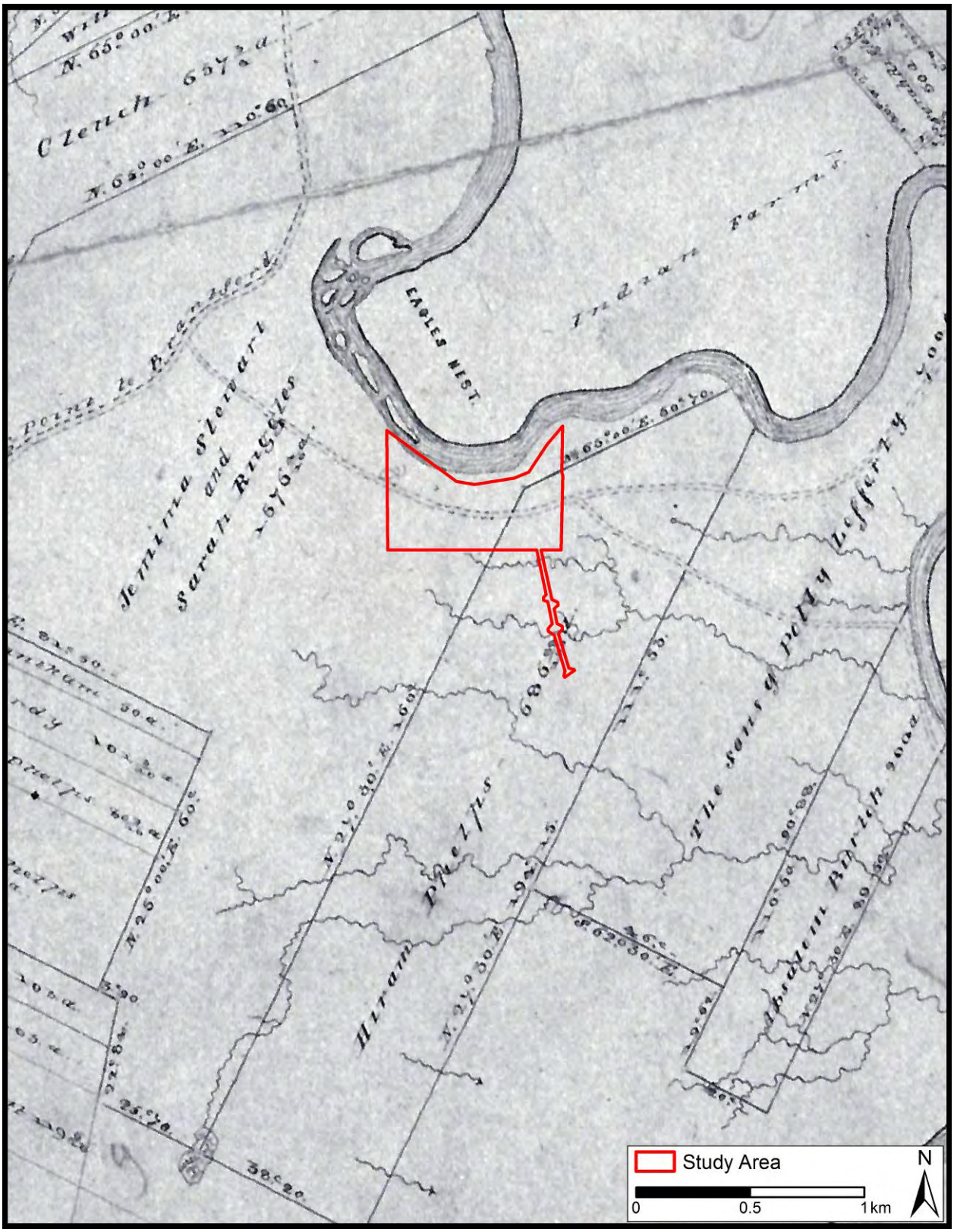


Map 20: Detail from Major B. de Rotenberg's *Map of the Principal Communications in Canada West* (1850)
(Gentilcore and Head 1984: Map 6.4)

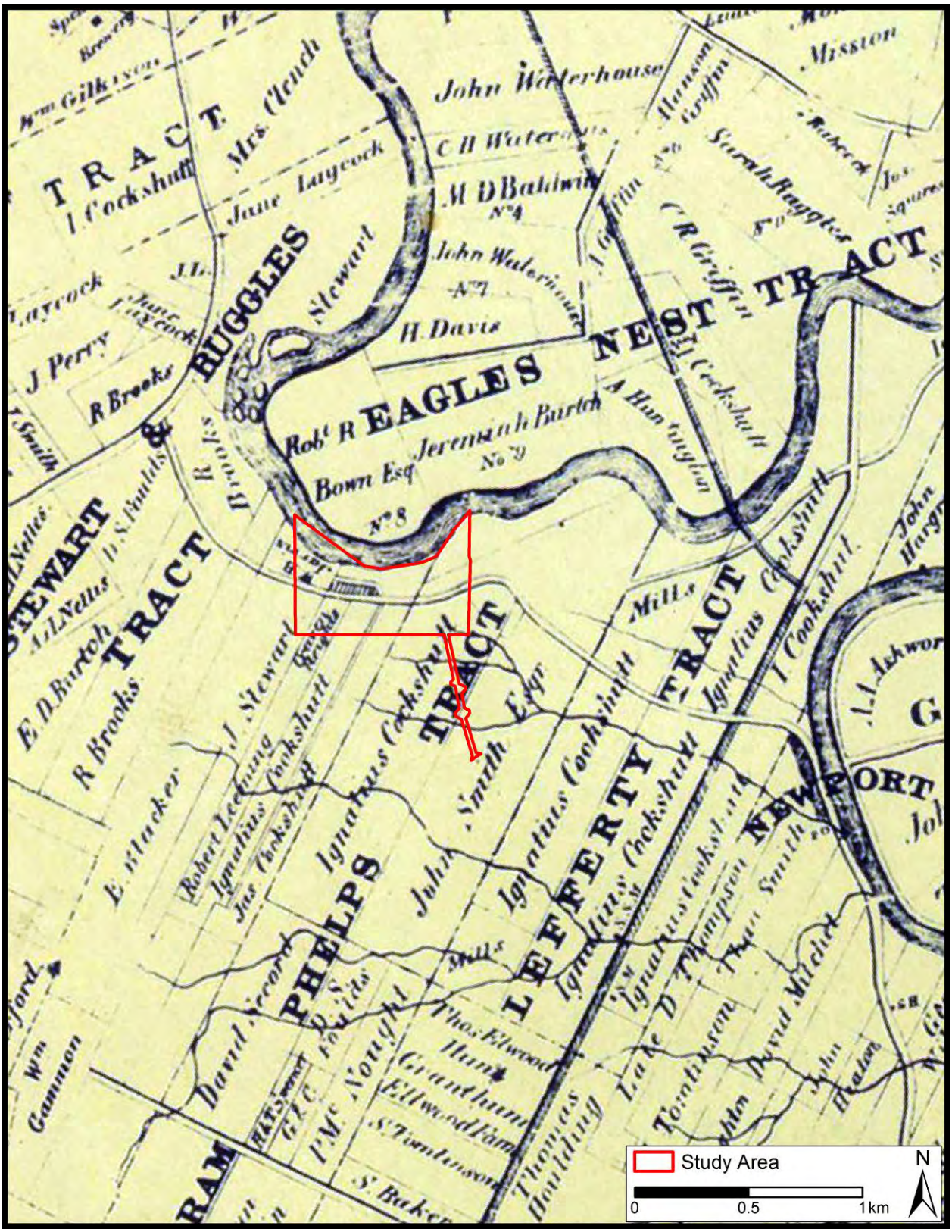
Map 21: *Brantford Township West of River* from Page & Smith's *Illustrated Historical Atlas of the County of Brant* (1875)
(McGill University 2001)

Map 22: *Brantford Township East of River* from Page & Smith's *Illustrated Historical Atlas of the County of Brant* (1875)
(McGill University 2001)

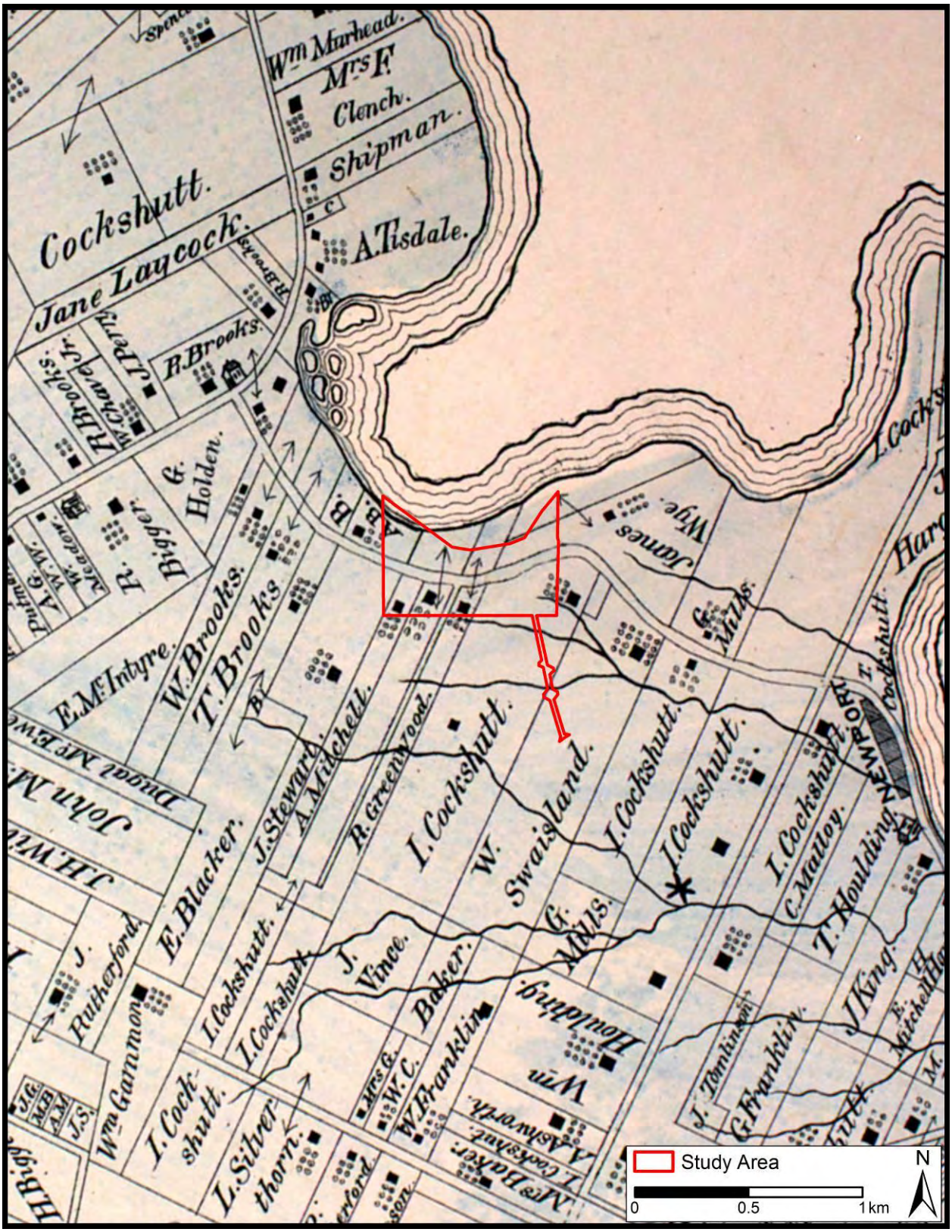
Map 23: H. Hale's *A Sketch Map showing the Stations & Direction of the Tutelo Migrations between A.D. 1671 and 1780* (1883)
(Hale 1883:47)



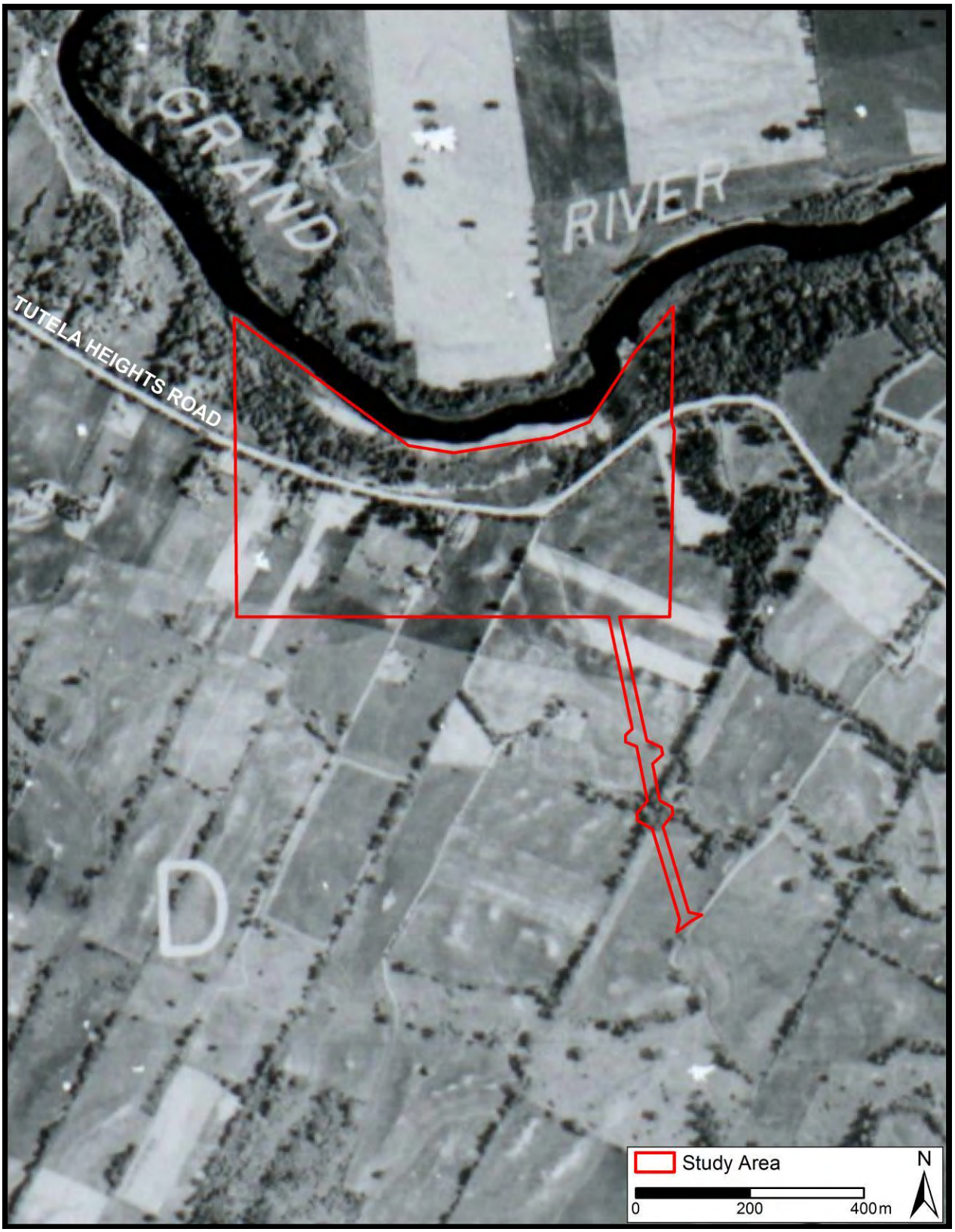
Map 24: Detail from L. Burwell's *Plan of the Township of Brantford in the County of Wentworth in the District of Gore* (1839)
(Gentilcore and Head 1984:Map 4.24)



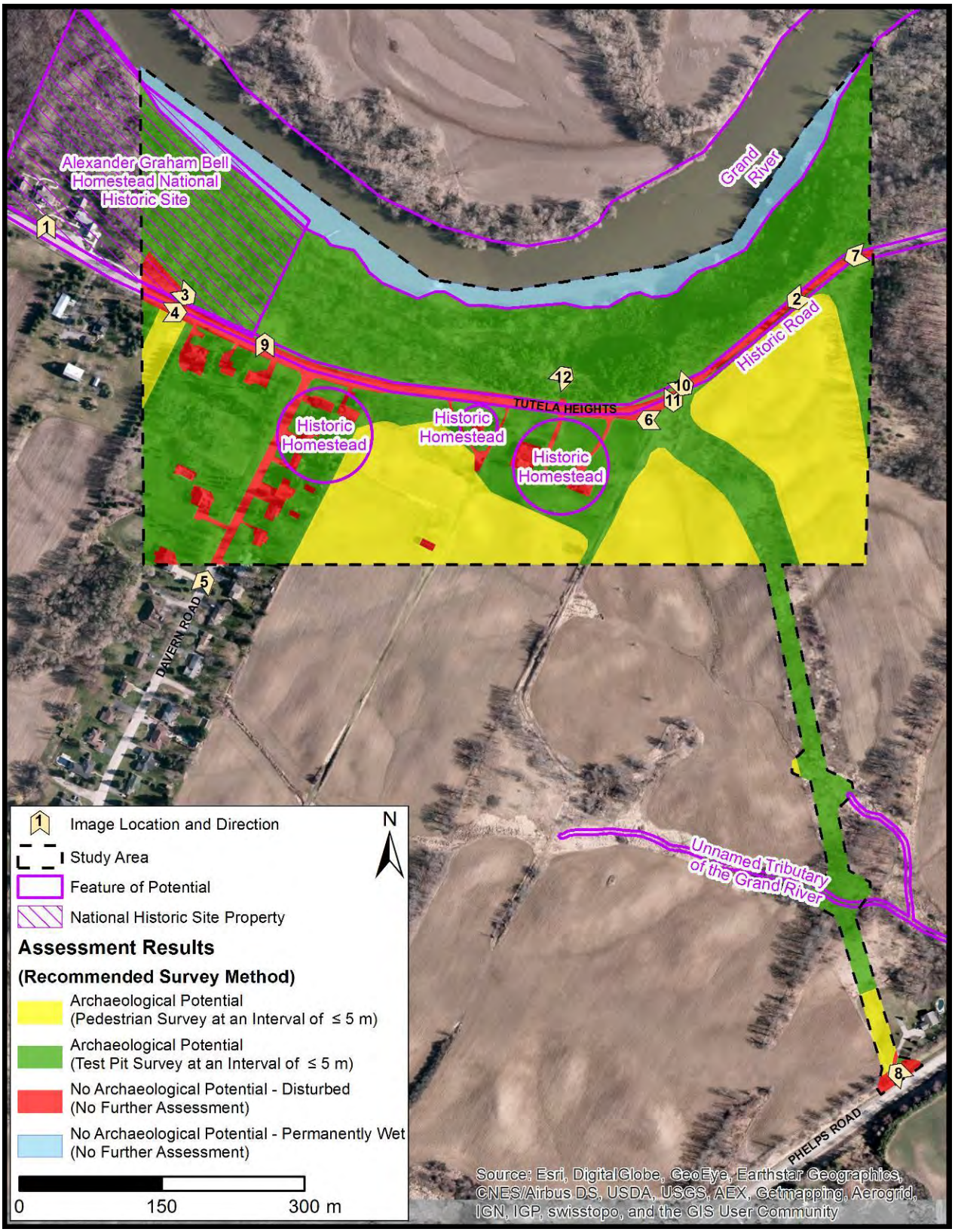
Map 25: Detail from G.R. and G.M. Tremaine's *Tremaine's Map of the County of Brant, Canada West* (1858), Showing the Study Area
(Brock University 2010)



Map 26: Detail of *Brantford Township West of River* from Page and Smith's *Illustrated Historical Atlas of the County of Brant* (1875)
(McGill University 2001)



Map 27: Historic Aerial Image (1954), Showing the Study Area
(University of Toronto 2009)



Map 28: Stage 1 Results – Potential Modelling and Image Locations
(Produced by ARA under licence using ArcGIS® software by Esri, © Esri)

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APPENDICES

Appendix A: Registered or Known Archaeological Sites in the Vicinity of the Study Area

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-6	TUTELA	1974 (Unknown)	Middle Woodland (Princess Point)	Unknown	None recorded.
			Late Woodland		
AgHb-282	N/A	2006 (Martelle)	Pre-Contact	Unknown	Stage 1–2 (Martelle): 3 artifacts in a 7.5 x 7.5 m area, recommended for further assessment; Stage 3 (Martelle): 149 artifacts in an 11 x 11 m area, not recommended for further assessment.
			Post-Contact	Unknown	
AgHb-283	Papple 2	2006 (Martelle)	Post-Contact	House	Stage 1–2 (Martelle): 13 artifacts in a 1 x 1 m area, not recommended for further assessment.
N/A	(H1)	2010 (Steiss)	Post-Contact	Isolated Findspot	Stage 1–2 (Steiss): 2 artifacts in a 10 x 10 m area, not recommended for further assessment.
AgHb-413	Tutela Heights (H2)	2010 (Steiss)	Late Woodland	Possibly Historic Aboriginal	Stage 1–2 (Steiss): 360 artifacts in an 81 x 77 m area, recommended for further assessment; Stage 3 (Steiss): 2,702 artifacts in a 100 x 90 m area from 100 test units, with 10 units exhibiting potential features, recommended for further assessment.
			Post-Contact		
N/A	(H3)	2010 (Steiss)	Post-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 metal button identified during pedestrian survey, not recommended for further assessment;
AgHb-414	AgHb-414 (H4)	2010 (Steiss)	Post-Contact	Homestead	Stage 1–2 (Steiss): 105 artifacts in a 37 x 33 m area, recommended for further work, avoidance and protection migration strategy initially recommended.
		2013 (Williams)		Farmstead	Stage 3 (Williams): 178 artifacts in a 37 x 33 m area, unknown recommendation.
AgHb-415	Blacker's Brickworks	2010 (Steiss)	Post-Contact	Manufacturing	Stage 1–2 (Steiss): 129 artifacts in a 55 x 68 m area, recommended for further assessment; Stage 3: 285 artifacts in a 55 x 68 m area during a CSP, no test units excavated.
		2010 (MacDonald)			Stage 3: 436 artifacts collected, recommended for further assessment.
		2013 (Robertson)			Stage 4 Excavation: No further information available.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-416	Blacker I (H5)	2010 (Steiss)	Post-Contact	Homestead	Stage 1–2 (Steiss): A 37 x 37 m scatter of Euro-Canadian artifacts, 71 artifacts collected from 11 PTPs, 10 artifacts collected from northern field and 15 artifacts collected from southern field, mid-19th to early 20th century diagnostics, recommended for further assessment; Stage 3 (Steiss): A total of 22 one-metre units excavated, 2,220 artifacts recovered, not recommended for further assessment.
AgHb-417	Blacker II (H6)	2010 (Steiss)	Post-Contact	Farmstead	Stage 1–2 (Steiss): 25 artifacts collected from 8 PTPs, and another 20 artifacts from the field north and south of the positive test pit area, culminating in 45 artifacts a 15 x 33 m area, recommended for further work; Stage 3 (Steiss): 821 artifacts recovered from 20 one-metre units, recommendation unknown.
AgHb-418	(P1)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 26 artifacts in an 18 x 29 m area, recommended for further assessment; Stage 3 (Steiss): 47 one-metre units were excavated over a 30 x 40 m area, high yield were recorded in 10 of these units, recommended for further assessment.
		2010 (Riddle)			Stage 4 (Riddle): 282 artifacts collected during the excavation.
AgHb-419	(P2)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 biface fragment identified during pedestrian survey, not recommended for further assessment.
N/A	(P3)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1-2 (Steiss): 1 piece of shatter, not recommended for further assessment.
AgHb-420	(P4)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 projectile point fragment identified during pedestrian survey, not recommended for further assessment.
AgHb-421	(P5)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 24 artifacts in a 30 x 17 m area including two Brewerton corner-notched projectile points, recommended for further assessment; Stage 3 (Steiss): 45 one-metre units were excavated in a 30 x 30 m area, unknown recommendation.
N/A	(P6)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-422	(P7)	2010 (Steiss)	Early Woodland	Isolated Findspot	Stage 1–2 (Steiss): 1 Early Woodland, Meadowood biface fragment was identified during pedestrian survey, not recommended for further assessment (OASD states 20 x 20 m scatter and undetermined Pre-Contact).
N/A	(P8)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-423	(P9)	2010 (Slocki)	Late Archaic	Scatter	Stage 1–2 (Slocki/ Steiss): 16 artifacts in a 47 x 22 m area including an Early Woodland, Meadowood biface fragment and a fragment of a probable Late Archaic corner-notched projectile point, recommended for further assessment; Stage 3 (Steiss): 201 artifacts recovered, no further details provided.
		2010 (Steiss)	Early Woodland		
N/A	(P10)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in an 11 x 9 m area identified during pedestrian survey, recommended for the site to be revisited.
N/A	(P11)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P12)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P13)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P14)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P15)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 16 x 18 m area identified during pedestrian survey, not recommended for further assessment.
N/A	(P16)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 secondary flakes identified during pedestrian survey, not recommended for further assessment.
N/A	(P17)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-424	(P18)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 78 artifacts in a 62 x 53 m area including two

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
			Late Archaic		complete Brewerton corner-notched projectile points, one of which is made in slate, recommended for further assessment (no associated Borden in PastPort site search).
N/A	(P19)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-426	(P20)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 13 artifacts in a 17 x 11 m area, including a biface and a biface fragment, recommended for further assessment (no associated Borden in PastPort site search).
N/A	(P21)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P22)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.
AgHb-427	(P23)	2010 (Steiss)	Middle Archaic Late Archaic	Scatter	Stage 1–2 (Steiss): 102 artifacts in a 91 x 44 m area including one intact Innes and two broken unidentified projectile points, recommended for further assessment.
N/A	(P24)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 secondary flakes identified during pedestrian survey, not recommended for further assessment.
N/A	(P25)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts identified during pedestrian survey, not recommended for further assessment.
AgHb-428	(P26)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in an 8 x 10 m area identified during pedestrian survey, not recommended for further assessment (no associated Borden in PastPort site search).
AgHb-429	(P27)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 7 artifacts in a 5 x 7.5 m area identified during pedestrian survey, recommended for further assessment (no associated Borden in PastPort site search).
AgHb-430	(P28)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 24 artifacts in a 10 x 15 m area identified during pedestrian survey, recommended for further assessment.
N/A	(P29)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-431	(P30)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 7 artifacts in a 10 x 16 m area, recommended for the site to be revisited (no associated Borden in PastPort site search).
N/A	(P31)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-432	(P32)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 3 artifacts in a 5 x 5 m area including one Brewerton side-notched projectile point, recommended for further assessment; Stage 3 (Steiss): Two one-metre units were excavated, an additional three units remain to be excavated.
AgHb-433	(P33)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): A 15 x 14 m scatter of 5 lithics, not recommended for further assessment.
N/A	(P34)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts in a 7 x 5 m, not recommended for further assessment.
N/A	(P35)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P36)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P37)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 secondary flakes identified during pedestrian survey, not recommended for further assessment.
AgHb-434	(P39)	2010 (Steiss)	Late Palaeo-Indian Middle Archaic Late Archaic Middle Woodland	Scatter	Stage 1–2 (Steiss): A 18 x 17 m scatter of 26 lithics, recommended for further assessment; Stage 3 (Steiss): A 70 x 45 m scatter yielding 70 additional lithics, 68 test units yielding 136 lithics, recommended for further assessment.
AgHb-435	(P40)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 23 artifacts in a 26 x 22 m area identified during pedestrian survey, recommended for further assessment (no associated Borden in PastPort site search).
AgHb-436	(P41)	2010 (Steiss)	Late Archaic	Scatter	Stage 1–2 (Steiss): 13 artifacts in a 24 x 14 m area including a Crawford Knoll projectile point, recommended for further assessment (no associated Borden in PastPort site search).

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-437	(P42)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 projectile point base identified during pedestrian survey, recommended for further assessment (no associated Borden in PastPort site search).
N/A	(P43)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts in a 7 x 5 m area, identified during pedestrian survey, not recommended for further assessment.
N/A	(P44)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P45)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P47)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P48)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P49)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P50)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-438	(P51)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 complete biface identified during pedestrian survey, not recommended for further assessment.
N/A	(P52)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-439	(P53)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 scraper identified during pedestrian survey, not recommended for further assessment.
N/A	(P54)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P55)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P56)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
N/A	(P57)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-440	(P58)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 2 artifacts including 1 Brewerton side-notched projectile point identified during pedestrian survey, recommended for further assessment; Stage 3 (Steiss): 5 one-metre units were excavated, with one at the centre of the scatter and the remainder at its cardinals, recommendation unknown.
N/A	(P59)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P60)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-441	(P61)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P62)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 secondary flakes identified during pedestrian survey. Not recommended for further assessment.
N/A	(P63)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P64)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-442	(P65)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in a 3 x 2 m area, identified during pedestrian survey, recommended for further assessment; Stage 3 (Steiss): 5 one-metre units were excavating yielding an additional 34 artifacts in a 42 x 23 m area, recommendation unknown.
AgHb-443	(P67)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 81 artifacts in an 18 x 17 m area, recommended for further assessment; Stage 3 (Steiss): 248 artifacts identified during the CSP in a 75 x 70 m area, 66 one-metre units were excavated recovering an additional 515 artifacts, recommended for further assessment.
		2011 (Riddle)			Stage 4 (Riddle): 718 artifacts collected during the excavation.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-444	(P68)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 26 artifacts in a 29 x 19 m area, recommended for further assessment (no associated Borden in PastPort site search).
N/A	(P69)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P70)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 flakes identified during pedestrian survey, not recommended for further assessment.
N/A	(P71)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P74)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 pieces of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P75)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P76)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P77)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P78)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P79)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P80)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-445	(P81)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts in a 17 x 10 m area including a graver and a tip of a projectile point, recommended for further assessment.
N/A	(P82)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 8 artifacts in a 15 x 10 m area identified during pedestrian survey, not recommended for further assessment.
AgHb-446	(P83)	2010 (Steiss)	Late Woodland	Scatter	Stage 1–2 (Steiss): 95 artifacts in a 58 x 95 m area identified during pedestrian survey, site extents overlap with AgHb-413,

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
			Post-Contact		recommended for further assessment (no site record for Stage 1-2 Steiss).
N/A	(P84)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P85)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P86)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P87)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P88)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P89)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P90)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-447	(P91)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts found together during pedestrian survey, not recommended for further assessment.
AgHb-448	(P92)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 26 x 15 m area including a biface fragment, not recommended for further assessment.
AgHb-449	(P93)	2010 (Steiss)	Late Woodland	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey including a Levanna projectile point, recommended for further assessment; Stage 3 (Steiss): No additional artifacts recovered during the CSP or from excavation of 5 one-metre units, not recommended for further assessment.
AgHb-450	(P94)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts in a 10 x 10 m area identified during pedestrian survey, recommended for further assessment; Stage 3 (Steiss): 9 artifacts identified during the CSP in a 20 x 20 m area, recommendation unknown.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-451	(P95)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 20 artifacts in a 18 x 12 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-452	(P97)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 15 artifacts in a 11 x 16 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-453	(P98)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 25 artifacts in a 18 x 25 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
N/A	(P99)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-454	(P100)	2010 (Steiss)	Early Woodland	Isolated Findspot	Stage 1–2 (Steiss): 1 Early Woodland Adena projectile point fragment identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-455	(P101)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 13 artifacts identified in a 46 x 26 m area during pedestrian survey, recommended for further assessment, however it has been assigned an avoidance and protection strategy; Stage 3 (Steiss): 219 artifacts recovered, unknown strategy and recommendation.
N/A	(P102)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts found together during pedestrian survey, not recommended for further assessment.
AgHb-456	(P103)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 6 artifacts in a 4 x 4 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-457	(P104)	2010 (Steiss)	Late Archaic	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 24 x 24 m area including a Transitional Archaic Perkiomen projectile point identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy; Stage 3 (Steiss): 102 additional artifacts recovered during CSP and test unit excavation, unknown recommendation.
AgHb-458	(P105)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 16 x 28 m area including a Middle Archaic Brewerton projectile point identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
N/A	(P106)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 3 artifacts found together during pedestrian survey, not recommended for further assessment.
AgHb-459	(P108)	2010 (Steiss)	Late Archaic	Scatter	Stage 1–2 (Steiss): 2 artifacts including a projectile point fragment identified during pedestrian survey, recommended for further assessment.
		2012 (Robertson)			Stage 3 (Robertson): 43 additional artifacts recovered, unknown strategy and recommendation.
N/A	(P109)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P110)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P111)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P112)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P114)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.
N/A	(P115)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, not recommended for further assessment.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-460	(P116)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 27 x 11 m area including a Middle Archaic Brewerton projectile point, recommended for further assessment, it has been assigned an avoidance and protection strategy.
		2010 (Unknown)			Stage 3 (Unknown): 45 additional artifacts recovered from CSP and test unit excavation, unknown recommendation.
AgHb-461	(P117)	2010 (Steiss)	Early Archaic	Scatter	Stage 1–2 (Steiss): 61 artifacts in a 72 x 33 m area including 3 projectile point fragments (Early Archaic Nettling, Early Woodland Meadowood, and one unknown) and a complete Late Archaic Crawford Knoll projectile point, recommended for further assessment.
		2012 (Robertson)	Early Woodland		Stage 3 (Robertson): 187 additional artifacts recovered, unknown strategy or recommendation.
N/A	(P118)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P119)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
AgHb-462	(P120)	2010 (Steiss)	Early Woodland	Scatter	Stage 1–2 (Steiss): 2 artifacts including an Early Woodland Meadowood projectile point fragment identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-463	(P122)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts identified during pedestrian survey, recommended for the site to be revisited.
N/A	(P123)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P124)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-464	(P125)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 biface identified during pedestrian survey, not recommended for further assessment.
N/A	(P126)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 artifacts identified during pedestrian survey, not recommended for further assessment.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-465	(P127)	2010 (Steiss)	Late Archaic	Scatter	Stage 1–2 (Steiss): 7 artifacts including a Late Archaic Crawford Knoll projectile point identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
N/A	(P129)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-466	(P131)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 13 artifacts in a 15 x 20 m area identified during pedestrian survey, not recommended for further assessment.
AgHb-467	(P132)	2010 (Steiss)	Middle Woodland	Scatter	Stage 1–2 (Steiss): 27 artifacts in a 33 x 17 m area including a possible Middle Woodland Snyders projectile point, recommended for further assessment.
		2013 (Williams)			Stage 3 (Williams): 396 additional artifacts in a 33 x 14 m area, recovered during CSP and test unit excavation, unknown recommendation.
N/A	(P133)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P134)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-468	(P136)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 projectile point fragment identified during pedestrian survey, not recommended for further assessment.
AgHb-469	(P137)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 biface identified during pedestrian survey, not recommended for further assessment.
AgHb-470	(P138)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 17 artifacts in a 16 x 20 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-471	(P139)	2010 (Steiss)	Early Archaic	Scatter	Stage 1–2 (Steiss): 6 artifacts in a 10 x 10 m area identified during pedestrian survey including an Early Archaic Nettling and a probable Middle Archaic projectile point, recommended for further assessment, it has been assigned an avoidance and protection strategy.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
N/A	(P140)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P141)	2010 (Steiss)	Pre-Contact	Isolated Findspot	None recorded.
N/A	(P142)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 2 pieces of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P143)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
N/A	(P144)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 piece of shatter identified during pedestrian survey, not recommended for further assessment.
N/A	(P145)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake identified during pedestrian survey, not recommended for further assessment.
AgHb-472	(P147)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts in a 10 x 10 m area including a probable Late Archaic projectile point base, recommended for further assessment.
AgHb-473	(P148)	2010 (Steiss)	Middle Archaic	Scatter	Stage 1–2 (Steiss): 1 Late Woodland Iroquoian projectile point identified during pedestrian survey, recommended for further assessment; Stage 3 (Steiss): 26 additional artifacts in a 90 x 57 m area recovered during CSP including two unnamed projectile points.
		2011–2012 (MacDonald)	Late Woodland		Stage 3 (MacDonald): 38 artifacts recovered from test units excavated in a 10 x 10 m area (2011, MacDonald), a test trench excavated (2012, MacDonald) identifying deposit as a displaced fill as a by-product of grading or filling within AgHb-415.
AgHb-474	(P10)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in an 11 x 9 m area, recommended for further assessment.
AgHb-475	(P15)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 10 artifacts in an 18 x 16 m area, not recommended for further assessment.
AgHb-476	(P38)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in a 10 x 8 m area, recommended for the site to be revisited.
AgHb-477	(P66)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 secondary flake (Fossil Hill chert) identified during pedestrian survey, recommended for the site to be revisited.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-478	(P72)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 10 artifacts in a 19 x 9 m area, not recommended for further assessment.
AgHb-479	(P73)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in a 15 x 12 m area, site recommended for the site to be revisited, site revisited and no further artifacts were found, not recommended for further assessment.
AgHb-480	(P96)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 5 artifacts in a 8 x 9 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-481	(P113)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 artifacts identified during pedestrian survey, not recommended for further assessment.
AgHb-482	(P128)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 13 artifacts in a 28 x 23 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-483	(P130)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 8 artifacts in a 20 x 18 m area identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
		2010 (Unknown)	Middle Archaic		Stage 3 (Unknown): 171 additional artifacts recovered, unknown strategy or recommendation.
AgHb-484	(P135)	2010 (Steiss)	Pre-Contact	Scatter	Stage 1–2 (Steiss): 4 secondary flakes identified during pedestrian survey, not recommended for further assessment.
AgHb-485	(P146)	2010 (Steiss)	Pre-Contact	Isolated Findspot	Stage 1–2 (Steiss): 1 primary flake identified during pedestrian survey, recommended for the site to be revisited (Mislabeled in report as AgHb-185).
AgHb-486	(P121)	2010 (Steiss)	Early Woodland	Isolated Findspot	Stage 1–2 (Steiss): 1 Early Woodland Meadowood projectile point fragment identified during pedestrian survey, recommended for further assessment, it has been assigned an avoidance and protection strategy.
AgHb-491	AgHb-491 (P157)	2011 (Riddle)	Early Woodland	Scatter	Stage 1–2 (Riddle): 7 artifacts in a 20 x 16 m area identified during pedestrian survey, unknown recommendation.
AgHb-492	AgHb-492 (P158)	2011 (Riddle)	Late Archaic	Scatter	Stage 1–2 (Riddle): 4 artifacts in a 10 x 10 m area identified during pedestrian survey, unknown recommendation.

