THE REGIONAL MUNICIPALITY OF NIAGARA

CONTRACT DOCUMENTS

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

James Bradley
Regional Chair

Catherine Habermebl
Acting Commissioner of Public Works

APRIL 2019

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

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NOTICE

This contract utilizes the Niagara Peninsula Standard Contract Document (Revision 19). This document constitutes the specification for this project and must be utilized in preparing bids for tenders or quotations.

The Niagara Peninsula Standard Contract Document is available on-line at the “Bid Opportunities” section of the Regional Municipality of Niagara website (www.niagararegion.ca).

Contracts issued through tender calls and quotations will reference the Standard Document and the responsibility for obtaining or having access to the Document will rest with the bidder. The Standard Document can be utilized on all projects which clearly indicate reference and use of the Niagara Peninsula Contract Document.

SPECIAL INSTRUCTIONS TO BIDDERS

INSTRUCTIONS TO BIDDERS

(Refer to Niagara Peninsula Standard Contract Documents)

SPECIAL INSTRUCTIONS TO BIDDERS

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Contract No. 2019-T-155
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SPECIAL INSTRUCTIONS TO BIDDERS

1. Named Parties

For the purposes of this contract the following parties are identified:

Owner:	**The Regional Municipality of Niagara**
Engineer:	**ELLIS Engineering Inc.**
Contract Administrator:	**ELLIS Engineering Inc.**
Inspector:	**ELLIS Engineering Inc.**
Contact for Enquiries:	Procurement Agent Kristine Richardson Niagara Region Telephone: 905-980-6000, extension 3315

2. Tender Procedure

The following policy regarding the submission of tenders and the tender opening procedures will be applicable for this project. Bidders are requested to adhere strictly to the instructions concerning submission.

(a) **All tenders must be submitted in a sealed envelope to:**

Title: **Kristine Richardson, Purchasing Agent**
Address: **Purchasing Services Office,**
First Level (Upstairs), Campbell West
1815 Sir Isaac Brock Way, P.O. Box 1042, Thorold, ON L2V 4T7

By the following time, as determined on the clock located at the location receiving bids:

Time: **2:00 p.m.**
Date: **TUESDAY, APRIL 30th, 2019**

(b) Submissions received after this deadline will not be accepted and will be returned unopened to the bidder. Please note that bidders are solely responsible to ensure that their submissions are received by the office of the Purchasing Agent on or before the deadline. The Purchasing Agent will not accept any submission after this deadline notwithstanding the reason for its late receipt.

Please also note that, in the event of any question regarding the timely receipt of any submission, the time on the clock designated by the Purchasing Agent will absolutely prevail over any other time piece regardless of any discrepancies between the time on the Purchasing Agent's designated clock and actual time.

Tenders must be plainly marked to reveal the contents and the Bidder's name and address.

(c) Tenders shall be submitted in the one envelope, as follows:

i) The envelope shall contain:

* "Agreement to Bond", duly signed and sealed (no copies or facsimiles will be accepted).

* Tender deposit in the form of a Certified Cheque, Bank Draft or Bid Bond and in the amount of **$ 100,000** made payable to The Regional Municipality of Niagara.

* Form of Tender, specifically:
  - Pages FT-1 through FT-12 (Form of Tender)
  - Pages FT-13 through FT-16 (Statement "A", "B", "C", and "D")
  - Signed pages of all Addendum/Addenda

(including addenda if applicable).

(d) Tenders will be opened the same day that tenders close.

Time: **2:15 p.m.**

Location: **Campbell West**
1815 Sir Isaac Brock Way, P.O. Box 1042, Thorold, ON L2V 4T7

Firms submitting tenders will be permitted to attend the tender opening.

(e) The total tender price will be announced for each tender opened, (excluding H.S.T.).

3. Estimated Tender Value

The estimated tender value of the project is as follows (excluding H.S.T.).

Estimated Tender Value **$1,300,000.00**

4. Tender Award

The award of this tender is subject to the Owner obtaining approval from:

The Regional Municipality of Niagara Council

Niagara Peninsula Conservation Authority

Tentatively, construction may commence, but is not guaranteed, by:

TUESDAY, JULY 2, 2019

5. Maintenance Holdback

This contract will be subject to a Maintenance Holdback of two percent (2%) of the final contract value (excluding HST). The holdback will be released as specified in Special Provisions – General.

6. Liquidated Damages

The liquidated damages for this contract shall be One Thousand Dollars ($1,000.00) for each and every day's delay as outlined in Special Provisions - General.

7. Additional Insured

The following parties are identified to be included as additional insured for this project:

The Regional Municipality of Niagara

ELLIS Engineering Inc.

Landtek Limited

Wood Group

Niagara Peninsula Conservation Authority

City of Niagara Falls

8. Confidentiality

The Region will treat all bids as confidential. The Region will comply with the *Municipal Freedom of Information and Protection of Privacy Act,* and its retention by-law pursuant to the *Municipal Act*, in respect of all bids. All Public Reports approved by the Council of the Region will become public information. Such Public Reports will not include bid documents. The Region will not return or destroy any copies of any unsuccessful bid.

9. Procurement By-Law

Submissions will be solicited, received, evaluated, accepted, and processed in accordance with the latest version of The Region's Procurement By-Law as amended from time to time. In submitting a bid, in response to this solicitation, the Bidder agrees and acknowledges that it has read and will be bound by the terms and conditions of the Procurement By-Law.

The Procurement By-Law can be viewed on the Region's website, www.niagararegion.ca

Bidding System Registration

Niagara Region will only consider bids received from bidders who have registered with Niagara Region's electronic bidding system at https://niagararegion.bidsandtenders.ca (the "Bidding System") and have obtained the RFT directly from the Bidding System.

All bidders must establish a Bidding System account and be registered as a Plan Taker for the bid opportunity, which will enable the bidder to download the tender documents, receive addenda email notifications, and download addenda.

10. Dispute Resolution

(a) The Corporation encourages competitive bidding and an open, accountable and transparent process for the Purchase of Goods and/or Services.

(b) To maintain the integrity of the Bid Solicitation process, Suppliers who believe they have been treated unfairly in a Bid Solicitation process shall submit a Substantive Objection to the Director of Procurement and Strategic Acquisitions providing sufficient detail regarding their complaint within:

(i) 7 days from the conclusion of the Bid opening process for Request for Quotations or Request for Tenders.

(ii) 7 days of the Supplier being notified of the results of a Request for Pre-Qualification or Request for Expressions of Interest or Request for Proposals.

(c) The Director of Procurement and Strategic Acquisitions will arrange a debriefing with the Supplier to explain the Bid Solicitation process that led to the selection of the successful Supplier.

(d) The Director of Procurement and Strategic Acquisitions will investigate the complaint and will make a recommendation to the Commissioner of Corporate Services/Treasurer, CAO or Council, as appropriate.

(e) To ensure that the Dispute Resolution process for the particular Bid Solicitation process is seen to be fair and impartial, elected officials shall not advocate on behalf of Suppliers who have submitted a Substantive Objection.

(f) Should a Supplier continue to have concerns respecting the Award and the decision, the Supplier may then request, in writing to the Commissioner of Corporate Services/Treasurer, a mediator, to assist in resolving any outstanding issues between the Supplier and the Corporation.

(g) The recommended mediator will be approved by both the Supplier and the Corporation.

(h) The mediator shall make his/her best efforts to assist the parties to reach a mutually acceptable solution.

(i) Costs for the mediator shall be equally shared by the Supplier and the Corporation.

(j) Any resolution reached through the mediation process shall remain confidential if requested by either of the parties.

11. Lobbying Restrictions

(a) Lobbying restrictions shall apply to Suppliers, their staff members, or anyone involved in preparing a Bid, shall not engage in any form of political or other Lobbying whatsoever or seek to influence the outcome of the Bid Solicitation process or subsequent Award. This restriction extends to all of the Corporation's staff and anyone involved in preparing a Bid Solicitation or participating in a Bid evaluation process, and members of Council.

(b) The Corporation may reject any Bid by a Supplier that engages in such Lobbying, without further consideration, and may terminate that Supplier's right to continue in the Bid Solicitation process.

(c) During a Bid Solicitation process, all communications shall be made through Procurement and Strategic Acquisitions. No Supplier or person acting on behalf of a Supplier or group of Suppliers, shall contact any

elected official, consultant or any employee of the Corporation to attempt to seek information or to influence the Award.

(d) Elected officials shall refer any inquiries about a Bid Solicitation process to the Commissioner of Corporate Services/Treasurer.

12. <u>Bidder Performance</u> (Litigation)

The Corporation may, in its sole discretion, reject a Bid if a bidder:

(i) has, at any time, threatened, commenced or engaged in legal claims or litigation against the Corporation;

(ii) is involved in a claim or litigation initiated by the Corporation;

(iii) previously provided goods or services to the Corporation in an unsatisfactory manner;

(iv) has failed to satisfy an outstanding debt to the Corporation;

(v) has a history of illegitimate, frivolous, unreasonable or invalid claims;

(vi) provides incomplete, unrepresentative or unsatisfactory references; or

(vii) has engaged in conduct that leads the Corporation to determine that it would not be in the Corporation's best interests to accept the Bid.

13. <u>Tender Deposit</u>

Tender deposits, with the exception of those from the two lowest Bidders will be returned within fifteen (15) days after the tenders are opened.

The Tender Deposit of the two lowest Bidders will be held until all necessary documentation has been provided by the successful Bidder (i.e. – Insurance, W.S.I.B. Certificate of Clearance, Bonding, etc.), the Agreement has been duly executed and the Bidder has provided evidence, satisfactory to the Region, that all arrangements have been made for commencement of the services to be provided, on the Contract start date.

No interest will be paid for deposits retained and/or cashed by The Regional Municipality of Niagara. Bidders are deemed to have made due allowances for this requirement in their total contract tender price, including contingency items and excluding HST.

14. Insurance Certificate

Immediately upon Award, the successful Bidder shall provide the Region with a Certificate of Insurance acceptable to the Region and, if requested by the Region, certified copies of the insurance policies. The Certificate of Insurance must comply with the insurance requirements outlined in this Bid Solicitation and must be on the Region's form of Certificate of Insurance, which can be found on the Region's website – www.niagararegion.ca/business/fpr/cert-insurance.aspx. If the Certificate of Insurance is provided in a non-original form (e.g. a facsimile, photocopy or scanned electronic copy), the Bidder acknowledges and agrees that the Region is fully entitled to treat any such Certificate as an original and that the Bidder will be responsible for the accuracy and validity of the information contained therein.

15. Exclusion

Except as expressly and specifically permitted herein, no Bidder shall have any claim for any compensation of any kind whatsoever, as a result of participating in this Tender, and by submitting a tender each Bidder shall be deemed to have agreed that it has no claim.

16. Maintenance of Traffic

The successful Tender shall submit a Construction Schedule and Traffic Management Plan, listing work items, and the proposed progression of work to the Contract Administrator within seven (7) days of the contract award. The schedule shall show in a clear critical path diagram the proposed progress of all activity for the main items and site development of the contract, including key milestones and completion of work within the specified time allowed. Construction will not be allowed to commence until these documents are received and accepted.

The proposed schedule for the work of the culvert replacements shall be as per the following:

Stage 1 (Structure No. 098315):

- The closure of Montrose Road at structure No. 098315 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.
- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098310 shall remain open.

Stage 2 (Structure No. 098310):

- The closure of Montrose Road at structure No. 098310 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.
- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098315 shall remain open.

Access Closures are to be scheduled at least 2 business days in advance between the Contractor and the business owner or residents and approved by the Contract Administrator and/or construction inspector.

17. Additions and Deletions

The Regional Municipality of Niagara reserves the right to add to or delete from any portion or portions of the Schedule of Work. These changes under this contract shall **NOT** be subject to the unit price adjustment provisions in the General Conditions of Contract.

18. Construction Schedule

The successful Tenderer shall submit a construction schedule to the Contract Administrator within seven (7) days of the contract award. The schedule shall show in a clear critical path diagram the proposed progress of all activity for the main items and site development of the contract, including key milestones and completion of work within the specified time allowed.

All in water work, including excavation and backfilling to the high waterline, supply and installation of the precast concrete apron walls, supply and installation of the precast concrete box culvert units, and any other in water work requiring dewatering or temporary diversion of the stream may not be completed between March 1, 2019 to July 1, 2019, in accordance with the restrictions governed by the Niagara Peninsula Conservation Authority and the Ministry of Natural Resources.

All construction work is to be completed and the roadway is to be opened to vehicular and pedestrian traffic by Friday September 27th, 2019.

19. Examination of Plans, Specifications, and Site of Work

Tenderers shall carefully examine and study all of the Contract Specifications and the site of work in order to satisfy themselves by examination as to all conditions affecting the contract and as to the detailed requirements of the construction.

20. Geotechnical Investigation

A copy of the soil investigation report is appended to these specifications.

The geotechnical investigation and supporting data is provided for information only and represents the considered opinion and findings of the firm which undertook the work. The Owner does not take responsibility for the accuracy of the information and provides it for consideration by tenderers. Tenderers are to make further investigation as they deem necessary, and at their own expense, to accurately assess the subsurface conditions to be encountered.

21. Accessibility Regulations for Contracted Services

Contracted employees, third party employees, agents and others that provide customer service on behalf of Owner are legally responsible to be in compliance with the provisions outlined in Section 6 of the Ontario Regulation 429/07 with respect to training under the Customer Service Standard of the *Accessibility for Ontarians with Disabilities Act (2005).* The Contractor shall ensure that such training includes, without limitation, a review of the purposes of the Act and the requirements of the Regulation, as well as instructions regarding all matters set out in Section 6 of the Regulation. By signing Statement "C" the bidder has agreed to be in full compliance with this regulation. The successful bidder will be expected to complete the confirmation form, prior to the issue of the agreement or purchase order. For any further information please contact accessibility@niagararegion.ca

Contractors shall be responsible for notifying the general public when planning/implementing a disruption to any transportation walkway, pathway, driveway, roadway, etc. It shall be the Contractor's responsibility to notify the general public of any disruption to regular service; prior to the commencement of the disruption. In the case where construction activities will cause a disruption to normal service appropriate signage shall be installed. At the Owner's request, information relating to the disruption shall be supplied to allow for the posting of disruption notices on the Owner's web page of choice.

The posted **s**ignage shall **–** as a minimum **-** include the headings listed below (or forma**t** supplied by the Owner) and shall be filled out by the contractor and installed in advance of the service disruption.

NOTICE OF SERVICE DISRUPTION
Please be advised of a disruption to:
Reason for disruption:
This service will be unavailable for the period of:
Alternative facilities or services:
For more information or service accommodation, please contact:

WE APOLOGIZE FOR THE INCONVENIENCE.
THANK YOU

22. Contractor Safety Program

The successful contractor must comply with the Region's Contractor Safety Policy #C3-H17. The policy and forms can be found on the Region's website at:

http://www.niagararegion.ca/business/tenders/compliance-with-standards.aspx.

Failure to comply with this policy will result in disqualification of the contractor.

23. Tender Enquiries

The deadline for tender inquiries is April 23, 2019 at noon.

Prior to the Deadline for Questions, bidders may ask questions or seek additional information in relation to this RFT through the Bidding System using the "Submit a Question" link associated with this bid opportunity. Niagara Region will not accept any bidder's questions or requests for information by any other means, except as specifically stated in this RFT.

24. Insurance Requirements

The provisions of Niagara Peninsula Standard Contract Document Special Provisions – General Clause G1 shall apply except as amended or extended herein.

The following is to be added to Clause G1 b):

Commercial General Liability Insurance ("CGL")

The Contractor shall be required to provide, maintain, and pay for General Liability Insurance (as described under General Condition Clause GC 6.03.02) to a limit of no less than five million dollars total with a property damage deductible of no more than $5,000 (five thousand dollars).

XCU Endorsement

The CGL policy must include coverage for Explosion, Collapse or Underground (XCU Endorsement) or not contain an exclusion.

Automobile Insurance

The Contractor shall be required to provide, maintain, and pay for Automobile Liability Insurance (as described under General Condition Clause GC 6.03.03) for owned and non-owned auto to a limit of no less than five million dollars. Coverage must also apply in the event the operations of the insured resulted in a pollution condition including remediation costs.

Pollution Liability

The Contractor shall be required to provide, maintain, and pay for Contractor's Pollution Liability Insurance to a limit of no less than two million dollars per claim insuring all services and operations of the Contractor for third party losses arising from a pollution event performed by or on behalf of the Contractor and shall include coverage for but not limited to, bodily injury including death, property damage and remediation costs which are reasonable and necessary to investigate, neutralize, remove, remediate (including associated monitoring) or dispose of soil, surface water, groundwater or other contamination. The policy shall be endorsed to:

(a) Include the Owner as an additional insured;

(b) Contain an undertaking by the insurers to give thirty (30) days prior written notice in the event that there is a material change in the foregoing policies or coverage affecting the additional insured or cancellation of coverage before the expiration date of any of the foregoing policies; and

(c) The policy shall be maintained continuously during the term of this Contract and for two (2) years after the termination or expiration of this Contract and shall cover insurable losses arising out of or in association with an error or omission in the rendering of or failure to render the Services. If coverage under the policy is cancelled within the two (2) year period after the termination or expiration of this Contract the Contractor shall provide the Owner with notice within thirty (30) days of cancellation and shall be required to purchase an extended reporting endorsement to confirm that coverage is maintained.

Hook and Crane Liability

The Contractor shall be required to provide, maintain, and pay for Hook and Crane Liability Insurance in an amount of $500,000.

Broad Form Contractor's Equipment

The Contractor shall be required to provide, maintain, and pay for Contractor's Equipment Insurance (as described under General Condition Clause GC 6.03.06) and also covering performance of the Work including costs to cleanup and restore property damaged by sudden and accidental escape of pollutants and shall not allow subrogation claims by the Insurer against the Owner.

Property

The Contractor shall be required to provide, maintain, and pay for Builders All Risk coverage "Broad Form" in the joint names of the Owner, General Contractor and the Consultant (as described under General Condition Clause GC 6.03.05).

25. Working Around Overhead Hydro

The Contractor shall plan construction activities to complete the work around all existing utilities. At each site, there are existing overhead hydro lines and at the time of tender, NPEI could not confirm if the existing overhead lines could be de-energized or relocated during construction.

26. Third Party Requirments in the Vicinity of Natural Gas Facilities

All work within the vicinity of natural gas pipeline must adhere to the specification set forth by Enbridge Gas Distribution Inc. A copy of this specification has not been included within the tender.

https://www.enbridgegas.com/gas-safety/pipeline-safety.aspx

Questions regarding work within the vicinity of a natural gas pipeline and the corresponding specifications may be obtained from the following source:

EGD CONTACTS

Rob D'Onofrio, C.Tech., GDP Planning Sr. Specialist
ENBRIDGE Gas Distribution Inc.
Niagara Region
Tel: 905-641-4876 / Fax: 905-704-3683
robert.donofrio@enbridge.com

The contractor is to become familiar with all of Enbridge's requirement pertaining to work within the vicinity of a natural pipe line and these provisions are to be included within the tender bid. No additional cost associated with work within the vicinity of a natural gas pipe line will be entertained.

FORM OF TENDER

Contract No. 2019-T-155
(RN19-55)

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(Structure No. 098310 and 098315)
In The City of Niagara Falls

FORM OF TENDER

We, the undersigned Contractor(s) have carefully examined the attached documents as herein listed and forming part of this Tender

DOCUMENTS INCLUDED IN CONTRACT

Special Provisions
Special Instructions to Bidders
Instructions to Bidders
General Conditions
Supplementary General Conditions
Standard Specifications (as noted)
Supplementary Specifications (as noted)
Plans (as noted)
Addenda (if applicable)

and have carefully examined the site and location of the work to be done under this Contract. We, the undersigned Contractor(s), understand and accept the said drawings and contract documents, and, for the prices set forth in this Tender, hereby offer to furnish all machinery, labour, tools, apparatus, and other means of construction, furnish all materials except as otherwise specified in the Contract, and to complete the work in strict accordance with the drawings and contract documents referred to above, for the total tender price of: _____

_____ Dollars ($_____) including contingency and *excluding H.S.T.*.

We acknowledge that we have received Addendum/Addenda No. inclusive, and that all changes specified in the Addendum/Addenda have been included in the prices submitted.

ADDENDA

We agree to commence work as specified to proceed continuously to completion specified as **September 27th, 2019**

COMMENCEMENT AND COMPLETION

We agree that his tender is to continue open to acceptance and irrevocable until the formal contract has been executed by the successful tenderer for the said work, and the bond or bonds as specified have been executed by the approved surety or sureties, and that the Corporation may, at any time, within 45 (forty-five) calendar days of the closing date, accept this tender without notice, whether any tender has been previously accepted or not.

TENDER IS OPEN TO ACCEPTANCE & IRREVOCABLE

** to be filled in by the Tenderer.*

OFFERED ON BEHALF
Safety OF THE CONTRACTOR

Insert Workplace & Insurance Board Account No.

_____
Signature

_____
Signature

Company Name

_____
Address

Contractor's Seal

_____
Witness

_____
Date

_____
Witness

NOTE:

(a) If the Tenderer is a Corporation, the Corporate Seal must be affixed under the signature of a duly authorized officer or officers of the Corporation.

(b) If the Tenderer is not a Corporation or a Partnership, the Tenderer must sign in the presence of a witness who must also sign.

(c) If the Tenderer is a Partnership, each member of the Partnership must sign in the presence of a witness who must also sign.

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SCHEDULE OF QUANTITIES

SECTION 1: Structure No. 098310 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1-1	SP-A1 SSP-1	Mobilization & Demobilization	100%	L.S.	-	$
1-2	SP-A4 SSP-2	Construction Layout	100%	L.S.	-	$
1-3	SSP-3	Construction Schedule	100%	L.S.	-	$
1-4	518 805 902 SP-A7 SSP-4	Waterway Protection and Dewatering	100%	L.S.	-	$
1-5	SSP-5	Fish Salvage and Transfer	100%	L.S.	-	$
1-6	SP-A7 SSP-6	Light Duty Silt Fence Barrier	100	m.	$	$
1-7	SSP-7	Clearing and Grubbing	100%	L.S.		$
1-8	SP-A8 SSP-8	Construction Signs, Traffic Control, and Traffic Management Plan	100%	L.S.		$
1-9	510-MUNI SSP-9	Removal of Asphalt Pavement	600	m^2	$	$
1-10	510-MUNI SSP-10	Removal of Existing Culvert	100%	L.S.		$

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SECTION 1: Structure No. 098310 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1-11	902 SSP-11	Excavation and Grading	1600	m^3	$	$
1-12	SSP-12	Dura Hold 2 Retaining Wall System	100%	L.S.		$
1-13	422 909-MUNI SSP-13	Supply and Installation of Precast Concrete Box Culvert	100%	L.S.		$
1-14	904-MUNI SSP-14	Concrete in Distribution Slab and Headwalls	100%	L.S.		$
1-15	950-MUNI SSP-15	Glass Fibre Reinforced Polymer (GFRP) Bars	100%	L.S.		$
1-16	904-MUNI SSP-16	Dowels into Concrete	180	Ea.	$	$
1-17	405-MUNI SSP-17	Subdrains	100	m	$	$
1-18	501-MUNI 902 SSP-18	Granular 'A'	650	t	$	$
1-19	501-MUNI 902 SSP-19	Granular 'B' Type II	1770	t	$	$
1-20	902 SSP-20	19mm Clear Stone, Type II	150	t	$	$

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SECTION 1: Structure No. 098310 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity.	Unit	Unit Price	Amount
1-21	511-MUNI SSP-21	Geotextile				
		a) Class I	80	m^2	$	$
		b) Class II	100	m^2	$	$
1-22	511-MUNI SSP-22	Rip-Rap	150	t	$	$
1-23	511-MUNI SSP-23	River Stone	160	m^2	$	$
1-24	914-MUNI SSP-24	Waterproofing	110	m^2	$	$
1-25	914-MUNI SSP-25	Polyester Fabric Reinforcement	110	m^2	$	$
1-26	206-MUNI SP-B19 SSP-26	Re-Grading Ditches and Swales	100	m	$	$

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SECTION 1: Structure No. 098310 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity.	Unit	Unit Price	Amount
1-27	310-MUNI SP-B14 SSP-27	Hot Mix Asphalt Paving				
		a) HL3- HS – 50mm	75	t	$	$
		b) HL8- HS – 100mm	145	t	$	$
1-28	802 804 SP-B22 SSP-28	Topsoil, Seed and Erosion Control Blanket	400	m^2	$	$
1-29	721-MUNI SSP-29	Steel Beam Guide Rail and Posts	90	m	$	$
1-30	SSP-31	Utility Allowance (Cogeco)	100%	L.S.		$
1-31	SSP-32	Utility Allowance (Enbridge)	100%	L.S.		$
1-32	SSP-33	Utility Allowance (Niagara Peninsula Energy)	100%	L.S.		$

SECTION 1 - SUBTOTAL $_____

Contract No. 2019-T-155 (RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF QUANTITIES

SECTION 2: Structure No. 098315 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity	Unit	Unit Price	Amount
2-1	SP-A1 SSP-1	Mobilization & Demobilization	100%	L.S.	-	$
2-2	SP-A4 SSP-2	Construction Layout	100%	L.S.	-	$
2-3	SSP-3	Construction Schedule	100%	L.S.	-	$
2-4	518 805 902 SP-A7 SSP-4	Waterway Protection and Dewatering	100%	L.S.	-	$
2-5	SSP-5	Fish Salvage and Transfer	100%	L.S.	-	$
2-6	SP-A7 SSP-6	Light Duty Silt Fence Barrier	100	m.	$	$
2-7	SSP-7	Clearing and Grubbing	100%	L.S.	-	$
2-8	SP-A8 SSP-8	Construction Signs, Traffic Control, and Traffic Management Plan	100%	L.S.		$
2-9	510-MUNI SSP-9	Removal of Asphalt Pavement	600	m^2	$	$

Contract No. 2019-T-155 (RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF QUANTITIES

SECTION 2: Structure No. 098315 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity	Unit	Unit Price	Amount
2-10	510-MUNI SSP-10	Removal of Existing Culvert	100%	L.S.		$
2-11	902 SSP-11	Excavation and Grading	1050	m^3	$	$
2-12	SSP-12	Dura Hold 2 Retaining Wall System	100%	L.S.		$
2-13	SSP-13	Supply and Installation of Precast Concrete Box Culvert	100%	L.S.		$
2-14	904-MUNI SSP-14	Concrete in Distribution Slab and Headwalls	100%	L.S.		$
2-15	950-MUNI SSP-15	Glass Fibre Reinforced Polymer (GFRP) Bars	100%	L.S.		$
2-16	904-MUNI SSP-16	Dowels into Concrete	150	Ea.	$	$
2-17	405-MUNI SSP-17	Subdrains	50	m	$	$
2-18	501-MUNI 902 SSP-18	Granular ‘A’	550	t	$	$
2-19	501-MUNI 902 SSP-19	Granular ‘B’ Type II	1550	t	$	$

Contract No. 2019-T-155 (RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF QUANTITIES

SECTION 2: Structure No. 098315 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity.	Unit	Unit Price	Amount
2-20	902 SSP-20	19mm Clear Stone, Type II	120	t	$	$
2-21	511-MUNI SSP-21	Geotextile				
		a) Class I	70	m^2	$	$
		b) Class II	100	m^2	$	$
2-22	511-MUNI SSP-22	Rip-Rap	100	t	$	$
2-23	511-MUNI SSP-23	River Stone	150	m^2	$	$
2-24	914-MUNI SSP-24	Waterproofing	90	m^2	$	$
2-25	914-MUNI SSP-25	Polyester Fabric Reinforcement	90	m^2	$	$
2-26	206-MUNI SP-B19 SSP-26	Re-Grading Ditches and Swales	100	m	$	$

Contract No. 2019-T-155 (RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF QUANTITIES

SECTION 2: Structure No. 098315 – Montrose Road Culvert

Item	Spec. No.	Description	Estimated Quantity.	Unit	Unit Price	Amount
2-27	310MUNI SP-B14 SSP-27	Hot Mix Asphalt Paving				
		a) HL3- HS – 50mm	75	t	$	$
		b) HL8- HS – 100mm	145	t	$	$
2-28	802 804 SP-B22 SSP-28	Topsoil, Seed and Erosion Control Blanket	150	m^2	$	$
2-29	721-MUNI SSP-29	Steel Beam Guide Rail and Posts	25	m	$	$
2-30	732 SSP-30	Softstop Terminal System	4	Ea.	$	$
2-31	SSP-31	Utility Allowance (Cogeco)	100%	L.S.		$
2-32	SSP-33	Utility Allowance (Niagara Peninsula Energy)	100%	L.S.		$

SECTION 2 - SUBTOTAL $_____

Contract No. 2019-T-155 (RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF QUANTITIES

Tender Price Summary

Section	Amount
SECTION 1: Structure No. 098310 – Montrose Road Culvert	$
SECTION 2: Structure No. 098315 – Montrose Road Culvert	$
SUB TOTAL (SECTIONS 1 AND 2):	$
CONTINGENCY ALLOWANCE :	$ 200,000.00
TOTAL TENDER PRICE: **(Subtotal and Contingency Allowance)**	**$**

STATEMENT "A"

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

TENDERER'S EXPERIENCE IN SIMILAR WORK

UNLESS THIS LIST IS PROPERLY COMPLETED, THE TENDER MAY BE DISQUALIFIED

YEAR COMPLETED	DESCRIPTION OF WORK	FOR WHOM WORK PERFORMED	VALUE

STATEMENT "B"

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

(a) Harmonized Sales Tax:

The Contractor shall **NOT** include any amount in his tender price for the Harmonized Sales Tax (H.S.T.). Any amount to be levied with respect to the H.S.T. will be included as a separate item on the payment certificate. The appropriate H.S.T. levy will be paid to the Contractor in addition to the amount approved by the Contract Administrator for work performed under the contract and will, therefore, not affect the amount of the contract. The Contractor will be required to make the appropriate remittance to Revenue Canada in accordance with the legislation.

i) Total Tender Price including contingency and excluding HST $

ii) Estimated Cost of Harmonized Sales Tax..... $

iii) Total Contract Amount [(i) + (ii)] ..... $

iv) H.S.T. Registration Number: _____

_____ _____
Company Name **Contractor's Signature(s)**

_____
Address **Contractor's Seal**

Witnesses: _____

_____

STATEMENT "C"

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

ACCESSIBILITY REGULATIONS FOR CONTRACTED SERVICES CONFIRMATION FORM

If the nature of your business with the Regional Municipality of Niagara (the "Region") creates the opportunity that any of your staff, contractors or any others associated with you would interact with the public on behalf of the Owner, it is necessary that the Owner ensure those providing service on our behalf have received the Customer Service Training in order that we retain our compliance with the requirements of the *Accessibility for Ontarians with Disabilities Act 2005.*

Please sign below to ensure you are the person able to bind your company. Companies whose employee's role may require them to interact with the public on behalf of the Owner, shall receive the CUSTOMER SERVICE STANDARD TRAINING of the ACCESSIBILITY FOR ONTARIANS WITH DISABILITIES ACT 2005.

If you have any questions, please contact the **Accessibility Advisory Coordinator** at 905-980-6000, ext. 3252 or email **accessibility@niagararegion.ca**

Please enclose this form with your bid submission.

Company Name: _____

Signature of Authorized Individual: _____

Position: _____

STATEMENT "D"

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

LIST OF SUB-CONTRACTORS

The bidders shall list hereunder the names of all sub-contractors intended to be used in the execution of this work subject to the approval of the Contract Administrator.

All work not performed directly by the Contractor's forces shall be included in this list. All changes to this list must be approved by the Contract Administrator.

SUB-TRADE	NAME OF SUB-CONTRACTOR	ADDRESS OF SUB-CONTRACTOR

AGREEMENT TO BOND

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts (Structure No. 098310 and 098315)
In The City of Niagara Falls

AGREEMENT TO BOND

We, the undersigned, hereby agree to become bound as surety for:

.....

.....

in a bond totalling One Hundred Percent (100%) of the contract amount, and conforming to the Instruments of Contract attached hereto, for the full and due performance and maintenance of the works shown as described herein if the Tender for

.....

.....

is accepted by the Owner. We also agree to bond as surety for the payment of the cost of all labour and materials for an amount equal to 100% of the contract sum used by the contractor in due performance of his work.

It is a condition of this Agreement that if the above mentioned Tender is accepted, application for a Performance Bond and Labour Materials Payment Bond must be completed with the undersigned within fourteen (14) days of acceptance of the tender related thereto, otherwise this Agreement shall be null and void.

Dated this _____ day of _____, 2019

_____
Name of Bonding Company

_____
Signature of Authorized Person Signing for Bonding Company

_____

(Company Seal)

_____
Position

FORM OF CONTRACT AGREEMENT

THIS AGREEMENT made in triplicate this _____ day of _____ 2019.

- BETWEEN -

THE REGIONAL MUNICIPALITY OF NIAGARA
1815 Sir Isaac Brock Way, P.0. Box 1042
Thorold, Ontario, L2V 4T7

Hereinafter called the "Region" (of the first part)

- AND –

CONTRACTOR NAME

Address

Hereinafter called the "Contractor" (of the second part)

WHEREAS on **April 2nd, 2019** the Region issued Tender #**2019-T-155 (RN19-55)** (*if applicable* **and Addendum # (insert number) dated (date)** *[repeat for each Addendum])* for **Contract No.: 2019-T-155 (RN19-55) Replacements of Montrose Road Culverts (Structure No.098310 and 098315)** (the "Tender");

AND WHEREAS on **(enter date of Contractor's proposal)** the Contractor submitted a bid in response to the Tender (the "Bid");

AND WHEREAS the Region wishes to enter into an agreement with the Contractor for the services, as more particularly described in the Tender and the Bid, attached hereto as Schedule "A" and forming part of this Agreement (the "Services");

NOW THEREFORE THIS AGREEMENT WITNESSETH that in consideration of the premises and other good and valuable consideration, the sufficiency whereof is acknowledged hereby by the parties, the parties hereto agree with each other as follows:

1. The Contractor shall provide the Services pursuant to all the terms and specifications set out in Schedule "A". If there should be any conflict between the provisions of this Agreement and the provisions of Schedule "A", the provisions of this Agreement shall prevail.

2. The term of this Agreement shall commence _____.

3. The Region shall pay the Contractor for Services as outlined in Schedule "A".

4. If either party, acting reasonably, determines that the other party has failed to perform its obligations pursuant to this Agreement, then such party may terminate this Agreement upon giving at least thirty (30) days' written notice to the other party.

5. The Contractor shall indemnify and save harmless the Region, its elected officials, officers, employees and agents from and against any and all claims of any nature, actions, causes of action, losses, expenses, fines, costs (including legal costs), interest, or damages of every nature and kind whatsoever arising out of the negligence, errors, omissions, fraud or willful misconduct of the Contractor its officers, employees, agents and subcontractors, or any of them, attributable to or connected with the performance, non-performance or purported performance of the Contractor obligations pursuant to this Agreement, except to the extent that same is attributable or caused by the negligence of the Region, its officers, employees and agents, or any of them. Further, this indemnity shall survive the expiration or early termination of this Agreement and continue in full force and effect.

6. This Agreement together with its schedule constitutes the entire understanding between the parties. Any change, addition to, or waiver of the terms hereof must be specifically agreed upon, in writing, and signed by both parties. Failure on the part of either party to insist upon the strict observance of any of the terms and/or conditions herein shall not operate as a waiver of such party's right to require the future observance of any such terms or conditions.

7. This Agreement shall not be assigned, in whole or in part, by either party hereto without the prior written consent of the other party. This Agreement, all its covenants, promises and conditions shall ensure to the benefit of and be binding upon the parties hereto and their respective permitted successors and assigns.

8. Either party may terminate this Agreement at any time, without notice, for just cause which shall include, without limitation, dishonesty, fraud, willful deceit or failure to properly fulfill the obligations hereunder where such failure is not remedied within ten (10) days after notice of same is given.

9. This Agreement shall be construed and interpreted in accordance with the laws of the Province of Ontario, Canada.

IN WITNESS WHEREOF the parties hereto have duly executed this Agreement.

(CONTRACTOR NAME)

Per: _____
Name:
Position:

Per: _____
Name:
Position:
I/We have authority to bind the Corporation.

THE REGIONAL MUNICIPALITY OF NIAGARA

Per: _____
Name:
Position:

Per: _____
Name:
Position:
I/We have authority to bind the Corporation.

SPECIAL PROVISIONS - GENERAL

(Refer to Niagara Peninsula Standard Contract Documents)

SPECIAL PROVISION - CONTRACT ITEMS

(Refer to Niagara Peninsula Standard Contract Documents)

SPECIAL PROVISIONS - SUPPLEMENTARY SPECIAL PROVISIONS

Contract No: 2019-T-155 (RN19-55)

Montrose Road Culvert Replacements

Structure Numbers: 098310, 098315

SUPPLEMENTARY SPECIAL PROVISIONS

Contract No: 2019-T-155 (RN19-55)

Montrose Road Culvert Replacements

Structure Numbers: 098310, 098315

Special Provisions

Supplementary Special Provisions

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SSP-3	Construction Schedule – Items 1-3 & 2-3	4
SSP-4	Waterway Protection and Dewatering – Items 1-4 & 2-4	6
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SSP-6	Light Duty Silt Fence Barrier – Items 1-6 & 2-6	8
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SSP-8	Construction Signs, Traffic Control, and Traffic Management Plan – Items 1-8 & 2-8	9
SSP-9	Removal of Asphalt Pavement – Items 1-9 & 2-9	12
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SSP-14	Concrete in Distribution Slab and Headwalls – Items 1-14, 2-14	30
SSP-15	Glass Fibre Reinforced Polymer (GFRP) Bars – Items 1-15, 2-15	30
SSP-16	Dowels into Concrete – Items 1-16, 2-16	30
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SSP-20	19mm Clear Stone, Type II – Items 1-20, 2-20	32
SSP-21	Geotextile – Items 1-21, 2-21	32
SSP-22	Rip-Rap – Items 1-22, 2-22	33
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SSP-26	Re-Grading Ditches and Swales – Items 1-26, 2-26	34

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SSP-28 Topsoil, Seed and Erosion Control Blanket – Items 1-28, 2-28 35
SSP-29 Steel Beam Guide Rail and Posts – Items 1-29, 2-29 35
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SSP-31 Utility Allowance (Cogeco) – Items 1-30, 2-31 36
SSP-32 Utility Allowance (Enbridge) – Item 1-31 37
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Contract No: 2019-T-155 (RN19-55)

Montrose Road Culvert Replacements

Structure Numbers: 098310, 098315

Special Provisions

Supplementary Special Provisions

SSP-1 Mobilization and Demobilization – Items 1-1 & 2-1

The work of this item shall include:

- Allowance for insurance/bonding related expenses.
- Mobilization of plant and materials including contractor site offices, etc.
- Site preparation before removals.
- Miscellaneous expenses during mobilization and demobilisation.
- Removal of any existing signs in the work area and reinstatement upon completion of the work.
- Provide and maintain access to private driveways and adjacent roadways during the extent of the contract.
- Site restoration after completion of work.

This roadway shall be closed to all through vehicular traffic until the new structure is ready to be opened to traffic.

The Contractor shall reinstate the boulevard, grassed areas, road shoulder, road surfaces, ditches, and driveway entrances along the alignment of the proposed work. Where specific reference is omitted, then it shall be understood that as a minimum, reinstatement must be equal to the existing conditions prevailing prior to commencement of construction. Topsoil, seed and mulch should be used to reinstate existing grassed areas. The contractor shall be responsible for repairs to damaged asphalt beyond the match lines on the contract drawings.