Borden No.	Site Name (Identifier)	Year(s) Assessed	Cultural Affiliation	Site Type	Comments
AgHb-497	AgHb-497 (P166, P183, P184, P185)	2011 (Riddle)	Middle Woodland	Scatter	Stage 1–2 (Riddle): 10 artifacts in a 36 x 28 m area identified during pedestrian survey, unknown recommendation.

APPENDIX D

Grand River Geomorphic and Erosion Hazard Assessment

Aquafor Beech Limited

February 2016

February 29th, 2016

Attn: Mr. Rajan Philips, M.Sc., P. Eng.
Parsons - Manager, Waterloo Regional Operations
540 Bingemans Centre Drive, Suite 101
Kitchener, Ontario, N2B 3X9
Phone: 519-340-7401

Re: County of Brant - Tutela Heights Road Schedule C Environmental Assessment Grand River Geomorphic and Erosion Hazard Assessment

The Grand River at Tutela Heights has a long history of erosion and slope stability hazards which have placed the adjacent roadway and property at risk. Aquafor Beech Ltd. was retained by Parsons on behalf of the County of Brant to complete a Geomorphic and Erosion Hazard Assessment of the Grand River within the study area. This study recommends a 100-year erosion allowance to be applied to the geotechnical long-term stable slope by Englobe Corp. in the vicinity of historic valley slope failures along Tutela Heights Road.

The desktop analysis of the geomorphic assessment is supported by field data from site inspections and topographic surveys completed in November 2015. The primary erosion hazard assessment is based on analysis of historic aerial imagery spanning a 68 year period (1945–2013).

Grand River Physiography Desktop Analysis

The landscape context of the Grand River study area was reviewed to provide background for the existing channel conditions. The drainage area of the Grand River at the study site is about 5200 km^2 and the river valley is cut over 30 m into the glacial surface geology (**Figure 1**). Within the County of Brant, the Grand river flows through glacial outwash valleys of the Galt-Paris moraine complex and then into the glaciolacustrine deposits of the Norfolk Sand Plain and the Haldimand Clay Plain (Chapman and Putnam, 2007). The river and valley planforms exhibit sinuous meandering patterns indicating that bank erosion and lateral channel migration have been long-term natural geomorphic processes. The decrease in the channel slope transitioning from the geology of moraines to plains results in commensurate decrease in stream energy, or stream power (W/m^2). For approximate bankfull discharges, this profile trend was mapped by Phillips and Desloges (2014) with stream powers over 100 W/m^2 within the moraine complex and stream powers of less than 30 W/m^2 entering the clay plain (**Figure 1**). The approximate sediment transport competence of this transition corresponds to a decreasing bedload size of cobbles to gravel to fine-gravel and sand. The stream power of the Grand River at Tutela Heights is in the range of 30-60 W/m^2, with a representative value of about 45 W/m^2 that is typical of gravel sediment transport (Parker et al., 2011).

In summary, the Grand River at Tutela Heights is characterized as a sinuous mixed-gravel bed river with evidence of lateral channel migration expressed in the valley and floodplain landforms (Phillips and Robert, 2005; Phillips and Desloges, 2015[a], 2015[b]), and evident in the existing bank erosion scars along the modern river channel.

Field Inspection, Topographic Survey, and Geotechnical Data

Field data were collected in November 2015 to locally characterize the river channel and valley slope adjacent to Tutela Heights Road. Historic valley slope failures and ongoing slope instability were clearly evident in the field (**Figure 2A**). Three cross-sections (A, B, and C) were surveyed along the valley slope for the study (**Figure 1**). The steepest portion of the valley slope at cross-section C ranged from 2 to 2.5 horizontal to 1 vertical, or about a 45% grade. In a number of locations the steep upper slope consisted of exposed glacial materials, while the lower slope was generally well vegetated with trees and shrubs. Boreholes documented by Englobe Corp indicate that the valley slope materials are a variable mixture of glacial silt and clay layers, indicated as silt till within the lower half of the slope. Minor sand layers were recorded in upper half of the slope, although the dominance of silt and clay demonstrates the texture variability of surface geology layers within the Norfolk Sand Plain.

The river channel width was measured to be about 80 m (**Figure 2B**), while the bankfull depth based on erosion scars and adjacent floodplain surfaces was estimated to be in the range of 3 to 5 m. The bed material was visually assessed to be dominantly gravel sized material in the sediment bars (~1–6 cm; **Figure 2C**) with higher proportions of coarse gravel and some cobble within the deeper parts of the channel. Mid-channel sediment bars with a partial vegetation cover were observed in the downstream portion of the study area where the channel also appeared to be locally widened to about 100 m. Bank erosion scars were observed on both sides of the river channel, with evidence being based on steeply cut banks of bare soil and sharp inflections in the bank grade.

Previous slope stabilization works from 1973 were evident throughout the study area, including the access road, angular-rock groynes, regraded slopes, and a locally widened river channel due to historic dredging. Results of the November 2015 field inspections have confirmed that three of the seven groynes originally constructed have failed within the downstream portion of the site (at cross-section C), and natural bank erosion processes have re-established locally since 1973. The angular-rock structures for the remaining four groynes upstream were still evident during the 2015 field inspection.

Historic Airphoto Analysis

Historic aerial imagery was used as the basis to constrain bank erosion rates for the Grand River within the study area. Historic aerial photographs were collected from the County of Brant, the Grand River Conservation Authority (GRCA), and the National Airphoto Library for comparison with the current 2013 orthophotograpy and the 2015 topographic survey. The representative years of historic imagery that were collected include 1945, 1961, 1967, 1975, 1982, and 1995 (1964 and 1995 topographic mapping was also subsequently reviewed). Based on optimal airphoto year, quality, and scale considerations, the primary analysis periods before and after the 1973 groyne construction were identified as pre-construction (1945–1967) and post-construction (1975–2013). For the analysis, the historic airphotos were imported into ArcGIS and georeferenced using a spline transformation based on 15–20 ground control points identified on both the historic and 2013 imagery. For each historic image, river bank locations were then digitized as water-edge, bank, and slope crest vector polylines (**Figures 3 to 6**). Average distances of lateral bank regression in meters were then calculated from the area (m^2) between successive bank locations divided by the length of the historic bank (m).

Historic Erosion Rate and Erosion Allowance

For each historic period, the average distances of lateral migration within the study area were used to calculate the erosion rates for each type of bank-line (**Table 1 and Figure 7**). Each erosion rate represents a longitudinal average for 250–550 m of channel primarily within the downstream portion of the study area where the highest amount of change was observed (**Figures 3 to 6)**. For the river channel in the pre-construction period (1945–1967), the bank and water-edge calculations provide erosion rates in range of 0.72 and 0.78 m/yr, respectively (**average = 0.75 m/yr**). In the area of the three failed groynes downstream (at cross-section C), two calculations were made for the post-construction period from 1975 and 1982 providing erosion rates of 0.31 and 0.20 m/yr, respectively. As the lateral regression of the valley slope is expected to be more gradual than bank erosion and is less responsive to erosional events within the river channel, the average 0.20 m/yr regression of the slope crest in **Table 1** provides a reasonable lower-limit for the long-term erosion rate.

Extrapolation of the rates in **Table 1** to a 100-year erosion hazard limit yields a maximum recommended **erosion allowance of 75 m** to be applied to the geotechnical long-term stable slope projection. This erosion allowance reflects a potential pre-construction erosion rate and is most appropriate for the downstream portion of the study area where the groynes have failed and continued erosion of the slope-toe should be expected. Given that the erosion rates were measured downstream and four of the groyne structures are still largely intact upstream, an intermediate **erosion allowance of 30 m** provides a reasonable constraint for the erosion hazard limit in the upstream portion of the study area at cross-sections A (assuming ongoing monitoring / maintenance of the groins). A transitional 40 m erosion allowance is recommended at cross-section B, a value in line with previous work by Golder (1986) and GRCA mapping. The erosion rate estimates of 0.30 and 0.75 m/yr transitioned through the study area are considered to be conservatively high as they were measured only within the downstream portion of the river bend (i.e., the area of highest erosive energy). Furthermore, the 1967 and 2013 imagery appear to have been taken at higher stages of river discharge and therefore the 1945–1967 and 1975–2013 erosion rates for the water-edge also include a larger flow width (i.e., a portion of measured difference was not actually due to erosion). It is also acknowledge that bank slumping and slope failure processes have the potential to confound interpretations of bank erosion and regression within the study area, but such process would act to decrease the measured erosion rates — rates that are already considered to be conservatively high.

Table 1: Preliminary Results – Historic Erosion Rates for Grand River at Tutela

Bank-Line Type	Period	Years	Average Erosion (m)	Average Rate (m/yr)	100 Year Allowance (m)
Water-Edge	1945–1967	22	17.2	0.78	78
	1975–2013	38	11.9	0.31	31
Bank	1945–1967	22	15.9	0.72	72
	1982–2013	31	6.25	0.20	20
Slope Crest	1945–1967	22	5.2	0.24	24
	1967–2013	46	9.1	0.20	20
	1945–2013	68	13.8	0.20	20

Note: Erosion rates are calculated as average erosion over river lengths of 250–550 m

Conclusions and Recommendations

Aquafor Beech Ltd has completed a Geomorphic and Erosion Hazard Assessment of the Grand River within the vicinity of Tutela Heights Road. The sinuous meandering river within the study area is characterized by lateral channel migration, the product of natural bank erosion and sediment transport processes. A documented history of bank erosion and slope instability in the vicinity of Tutela Heights is further supported in this study based on field data and an analysis of historic aerial photography from 1945 to 2013. This history includes construction of seven angular-rock groynes in 1973 to protect the toe of the valley slope, of which the three groynes downstream have since failed (at cross-section C). The pre-construction and post-construction periods are represented in the erosion assessment, however to account for uncertainty the pre-construction erosion rates are referenced to recommend a future 100-year erosion allowance.

Based on the historic airphoto analysis and the measured erosion rates, the following 100year erosion allowances are recommended and have been mapped in **Figure 8**:

- **75 m erosion allowance at cross-section C** – based on the pre-construction erosion rate at cross-section C, with the expectation that natural rates of bank erosion will continue at this location and downstream. With failure of the downstream groynes, it is unclear if historic dredging of the channel has slowed slope erosion (or possibly reinforced bank erosion with the development of a mid-channel sediment bar).
- **40 m erosion allowance transition at cross-section B** – consistent with Golder (1986).
- **30 m erosion allowance at cross-sections A** – based on the post-construction erosion rate at cross-section C, with the expectation that erosion rates will continue to be moderated by the four remaining groyne structures. It is recommended that the County of Brant (and/or GRCA) continue to monitor these structures to ensure that erosion rates do not exceed 0.30 m/yr.

The recommended erosion allowances are based on a detailed technical analysis that goes beyond the basic provincial technical guidelines for erosion hazard limits (MNR, 2002). The recommended erosion allowances as mapped in **Figure 8** are to be applied to the geotechnical slope stability analysis by Englobe Corp for projecting the long-term stable slope to the upland surface. Determination of the long-term stable slope at identified cross-sections will allow for mapping of the 100-year erosion hazard limit in the vicinity of Tutela Heights Road.

The airphoto analysis method of georeferencing and spline raster-transformation used for this study provides an established technical approach to constrain historic river-bank erosion rates, but the method includes inherent errors and uncertainties. The recommendations of this study have been made by qualified fluvial geomorphologists based on the analytical results and limitations derived from the methodology.

AQUAFOR BEECH LIMITED

Roger Phillips, Ph.D., P.Geo.
Research Geoscientist, Fluvial Geomorphologist

Robert Amos, MASc. P.Eng.
Project Manager, Fluvial Geomorphologist

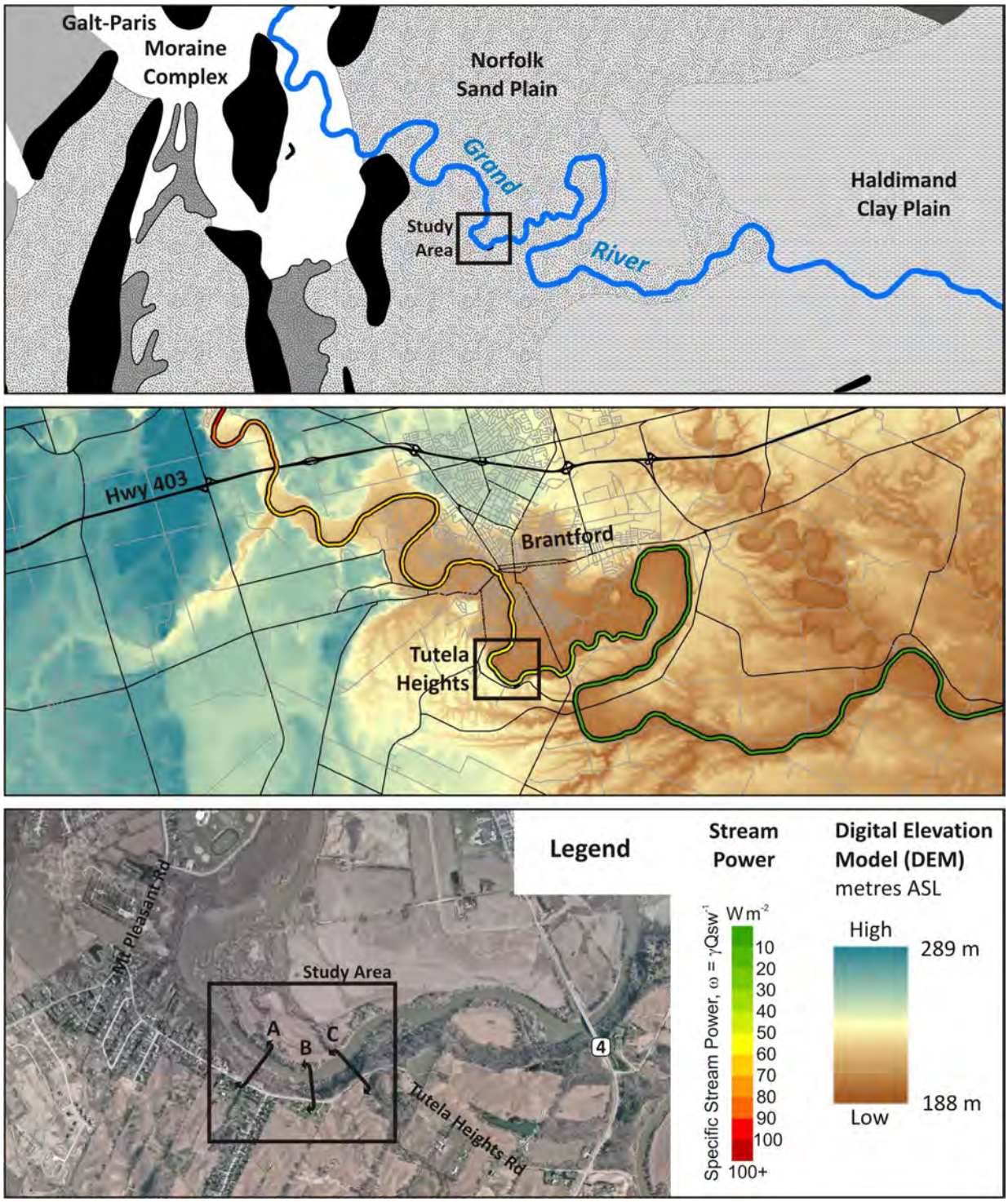

Figure 1: Grand River study area within the County of Brant. (top) glacial landform physiography (Chapman and Putnam, 2007) of the Grand River study area; (middle) digital elevation model (DEM) and stream power mapping (Phillips and Desloges, 2014); and (bottom) Tutela Heights orthophotograpy 2013 imagery cross-section surveys A, B, and C.

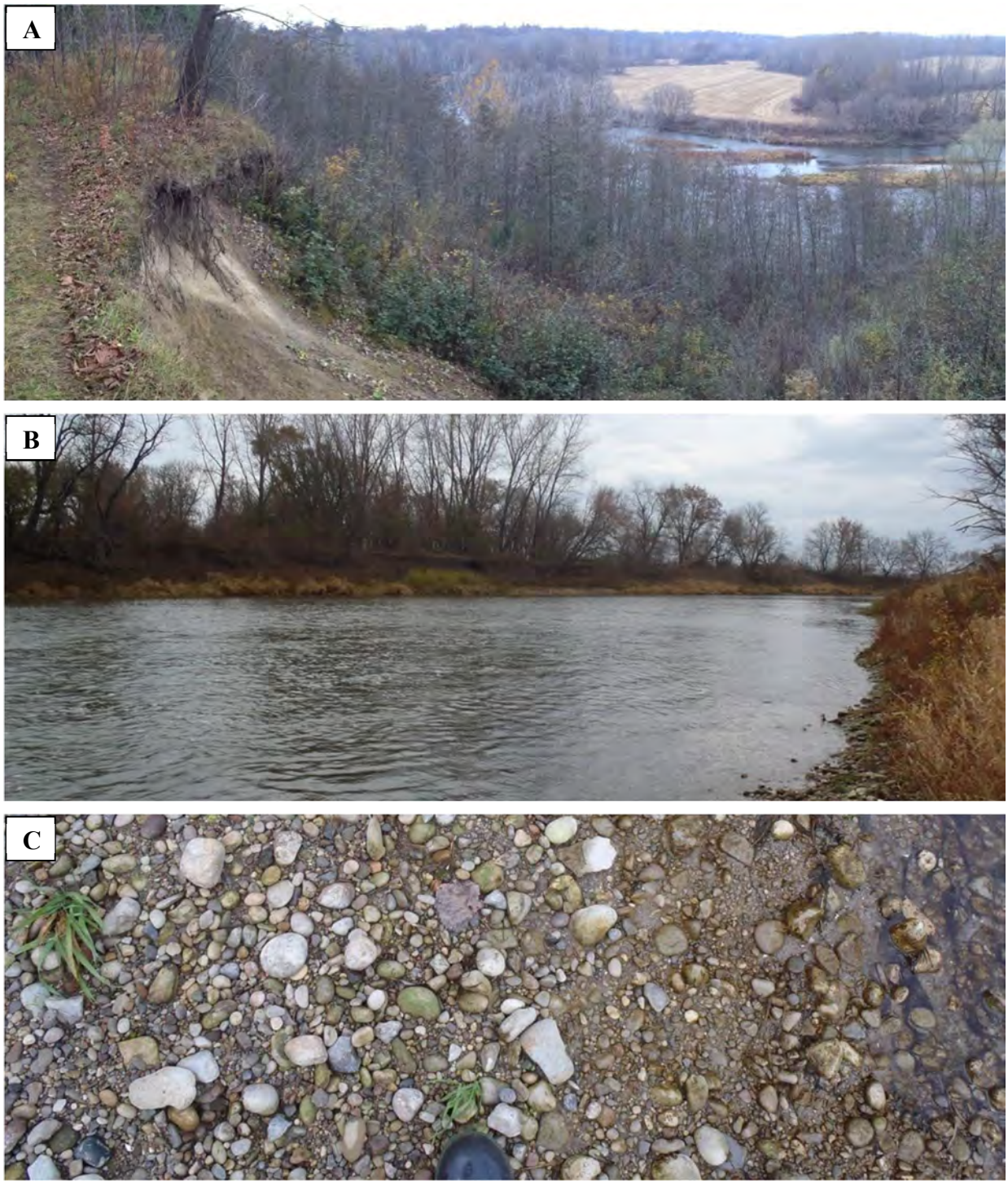

Figure 2: Field inspection photographs of Grand River study site near Tutela Heights collected on November 5, 2015. **A)** View from crest of valley slope overlooking Grand River valley to the northwest. **B)** view of Grand River channel 80–100 m wide, looking downstream; **C)** Representative photo of mixed gravel-size bed material of Grand River channel within the study area (toe of boot for scale).

Figure 3: Grand River at Tutela 1945 historic imagery. Dashed lines are for water-edge and slope crest in 1945. Arrow indicates representative distance of water-edge from road at cross-section C (**Note:** erosion rates in **Table 1** are calculated based on average erosion over river lengths of 250–550 m).

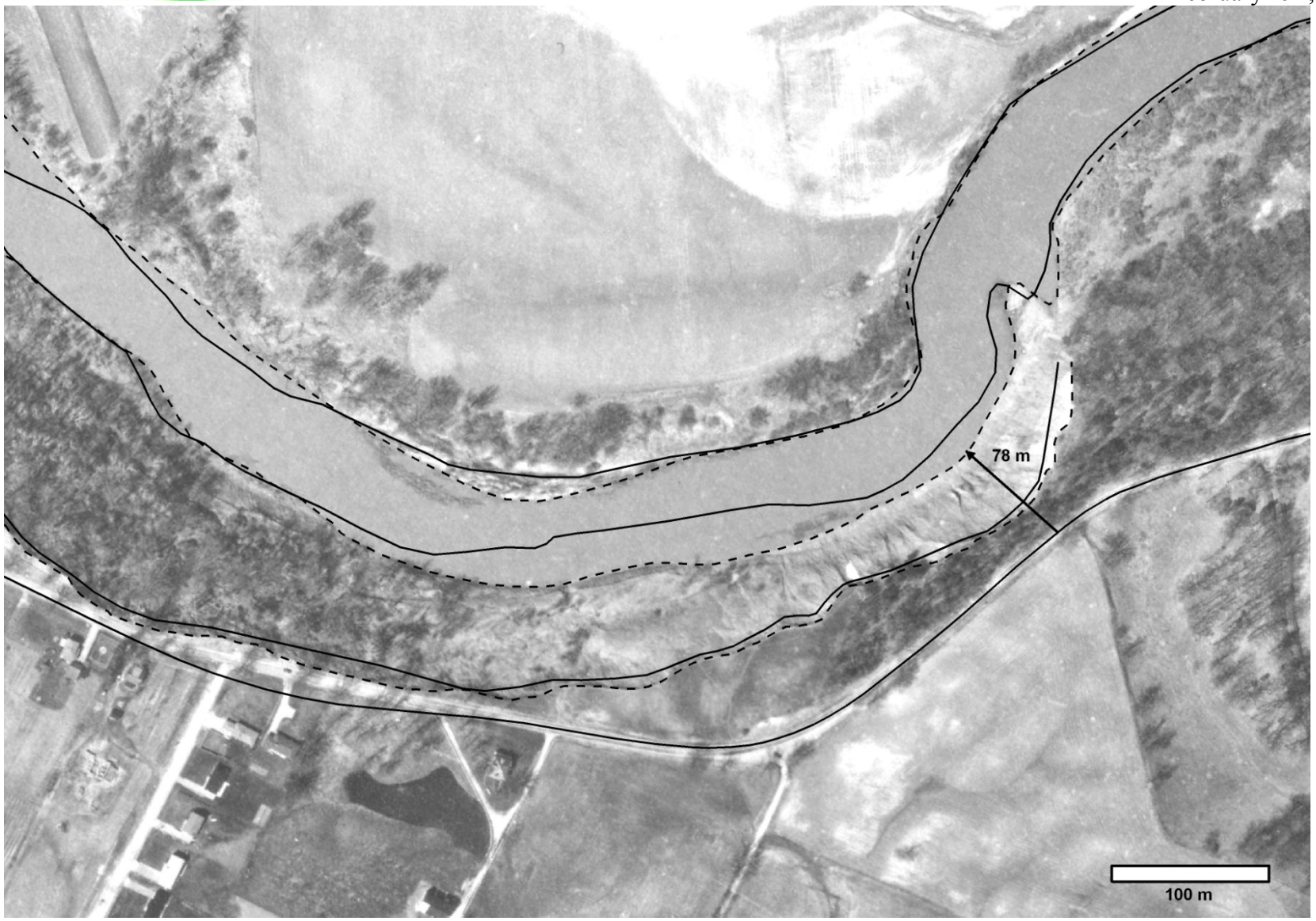

Figure 4: Grand River at Tutela 1967 historic imagery. Dashed lines are for water-edge and slope crest in 1967 (Solid lines represent 1945 locations). Arrow indicates representative distance of water-edge from road at cross-section C (**Note:** erosion rates in **Table 1** are calculated based on average erosion over river lengths of 250–550 m). Higher water conditions in 1967 compared to 1945 may overestimate the erosion rate estimate.

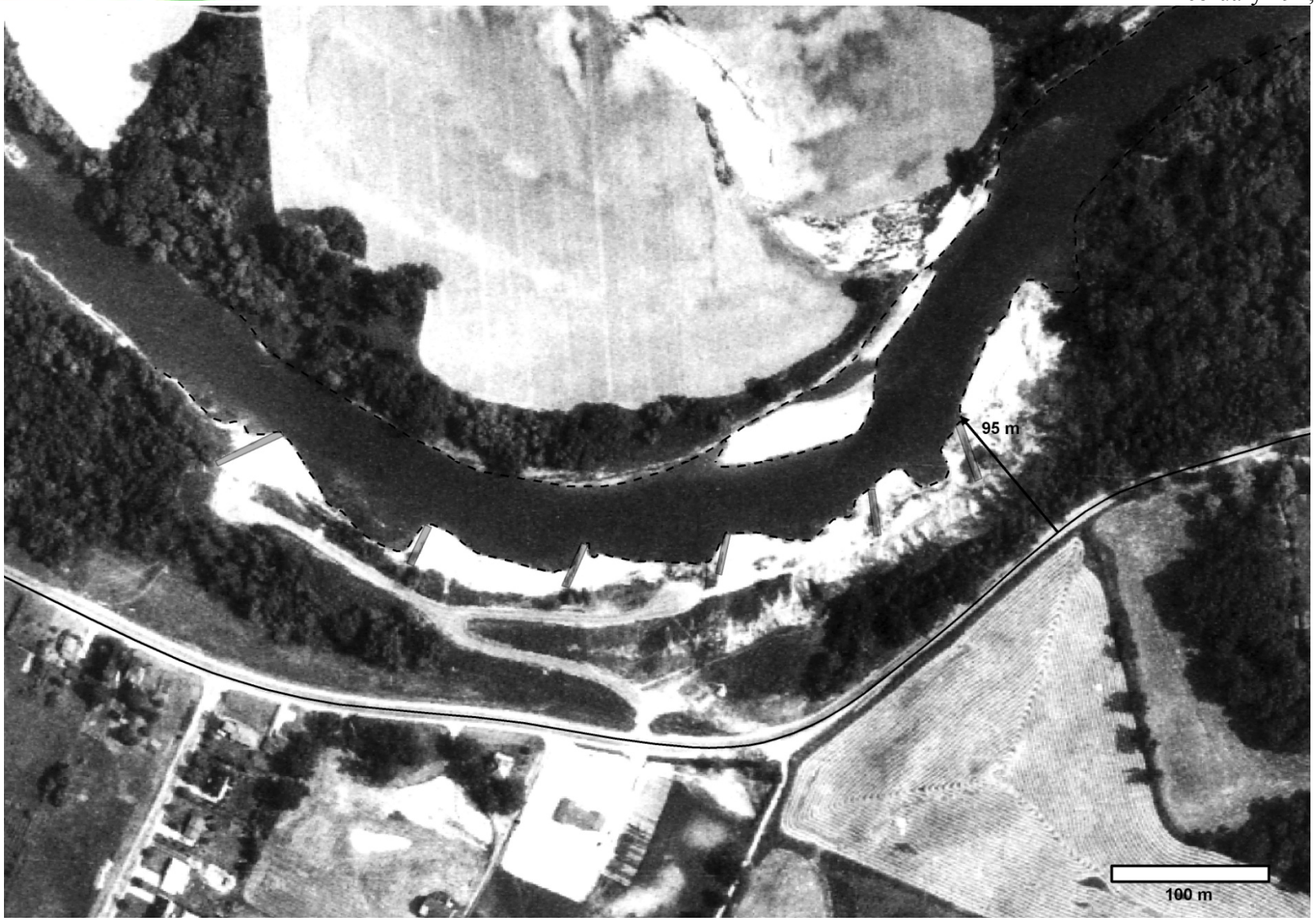

Figure 5: Grand River at Tutela 1975 historic imagery. Dashed lines are for water-edge in 1975. Arrow indicates representative distance of water-edge from road at cross-section C (**Note:** erosion rates in **Table 1** are calculated based on average erosion over river lengths of 250–550 m).

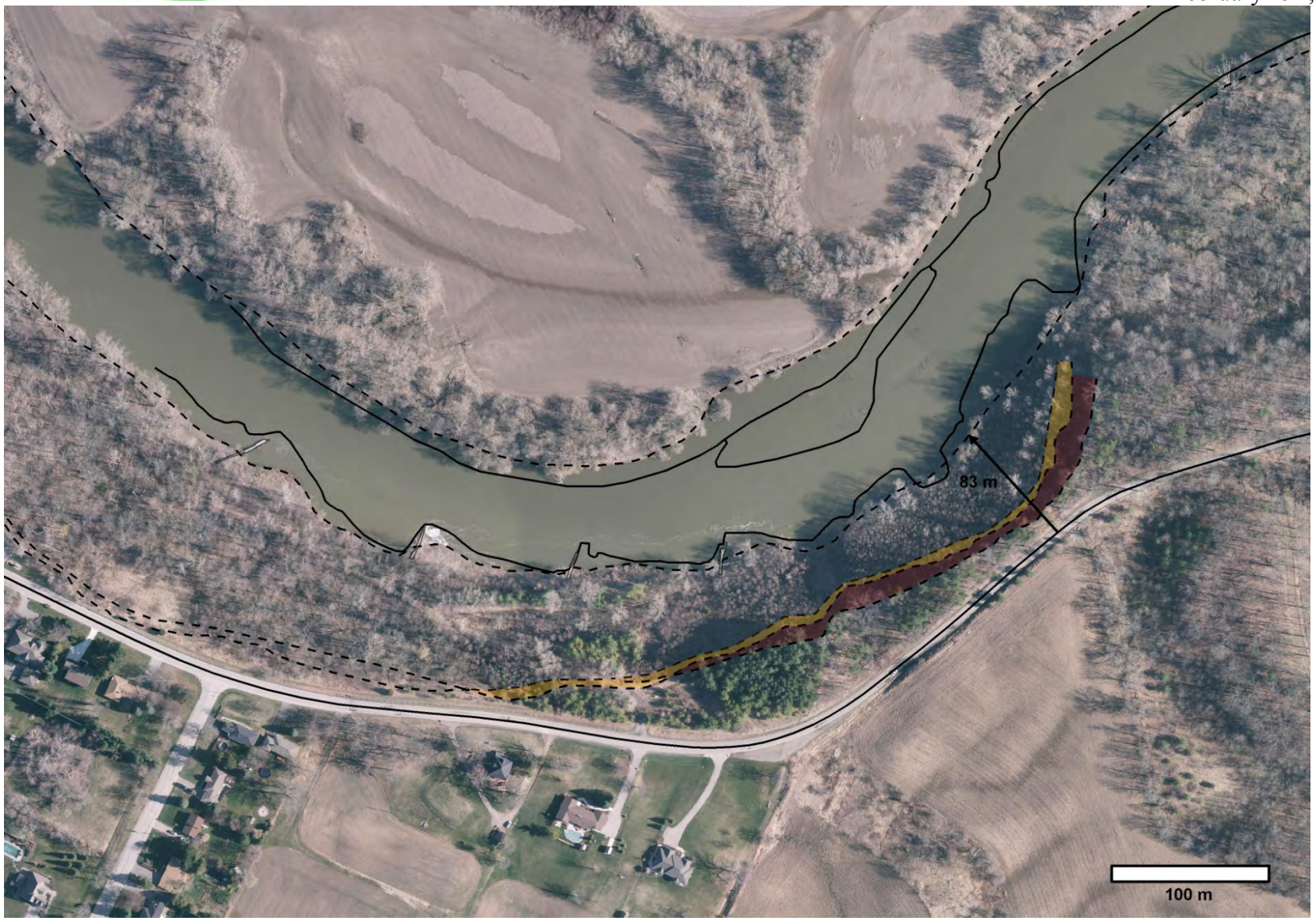

Figure 6: Grand River at Tutela 2013 orthophoto imagery. Dashed lines for river are water-edge in 2013 (Solid lines represent 1975 locations). Arrow indicates representative distance of water-edge from road at cross-section C (**Note:** erosion rates in **Table 1** are calculated based on average erosion over river lengths of 250–550 m). Shaded areas on slope represent slope regression between 1945–1967 (orange) and 1967–2013 (red).

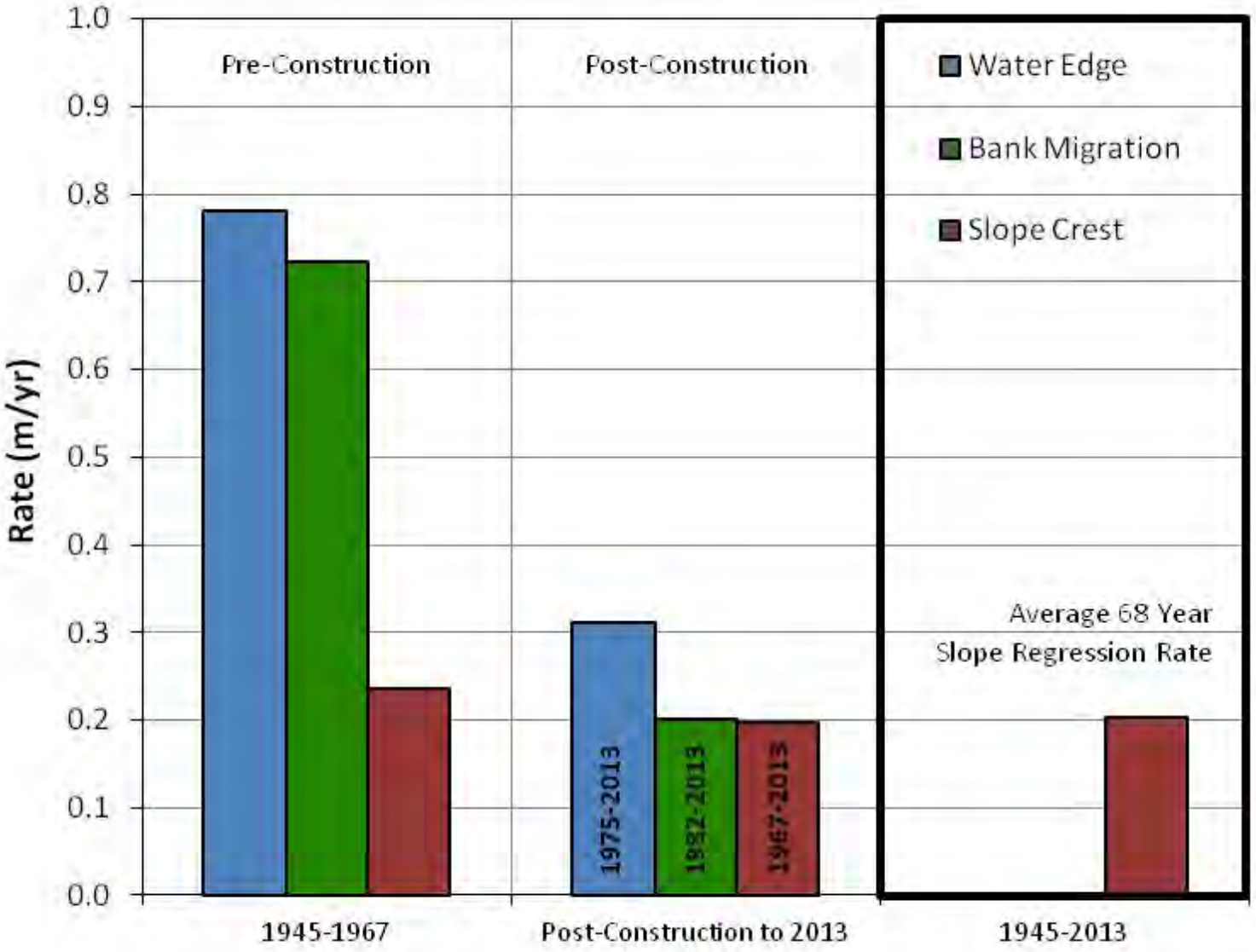

Figure 7: Grand River at Tutela – summary bar graph of erosion and slope regression rates from Table 1 for pre-construction, post-construction, and entire period of 1945–2013. Types of erosion measurement (i.e., bank-line types) are indicated by the colours in the legend.

Figure 8: Recommended 100-year erosion allowance mapping for Grand River at Tutela Heights Road, including 75 m erosion allowance at cross-section C and 30 m erosion allowance at cross-sections A (with transition offset of 40 m at cross-section B, based on Golder, 1986). Dashed black line represents generalized top of bank for Grand River digitized from 2013 orthophotography.

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APPENDIX E

Geotechnical Investigation Report

Englobe

January 2017

Englobe
Soils Materials Environment

Parsons Inc.

Tutela Heights Road Slope Stabilization
Tutela Heights Road
Brantford, Ontario

Geotechnical Investigation Report

Date: January 26, 2017
Ref. N°: 160-P-0009053-0-01-100-GE-R-0001-00

Englobe

Parsons Inc.