All areas requiring reinstatement outside of the limits of work shown or described on the contract drawings shall be reinstated by the Contractor at no cost to the Owner, unless specifically agreed to by the Contract Administrator.

The Contractor shall identify, salvage and reinstate any roadside signs within the Construction area as required.

The Contractor will be allowed to invoice sixty-per-cent of the lump sum price once the Contractor's plant has been mobilized. The remaining balance will be paid once the traffic barriers have been removed and the bridge is opened to traffic.

SSP-2 Construction Layout – Items 1-2 & 2-2

The Contractor is responsible for Construction Layout. The owner will not supply CAD drawings for construction layout, the contractor shall use provided contract drawings.

All of the layout must be done referencing the working points and elevations as shown on the Contract drawings.

Payment at the Contract price for the above tender item shall be full compensation for all labour, equipment and material to do the work

SSP-3 Construction Schedule – Items 1-3 & 2-3

The Contractor shall provide to the Corporation, before work commences, a detailed Construction Schedule listing work items and the proposed progression of work.

'Milestone Dates' for the completion of each scheduled work item shall be clearly indicated. The Construction Schedule shall indicate the critical path, and critical tasks shall be uniquely distinguished from other tasks.

The work of this item shall include the following:

Stage 1 (Structure No. 098315):

- The closure of Montrose Road at structure No. 098315 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.
- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098310 shall remain open.

Stage 2 (Structure No. 098310):

- The closure of Montrose Road at structure No. 098310 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.
- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098315 shall remain open.

The Construction Schedule shall be in the form of a bar chart indicating the starting date and completion date of work items.

The Contractor shall inform emergency services, transit, bus companies, waste collection, etc. of the schedule of road closures.

The following items shall be included in the Construction Schedule where applicable:

- Mobilization
- Utility locates and coordination with utility providers.
- Installation and removal of silt control devices and dewatering systems.
- Removal of asphalt

- Excavation.
- Removal of existing structure.
- Supply and installation of precast concrete apron walls.
- Supply and installation of precast concrete box culvert units.
- Supply and installation of Dura-Hold 2 retaining walls.
- Place concrete in distribution slab and headwalls.
- Backfilling and grading.
- Rip-rap / river stone.
- Asphalt paving.
- Supply and installation of steel beam guide rail.
- Site restoration.
- Demobilization

The Construction Schedule shall be updated by the Contractor on a monthly basis, or as requested by the Contract Administrator. The Owner shall be advised of any changes that are required and the reasons for the proposed changes.

The Contractor shall organize his activities to minimize the length of time the roadway is closed to traffic.

All in water work, including excavation and backfilling to the high waterline, supply and installation of the precast concrete apron walls, supply and installation of the precast concrete box culvert units, and any other in water work requiring dewatering or temporary diversion of the stream may not be completed between March 1, 2019 to July 1, 2019, in accordance with the restrictions governed by the Niagara Peninsula Conservation Authority and the Ministry of Natural Resources.

All construction work is to be completed and the roadway is to be opened to vehicular and pedestrian traffic by Friday September 27th, 2019.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

The Contractor will be allowed to invoice fifty-per-cent of the lump sum price Contract price once the Construction Schedule is submitted. The remaining balance will be paid once the traffic barriers have been removed and the culvert is opened to traffic.

SSP-4 Waterway Protection and Dewatering – Items 1-4 & 2-4

The provisions of Niagara Peninsula Standard Contract Documents, Special Provision Contract Item A7 shall apply except as amended or extended herein, for the duration of the contract.

The work of this item shall include:

- Design, installation, maintenance and removal of dewatering dams, rip-rap splash pads and sediment ponds/filter bags.
- Design, supply, installation, maintenance and removal of dewatering equipment including pumps and/or bypass culverts.
- The installation, maintenance and removal of a waterway protection system to prevent and isolate surface run-off from entering the work site.
- The installation, maintenance and removal of straw bale flow check dams as per OPSD 219.180 or approved equal.
- The installation, maintenance and removal of light duty silt fence barrier as per OPSD 219.110 are required.
- Compliance with Niagara Peninsula Conservation Authority (NPCA), DFO, MNRF, and the following Waterway Protection Special Provision.

The Contractor shall make allowance for multiple sediment control and dewatering layouts as necessary to accommodate the construction of the new structure, and new retaining wall.

The Contractor shall make allowance for waterway protection and dewatering during storm events during construction.

The Contractor's Waterway Protection and Dewatering installations shall be sufficient to permit the completion of the work in the dry.

<u>Watercourse/Fisheries Protection - General</u>

At all times, the Contractor's operations shall be controlled so as to prevent the entry of deleterious materials to watercourse. Controls shall include, but not be restricted to, the following:

a) Erosion and sedimentation control, and protection of the environmentally sensitive area, shall be in compliance with requirements specified in the Contract.

b) Watercourses shall not be diverted, or blocked, and temporary watercourse crossings shall not be constructed or utilized, unless otherwise specified in the Contract.

c) Construction material, excess material, construction debris, and empty containers shall be stored away from watercourses and watercourse banks.

d) All equipment maintenance and refuelling shall be controlled so as to prevent any discharge of petroleum products. Vehicular maintenance and refuelling shall be conducted away from watercourses and watercourse banks.

During closure of the permanent watercourse channel or the temporary water passage system, the Contractor shall release any stranded fish to the open portion of the watercourse without harm.

Erosion and Sedimentation Control - General

Silt control devices shall be constructed before the commencement of any related cut or fill.
The time interval between commencement and completion of any work that disturbs earth surfaces shall be a maximum of 20 calendar days. Commencement of such work shall be considered to have occurred when the original stabilizing ground cover has been removed, including grubbing, or has been covered with fill material. Completion of such work shall be considered to have occurred when the specified cover material (seed and mulch, seed and erosion control blanket, sod, rip rap etc.) has been applied.

Unless otherwise specified, the period in which the time interval is permitted shall be determined by the Contract Administrator.

Run-off from construction materials and any stockpiles shall be contained and discharged so as to prevent entry of sediment to the watercourse.

A 20 m stand-by supply of prefabricated silt fence barrier shall be maintained at the Contract site prior to commencement of grading operations and throughout the duration of the contract.

Operation of Contractors equipment shall:

- be kept to the minimum necessary to perform the specified work.
- comply with operational constraints specified in the Contract.
- proceed in a continuous fashion so as to minimise the duration of work.
- In addition, the Contractor shall take measures and provide such protection system or systems to ensure the following:
- water flow shall be isolated from the work area; and
- materials that result from the work or that are disturbed by the same, shall be prevented from entering the open portion of watercourses.
- The protection system or systems shall cover the following:
- all phases of work, and transitions between phases of the work.
- installation, operation, and removal of the protection system.
- interfaces between the permanent watercourses and temporary water passage systems;
- stabilisation of disturbed fill and earth materials, until treatment with the specified cover material (seed and cover, rip rap etc.)

The Contractor shall submit to the Contract Administrator a pdf copy of the notice a minimum of 14 calendar days prior to the date that permission is requested to proceed with this work. The notice shall be comprehensive, and shall provide descriptions, working drawings and schedules that detail the sequence of this work, and the provision of temporary water passage associated with each stage of same.

Permission to proceed with the above will be provided if the Contract Administrator determines that the details of the notice meet the requirements of this supplemental special provision. Whenever the proposals with which the Contractor was permitted to proceed with the work are found by the Contract Administrator to be ineffective, changes shall immediately be made so as to ensure watercourse/fisheries protection.

The Contractor will be allowed to invoice fifty-per-cent of the lump sum price once the waterway Protection systems are constructed and all protection measures are in place. The remaining balance will be paid once the waterway protection systems have been dismantled and all waterway protection measures are no longer required.

SSP 5 Fish Salvage and Transfer – Items 1-5 & 2-5

The work of this item shall include the following:

- Retaining a biologist or environmental technician qualified to collect and transfer fish, satisfactory to the Ministry of Natural Resources and Forestry.
- Obtaining a License to Collect Fish for Scientific Purpose from the Ministry of Natural Resources and Forestry.
- Performing fish salvage and transfer operations as required during the construction period.
- Identifying and reporting as per Ministry of Natural Resources and Forestry requirements.

After award of contract, the Contractor shall apply for and obtain a License to Collect Fish for Scientific Purpose. A copy of the application shall be submitted to the Contract Administrator. No on-site work shall commence until the permit has been issued by the Ministry of Natural Resources and Forestry, and a copy is received by the Contract Administrator.

Basis of Payment

Payment at the lump sum price bid for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-6 Light Duty Silt Fence Barrier – Items 1-6 & 2-6

The work under this item shall include the supply, installation, maintenance, and removal of a Light Duty Silt Fence Barrier, as per OPSD 219.110, and Straw Bale Flow Check Dams as per OPSD 219.180, at the following locations:

- Around the ends of the creek at extents of construction.
- Across ditches entering the construction area.
- As required to prevent muddy water, silt or debris from entering the river.

All as shown on the contract drawings and as per OPSD 219.110.

Payment at the Unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-7 Clearing and Grubbing – Items 1-7 & 2-7

All bushes small trees, stumps and brush within the road alignment and new structure construction alignment, including the channel working area, are to be cleared and grubbed.

All removed materials become the property of the Contractor and from thereon, he/she has full responsibility and liability to arrange for its removal and disposal outside the area of work at his own expense. The Contractor must obtain all necessary approvals from various government agencies including, but not limited to, the Niagara Peninsula Conservation Authority, The Ministry of the Environment and the Ministry of Natural Resources.

When hauling rubble, excavated materials or fill from or to the site, the Contractor shall comply with the requirements of the Highway Traffic Act.

The Contractor must provide the Contract Administrator with written authorization for use of any private disposal site, including description of the key terms and condition of the authorization.

Special Provision A5 is amended as follows:

DELETE

Measurement for payment shall be as per OPSS 201.09.01.01.02

and ADD

Basis of Payment:

Payment at the lump sum Contract price for the above tender item shall be full compensation for all labour, equipment and material to do the work.

SSP-8 Construction Signs, Traffic Control, and Traffic Management Plan – Items 1-8 & 2-8

The provisions of Niagara Peninsula Standard Contract Document, Special Provision Contract Item A8 shall apply except as amended or extended herein.

The work of this item shall include the following:

<u>Stage 1 (Structure No. 098315):</u>

- The closure of Montrose Road at structure No. 098315 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.
- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098310 shall remain open.

<u>Stage 2 (Structure No. 098310):</u>

- The closure of Montrose Road at structure No. 098310 to pedestrian and vehicular traffic at the structure throughout the duration of the culvert replacement.

- Access to all businesses and residences to be maintained at all times. The roadway over structure No. 098315 shall remain open.

General:

- Contractor shall be responsible for supply and maintenance of the required signage for all detour routes.
- The detour shall only be on Regional roads.
- The detour shall follow the following Regional roads: RR98 – RR25 – RR84 – RR27
- Contractor shall supply a pdf copy of proposed detour route signage prior to construction for review by the Owner.

Access Closures are to be scheduled at least 2 business days in advance between the Contractor and the business owner or residents and approved by the Contract Administrator and/or construction inspector.

Traffic Control & Traffic Plan

The Contractor shall be responsible for the preparation of a traffic management and control plan, to be provided to the Contractor Administrator for review and comment within seven (7) days of contract award. The review of the traffic control plan shall be completed by the Owner prior to the authorisation to proceed with construction.

The plan shall be updated and submitted to the Contract Administrator at each site meeting (every two [2] weeks) and shall incorporate any comments made at these meetings.

Signage

The contractor shall supply, locate, erect, operate, maintain, relocate as necessary and remove traffic control measures as required for complete control of both pedestrians and vehicular traffic, including:

- Advanced road closure signs,
- Construction signs,
- Information signs,
- Detour signage,
- Competent flag persons,
- Traffic barrels (TC-54's),
- Delineators,
- Barricades,
- Flashing lights,
- Installation, maintenance and removal (if required) of all ground mounted signs
- Any other installations deemed necessary for safe traffic control.

The Contractor shall organize construction activities to minimize all temporary traffic control operations.

The Contractor shall be responsible for signing and barricading the actual work site from public vehicular and pedestrian traffic. Fencing, gates, and other enclosures shall be supplied, placed and maintained by the Contractor, surrounding the extents of the project.

The barricades shall be sufficient to protect the public and to safely prevent entry into the work site by vehicular and pedestrian traffic at all times.

All temporary traffic control signs, barriers, flagging, delineators, etc. shall be in accordance with OPSS MUNI 706 and the Ministry of Transportation (MTO) Ontario Traffic Manual – Temporary Conditions (2014) or latest edition thereof.
The Contractor is responsible for daily maintenance of all signs, and information signage throughout the contract.

The Contractor shall be responsible for supplying any necessary safety and/or protective equipment, including crash trucks, required to perform the work safely.

During construction, special consideration shall be given to the safety of pedestrian traffic. This shall include but not be limited to signs/directions to alternate routes around construction zones. Such alternate routes shall be maintained at all times to ensure unobstructed and safe movement of pedestrian traffic.

Communications

The Contractor shall advise the local Police Department, Fire Department and Ambulance Service Headquarters, with current status of the road construction as it pertains to the passage of traffic within the contract limits.

The Contractor shall co-ordinate the closing and opening the lanes or roadway with the Owner. The Contractor shall provide weekly reports of closures to the Contract Administrator.

Basis of Payment

The cost for all the requirements noted above shall be deemed to have been included in the appropriate unit or lump sum prices and no additional payments will be made.

Payment at the lump sum price for this item shall be full compensation for all labour, equipment and materials necessary to complete the work. The Contractor will be allowed to invoice fifty-per-cent of the lump sum price upon initial supply of the construction signs. The balance will be pro-rated over the remainder of the working period.

SSP-9 Removal of Asphalt Pavement – Items 1-9 & 2-9

The work of this item shall include the full depth removal and disposal off site of the existing asphalt pavement and/or surface treatment on the approaches to areas outlined on the drawings.

ITEM 1-8, STRUCTURE No. 098310 – Montrose Road Culvert

- Boreholes drilled at the site found the asphalt thickness to range from 165mm to 180mm (as per the Geotechnical Investigation included at the end of this Contract Document).

ITEM 2-8, STRUCTURE No. 098315 – Montrose Road Culvert

- Boreholes drilled at the site found the asphalt thickness to range from 150mm to 160mm (as per the Geotechnical Investigation included at the end of this Contract Document).

The asphalt thicknesses encountered during the geotechnical investigation were at specific site locations. The Contractor shall make an allowance for thicker or thinner asphalt throughout the site. No additional payment will be made for various asphalt thicknesses. The existing sand, gravel, and fill materials below the asphalt shall be paid under the excavation and grading item.

Payment at the unit bid price shall be payment in full for all labour, equipment, and materials necessary to complete the work.

SSP-10 Removal of Existing Culvert – Items 1-10 & 2-10

The work of this item shall include the complete removal and disposal off site of the following:

- Existing reinforced concrete culvert.
- Existing reinforced concrete and/or stone foundations.
- Existing reinforced concrete and/or stone buried headwalls or wingwalls.
- Removal and salvage of the existing bridge identification plaques.

This item shall also include supplying, erecting, maintaining and removing any temporary supporting structures that may be required during the work.

All removed materials become the property of the Contractor and from thereon, he/she has full responsibility and liability to arrange for its removal and disposal outside the area of work at his/her own expense. The Contractor must obtain all necessary approvals from various government agencies including, but not limited to, the Niagara Peninsula Conservation Authority, the Ministry of the Environment and Climate Change, the Ministry of Natural Resources and Forestry and the DFO.

When hauling rubble, excavated materials or fill from or to the site, the Contractor shall comply with the requirements of the Highway Traffic Act.

The Contractor must provide the Contract Administrator with written authorization for use of any private disposal site, including description of the key terms and condition of the authorization.

Payment at the lump sum Contract price for this item shall be full compensation for all labour, equipment, material, and disposal necessary to complete the work.

SSP-11 Excavation and Grading – Items 1-11 & 2-11

This item shall include all excavation and grading of materials for the following:

- Removal of existing structure;
- Local removal of organic or other non-suitable soils as directed by the Contract Administrator;
- Granular foundations
- Installation of new precast concrete apron walls;
- Installation of new precast concrete box culvert units;
- Precast concrete retaining walls;
- Rip-Rap / river stone;
- Subdrains;
- Frost tapers;
- Roadway approaches;
- Embankment slopes.
- Utilities.

All as shown on the Contract Drawings.

Materials excavated under this item which are surplus to or unsuitable for the fill requirements shall be disposed of offsite by the Contractor at an approved land fill site. The Contractor must provide the Contract Administrator with written authorization for use of any private disposal site, including description of the key terms and conditions of the authorization. All to be in accordance with the Owner's site alteration by-law.

Local excavation of organic or other non-suitable soils shall be as directed by the Soils Engineer and the Contract Administrator. No granular materials shall be placed on the sub-grade until the sub-grade has been checked and approved by the Soils Engineer and Contract Administrator.

The Contractor shall note that the extents of the earth excavation are below the water table. The Contractor shall ensure that the excavations are kept dry and make the necessary arrangements for installing pumps and discharge points, if necessary.

Appendix 902-B, November, 2010 *is* invoked by the Owner for the work under this item.

Payment at the unit price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-12 Dura Hold 2 Retaining Wall System – Items 1-12 & 2-12

The work covered by this section includes the furnishing of all labour, materials, equipment and incidentals for the design, supply and construction of a modular concrete retaining wall including drainage system and reinforcement as shown on the Construction Drawings and as described by the Contract Specifications. The work included in this section consists of, but is not limited, to the following:

- Design and Geotechnical Review of Design by a registered Professional Engineer.
- Core drill through Dura Hold 2 wall for subdrain outlet at northeast corner.
- Furnishing and placement of geotextiles.
- Furnishing and placement of segmental retaining wall facing units.
- Furnishing and placement of geosynthetic reinforcement.
- Furnishing and compaction of infill, drainage and retained soils.
- Furnishing of final grading to ensure water is directed away from the wall.

REFERENCE STANDARDS

Engineering Design

- NCMA Design Manual for Segmental Retaining Walls, Second Edition.
- NCMA TEK 2-4 – Specifications for Segmental Retaining Wall Units.
- NCMA SRWU-1 – Determination of Connection Strength between Geosynthetics and Segmental Concrete Units.
- NCMA SRWU-2 – Determination of Shear Strength between Segmental Concrete Units.

Segmental Retaining Wall Units

- ASTM C 140 – Sampling and Testing Concrete Masonry Units
- ASTM C 1262 – Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units.
- ASTM C 33 – Specification for Concrete Aggregates
- ASTM C 90 – Standard Specification for Load-Bearing Concrete Masonry Units
- ASTM C 150 – Specification for Portland Cement
- ASTM C 595 – Specification for Blended Hydraulic Cements

Geotextile Filter

- ASTM D 4751 – Standard Test Method for Apparent Opening Size

Geosynthetic Reinforcement (Applicable for structures designed with geogrid reinforcement)

- ASTM D 4595 – Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

- ASTM D 5262 – Test Method for Evaluating the Unconfined Creep Behaviour of Geosynthetics.
- GRI GG-1: Single Rib Geogrid Tensile Strength
- GRI GG-5: Geogrid Pullout
- GRI GT-6: Geotextile Pullout

Soils

- ASTM D 698 – Moisture Density Relationship for Soils, Standard Method
- ASTM D 422 – Gradation of Soils
- ASTM D 424 – Atterberg Limits of Soils
- ASTM D G51 – Soil pH

Drainage Pipe

- ASTM D 3034 – Specification for Polyvinyl Chloride (PVC) Plastic Pipe
- ASTM D 1248 – Specification for Corrugated Plastic Pipe

Where specifications and reference documents conflict, the Owner or Owner's Representative shall make the final determination of applicable document.

Approved Products

- Durahold2 Segmental Retaining Wall System as supplied by the Risi Stone Systems Authorized Manufacturer.
- Colour and finish shall be as directed by the Owner or as shown in the Drawings

The Contractor

- The term Contractor shall refer to the individual or firm who will be installing the retaining wall.
- The Contractor must have the necessary experience for the project and have successfully completed projects of similar scope and size.

Delivery, Material Handling and Storage

- The installing Contractor shall check all materials delivered to the site to ensure that the correct materials have been received and are in good condition and meet the required dimensional tolerances.
- The Contractor shall store and handle all materials in accordance with manufacturer’s recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, breaking, chipping or other causes.

Design

- The term Wall Design Engineer refers to the Individual or Firm that has been retained by the contractor to provide the Retaining Wall Design for each section of wall in accordance with Design Section of this specification.

Submittals

The Contractor shall submit the following information for approval within the time frame set out in the contract, prior to the construction of the segmental retaining wall:

- Design Submittal – Provide stamped construction drawings and specifications completed and sealed by the Wall Design Engineer in accordance with the design requirements outlined in Part 3 of this specification.
- Materials Submittal – Manufacturer's certifications, stating that the SRW units, the geosynthetic reinforcement if applicable and imported aggregates and soils meet the requirements of this specification and the Engineer's design.
- Installer Qualifications – The Contractor must be able to demonstrate that their field construction supervisor has the necessary experience for the project by providing documentation showing that they have successfully completed projects of similar scope and size.

Measurement for Payment

- Payment for earthworks and retaining wall system will be in accordance with the contract documents or this specification, if it has been included in the contract documents by the Project Administrator.
- Payment for earthworks to prepare the site for the retaining wall construction will be based on the contract lump sum price for site cut and fill earthwork as detailed in the Contract Drawings. Additional earthwork as directed and approved in writing by the Owner, or Owner's representative, shall be paid for under a separate pay item.
- Payment for the retaining wall system will be paid for in lump sum. The contract lump sum price shall include the cost of all engineering (design), labour, materials, and equipment used to install the wall modules, drainage materials, infill soil, geosynthetic reinforcement, retained soil and site clean-up.

MATERIALS

Definitions

- Modular concrete retaining wall units are dry-cast solid concrete units that form the external facia of a modular unit retaining wall system.
- Coping units are the last course of concrete units used to finish the top of the wall.
- Infill soil is specified material that is placed directly behind the drainage soil and within the reinforced zone, if applicable.
- Retained soil is an in-situ soil or a specified soil that is placed behind the wall infill soil (beyond the geogrid reinforced zone).

- Foundation soil is the in-situ soil beneath the wall structure
- Drainage aggregate is a free draining soil with natural soil filtering capabilities, or a free draining soil encapsulated in a suitable geotextile, or a combination of free draining soil and perforated pipe all wrapped in a geotextile, placed directly behind the modular concrete units. If the design specifies that the entire infill zone (geogrid zone) is to be well graded, gravel material with a maximum of 8% fines, a separate drainage layer may not be required (refer to design drawings).
- Drainage pipe is a perforated polyethylene pipe used to carry water, collected at the base of a soil retaining wall, to outlets in order to prevent pore water pressures from building up behind the wall facing modules.
- Non-woven geotextiles are permeable synthetic fabrics formed from a random arrangement of fibres in a planar structure. They allow the passage of water from one soil medium to another while preventing the migration of fine particles that might clog a drainage medium.
- Geogrid reinforcement is a polymer grid structure having tensile strength and durability properties that are suitable for soil reinforcement applications.
- All values stated in metric units shall be considered as accurate. Values in parenthesis stated in imperial units are the nominal equivalents.

Products

Concrete Segmental Retaining Wall Units will be the following as specified in the design:

- The concrete wall modules shall be 305 x 1830 x 355 mm (12 x 72 x 14 inches) with a maximum tolerance of plus or minus 3 mm (1/8 in.) for each dimension
- The retaining wall modules shall be solid units and have a minimum weight of 395kg (870 lbs.) per unit.
- The concrete wall modules shall have a minimum 28-day compressive strength of 35 MPa (5000 psi) as tested in accordance with ASTM C 140. The concrete shall have a maximum moisture absorption rate of 5 percent to ensure adequate freeze-thaw protection.
- The concrete wall modules shall have a integral shear key connection that shall be offset to permit a minimum wall batter of 1H : 8V. A vertical alignment is possible if specified in the design. Vertical alignment is achieved by rotating every second course 180 degrees. A slight negative batter (as specified in the design) must be constructed into the gravel base when aligning the blocks vertically to account for minor forward movement of the wall during and following construction.
- The concrete wall modules shall have a minimum 28-day compressive strength of 35 MPa (5000 psi) as tested in accordance with ASTM C 140. The concrete shall have a maximum moisture absorption rate of 5 percent to ensure adequate freeze-thaw protection.

Infill Soil

The infill soil shall consist of free draining Granular ‘B’ – Type II material as specified in the Construction Drawings and as per OPSS 902.

Following construction, final grading must be established immediately to ensure the backfill zone is protected from water infiltration.

Foundation Soil

- The foundation soil shall be the native undisturbed on site soils with an allowable bearing capacity as specified on the construction drawing. The foundation soil shall be examined and approval by a Geotechnical Engineer retained by the Owner prior to the placement of the base material. The Foundation zone encompasses the area beneath the wall facia and the geogrid reinforced zone (entire footprint of wall). In the case where unsuitable founding soil exists, removal and replacement of the foundation soil must be conducted under the direction of the Geotechnical Engineer. The foundation zone extends out in front and behind the wall footprint at a 1H:1V line to the required depth, or as determined by the Geotechnical Engineer.

Levelling Base Material

- The footing material shall be non-frost susceptible, well graded compacted crushed stone (Granular 'A'), or a concrete levelling base, or as shown on the Construction Drawings.

Subdrain

- The subdrain shall be perforated corrugated HDPE or PVC pipe, with a minimum diameter of 150 mm (6 inches), protected by a geotextile filter to prevent the migration of soil particles into the pipe, or as specified on the construction drawings.

Geotextile Filter

- The non-woven geotextile shall be installed as specified on the construction drawings. Although selection of the appropriate geotextile specifications is site soil specific, a commonly used geotextile for filtration will have an Apparent Opening Size ranging between 0.149 and 0.212 mm (U.S. Sieve Sizes 100 to 70) and a minimum unit weight of 135 grams per square meter (5.0 oz /square yard). The coefficient of permeability will typically range between 0.1 and 0.3 cm/second.

Geogrid Reinforcement (Applicable for structures designed with geogrid reinforcement)

- The Wall Design Engineer shall determine the type, strength and placement location of the reinforcing geosynthetic. The design properties of the reinforcement shall be determined according to the procedures outlined in this specification. If required, detailed test data shall be submitted with the design calculations and shall include tensile strength (ASTM D 4595 or GGI GG-1), creep potential (ASTM D 5262), site damage and durability (GRI GG-4) and pullout resistance (GRI GG-5 or GRI-GT-6) and connection strength (NCMA SRWU-The geosynthetic must be a polyester geogrid approved by Risi Stone Systems for use with the intended product. The Contractor must not substitute the geogrid specified in the design with another without the consent of the Wall Design Engineer.

Concrete Adhesive

- The adhesive is used to permanently secure the coping stone to the top course of the wall. The adhesive must provide sufficient strength and remain flexible.

WALL DESIGN

Design Standard

- The Wall Design Engineer is responsible for providing a design for each section of wall that shall consider the external stability, internal stability, and local stability of the SRW System.

- It is the responsibility of the Inspecting Geotechnical Engineer (IGE) to review the Wall Design to determine if further design considerations must be implemented to ensure adequate global/overall slope stability, and/or, if the foundation soils will require special treatment to control total and differential settlement. The design life of the structure shall be 75 years unless otherwise specified in the construction drawings.

- The segmental retaining wall shall be designed in accordance with recommendations of the NCMA Design Manual for Segmental Retaining Walls, Second Edition. The following is a summary of the minimum factors of safety for the various modes of failure evaluated in the proposed design.

External Stability	
Base Sliding	1.5
Overturning	2.0
Bearing Capacity	2.0
Global Stability	1.3
Internal Stability	
Tensile Overstress	1.0
Pullout	1.5
Internal Sliding	1.5
Local Stability	
Facing Shear	1.5
Connection	1.5

Soil

- Design parameters: The soil parameters assumed in the design shall be stated on the design drawings. If sufficient site soil information is unavailable at time of design, and typical, assumed soil design parameters are used for design purposes, the assumed parameters must be verified by the Inspecting Geotechnical Engineer upon further exploration or excavation of the site. If the design parameters are required to be modified, site specific design parameters shall be provided to the Wall Design Engineer by the IGE in a letter.

Design Geometry

- The length, height, and overall elevations of the retaining wall must comply with the requirements of the proposed elevation detail, station information and site grading plan.

- The structures' design height, H, shall be measured from the top of the levelling pad to the top of the wall where ground surface intercepts the wall facing.
- Slopes above and below all sections of the segmental retaining wall are detailed in the site grading plan.

- The minimum wall embedment shall be the greater of 1) the height of a SRW unit or 2) the minimum embedment required because of the slope below the wall. Increased embedment may be required due to erosion potential or global stability requirements.

Slope Below Wall	Minimum embedment
Level	H/10
3 : 1 (18.4 deg)	H/10
2 : 1 (26.5 deg)	H/7

- The following surcharges shall be applied to the top of each design cross section based on the following proposed uses above the wall.

Use Above Wall	Minimum Surcharge
No Traffic	0 kPa (0 lb/sq. ft)
Light Traffic	4.8 kPa (100 lb/sq. ft)
Heavy Traffic	12.0 kPa (250 lb/sq. ft)

State of Stress

- The lateral earth pressure to be resisted by the reinforcements at each reinforcement layer shall be calculated using the Coulomb coefficient of earth pressure, Ka, times the vertical stress at each reinforcement layer.

- The vertical soil stress at each reinforcement layer shall be taken equal to the unit weight of the soil times the depth to the reinforcement layer below the finished grade behind the facing units. A coefficient of active earth pressure, Ka, shall be used from the top to the bottom of the wall. The coefficient of active earth pressure, Ka, shall be assumed independent of all external loads except sloping fills. For sloping fills, the coefficient of active earth pressure, Ka, appropriate for the sloping condition, using Coulomb earth pressure shall be used in the analysis.

Inclination of Failure Surface

- A Coulomb failure surface passing through the base of the wall at the back of the reinforced zone up to the ground surface at or above the top of wall shall be assumed in design of walls.

Geosynthetic Reinforcement(Applicable for structures designed with geogrid reinforcement)

- The allowable reinforcement tension, Ta, shall be determined in accordance with the method outlined in the NCMA Design Manual for Segmental Retaining Walls, Second Edition. This method calculates the Long Term Design Strength (LTDS) of the geosynthetic reinforcement by considering the time-temperature creep characteristics of the reinforcement, environmental degradation, construction induced damage and an overall factor of safety.

Geogrid Length (as required on the construction drawing)

- The minimum soil reinforcement length shall be as required to achieve a minimum width of structure, B, measured from the front face of the wall to the end of the soil reinforcements. B must be greater than or equal to 60 percent of the total height, H. The length of the reinforcements at the top of the wall may be increased beyond the minimum length required to increase pullout resistance.

Settlement Control

- It is the responsibility of the Inspecting Geotechnical Engineer to determine if the foundation soils will require special treatment to control total and differential settlement.

Further Design Assumptions

- Design assumptions listed below must be verified during the review process by Civil Engineer and during construction by the Inspecting Geotechnical Engineer and General Review Engineer, where applicable, as noted in Section 4.0.

- The Wall Design assumes that surrounding structures will not exert any additional loading onto proposed wall (ie. An adjacent structural foundation is at or below proposed wall base or outside of a theoretical zone of influence as determined by the IGE). The Design also assumes that structures will remain structurally independent from proposed wall unless otherwise noted in the design.

- The Wall Design assumes that the maximum anticipated groundwater elevation is a minimum of 2/3 x H (height) below the base of the wall. The Inspecting Geotechnical Engineer (IGE) must confirm this prior to construction. If the maximum anticipated groundwater elevation exceeds this, additional blanket and/or chimney drains will be required. The IGE must contact the Wall Design Engineer in writing, detailing the anticipated conditions, in order that a redesign may be performed.

- The Wall Design assumes no hydrostatic pressure within or behind the wall. Therefore site water management is of extreme concern and is required both during construction of the wall and after completion of construction. it includes:

    a) Verification of the grading plan has been developed to route water away from the retaining wall location by the Civil Engineer.

b) Drain pipes are properly installed and vented to daylight at all times during construction.

c) Surface water is directed away from the wall. The Civil Engineer must be notified of the requirement for a swale by the Contractor. The design of the swale system behind the wall must be performed by the site Civil Engineer as part of the overall site drainage/grading plan based on anticipated surface water flows. This may require re-grading to accommodate the dimensions of the swale. Modifications to the grades may result in increased wall height(s).

d) Constant monitoring of the site for other sources of seepage at the excavation (i.e. irrigation pipes, fluctuations in groundwater, etc.).

e) The design has assumed that no utilities such as gas/water mains, storm sewers, hydro/communications cables, etc, are placed within the reinforced zone of the wall(s). The contractor must notify the Civil Engineer and the Wall Design Engineer if conflicts exist to discuss moving these elements or designing to accommodate them.

Global Stability Analysis

- A qualified Geotechnical Engineer (IGE) must be retained to review the Wall Design and site conditions for overall global stability prior to construction based on the actual site geometric, soil, and groundwater conditions known at the time. Further exploration of the geotechnical conditions may be required at the discretion of the IGE. This analysis, and the subsequent impact on the design (i.e, the results of the global stability analysis may require increased geogrid length, strength, and/or quantity, and/or increased wall embedment from that originally assumed in the wall design) must be relayed back to the Wall Design Engineer in order that the design revisions can be implemented.
- The Wall Design Engineer must be provided with a copy of the global stability analysis for review prior to construction

Required Design Review by Contract Administrator

- The following highlights the minimum review process that is required prior to construction.

- Contract Administrator – The Contract Administrator must be provided with a copy of the plans and specifications for the proposed wall(s) in order that they may review the wall design for general compatibility with the site, including the following specific elements:

  a) Surface drainage. The design requires that surface water be directed away from the retaining wall(s). If slopes behind the wall exist, a swale system will be required which must be included as part of the overall site drainage plan. If the inclusion of a swale was not considered in the original grading plan, the Civil Engineer must provide for this, including required dimensions based on the anticipated volume of water to be collected as well as any grading changes required to accommodate the swale (i.e. potential minor increases in wall height).

b) Drainage of other structures. The design requires that other structures such as pavements adjacent to the wall have independent drainage systems (perimeter drain) to ensure the wall drainage system is relied on to perform an outletting function for these other structures. Further to this, down spouts from buildings must be outletted away from the wall into other specified positive drains.

c) Outletting/connection of internal drainage system pipes. The Contract Administrator must provide direction as to the connection points or outletting of the wall(s) internal and external drainage system as part of the overall site drainage plan. This must be provided to the contractor in writing prior to construction.

d) Utilities beneath and adjacent to the retaining wall. The design does not allow utilities, unless otherwise specified, within the reinforced zone of the retaining wall. Furthermore, it is advisable to locate all utilities (catch basins, water lines, hydro, communications, etc) outside of the general wall area (assume a 1H:1V cut from the back of the reinforced zone) to allow future access to the utilities. Also, utilities existing or proposed to be located beneath or through (as in the case of a culvert pipe) the wall must be verified as capable of supporting the applied loads. The applied wall load is listed on the cross section drawing as the minimum allowable bearing capacity required to support the wall.

e) Other structures. Unless specifically provided for in the design, other structures such as buildings, light standards, fences, parking lots and roadways, signage, curbs and barriers, etc, that are within the area of the retaining wall must be highlighted to the Wall Design Engineer, as these must be taken into account in the design of the wall or provisions provided for in the design of the other structures to prevent additional loading on the proposed retaining wall (i.e. offsetting the structures or extending the depth of the foundations below the bottom of the wall).

f) Use of area above/around wall. The wall was designed for the loading specified in this drawing. This loading was chosen based on the site grading plan and assumed use. The design requires that the Civil Engineer verify that the assumed use is acceptable for the site. Also, it must be determined if the area above the wall will ever be used as a depot for the storage of other materials or equipment during or after construction or for snow ploughing in the winter. The wall has not been designed to bear the unknown weight of a snow storage area, nor has the drainage system been designed to accommodate the subsequent snow melt.

CONSTRUCTION

Inspection and Testing

The Owner will retain a Geotechnical Engineering company to inspect the construction of the wall, the foundation, and to perform testing of the backfill material.

Construction Tolerances

Installation of SRW face location shall be within all the following tolerances:

- Vertical Control from plan: +/- 1.25 inches over a 10 ft distance
- Horizontal Control from plan:
  a) Straight lines: +/- 1.25 inches over a 10 ft distance
- Rotation of the wall face during construction:
  a) Maximum 2.0 degrees from established wall plan batter
  b) Maximum, +/-10.0% from total established horizontal setback.
- Bulging:
  c) +/- 1.25 inch over a 10 ft distance

Site Preparation

- Comply with Federal, State/Provincial, and local requirements for execution of the work, including local building codes and current OHSA excavation regulations. Provide excavation support as required to maintain stability of the area during excavation and wall construction and to protect existing structures, utilities, landscape features, or property or improvements.

- Prior to grading or excavation of the site, confirm the location of the retaining walls and all underground features, including utility locations within the area of construction. Ensure surrounding structures are protected from effects of wall excavation.
- Coordinate installation of underground utilities with wall installation.

- Control surface water drainage and prevent inundation of the retaining wall area during construction.

- The foundation soil shall be excavated or filled as required to the grades and dimensions shown on the Construction Drawings or as directed by the Owner or Owner's Representative.

- The foundation soil shall be proof rolled and examined by the IGE to ensure that it meets the minimum strength requirements according to the design. If unacceptable foundation soil is encountered, the contractor shall excavate the affected areas and replace with suitable quality material under the direction of the Engineer.

- In cut situations, the native soil shall be excavated to the lines and grades shown on the Construction Drawings and removed from the site or stockpiled for reuse as retained soil if the design has allowed the use of this material.

Installing Drainage System

- If specified in the design, the approved geotextile shall be set against the back of the first retaining wall unit, over the prepared foundation, and extend towards the back of the excavation, up the excavation face and back over the top of the infill soil to the retaining wall, or as shown in the Construction Drawings.

- If specified in the design, the remaining length of geotextile shall be pulled taut and pinned over the face of the retained soil. Geotextile overlaps shall be a minimum of 300 mm (1 ft.) and shall be shingled down the face of the excavation in order to prevent the Infiltration of retained soil into the wall infill.

- The drainage collection pipe shall be placed under the direction of the Civil Engineer in accordance with the overall drainage plan for the site. The pipe shall be laid to maintain gravity flow of water from reinforced soil zone. Daylight drainage collection pipe at storm sewer manhole or along slope at an elevation lower than lowest point of pipe within reinforced soil mass, every 40 feet minimum.

- Main collection drain pipe just behind segmental units shall be minimum 100mm (4 inches) in diameter. Secondary collection drain pipe shall gravity flow independently or tie into main collection drain pipe with laterals at maximum 12m (40 feet) spacing along wall face.

- If other sources of water are discovered during excavation or anticipated, other drainage measures/systems such as chimney or blanket drains may be required. The IGE should contact Wall Design Engineer for recommendations.

Levelling Base or Spread Footing Placement

- The levelling base material shall be crushed stone compacted to 98% Standard Proctor Density, or vibrated concrete along the grades and dimensions shown on the Construction Drawings or as directed by the Engineer. The minimum thickness of the levelling base shall be shown on the Construction Drawings.

Installation of Modular Concrete Retaining Wall Units

- The bottom row of retaining wall modules shall be placed on the prepared levelling base as shown on the Construction Drawings. Care shall be taken to ensure that the wall modules are aligned properly, levelled from side to side and front to back and are in complete contact with the base material. The units shall be placed in the middle of the gravel base, with equal distance from the front and back of the base. The minimum base width is specified on the design drawings, generally extending at least 1 block height in front and behind the base course.