Tutela Heights Road Slope Stabilization
Tutela Heights Road
Brantford, Ontario

Geotechnical Investigation Report | 160-P-0009053-0-01-100

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Property and Confidentiality

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Kitchener, Ontario N2B 3X9
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REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And/Or Publication Details
0A	2015-12-17	Draft Report Issued
0B	2016-02-09	Revised Draft Report Issued
0C	2016-02-19	Revised Draft Report Issued
0D	2016-03-03	Revised Draft Report Issued
00	2017-01-26	Final Report Issued

DISTRIBUTION	
1 electronic copy / 2 hard copies	Parsons Inc., Attention: Mr. Rajan Philips and Mr. Stuart Mitchell
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INTRODUCTION

Englobe Corp. (Englobe) is pleased to submit the results of the slope stability analysis completed for an approximately 1 km long section of the Grand River valley slope adjacent to Tutela Heights Road in the County of Brant, Ontario at the location shown on Drawing 1 in Appendix 1. This work was authorized by Parsons Inc. under Subconsultant Agreement 602915 following submission of a detailed proposal.

The purpose of the investigation was to establish the soil profile and groundwater regime adjacent to the slope; assess the present stability of the slope in the area of Tutela Heights Road; provide an appropriate setback from the top of the slope for a do nothing approach as well as recommend best practises to stabilize the slope in accordance with the Ministry of Natural Resources (MNR) Guidelines and Grand River Conservation Authority (GRCA) Policies. The results of the slope stability assessment in this report are specific to the road right-of-way currently owned by the County and the Environmental Assessment completed for the subject section of Tutela Heights Road.

1 GENERAL INFORMATION

The slope section along the Grand River under discussion is located on the north side of Tutela Heights Road and extends from the east side of the Bell Homestead National Historic Site (Bell Homestead) to approximately 1 km east. The slope is located on the outside bend of the Grand River and has a height of about 23 to 35 m. Slope inclinations vary from approximately 2 to 4 horizontal to 1 vertical; however, steeper sections with exposed vertical slope failures were observed in the east and centre sections of the subject slope.

The subject site has a history of slope failures and large earthworks operations were completed on a portion of the subject slope in the 1970s to stabilize the bank. As part of these works, hundreds of gabions and seven groynes were installed into the river at the toe of the slope to reduce erosion. Three of the groynes no longer exist and the remaining four have deteriorated and the gabion baskets have fallen apart in most areas.

The channel of the Grand River within the subject limits is about 50 to 90 m wide and the normal flow water level is estimated to be 1 to 2 m deep. The Grand River at the site is considered to be a confined system where the water course is located within the valley corridor, either with or without a flood plain.

2 INVESTIGATION PROCEDURE

2.1 PREVIOUS WORK

In 1969, J. M. Tomlinson and Associates Ltd. completed a preliminary engineering study including the current subject section along Tutela Heights Road. This preliminary engineering study utilized the results of a bank stability assessment completed by H.Q. Golder and Associates Ltd. in 1969 and provided recommendations for remedial options under consideration of traffic volumes and cost estimates. The report completed by H.Q. Golder and Associates Ltd. was not available for review at the time of report preparation.

In 1986, Golder Associates Ltd. completed a preliminary geotechnical assessment of an approximately 1.1 km long section along the north Grand River valley wall known as “The Oxbow”. This investigation was completed following a slope failure affecting a slope area of about 365 m long and included a review of available subsurface and topographic information to assess the cause of failure and provide preliminary recommendations for stable slope inclinations and potential remedial works.

In 2004, Naylor Engineering Associates Ltd. (NEA) completed a slope assessment of the subject slope section including a detailed slope reconnaissance and identification of three predominant slope zones along Tutela Heights Road. The three zones were identified based on factors such as slope inclination, slope vegetation, distance of the toe of the slope to the Grand River and active toe erosion, and/or indicators of past slope failures and slope movement.

In 2013, LVM inc. completed a slope stability assessment of the subject slope section providing a summary of slope observations as well as comments pertaining to relocating Tutela Heights Road and protection of the public.

In 2014, LVM, a division of Englobe Corp. completed a slope stability assessment and inspected the three slope zones defined by NEA in 2004. The findings identified continued problems with slope stability and unsafe conditions and provided recommendations for monitoring of slope movement.

In 2015, LVM, a division of Englobe Corp. supervised the installation of nineteen standard iron bars (SIBs) by J.H. Cohoon Engineering Limited along the section of the slope under discussion and provided a fee estimate of a specialist firm for automated continuous monitoring at the top of the slope and installation of an early warning system. The report concluded that all three slope zones experience continued movement and remain unstable. The SIBs were installed in January and surveyed in April 2015. LVM, a division of Englobe Corp. issued a factual letter report including the results of the SIB survey. An additional survey of the SIBs was completed on November 5, 2015 and the findings are discussed in Section 3.3 of this report.

The results of the aforementioned investigations were provided in the following documents that should be read in conjunction with this report:

- J. M. Tomlinson and Associates Ltd., Preliminary Engineering Study, Grand River Bank Stability at Tutela Heights Road and at Onandaga. (1969)
- Golder Associates Ltd., Preliminary Geotechnical Assessment, Grand River Valley Wall, Colborne Street East, Brantford, Ontario. (Report No. 861-3127, June 1986)
- Naylor Engineering Associates Ltd., Slope Assessment, Tutela Heights Road, Brant County, Ontario. (Report No. 5456G1.R01, October 2004)
- LVM inc., Slope Stability Assessment, Tutela Heights Road, Brant County, Ontario. (Report No. 160-B-0005783-1-GE-L-0001-00, May 17, 2013)
- LVM, a division of Englobe Corp., Slope Stability Assessment, Tutela Heights Road, Brant County, Ontario. (Report No. 160-P-0004847-0-14-104-01-IM-I-0001-00, October 29, 2014)

- LVM, a division of Englobe Corp., Slope Stability Assessment, Tutela Heights Road, Brant County, Ontario. (Report No. 160-P-0004847-0-14-104-01-GE-L-0001-00, February 27, 2015)
- LVM, a division of Englobe Corp., Tutela Heights Slope Stability Monitoring, Tutela Heights Road, County of Brant, Ontario. (Report No. 160-P-0004847-0-16-106-01-GE-L-0001-00, May 5, 2015)

In 2011, LVM inc. completed a geotechnical investigation for the repair of storm sewer outlets along the west property line of the Bell Homestead. The fieldwork for this investigation included drilling of two boreholes to 6.6 and 19.2 m depths and installation of standpipes at the borehole locations.

The results of the aforementioned investigation were provided in the following document that should also be read in conjunction with this report:

- LVM inc., Storm Sewer Outlet Repairs, Tutela Heights, County of Brant, Ontario. (Report No. 161-P-037963-0100-GE-0001-01, March 2, 2011)

2.2 FIELD PROGRAM

The fieldwork for this investigation was carried out from September 28 to October 8, 2015 and involved the drilling of three boreholes (Boreholes BH-01-15 to BH-03-15) to depths ranging between 25.0 and 32.5 m at the locations shown on the Site Plan, Drawing 2 in Appendix 1. The boreholes were advanced with a CME-75 truck-mounted drillrig using mud rotary methodology. The drillrig was supplied and operated by In-Depth Geotechnical Inc.

Local utility companies were contacted prior to the start of drilling activities in order to demarcate underground utilities near the boring locations.

Traffic protection was provided in accordance with MTO Ontario Traffic Manual, Book 7 – Temporary Conditions. A road occupancy permit was obtained from the County of Brant, where required.

Soil samples were recovered from the boreholes at regular depths intervals using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Samples of the cohesive soils were tested using a hand-held pocket penetrometer to determine approximate shear strengths. Additionally, in-situ vane shear tests were completed in the cohesive soils at variable depths in all boreholes. The SPT N-values and results of pocket penetrometer and vane shear testing are plotted on the borehole logs included in Appendix 2.

Thin walled (Shelby) tube sampling (ASTM D1587) was carried out to recover relatively undisturbed samples (75 mm OD diameter by 600 mm long) of the cohesive soils. The tubes were sealed with paraffin wax immediately after sampling.

Groundwater observations and measurements were carried out in the open boreholes during and upon completion of drilling, and the observations are summarized on the appended borehole logs.

Inclinometers were installed in all boreholes over the depths explored by inserting and grouting a 70 mm OD inclinometer casing. Baseline readings were completed following the inclinometer installation. Monitoring of the inclinometers was completed in two events scheduled at a three month interval and the results are presented in Section 3.3.

The fieldwork was continuously observed by a member of the Englobe's geotechnical engineering staff who documented the drilling and sampling procedures; recorded the SPT N-values and approximate shear strengths; documented the soil stratigraphies; monitored the groundwater conditions; and cared for the recovered soil samples.

The borehole locations and ground surface elevations were surveyed by J.H. Cohoon Engineering Limited and supplied to us in CAD format. It is understood that the elevations are related to a geodetic datum.

2.3 LABORATORY TESTING

The soil samples secured during this investigation were returned to our laboratory for visual examination as well as moisture content determinations. The moisture content test results are plotted on the borehole logs. The geotechnical laboratory testing also included:

- three particle size distribution analyses with results plotted on Figure 1 in Appendix 3 and summarized in Section 3.2.2, and
- five Atterberg Limits tests with results plotted on the borehole logs in Appendix 2 and summarized in Section 3.2.2.
- ten soil unit weight tests with results provided Sections 3.2.2 and 3.2.3; and,
- two soil direct shear tests (ASTM D3080) with results provided in Section 3.2.2.

The soil samples will be stored for a period of three months from the date of sampling. After this time, they will be discarded unless prior arrangements have been made for longer storage.

3 SUMMARIZED CONDITIONS

3.1 SITE DESCRIPTION

Based on previous reports of the site, the subject slope section can be divided into two zones (Zones B and C) differentiated by surficial conditions. Zone A, as previously defined, is located outside the eastern project limits. All three zones are described in the following paragraphs.

Zone A extends from the easterly project limits downstream. This zone is characterized by a steep slope vegetated with some mature trees. Leaning trees are indicative of creep movements. A floodplain is located at the toe of the slope in Zone A.

Zone B extends from about 500 to 850 m east of the Bell Homestead and is characterized by recent slope failures and a vertical slope scarp/cliff. The toe of the slope section is exposed to river erosion and the bottom of the slope shows signs of movement. It is understood that groynes previously installed within Zone B have failed and no longer exist.

Zone C extends from the Bell Homestead to the lookout point (approximately 500 m east of the Bell Homestead). The central and downstream sections of this zone were previously rehabilitated including partial grading of the slope, construction of groynes in the river channel, and installation of storm sewers at the crest. The groynes are deteriorated and are failing, drainage ditches and culverts on the slope are not maintained and the formation of occasional gullies is evident. The toe of the slope section is exposed to river erosion. Slip scarps and results of the SIB survey indicate signs of movement.

Along the subject section, Tutela Heights Road is located between 4 and 50 m south of the top of slope. A plan view of the borehole locations and slope are shown on Drawing 2 in Appendix 1, cross-sections are provided on Drawings 3 and 4.

3.2 SUBSURFACE SOIL CONDITIONS

The subsurface soil stratigraphy at the borehole locations generally comprises topsoil underlain by native deposits of interlayered sand, silt, and clay deposits which in turn are underlain by silt till. Descriptions of the various soil deposits encountered are provided in the following subsections with the subsoil details given on the borehole logs in Appendix 2.

3.2.1 Topsoil

All boreholes were advanced as close as possible to the existing top of slope. The surficial topsoil contacted in the boreholes is 0.1 to 0.2 m thick and generally comprises silt with traces to some sand and nil to trace gravel. At the time of sampling the topsoil was moist.

3.2.2 Sand, Silt, Clay

Sand and silt deposits were generally contacted in the upper soil horizons; however, layers of silt were contacted interlayered with clay and silt till deposits at greater depths. The sand generally ranges in composition from sand with some silt to silty fine sand. At the time of sampling the sand was moist to wet. SPT N-values of 11 and 31 blows per 300 mm penetration of a split spoon sampler indicate compact to dense relative densities.

Silt contacted at the borehole locations ranges in composition from non-cohesive sandy silt to cohesive clayey silt. Traces of organics were observed in the upper silt in Borehole BH-03-15. At the time of fieldwork the non-cohesive silt was very moist to wet and the cohesive silt was about to wetter than the plastic limit. SPT N-values in the non-cohesive silt range between 11 and greater than 50 blows per 300 mm indicating a compact to very dense relative density. Approximate shear strengths in the cohesive silt range from 125 to 225 kPa.

Clay deposits were generally contacted underlying the upper sand and silt deposits and range in composition from silty clay to clay and silt with traces to some of sand. At the time of sampling the clay was about to wetter than the plastic limit. Approximate shear strengths were measured between 50 and greater than 200 kPa indicating variable firm to hard consistencies.

Five Atterberg Limits tests were completed on samples of the clay and the results are summarized in Table 1. Based on the results of the Atterberg Limits testing, the clay has a low degree of plasticity and is over- to normally consolidated.

Table 1: Atterberg Limits Test Results

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX	LIQUIDITY INDEX
BH-01-15, SS-15	19.2 – 19.7	25.1	28	19	9	0.68
BH-02-15, ST-10	11.0 – 11.6	26.7	26	18	8	1.09
BH-03-15, SS-6	5.5 – 5.9	25.9	27	17	10	0.89
BH-03-15, ST-8	7.8 – 8.3	29.2	31	20	11	0.84
BH-03-15, SS-13	16.2 – 16.6	30.9	26	18	8	1.61

The results of eight soil unit weight tests carried on samples of the silt and clay are summarized in Table 2.

Table 2: Soil Unit Weight Test Results – Silt and Clay

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	SOIL TYPE	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (kN/m^3)
BH-01-15, SS-11	13.1 – 13.6	Silt	16.4	17.7
BH-01-15, SS-15	19.2 – 19.5	Clay	25.2	16.1
BH-02-15, SS-2	1.5 – 2.0	Silt	23.5	16.3
BH-02-15, ST-10	11.0 – 11.6	Clay and Silt	25.1	16.0
BH-03-15, SS-6	5.5 – 5.9	Clay and Silt	27.7	15.0
BH-03-15, ST-8	7.8 – 8.3	Clay and Silt	30.4	14.6
BH-03-15, SS-9	10.1 – 10.5	Clay	27.1	16.8
BH-03-15, SS-13	16.2 – 16.6	Clay	30.9	16.4

Representative soil samples of the silt and clay deposits were submitted for completion of particle size distribution analyses and the results are illustrated on appended Figure 1 and summarized in Table 3.

Table 3: Results of Particle Size Distribution Analyses – Silt and Clay

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	SOIL TYPE	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)
BH-01-15, SS-3	2.3 – 2.7	Silt	2	91	7	0
BH-02-15, ST-10	11.0 – 11.6	Clay and Silt	35	61	4	0
BH-03-15, ST-8	7.8 – 8.3	Clay and Silt	46	54	0	0

Two direct shear tests were performed on samples of the clay and silt and the results are summarized in the Table 4:

Table 4: Summary of Direct Shear Test Results

BOREHOLE NUMBER	SAMPLE DEPTH (m)	SOIL TYPE	FAILURE STRESS/COHESION	ANGLE OF FRICTION (Ø)
BH-02-15, ST-10	11.0 – 11.6	Clay and Silt	0 kPa	32.9°
BH-03-15, ST-8	7.8 – 8.3	Clay and Silt	9.6 kPa	26.1°

3.2.3 Silt Till

Silt till was contacted in Boreholes BH-02-15 and BH-03-15 generally underlying the silt and clay deposits. The silt till ranges in composition from non-cohesive silt with some fine sand and clay to cohesive clayey silt with traces of sand and gravel. Shale fragments were contacted in the silt till in Borehole BH-03-15 below a 32.0 m depth. At the time of fieldwork the non-cohesive silt till was very moist to wet; the cohesive silt till was about the plastic limit.

SPT N-values in the non-cohesive silt till of 34 and 43 indicate dense relative densities. Approximate shear strengths in the cohesive silt till of 200 kPa and greater indicate hard consistencies.

The results of two soil unit weight tests carried on samples of the silt till are summarized in Table 5.

Table 5: Soil Unit Weight Test Results – Silt Till

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	SOIL TYPE	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (kN/m^3)
BH-02-15, SS-16	20.7 – 21.2	Silt Till	16.3	19.4
BH-03-15, SS-17	22.3 – 22.7	Silt Till	18.4	18.6

3.2.4 Groundwater

Mud rotary drilling was used for the advancement of the boreholes and groundwater observations were limited to observations on the recovered soil samples. Typically, the grey colour of the soils noted at depths between 3.1 and 4.6 m (Elevations 213.4 to 223.5 m) is indicative of long-term saturated conditions, and therefore, the fluctuations of the long-term groundwater are not expected to drop below this depth.

Groundwater observations from previous investigations completed in the vicinity of the slope indicated that shallow groundwater occurred within the upper 1.1 to 3.6 m of the soil deposits. Seasonal fluctuations in the groundwater levels may occur above these depths particularly following heavy rainfall or snowmelt.

3.3 RESULTS OF INCLINOMETER READINGS AND SIB SURVEY

The summary data from the slope inclinometer readings is included in Appendix 4 and indicate maximum displacements of less than 2 mm in any given direction or depth with maximum displacements recorded on January 15, 2016.

Continued monitoring of the inclinometers at Boreholes BH-01-15 to BH-03-15 is recommended to observe potential slope movement over time; to define failure zones within the slope; and to reduce background readings associated with climatic conditions, seasonal changes within the soil mass, and others.

Nineteen standard iron bars (SIBs) were installed along the section of the slope under discussion in January 2015 and surveyed in April 2015. The results were issued in a letter by LVM, a division of Englobe Corp. indicting that all three slope zones experience continued movement and remain unstable. The monitoring points were surveyed by J.H.Cohoon Engineering Limited in November 2015 and the results indicate that no significant movement has occurred since January 2015. It is noted that horizontal displacements have an accuracy of ±0.02 m. The horizontal displacements recorded since January 2015 range from 0.00 to 0.05 m. Vertical movements were observed in the range of 0.00 to 0.04 m.

It is considered important to continue the monitoring of the inclinometers and SIBs over time to observe future movements and the associated trends in the movements.

4 SLOPE STABILITY ANALYSIS

The slope is approximately 23 to 35 m high and is inclined at between approximately 2 to 4 horizontal to 1 vertical. Steeper sections with exposed vertical slope failures were observed in the east and centre sections of the subject slope. Indicators of slope movement have been observed over the subject limits of the project. Previous investigations including the subject slope section along the Grand River north of Tutela Heights Road differentiated three distinct slope zones (Zones A through C). Slope Zones B and C are located within the current project limits. The slope section previously described as Zone A is located east of the current project limits and is not included in the slope stability analysis.

J. H. Cohoon Engineering Limited completed a topographic survey of the slope and provided three cross-sections at the borehole locations (Tutela Heights Road Slope Area Erosion and Stability Analysis, Existing Topography and X-Sections, Job Number 11369, Drawing Numbers 11369-EX1 and 11369-EX2, dated November 18, 2015).

According to GRCA policies three components have to be considered to determine an appropriate setback along slopes including toe erosion allowance, stable slope allowance, and access allowance. The combination of these setbacks from the toe of a slope results in an appropriate setback for new structures.

4.1 TOE EROSION ALLOWANCE

When a river channel is within 15 m of the toe of a slope, and there is evidence of toe erosion, the toe erosion allowance has to be considered. The toe erosion allowance provides a setback for slope regression due to erosion of the valley wall by river or stream action.

Aquafor Beech Limited has completed a geomorphic and erosion hazard assessment for the subject slope (Aquafor Beech Limited, County of Brant – Tutela Heights Road Schedule C Environmental Assessment, Grand River Geomorphic and Erosion Hazard Assessment – draft report, dated February 17, 2016) and the following erosion rates for a 100 year period have been provided:

- Under the assumption that the remaining four groyne structures will continue to moderate the erosion rates, a toe erosion allowance of 30 m taken from the edge of water is applicable for the slope section extending from the western project limits to approximately 400 m downstream (Zone C, Cross-Section A-A').
- A transitional erosion allowance of 40 m is applicable near Cross-Section B-B'.
- For the remaining downstream section of the subject slope a toe erosion allowance of 75 m taken from the edge water applies (Zone B, Cross-Section C-C').

The toe erosion allowances for the upstream slope section (Cross-Sections A-A' and B-B') are illustrated in Drawing 3. The toe erosion allowance for the downstream section (Cross-Section C-C') is illustrated in Drawing 4.

4.2 STABLE SLOPE ALLOWANCE

The information obtained from the boreholes and slope survey was used for computer analysis of the slope stability using the GeoStudio 2007 Slope/W Program (Morgenstern-Price Method). The soil parameters used in the analysis have been estimated based on the results of borehole measurements (SPT, vane and pocket penetrometer tests), laboratory test results, empirical correlations, and other references and are provided in the Table 6. The soil parameters used for the analyses reflect the generally high moisture contents of the soils as well as seepage conditions in the slope.

Table 6: Summary of Soil Strength Parameters for Slope Stability Analyses

SOIL MATERIAL	BULK UNIT WEIGHT (kN/m^3)	ANGLE OF INTERNAL FRICTION (°)	COHESION (kPa)
Sand	19	30	0
Silt, non-cohesive	18	30	0
Silt, cohesive	18	28	2
Clay	17	26	2
Silt Till, non-cohesive	19	30	0
Silt Till, cohesive	19	28	5

The slope stability analyses were carried out for a number of potential failure modes. The various failures analyzed include shallow transitional type failures of the surficial displaced soil, medium depth rotational failures at the bottom, middle and top of the slope, and deep rotational failures through the entire height of the slope.

The results of the analyses indicate that some areas of the existing slope section in Zones B and C have a Factor of Safety (FS) against slope failure below 1.0 consistent with observations made during our site visits over the past 11 years. The FS is closely related to the steepness of the slope, porewater pressure, soil strength, and slope height.

Based on our analyses, it is considered that several failures mechanisms of the slope could take place throughout the study area. These include shallow translational failures, medium depth rotational failures at the crest and toe, and deep seated failures throughout the entire slope.

Site observations confirm the existence of shallow translational slides and medium depth rotational failures. Specifically, the slope observations made over 11 years for Zone B note continued failures at the top of the bank exposing a near vertical upper slope and translational and rotational movement of the talus debris near the bottom. The observations made for Zone C include slip scarps at the top of the bank, movement of the talus debris, as well as cracking of the pavement structure possibly indicating tension cracking of the underlying soil.

Englobe is currently conducting monitoring of the inclinometers installed at the borehole locations including two sets of readings scheduled at three month intervals. The results of the first readings are presented on Section 3.3 and indicate no measurable movement has occurred since installation. The results of the readings scheduled for April 2016 will be issued under separate cover and may provide further data on failure types in the slope.

The recommended FS for the slope along Tutela Heights Road (infrastructure and public use) is 1.4 to 1.5 according to GRCA policies. Following the review of additional literature made available for the greater area as well as review of our data, analysis, and results we have revised the previously provided long-term stable slope inclination. A revised long-term stable slope inclination of 3.5 horizontal to 1.0 vertical is required to achieve a FS = 1.5. The Slope W output for each cross-section has been included in Appendix 5. The stable slope line is shown on the appended cross-sections, Drawings 3 and 4. The combination of toe erosion allowance and stable slope allowance (erosion hazard limit) is illustrated on the appended Drawing 5. The distance between the centre line of Tutela Heights Road and the erosion hazard limit at the three cross-sections is summarized in Table 7.

Table 7: Distance of Erosion Hazard Limit to Centre Line of Tutela Heights Road

CROSS-SECTION	Distance of Erosion Hazard Limit to Centerline of Tutela Heights Roadway
A-A'	8.5 m south of centerline
B-B'	18.0 m south of centerline
C-C'	89.5 m south of centerline

4.3 ACCESS ALLOWANCE

GRCA policy requires that structures be set back an additional 6 to 15 m from the long-term stable slope for access in the case of slope failure or slope maintenance. This setback should be confirmed with the GRCA and has not been illustrated on the appended cross-sections, Drawing 3 and 4.

5 SUMMARY AND RECOMMENDATIONS

The project involves the approximately 1 km long existing slope section along an outside bend of the Grand River north of Tutela Heights Road in Brantford, Ontario.

In general, site grades along the top of slope can be described as rolling with elevations decreasing from the western and eastern project limits toward the lookout point located in Zone C (near cross-section B-B'). A storm sewer runs parallel along the north of Tutela Heights Road near the top of the slope in the western section of Zone C; a surficial ditch was observed in the eastern section. Based on field observations it can be assumed that the low section near the lookout point experiences significant stormwater runoff.

The existing unstable conditions along the slope are caused primarily by toe and sheet erosion which oversteepens the natural slopes and leads to translational, rotational, and block slumps of the soil deposits.

The following paragraphs discuss options for the slope remediation/repair including a do nothing approach, mechanical slope reinforcement, and a combination of geometric and mechanical stabilization. It should be noted that this report is not intended to provide design details, only present preliminary options based on the geotechnical fieldwork completed. It is noted that slope remedial measures must consider the effect of toe erosion on the stability of the slope. Elimination of toe erosion is considered a key element for improving the long-term stability of the slope.

5.1 DO NOTHING

If left in the existing condition, the slope will continue to erode and slope failures will continue to occur. The rate of the slope failures is partially dependent on decreases in shear strength of the soil, weather, seismic events, and toe erosion. The decrease in shear strength could be caused by a rise in groundwater levels (increase pore pressure) and/or seepage during rain and snow-melt events, weathering, creep caused by freeze-thaw and/or wet-dry cyclic conditions, and development of tension cracks near the slope crest (Duncan and Wright, 2005).

Without the elimination of toe erosion, improvement of drainage conditions, control of surface runoff over the slope, regrading or mechanically stabilizing the slope, and/or application of erosion protection along the toe and crest, it is envisioned that the slope will continue to fail and regress. This slope regression will affect the safety of the public as well as adjacent properties and buildings if no remedial measures are taken.

The following recommendations are provided pertaining to the current use of the lands and are applicable to a do nothing approach:

- Close all trails along the slope east of the lookout and below the Bell Homestead;
- Place warning signs throughout the area to alert pedestrians of the risk;
- Arrange for annual inspections of the area by qualified geotechnical engineers in order to record existing conditions, monitor slope movements, and report new hazards;
- Survey the nineteen SIBs (monitoring points) in spring and fall to monitor slope movement. It is inferred that surveying the SIBs in summer and winter will be a problem because of thick vegetation and snow cover, respectively);
- Continued monitoring of the three inclinometers at a minimum recommended three month interval, to record movements at depth within the slope;
- Monitoring of the condition of the four remaining groynes to ensure continued moderation of erosion rates;
- Develop a plan for the future of Tutela Heights Road;
- Install fencing to prevent pedestrian access to the unsafe slope areas;
- Prohibit new develop within the setback limits along Tutela Heights Road as provided in this report; and,
- Consider installation of a real-time monitoring system that can alert staff immediately of slope failures and/or mass soil movements.

We note the slope failures are complicated and unpredictable; they may be triggered by numerous items such as rain, saturated ground, snowmelt, erosion, minor earthquakes, vibration from construction work, and high and low groundwater levels. The slope at the site has a history of failure, and therefore caution must be exercised to protect the life and property of the people at the top of bank.

5.2 MECHANICAL SLOPE REINFORCEMENT

In order to prevent tableland loss and protect adjacent roadways and residences the slope would need to be mechanically reinforced. This would involve placing multiple layers of reinforcement at various levels within the slope to increase the existing factor of safety. Measures must also be taken to reduce the effect of toe erosion.

This reinforcement would allow the slope to be inclined at a steeper angle than 3.5 horizontal to 1.0 vertical for an accepted factor of safety. Types of reinforcing materials could include geotextile fabrics, geogrids, steel strips, steel grids, soil nails, and high strength steel tendons. The designed capacity of this reinforcement depends on the tensile strength, creep characteristics, durability, pullout resistance, stiffness and tolerated strains of the used materials as well as geotechnical properties of the soil within the slope (Duncan and Wright, 2005).

An additional mechanical slope reinforcement method would involve the installation of helical anchors installed at predetermined spacing. Each helical anchor would extend below the stable slope elevation as specified by the structural engineer and each anchor would have multiple plates (size and quantity to be determined). Geotextile could then be placed over the entire surface and a termination bracket would be welded to the top of each helical anchor. The helical anchors would retain the soil above the stable slope by anchoring into very stiff bearing soil below the stable slope elevation and geotextile would aid in reducing surface erosion. For details on this type of mechanical slope reinforcement we refer you to EBS Geostructural Inc.

5.3 GEOMETRIC AND MECHANICAL SLOPE STABILIZATION COMBINATION

A combination of mechanical slope reinforcement and geometric slope stabilization could be used to reduce, not eliminate, the tableland loss along Tutela Heights Road. The remedial measures could include cutting back the slope to a more stable angle (i.e., geometric stabilization), applying erosion protection along the face and toe of slope, installation of soil reinforcement measure along the upper portion of the slope, and installing a drainage system along the top of slope.

Stabilization of the bare eroded areas would necessitate cutting back the top section of the slope to an inclination of 3.5 horizontal to 1.0 vertical or less. If mechanical soil reinforcement is used the top section of the slope may be cut back at a steeper angle and/or tiered/benched (see Section 5.2).

Once the slope regrading and stabilization are complete, vegetation of the unreinforced slope areas can be carried out by hydro-seeding and applying erosion matting. The vegetation will reinforce the soil with a roots system, remove water from soil by uptake and transpiration, reduce flow velocity and provide frost protection (refer to Section 2.4.4 MNR Technical Guide, 2002).

5.4 DRAINAGE

Depending on the preferred option(s) for slope stabilization, drainage improvement options should be explored to reduce pore pressures (groundwater levels) in the slope. Promoting proper slope drainage will improve the stability of the slope by reducing pore pressure in the soil which increases effective stress and shear strength, and reduces the driving force in tension cracks (refer to Slope Strength and Stability, Duncan and Wright, 2005).

Surface run-off must be directed away from the slope in order to prevent erosion from forming or expanding. Downspouts, street runoff, and other sources of surface drainage should be redirected to storm sewers, not the slope. Surface water drainage can be improved by establishing swales to direct water away from the affected area, proper grading to minimize low spots where water can pond and minimizing infiltration with the assistance of proper vegetation (Duncan and Wright, 2005).

Existing drainage ditches and culverts on the slope should be repaired to control surface runoff and prevent the formation of gullies.

6 STATEMENT OF LIMITATIONS

The geotechnical recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known at the time of report preparation, we recommend that we be retained during the final design stage to verify that the geotechnical recommendations have been correctly interpreted in the design. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of the project, Englobe should be contacted. We recommend that we be retained during construction to confirm that the subsurface conditions do not deviate materially from those encountered in the test holes and to ensure that our recommendations are properly understood.

The geotechnical recommendations provided in this report are intended for the use of the owner and its retained designer. They are not intended as specifications or instructions to contractors. Any use which a contractor makes of this report, or decisions made based on it, are the responsibility of the contractor. The contractor must also accept the responsibility for means and methods of construction, seek additional information if required, and draw their own conclusions as to how the subsurface conditions may affect their work. Englobe accepts no responsibility and denies any liability whatsoever for any damages arising from improper or unauthorized use of the report or parts thereof.

It is important to note that the geotechnical investigation involves a limited sampling of the site gathered at specific test hole locations and the conclusions in this report are based on this information gathered. The subsurface geotechnical, hydrogeological, environmental and geologic conditions between and beyond the test holes will differ from those encountered at the test holes. Also such conditions are not uniform and can vary over time. Should subsurface conditions be encountered which differ materially from those indicated at the test holes, we request that we be notified in order to assess the additional information and determine whether or not changes should be made as a result of the conditions.

Appendix 1 Drawings

Drawing 1: Location Plan
Drawing 2: Site Plan
Drawing 3: Cross-Sections A-A' and B-B' 30 m Toe Erosion Allowance
Drawing 4: Cross-Section C-C' 75 m Toe Erosion Allowance
Drawing 5: Erosion Hazard Limit with Variable Toe Erosion Allowance

Englobe

NOTES :
1-REFERENCES : © OpenStreetMap contributors (2015).

0 250 500 750 1000 m
SCALE 1:25000

Project

Tutela Heights Road Slope Stabilization

Tutela Heights Road, Brantford, Ontario

Title

LOCATION PLAN

Englobe Corp.
353, Bridge Street East
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Prepared	K. Ashe	Discipline	GEOTECHNICAL	Project manager	K. Thrams
Drawn	K. Ashe	Scale	1 : 25000	Sequence no.	01 of 05
Checked	K. Thrams	Date	2017-01-16		

M. dept.	Project	Disc.	Dwg no.	Rev.
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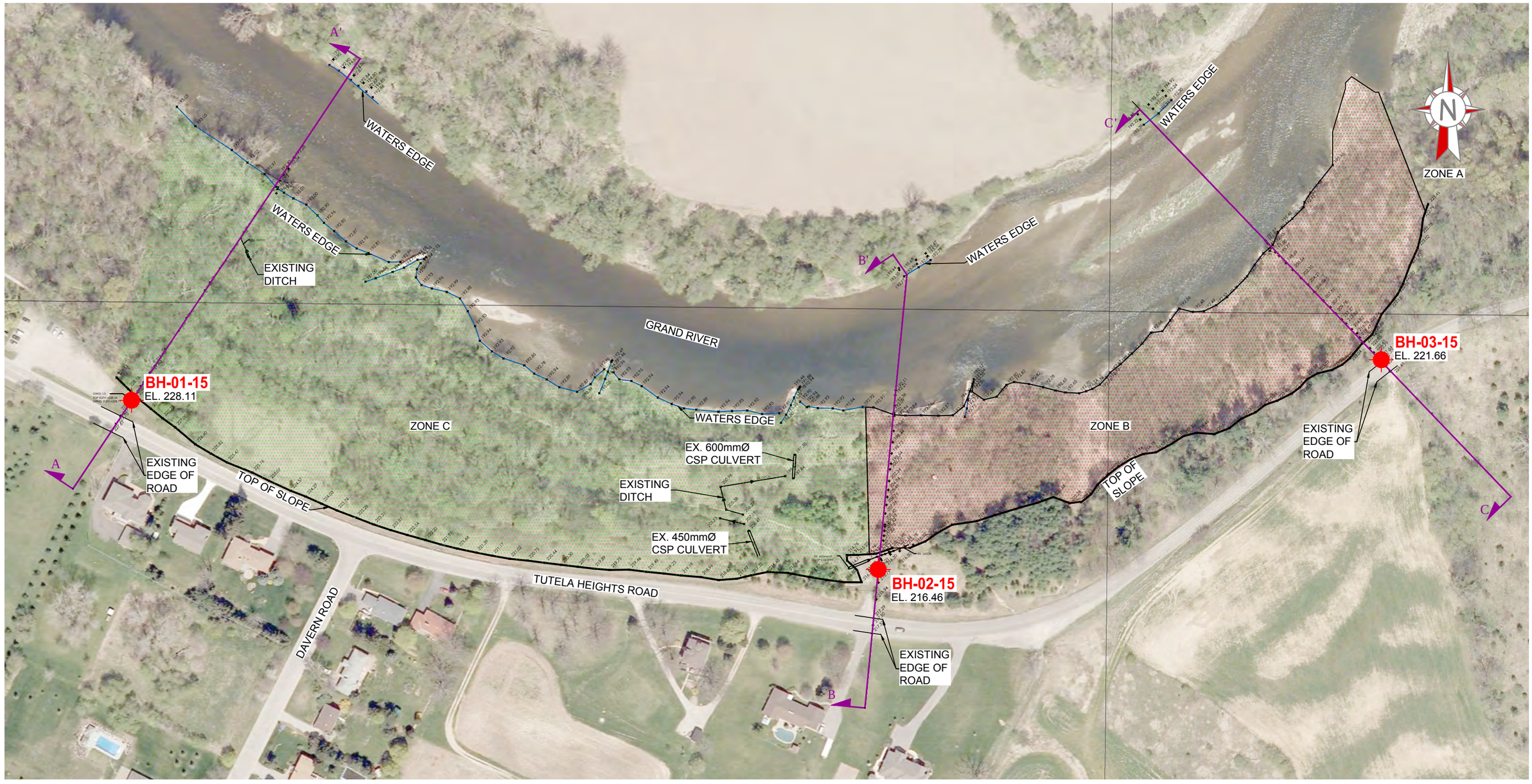

LEGEND :

BOREHOLE LOCATION

EL. 228.11 GROUND SURFACE ELEVATION (m)

NOTES :

1-REFERENCES : J.H. COHOON ENGINEERING LIMITED, Project Tutela Heights Road Slope Area Erosion and Stability Analysis, Drawing Existing Topography, Drawing number 11369-EX1, dated November 18, 2015.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 20 40 60 80 100 m