- The wall modules above the bottom course shall be placed such that the tongue and grove arrangement provides the design batter (i.e. setback) of the wall face. Successive courses shall be placed to create a running bond pattern with the edge of all units being approximately aligned with the middle of the unit in the course below it.
- The wall modules shall be swept clean before placing additional levels to ensure that no dirt, concrete or other foreign materials become lodged between successive lifts of the wall modules.
- **A maximum of 3 courses of wall units can be placed above the level of the infill soil at any time**.
- The contractor shall check the level of wall modules with each lift to ensure that no gaps are formed between successive lifts that may affect the pullout resistance of geogrid reinforcement, if applicable.
- Care shall be taken to ensure that the wall modules and geosynthetic reinforcement where applicable are not broken or damaged during handling and placement.

Drainage Soil (As required by Design)

- The drainage soil will be placed behind the retaining wall modules with a minimum width of 300 mm (1 ft.) and separated from other soils using the approved geotextile.
- Drainage soil shall be placed behind the wall facing in maximum lifts of 6 inches and compacted to a minimum density of 95% Standard Proctor.
- No heavy compaction equipment or paving equipment shall be allowed within 1 meter (3 ft.) of the back of the wall facia.

Infill Soil (As specified on the construction drawing)

- Wall infill soil shall be placed behind the first course of the wall facing units in maximum lifts of 150 mm (6 inches) and compacted to a minimum density of 95% Standard Proctor Maximum Dry Density(ASTM D 698) at a moisture content from 2% below to 2% above optimum. The fill shall be placed and compacted level with the top of the wall modules at the specified geogrid elevations prior to placing the geogrid reinforcement where applicable.
- Wall infill soil shall be placed on top of the geogrid reinforcement layers if applicable in maximum lifts of 150 mm (6 inches) and compacted to a minimum of 95% Standard Proctor Density. Care shall be taken to ensure that the geogrid lays flat and taut during placement of the infill soil. This is best achieved by placing fill on top of the geogrid near the wall facia and spreading toward the back of the infill soil zone.
- No tracked construction equipment shall be allowed to operate directly on top of the geogrid until a minimum thickness of 150 mm (6 inches) of fill has been placed. Rubber tired equipment may drive on top of the geogrid at slow speeds but should exercise care not to stop suddenly or make sharp turns. No heavy equipment shall be allowed within 1 meter (3 ft.) of the back of the wall.
- At the end of each day’s operation, slope the last lift of reinforced backfill away from the wall facing to rapidly direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

Geogrid Soil Reinforcement (Applicable for structures designed with geogrid reinforcement)

- Verify type and orientation (Roll direction) of geosynthetic reinforcement.
- Geogrid sections, pre-cut to meet the length required in the design drawings, shall be placed horizontally at the specified elevations and with longitudinal axis perpendicular to the wall face (i.e. machine direction), at the elevations shown on the Construction Drawings. The pre-cut sections of geogrid are to be placed immediately adjacent to one another, without overlapping and without gaps between them. Ensure the strong (machine) direction of the geogrid is placed perpendicular with the wall facing. **Do not** roll geogrid out along the length of the wall (parallel).
- The geogrid shall be placed over the compacted infill soil and the wall facing units with the outside edge extending over the tongue of the bottom unit and to within 25 mm (1 in.) of the front facing unit. The compacted infill soil must be level with the back of the block to ensure the geogrid is placed horizontally, and that no voids exist under the geogrid as it extends out over the infill zone. Care shall be taken to ensure that the wall modules are swept clean and that the geogrid is in complete contact with the top and bottom faces of the adjacent wall modules. The next course of wall modules shall be carefully placed on top of the lower modules to ensure that no pieces of concrete are chipped off and become lodged between unit layers.
- With the geogrid secured in place, the geogrid shall be pulled taut away from the back the wall modules during placement of infill soil. Alternatively, suitable anchoring pins or staples can be used to ensure that there are no wrinkles or slackness prior to placement of the infill soil. The geogrid shall lay perfectly flat when pulled back perpendicular to the back of the wall facia.

Retained Soil

- Retained soils shall be placed and compacted behind the infill soil or drainage soil if applicable, in maximum lift thickness of 150 mm (6 inches). The retained soils shall be undisturbed native material or engineered fill compacted to a minimum density of 95% Standard Proctor.
- No heavy compaction equipment shall be allowed within 1 m (3 ft.) of the back of the wall modules.

Finishing Wall

- Coping units shall be secured to the top of the wall with two 10 mm (3/8 inch) beads of the approved flexible concrete adhesive positioned 50mm (2 inches) in front and behind the tongue of the last course of retaining wall units.
- Finish grading above the wall to direct surface run off water away from the segmental retaining wall. A swale system must be implemented above the wall if the grade slopes toward the back of the wall. The dimensions of the swale are dependent on the anticipated water flow and must be determined by the Civil Engineer responsible for site drainage. Use a soil with a low permeability to restrict the rate of water infiltration into the retaining wall structure. The low permeability material used to cap off the top of the wall shall be between 200mm (8”) and 300mm (12”) in thickness, unless the designed requires otherwise.

- Upon completion of the wall(s), additional structures (fences, handrails, vehicular guardrails, buildings, pools/ponds, etc) or changes to grading/loading (increased wall height beyond that shown in the design, slopes, parking areas, changes in proximity to water flow, etc), other than those shown in the construction design, can not be installed/implemented without the review and consent of the Wall Design Engineer.
- If the Contractor is not responsible to complete final landscaping above or around the wall, they must ensure that whoever is doing it is made away of the requirements with respect to final grading, allowable depth of topsoil, excavation behind the wall for planting, etc. The Contractor must not leave the wall unfinished without making those responsible for landscaping fully aware of the limitations and requirements of the Wall Design. This extends to handrails and fences, signs, or other appurtenances that may impact the wall performance. If paving is required behind the wall, the paving contractor must be notified of the limitations of the wall with respect to heavy compaction/paving equipment within 1.0m (3.0ft) of the back of the wall.

SSP-13 Supply and Installation of Precast Concrete Box Culvert – Items 1-13, 2-13

The work under this item shall include the following:

- Design, supply, and install the precast concrete box culvert units, including all manufacturing and delivery costs and associated hardware anchors and joint sealer, as required.
- Design, supply, and install the precast concrete apron walls, including all manufacturing and delivery costs and associated hardware anchors and joint sealer, as required.
- Supply and installation of 25M reinforcing steel bars to connect the precast box culvert units to the cut-off walls.

The box culverts at both structures shall be installed within the vicinity of the overhead hydro lines that cannot be de-energized or relocated. Therefore, as an alternative, the Contractor may elect to construct a portion of or the entire box culvert structures as cast-in-place reinforced concrete box culverts. The in-situ concrete shall match the dimensions shown on the Contract Drawings. In the alternative case, the work of this item shall include design, supply, and placing of 35MPa concrete and steel reinforcing.

Precast units shall be fabricated and installed in accordance with OPSS 422 and OPSS.MUNI 909 except as otherwise specified herein.

909.02 References: This specification shall follow the Municipal-oriented specifications.

909.05.03 Concrete: Concrete shall have at least a concrete compressive strength of 35MPa.

Section 909.07.15.01 Sampling for Quality Assurance – General is amended by the deletion of:

The specimens shall be delivered to the ministry’s regional quality assurance laboratory, as directed by the Contract Administrator.

And replaced with:

The specimens shall be delivered to the Contract Administrator upon request.

Section 909.07.15.04 Sampling of Steel Reinforcement is revised by the deletion of:

Samples shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

And replacement with:

Samples shall be delivered by the Contractor to the Contract Administrator, upon request.

The units are not to be prestressed.

The Contractor shall supply precast concrete box culvert units that match the interior dimensions shown on the contract drawings. The Contractor is responsible for any additional cost for the supply of custom precast box culvert units and the Contractor shall take into account manufacture and delivery times for custom units.

Alternatively, the Contractor may supply available precast box culvert units that are a similar size but slightly larger than the interior dimensions shown on the contract drawings. The Contractor will be responsible for the cost of all changes to the work due to any revision of the specified box culvert size, including but not limited to: engineering revisions, additional excavation, additional fill, additional concrete, revisions to reinforcing steel and dowel locations, utility relocation, etc.

Prequalification

The precast concrete culvert units shall be fabricated by a manufacturer certified in conformance to the “Prequalification Requirements for Manufacturers of Precast Concrete Drainage Products - May 1998", by the MTO/MEA/OCPA/OPS Prequalification Advisory Committee.

Units are to be designed in accordance with the CHBDC 2014 (CAN/CSA-S6-14) for highway loads.

Submission Requirements

Design and shop drawings including joint details and reinforcing, shall be submitted for all precast concrete box culvert sections. PDF drawings shall be submitted a minimum of 14 days before commencing fabrication. The proposals shall bear the seal and signature of a Professional Engineer who is licensed by the Association of Professional Engineers of Ontario.

Fabrication shall not proceed until the design and shop drawings have received the Engineers “Permission to Construct”, in writing.

All exposed lifting lugs shall be parged with cementitious grout. No materials suspect to corrosion, such as form chairs, wire ties or spacers shall be placed within the minimum concrete cover areas of the precast concrete culvert units.
All as shown on the contract drawings.

Payment at the lump sum Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-14 Concrete in Distribution Slab and Headwalls – Items 1-14, 2-14

The work of this item shall include:

- Supply and placing of 150mm minimum thickness concrete in distribution slab over the new precast concrete culvert.
- Supply and placing of concrete in headwalls at the ends of the new precast concrete culvert.
- Finish and cure concrete distribution slab and headwalls.

All as shown on the Contract Drawings.

Payment at the Contract price for the above tender item shall be full compensation for all labour, equipment and material to do the work.

SSP-15 Glass Fibre Reinforced Polymer (GFRP) Bars – Items 1-15, 2-15

The work of this item shall be in accordance with OPSS MUNI-950 and shall include the following:

- Supply and installation of GFRP reinforcing for concrete in distribution slab and headwalls.

All as shown on the Contract Drawings.
Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-16 Dowels into Concrete – Items 1-16, 2-16

The work of this item shall include the following:

- Drill and epoxy grout GFRP dowels into precast concrete box culvert units for distribution slab. Supply of the GFRP dowels shall be included under item “Glass Fibre Reinforced Polymer (GFRP) Bars”.

All as shown on the Contract Drawings.

Payment at the unit price bid shall be payment in full for all labour, equipment and materials necessary to complete the work.

SSP-17 Subdrains – Items 1-17, 2-17

The work in this item shall cover the supply and installation of 150 mm diameter perforated high density polyethylene ASTM Class 210 flexible pipe sub drains with filter wrap, including the following:

- 19mm Clear Crushed Stone wrapped in geotextile;
- Galvanized wire mesh (max. opening 6 mm) and filter fabric to cover the ends of the drains or similar rodent trap.

All as shown on the Contract Drawings and typical for all subdrains.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-18 Granular 'A' – Items 1-18, 2-18

The work of this item shall include supply and placing of Granular 'A' material in the following locations:

- 525mm minimum thickness, compacted to 100% SPMDD, below roadway asphalt
- Roadway side slope fill and grading for installation of steel beam guide rails;
- Roadway grading where asphalt was removed;
- Roadway grading in frost tapers.

All as shown on the Contract Drawings.

Appendix 902-B, November, 2010 *is* invoked by the Owner for the work under this item.

OPSS.MUNI 501.07.04.02 is amended by the deletion of:

The Contractor is responsible for establishing QC procedures.
And replacement with:
The Contract Administrator is responsible for establishing QC procedures in accordance with OPSS 501 TABLE 1 – Compaction Lot Size. The Contract Administrator will arrange for all compaction testing. The Contactor shall provide a minimum 24 hours notice that compaction testing is required.

OPSS.MUNI 501.07.04.03 Method B is deleted.
Payment at the unit price bid, shall be payment in full for all labour, equipment and materials necessary to complete the work.

SSP-19 Granular 'B' Type II – Items 1-19, 2-19

The work of this item shall include supply and placing of Granular 'B', Type II material in the following locations:

- Culvert backfill, compacted to 98% SPMDD.
- Dura Hold 2 Retaining Wall backfill compacted to 95% SPMDD.

Appendix 902-B, November, 2010 *is* invoked by the Owner for the work under this item.

OPSS.MUNI 501.07.04.02 is amended by the deletion of:

The Contractor is responsible for establishing QC procedures.

And replacement with:

The Contract Administrator is responsible for establishing QC procedures in accordance with OPSS 501 TABLE 1 – Compaction Lot Size. The Contract Administrator will arrange for all compaction testing. The Contactor shall provide a minimum 24 hours notice that compaction testing is required.

OPSS.MUNI 501.07.04.03 Method B is deleted.

All as shown on the Contract Drawings.

Payment at the unit price bid, shall be payment in full for all labour, equipment and materials necessary to complete the work.

SSP-20 19mm Clear Stone, Type II – Items 1-20, 2-20

The work of this item shall include supply and placing of 19mm Clear Stone, Type II material for the following locations:

- Below the new precast concrete box culvert, mechanically compacted during placement
- Below and around the new precast concrete apron walls, mechanically compacted during placement.
- Fill for areas excavated due to unsuitable material at the footing level.

All as shown on the contract drawings and as per OPSS.MUNI 1004.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-21 Geotextile – Items 1-21, 2-21

The work of this item shall include supplying and placing geotextile as follows:

- Class I Geotextile strips 0.6m wide along all exposed joints between the precast concrete box culvert units, positively attached to the concrete.
- Class I Geotextile strips 1.0m wide along joints between the precast concrete box culvert units and the Durahold 2 Retaining wall, positively attached to the concrete.
- Class II Geotextile underlying all rip-rap / river stone placed on grade.

All as shown on the Contract Drawings.

Payment at the unit price bid, shall be payment in full for all labour, equipment and materials necessary to complete the work.

SSP-22 Rip-Rap – Items 1-22, 2-22

The work of this item shall include supply and placing:

- R-50 rip-rap with a minimum thickness of 450mm in the creek bed, along the roadway/creek side slopes;

All as shown on the Contract documents.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-23 River Stone – Items 1-23, 2-23

The work of this item shall include supply and placing of one layer of river stone in the creek bed over the R-50 rip-rap.

The gradation of river stone shall match the gradation specified for R-10 rip-rap specified under OPSS 1004.

All as shown in the Contract Drawings.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-24 Waterproofing- Items 1-24, 2-24

The work of this item shall include supply and placing of a hot rubberised waterproofing membrane over the entire bridge deck.

The hot rubberised asphalt shall be laid down in two (2) coats. The reinforcing mesh is placed over the first coat and the second coat must completely cover the reinforcing mesh. The surface preparation, tack coat and asphalt membrane below and above the reinforcing mesh shall be in accordance with OPS 914.

Appendix 914-B, November, 2014 *is* invoked by the Owner for the work under this item.

All as shown in the Contract Drawings.

The unit price bid for this item shall include the surface preparation, tack coat, the second coat of asphalt membrane and protection board shall be paid for under the waterproofing item. The polyester fabric reinforcing mesh and one layer of asphalt membrane shall be paid under the Polyester Fabric Reinforcement item.
Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-25 Polyester Fabric Reinforcement – Items 1-25, 2-25

Under this item, the Contractor shall supply and install polyester fabric reinforcing mesh embedded in the rubberised asphalt bridge deck waterproofing membrane as reinforcement over the entire bridge deck.

The hot rubberised asphalt shall be laid down in two (2) coats. The reinforcing mesh is placed over the first coat and the second coat must completely cover the reinforcing mesh. The surface preparation, tack coat and asphalt membrane below and above the reinforcing mesh shall be in accordance with OPS 914.
The polyester fabric shall be Reemay spunbonded polyester Style 2017, as supplied by Hydrotech Membrane Corporation, 96 Main Street, Markham, Ontario (Tel: (905)-471-6677); or approved equal.

The polyester fabric shall be installed and lapped in accordance with the manufacturer's and/or supplier's application.

Minimum overlap at all fabric joints shall be 50 mm.

Measurement for payment shall be made in square metres of polyester fabric reinforcing mesh actually and acceptably installed as measured on site by the Contract Administrator with no allowance for overlaps and vertical turn ups.

The unit price bid for this item shall include the polyester fabric reinforcing mesh and one layer of asphalt membrane. The surface preparation, tack coat, the second coat of asphalt membrane and protection board shall be paid for under the waterproofing item.

Appendix 914-B, November, 2014 *is* invoked by the Owner for the work under this item.

Payment at the unit price bid, shall be payment in full for all labour, equipment and materials necessary to complete the work.

SSP-26 Re-Grading Ditches and Swales – Items 1-26, 2-26

The work of this item shall include the grading of ditches and swales to match as-built site conditions.

Field drains encountered during regrading and realigning operations shall be salvaged and re-aligned as required. Any damaged field drains shall be replaced within the limits of construction.

All as per the Contract Drawings.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-27 Hot Mix Asphalt Paving – Items 1-27, 2-27

The work of this item shall include the supply and placing of hot mix asphalt paving in the following locations:

- 50mm HL3 HS surface course on the approaches and over the culvert;
- 100mm HL8 HS binder (placed in 2-50mm lifts) over the culvert and on the approaches

All as shown on the Contract Drawings.
Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-28 Topsoil, Seed and Erosion Control Blanket – Items 1-28, 2-28

The work of this item shall include supply and application of topsoil, seed, and erosion control blanket to roadway side slopes disturbed by construction.
Seed mix shall be submitted to the Contract Administrator for approval prior to placing.
All as shown on the Contract Drawings.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-29 Steel Beam Guide Rail and Posts – Items 1-29, 2-29

The work of this item shall include the following:

ITEM 1-29, STRUCTURE No. 098310 – Montrose Road Culvert

- Existing steel beam guiderail is to be removed, salvaged, and reinstated in accordance with OPSD 912.130.
- Supply and fabrication of six steel beam guiderail posts with base plates as per Contract Drawing No. 804-1-3.
- Supply and placing of galvanized anchorage assemblies including plates, bolts, nuts and washers as per Contract Drawing 804-1-3. The Contractor shall allow for field measurement of the anchorage assemblies prior to manufacture (or grind the concrete locally) to ensure that plumb vertical posts are provided without the use of shims and posts are the correct height. All manufacture of the anchorage assemblies, including, welding, drilled bolt holes, cutting to height and galvanizing shall be completed prior to delivery to site. **Field modification of the anchorage assemblies will not be permitted.**

ITEM 2-29, STRUCTURE No. 098315 – Montrose Road Culvert

- Supply and placing of steel beam guide rail, steel posts and plastic offset blocks (no channel).
- Supply and fabrication of steel beam guiderail posts with base plates as per Contract Drawing No. 804-2-3.

- Supply and placing of galvanized anchorage assemblies including plates, bolts, nuts and washers as per Contract Drawing 804-2-3. The Contractor shall allow for field measurement of the anchorage assemblies prior to manufacture to ensure that plumb vertical posts are provided without the use of shims and posts are the correct height. All manufacture of the anchorage assemblies, including, welding, drilled bolt holes, cutting to height and galvanizing shall be completed prior to delivery to site. **Field modification of the anchorage assemblies will not be permitted.**

All as shown on the Contract Drawings.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-30 Softstop Terminal System – Item 2-30

The work of this item shall include the following:

- Supply and place Softstop Terminal System components as per OPSD 922.161.

All as shown on the Contract Drawings.

Payment at the unit Contract price for this item shall be full compensation for all labour, equipment and material necessary to complete the work.

SSP-31 Utility Allowance (Cogeco) – Items 1-30, 2-31

The work of this item shall include the following, if required:

- Allowance for the completion of all construction activities while working around existing underground Cogeco lines.
- Allowance for temporary support, protection, and/or working around the existing utility lines and pedestals during removals, excavation, culvert installation, backfilling, and grading of side slopes.

The site-specific utilities of this item include the following:

<u>ITEM 1-31, STRUCTURE No. 098310 – Montrose Road Culvert</u>

- Cogeco buried mainline fiber cable running along west side of roadway, directionally bored under drainage ditches (exact depth unknown).
- Mainline fiber cable approximately 1.6m west of edge of existing pavement.

<u>ITEM 2-30, STRUCTURE No. 098315 – Montrose Road Culvert</u>

- Cogeco buried mainline fiber cable running along west side of roadway, directionally bored under drainage ditches (exact depth unknown).
- Mainline fiber cable approximately 1.4m west of edge of existing pavement.

The Contractor shall demonstrate to the Contract Administrator that they have contacted Cogeco and have demonstrated safe limits of approach.

All as shown in the Contract Drawings.
The Contractor shall allow utility owners access to the work area for periodic inspections, as required.

Any damage to the existing plant shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.

In the event that the existing plant is damaged, the Contractor shall immediately notify Cogeco of the damaged plant. The Contractor shall then cooperate fully with the owner to repair the damaged plant, including but not limited to:

- Additional excavation or exposure of the damaged plant.
- Vacating the site as required to allow access for the Cogeco's repair Contractor.
- Rescheduling or postponing construction activities as required to repair the damaged plant.

Payment at the lump sum Contract price for the above tender items shall be full compensation for all labour, equipment and material to do the work.

SSP-32 Utility Allowance (Enbridge) – Item 1-31

The work of this item shall include the following, if required:

- Allowance for temporary support, protection, and/or working around the existing utility lines and pedestals during removals, excavation, culvert installation, backfilling, and grading of side slopes.

The site-specific utilities of this item include the following:

- 1 NPS 4 ST IP along the west side of Montrose Road, approximately 5.3m west of centreline of roadway, at a depth of 0.9m below existing grade, and 0.3m above the existing culvert.
- 2" plastic gas main crossing Montrose Road approximately 14m south of culvert.
- 1" plastic gas service crossing Montrose Road to lot #14011.

The Contractor shall demonstrate to the Contract Administrator that they have contacted Enbridge and have demonstrated safe limits of approach in compliance with Enbridge requirements.

All work within the vicinity of natural gas pipeline must adhere to the specification set forth by Enbridge Gas Distribution Inc. A copy of this specification has not been included within the tender.

https://www.enbridgegas.com/gas-safety/pipeline-safety.aspx

Questions regarding work within the vicinity of a natural gas pipeline and the corresponding specifications may be obtained from the following source:

EGD CONTACTS

James Callaghan
ENBRIDGE Gas Distribution Inc.
Niagara Region
Tel: 905-641-4876 / Fax: 905-704-3683
james.callaghan@enbridge.com

The contractor is to become familiar with all of Enbridge's requirements pertaining to work within the vicinity of a natural pipe line and these provisions are to be included within the tender bid. No additional cost associated with work within the vicinity of a natural gas pipe line will be entertained. All as shown in the Contract Drawings.

The Contractor shall allow utility owners access to the work area for periodic inspections, as required.
Any damage to the existing plant shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.

In the event that the existing plant is damaged, the Contractor shall immediately notify Enbridge of the damaged plant. The Contractor shall then cooperate fully with the owner to repair the damaged plant, including but not limited to:

- Additional excavation or exposure of the damaged plant.
- Vacating the site as required to allow access for the affected utility's repair Contractor.
- Rescheduling or postponing construction activities as required to repair the damaged plant.

Payment at the lump sum Contract price for the above tender items shall be full compensation for all labour, equipment and material to do the work.

SSP-33 Utility Allowance (Niagara Peninsula Energy) – Items 1-32, 2-32

The work of this item shall include the following, if required:

- Allowance for the completion of all construction activities while working around and/or under the existing live overhead Hydro lines in compliance with Hydro requirements.
- Allowance for costs related to power shut downs, service interruptions, dropping or relocating overhead lines etc.
- Allowance for temporary support of hydro poles, guy wires, and any other associated hardware.
- Allowance for temporary support, protection, and/or working around the existing utility lines and pedestals during removals, excavation, culvert installation, backfilling, and grading of side slopes.

The site-specific utilities of this item include the following:

ITEM 1-33, STRUCTURE No. 098310 – Montrose Road Culvert

- Niagara Peninsula Energy (Hydro) overhead hydro lines along the east side of Montrose Road.
- Niagara Peninsula Energy (Hydro) pole # 225-12, located just north of the structure and the east side of Lake Street.

ITEM 2-31, STRUCTURE No. 098315 – Montrose Road Culvert

- Niagara Peninsula Energy (Hydro) overhead hydro lines along the east side of Montrose Road.

The Contractor shall demonstrate to the Contract Administrator that they have contacted Niagara Peninsula Energy and have demonstrated safe limits of approach.
OHSA requirements state that no equipment shall encroach within 3 metres of overhead lines to maintain safe limits of approach, also any excavation around the base of a pole should not be closer than 3 metres without having the pole properly supported.
All as shown in the Contract Drawings.

The Contractor shall allow utility owners access to the work area for periodic inspections, as required.

Any damage to the existing plant shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.
In the event that the existing plant is damaged, the Contractor shall immediately notify Niagara Peninsula Energy of the damaged plant. The Contractor shall then cooperate fully with the owner to repair the damaged plant, including but not limited to:

- Additional excavation or exposure of the damaged plant.
- Vacating the site as required to allow access for the Niagara Peninsula Energy's repair Contractor.
- Rescheduling or postponing construction activities as required to repair the damaged plant.

Payment at the lump sum Contract price for the above tender items shall be full compensation for all labour, equipment and material to do the work.

SCHEDULE OF DRAWINGS

STANDARD DRAWINGS

(Refer to Niagara Peninsula Standard Contract Documents)

Contract No. 2019-T-155
(RN19-55)

Replacements of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

SCHEDULE OF DRAWINGS

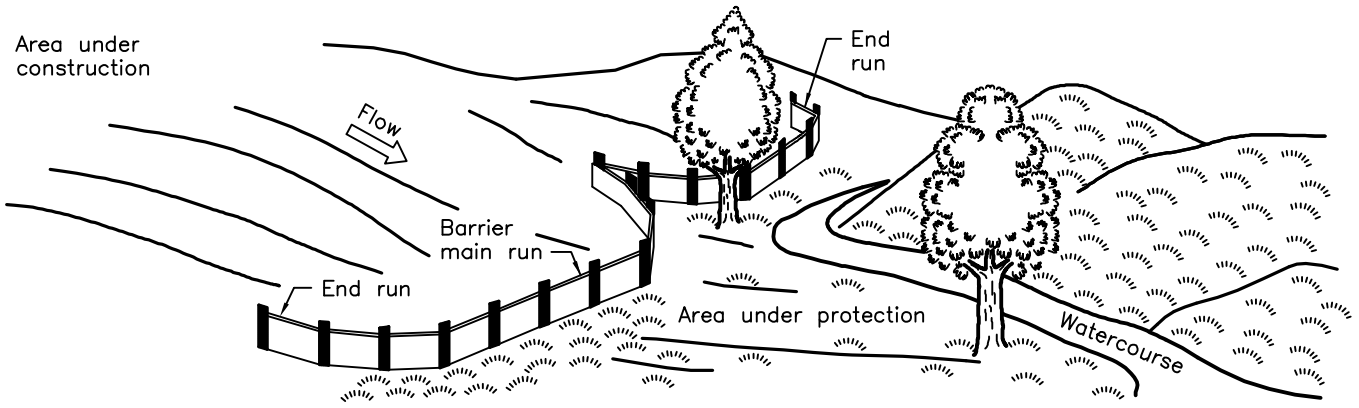
Schedule of Drawings

1. Contract Drawings (Not Included In the Contract Documents)

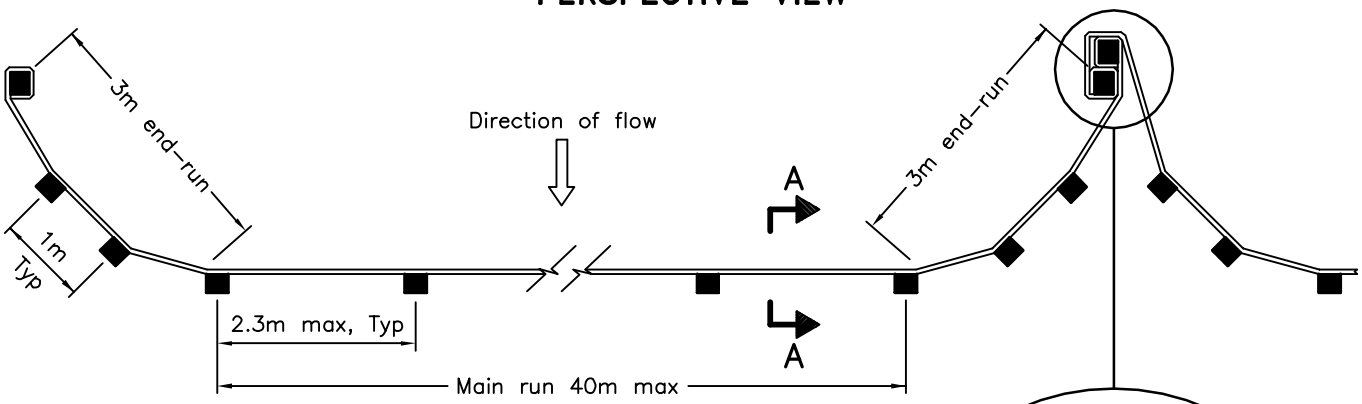
Structural Drawings	
Dwg #	**Drawing Title**
N/A	Title Sheet
804-1-1	General Arrangement (098310)
804-1-2	Distribution Slab and Misc. Details
804-1-3	SBGR Post and Northeast Retaining Wall
804-1-4	Dura Hold 2 Retaining Wall
804-1-5	Proposed Sediment and Erosion Control Plan
804-2-1	General Arrangement (098315)
804-2-2	Distribution Slab and Misc Details
804-2-3	SBGR Post and Joint Details
804-2-4	Dura Hold 2 Retaining Wall
804-2-5	Proposed Sediment and Erosion Control Plan

2. OPS Drawings (Included In the Contract Documents)

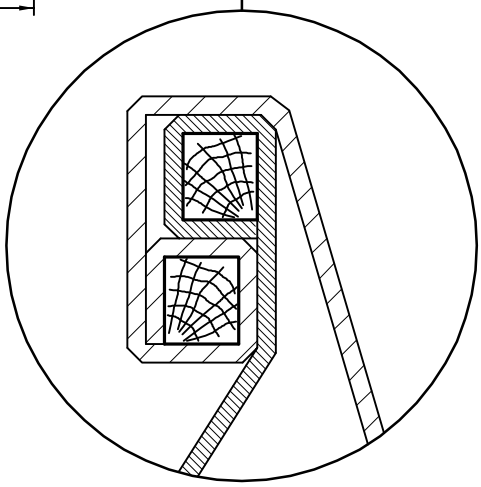
OPSD – 219.110 -	LIGHT DUTY SILT FENCE BARRIER
OPSD – 219.180 -	STRAW BALE FLOW CHECK DAM
OPSD – 912.130 -	GUIDE RAIL SYSTEM, STEEL BEAM STEEL POST WITH OFFSET BLOCK ASSEMBLY INSTALLATION SINGLE RAIL
OPSD – 922.161 -	ENERGY ATTENUATOR, END TREATMENT STEEL BEAM ENERGY ATTENUATING TERMINAL MASH SOFTSTOP TERMINAL SYSTEM INSTALLATION



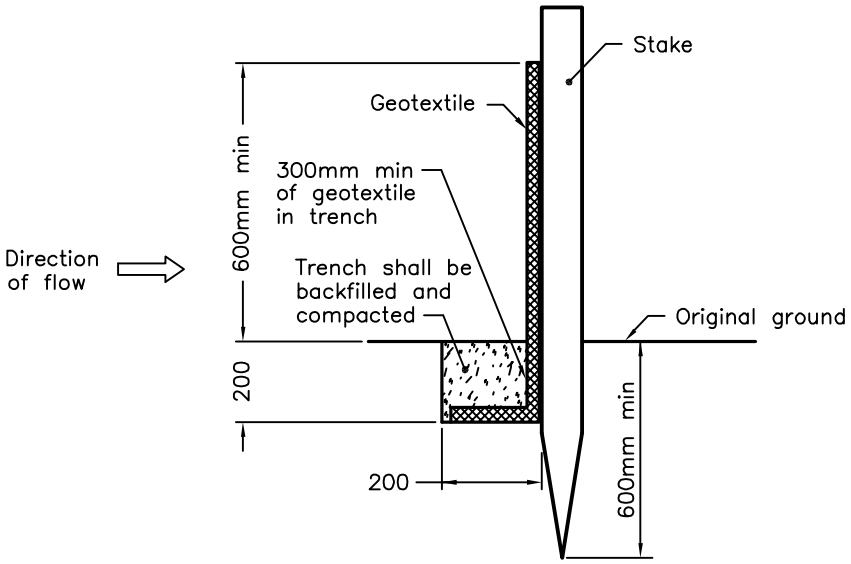
PERSPECTIVE VIEW



PLAN



JOINT DETAIL

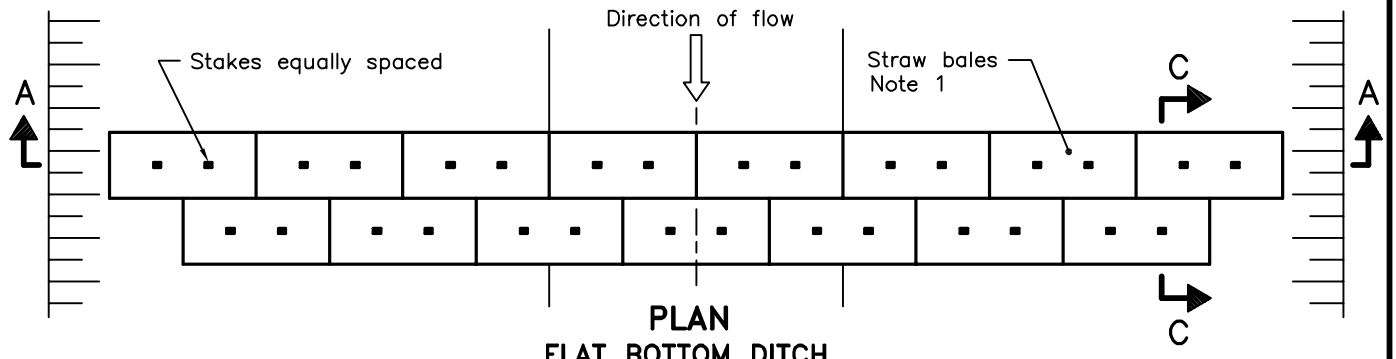


SECTION A–A

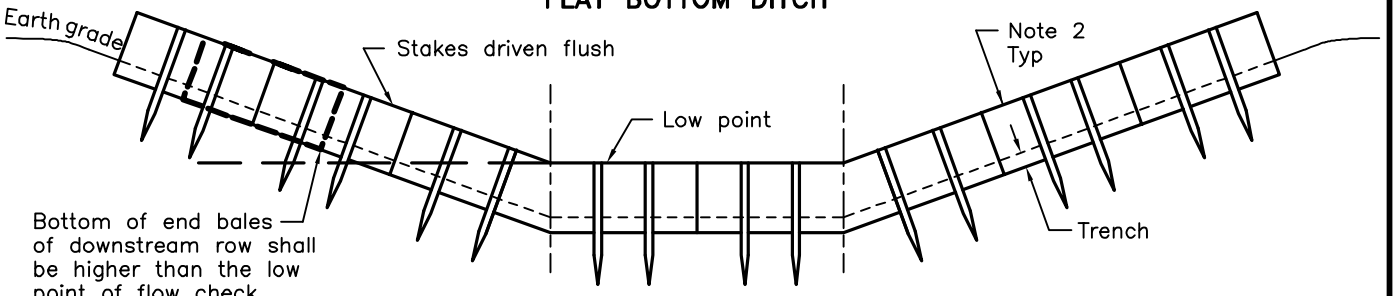
NOTE:

A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev	2
LIGHT–DUTY SILT FENCE BARRIER			
	OPSD 219.110		

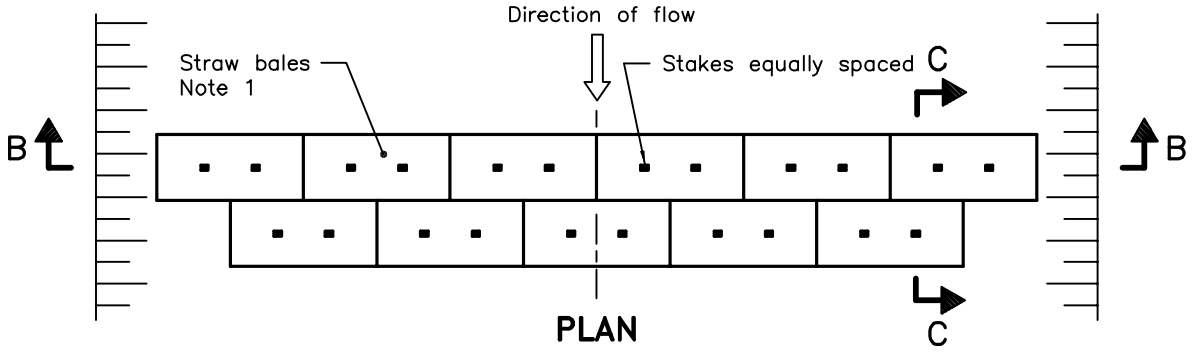


PLAN
FLAT BOTTOM DITCH

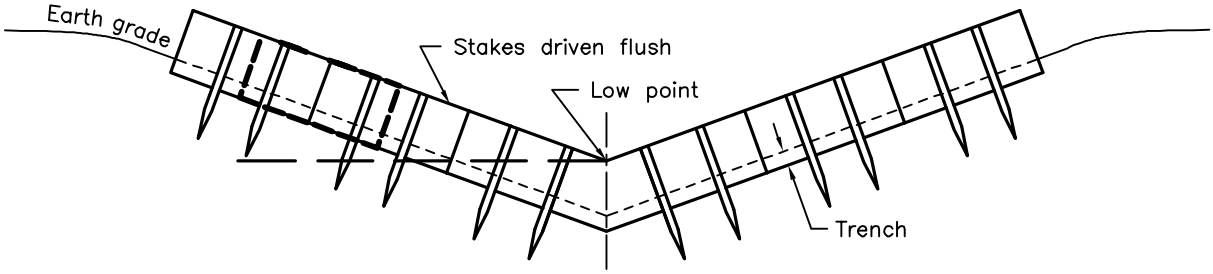


Bottom of end bales of downstream row shall be higher than the low point of flow check. Downstream bale position outlined. Typ

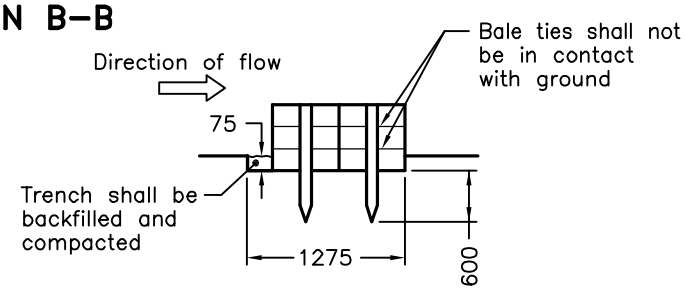
SECTION A–A



PLAN
V–DITCH



SECTION B–B



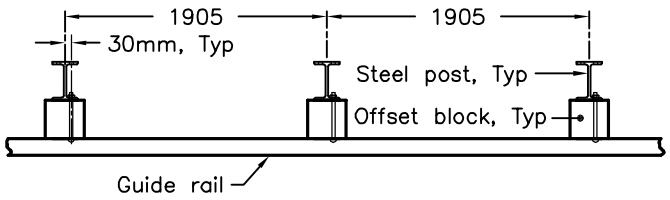
SECTION C–C

NOTES:

1 Number of bales varies and shall suit ditch.
2 Straw bales shall be butted tightly against adjoining bales and shaped to conform to the sides of the ditch to prevent water flow through barrier.