SCALE 1:2000

Project

Tutela Heights Road Slope Stabilization

Tutela Heights Road, Brantford, Ontario

Title

SITE PLAN

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M. dept.	Project	Disc.	Dwg no.	Rev.
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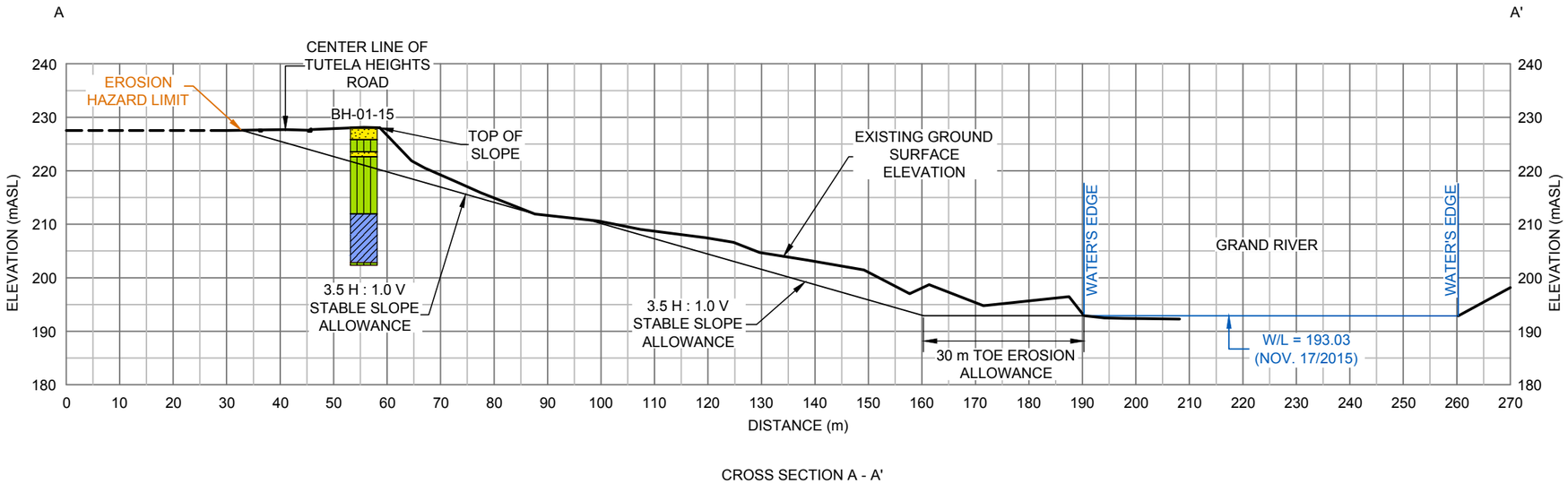
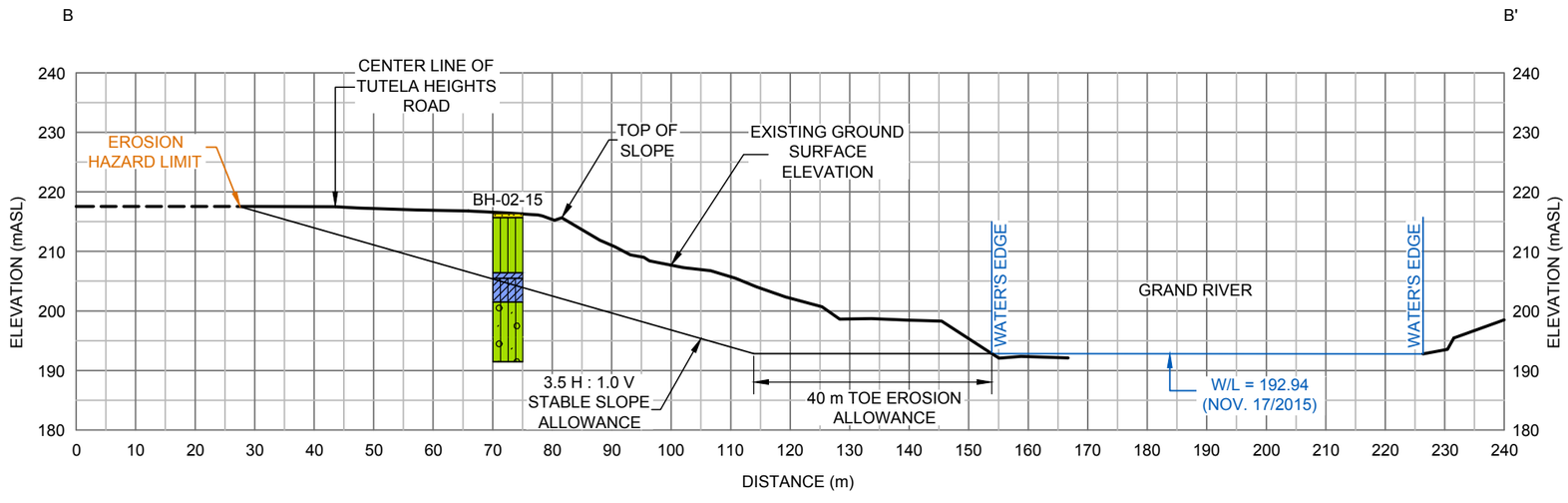


CROSS SECTION A - A'



CROSS SECTION B - B'

LEGEND :

- TOPSOIL
- CLAY AND SILT
- CLAY
- SILT
- SAND
- SILT TILL

NOTES :

1-REFERENCES : J.H. COHOON ENGINEERING LIMITED, Project Tutela Heights Road Slope Area Erosion and Stability Analysis, Drawing X-Sections, Drawing number 11369-EX2, dated November 18, 2015.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Tutela Heights Road Slope Stabilization

Tutela Heights Road, Brantford, Ontario

Title

CROSS SECTIONS A - A' AND B - B'
30 m TOE EROSION ALLOWANCE

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Checked	K. Thrams	Date	2017-01-16

Project manager: K. Thrams

Sequence no.: 03 of 05

M. dept.	Project	Disc.	Dwg no.	Rev.
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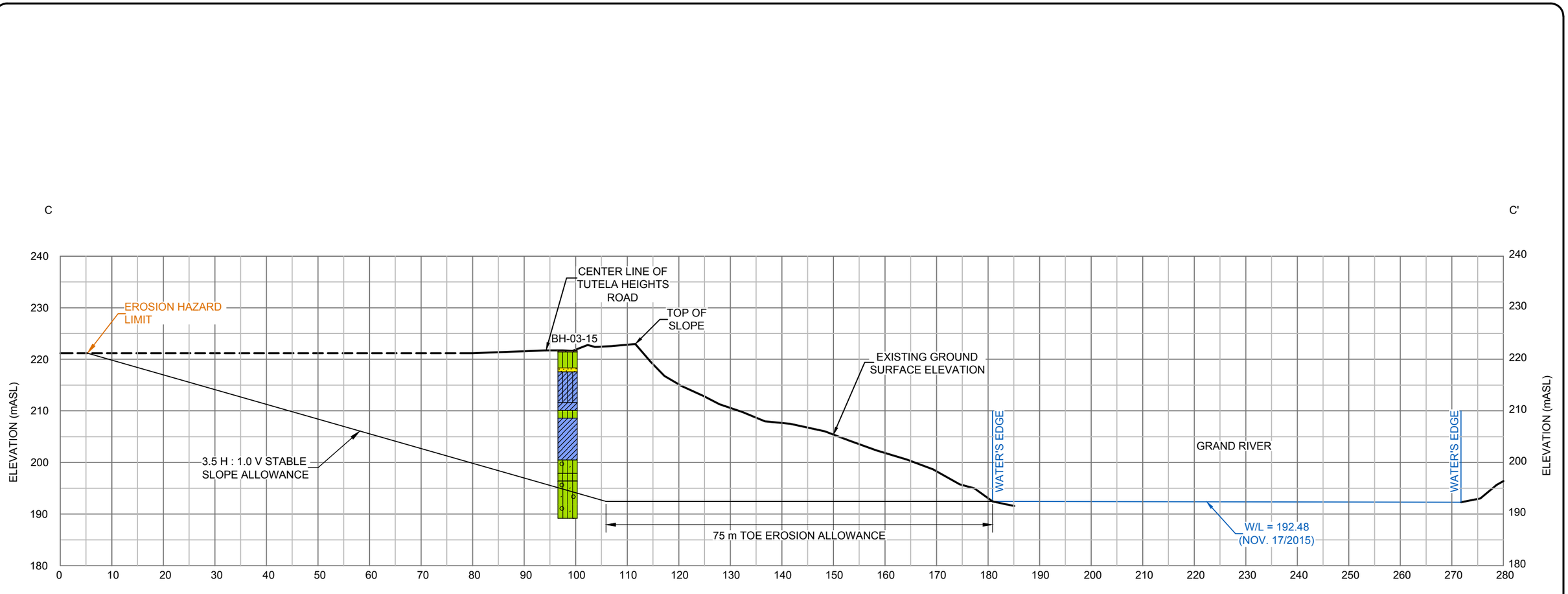

CROSS SECTION C - C'

LEGEND :

- TOPSOIL
- CLAY
- CLAY AND SILT
- SILT
- SAND
- SILT TILL

NOTES :

1-REFERENCES : J.H. COHOON ENGINEERING LIMITED, Project Tutela Heights Road Slope Area Erosion and Stability Analysis, Drawing X-Sections, Drawing number 11369-EX2, dated November 18, 2015.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Tutela Heights Road Slope Stabilization

Tutela Heights Road, Brantford, Ontario

Title

CROSS SECTION C - C'
75 m TOE EROSION ALLOWANCE

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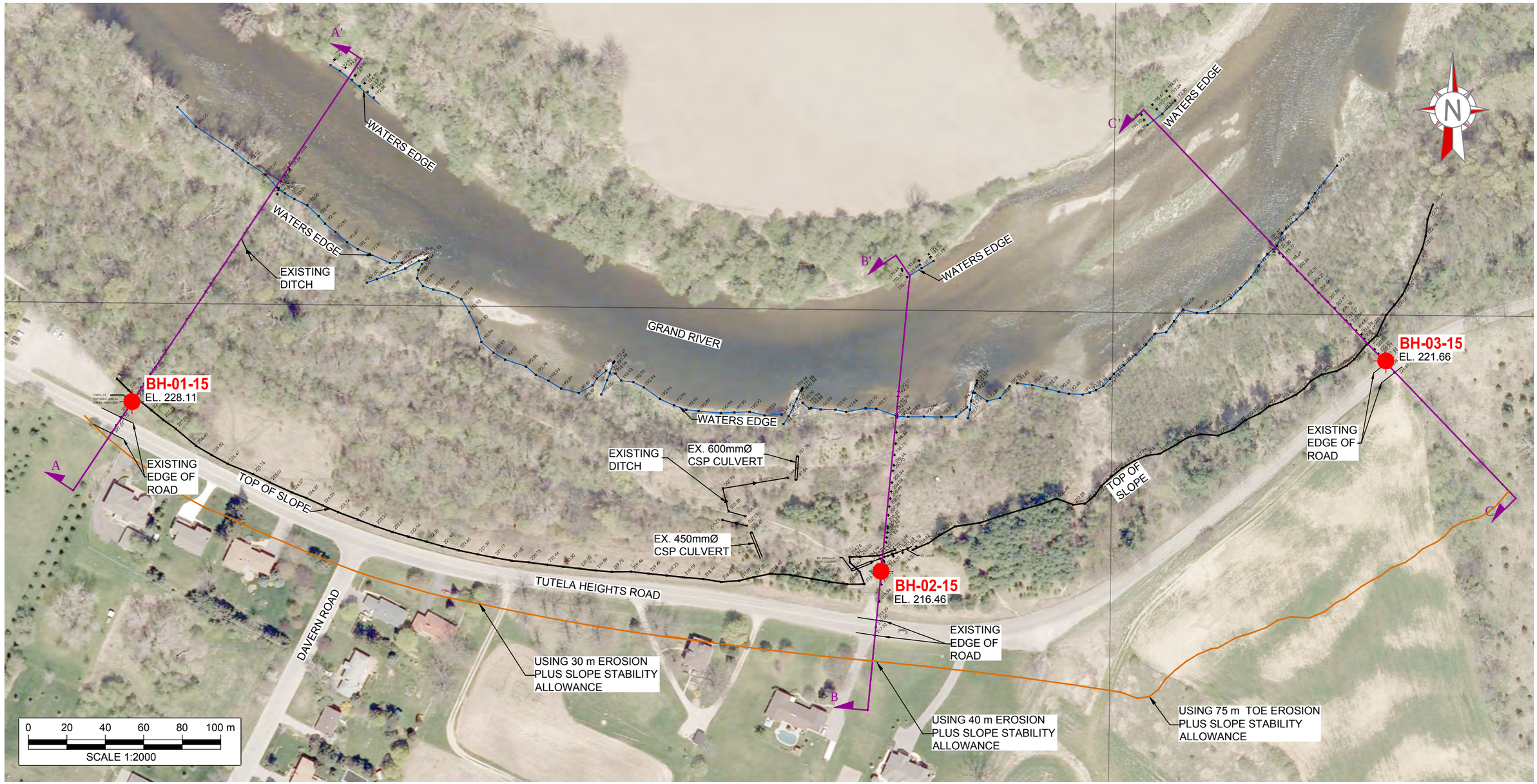
Prepared	K. Ashe	Discipline	GEOTECHNICAL
Drawn	K. Ashe	Scale	H = 1:750 V = 1:750
Checked	K. Thrams	Date	2017-01-16

Project manager: K. Thrams
Sequence no.: 04 of 05

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0009053-0-01-100	GE	004	00



LEGEND :

- BOREHOLE LOCATION
- EL. 228.11 — GROUND SURFACE ELEVATION (m)
- TOP OF SLOPE
- EROSION HAZARD LIMIT

NOTES :

1-REFERENCES : J.H. COHOON ENGINEERING LIMITED, Project Tutela Heights Road Slope Area Erosion and Stability Analysis, Drawing Existing Topography, Drawing number 11369-EX1, dated November 18, 2015.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Tutela Heights Road Slope Stabilization

Tutela Heights Road, Brantford, Ontario

Title

EROSION HAZARD LIMIT WITH VARIABLE TOE EROSION ALLOWANCE

Englobe

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	K. Ashe	Discipline	GEOTECHNICAL
Drawn	K. Ashe	Scale	1 : 2000
Checked	K. Thrams	Date	2017-01-16

Project manager: K. Thrams
Sequence no.: 05 of 05

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0009053-0-01-100	GE	005	00

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10 cm

Appendix 2 Borehole Logs

List of Abbreviations
Boreholes BH-01-15 to BH-03-15

LIST OF ABBREVIATIONS

The abbreviations commonly employed on the borehole logs, on the figures, and in the text of the report, are as follows:

Sample Types		Soil Tests and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid limit
WC	Water Content Sample	I_L	Liquidity index
TP	Thinwall, Piston	I_p	Plasticity index
		PP	Pocket penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60º cone a distance 300 mm (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	sampler advanced by static weight of hammer
PH	sampler advanced by hydraulic pressure
PM	sampler advanced by manual pressure

Soil Description		
Cohesionless Soils	**SPT N-Value**	**Relative Density (D_r)**
Compactness Condition	(blows per 0.3 m)	(%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	over 50	80 to 100
Cohesive Soils	**Undrained Shear Strength (C_u)**	
Consistency	**kPa**	**psf**
Very Soft	less than 12	less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L <30
APL	About plastic limit	Medium Plasticity, 30 < W_L < 50
WTPL	Wetter than plastic limit	High Plasticity, W_L > 50

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Ground Elevation: *228.11 m*

Borehole Number: **BH-01-15**

Job N°: *P-0009053-0-01-100*

Drill Date: *2015-09-28 to 2015-09-30*

Project: *Tutela Heights Road Slope Stabilization*

Field Tech: *D. Souter*

Location: *Tutela Heights Road, Brantford, Ontario*

Drill Method: *Mud Rotary*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		228.11			
1	***TOPSOIL:*** dark brown silt, some sand, moist		0.00 / 227.96	SS-1	3-5 6	11
2			0.15 / 226.59	SS-2	7-12 19	31
3	***SAND:*** compact brown silty fine sand, very moist to wet		1.52 / 225.82	SS-3	11-13 10	23
4	dense		2.29 / 225.06	SS-4	12-20 30	50
5	***SILT:*** compact silt, trace sand and clay, wet		3.05 / 223.54	SS-5	10-12 29	41
6	very dense		4.57 / 222.62	SS-6	12-15 24	39
7	***SAND:*** dense grey / brown silty fine sand, some thin silt layers, wet		5.49	SS-7	12-21 28	49
8			219.58			
9	***SILT:*** dense grey fine sandy silt, very moist		8.53	SS-8	21-30 36	66
10	very dense		218.05			
11	hard grey clayey silt, some fine sand, APL		10.06	SS-9	6-8 8	16
12	clayey silt, APL		216.53			
13	trace fine gravel, APL		11.58	SS-10	3-5 6	11
14	very stiff		215.00			
15			12.80	SS-11	5-7 8	15
16	***CLAY:*** stiff to very stiff grey silty clay, APL to WTPL		213.48			
17			14.63	SS-12	4-6 8	14
18			211.96			
19			16.15	SS-13	2-4 5	9
20	firm to stiff			ST-14		
21			208.91			
22	very stiff		19.20	SS-15	1-4 7	11
23			207.38			
24	stiff silty clay, trace fine gravel, WTPL		20.73	SS-16	4-7 9	16
25			205.86			
26	***SILT:*** dense grey fine sandy silt, some clay, trace gravel, very moist to wet		22.25	SS-17	3-5 6	11
27			202.81			
28	Borehole terminated at 25.76 m		25.30 / 202.35 / 25.76	SS-18	12-12 21	33
29						
30						
31						
32						
33						
34						
35						
36						
37						

Dynamic Cone — Std Penetration: 20 40 60 80

Shear Strength (PP) kPa: 50 100 150 200 — Initial / Remold — Shear Strength (FV) kPa: 50 100 150 200

WP WL — Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details

- topsoil fill
- protective cover and concrete
- grout seal
- 70 mm OD inclinometer pipe
- native cave

Reviewed by: *K. Thrams*

Drafted by: *K. Ashe*

Sheet: *1 of 1*

Notes:

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Vertical Scale = 1 : 210.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation: *216.46 m*

Borehole Number: **BH-02-15**

Job N°: *P-0009053-0-01-100*

Drill Date: *2015-10-01 to 2015-10-05*

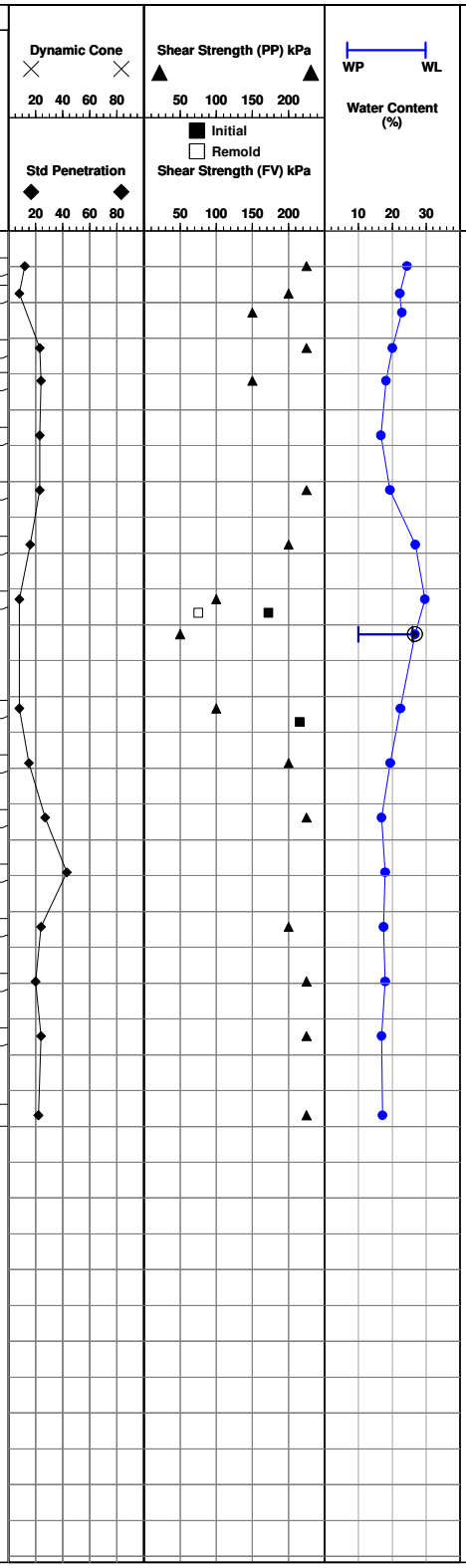
Project: *Tutela Heights Road Slope Stabilization*

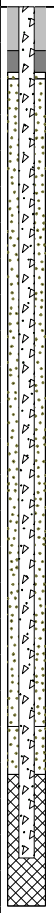
Field Tech: *D. Souter*

Location: *Tutela Heights Road, Brantford, Ontario*

Drill Method: *Mud Rotary*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		216.46			
0	***TOPSOIL:*** dark brown silt, some sand, moist		0.00 / 216.36	SS-1	3-5 7	12
1			0.10 / 215.70	SS-2	3-3 5	8
2	***SAND:*** brown sand, some silt, moist		0.76 / 214.48	ST-3		
3	***SILT:*** hard grey / brown clayey silt, trace fine sand, APL		1.98 / 213.41	SS-4	7-11 12	23
4			3.05 / 212.50	SS-5	3-8 16	24
5	stiff to hard brownish grey to grey		3.96 / 210.97	SS-6	9-11 12	23
6			5.49 / 209.45			
7	hard grey APL to WTPL		7.01	SS-7	4-9 14	23
8	compact silt, some fine sand and clay, wet			SS-8	7-8 8	16
9	hard clayey silt, some fine sand, APL to WTPL		206.40			
10	***CLAY:*** stiff to very stiff grey silty clay, WTPL		10.06 / 205.49	SS-9	2-3 5	8
11			10.97	ST-10		
12	***CLAY AND SILT:*** firm clay and silt, trace sand, WTPL		203.35			
13			13.11 / 203.05	SS-11	2-4 4	8
14	stiff to very stiff, WTPL to APL		13.41			
15	APL		201.53 / 14.94	SS-12	6-7 8	15
16	***SILT TILL:*** hard grey clayey silt, some fine sand, trace gravel, APL			SS-13	7-12 15	27
17			199.39 / 17.07			
18	dense silt, some fine sand and clay, very moist to wet			SS-14	9-16 27	43
19			197.26			
20	hard clayey silt, trace fine sand and gravel, APL		19.20	SS-15	6-11 13	24
21				SS-16	5-9 11	20
22						
23				SS-17	4-9 15	24
24						
25			191.47	SS-18	5-10 12-20	22
	Borehole terminated at 24.99 m		24.99			
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						





Reviewed by: *K. Thrams*

Drafted by: *K. Ashe*

Sheet: *1 of 1*

Notes:

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Vertical Scale = 1 : 210.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation: *221.66 m*

Borehole Number: **BH-03-15**

Job N°: *P-0009053-0-01-100*

Drill Date: *2015-10-08*

Project: *Tutela Heights Road Slope Stabilization*

Field Tech: *D. Souter*

Location: *Tutela Heights Road, Brantford, Ontario*

Drill Method: *Mud Rotary*

Depth (m)	Description	Elevation (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation	221.66			
	TOPSOIL: dark brown silt, trace sand and gravel, moist	0.00 / 221.43	SS-1	4-5 / 6	11
		0.23	SS-2	3-10 / 12	22
	SILT: compact mottled grey and brown silt, some clay, trace sand, gravel and organics, wet	219.37 / 2.29	SS-3	6-12 / 13	25
		218.61 / 3.05	SS-4	4-10 / 24	34
	greyish brown, some fine sand and clay, very moist	218.31 / 3.35	SS-5	3-9 / 13	22
	hard grey clayey silt, some fine sand, APL	217.54 / 4.12	SS-6	2-3 / 4	7
	SAND: dense grey fine sand, some silt, very moist to wet	216.17 / 5.49	SS-7	2-3 / 3	6
		213.89 / 7.77	ST-8		
	CLAY AND SILT: hard grey clay and silt, trace fine sand, APL	211.60 / 10.06	SS-9	2-5 / 5	10
	very stiff, APL to WTPL	210.08			
	stiff to hard, APL to WTPL	11.58	SS-10	8-10 / 10	20
	CLAY: hard grey silty clay, WTPL to APL	208.55 / 13.11	SS-11	4-6 / 11	17
	SILT: hard grey clayey silt, some fine sand, WTPL to APL	207.03 / 14.63	SS-12	4-9 / 8	17
	CLAY: very stiff to stiff grey silty clay, WTPL	205.51 / 16.15	SS-13	5-5 / 5	10
	APL		SS-14	3-6 / 8	14
	WTPL - APL		SS-15	3-8 / 8	16
		200.48	SS-16	1-4 / 6	10
	SILT TILL: hard grey clayey silt, trace fine sand and gravel, APL	21.18	SS-17	7-12 / 15	27
	SILT: hard grey and brown clayey silt, some fine sand, WTPL	197.89 / 23.77	SS-18	6-11 / 16	27
		196.36 / 25.30	SS-19	8-12 / 22	34
	SILT TILL: dense grey and brown silt, some clay and fine sand, trace gravel, wet	196.06 / 25.60			
	some gravel	193.31 / 28.35	SS-20	6-13 / 25	38
	hard grey clayey silt, trace sand and gravel, APL				
		189.66 / 32.00	SS-21	7-15 / 25	40
	shale fragments	189.20 / 32.46	SS-22	50 /25 mm	
	dark grey shale fragments with silty clay, wet	189.17 / 32.49			
	Borehole terminated at 32.49 m upon practical refusal				

Dynamic Cone — Std Penetration: 20 40 60 80

Shear Strength (PP) kPa: 50 100 150 200 — Initial / Remold — Shear Strength (FV) kPa: 50 100 150 200

WP WL — Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details

- flushmount cover and concrete
- bentonite seal
- 70 mm OD inclinometer
- grout seal
- clay cave
- native cave

Reviewed by: *K. Thrams*

Drafted by: *K. Ashe*

Sheet: *1 of 1*

Notes:

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Vertical Scale = 1 : 210.0

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Appendix 3 Figures

Figure 1: Particle Size Distribution Analyses

PARTICLE SIZE ANALYSIS

Project: **Tutela Heights Road Slope Stabilization**

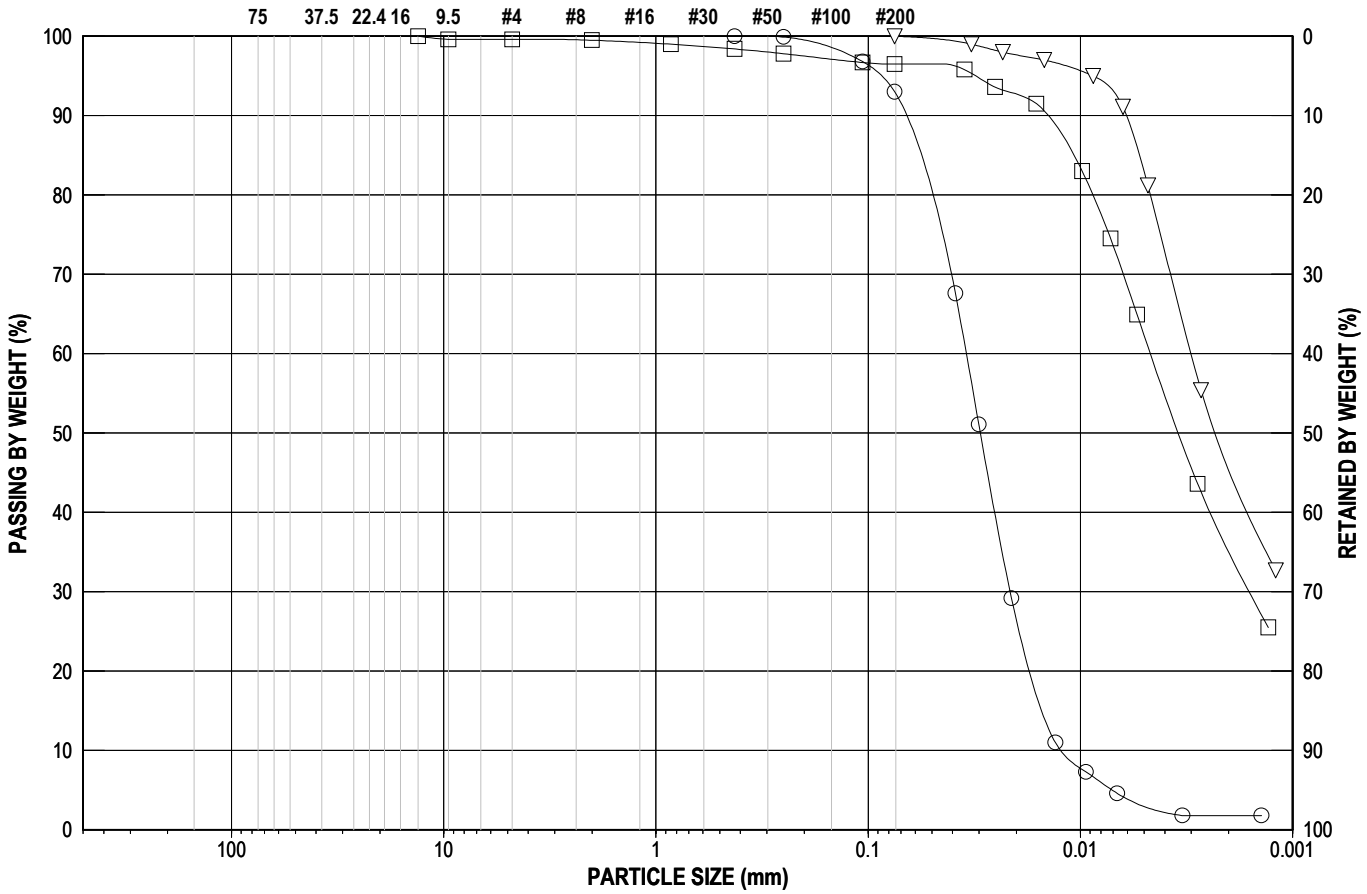
Location: **Tutela Heights Road, Brampton, Ontario**

Figure No : **1**

File No : **P-0009053-0-01-100**

UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (m)	Description
○	BH-01-15	SS-3	2.29 - 2.74	SILT, trace Sand and Clay
□	BH-02-15	ST-10	10.97 - 11.56	CLAY and SILT, trace Sand
▽	BH-03-15	ST-8	7.77 - 8.33	CLAY and SILT

Appendix 4 Results of Inclinometer Readings

Inclinometer Monitoring Data
Tutela Heights Project, Ontario
Revised January 15, 2017

Project No. IDG 150228

Prepared for:
Ms. Karen Thrams, Dipl.-Ing., M.Eng.

Englobe
353 Bridge Street East
Kitchener, Ontario
N2K 2Y5

In-Depth Geotechnical Inc.
20 Ravenscliffe Avenue
Hamilton, Ontario
L8P 3M4
Phone: (905) 541 9937
Fax: (877) 624 0140

1. Introduction

In-Depth Geotechnical Inc. was retained by Englobe to install three inclinometer casings and monitor movement of soil masses in relation to their Geotechnical Investigation for the Tutela Heights Slope Stability Project, in Brantford, Ontario.

This letter report presents the latest update results from inclinometer readings at the three borehole locations.

2. Field Installation Procedure

Drilling of boreholes BH-01-16 to BH-03-16 was completed using mud rotary drilling, with our truck mounted CME 75 drill rig.

After SPT testing and sampling, the borings were reamed up with a 6 inch drag bit to produce a sufficiently big diameter to install the inclinometer casing. Drilling dates were as follows:

BH-01-16: between September 28 to 30, 2015, to a depth of 25.76 m below ground surface;

BH-02-16: between October 1to 5, 2015, to a depth of 24.99 m; and

BH-03-16: between October 6 to 8, 2105, to a depth of 32.49 m.

The inclinometer casing system consisted of Model ***Geo-Lok***, 70 mm OD, supplied by Roctest, of Montreal. This casing Model is manufactured in ABS plastic. The inclinometer probe and read-out unit consisted of a ***Profil*** inclinometer unit, also manufactured and supplied by Roctest Ltée. The User manual and software manuals are attached to this report in pdf format.

After insertion of the casing onto the borings, the boring space outside the inclinometer casings were backfilled with cement-bentonite grout, using the tremie pipe method.

Inclinometer casing has two sets of grooves, orthogonally placed with respect to each other. During installation, the main orientation of grooves (A-A) were set pointing to the face of the slope, while the secondary orientation (B-B) were aligned parallel to the face of the slope.

3. Field Monitoring Procedures and Results

Initial baseline reading of the three inclinometer casings was completed on October 15, 2015. Subsequent monitoring readings were completed at the following dates:

November 6, 2015

December 18, 2015

January 15, 2016

April 12, 2016, and

May 16, 2016.

The summarized inclinometer data is attached into Appendix One. The data is provided in tables and plot formats. The provided data refers to recorded displacements along the A-A and B-B orientation, in mm, from the base line readings. Depths are referred from the ground surface to the center of probe at the time of the recording.

Based on the recorded data up to date the following observations can be made:

1. From the observation time period of about 7 months, the maximum amount of displacements do not exceed 2 mm, in any given direction or depth.
2. It appears that maximum displacements were recorded during the January 15, 2016 readout date. Two subsequent readings indicated a reverse of the displacement trends.
3. Spurious modes of deformations are observed at several localized depths. These 'funny' readings may be associated to a) seasonal variations (temperature/moisture), and/or b) grout backfill material is setting along the casing at a different rate.

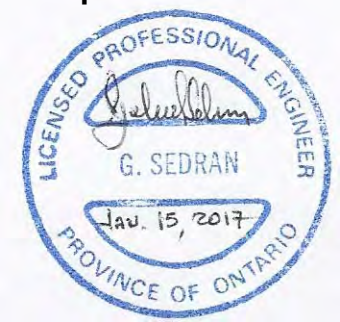
In any case, future readings will reinforce actual ground mass displacements while filtering out the spurious displacements.

4. Closure

We trust that the present report fulfill your requirements. Should you have any question, please feel free to contact the undersigned.

Sincerely,

In-Depth Geotechnical Inc.



Gabriel Sedran, P.Eng., Ph.D.
President

Appendix One

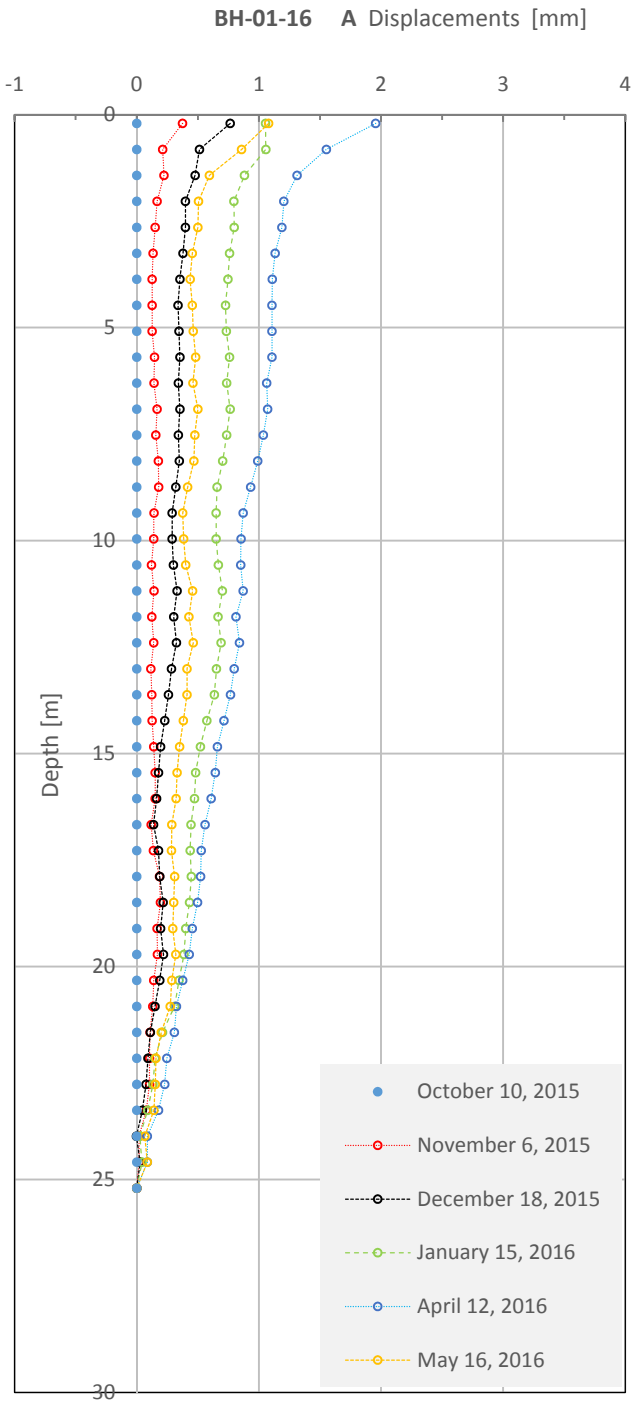
Inclinometer Data

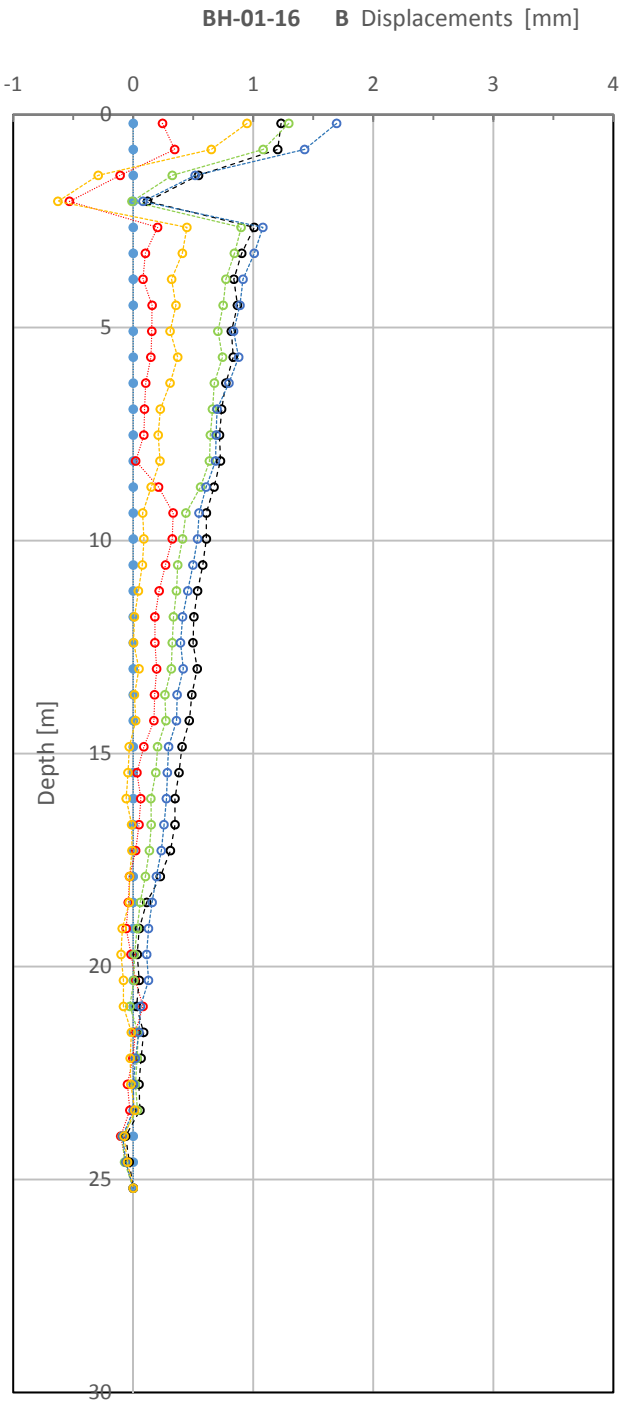
Inclinometer BH-01-16

Displacements along plane perpendicular to the face of slope - **A direction**
Profile Change in mm

Displacements along plane parallel to the face of slope - **B direction**
Profile Change in mm

Depth m	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016
0.21	0.00	0.37	0.76	1.05	1.96	1.08	0.00	0.24	1.23	1.30	1.69	0.95
0.82	0.00	0.21	0.51	1.06	1.55	0.86	0.00	0.35	1.20	1.08	1.43	0.65
1.43	0.00	0.22	0.48	0.88	1.31	0.59	0.00	-0.11	0.54	0.33	0.52	-0.29
2.04	0.00	0.17	0.40	0.80	1.20	0.51	0.00	-0.53	0.12	-0.01	0.08	-0.63
2.65	0.00	0.15	0.40	0.80	1.19	0.50	0.00	0.20	1.01	0.90	1.08	0.45
3.26	0.00	0.13	0.38	0.76	1.13	0.45	0.00	0.10	0.90	0.84	1.01	0.41
3.87	0.00	0.13	0.35	0.75	1.11	0.44	0.00	0.08	0.84	0.77	0.91	0.32
4.48	0.00	0.13	0.34	0.73	1.11	0.45	0.00	0.16	0.87	0.75	0.89	0.36
5.09	0.00	0.13	0.35	0.73	1.11	0.46	0.00	0.15	0.82	0.71	0.84	0.31
5.70	0.00	0.15	0.35	0.76	1.11	0.48	0.00	0.15	0.83	0.74	0.88	0.37
6.31	0.00	0.14	0.34	0.74	1.06	0.46	0.00	0.10	0.77	0.68	0.80	0.31
6.92	0.00	0.17	0.35	0.76	1.07	0.50	0.00	0.09	0.74	0.66	0.70	0.23
7.52	0.00	0.16	0.34	0.74	1.04	0.47	0.00	0.09	0.72	0.64	0.69	0.21
8.13	0.00	0.18	0.35	0.70	0.99	0.47	0.00	0.02	0.73	0.64	0.69	0.22
8.74	0.00	0.18	0.32	0.66	0.93	0.42	0.00	0.21	0.67	0.56	0.61	0.15
9.35	0.00	0.14	0.29	0.65	0.87	0.38	0.00	0.33	0.61	0.44	0.55	0.08
9.96	0.00	0.14	0.29	0.65	0.85	0.38	0.00	0.33	0.61	0.41	0.54	0.09
10.57	0.00	0.12	0.30	0.67	0.85	0.40	0.00	0.27	0.58	0.37	0.50	0.08
11.18	0.00	0.14	0.33	0.70	0.87	0.46	0.00	0.22	0.54	0.36	0.45	0.04
11.79	0.00	0.12	0.30	0.67	0.81	0.43	0.00	0.18	0.51	0.34	0.41	0.01
12.40	0.00	0.14	0.33	0.69	0.84	0.46	0.00	0.18	0.50	0.33	0.39	0.00
13.01	0.00	0.12	0.28	0.65	0.80	0.41	0.00	0.20	0.53	0.32	0.42	0.05
13.62	0.00	0.12	0.26	0.64	0.77	0.41	0.00	0.18	0.49	0.26	0.37	0.01
14.23	0.00	0.13	0.23	0.57	0.71	0.38	0.00	0.17	0.47	0.27	0.36	0.02
14.84	0.00	0.14	0.20	0.52	0.66	0.35	0.00	0.09	0.41	0.20	0.29	-0.03
15.45	0.00	0.15	0.18	0.48	0.64	0.33	0.00	0.03	0.38	0.19	0.28	-0.04
16.06	0.00	0.15	0.16	0.47	0.61	0.32	0.00	0.06	0.35	0.15	0.28	-0.06
16.67	0.00	0.12	0.14	0.44	0.56	0.29	0.00	0.05	0.35	0.15	0.26	-0.01
17.28	0.00	0.14	0.18	0.44	0.53	0.28	0.00	0.02	0.31	0.13	0.23	-0.01
17.89	0.00	0.19	0.19	0.45	0.52	0.31	0.00	-0.03	0.23	0.10	0.19	-0.03
18.50	0.00	0.19	0.22	0.43	0.50	0.30	0.00	-0.04	0.11	0.06	0.16	-0.03
19.11	0.00	0.17	0.20	0.40	0.45	0.29	0.00	-0.06	0.05	0.03	0.13	-0.09
19.72	0.00	0.17	0.22	0.39	0.43	0.32	0.00	-0.02	0.03	0.01	0.11	-0.10
20.33	0.00	0.14	0.19	0.35	0.38	0.29	0.00	0.02	0.05	0.01	0.13	-0.08
20.94	0.00	0.13	0.15	0.31	0.33	0.27	0.00	0.08	0.03	-0.03	0.06	-0.08
21.55	0.00	0.11	0.11	0.21	0.31	0.20	0.00	0.02	0.09	0.04	0.05	-0.02
22.16	0.00	0.10	0.09	0.15	0.25	0.16	0.00	0.00	0.07	0.03	0.02	-0.03
22.76	0.00	0.10	0.08	0.13	0.23	0.15	0.00	-0.05	0.05	0.02	0.00	-0.02
23.37	0.00	0.08	0.05	0.09	0.18	0.14	0.00	-0.03	0.06	0.04	0.00	0.01
23.98	0.00	0.02	0.00	0.03	0.09	0.07	0.00	-0.10	-0.06	-0.09	-0.09	-0.08
24.59	0.00	0.02	0.03	0.04	0.09	0.09	0.00	-0.06	-0.03	-0.07	-0.06	-0.05
25.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00


BH-01-16 A Displacements [mm]
-1
0
1
2
3
4
0
5
10
15
20
25
30
Depth [m]
October 10, 2015
November 6, 2015
December 18, 2015
January 15, 2016
April 12, 2016
May 16, 2016

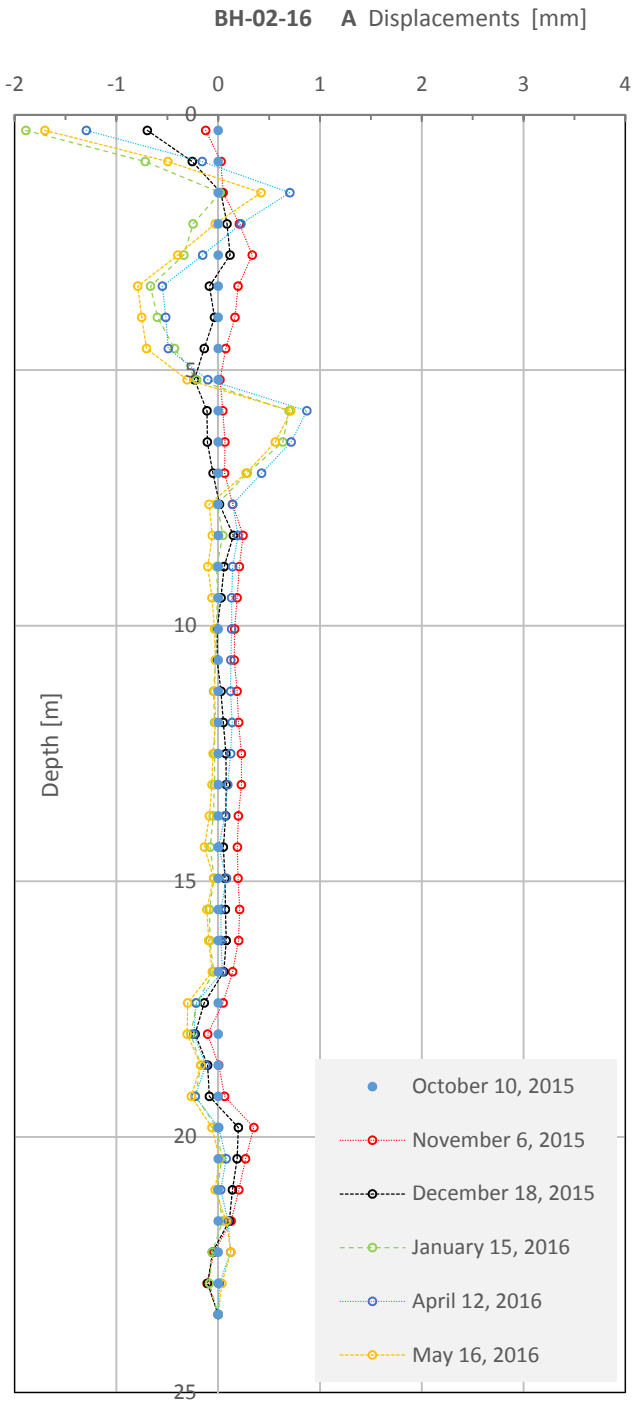

BH-01-16 B Displacements [mm]
-1
0
1
2
3
4
0
5
10
15
20
25
30
Depth [m]

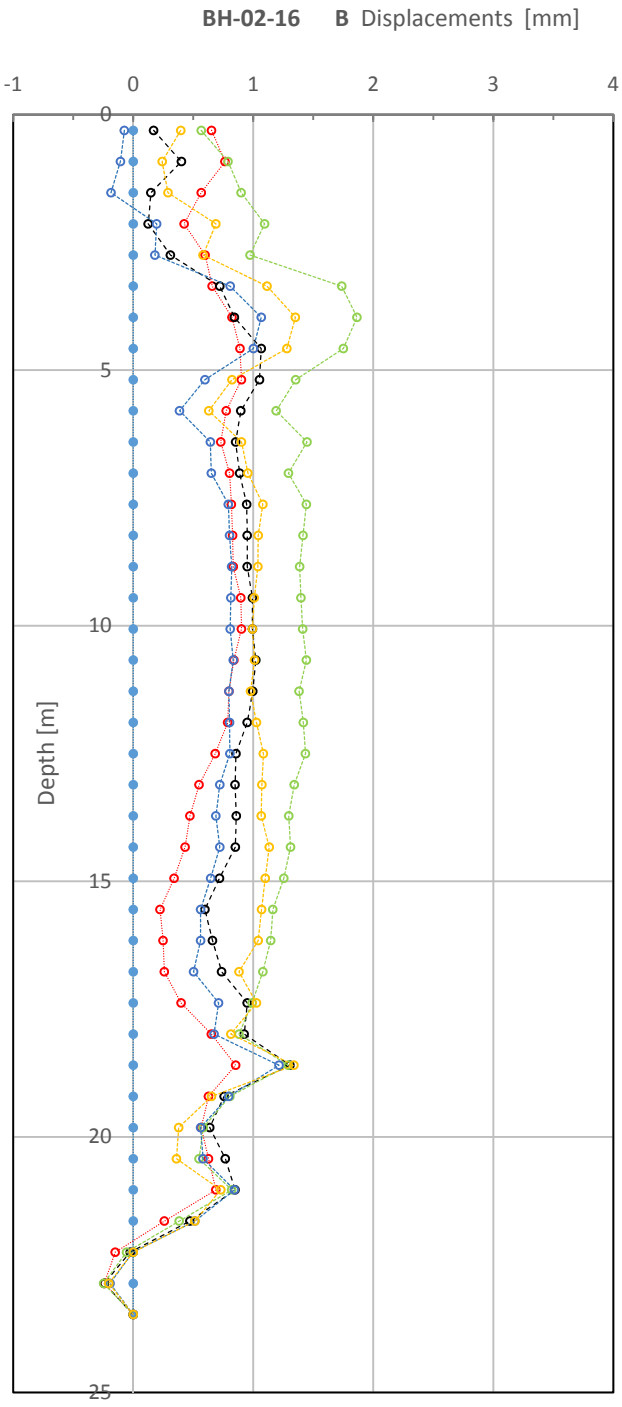
Inclinometer BH-02-16

Displacements along plane perpendicular to the face of slope - **A direction**
Profile Change in mm

Displacements along plane parallel to the face of slope - **B direction**
Profile Change in mm

Depth m	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016
0.31	0.00	-0.12	-0.70	-1.89	-1.30	-1.70	0.00	0.65	0.17	0.57	-0.07	0.40
0.92	0.00	0.03	-0.25	-0.72	-0.16	-0.49	0.00	0.76	0.40	0.79	-0.11	0.24
1.53	0.00	0.05	0.03	0.02	0.70	0.42	0.00	0.57	0.15	0.90	-0.19	0.29
2.14	0.00	0.21	0.09	-0.25	0.22	-0.03	0.00	0.42	0.12	1.09	0.20	0.69
2.75	0.00	0.34	0.12	-0.34	-0.15	-0.40	0.00	0.60	0.31	0.97	0.18	0.58
3.36	0.00	0.20	-0.09	-0.67	-0.55	-0.79	0.00	0.66	0.72	1.74	0.81	1.12
3.97	0.00	0.17	-0.04	-0.60	-0.52	-0.75	0.00	0.82	0.84	1.86	1.07	1.35
4.58	0.00	0.07	-0.14	-0.43	-0.49	-0.70	0.00	0.89	1.07	1.75	1.00	1.28
5.19	0.00	0.02	-0.23	-0.21	-0.10	-0.30	0.00	0.90	1.05	1.35	0.60	0.82
5.80	0.00	0.05	-0.11	0.70	0.87	0.71	0.00	0.77	0.90	1.19	0.39	0.63
6.41	0.00	0.07	-0.11	0.64	0.72	0.56	0.00	0.73	0.85	1.45	0.64	0.90
7.02	0.00	0.06	-0.05	0.28	0.43	0.27	0.00	0.80	0.89	1.29	0.65	0.96
7.62	0.00	0.14	0.01	-0.01	0.14	-0.09	0.00	0.82	0.94	1.44	0.79	1.08
8.23	0.00	0.24	0.15	0.05	0.20	-0.06	0.00	0.83	0.95	1.41	0.80	1.04
8.84	0.00	0.21	0.06	-0.02	0.14	-0.10	0.00	0.83	0.95	1.39	0.82	1.04
9.45	0.00	0.19	0.03	-0.01	0.13	-0.06	0.00	0.90	0.99	1.40	0.81	1.01
10.06	0.00	0.16	-0.01	-0.02	0.13	-0.04	0.00	0.90	0.99	1.41	0.81	0.99
10.67	0.00	0.16	-0.01	-0.03	0.12	-0.03	0.00	0.84	1.02	1.44	0.83	1.01
11.28	0.00	0.19	0.03	-0.05	0.12	-0.04	0.00	0.80	1.00	1.38	0.80	0.98
11.89	0.00	0.20	0.05	-0.04	0.14	-0.03	0.00	0.79	0.95	1.42	0.80	1.03
12.50	0.00	0.23	0.08	-0.04	0.12	-0.05	0.00	0.68	0.86	1.44	0.81	1.08
13.11	0.00	0.23	0.08	-0.04	0.09	-0.06	0.00	0.55	0.85	1.34	0.72	1.07
13.72	0.00	0.20	0.07	-0.05	0.07	-0.09	0.00	0.47	0.86	1.30	0.69	1.07
14.33	0.00	0.19	0.05	-0.08	0.01	-0.13	0.00	0.43	0.85	1.31	0.72	1.13
14.94	0.00	0.20	0.07	-0.04	0.08	-0.05	0.00	0.34	0.72	1.25	0.65	1.10
15.55	0.00	0.21	0.07	-0.09	0.03	-0.11	0.00	0.22	0.60	1.16	0.56	1.07
16.16	0.00	0.20	0.08	-0.08	0.03	-0.09	0.00	0.25	0.66	1.15	0.56	1.04
16.77	0.00	0.14	0.06	-0.04	0.04	-0.06	0.00	0.26	0.74	1.08	0.50	0.88
17.38	0.00	0.05	-0.14	-0.21	-0.22	-0.30	0.00	0.40	0.95	0.99	0.71	1.03
17.99	0.00	-0.10	-0.23	-0.27	-0.24	-0.30	0.00	0.65	0.92	0.88	0.67	0.81
18.60	0.00	0.01	-0.10	-0.17	-0.12	-0.17	0.00	0.85	1.31	1.29	1.21	1.34
19.21	0.00	0.06	-0.09	-0.22	-0.23	-0.26	0.00	0.63	0.76	0.81	0.80	0.65
19.82	0.00	0.35	0.20	-0.01	0.01	-0.06	0.00	0.57	0.64	0.58	0.56	0.38
20.43	0.00	0.27	0.19	0.03	0.08	0.01	0.00	0.63	0.77	0.55	0.58	0.36
21.04	0.00	0.20	0.14	-0.01	0.03	-0.03	0.00	0.69	0.85	0.82	0.84	0.73
21.65	0.00	0.13	0.11	0.04	0.10	0.08	0.00	0.26	0.47	0.38	0.51	0.51
22.26	0.00	-0.04	-0.06	-0.06	0.12	0.12	0.00	-0.15	-0.03	-0.06	0.00	0.00
22.86	0.00	-0.11	-0.10	-0.09	0.01	0.04	0.00	-0.24	-0.24	-0.25	-0.19	-0.20
23.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00


BH-02-16 A Displacements [mm]
-2
-1
0
1
2
3
4
0
5
10
15
20
25
Depth [m]
October 10, 2015
November 6, 2015
December 18, 2015
January 15, 2016
April 12, 2016
May 16, 2016

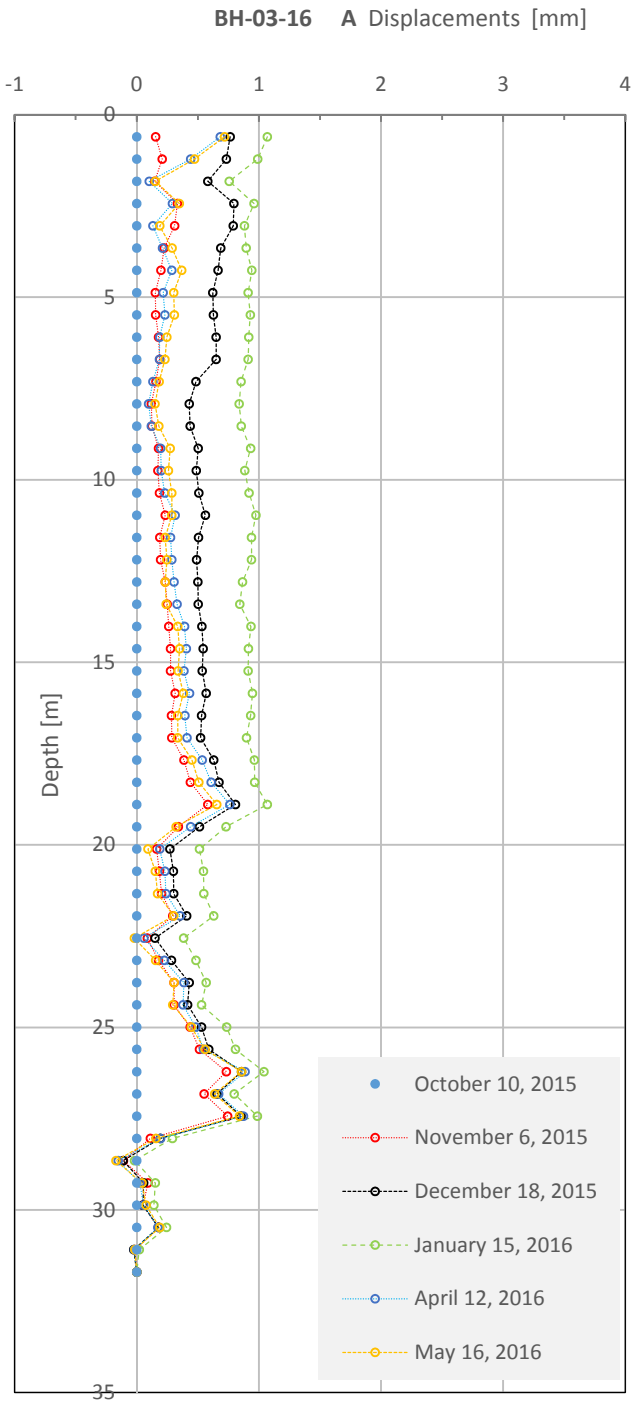

BH-02-16 B Displacements [mm]
-1
0
1
2
3
4
0
5
10
15
20
25
Depth [m]

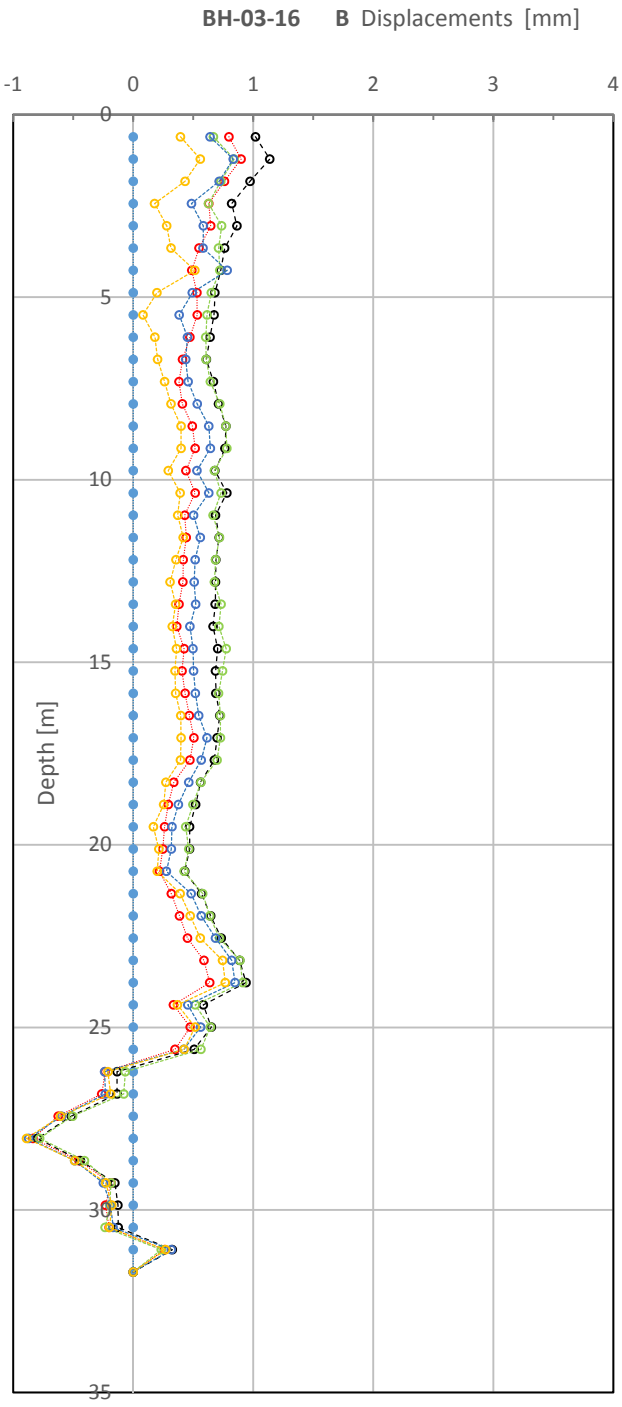
Inclinometer BH-03-16

Displacements along plane perpendicular to the face of slope - **A direction**
Profile Change in mm

Displacements along plane parallel to the face of slope - **B direction**
Profile Change in mm

Depth m	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016	October 10, 2015	November 6, 2015	December 18, 2015	January 15, 2016	April 12, 2016	May 16, 2016
0.61	0.00	0.15	0.76	1.07	0.68	0.72	0.00	0.80	1.02	0.67	0.64	0.39
1.22	0.00	0.21	0.73	0.99	0.44	0.47	0.00	0.90	1.14	0.84	0.83	0.56
1.83	0.00	0.15	0.58	0.76	0.10	0.15	0.00	0.76	0.97	0.73	0.72	0.43
2.44	0.00	0.33	0.80	0.96	0.29	0.35	0.00	0.63	0.82	0.63	0.49	0.18
3.05	0.00	0.31	0.79	0.88	0.13	0.19	0.00	0.65	0.86	0.74	0.58	0.28
3.66	0.00	0.22	0.69	0.90	0.21	0.29	0.00	0.55	0.76	0.71	0.58	0.31
4.27	0.00	0.20	0.67	0.94	0.29	0.37	0.00	0.49	0.73	0.72	0.78	0.51
4.88	0.00	0.15	0.62	0.91	0.22	0.30	0.00	0.53	0.68	0.65	0.49	0.20
5.49	0.00	0.15	0.63	0.93	0.23	0.31	0.00	0.53	0.67	0.61	0.38	0.08
6.10	0.00	0.18	0.65	0.92	0.19	0.25	0.00	0.47	0.64	0.60	0.45	0.18
6.71	0.00	0.19	0.65	0.91	0.19	0.23	0.00	0.41	0.61	0.61	0.44	0.20
7.32	0.00	0.16	0.49	0.85	0.13	0.18	0.00	0.38	0.67	0.64	0.46	0.26
7.92	0.00	0.12	0.43	0.84	0.10	0.15	0.00	0.41	0.71	0.72	0.53	0.31
8.53	0.00	0.12	0.44	0.86	0.12	0.18	0.00	0.49	0.77	0.77	0.63	0.40
9.14	0.00	0.18	0.50	0.93	0.20	0.27	0.00	0.52	0.76	0.78	0.64	0.40
9.75	0.00	0.17	0.49	0.88	0.20	0.26	0.00	0.44	0.68	0.68	0.53	0.29
10.36	0.00	0.19	0.51	0.92	0.23	0.29	0.00	0.52	0.78	0.73	0.63	0.39
10.97	0.00	0.23	0.56	0.98	0.31	0.29	0.00	0.43	0.69	0.67	0.50	0.37
11.58	0.00	0.19	0.51	0.94	0.28	0.23	0.00	0.44	0.72	0.72	0.56	0.42
12.19	0.00	0.20	0.49	0.94	0.29	0.25	0.00	0.42	0.69	0.69	0.52	0.36
12.80	0.00	0.23	0.50	0.87	0.30	0.23	0.00	0.41	0.69	0.68	0.51	0.31
13.41	0.00	0.25	0.50	0.84	0.33	0.24	0.00	0.38	0.68	0.73	0.52	0.35
14.02	0.00	0.26	0.53	0.93	0.39	0.34	0.00	0.36	0.67	0.71	0.47	0.33
14.63	0.00	0.28	0.54	0.91	0.41	0.35	0.00	0.42	0.70	0.77	0.50	0.36
15.24	0.00	0.28	0.54	0.91	0.39	0.34	0.00	0.41	0.69	0.74	0.50	0.35
15.85	0.00	0.31	0.57	0.95	0.43	0.38	0.00	0.43	0.69	0.71	0.52	0.35
16.46	0.00	0.28	0.53	0.93	0.39	0.34	0.00	0.47	0.72	0.73	0.55	0.40
17.07	0.00	0.29	0.52	0.90	0.41	0.34	0.00	0.51	0.70	0.73	0.61	0.40
17.68	0.00	0.39	0.63	0.96	0.54	0.45	0.00	0.47	0.68	0.70	0.57	0.39
18.29	0.00	0.44	0.67	0.97	0.61	0.51	0.00	0.34	0.56	0.56	0.46	0.27
18.90	0.00	0.58	0.81	1.07	0.76	0.66	0.00	0.29	0.52	0.50	0.38	0.25
19.51	0.00	0.34	0.51	0.73	0.44	0.32	0.00	0.26	0.47	0.44	0.32	0.17
20.12	0.00	0.16	0.27	0.51	0.19	0.09	0.00	0.25	0.47	0.46	0.32	0.21
20.73	0.00	0.19	0.30	0.55	0.23	0.15	0.00	0.22	0.43	0.42	0.28	0.20
21.34	0.00	0.20	0.30	0.55	0.24	0.17	0.00	0.32	0.57	0.58	0.48	0.39
21.95	0.00	0.29	0.41	0.63	0.36	0.30	0.00	0.39	0.65	0.64	0.57	0.47
22.56	0.00	0.09	0.15	0.38	0.06	-0.02	0.00	0.45	0.73	0.72	0.69	0.56
23.16	0.00	0.18	0.28	0.49	0.23	0.15	0.00	0.59	0.89	0.89	0.82	0.74
23.77	0.00	0.30	0.43	0.57	0.39	0.30	0.00	0.64	0.94	0.91	0.85	0.77
24.38	0.00	0.30	0.42	0.53	0.38	0.29	0.00	0.34	0.58	0.52	0.45	0.37
24.99	0.00	0.44	0.53	0.74	0.48	0.45	0.00	0.47	0.65	0.64	0.56	0.52
25.60	0.00	0.51	0.59	0.81	0.55	0.56	0.00	0.35	0.51	0.56	0.42	0.42
26.21	0.00	0.73	0.86	1.04	0.89	0.86	0.00	-0.23	-0.13	-0.07	-0.24	-0.21
26.82	0.00	0.55	0.66	0.80	0.67	0.64	0.00	-0.26	-0.13	-0.08	-0.23	-0.19
27.43	0.00	0.74	0.85	0.99	0.87	0.84	0.00	-0.62	-0.52	-0.51	-0.60	-0.60
28.04	0.00	0.11	0.19	0.29	0.20	0.16	0.00	-0.84	-0.80	-0.78	-0.87	-0.89
28.65	0.00	-0.11	-0.11	-0.02	-0.15	-0.17	0.00	-0.45	-0.44	-0.41	-0.49	-0.49
29.26	0.00	0.09	0.06	0.15	0.03	0.04	0.00	-0.19	-0.15	-0.19	-0.25	-0.23
29.87	0.00	0.05	0.05	0.14	0.06	0.08	0.00	-0.23	-0.13	-0.20	-0.19	-0.18
30.48	0.00	0.18	0.18	0.24	0.17	0.19	0.00	-0.20	-0.12	-0.23	-0.17	-0.20
31.09	0.00	-0.02	-0.03	0.02	-0.02	-0.02	0.00	0.26	0.33	0.23	0.32	0.27
31.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

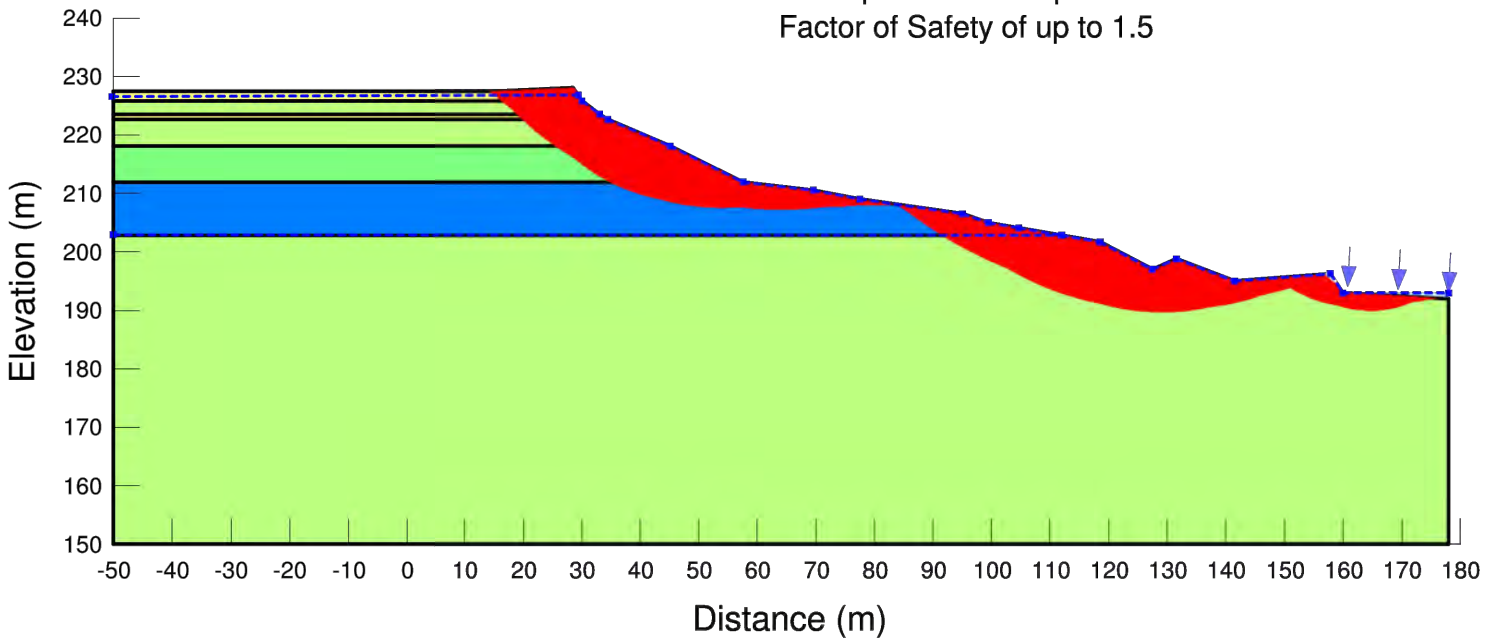

BH-03-16 A Displacements [mm]
-1
0
1
2
3
4
0
5
10
15
20
25
30
35
Depth [m]
October 10, 2015
November 6, 2015
December 18, 2015
January 15, 2016
April 12, 2016
May 16, 2016


BH-03-16 B Displacements [mm]
-1
0
1
2
3
4
0
5
10
15
20
25
30
35
Depth [m]

Appendix 5 Slope W Model Output

Project Number: 160-P-0009053-0-01-100
Tutela Heights Road Slope Stabilization
Crosss-Section A-A'

The failure zone shown in red represents a composite of all slip surfaces with a Factor of Safety of up to 1.5



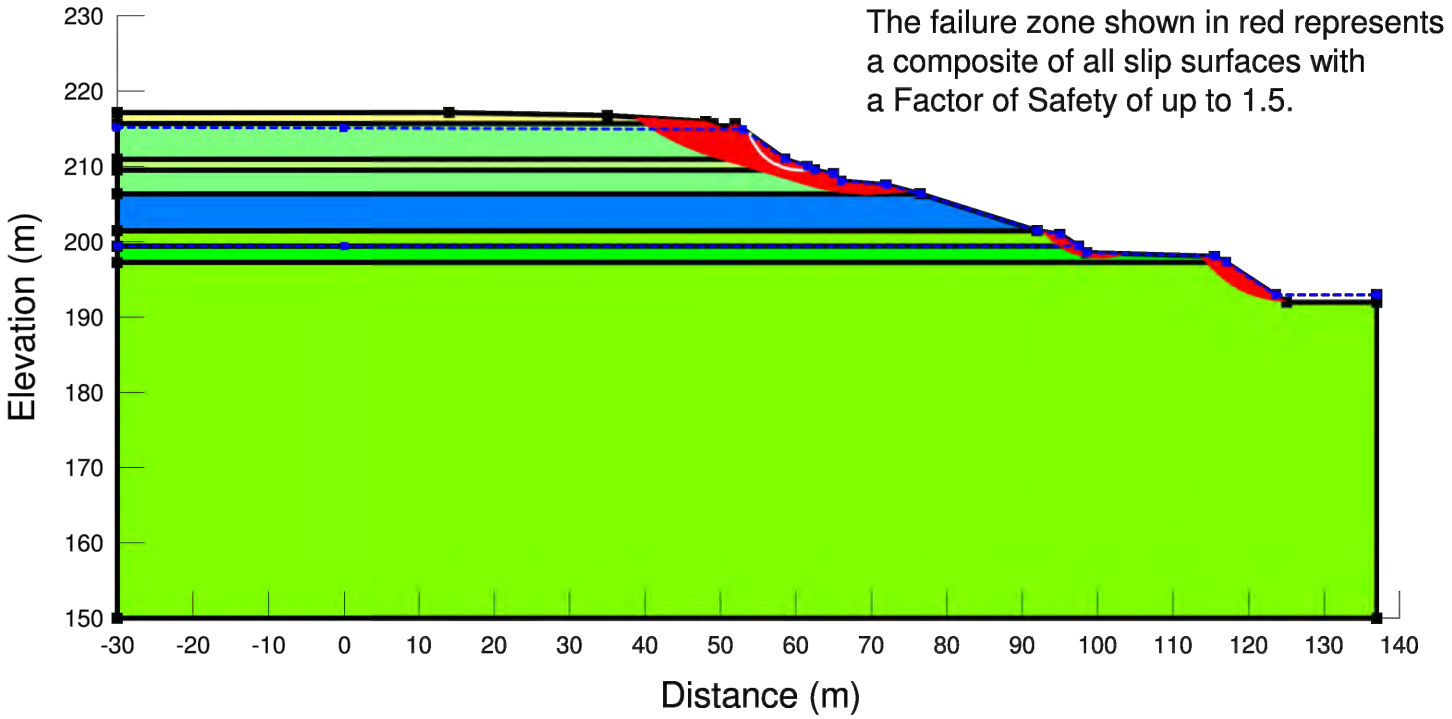
Name: Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: Silt, non-cohesive
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: Silt, cohesive
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 28 °

Name: Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 26 °

Project Number: 160-P-0009053-0-01-100
Tutela Heights Road Slope Stabilization
Crosss-Section B-B'



Name: Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: Silt, non-cohesive
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: Silt, cohesive
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 28 °

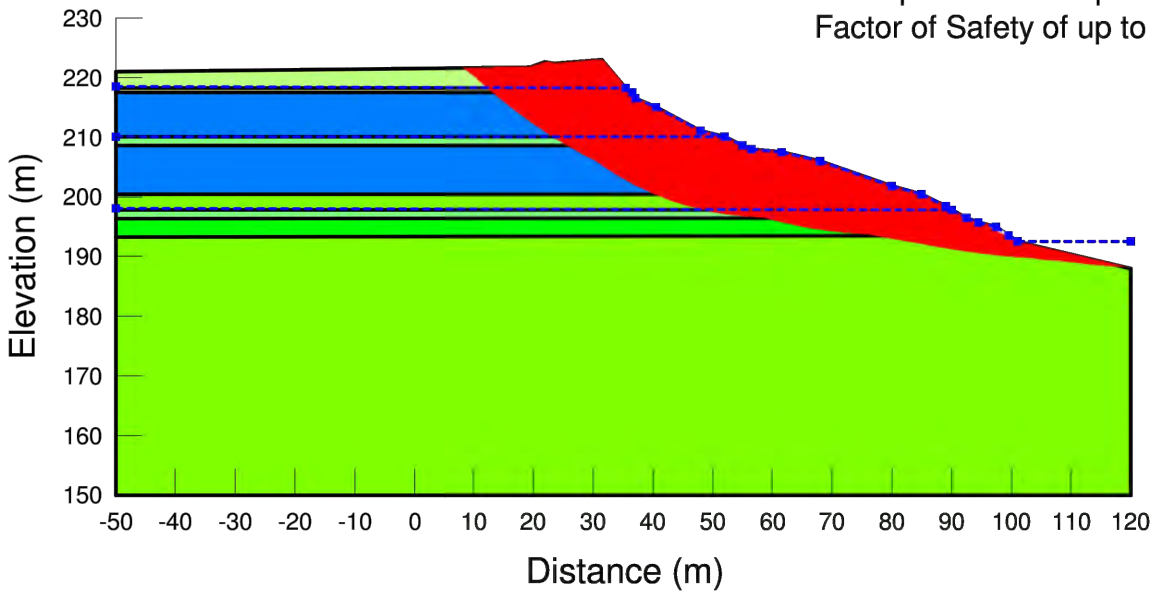
Name: Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 26 °

Name: Silt Till, cohesive
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 28 °

Name: Silt Till, non-cohesive
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Project Number: 160-P-0009053-0-01-100
Tutela Heights Road Slope Stabilization
Cross-Section C-C'

The failure zone shown in red represents a composite of all slip surfaces with a Factor of Safety of up to 1.5.