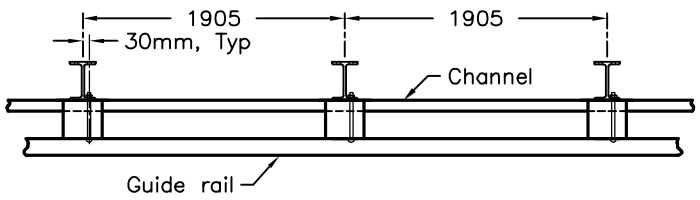
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev	2
STRAW BALE FLOW CHECK DAM			
	OPSD 219.180		

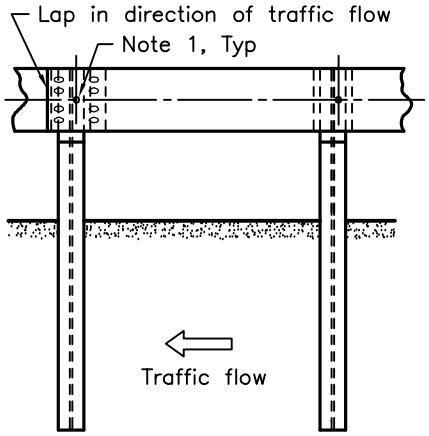


PLAN

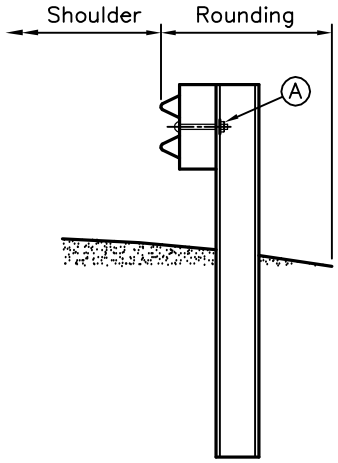
POST BOLT		
	Post Bolt Size and Type	Washer @ Nut
(A)	16x250 BH	Plate
(B)	16x100 CaB	Plate



PLAN

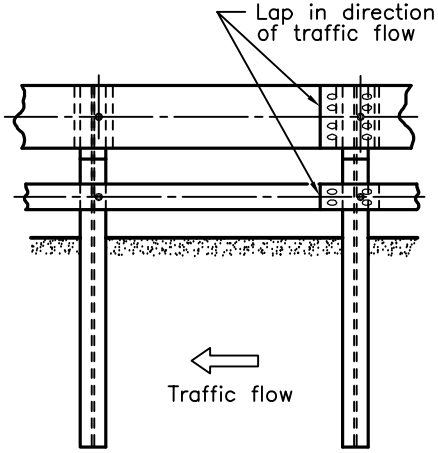


ELEVATION

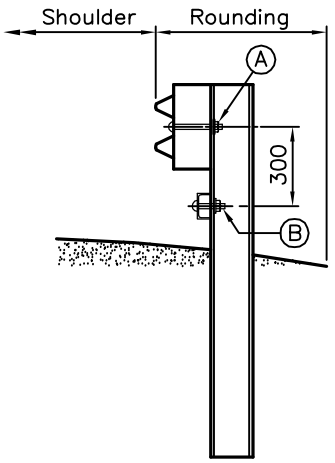


SIDE VIEW

SINGLE RAIL



ELEVATION



SIDE VIEW

SINGLE RAIL WITH CHANNEL

NOTES:

1 Washer shall not be installed at front face of rail. One bolt located at centre of steel beam guide rail.

A This OPSD to be read in conjunction with OPSD 912.101, 912.102, 912.103, and 912.104.

B Steel beam guide rail mounting heights shall be as specified.

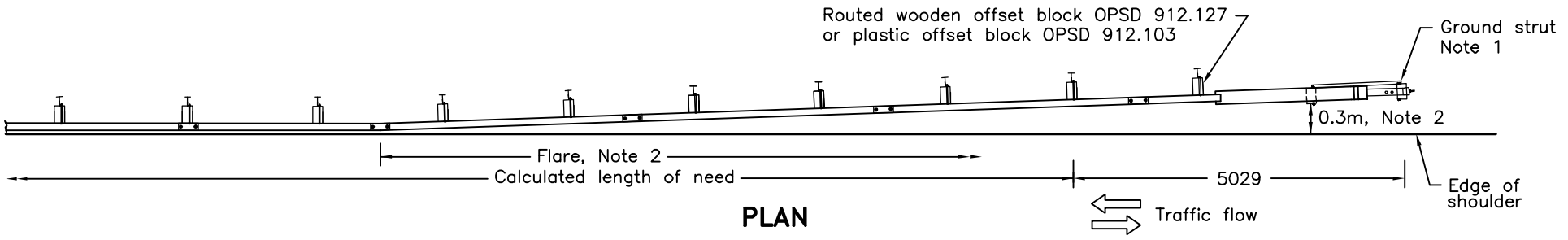
C All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

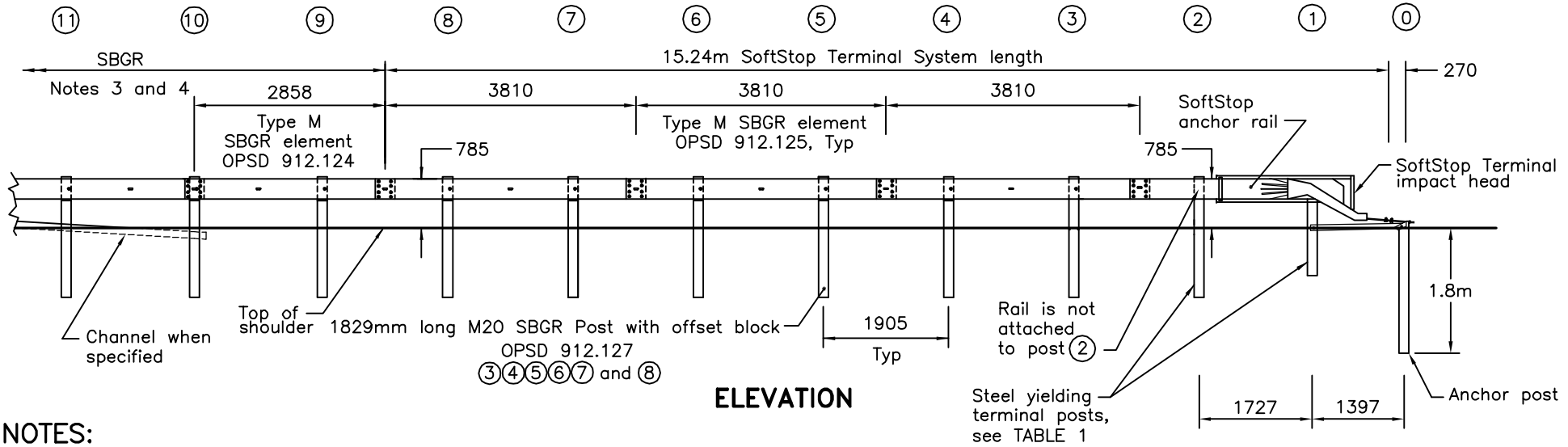
GUIDE RAIL SYSTEM, STEEL BEAM STEEL POST WITH OFFSET BLOCK ASSEMBLY INSTALLATION – SINGLE RAIL

Nov 2016 | Rev 3

OPSD 912.130



PLAN



ELEVATION

NOTES:

1 This OPSD shows right shoulder installation. The SoftStop Terminal shall be inverted for left shoulder installation.

2 The system length shall be installed in a straight line at a 50:1 flare rate or parallel to roadway when specified.

3 SBGR or SBGR with channel when specified.

4 SBGR transition in height shall occur beyond terminal between post (10) and post (13).

A Delineation shall be according to OPSD 984.201 and 984.202.

B The system depicted here is a proprietary product.

C System configuration meets AASHTO MASH TL–3.

D This OPSD shall be read in conjunction with OPSD 202.031 or 202.032 as specified.

E All dimensions are in millimetres unless otherwise shown.

TABLE 1	
Steel Yielding Terminal Post	
Post	Length m
1	1.46
2	1.83

ONTARIO PROVINCIAL STANDARD DRAWING

ENERGY ATTENUATOR, END TREATMENT STEEL BEAM ENERGY ATTENUATING TERMINAL SOFTSTOP TERMINAL SYSTEM INSTALLATION

Apr 2016 | Rev 0

ONTARIO STANDARDS MUNICIPAL–PROVINCIAL

OPSD 922.161

SUPPLEMENTARY GENERAL CONDITIONS OF CONTRACT

(Refer to Niagara Peninsula Standard Contract Documents)

OPS GENERAL CONDITIONS OF CONTRACT

(Refer to Niagara Peninsula Standard Contract Documents)

APPENDICES

Contract No. 2019-T-155
(RN19-55)

Replacement of Montrose Road Culverts
(Structure No. 098310 and 098315)
In The City of Niagara Falls

APPENDIX 'A'

Geotechnical Investigation
Structure No. 098310: Montrose Road Culvert
City of Niagara Falls
Regional Municipality of Niagara, Ontario
May 18, 2018
(66 Pages)

Geotechnical Investigation
Structure No. 098315: Montrose Road Culvert
City of Niagara Falls
Regional Municipality of Niagara, Ontario
May 18, 2018
(66 Pages)

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Geotechnical Investigation
Proposed Culvert Rehabilitation
Montrose Road and Schneider Road, Niagara Falls, Ontario

Prepared for:

The Regional Municipality of Niagara
Campbell West Building
1815 Sir Isaac Brock Way
Thorold, Ontario, L2V 4T7

Landtek File: 18025
May18, 2018

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Scope	The Regional Municipality of Niagara is intending to rehabilitate the existing culvert located at the intersection of Montrose Road and Schneider Road in Niagara Falls, Ontario. The proposed new culvert will be an open-base type structure founded on spread footings. No grade changes to the creek channel or road profile are proposed, with a 'restore-to-existing' reconstruction anticipated.
Report Deliverables	The purposes of the Geotechnical Investigation were to confirm the subsurface conditions at the site and to provide recommendations with regards to the installation and construction of the proposed culvert, and assess the characteristics of the soils to be excavated and their suitability for reuse.

SITE DETAILS AND SETTING

UTM 17T Coordinates	653086, 4760050	**Geodetic Elevation**	177 m
Site Description	The project site is situated at the intersection of Montrose Road and Schneider Road. The area surrounding the project site is covered predominately by some dense clusters of trees and a small number of residential premises in the vicinity of the site, with associated landscaped areas.		
Geology	A pavement structure consisting of about 165 mm to 180 mm of asphalt overlying approximately 450 mm to 510 mm of sand and gravel was encountered at the surface of the boreholes. Underlying the existing pavement structure is fill material comprised primarily of silty clay. Native silty clay to clayey silt deposits were encountered underlying the fill material and extend to the maximum drill depth of about 11.0 m. No bedrock was encountered during this investigation.		

ENGINEERING CONSIDERATIONS

Foundations	It is considered by Landtek that bearing conditions to support a lightly loaded structure on concrete footings can be provided by the native silty clay soils.
Settlements	The general limiting of the total settlement of 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate for the native soils at the site.
Earthquake Considerations	The subject property is considered to be an 'D' Site Class

CONSTRUCTION CONSIDERATIONS

Excavations	The subsurface soils to be encountered during excavation at the site are expected, in general, to behave as Type "2" and Type "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the generally compact fill material. The stiff to very stiff silty clay soils are considered Type "2" soils.
Dewatering	It is expected that construction measures will be required to address both surface water and ground water control. Water levels in the watercourse will vary with the season of the year and groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction.

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APPENDIX E LABORATORY TEST RESULTS (SIEVE ANALYSIS)

1.0 INTRODUCTION

Landtek Limited (herein "*Landtek*") is pleased to submit the geotechnical investigation report for the proposed culvert rehabilitation at the intersection of Montrose Road and Schneider Road in Niagara Falls, Ontario. Authorization to proceed with the work was received from Mr. Brian Ellis of Ellis Engineering Inc. herein ("*Ellis*") on behalf of the Regional Municipality of Niagara (herein "*Niagara Region*") in February 2018.

It is understood that the existing culvert, located at the intersection of Montrose Road and Schneider Road is to be rehabilitated. The proposed new culvert will be an open-base type structure founded on spread footings. No grade changes to the creek channel or road profile are proposed, with a "*restore-to-existing*" reconstruction anticipated.

The primary objectives of this investigation were:

- To confirm the subsurface soil and groundwater conditions for the culvert design and construction;
- Provide installation and construction recommendations with regards to the proposed culvert; and,
- Assess the characteristics of the soils to be excavated and their suitability for reuse on site.

This report has been prepared for Niagara Region, their nominated engineers, designers, and project managers for the proposed culvert rehabilitation. Further dissemination of this report is not permitted without Landtek's prior written approval. Further details of the limitations of this report are presented in Appendix A.

2.0 METHODOLOGY

Fieldwork undertaken at the site by Landtek included clearance of underground services, borehole layout, borehole drilling and soil sampling, field supervision, and traffic management. A total of two boreholes (boreholes BH/MW1 and BH2) were drilled through the existing road surface on Montrose Road on February 22, 2018. All boreholes were logged using those standard symbols and terms defined in Appendix B. The borehole location plan, Drawing 3, and the borehole logs are provided in Appendix C.

Boreholes BH3, BH4, BH5 and BH6 were drilled adjacent to two additional culvert structures located on Effingham Street and Montrose Road, in conjunction with this investigation. A geotechnical investigation report was prepared for each of the three (3) culvert sites.

All boreholes were drilled using a truck mount drilling rig equipped with continuous flight, hollow stem augers, and were advanced to a maximum depth of about 11.0 m below existing pavement surface.

One, 50 mm diameter monitoring well was installed in borehole BH/MW1 to a depth of approximately 10.6 m below existing pavement surface to monitor groundwater conditions. The monitoring well consisted of new/sealed 50 mm polyvinyl chloride (PVC) screen with No.10 slots threaded onto a matching riser. The screens and riser were pre-threaded including o-ring seals such that no glues or solvents were used to connect the pipe sections. The annular space between the PVC well and the borehole was backfilled to approximately 0.6 m above the top of the screen section with sand pack, and then with borehole cuttings and bentonite to approximately 0.1 m below existing pavement surface. A J-Plug lockable air-tight cap was installed on the riser, and an aluminum flush mount casing then placed over the well and sealed with concrete. The borehole logs in Appendix C present the monitoring well installation details and the results of a subsequent water monitoring visit completed on April 13, 2018.

The soil samples were then transported to Landtek's in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture contents were carried out on all samples. Sieve testing for soil samples from each borehole was undertaken and selected composite soil samples taken from each borehole were submitted for chemical analyses to ALS Environmental.

Borehole strata depths are referenced to the top of the existing pavement surface at each respective location, and borehole locations have been established by Landtek relative to site measurements.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Location

The site is located on Montrose Road in Niagara Falls, Ontario, and is centered at approximate grid reference 653086, 4760050 (UTM 17T coordinates). The Geodetic elevation of the ground surface at the boreholes is approximately 177 m.

The site location is shown in Figure 1 below.



Figure 1
Site Location

The project site is situated at the intersection of Montrose Road and Schneider Road. The area surrounding the project site is covered predominately by some dense clusters of trees and a small number of residential premises in the vicinity of the site, with associated landscaped areas.

3.2 Subsurface Conditions

Based on published geological information[1,2] and previous geotechnical experience[3] for the area, the predominant native overburden soils consist of glaciolacustrine deeper water clay and silt deposits. The bedrock in the area is identified as argillaceous dolostone and shale of the Salina Formation.

The borehole information is generally consistent with the geological data, and the predominant soils comprise of clay and silt deposits. No bedrock was encountered during this investigation. The detailed borehole logs are presented in Appendix C, and the ground conditions encountered by the boreholes are discussed further in the following sections.

Existing Pavement Structure

All boreholes were drilled through the existing pavement structure on Montrose Road. The asphalt thickness ranges from 165 mm to 180 mm at the borehole locations. Pavement granular material was encountered in all boreholes underlying the asphalt, and consisted of approximately 450 mm to 510 mm of sand and gravel.

Fill

Fill material comprising predominantly of silty clay was encountered in all the boreholes underlying the existing pavement structure and extends to a depth of approximately 3.0 m below existing pavement surface. The fill contains varying proportions of limestone fragments and some gravel, and is primarily brown and black in colour. SPT 'N' values of 20 to 50 blows for 150 mm of spoon penetration were reported, indicating the fill to be of a compact to very dense condition. Moisture contents of 16 % were recorded.

Silty Clay

Silty clay to clayey silt deposits were encountered underlying the fill material in all boreholes at depths of 3.0 m and extend to the terminus of the boreholes at a depth of approximately 11.1 m below the existing pavement surface. The silty clay to clayey silt is brown and occasionally grey in colour. SPT 'N' values of 9 to 21 were reported, indicating the silty clay to clayey silt to be of a stiff to very stiff condition. Moisture contents range from 20 % to 35 %.

The particle size analysis results indicate that the soil is comprised of approximately the following characteristics:

BH1/SS4 0.0 % Gravel; 1.3 % Sand; 39.0 % Silt; 59.7 % Clay

Based on the above, the soil is classified as a CL-ML (Silty Clay) type soil according to the Unified Soil Classification Chart (ASTM D2487-06-Table 1).

The hydraulic conductivity of the Silty Clay is approximately 1 $x10^{-6}$ cm/s, and the estimated percolation (T time) is expected to be approximately 40 min/cm.

Bedrock

Bedrock was encountered during this investigation.

Groundwater

Groundwater conditions were observed in borehole BH/MW1 during drilling and then measured from the installed monitoring well on April 13, 2018. A water level reading in the monitoring well was recorded and is summarized in Table 1.

Groundwater conditions and surface water flow conditions in the existing creek are expected to vary according to the time of the year and seasonal changes in precipitation. Water seepage is also expected from soil fissures above the water table in the fill.

Table 1: Summary of Water Level Measurements

Borehole ID	Date Drilled	Water Strike	Measured Water Level	
		(mbps*)	Depth (mbps*)	Date
BH/MW1	February 22, 2018	-	2.0	April 13, 2018

* mbps metres below existing pavement surface

4.0 CULVERT DESIGN CONSIDERATIONS

It is understood from Ellis that the new culvert structure is to be an open-base type structure founded on spread footings. It is anticipated that the existing culvert and associated infrastructure located on site will be removed in full, and no grade changes are proposed.

4.1 Culvert Foundation Considerations

The fill encountered in the boreholes is considered unsuitable as a bearing stratum due to the high risk of unacceptable settlements. The underlying native soil represents a satisfactory bearing stratum, with negligible settlements anticipated under the weight of the new culvert structure. As such, it is deemed that deep foundation solutions will not be required. It is considered by Landtek that the culvert structure can be adequately supported by reinforced concrete spread footings founded in the native silty clay soil for a geotechnical reaction at the SLS of 150 kPa, and a factored geotechnical resistance at the ULS of 225 kPa

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. Therefore, a Geotechnical Engineer should be engaged during construction to examine the exposed sub-soil quality and condition, and confirm the subsurface conditions are consistent with design assumptions. This is in compliance with field review requirements in the National Building Code, Volume 1, Clause 4.2.2.3.

4.2 Support Considerations for Box Culverts

Subgrade preparation work will be required to provide suitable bearing and ground support conditions. The design should include a granular pad of Ontario Provincial Standard Specification (herein "*OPSS*") 1010 Granular A to provide a working mat to facilitate placement of the box sections and a more uniform support condition under the box structure. The minimum thickness of the layer should be 300 mm.

In the event that there is significant water seepage into the excavation it may be an advantage to substitute clear 19 mm stone in place of Granular A for the granular pad. The clear stone fill should allow for the free movement of water through the construction area and should meet the requirements of OPSS 1004 for Type 2, 19 mm clear stone.