Name: Sand
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °

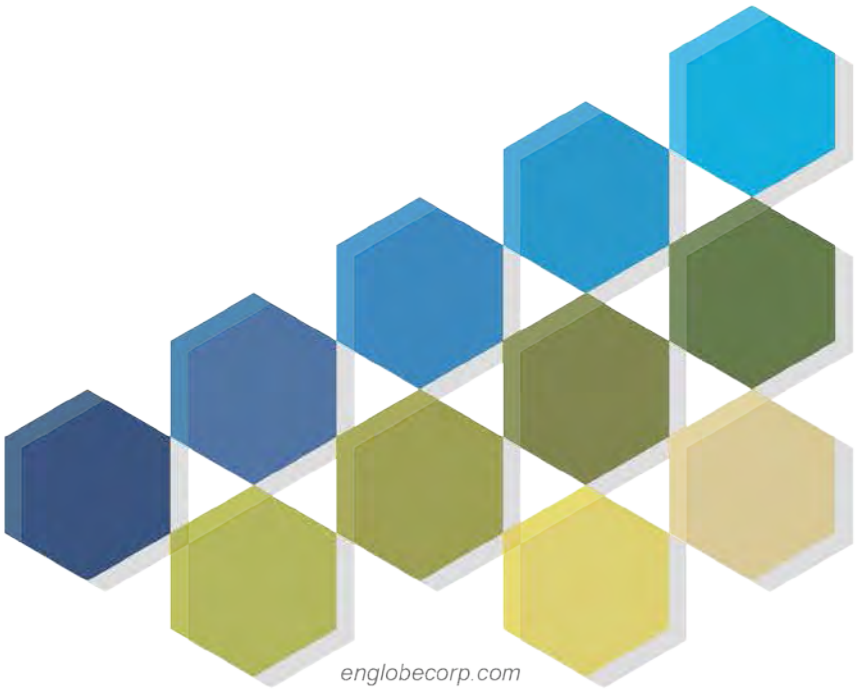
Name: Silt, non-cohesive
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: Silt, cohesive
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 28 °

Name: Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 26 °

Name: Silt Till, cohesive
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 28 °

Name: Silt Till, non-cohesive
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Phi: 30 °



APPENDIX F:
Road Realignment Alternatives

As identified in the Transportation and Corridor Assessment, the 2008 Brant County Transportation Master Plan identified a potential New Road Connection between Tutela Heights Road and Phelps Road utilizing the vacant north-south corridor "for a possible realignment of Tutela Heights Road should riverbank slope instability making the existing road unsafe for public use." Figure 1 illustrates the vacant north-south corridor that is owned by the County.

Figure 1 also illustrates a conceptual realignment alternative (RA-1) for Tutela Heights Road, and two new road alignment alternatives, RA-2 and RA-3, as described below.

Realignment Alternative RA-1: This alternative involves the relocation of the subject section of Tutela Heights Road outside the EHL limit plus the access allowance as required by GRCA policy, and reconnecting it to the existing alignment to the west and east of the subject section.

New Alignment Alternative RA-2: This will be a new alignment, consistent with the easterly extension of the road system as conceptually shown in the plans for the proposed new subdivision to the west of Davern Road, and could be connected to the north-south corridor.

New Alignment Alternative RA-3: This alternative creates a new alignment connecting the north-south corridor to the easterly section of the existing Tutela Heights Road alignment outside the EHL limit.

As identified in the Transportation and Corridor Assessment, the existing and future traffic volumes are not significant enough to justify either (a) realigning Tutela Heights Road as in Alternative RA-1; or (b) developing new road alignments as in Alternatives RA-2 and RA-3.

In addition, Alternative RA-1 will have significant impacts on the residential properties currently located to the south of existing road alignment.

Based on environmental and archaeological assessments undertaken as part of this EA, Alternatives RA-2 and RA-3 will have potential environmental and archaeological impacts. Although these impacts could be minimized and mitigated, neither alternative will be of benefit in accommodating the current and projected traffic volumes on the existing Tutela Heights Road alignment.

Based on these considerations, it would not be possible to support alignment options for Tutela Heights Road, either as a realignment (RA-1), or as new alignments (RA-2 and RA-3). However, road alignment alternatives have been included in the identification and evaluation of alternatives for the purpose of comparing other alternatives. Preliminary cost estimates of roadway alternatives including land costs are tabulated below:

Roadway Alternative	Preliminary Cost Estimate
Road Closure + Realignment Alternative – RA-1	$4.0M
Road Closure + New Alignment Alternative – RA-2	$4.6M
Road Closure + New Alignment Alternative – RA-3	$3.2M

Figure 1.0: Realignment Alternatives

APPENDIX G

Slope Area and Roadway Recommendations

Preliminary Cost Estimates

Location	Recommendation	Specific Tasks / Issues	Cost Estimate
1. Monitoring Items			
Slope Area	Monitoring – Survey Standard Iron Bars (SIB) and review for movement	SIBs in place. Monitoring twice a year @ $2,600.00	$5,200.00 –annually. Over 10 years: $52,000.00
	Monitoring - Inclinometers and review for movement	Monitoring 3 inclinometers every three months – 4 @ $1700 per visit	$6,800.00 - annually. Over 10 years: $68,000.00
	Periodical Geotechnical investigation	Assume every five years – including boreholes, inclinometers and SIBs installation and analysis as required.	$30,000.00. Over 10 years: $60,000.00
Total Monitoring Costs over 10 year period			**$180,000**
2. Short Term Items			
Slope Area Drainage Outlet	Existing Storm Sewer System and Outlet Slope Area Surface Runoff	Retain existing storm sewer system with improved outlet in the slope area Re-grading and re-directing flows at specific locations	$150,000.00 $50,000.00
Slope Area	Safety-Warning - Signage	Already signage in place. Provide for 25 signs @ $100.00	$2,500.00
	Safety-Warning – Fencing	Locations, lengths to be determined. Provide for 100 metres @ $75.00	$7,500.00
Total Short Term Item Cost (10 years)			**$210,000**
3. Road Closure Costs			
Roadway	Property Access	Different access options depending on slope deterioration and closure limits. Worst-case scenario – to provide access to Tutela Height Road outside of Erosion Hazard Limit (EHL) for properties within the study area – including watermain and drainage	Land Cost: $1.6M Construction Cost: $0.6M
Roadway	Underground Services	EHL restricts new development or site alterations, but no protocol for existing infrastructure. New watermain on new access road. Utilities to be consulted.	
Total Roadway Costs (Access, Watermain and Drainage)			**$2.2M**

APPENDIX H
Public Consultation

NOTICE OF STUDY COMMENCEMENT AND PUBLIC INFORMATION CENTRE No. 1

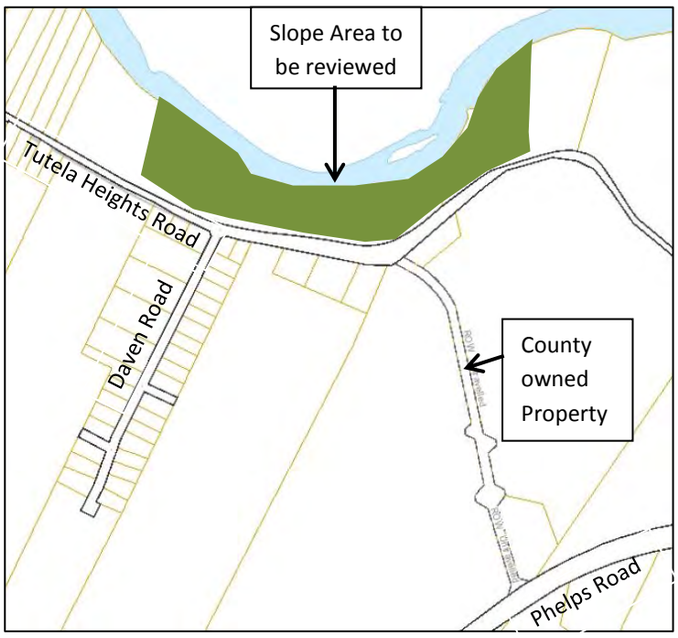
TUTELA HEIGHTS ROAD SLOPE STABILITY MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

The County of Brant, through their consultant Parsons Inc., has initiated a Municipal Class Environmental Assessment to review the slope stability along a section of Tutela Heights Road.

The section of slope along Tutela Heights Road being studied extends easterly from the Bell Homestead Historical Site for approximately one kilometre, as shown in the Key Map below.

The Process

The Study is being undertaken as a Schedule "C" in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA) process. The Class EA process includes public and review agency consultation, evaluation of alternatives, impact assessment of proposed alternatives, and identification of measures to mitigate adverse impacts. Study updates including the Notice of Completion of the study will be provided to all stakeholders who express interest in the project as a result of the Notice of Commencement and/or through participation in the public consultation process.



Public Consultation

The County wishes to ensure that those interested in this study have the opportunity to be involved and to provide input. Three Public Information Centres (PICs) will be held during the study to provide information and receive feedback from the public. A fourth PIC will be held after the completion of the study during the 30-day Environmental Study Report (ESR) review period mandated by the Class EA process. Notices for the project will be posted on the County Website at http://www.brant.ca/en/explore-our-services/Public-Works-Notices.asp under "Environmental Assessment".

The first Public Information Centre is scheduled for:

Date: Wednesday, October 14, 2015
Time: 4:30 pm to 7:30 pm
Location: Mount Pleasant Community Centre
711 Mount Pleasant Rd, Mount Pleasant, Ontario N0E 1K0

The PIC will be an open house style meeting for the purpose of providing background information on the project and receiving input and comments from the public.

If you would like to receive updates about this study, or if you have any questions, please contact the following:

Rajan Philips, P. Eng.
Project Manager
Parsons Inc.
540 Bingemans Centre Drive
Suite 101
Kitchener, Ontario N2B 3X9
Tel: 519-744-4509
Fax: 519-744-2822
Email: rajan.philips@parsons.com

Matthew D'Hondt, C.E.T.
Solid Waste/Wastewater Operations Manager
Corporation of the County of Brant
Public Works Department
26 Park Avenue, PO Box 160
Burford, Ontario N0E 1A0
Tel: 519-449-2451
Fax: 519-449-3382
Email: matt.dhondt@brant.ca

Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

WELCOME

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

Public Information Centre No. 1

Mount Pleasant Community Centre
October 14, 2015
4:30 – 7:30 p.m.

PLEASE SIGN IN AND TAKE A COMMENT SHEET

The Purpose of this Information Centre

- Provide information on Project purpose and background
- Describe the process that will be followed
- Indicate Environmental Assessment activities now in progress
- Provide an opportunity for your input

NOTICE OF STUDY OF COMMENCEMENT

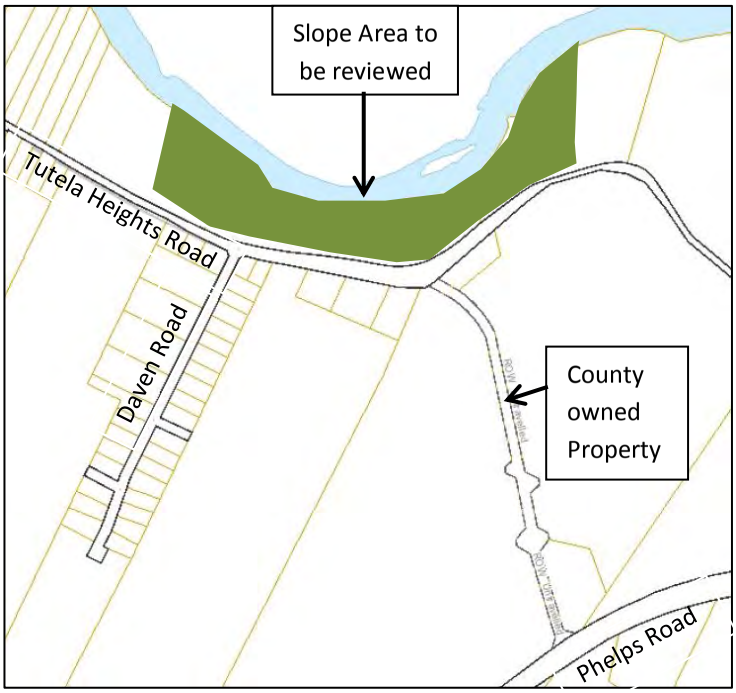
TUTELA HEIGHTS ROAD SLOPE STABILITY
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

The County of Brant, through their consultant Parsons Inc., has initiated a Municipal Class Environmental Assessment to review the slope stability along a section of Tutela Heights Road.

The section of slope along Tutela Heights Road being studied extends easterly from the Bell Homestead Historical Site for approximately one kilometre, as shown in the Key Map below.

The Process

The Study is being undertaken as a Schedule "C" in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA) process. The Class EA process includes public and review agency consultation, evaluation of alternatives, impact assessment of proposed alternatives, and identification of measures to mitigate adverse impacts. Study updates including the Notice of Completion of the study will be provided to all stakeholders who express interest in the project as a result of the Notice of Commencement and/or through participation in the public consultation process.



Public Consultation

The County wishes to ensure that those interested in this study have the opportunity to be involved and to provide input. Three Public Information Centres (PICs) will be held during the study to provide information and receive feedback from the public. A fourth PIC will be held after the completion of the study during the 30-day Environmental Study Report (ESR) review period mandated by the Class EA process. Notices for the project will be posted on the County Website at http://www.brant.ca/en/explore-our-services/Public-Works-Notices.asp under "Environmental Assessment".

Key Plan

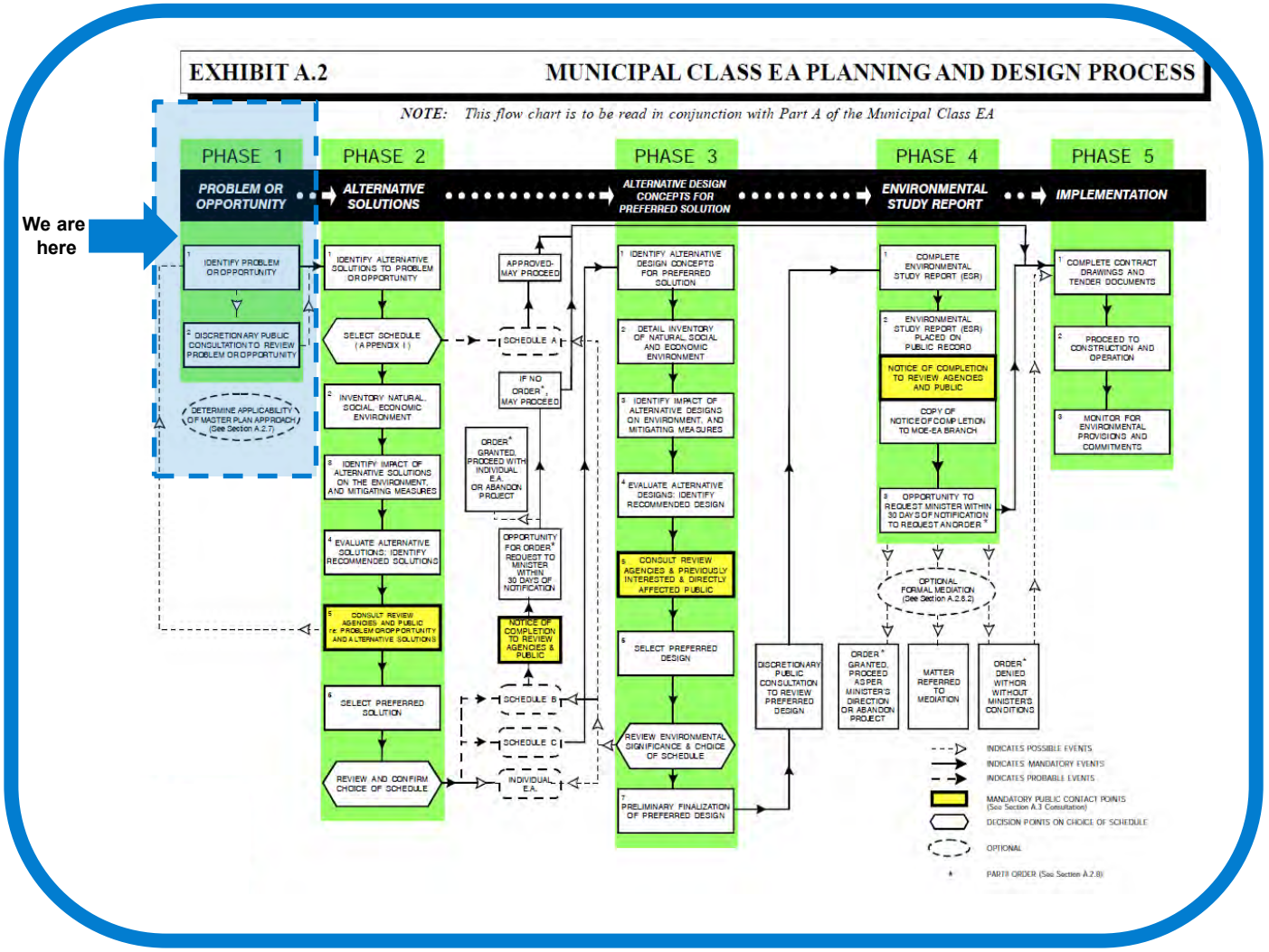

Tutela Heights Road
Slope Area to be reviewed
Roadway Section Under Class EA Study
Davern Road
Tutela Heights Road
County Owned Property
Phelps Road

Background Information

- The ‘Slope Area’ north of Tutela Heights Road from the Bell Homestead Property to 1 km east has historically experienced slope failures
- Slope stabilization measures were undertaken in 1973 by the Grand River Conservation Authority (GRCA)
- In May 2013 the geotechnical firm LVM undertook inspection and assessment of the ‘Slope Area’. As a result of the findings the Grand Valley Trail Association installed additional trail signage and relocated a portion of their trail away from eroded section of the slope.
- Investigations in 2014 and 2015 have confirmed that sections of the ‘Slope Area’ continue to be unstable

Municipal Class EA Process

- Formal planning process approved under the **Ontario Environmental Assessment (EA) Act** that must be undertaken in advance of road, water and wastewater construction projects
- Ensures that all **reasonable alternatives** are considered and that a selected alternative would have **minimal impact on the surrounding environment**
- The Municipal Class EA process provides opportunities for public/stakeholder involvement throughout the project
- The Tutela Heights Road Slope Stabilization EA study is being undertaken as a **"Schedule C"** Class EA project



Class EA for Slope Stabilization

- The Class EA process for Slope Stabilization involves the determination of the Erosion Hazard Limit (EHL) for the Slope Area
- Erosion Hazard Limit (EHL) is the limit (setback from the Grand River) within which it would be unsafe to allow development, infrastructure, or site alteration activities
- EHL is determined using information on the historical erosion rate of the river, an allowance for slope stability, and an allowance for future erosion
- EHL for the Tutela Heights Road Slope Area will be determined through Geotechnical and Geomorphic Assessments

Assessment of Existing Conditions

- Geotechnical Investigation – ***to analyze slope stability***
- Geomorphic Assessment – ***to determine the river erosion rate***
- Natural Heritage Assessment – ***to determine potential impacts on the natural environment***
- Stage 1 Archaeological Assessment – ***to determine potential impacts on areas of archaeological and/or cultural significance***
- Social Assessment – ***to determine impacts on surrounding communities***
- Economic/Financial Assessment - ***to determine cost/life cycle impacts***

Next Steps Before PIC #2

- Summarize Description of Existing Conditions
- Determine 'Erosion Hazard Limit' (EHL) based on Geotechnical / Geomorphic Assessments
- Assess the Implications for Tutela Heights Road
- Prepare "Problem Statement" for the Municipal Class Environmental Assessment Study
- Public Information Centre #2
  - Present Existing Conditions
  - Present the Erosion Hazard Limit for the Tutela Heights Road Slope Area
  - Present Problem Statement
  - Present Alternative Solutions
  - Receive public input on the proposed Alternative Solutions

Project Contacts

Please complete a Comment Sheet and leave it here today, or return it to

Rajan Philips by Friday, October 30, 2015

Should you have any questions or concerns at any time during the project, please contact either of the following:

Rajan Philips, P. Eng.
Project Manager
Parsons Inc.
540 Bingemans Centre Drive
Suite 101
Kitchener, Ontario N2B 3X9
Tel: 519-744-4509
Fax: 519-744-2822
Email: rajan.philips@parsons.com

Matthew D'Hondt, P. Eng.
Solid Waste/Wastewater Operations Manager
Corporation of the County of Brant
Public Works Department
26 Park Avenue, PO Box 160
Burford, Ontario N0E 1A0
Tel: 519-449-2451
Fax: 519-449-3382
Email: matt.dhondt@brant.ca

PUBLIC INFORMATION CENTRE #1

Mount Pleasant Community Centre
4:30 – 7:30 pm, October 14, 2015

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

SIGN IN FORM

NAME	ADDRESS	PHONE #	EMAIL
M+B ROBERTSON	125 TUTELA HEIGHTS RD	519-753-1314	mroberts218@rogers.com
N. N Cuthbert-	34 Davern Road.	519 759 2525	DNMC57 ~~EUN~~ @ROGERS.COM
HARTLEY MITCHELL	5 Rosehill Ave.	519-753-2560	
ALISON HUHTALA	27 BELHOLME AV	519-754 0434	—
KEN BIRKETT	34 BELHOLME AVE	-752-3057	
GUS RUNGIS	GRCA		GRUNGIS@GRANDRIVER.CA
R+L Makkreel	12 Tutela Heights Rd.	752-2806	lenmakkreel@hotmail.com
Janet Engel	GRCA		jengel@grandriver.ca
FRANK KAMINSKY	53 TUTELA HTS RD	519-753-1480	—
RON EDDY		519 442-2040	
Tom+Gail Bury	28 Davern, Brantford	519-751-3172	gailmbary@rogers.com.
Chuck Barsony	103 Tutela Heights Rd	519-752-6856	clbarsony@sympatico.ca
Harry & Karin Norton	78 Tutela Hts Rd	226-920-5597	harry.norton@hotmail.ca

PUBLIC INFORMATION CENTRE #1

Mount Pleasant Community Centre
4:30 – 7:30 pm, October 14, 2015

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

SIGN IN FORM

NAME	ADDRESS	PHONE #	EMAIL
Karen McKelvey	111 Tutela Heights Rd.	519-759-4764	mckelvey4764@silomail.com
Hilda + Gunter ASCHE	52 Tutela Heights Rd	519 752-3264	—
David Downie	13 DAVERN Rd	519-753-5193	ddownie1216@ROGERS.com
Joan Gatward	7 Malcolm St Oakland	519-446-0060	jgatward@sympatico.ca
MARY Lou KRECHTEL	17 OXBOW LANE BTFD	519-759-5076	Lou@FORESTWALKER.ca
Rick + Michele Carter	39 Davern Rd Brantford	519 753 9550	
Ben Tolan	RR 7 BTFD		

Vandyk, Mary

From: harry norton <harry.norton@hotmail.ca>
Sent: October-15-15 6:55 PM
To: mary.vandyk@parsons.com
Cc: harry norton; krnnrtn@hotmail.com
Subject: PIC #1 Tutela Heights Road Slope

We are Harry and Karin Norton, 78 Tutela Heights Rd. living adjacent to the Bell Homestead. We attended the initial Public Information meeting and wanted to share our initial thoughts based on the information provided.
First off, thank you for initiating this assessment, we fully agree it is needed.

We have lived in our present home since Oct. 2003 and have certainly noticed evidence of erosion occurring in the areas outlined at the PIC session. There is really no question in our minds that this erosion is most likely to continue and we are of the opinion that traffic is already increasing on Tutela Hts Rd which we believe can aggravate the slope stability even if the main influence is the Grand River itself.

We have concerns that the anticipated Walton development will lead to further increases in traffic...again aggravating further the slope stability.

The traffic issue is something that we want to see included in the impact assessment on the slope.

We would fully support the idea of closing Tutela Heights Rd. in the area where the critical erosion is occurring. In our minds we see this as allowing the river to exist in a natural manner, and probably avoid significant costs that would be associated with any further efforts to deflect the river, and / or change the direction of water flow in any material way. Rather than attempt to find huge sums of money to fund repair efforts, why not close the road.

There are other avenues for all of us to travel east or west and Tutela Heights is already a narrow winding road that is seeing far too many drivers traversing Tutela Heights at unacceptable speed levels. The road closure would resolve the safety issue of the speeding traffic as well as minimize the efforts needed to manage the erosion (assuming no houses / outbuildings are at risk with this recommendation). The road closure would lead to possible cycling and pedestrian walkers increasing in usage and tying in nicely with the park atmosphere of the Bell Homestead. This could easily evolve into an attractive 'trail head' that would be a nice asset for Brant County residents.

We look forward to attending the next PIC which we understand is likely to be in Jan /2016. Please be sure to advise us of the date and location. We would also recommend an additional chart be made available featuring a Time Line that would outline anticipated timing of future meetings and implementation date of the action plan.

If you have any questions and / or further comments to share with us, feel free to contact us at:

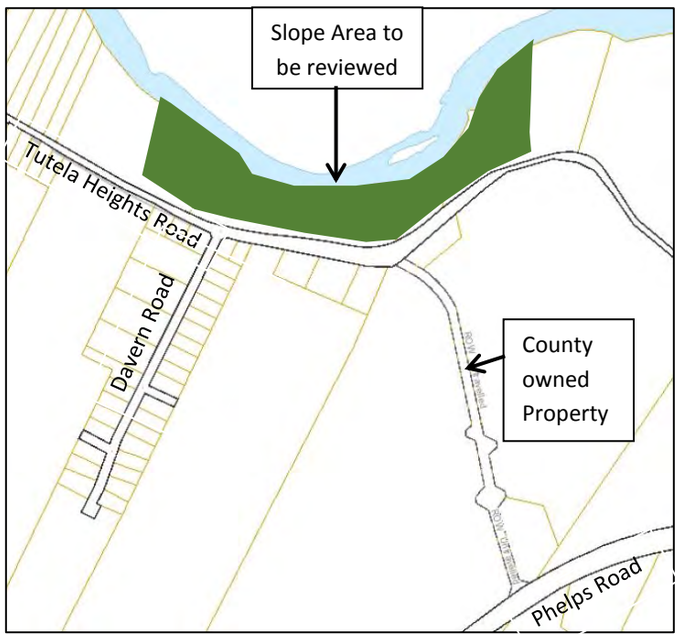
78 Tutela Heights Rd.
N3T1A1
226-920-5597

NOTICE OF PUBLIC INFORMATION CENTRE No. 2
TUTELA HEIGHTS ROAD SLOPE STABILITY
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

The County of Brant, through their consultant Parsons Inc., has initiated a Municipal Class Environmental Assessment Study to identify and address impacts on Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, due to unstable conditions in the slope area between the roadway and the Grand River.

The Process

The Study was initiated as a Schedule "C" project in October 2015, in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA) process. Based on a review of the Schedule in light of the study findings and identified alternative solutions, the County is now proceeding with the Study as a Schedule "B" project, as allowed under the Class EA process. The Class EA process includes public and review agency consultation, identification and evaluation of alternatives, impact assessment of proposed alternatives, and identification of measures to mitigate adverse impacts.



Public Consultation

The County wishes to ensure that those interested in this study will continue to be given the opportunity to be involved and to provide input. The Notice of Study Commencement was issued in October 2015, and the first Public Information Centre was also held in October to provide background information and receive public input. A second Public Information Centre (PIC #2) will be held on January 12, 2017, to provide study updates and present the evaluation and selection of the project team's recommended solutions. Following PIC #2, a preferred solution and recommendations for implementation will be developed to address the Study requirements. In accordance with the Class EA process for Schedule "B" projects, a project file documenting the study process and recommendations will be made available for public review. A Notice of Study Completion will be issued indicating opportunities for public involvement during the mandated 30-day review period. Notices for the project will be posted on the County Website at http://www.brant.ca/en/explore-our-services/Public-Works-Notices.asp under "Environmental Assessment".

The second Public Information Centre is scheduled for:

Date: Thursday, January 12, 2017
Time: 4:30 pm to 7:30 pm
Location: Mount Pleasant Community Centre
711 Mount Pleasant Rd, Mount Pleasant, Ontario N0E 1K0

The PIC will be an open house style meeting for the purpose of providing project updates and recommended solutions and receiving input and comments from the public.

If you would like to receive updates about this study, or if you have any questions, please contact the following:

Rajan Philips, P. Eng.
Project Manager
Parsons Inc.
540 Bingemans Centre Drive
Suite 101
Kitchener, Ontario N2B 3X9
Tel: 519-744-4509
Fax: 519-744-2822
Email: rajan.philips@parsons.com

Matthew D'Hondt, C.E.T.
Solid Waste/Wastewater Operations Manager
Corporation of the County of Brant
Public Works Department
26 Park Avenue, PO Box 160
Burford, Ontario N0E 1A0
Tel: 519-449-2451
Fax: 519-449-3382
Email: matt.dhondt@brant.ca

Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

WELCOME

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

Public Information Centre No. 2

Mount Pleasant Community Centre
January 12, 2017
4:30 – 7:30 p.m.

PLEASE SIGN IN AND TAKE A COMMENT SHEET

The Purpose of this Information Centre

- Present Problem Statement
- Present Project Background & Status
- Present Summaries of Existing Conditions Assessments:
  - Cultural Heritage
  - Natural Heritage
  - Transportation
  - Geotechnical & Geomorphic
  - Erosion Hazard Limit and Implications
- Present Alternative Solutions and Evaluation
- Present Recommended Solution
- Request public and stakeholder input

Problem Statement

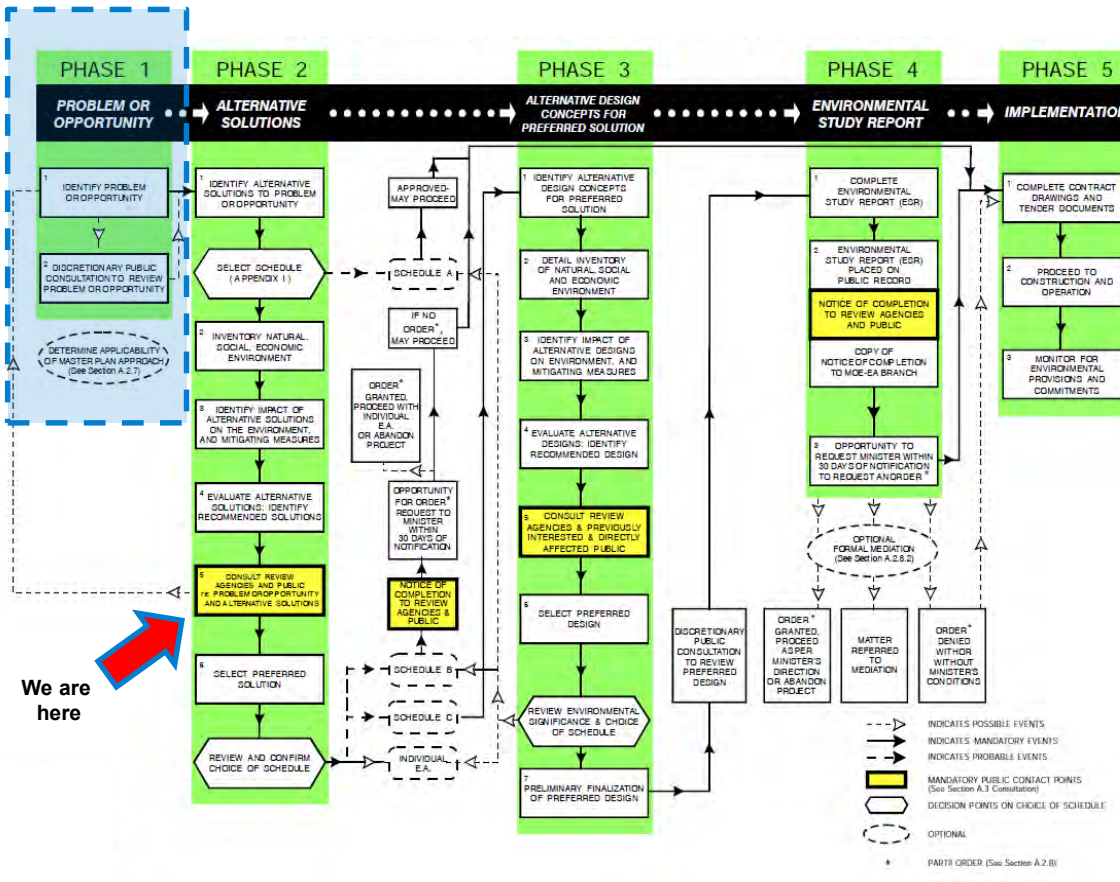
- A Municipal Class Environmental Assessment (Class EA) Study is being completed to identify and address impacts on Tutela Heights Road, from the Bell Homestead to approximately one kilometre east, due to unstable conditions in the slope area between the roadway and the Grand River. The Class EA includes the determination of Erosion Hazard Limit for the slope area; and the identification and evaluation of slope stabilization alternatives, roadway alternatives, and combinations of slope stabilization and roadway alternatives to determine a preferred solution.

Background Information

- The ‘Slope Area’ north of Tutela Heights Road from the Bell Homestead Property to 1 km east has historically experienced slope failures
- Slope stabilization measures were undertaken in 1973 by the Grand River Conservation Authority (GRCA)
- Geotechnical Investigations in 2014 and 2015 have confirmed that sections of the ‘Slope Area’ continue to be unstable
- August, 2015: Commencement of Municipal Class EA Study
- Current Status of Class EA Study:
  - Public Information Centre #1 held on October 14, 2015
  - Assessments of Existing Conditions completed
  - Development and Evaluation of Alternatives
  - Selection of Recommended Alternative
  - Public Information Centre #2

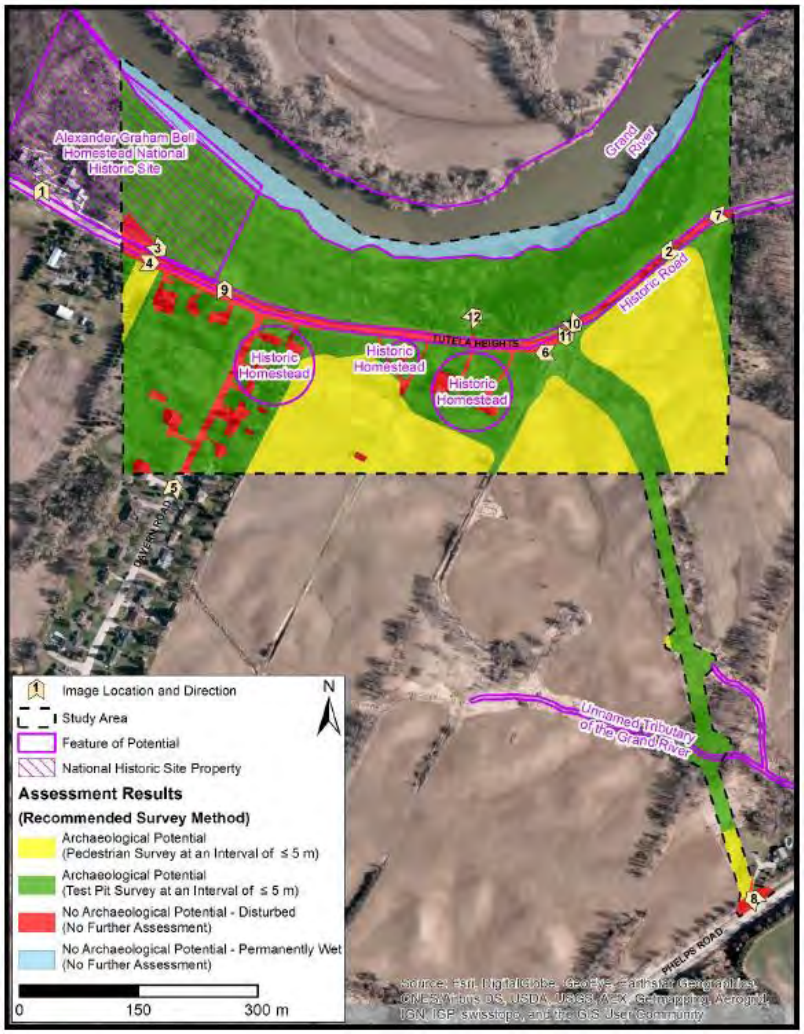
Municipal Class EA Process

- Formal planning process approved under the **Ontario Environmental Assessment (EA) Act** that must be undertaken in advance of road, water and wastewater construction projects
- Ensures that all **reasonable alternatives** are considered and that a selected alternative would have **minimal impact on the surrounding environment**
- The Municipal Class EA process provides opportunities for public/stakeholder involvement throughout the project
- The Tutela Heights Road Slope Stabilization EA study is being undertaken as a **"Schedule B"** Class EA project



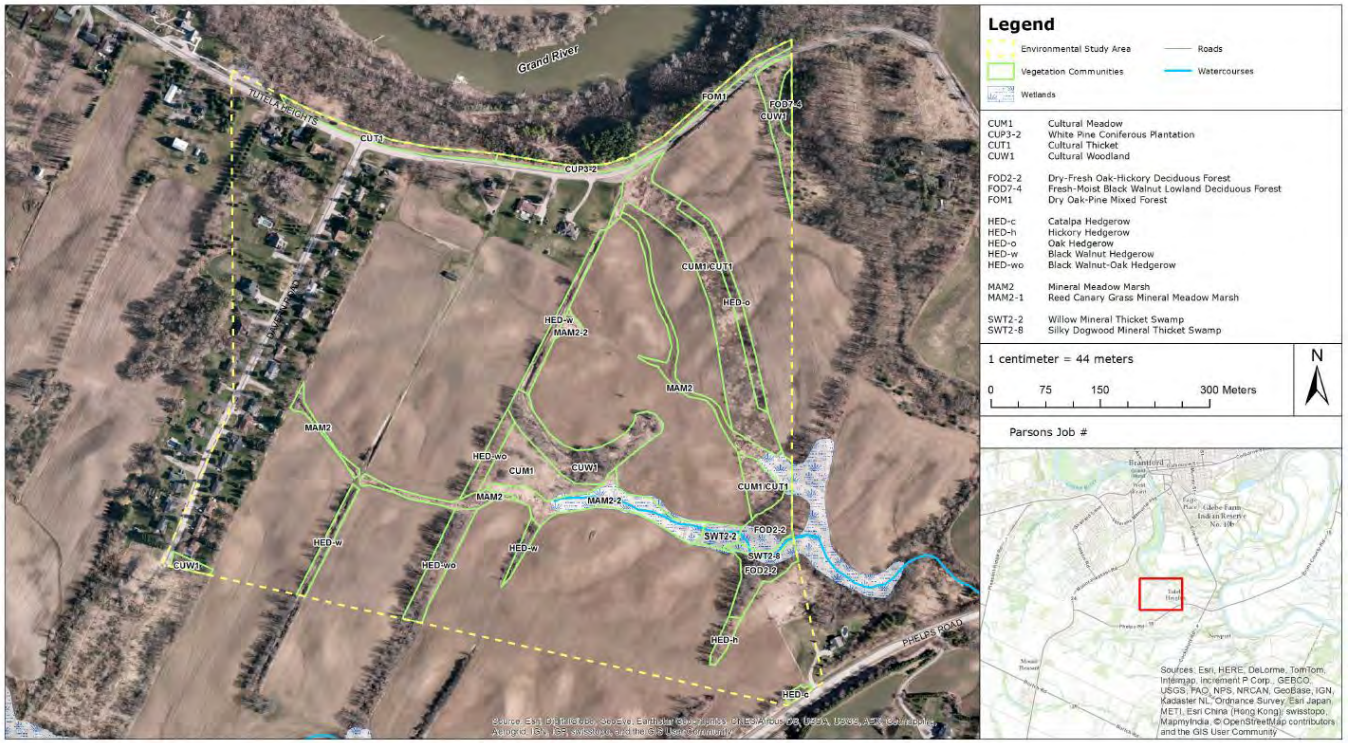
Existing Conditions – Cultural Heritage

- Numerous heritage features including:
  - Multiple primary water sources
  - One historic roadway (Tutela Heights Road)
  - One National Historic Site (the Bell Homestead)
  - Three historic homestead localities
- Archaeological potential identified in existing farmlands (yellow) and forest/woodlot areas (green)



Existing Conditions – Natural Heritage

- Significant vegetation communities including species of concern – Pignut Hickory
- Migratory Birds
- Potential Species at Risk – Eastern Milksnake
- Significant Wildlife Corridors
- Significant Wetland Features



Copyright 2015 by Parsons Inc.
Map created by Will Van Hemessen
1069 Wellington Rd S Suite 214
London, ON N6E 2H6

Data Source: Parsons Inc, Ontario Ministry of Natural Resources and Forestry; ESRI Canada

Map 2:
Vegetation Communities

PARSONS

PARSONS

Existing Conditions – Tutela Heights Road

- Rural Local Road – property access is primary function
- Connects Mount Pleasant Road and Cockshutt Road – more local traffic than through traffic
- High level-of-service under current and future (background/development) traffic conditions
- Existing watermain and limited storm infrastructure

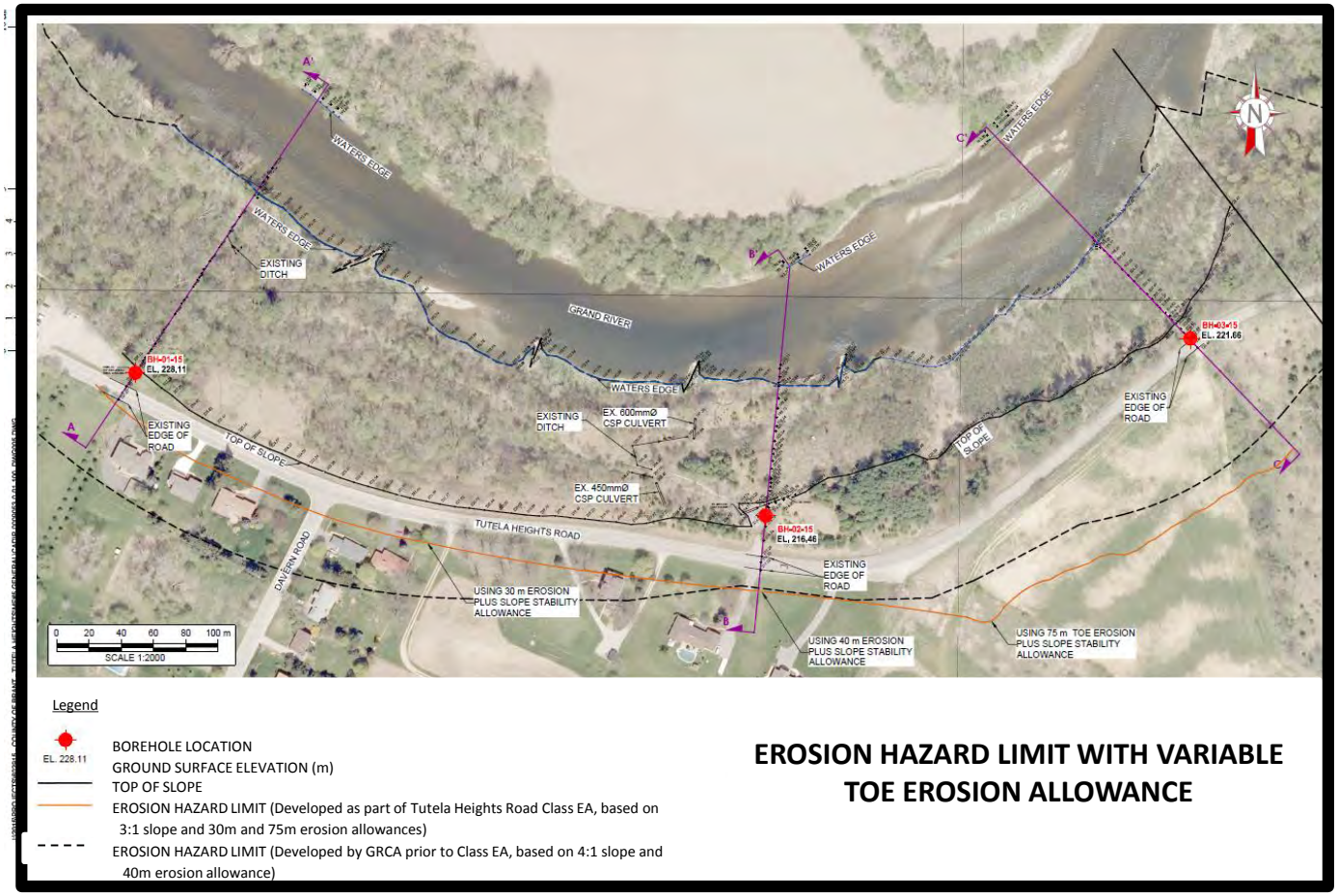
Existing Conditions – Slope Area

- Geotechnical & Geomorphic Investigations:
  - Significant bank erosion due to natural geomorphic processes
  - Unstable slope conditions due to toe and sheet erosion; and over-steepening of natural slopes

Grand River at Tutela 1945 historic imagery

Erosion Hazard Limit

- Erosion Hazard means the loss of land, due to human or natural processes, that poses a threat to life and property.
- Erosion Hazard Limit (EHL) is determined using the 100 year erosion rate (the average annual rate of recession extended over a hundred year time span), an allowance for slope stability, and an erosion allowance.
- Lands within the EHL should not be built upon.



EROSION HAZARD LIMIT WITH VARIABLE TOE EROSION ALLOWANCE

Identification & Evaluation of Alternatives

- The Class EA identified three slope stabilization alternatives, three roadway alternatives, and four ‘combination alternatives’ pairing slope stabilization and roadway alternatives.

- Evaluation criteria were identified to address the role and function of Tutela Heights Road; property impacts; environmental & archaeological impacts; costs; and effectiveness of slope stabilization measures.

- The four combination alternatives were evaluated through ‘pair-wise’ comparison, in three steps, to select the recommended alternative.

Slope/Roadway Alternative Solutions

Slope Stabilization Alternatives	Roadway Alternatives
Do Nothing – Subject to specific Safety-Warning, Drainage–Mitigation and Slope-Monitoring Measures	Do Nothing
Geometric and Mechanical Slope Stabilization – will only reduce, not eliminate tableland loss	Road Closure: Close impacted Section of Roadway
Mechanical Slope Stabilization – prevents tableland loss	Road Closure with Alignment Alternatives

Combination Alternatives

Combination Alternatives			
Roadway Alternatives	**Slope Alternatives**		
	Do Nothing[2]	**Geometric & Mechanical Slope Stabilization**	**Mechanical Slope Stabilization**
Do Nothing	Not a viable Alternative	Not a viable Alternative	*Alternative - 4*
Road Closure[1]	*Alternative – 1*	Not a viable Alternative	No need to close road
Road Closure + Alignment Alternatives	Alternative - 2	*Alternative – 3*	No need to close road / realign road

1. The timing of road closure would be guided by periodical monitoring and observations.
2. The “Do nothing” Slope Alternative includes ongoing slope monitoring, drainage improvements, limiting public access to slope area (trail closure, warning signs, fencing)

Description of Alternatives

- Alternative-1 - Do Nothing on the slope area + closing the impacted section of Tutela Heights Road.
- Alternative-2 - Do Nothing on the slope area + closing the impacted road section and developing a new alternative road alignment (RA-2 or RA-3).
- Alternative-3 – closing the impacted road section and realigning the road in close proximity to the existing alignment (RA-1) + limited slope stabilization measures that will reduce, but not prevent, tableland loss.
- Alternative-4 – unitizing mechanical slope stabilization methods to eliminate tableland loss, thus retaining the existing roadway.

Notes:
1. All alternatives, except for Alternative 4, would provide for alternative access to impacted properties and relocating underground infrastructure.
2. Alternative Road Alignments (RA-1, RA-2, RA-3) shown are conceptual alignments.

Evaluation Criteria

- Role and Function of Tutela Heights Road
  - ***traffic service***
  - ***property access***
  - ***underground services***
- Property Frontage Impacts - This criterion compares the impacts on property frontage due to roadway alternatives.
- Environmental Impacts - Both roadway and slope stabilization alternatives have different impacts on the natural environment, and are compared under this criterion.
- Archaeological Impacts - The archaeological impacts arising from roadway and slope stabilization alternatives are compared under this criterion.
- Roadway / Stabilization Costs
- Effectiveness of potential Slope Stabilization Measures - This criterion captures the uncertainty of erosion control and slope protection measures as well as the unpredictability of sudden failure.

Evaluation - Step 1

Evaluation of Alternative 1 and Alternative 2		
Evaluation Criteria	**Alternative 1 (Road Closure)**	**Alternative 2 (Road Closure + New Alignment)**
Local Traffic Service	Yes	Yes
Property Access	Will require modifications	Will require modifications
Underground Services	Will require modifications	Will require modifications
Property Frontage Impacts	Driveway Impacts	Driveway Impacts
Environmental Impacts	None	Yes
Archaeological Impacts	None	Yes
Slope Area Cost	$390,000	$390,000
Roadway Cost	$2.2M	$4.6M to $5.4M
Step 1 – Selected Alternative	**Yes**	**No**

Evaluation - Step 2

Evaluation of Alternative 3 and Alternative 4		
Evaluation Criteria	**Alternative 3 (Realignment + Geometric and Mechanical Slope Stabilization)**	**Alternative 4 (Do Nothing + Mechanical Slope Reinforcement)**
Local Traffic Service	Yes	No Change
Property Access	Will require modifications	No Change
Underground Services	Will require modifications	No Change
Property Frontage Impacts	Significant Frontage Impacts	None
Environmental Impacts	Significant Impacts on the Slope Area	Significant Impacts on the Slope Area
Archaeological Impacts	Potentially Significant Impacts	Potentially Significant Impacts
Stabilization Costs	$5.0M	$10M
Roadway	$4.0M	Nil
Long-Term Effectiveness	More Uncertain	Less Uncertain
Step 2 – Selected Alternative	**No**	**Yes**

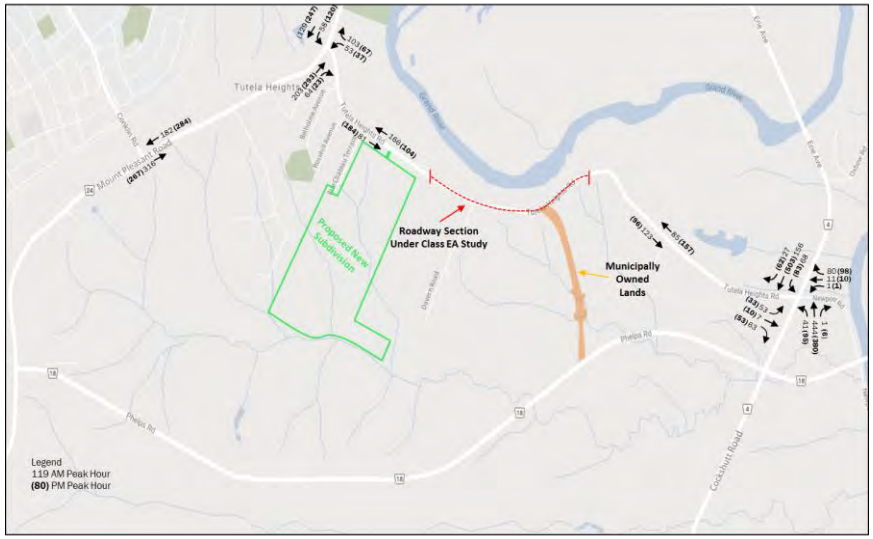
Evaluation – Step 3

Evaluation of Alternative 1 and Alternative 4		
Evaluation Criteria	**Alternative 1 (Road Closure)**	**Alternative 4 (Do Nothing + Mechanical Slope Reinforcement)**
Local Traffic Service	Yes	No Change
Property Access	Will require modifications	No Change
Underground Services	Will require modifications	No Change
Property Frontage Impacts	Driveway Impacts	None
Environmental Impacts	None	Significant Impacts on the Slope Area
Archaeological Impacts	None	Potentially Significant Impacts
Slope Area/Slope Stabilization Cost	$390,000	$10M
Roadway Costs	$2.2M	Nil
Long-Term Effectiveness	Not Applicable	Not Assured
Recommended Alternative	**Yes**	**No**

Traffic Service Impacts Due to Road Closure

- Closing a section of Tutela Heights Road between Mount Pleasant Road and Cockshutt Road, due to slope area failure, will not create significant impacts on the road network serving the Tutela Heights Settlement Area. The impact on through traffic will be minimal, and local traffic at present can be served by the intersection at Mount Pleasant Road at satisfactory Levels-of-Service. The intersection at Cockshutt Road will function primarily as a Tee intersection.

- Future developments in the vicinity of Mount Pleasant Road or Cockshutt Road could potentially be served by the respective intersections with appropriate modifications as required and identified through Traffic Impact Studies undertaken in support of development.



2021 Traffic Volumes
(including traffic from proposed development)

2021 Traffic Volumes with Closure
(including traffic from proposed development)

Recommended "Alternative 1" – Slope Area Recommendations

The following safety-warning, mitigating and monitoring measures should be undertaken on a priority basis:

- **Safety-Warning**: Close all trails along the slope east of the lookout and below the Bell Homestead; install fencing to prevent pedestrian access to unsafe slope areas; and placing warning signs throughout the slope area to alert the public.
- **Drainage-Mitigation**: Drainage improvement measures to protect the slope area from surface runoff by: redirecting existing sources of surface runoff away from the slope area; providing swales to direct water away from affected areas; and grading and vegetation in specific locations to avoid ponding and minimize infiltration.
- **Slope-Monitoring**: Periodical monitoring of the slope area involving frequent observations of surface and in-depth movements through Standard Iron Bars (SIB) and inclinometers respectively; geotechnical inspection; and the monitoring of the condition of the remaining gryones in the river.

Recommended "Alternative 1" – Roadway Recommendations

The following roadway recommendations address the timing and staging of road closure and the mitigation of associated impacts:

- **Road Closure**: The timing of road closure should be guided by periodical monitoring and observations. The easterly and westerly limits of road closure will depend on the extent and location of deterioration in the slope area. The limits of road closure should be established by slope-monitoring and through additional investigation as appropriate.
- **Property Access**: Where road closure will impact driveways to existing properties, driveway modifications would need to be undertaken, potentially through a cul-de-sac arrangement, outside the EHL limit.
- **Underground Services**: The outlet to the existing storm sewer system should be modified to minimize impacts in the slope area. Existing watermain and utilities should be relocated outside the EHL limit.

Next Steps

- Review all comments submitted following this Public Information Centre and incorporate them as appropriate in the Recommendations
- Prepare a Project File describing the Study Process and Recommendations, including all documentation, for 30-Day Public Review
- Issue Notice of Completion to start the 30-Day Public Review Period of the Project File, anticipated to be issued in the Spring of 2017
- Address issues, concerns that may arise during the Review Period
- Complete the Class EA process if no Part II Order Requests are received during the 30-Day Review Period

Project Contacts

Please complete a Comment Sheet and leave it here today, or return it to

Rajan Philips by Friday January 27, 2016

Should you have any questions or concerns at any time during the project, please contact either of the following:

Rajan Philips, P. Eng.
Project Manager
Parsons Inc.
540 Bingemans Centre Drive
Suite 101
Kitchener, Ontario N2B 3X9
Tel: 519-744-4509
Fax: 519-744-2822
Email: rajan.philips@parsons.com

Clint Brown
Infrastructure Services Technologist
Corporation of the County of Brant
Public Works Department
26 Park Avenue, PO Box 160
Burford, Ontario N0E 1A0
Tel: 519-449-2451
Fax: 519-449-3382
Email: cliint.brown@brant.ca

(1)

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

SIGN IN FORM

NAME	ADDRESS	PHONE #	EMAIL
GARY CHALK	P.O. Box 1041	519-448-0838	
Wendy Tenfold	Brantford.		wbrantford.ca
Ron Eddy	South Dundas		
JODY Varley	95 TUTELA.	519 752 6788	jdvarey@hotmail.com
J E. Wilmott	171 Tutela H.		
Mildred Barrie	31 Belholme Ave.	519-756-6759	
Alison Hustala	27 Belholme Av	519-754-0434	—
[illegible]	105 Tutela Hts	519-753-9344	[illegible]
Rick Weaver	11 McGuines	519 754-9912	
Gus Rungis	GRCA		GRUNGIS@GRANDRIVER.CA
Charles Gilbert	42 Oxbow Rd	416 525 1258	charles.gilbert @rogers.com

COUNTY OF Brant Simply Grand

PARSONS

2

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

SIGN IN FORM

NAME	ADDRESS	PHONE #	EMAIL
Viviane Wise	29 Westlake Blvd.	519-754-0604	v.v.wise@hotmail.com
HARRY KINGS	18 MARCH CRESC	519-752-0766	hkings@brantford.ca
Lucy Hives	City of Brantford - Planning	519-759-4150 x5434	lhives@brantford.ca
MIKE CHATE	42 HAMMOND RD.	5197525878	CHATECONSTRUCTION@GMAIL.COM
NICK PIROZZOLI	24 BELHOLME AVE	519-758-1261	
Dianne Guy	10-158 Willow St Paris	519-442-0018	
DAVE ZIMNICK	CITY of BRANTFORD PARKS	519-756-1500 ext 550	DZIMNICK@BRANTFORD.CA
Shirley Simms			
NORMA + ED SAYLES	8 OXBOW LANE	519-751-0293	
Joan Gatward	Oakland,	519-446-0060	joan.gatward@brant.ca

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

SIGN IN FORM

NAME	ADDRESS	PHONE #	EMAIL
Murray Powell	Councillor		
Mary Lou Krackel	OxBow Lane		lou@forestwalker.ca
Gunter Asche	52 TUTELA Hts Rd.	752-3264	
Harry & Karin Norton	78 Tutela Hts Rd	226-920-5597	harry.norton@hotmail.ca
JOE COHOON		519-753-2656	jhc@cohooneng.com
BRIAN JONES	225 Tutela Hts Rd	519-732-0341	jonesbrian1972@gmail.com
RICK CARTER	39 DAVERN CR	519 753 9530	RICHARD-CARTER@ROGERS.COM
CHUCK BARSONY	103 TUTELA HEIGHTS RD	519-752-6856	clbarsonysr@gmail.com
Keith & Sharon Langerby	59 Tutela Hgts Rd	519-753-2767	k_s_langerby@rogers.com
Deanna Boomsma	32 Tutela Hgts Rd	519-752-6119	
Ella HALEY	27 Ronald Rd		

Vandyk, Mary

From: harry norton <harry.norton@hotmail.ca>
Sent: January-13-17 12:44 PM
To: Vandyk, Mary
Cc: krnnrtn@hotmail.com
Subject: Tutela Heights Road Slope Stability Assessment

We are residents of Tutela Heights, living at 78 Tutela Heights Road. We attended the initial public meeting as well as the 2nd public meeting which occurred last evening.

In reviewing the information made available, we are of the opinion that Alternative #1, close the road and basically leave the river alone is the best approach under the circumstances.

We strongly believe closing the road would have minimal impact on the majority of residents and we also feel there is potential to then encourage more walking and cycling along Tutela Heights Rd and / or trail which would be a positive that could emerge from this.

We would like to be kept up to date on the developments.

Thank you.

Harry and Karin Norton
78 Tutela Heights Road
Brantford, ON
N3T1A1
226-920-5597

Sent from Mail[go.microsoft.com] for Windows 10

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

Concerns:

Monitoring - more frequent

More holes than 3 to monitor

Traffic has increased re: new subdivision on Conklin

When Colborne St fall in are we now waiting for Tutela Heights to fall in.

Who will be responsible when a school bus falls down the bank.

CONTACT NAME: Sharon Lazenby

ADDRESS: 59 Tutela Heights Rd.

TELEPHONE: 519-753-2767

E-MAIL: k_s_lazenby@rogers.com

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

With respect to Tutela Heights Road, I am very aware of the erosion because it is currently some 10 metres from the edge of the road in front of 103. My strong suggestion is that the HEAVY truck traffic on our street be completely banned! The reason should be obvious!

CONTACT NAME: Dr. Charles L. Barsony PEng FEC

ADDRESS: 103 Tutela Heights Rd
(New) Brantford ON N3T 1A4

TELEPHONE: 519-752-6956

E-MAIL: clbarsonysr@gmail.com

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017

PS: Writing on a rough table is difficult!

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

THE CITY OF BRANTFORD FIRST & FOREMOST SHOULD STOP ANY TRUCK TRAFFIC ALONG TUTELA HTGS RD. THIS IS THE FIRST AND EASIEST SOLUTION TO BANK STABALIZATION. ! !

CONTACT NAME: _____

ADDRESS: _____

_____

TELEPHONE: _____

E-MAIL: _____

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

I do not see any plans to provide the residents of Davern Rd a way to get ~~into~~ off of Davern Rd if ~~the~~ Tutela Hts Rd. at the end of Davern slides ~~into~~ down the embankment. WHAT ARE THE PLANS IF THIS HAPPENS?

CONTACT NAME: Rick Carter

ADDRESS: 39 DAVERN RD

TELEPHONE: 519 753 9550

E-MAIL: RICHARD.CARTER@ROGERS.COM

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017

Vandyk, Mary

From: Philips, Rajan
Sent: February-15-17 3:50 PM
To: Vandyk, Mary
Subject: Tutela - FW: Grand River Slope Stability Study

File

From: Rick Carter [mailto:Richard.Carter@rogers.com]
Sent: Thursday, January 19, 2017 7:17 PM
To: Philips, Rajan <Rajan.Philips@parsons.com>
Cc: WISE <stwise1@rogers.com>
Subject: Grand River Slope Stability Study

I am writing to express my concerns regarding the stability of the south slope of the Grand River in the Tutela Heights area of Brantford.

My wife, Michele, and I have lived at 39 Davern Road in Tutela Heights for over 48 years, and during this time we have seen numerous changes to the south slope of the Grand River in this area.

When we first moved into our new home in January 1969, there was no road access to the Grand River from Tutela Heights Road. In the early 1970's, the GRCA had a roadway built from Tutela Heights Road down to the Grand River. This allowed vehicles to drive down the slope to within 15 feet of the river, and I frequently took my wife and three young children down to the river, in my full size 1972 V8 Chevrolet, for fishing or a picnic.
Within a few years, there was a major landslide, and the roadway was closed to traffic. Today, it is very difficult to even walk down to the river where the roadway once existed.

I feel that if the GRCA, with all its resources, had any inkling that the slope was so unstable, they never would have wasted the money on building that roadway down to the river.

This was not the first time that some of the slope has slid towards the river. When I first purchased my building lot in 1965, I was told that the City of Brantford had taken an option on purchasing the Hartley farm (now the Varey farm) which is directly across the road from the historic Bell Homestead. This was because so much land that had been behind the Bell Homestead when Alexander Graham Bell lived there, had disappeared down the slope, that the City was concerned that the Bell Homestead would eventually be destroyed and they were considering relocating it on the other side of Tutela Heights road.

Obviously, this problem has being going on for well over 100 years, and this is without the proposed building of several thousand new homes in the immediate area with all the heavy

trucks and earthmoving equipment, and the vibrations that will be created, which I feel will only exacerbate the problem and which a past 100 year study will not take into consideration.

From the standpoint of damage to slopes and structures, there are only three important sources of man-made vibration: blasting, operation of heavy equipment and, in some extreme cases, traffic and other transportation. I am not sure if there will be any blasting, but I know that there will be an exponential increase in traffic and the use of heavy equipment.

With very rare exception, the Tutela Heights area is clay soil. Clay soils, because of their greater coherence, transmit vibration more efficiently than sandy or loamy soils. This means that if heavy equipment use and traffic are greatly increased in this area, the slope of the Grand River, in the Tutela Heights study area, will likely degenerate exponentially relative to the past 100 years.

Being at a greater distance from a vibration source can't always be seen as much comfort. If the slope is close enough to hear the vibration source it is well-known that some types of lesser vibrations at a greater distance can be more damaging than those closer in. This is due to lowering of the ground vibration frequency with distance. These lower frequency vibrations often have special interactions with slopes or structure that other, higher frequency, vibrations lack.
So, I am beseeching you to add to your report the danger that any major increase in construction, traffic, or use of heavy earth moving equipment in the Tutela Heights area, increases the danger of another major slope slide of the south side Grand River embankment.

Rick Carter, Masters in Engineering, MBA
39 Davern Road,
Brantford,
Ontario,
N3T1R6
(519) 753-9550

Vandyk, Mary

From: Philips, Rajan
Sent: February-15-17 3:55 PM
To: Vandyk, Mary
Subject: Tutela FW: Grand river slope concerns.

File

From: WISE [mailto:stwise1@rogers.com]
Sent: Friday, January 20, 2017 7:57 AM
To: Philips, Rajan <Rajan.Philips@parsons.com>
Cc: Rick Carter <richard.carter@rogers.com>
Subject: Grand river slope concerns.

Rajan -

Thanks again for your time yesterday.

To confirm our discussion, I have some very real concerns regarding the instability of the Grand River banks in the Tutela Heights area and feel these points should be addressed going forward:

- the history of this area, going back over the last 150 years, has shown substantial instability in the river banks and surrounding terrain. We have seen several instances of landslides requiring re-positioning of buildings, parking lots and other related factors. Time has proven that slope erosion is certainly greater than normal.

- due to the nature of the clay based soils found in this area, it is certain that resonant vibration caused by construction equipment and vehicular traffic has accelerated the erosion process.

- restorative ventures that have been completed in the past have not resolved these issues.

- to move ahead with new construction within the area to the south of Tutela Heights, due to the prominent increase of resonant vibration, will most certainly prove detrimental to the river banks and the ongoing erosion process.

- additional restorative work must be completed within the areas of concern before moving ahead with any new construction. This should be at the expense of the development corporation seeking approvals.

I am recommending that procedures be put in place immediately to insure that additional damage in this area will not occur and thereby accelerate the erosion/landslide process.

Thanks you in advance for addressing my concerns.

Steve Wise
29 Westlake Blvd.
Brantford, ON.
N3T 0E1
519-754-0604

PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

- Create a new River channel see attached drawing.

- this was the River channel years ago Before it eroded its way to the present location.

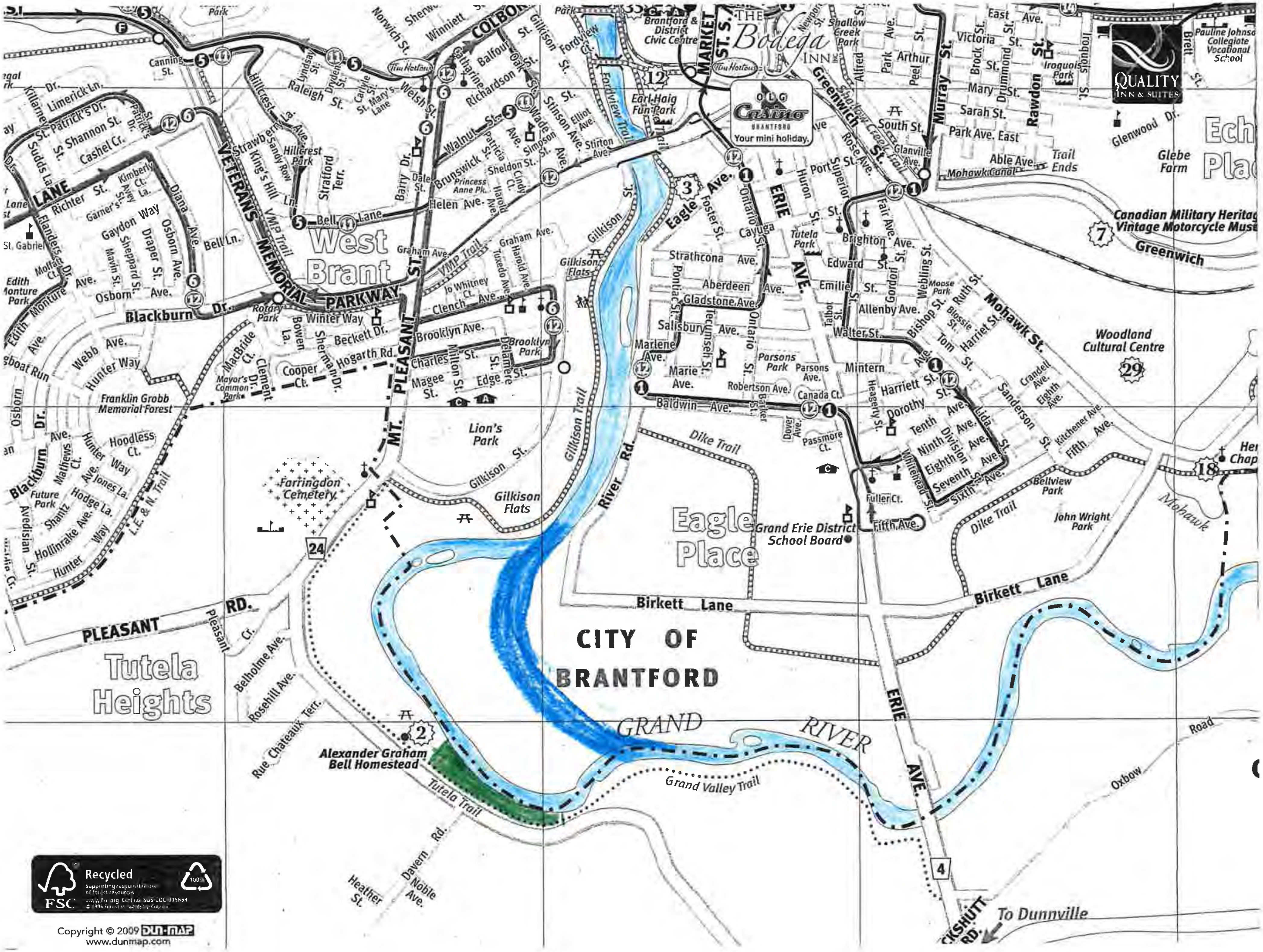
CONTACT NAME: Gunter Asche

ADDRESS: 52 TUTELA Hts Rd.

TELEPHONE: 752-3264

E-MAIL:

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017



CITY OF BRANTFORD
GRAND RIVER
West Brant
Eagle Place
Tutela Heights
Grand Valley Trail
Tutela Trail
Alexander Graham Bell Homestead
Farringdon Cemetery
Lion's Park
Gilkison Flats
Gilkison Trail
Dike Trail
Birkett Lane
ERIE AVE.
PLEASANT RD.
MT. PLEASANT ST.
VETERANS MEMORIAL PARKWAY
Blackburn Dr.
River Rd.
Eagle Ave.
Greenwich St.
Mohawk St.
Murray St.
MARKET ST. S.
COLBORNE
Woodland Cultural Centre
Canadian Military Heritage Vintage Motorcycle Museum
Brantford & District Civic Centre
Earl Haig Fun Park
Fordview Trail
Franklin Grobb Memorial Forest
Grand Erie District School Board
John Wright Park
Bellview Park
Glebe Farm
Mohawk Canal
Trail Ends
Pauline Johnson Collegiate Vocational School
To Dunnville
Oxbow Road
OLG Casino Brantford Your mini holiday.
The Bodega Inn
Quality Inn & Suites
Recycled
FSC
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PUBLIC INFORMATION CENTRE #2

Mount Pleasant Community Centre
4:30 – 7:30 pm, January 12, 2017

Tutela Heights Road Slope Stability
Municipal Class Environmental Assessment

COMMENT FORM

Realign river as shown on attached figure.
- believe option is cheaper
- would alleviate other erosion issues in area upstream of study area
- known similar projects completed in New York State.

CONTACT NAME: Mary Welsh

ADDRESS: 310 Mount Pleasant Road.
N3T 1V1

TELEPHONE: 519-753-0053

E-MAIL:

**Alternatively you may submit your Comment Form to mary.vandyk@parsons.com before January 26, 2017

Google Maps


DYKE
Franklin Grobb Memorial Forest
Lion's Park
Gilkison Flats
Grand Erie District School Board
Burkett Ln
Tutela Heights
Suggested By Law
Grand River
Schutt's Brick, Stone & Landscape
Bell Homestead National Historic Site
Google
Imagery ©2017 Google, Map data ©2017 Google 200 m
EROSION AREA

PARSONS

540 Bingemans Centre Drive, Suite 101 | Kitchener, Ontario N2B 3X9
P: 519-744-4509 | F: 519-744-2822 | www.parsons.com

May 2, 2017

Gunter Asche
52 Tutela Heights Road
Brantford ON N3T 1A1

Dear Mr. Asche,

Re: Tutela Heights Road Slope Stability – Environmental Assessment (EA)

We thank you for attending the Second Public Information Centre (PIC) for the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, held on January 12, 2017, and for providing comments on the recommended solution presented at the PIC.

We have reviewed your comments suggesting the creation of a new river channel by realigning the Grand River in the Study Area to prevent the erosion of the slope area abutting Tutela Heights Road. We have treated this option as a 'New Alternative' and evaluated it in comparison to Alternative 1 (Road Closure) and Alternative 4 (Do Nothing on the Road + Mechanical Slope Reinforcement) that were presented at the PIC.

The results of the evaluation are summarized in the attached Table. The Road Closure option (Alternative 1) is once again evaluated to be the 'Recommended Alternative' in terms of cost and the relative magnitudes of impacts.

The Project Team has now completed its review of public input and comments received following the PIC, including your comments, and has confirmed that the preferred solution is to close sections of Tutela Heights Road when warranted by ongoing monitoring measures, as presented at the PIC. The EA study will now proceed to its final stage, which will include issuing the Notice of Completion and commencing the mandatory 30-day public review period.

We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajan Philips, P.Eng.
Project Manager

Attach (1)

Copy: Matt D'Hondt, County of Brant

Evaluation of Alternatives: Road Closure; Mechanical Slope Reinforcement; River Realignment				
Evaluation Criteria		**Road Closure (Alternative 1)**	**Do Nothing + Mechanical Slope Reinforcement (Alternative 4)**	**Grand River Realignment (New Alternative)**
Local Traffic Service		Yes	No Impacts	Minimal Impacts
Property Access		Will require modifications	No Impacts	Minimal Impacts
Underground Services		Will require modifications	No Impacts	Minimal Impacts
Property Frontage Impacts		Driveway Impacts	No Impacts	Minimal Impacts
Environmental Impacts		None	Significant Impacts on the Slope Area	Significant Impacts on the River System Ecology; changes to floodplain area; and potential erosion impacts upstream and downstream
Archaeological Impacts		None	Significant Impacts	Significant Impacts
EHL Impacts	Stable Slope	Not Applicable	Improved Slope Stability	Slope stability not addressed by this alternative. Slope stability requires either mechanical reinforcement at a cost of $10M; or, stable incline of 3.5:1 as determined by slope stability analysis
	Toe Erosion	Not Applicable	Toe Erosion will continue subject to protection by remaining groynes	Toe Erosion caused by the rive is potentially eliminated
Costs Comparison	Slope Area Costs	$390,000	None (included in slope stabilization costs	$390,000
	Roadway Costs	$2.2M	None	$500,000 to address potential minimal impacts
	Slope Stabilization Costs	None	$10M	None
	River Realignment Costs	None	None	Estimated to be in the order of $20M, given the energy and the complexity of the River. Actual cost estimate will require at least preliminary investigation.
	Total Costs	$2.59M	$10M	$20M
Evaluation of Alternatives		**Recommended**	**Not Recommended**	**Not Recommended**

PARSONS

540 Bingemans Centre Drive, Suite 101 | Kitchener, Ontario N2B 3X9
P: 519-744-4509 | F: 519-744-2822 | www.parsons.com

May 2, 2017

Mary Welsh
301 Mount Pleasant Road
Brantford ON N3T 1V1

Dear Ms. Welsh,

Re: Tutela Heights Road Slope Stability – Environmental Assessment (EA)

We thank you for attending the Second Public Information Centre (PIC) for the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, held on January 12, 2017, and for providing comments on the recommended solution presented at the PIC.

We have reviewed your comments suggesting the realignment of the Grand River in the Study Area to prevent the erosion of the slope area abutting Tutela Heights Road. We have treated this option as a 'New Alternative' and evaluated it in comparison to Alternative 1 (Road Closure) and Alternative 4 (Do Nothing on the Road + Mechanical Slope Reinforcement) that were presented at the PIC.

The results of the evaluation are summarized in the attached Table. The Road Closure option (Alternative 1) is once again evaluated to be the 'Recommended Alternative' in terms of cost and the relative magnitudes of impacts.

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We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajah Philips, P.Eng.
Project Manager

Attach (1)

Copy: Matt D'Hondt, County of Brant

Evaluation of Alternatives: Road Closure; Mechanical Slope Reinforcement; River Realignment				
Evaluation Criteria		**Road Closure (Alternative 1)**	**Do Nothing + Mechanical Slope Reinforcement (Alternative 4)**	**Grand River Realignment (New Alternative)**
Local Traffic Service		Yes	No Impacts	Minimal Impacts
Property Access		Will require modifications	No Impacts	Minimal Impacts
Underground Services		Will require modifications	No Impacts	Minimal Impacts
Property Frontage Impacts		Driveway Impacts	No Impacts	Minimal Impacts
Environmental Impacts		None	Significant Impacts on the Slope Area	Significant Impacts on the River System Ecology; changes to floodplain area; and potential erosion impacts upstream and downstream
Archaeological Impacts		None	Significant Impacts	Significant Impacts
EHL Impacts	Stable Slope	Not Applicable	Improved Slope Stability	Slope stability not addressed by this alternative. Slope stability requires either mechanical reinforcement at a cost of $10M; or, stable incline of 3.5:1 as determined by slope stability analysis
	Toe Erosion	Not Applicable	Toe Erosion will continue subject to protection by remaining groynes	Toe Erosion caused by the rive is potentially eliminated
Costs Comparison	Slope Area Costs	$390,000	None (included in slope stabilization costs	$390,000
	Roadway Costs	$2.2M	None	$500,000 to address potential minimal impacts
	Slope Stabilization Costs	None	$10M	None
	River Realignment Costs	None	None	Estimated to be in the order of $20M, given the energy and the complexity of the River. Actual cost estimate will require at least preliminary investigation.
	Total Costs	$2.59M	$10M	$20M
Evaluation of Alternatives		**Recommended**	**Not Recommended**	**Not Recommended**

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May 2, 2017

Richard Carter
39 Davern Road
Brantford ON N3T 1R6

Dear Mr. Carter,

Re: Tutela Heights Road Slope Stability Environmental Assessment

We thank you for attending the Second Public Information Centre (PIC) for the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, held on January 12, 2017, and for providing written comments at the PIC, as well as your follow-up email dated January 19, 2017.

We have reviewed your comments regarding potential impacts on the Tutela Heights Road slope area due to future development on the south side of Tutela Heights Road and west of Davern Road. We advise as follows:

1) The Tutela Heights Road EA study addressed the stability of the section of the roadway to the east of Bell Homestead, and the proposed development lands are not abutting the slope area investigated in the current EA study.
2) Any concerns regarding the proposed development lands could be addressed as part of the development review process, as appropriate.

The Project Team has now completed its review of public input and comments received following the PIC, including your comments, and has confirmed that the preferred solution is to close sections of Tutela Heights Road when warranted by ongoing monitoring measures, as presented at the PIC. The EA study will now proceed to its final stage, which will include issuing the Notice of Completion and commencing the mandatory 30-day public review period.

We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajan Philips, P.Eng.
Project Manager

Copy: Matt D'Hondt, County of Brant

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May 2, 2017

Steve Wise
29 Westlake Blvd
Brantford ON N3T 0E1

Dear Mr. Wise,

Re: Tutela Heights Road Slope Stability – Environmental Assessment (EA)

We thank you for your comments on the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, regarding potential impacts on the Tutela Heights Road slope area due to future development on the south side of Tutela Heights Road and west of Davern Road. We advise as follows:

1) The Tutela Heights Road EA study addressed the stability of the section of the roadway to the east of Bell Homestead, and the proposed development lands are not abutting the slope area investigated in the current EA study.
2) Any concerns regarding the proposed development lands could be addressed as part of the development review process, as appropriate.

The Project Team has now completed its review of public input and comments received following the PIC, including your comments, and has confirmed that the preferred solution is to close sections of Tutela Heights Road when warranted by ongoing monitoring measures, as presented at the PIC. The EA study will now proceed to its final stage, which will include issuing the Notice of Completion and commencing the mandatory 30-day public review period.

We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajan Phillips, P.Eng.
Project Manager

Copy: Matt D'Hondt, County of Brant

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540 Bingemans Centre Drive, Suite 101 | Kitchener, Ontario N2B 3X9
P: 519-744-4509 | F: 519-744-2822 | www.parsons.com

May 8, 2017

Dr. Charles Barsony
103 Tutela Heights Road
Brantford ON N3T 1A4

Dear Dr. Barsony,

Re: Tutela Heights Road Slope Stability Environmental Assessment

We thank you for attending the Second Public Information Centre (PIC) for the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, held on January 12, 2017, and for providing written comments at the PIC.

We have reviewed your comments and considered your suggestion to ban 'heavy truck traffic' on Tutela Heights Road. We are pleased to inform you that one of the recommendations of the EA Study is to prohibit truck traffic on Tutela Heights Road, except for local deliveries.

The Project Team has now completed its review of public input and comments received following the PIC, including your comments, and has confirmed that the preferred solution is to close sections of Tutela Heights Road when warranted by ongoing monitoring measures, as presented at the PIC. The EA study will now proceed to its final stage, which will include issuing the Notice of Completion and commencing the mandatory 30-day public review period.

We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajan Philips, P.Eng.
Project Manager

Copy: Matt D'Hondt, County of Brant

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540 Bingemans Centre Drive, Suite 101 | Kitchener, Ontario N2B 3X9
P: 519-744-4509 | F: 519-744-2822 | www.parsons.com

May 8, 2017

Sharon Lazenby
59 Tutela Heights Road
Brantford ON N3T 1A4

Dear Ms. Lazenby,

Re: Tutela Heights Road Slope Stability – Environmental Assessment (EA)

We thank you for attending the Second Public Information Centre (PIC) for the Tutela Heights Road Slope Stability Environmental Assessment (EA) study, held on January 12, 2017, and for providing written comments at the PIC.

We have reviewed your comments regarding increased traffic on Tutela Heights Road and considered your suggestion for the monitoring of the slope area. As you would appreciate the recommendation to close Tutela Heights Road will discourage through traffic on the roadway. In addition, the EA Study recommends the prohibition of heavy truck traffic which could be implemented as soon as possible.

The EA Study also emphasizes the importance of regular monitoring and recommends frequent monitoring of the slope area and geotechnical investigation to guide the timing and limits of road closure.

The Project Team has now completed its review of public input and comments received following the PIC, including your comments, and has confirmed that the preferred solution is to close sections of Tutela Heights Road when warranted by ongoing monitoring measures, as presented at the PIC. The EA study will now proceed to its final stage, which will include issuing the Notice of Completion and commencing the mandatory 30-day public review period.

We will send you a copy of the Notice of Completion, indicating the arrangements for reviewing the Project File and the opportunity to comment and to make a Part II Order request to the Minister of the Environment and Climate Change.

Thank you.

Yours truly,

Rajan Philips, P.Eng.
Project Manager

Copy: Matt D'Hondt, County of Brant

APPENDIX I

Agency Contact

Ministry of Tourism, Culture and Sport

Culture Services Unit
Programs and Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7
Tel: 416 314 7145
Fax: 416 212 1802

Ministère du Tourisme, de la Culture et du Sport

Unité des services culturels
Direction des programmes et des services
401, rue Bay, Bureau 1700
Toronto ON M7A 0A7
Tél: 416 314 7145
Téléc: 416 212 1802

Ontario

October 29, 2015 (EMAIL ONLY)

Rajan Philips, P.Eng
Parsons Inc.
540 Bingemans Centre Drive, Suite 101
Kitchener, ON N2B 3X9
E: rajan.philips@parsons.com

RE: MTCS file #: 0003721
Proponent: County of Brant
Subject: Notice of Commencement and Public Information Centre (PIC) #1 Tutela Heights Road Slope Stabilization Municipal Class EA
Location: County of Brant, Ontario

Dear Rajan Philips:

Thank you for providing the Ministry of Tourism, Culture and Sport (MTCS) with the Notice of Commencement and PIC #1 for your project. MTCS's interest in this EA project relates to its mandate of conserving Ontario's cultural heritage, which includes:

- Archaeological resources, including land-based and marine;
- Built heritage resources, including bridges and monuments; and,
- Cultural heritage landscapes.

Under the EA process, the proponent is required to determine a project's potential impact on cultural heritage resources.

While some cultural heritage resources may have already been formally identified, others may be identified through screening and evaluation. Aboriginal communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Aboriginal communities includes a discussion about known or potential cultural heritage resources that are of value to these communities. Municipal Heritage Committees, historical societies and other local heritage organizations may also have knowledge that contributes to the identification of cultural heritage resources.

Archaeological Resources
As noted in your PIC #1 panels (panel #7), a Stage 1 archaeological assessment (AA) will be conducted in advance of the next PIC. MTCS archaeological sites data are available at archaeology@ontario.ca. As the AA will be undertaken by an archaeologist licenced under the *OHA*, they are responsible for submitting the report directly to MTCS for review.

We further advise that, in advance of the next PIC, a full Stage 1-2 AA be conducted, as the study area has archaeological potential, in all probability will require a Stage 2 AA, and an evaluation of alternatives prior to the Stage 2 AA (confirming or refuting the presence of archaeological sites, and if present their cultural heritage value or interest) will be deficient based on a lack of this relevant information. On brief review of our database of registered sites there are none within the study area, likely due to no AA being conducted to date. In contrast, assessments of adjacent properties to the east have identified several dozen sites within 1.0 km of the study area, confirming its archaeological potential.

Built Heritage and Cultural Heritage Landscapes
The MTCS *Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes* should be completed to help determine whether your EA project may impact cultural heritage resources. The Clerk for the County of Brant can provide information on property registered or designated under the *Ontario Heritage Act*. Municipal Heritage Planners can also provide information that will assist you in completing the checklist.

If potential or known heritage resources exist, MTCS recommends that a Heritage Impact Assessment (HIA), prepared by a qualified consultant, should be completed to assess potential project impacts. Our Ministry's *Info Sheet #5: Heritage Impact Assessments and Conservation Plans* outlines the scope of HIAs. Please send the HIA to MTCS for review, and make it available to local organizations or individuals who have expressed interest in heritage.

Environmental Assessment Reporting
All technical heritage studies and their recommendations are to be addressed and incorporated into EA projects. Please advise MTCS whether any technical heritage studies will be completed for your EA project, and provide them to MTCS before issuing a Notice of Completion. If your screening has identified no known or potential cultural heritage resources, or no impacts to these resources, please include the completed checklists and supporting documentation in the EA report or file.

Thank-you for consulting MTCS on this project: please continue to do so through the EA process, and contact me for any questions or clarification.

Sincerely,

Joseph Muller, RPP/MCIP
Heritage Planner
Joseph.Muller@Ontario.ca

Copied to: Matthew D'Hondt, P. Eng, Solid Waste/Wastewater Operations Manager, County of Brant

Ministry of Tourism, Culture and Sport

Heritage Program Unit
Programs and Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7
Tel: 416 314 7145
Fax: 416 212 1802

Ministère du Tourisme, de la Culture et du Sport

Unité des programmes patrimoine
Direction des programmes et des services
401, rue Bay, Bureau 1700
Toronto ON M7A 0A7
Tél: 416 314 7145
Téléc: 416 212 1802

Ontario

January 20, 2017 (EMAIL ONLY)

Rajan Philips, P.Eng
Parsons Inc.
540 Bingemans Centre Drive, Suite 101
Kitchener, ON N2B 3X9
E: rajan.philips@parsons.com

RE: MTCS file #: 0003721
Proponent: County of Brant
Subject: Municipal Class Environmental Assessment Public Information Centre #2 Tutela Heights Road Slope Stabilization
Location: County of Brant, Ontario

Dear Rajan Philips:

Thank you for providing the Ministry of Tourism, Culture and Sport (MTCS) with the Public Information Centre (PIC) #2 for your project. MTCS's interest in this Environmental Assessment (EA) project relates to its mandate of conserving Ontario's cultural heritage, which includes:

- Archaeological resources, including land-based and marine;
- Built heritage resources, including bridges and monuments; and,
- Cultural heritage landscapes.

Under the EA process, the proponent is required to determine a project's potential impact on cultural heritage resources. While some cultural heritage resources may have already been formally identified, others may be identified through screening and evaluation. Indigenous communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Indigenous communities includes a discussion about known or potential cultural heritage resources that are of value to these communities. Municipal Heritage Committees, historical societies and other local heritage organizations may also have knowledge that contributes to the identification of cultural heritage resources.

Archaeological Resources

A Stage 1 archaeological assessment (AA) under PIF# P007-0707-2015 has been entered into the Ontario Public Register of Archaeological Reports, determined that the majority of the EA study area exhibits archaeological potential, and recommends further Stage 2 AA if impacted by the chosen alternative. This AA should be undertaken by an archaeologist licenced under the *OHA*, who is responsible for submitting the report directly to MTCS for review. While the roadway itself is described as not being of archaeological potential, given the age of the alignment, there may be some potential for deeply buried remains below the roadbed, and if it is to be disturbed, archaeological monitoring may be warranted.

Built Heritage and Cultural Heritage Landscapes
The MTCS *Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes* should be completed to help determine whether your EA project may impact cultural heritage resources. The Clerk for County of Brant can provide information on property registered or designated under the *Ontario Heritage Act*. Municipal Heritage Planners can also provide information that will assist you in completing the checklist. While some potential built heritage features are indicated in the Stage 1 AA (Map 28), we have not received a Cultural Heritage Evaluation Report (CHER) identifying any cultural heritage value or interest within the study area, or a Heritage Impact Assessment (HIA), prepared by a qualified consultant, to assess potential project impacts. Our Ministry's *Info Sheet #5: Heritage Impact Assessments and Conservation Plans* outlines the scope of HIAs. If warranted, please send the HIA to MTCS for review, and make it available to local organizations or individuals who have expressed interest in review.

Environmental Assessment Reporting
All technical heritage studies and their recommendations are to be addressed and incorporated into EA projects. Please advise MTCS whether any further technical heritage studies will be completed for your EA project, and provide them to MTCS before issuing a Notice of Completion. If your screening has identified no known or potential cultural heritage resources, or no impacts to these resources, please include the completed checklists and supporting documentation in the EA report or file.

Thank-you for consulting MTCS on this project: please continue to do so through the EA process, and contact me for any questions or clarification.

Sincerely,

Joseph Muller, RPP/MCIP
Heritage Planner
Joseph.Muller@Ontario.ca

Copied to: Matthew D'Hondt, P. Eng, Solid Waste/Wastewater Operations Manager, County of Brant
Clint Brown, Infrastructure Services Technician, County of Brant

Vandyk, Mary

From:	Salter, Eva (MCIIT) <Eva.Salter@ontario.ca>
Sent:	September-29-15 4:27 PM
To:	Mary Vandyk
Cc:	Matt D'Hondt; 'Rajan Philips'; Andrew McGregor
Subject:	RE: Notice of Study of Commencement and Request for Information - Tutela Heights Road Slope Stability Municipal Class Environmental Assessment

Dear Mary,

Thank you for your e-mail notifying the ministry of study commencement and inviting us to participate in the above referenced study area that is part of a Municipal Class Environmental Assessment.

From a recreation perspective, the Ministry may be interested in commenting on the impact, if any, on cycling, hiking and walking, including the greatest level of safety and security for area residents. Please send me a copy of the slides to be presented at PEC #1 on October 14, 2015. Also, keep us apprised on future Public Information Centres and Open Houses and next steps.

The Ministry will also want to review the information and provide comments on the impact of the project on heritage resources. For review/comment on heritage resources, please contact:

Laura Hatcher
Team Lead - Heritage Land Use Planning (Acting) - CULTURE SERVICES UNIT
Ministry of Tourism, Culture and Sport
Suite 1700
401 Bay St
Toronto ON M7A0A7
Phone: 416-314-3108 **Fax:** 416-212-1802 **Email:** laura.e.hatcher@ontario.ca **URL:** http://www.mtc.gov.on.ca/en/home.shtml[mtc.gov.on.ca]

Sincerely

Eva S. Salter

Regional Advisor
Ministry of Citizenship, Immigration and International Trade
Ministry of Tourism, Culture and Sport
301 St.Paul St.
St.Catharines ON L2R 7R4
Tel: 1 800 263 2441 ext. 3 or 905 704 3953
Fax: 905 704 3955
eva.salter@ontario.ca

ONTARIO 400

From: Mary Vandyk [mailto:Mary.Vandyk@parsons.com]
Sent: September 29, 2015 10:27 AM
To: 'Mary Vandyk'
Cc: Matt D'Hondt; 'Rajan Philips'; Andrew McGregor
Subject: Notice of Study of Commencement and Request for Information - Tutela Heights Road Slope Stability Municipal Class Environmental Assessment

Dear Sir/Madam,

Please find attached the Notice of Study Commencement for the Tutela Heights Road Slope Stability Municipal Class Environment Assessment. The purpose of this email is to introduce the study and to obtain any relevant background information from you as it relates to the study area.

To ensure that the study considers your concerns, issues and expectations, we have provided a Comment Summary Form that you may fill out and return. This form will provide us with a summary of your contact information, your group/agency's interest in the study and your preferred communication feedback mechanism. Please note that all information provided will become part of the public record once the study is completed.

If you have any questions or require additional information please contact Rajan Philips at 519-744-4509. Thank you for your assistance with this project. We respectively request a response by October 30, 2015.

Yours very truly,

Rajan Philips, M.Sc. P. Eng.
Manager, Waterloo Regional Operations

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540 Bingemans Centre Drive, Suite 101
Kitchener, Ontario N2B 3X9
P: 519-744-4509
F: 519-744-2822
http://www.parsons.com

Grand River Conservation Authority
Resource Management Division
Ashley Graham, Resource Planner

400 Clyde Road, P.O. Box 729
Cambridge, Ontario N1R 5W6
Phone: (519) 621-2761 ext. 2238
Toll Free: 1-866-900-4722
Fax: (519) 621-4945
E-mail: agraham@grandriver.ca

October 19, 2015

Rajan Philips, P. Eng.
Project Manager
Parsons Inc.
540 Bingemans Centre Drive
Suite 101
Kitchener, ON N2B 3X9

Matthew D'Hondt, C.E.T.
Solid Waste/Wastewater Operations Manager
County of Brant
26 Park Avenue
PO Box 160
Burford, ON N0E 1A0

Dear Rajan Philips and Matthew D'Hondt:

RE: Municipal Class Environmental Assessment for Tutela Heights Road Slope Stability
Grand River Conservation Authority File No. W 60.6

The Grand River Conservation Authority (GRCA) is in receipt of your Notice of Study Commencement and Notice of Public Information Session Municipal Class Environmental Assessment for Tutela Heights Road Slope Stability. The purpose of the study is to review the slope stability along a section of Tutela Height Road. The section of slope along Tutela Heights Road being studied extends easterly from the Bell Homestead Historical Site for approximately one kilometre. The Grand River Conservation Authority wishes to participate in this study.

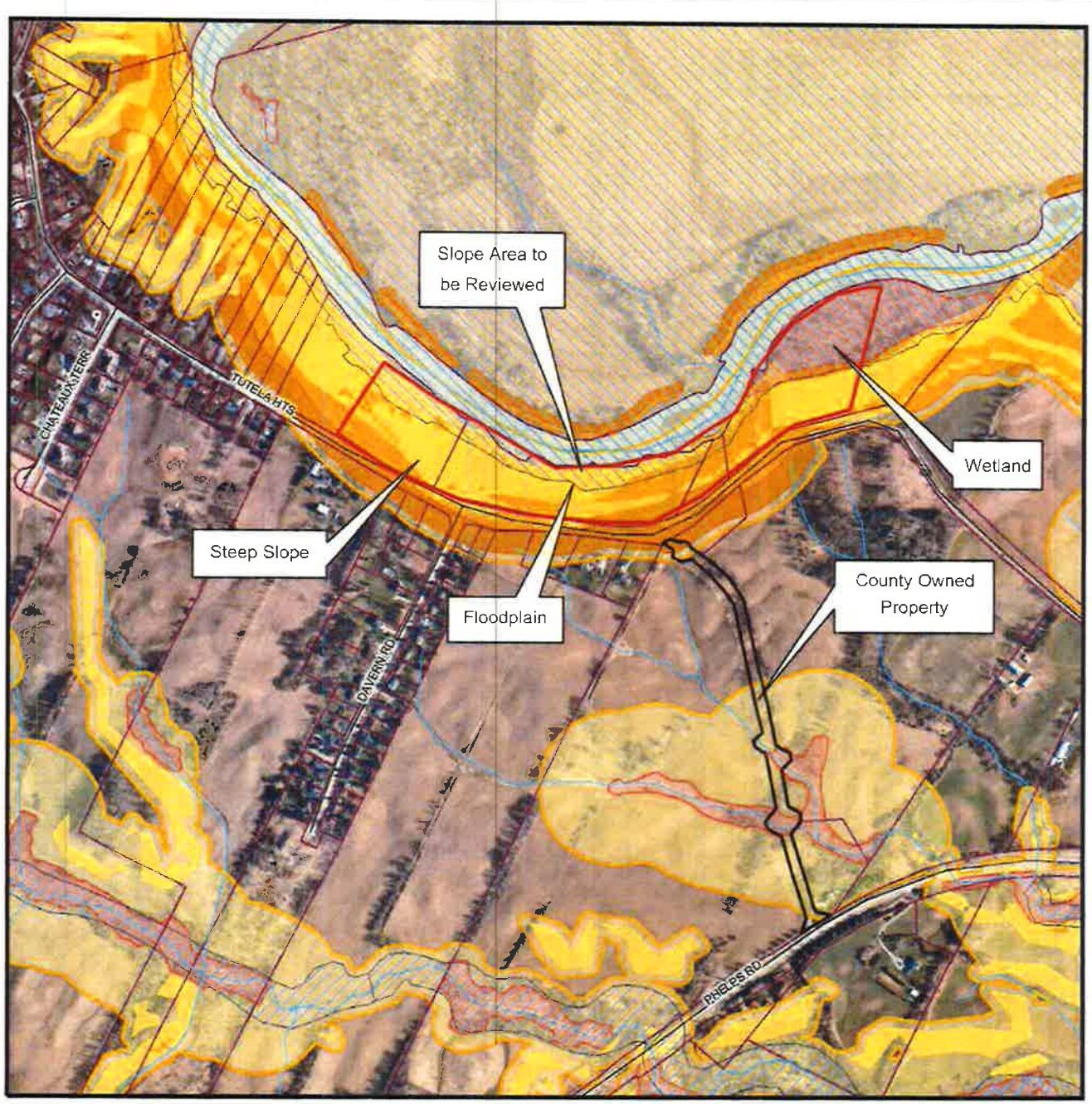
A series of features of interest to the GRCA exist within the study area. These features include an oversteepened slope on the bank of the Grand River as well as associated floodplain and wetland features.

The Grand River Conservation Authority is interested in continuing our involvement with this project. We look forward to an opportunity to review and provide comment on the proposal. Should you have any further questions please do not hesitate to contact the undersigned at 519-621-2763 ext 2238.

Sincerely,

Ashley Graham
Resource Planner
Grand River Conservation Authority

Enclosure (1)



Grand River Conservation Authority
Map created: October 19, 2015
Prepared by: AG

Tutela Heights, Brant

LEGEND

- WATERSHED BOUNDARY (GRCA)
- UTILITY LINE (NRVIS)
- ROADS-ADDRESSED (MNR)
- RAILWAY (NRVIS)
- DRAINAGE-NETWORK (GRCA)
- PARCELS-ASSESSMENT (MPAC)
- FLOODPLAIN-SPECIAL POLICY AREA (GRCA)
- FLOODPLAIN (GRCA)
  - ENGINEERED
  - APPROXIMATE
  - ESTIMATED
- WETLAND (GRCA)
- SLOPE VALLEY (GRCA)
  - STEEP
  - OVERSTEEP
- SLOPE EROSION (GRCA)
  - STEEP
  - OVERSTEEP
  - TOE
- WETLAND (NRVIS)
  - PROVINCIALLY SIGNIFICANT
  - LOCALLY SIGNIFICANT
  - UNEVALUATED
- PARKS (GRCA)
- REGULATION LIMIT 2014 (GRCA)
- DRAINAGE-POLY (NRVIS)
- 2010 ORTHO (ONT)

GRCA Disclaimer

This map is for illustrative purposes only. Information contained hereon is not a substitute for professional review or a site survey and is subject to change without notice. The Grand River Conservation Authority takes no responsibility for, nor guarantees, the accuracy of the information contained on this map. Any interpretations or conclusions drawn from this map are the sole responsibility of the user.

The source for each data layer is shown in parentheses in the map legend. For a complete listing of sources and citations go to:

http://grims.grandriver.ca/docs/SourcesCitations1.htm

0 115 230 345 460 m

NAD 1983, UTM Zone 17 Scale 1:10,000

THIS MAP IS NOT TO BE USED FOR NAVIGATION

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MINUTES OF MEETING

Subject:	**County of Brant Tutela Heights Road Slope Stabilization EA Project** **GRCA Review Meeting**	**Date:**	January 12, 2016
Attendees:	**GRCA** Gus Rungis – (GR) Ashley Graham – (AG) **County of Brant** Matthew D'Hondt – (MD) **LVM** Karen Thrams – (KT) **Aquafor Beech** Roger Phillips – (RP) **Parsons** Rajan Philips – (RJ) Stuart Mitchell – (SM)	**Location:** **Ref:**	GRCA Office 602915

ITEM	DISCUSSION	ACTION
2	**Project Background**	

2.1	**Background Information**
	• MD provided background information with respect to potential annexation of County land by the City of Brantford which may put this project on hold. It was noted that boundary negotiations have commenced and are expected to be finalized in the next 4-5 months. Initial land transfers are expected to take place in January 2017. It was indicated that lots fronting Davern Road and west along Tutela Heights Road are included in the proposed annexation.
	
	• MD questioned if there is anything that needs to be done in the short term (i.e. 0-5 years) in addition to ongoing monitoring, and it was indicated that surface draining issues need to be addressed.
	
	• The following points were also noted in the discussion:
	  • GRCA has reviewed and approved the Terms of Reference/Workplan for studies associated with the Walton Development.
	  • Water servicing is provided within the study limits, however, there is no sanitary servicing.
	  • Current reports will remain in "Draft" format. Reports to be updated to "Final Draft" status based on GRCA comments arising during this meeting.
	  • GR noted that the construction of groynes and slope stabilization work was undertaken in 1973 as a joint project with the County. There were originally seven (7) groynes constructed and not six (6) as noted in the reports. Design drawings are available. Only four (4) of the original groynes remain in some form. Dredging along the bank was also completed as part of this work. It was noted that dredging may have impacted erosion rates and that most erosion took place prior to this construction.	

3	**Geomorphic Assessment** • RP provided an overview of the Geomorphic Assessment which is essentially a desktop analysis utilizing historic air photos supported by field	

ITEM	DISCUSSION	ACTION
	data and observations. RP noted that the most stringent MNR guideline provides for a 15 m erosion allowance. GRCA supported this approach and agreed that 2002 MNR guidelines do not cover the appropriate scale and context of the Grand River Tutela Heights study area.	
	• RP noted that the approach of this assessment was not to define future erosion rates but to constrain historical erosion rates to an acceptable and defendable range.	
	• It was noted that in the downstream section (cross-section C), a comparison of air photos indicates 17m of bank/toe of slope erosion has occurred between 1945 and 1967.	
	• Based on the assessment completed, erosion allowances of 30 m (cross sections A and B), and 75 m (cross section C) are proposed. These allowances are conservative and physical evidence actually supports lower future erosion allowances/rates. Transition between 30 m and 75 m setback allowances is undefined.	
	• RP recommended formal monitoring of the current conditions vs. intervention works (i.e. maintenance of groynes), especially if the project is delayed until annexation/land transfer issues are finalized.	
	• GRCA presented 1964 and 1995 georeferenced mapping (from digital bitmap/PDF) and 2010 orthophotos, with suggestion that they be included in the erosion rate analysis. ABL agreed to receive and review the additional data, but clarified that historical aerial photos used in the analysis were georeferenced and orthorectified based on comparable technical procedures and can reasonably be considered as accurate as the georeferenced mapping. The period of 1964-1995 is also post-construction and thus may not contribute directly to the recommended erosion rate values. ABL to review new data, as provided, and consider if any possible revisions to the analysis and report are warranted.	ABL
	• GR indicated that existing GRCA hazard mapping delineates a stable slope line based on a 4:1 inclination and a 40 m erosion setback.	
	• It was noted that several private properties/buildings are within the slope hazard zone and are, therefore, regulated by GRCA.	
	• Report to be updated to account for construction of 7 groynes and more clearly account for the associated dredging on the opposite bank. The potential confounding effects of rotational slumping on the toe of bank location in the channel (i.e., movement "into" channel) should also be acknowledged and/or accounted for in the historic air photo mapping and estimates of erosion rates. Concerns were expressed for measuring erosion rates post-construction. ABL clarified that the 0.75 m/yr erosion rate is based on a preconstruction time period (1945-1967).	ABL
	• Questions were raised with respect to the transition of the 100 year erosion allowance line at cross-section B, between cross-section A (30 m) and cross-section C (75 m). The transition line represents the continued influence of the remaining groyne structures through cross-section B. MD	ABL

ITEM	DISCUSSION	ACTION
	suggested ABL might also include a 25 and 50 year erosion allowance line. ABL to consider a more gradual transition between cross-sections A and C, with an erosion allowance greater than 30 m at cross-section B.	
4	**Geotechnical Investigation** • KT provided an overview of the Geotechnical Investigation. Details of the investigation include: o 3 BHs were drilled and inclinometers were installed. Inclinometer readings will take place this week. o 19 SIBs were installed in order to monitor movement. Parsons to check if the recent survey of the SIBs indicated any movement. o Conservative soil parameters were incorporated in the slope stability analysis. • GR noted that a previous BH installed by Stantec was advanced through material that had previously failed. Indicated that data from this BH should be reviewed and incorporated in this analysis. • It was noted that Golder completed a larger scale investigation for the entire reach in the 1980's. This information will be provided by the GRCA if it is available. Englobe will review and update report if required.	Parsons GRCA/ Englobe GRCA
5	**Discussion** • The following points/issues were discussed or noted: • GRCA to assist in obtaining BH data information from Stantec. • Need to look at previous Oxbow failure. • GRCA and Matt D'Hondt questioned whether it would be worthwhile to show 25, 50, 100 year stable slope lines. RP indicated that 100 year was standard horizon for erosion analysis. Any line less than 100 would simply be a linear interpolation of the 100 year line. • GRCA to provide copy of Golder's 1980 report. • GRCA requested some additional text be provided to indicate that all analyses/assessments are specific to the County and the road EA and do not address implications for other projects/properties.	GRCA ABL/Englobe GRCA Parsons Englobe
6	**Other Business** • Need to review/comment on 3:1 vs. 4:1 stable slope line using BH data, information from Stantec and Golder report. • In next version of Technical Memo, eliminate drawing 7 and incorporate 30 m erosion setback (cross-section A), 75 m setback (cross-section C) and define transition (cross-section B). • Milestones for delivery of "Final Draft" reports to County and GRCA: o GRCA to provide all technical documentation by 01/22/2016. o Aquafor Beech and Englobe to revise technical reports by 02/05/2016.	Englobe Englobe GRCA ABL Englobe

ITEM	DISCUSSION	ACTION
	○ Parsons to submit "Final Draft" of technical memorandum to GRCA by 02/12/2016. ○ Matt d'Hondt requested a short technical memo that would discuss requirements for the 0-5 year timeline (i.e. low risk monitoring program including surface drainage, surveying SIB's, visual observations, etc.)	Parsons

These minutes are believed to reasonably summarize the major items of discussion at the meeting. Please advise as soon as possible if you note any significant errors or omissions. We thank you for your participation.

Stuart Mitchell, P.Eng.

COMMENT FORM

TO: **Rajan Philips, P. Eng.**
Manager, Waterloo Regional Operations

EMAIL: **rajan.philips@parsons.com**

FAX: **(519) 744-4509**

RE: **Municipal Class Environmental Assessment for Tutela Heights Road Slope Stabilization - Notice of Study Commencement**

CONTACT NAME: Pete Liptrott
TITLE: Inspector
GROUP/AGENCY: Brant County Ontario Provincial Police
ADDRESS: #28 Mechanic Street
Paris ON N3L 1K2
TELEPHONE: 519-442-2242
FAX: 519-442-6808
E-MAIL: pete.liptrott@opp.ca

☑ My group/agency is interested in this project and our concerns are noted in the space provided (see page 2).

☐ My group/agency has no concerns but would like to be kept informed. Please maintain our group/community on the contact list for this project.

☐ My group/agency has no concerns about this project and can be removed from your contact list.

Over...

COMMENTS/AREA OF INTEREST:

The main concerns we have at this point will be in relation to any anticipated road closures or traffic delays along Tutela Heights or surrounding roadways and have representatives of the Six Nations of the Grand River First Nations been contacted in relation to this specific location and environmental assessment as it fronts on the Grand River and is within an area of potential concern due to historical and ongoing land claim issues.

Please use additional paper if required to complete your comments. Please fill in the following information and return by **October 30, 2015**. Thank you for your time and effort!

COMMENT FORM

TO: **Rajan Philips, P. Eng.**
Manager, Waterloo Regional Operations

EMAIL: **rajan.philips@parsons.com**

FAX: **(519) 744-4509**

RE: **Municipal Class Environmental Assessment for Tutela Heights Road Slope Stabilization - Notice of Study Commencement**

CONTACT NAME: Philip Kuckyt

TITLE: Manager of Transportation Services

GROUP/AGENCY: Grand Erie District School Board

ADDRESS: 347 Erie Ave,
Brantford, ON N3T 5V3

TELEPHONE: 519-751-7532 ext 5

FAX: 519-751-1536

E-MAIL: pkuckyt@stsbhn.ca

☐ My group/agency is interested in this project and our concerns are noted in the space provided (see page 2).

☑ My group/agency has no concerns but would like to be kept informed. Please maintain our group/community on the contact list for this project.

☐ My group/agency has no concerns about this project and can be removed from your contact list.

Over...

PARSONS

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