It is recommended that the clear stone base layer receive mechanical compaction however the density of clear stone cannot be reliably measured with conventional nuclear density testing equipment such that the required amount of compaction effort will be a field judgment based on the compaction equipment used, the lift thickness, and the type of clear stone material.

4.3 Culvert Settlement Considerations

It is anticipated that of the loads to be applied to the ground by the replacement culvert structure will be of a generally low intensity. As such, associated settlements of the footings on undisturbed native soils are expected to be within the normally tolerated limits of 25 mm total, and 19 mm differential movement for the recommended geotechnical reaction at the SLS.

It is recommended that wherever possible the bearing stratum should be the same throughout the entire footprint of the structure to minimize the potential for differential settlement.

4.4 Seismic Design Considerations

In accordance with Section 4.4.3 and Table 4.1 of the CHBDC S6-14 the subject property is considered to be a “D” Site Class. The corresponding site coefficients, F(T), F(PGA), and F(PGV), should be determined from Tables 4.2 to 4.9 of the CHBDC for the above recommended Site Class.

4.5 Frost Susceptibility

The native superficial soils encountered at the site comprise silt and clay and are considered sensitive to water and frost; i.e. their physical and mechanical properties are dependent on in-situ moisture content. As such, the shallow soils at the site are considered to have a moderate to high frost susceptibility, being classified as Frost Group “*F4*” (Table 13.1 of the “*Canadian Foundation Engineering Manual*”, 4th Edition). The maximum depth for frost penetration is 1.2 m in the Niagara Region area. It will be important to ensure that any proposed, shallow seated footings will have a minimum of 1.2 m of soil cover, or equivalent insulation product, for frost protection.

4.6 Concrete Placement Considerations

The water levels in the watercourse at the site are expected to vary depending upon precipitation levels and the time of the year. In high flow periods appropriate construction methods will have to be implemented to divert and control water flow in order to facilitate placing concrete and/or granular materials for new foundations.

5.0 LATERAL EARTH PRESSURE CONSIDERATIONS FOR WINGWALLS

The earth pressure, p, acting on abutments and soil retaining wall systems at any depth, h, in metres below the ground surface assumes an equivalent triangular fluid pressure distribution and may be calculated using expression (1) below. It is assumed that granular material is used as backfill in the road. Allowances for pressure due to compaction operations should be included in the earth pressure determinations as per CHBDC Commentary clause C6.12.3. A value of 12 kPa is applicable for a vibratory compactor and granular material.

If the structure retaining soil can move slightly, the active earth pressure case can be used in determining the lateral earth pressure. For restrained structures and no yielding an “at rest” earth pressure condition should be used. The determination of the earth pressures should be based on the following expression:

$$p = K (\delta h + q) \qquad (1)$$

where:

p = the pressure in kPa acting against any subsurface wall at depth, h, in metres (feet) below the ground surface;

K = the earth pressure coefficient considered appropriate for subsurface walls; (see Table 2).

δ = the moist bulk unit weight of the retained backfill (see Table 3).

and,

q = the value for any adjacent surcharge in kPa which may be acting close to wall

h = the depth, in m, at which the pressure is calculated

The backfill behind retaining structures is assumed to meet an OPSS 1010 Granular B Type 1 pit-run sand and gravel material as a minimum specification. Should an OPSS 1010 Granular A material be used, then the effective angle of friction should be taken as approximately 37°, with a corresponding at rest earth pressure coefficient, K_O, of 0.40. This is based on a backfill compaction specification with a target of 98 % Standard Proctor Maximum Dry Density (herein “*SPMDD*”) and no individual tests below 96 % SPMDD.

Table 2: Recommended Unfactored Earth Pressure Parameters

Earth Pressure Condition	Unfactored Earth Pressure Parameters			
	OPSS 1010 Granular B Type I		OPSS 1010 Granular A	
	Earth Pressure Coefficient	Estimated Moist Unit Weight	Earth Pressure Coefficient	Estimated Moist Unit Weight
Active	$K_a = 0.31$	22 kN/m^3	$K_a = 0.25$	23 kN/m^3
At-Rest	$K_0 = 0.47$		$K_0 = 0.40$	

6.0 SUBSURFACE CONCRETE

6.1 Soil Corrosivity

A total of two selected soil samples were submitted for chemical analyses to ALS Environmental for analysis of PH, soil conductivity and redox potential, and concentrations of sulphides and chlorides.

The American National Standards Institute (ANSI)/ American Water Works Association (AWWA) 10-point scoring method was used to determine the soil corrosivity potential. For each given soil sample, points were assigned to the different parameters to evaluate their contribution towards the corrosivity of soil.

Corrosion protection for buried metallic improvements or steel are recommended, when a score of 10 points or greater is reported. The test results are provided in Appendix D and are summarized in Table 3 below, with the respective ANSI/AWWA point rating.

Table 3: Results of Soil Corrosivity Potential

Sample ID	Composite Sample Depth	Parameters Analysed	Measured Value	ANSI/AWWA Point Rating	Total ANSI/AWWA Points
BH1-SS2 AND SS3	3.0 m – 5.0 m	Sulphide (%)	<0.20	0	12
		pH (ph units)	7.77	0	
		Resistivity (ohm.cm)	346	10	
		Redox Potential (mV)	314	0	
		Moisture (%)	22.1	2	
BH2-SS4	6.0 m – 6.5 m	Sulphide (%)	<0.20	0	4
		pH (ph units)	7.73	0	
		Resistivity (ohm.cm)	1350	2	
		Redox Potential (mV)	318	0	
		Moisture (%)	22.5	2	

Based on the total ANSI/AWWA value of 12 within the native soils, it is considered that the soils at the site have a corrosion potential. Therefore corrosion protection is recommended for buried metallic improvements or steel in the soil.

The contribution of chloride ions to soil corrosivity towards buried metallic improvements or reinforced concrete structures is very significant. According to the Corrosion Guidelines (Caltrans, January 2015, version 2.1), a site is considered corrosive if, "*chloride concentration is 500 ppm or greater, sulphate concentration is 2000 ppm or greater, or the pH is 5.5 or less*. "

In addition, the Canadian Standards Association (CSA) A23.1-09 "*Concrete materials and methods of concrete construction*", Table 3, "*Additional requirements for concrete subjected to sulphate attack*", states that design requirements for sulphate resistant concrete are only necessary when the water soluble sulphate content of the soil in which the concrete is to be embedded is greater than 0.1 % (1,000 mg/kg).

The representative soil samples at the site contain sulphate and chloride ion concentrations of up to 13100 mg/kg and 175 µg/g respectively. This given, the soil environment within the native soils should be considered "*very severely*" corrosive towards concrete.

6.2 Concrete Class Considerations

The water level in the creek at the site is expected to vary depending upon precipitation levels and the time of the year. In high flow periods appropriate construction methods will have to be implemented to divert and control water flow in order to facilitate placing concrete for new foundations.

The requirements for subsurface concrete subject to a sulphate environment are presented in Canadian Standards Association (CSA) specification CAN/CSA-A3000-13. The results of chemical tests indicate that the soils have a low chloride concentration and generally very severe sulphate environment. It is recommended that subsurface concrete at the site have the following characteristics for an S-1 exposure class:

- minimum 56-day strength = 35 MPa;
- maximum water to cement ratio = 0.40;
- cementing materials:
  HS hydraulic cement or HSb; as per tables 3 and 4 respectively in CSA A23.1-14; and,
- air content:
  4 – 7 % for 14 mm to 20 mm nominal size coarse aggregate
  3 – 6 % for 28 mm to 40 mm nominal size coarse aggregate

The concrete should be placed without segregation and should be consolidated to achieve a uniform dense mass.

6.3 Methods for Specifying Concrete

Alternative methods of specifying concrete for a project are outlined in CSA A23.1-14 and allow for "*Performance*" or "*Prescription*" based methods. Each method attaches different levels of responsibility to the owner, the contractor, and the concrete supplier. The pros and cons of each method should be examined prior to completion of the specifications for the project.

7.0 EXCAVATION AND BACKFILL CONSIDERATIONS

7.1 Excavation Considerations

All temporary excavations and unbraced side slopes in the soils should conform to standards set out in the Occupational Health and Safety Act, Ontario Regulation 213/91 "*Construction Projects*" (herein "*OHSA*"). The subsurface soils to be encountered during excavation at the site are expected, in general, to behave as Type "2" and Type "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the generally loose to compact fill material. The stiff to very stiff silty clay soils are considered Type "2" soils.

It should be possible to excavate the overburden soils with a hydraulic backhoe. Moist Type 3 and Type 2 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e. 1V:1H). In Type 2 soil, the sides of a trench will remain vertical for a short period of time with no apparent tension cracks, and trench walls should be sloped to within 1.2 m of the trench bottom. According to the OHSA the excavation slope should be cut and shaped to meet the OHSA requirements for the soil with the highest classification number

It is expected that construction measures will be required to address both surface water and ground water control. Water levels in the watercourse will vary with the season of the year and groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction. Water seepage in open cut excavations should be expected below the watercourse water level. The ground water seepage rate will depend upon the thickness and frequency of permeable layers and seams in the existing fill and native soils. Contractors bidding on construction should be prepared to address variable surface water flow conditions as well as variable ground water seepage control conditions.

7.2 Excavation Dewatering Considerations

Where groundwater dewatering volumes are to be in excess of 50,000 litres per day but less than 400,000 litres per day, then a construction project will require registration online with the MOECC Environmental Activity and Sector Registry (EASR). For amounts greater than 400,000 litres per day a Category 3 Permit To Take Water (herein "*PTTW*") will be required.

In order to enable the construction of the proposed culvert, it is anticipated that temporary surface water control will be in the form of sheet piles; diverting the surface water flow and allowing the work area for construction to be exposed. In this circumstance, and assuming a suitably watertight sheet pile construction, groundwater volumes are anticipated to be below the threshold for water pumping permitting (i.e. less than 50,000 litres per day), and will be manageable using sump pumps per standard construction dewatering practices.

Based on the groundwater conditions encountered and the permeability of the soils present beneath the site it is anticipated that any excavation to be extended below the reported water seepage levels can be dewatered using sump pumps per standard construction dewatering practices. As such, construction dewatering volumes in excess of 50,000 litres per day are not anticipated.

7.3 Embankment Fill Materials

Embankment fill can consist of clean compactable earth fill that meets suitable environmental soil quality limits, or imported granular. If imported granular is used it should meet OPSS 1010 Granular B Type 1 specifications as a minimum requirement.
Embankment fill such as commercial grade granular materials can be expected to undergo settlements in the order of 1 % of the fill height, with the majority of the fill settlement expected to occur during the construction period of the new structure. Additional long-term consolidation settlement of embankment fill areas is expected to be negligible.

Embankment fill placement should be in accordance with the following recommendations:

1. Embankment fill should only be placed in an area that has been satisfactorily prepared by stripping surface organic soils and vegetation, and proof-rolling the native exposed soil with at least 5 passes of a minimum 10 ton static pad-foot steel drum type roller. Construction of embankment fill areas should be undertaken in a tiered progressive operation with the bottom foundation layer being compacted first;

2. Fill should be placed in maximum 300 mm loose lifts. The target compaction value should be 97 % SPMDD on each lift, with no individual tests being less than 95 % SPMDD. The placement and compaction of each lift should be monitored full time by Landtek Limited, with in-place compaction determined using nuclear moisture/density testing equipment; and,

3. Fill layers that do not meet the compaction requirements, or become wet or frozen, should not be approved for the placement of additional material.

7.4 Embankment Fill Stability and Side Slopes

Embankment side slopes with earth fill should be designed at a long term stable slope of 1V:3H, or approximately 18° to the horizontal.

Where imported granular materials are used for the embankment fill the estimated angle of repose for Granular B Type I material is expected to be in the range of 30° to 32° to the horizontal, such that side slopes should be at approximately 1V:2H.

8.0 ENVIRONMENTAL CONSIDERATIONS AND SOIL MANAGEMENT

Soil samples taken from each borehole were submitted for chemical analyses to ALS Environmental to determine a variety of parameters including metals and inorganic properties *(Regulation 153/04*) and analysis of Ontario Regulation 347/90 Toxicity Characteristics Leaching Procedure (herein "*TCLP*") for metal and inorganics, polychlorinated biphenyls (herein *"PCBs") and* volatile organic compounds *(herein "VOCs").*

The test results are provided in Appendix D and are summarized in Table 4 of this report in relation to the Industrial/Commercial/Community (ICC) land use soil quality standards given in the Table 3 of the MOECC document, "*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*", dated April 15, 2011.

Table 4: Summary of O. Reg. 153 Metals & Inorganics Test Data

Sample ID	Sample Depth	Parameters Analyzed	MOECC Table Comparison	
			Table 3 (ICC)	Exceedance
BH1-SS1	1.5 m – 2.0 m	O. Reg. 153 Metals & Inorganics	×	EC*
BH1-SS2	3.0 m – 3.5 m	O. Reg. 153 Metals & Inorganics	×	EC*
BH2-SS2 AND SS3	3.0 m – 5.0 m	O. Reg. 153 Metals & Inorganics	✓	-
BH2-SS4	6.0 m – 6.5 m	O. Reg. 153 Metals & Inorganics	✓	-

* Electrical Conductivity
✓ Meets MOECC Table 3 soil quality guidelines

The test results for metals and inorganic parameters indicate that the selected subgrade soil samples obtained from the boreholes all meet soil quality requirements for MOECC Table 3 ICC, with the exception of the Electrical Conductivity (EC) levels that exceed Table 3 ICC requirements.

Elevated Electrical Conductivity (EC) values are commonly associated with impacted conditions from long term use of road salt. Section 2 of Ontario Regulation 339 of the Revised Regulations of Ontario, 1990 (Classes of Contaminants – Exemptions) indicates that elevated residual road salt parameters in soils within the road allowance that result from winter salting that was placed to address safety issues are not regarded as an environmental problem that requires remediation. Based on the results of the chemical analysis, the soils represented by the samples analysed with EC impacts may be reused within the site area as the site is to remain a Municipal right of way (or "*highway*", as defined by the Highway Traffic Act).

Some variability in soil quality parameters may occur within a given sample as well as throughout a site. If excavated subgrade soils with EC impacts are to be disposed of off-site it should be noted that there may be soil quality criteria established for the site that is to receive the excavated materials. As such, the owners or operators of potential receiving sites must be notified of the environmental quality of the material and must agree in writing to accept the material. Some variability in soil quality parameters may occur along the length of a road section, and the contractor may be required to complete testing to address a designated list of chemical parameters for the receiving site.

One sample was analyzed for waste classification by ALS Environmental in accordance with Ontario Regulation 347/90 TCLP procedures for metals and inorganics, PCBs, and VOCs for landfill acceptance. The test results are provided in Appendix D and are summarized in Table 5.

Table 5: Summary of Ontario Regulation 347/90

Sample ID	Composite Sample Depth	Parameters Analyzed	Ontario Regulation 347/90	
			Waste Regulation	Exceedance
BH2-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 347/90 Metals & Inorganics	✓	-
BH2-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 558 PCBs	✓	-
BH2-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 558 VOCs	✓	-

✓ Meets Ontario Regulation 347/90-Leachate Quality Criteria

The test results for soil samples obtained from borehole BH2 at depths of between 1.5 m and 3.5 m indicate that the selected soil samples meet the Ontario Regulation 347/90 requirements for landfill acceptance.

9.0 PAVEMENT REINSTATEMENT

9.1 Pavement Structure Recommendations

The pavement structure thicknesses presented in Table 6 are defined by the City of Niagara Falls standard section for the class of road, and are based on a 20-year design life. Though no traffic data or pavement design criteria were available, the pavement design section does take into account the accepted design practice that the total pavement structure thickness should be as close as practicable to or exceed one-half the anticipated depth of frost penetration for the geographical area, being 1.2 m in the City of Niagara Falls area (i.e. 600 mm).

Table 6: Pavement Structure Layer Thicknesses

Pavement Structure Layer	Pavement Structure Layer Thicknesses City of Niagara Falls Standard Section	
HI 3 Surface Course Asphalt	40 mm	
HI 8 Binder Course Asphalt	80 mm	
Granular Base (OPSS Granular A)	150 mm	450 mm
Granular Subbase (OPSS Granular B Type II)	300 mm	-
Total Thickness	570 mm	

Granular Base Course and Subbase

The granular base course materials should meet OPSS Granular “A” specifications. Quarried 20 mm limestone, crushed to Granular "A" gradation specifications is recommended. If the option with granular subbase material is used, the granular subbase should meet OPSS Granular B Type II requirements for 100 percent crushed quarried bedrock (50 mm crusher-run limestone).

Hot Mix Asphalt

The binder course asphalt should meet current OPSS 1150 specifications for HL 8.The surface course asphalt should meet current OPSS 1150 requirements for HL 3. Pavement asphalt transitions from new to existing should be in accordance with OPSS 310.

The standard asphalt binder grade for the climate conditions in Niagara Falls is PG 58-28. Given the anticipated low volume of commercial truck traffic it is considered that there is no requirement for a bump up to a higher PG grade of asphalt cement.

Compaction

Granular base course and subbase course fill material should be compacted to 100 percent Standard Proctor Density. Hot mix asphalt should be compacted to the criteria set out in the City of Niagara Falls Engineering Design Guidelines Manual, Section 2.

9.2 Subgrade Preparation

The subgrade conditions and bearing strength may be variable along the road section and some subgrade repairs should be anticipated. It is recommended that prior to the placement of pavement granular fill, the exposed subgrade soil should be inspected and proof-rolled using a loaded tandem axle truck to traverse the exposed subgrade and provide for full coverage. The proof-rolling should be monitored by a geotechnical representative of this office to delineate any soft areas which may require repair. Repairs should be undertaken to avoid creating "*bathtub*" conditions in the subgrade within the pavement structure.

9.3 Reclamation and Reuse of Existing Pavement Materials

The existing bituminous material and granular could be considered for reclamation and reuse however it may not be practical and cost-effective since the quality of the recovered material is expected to be quite variable.

10.0 CLOSURE

The Limitations of Report, as stated in Appendix A, are an integral part of this report.

Soil samples will be retained and stored by Landtek for a period of three months after the report is issued. The samples will be disposed of at the end of the three month period unless a written request from the client to extend the storage period is received.

We trust this report will be of assistance with the design and construction of the proposed development. Should you have any questions, please do not hesitate to contact our office.

Yours sincerely,

LANDTEK LIMITED

Isaac Asonya, EIT
Author

James Dann, B. Eng. (Hons)
Geotechnical Manager



Ralph Di Cienzo, P. Eng.
Consulting Engineer

REFERENCES

[1] Freenstra, B.H, 1984 Quaternary Geology of the Niagara-Welland Area, Ontario Geological Survey, Map 2496, Quaternary Geology Series, scale 1: 50 000, Geology 1969-1972.

[2] Liberty, B.A., Feenstra, B.H. and Telford, P. G. 1976. Paleozoic Geology, Niagara, southern Ontario; Ontario Division of Mines, Map 2344, Geol. 1: 50 000.

[3] Geotechnical Investigation Report, Proposed Warren Woods Phase 5, Niagara Falls, Landtek Limited Report #16416, April 10, 2017.

APPENDIX A
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

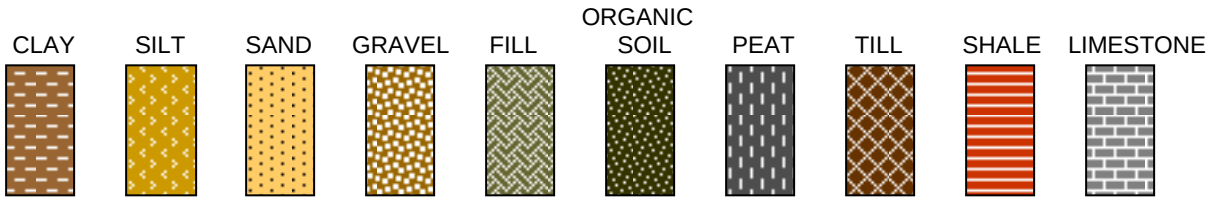
The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the 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, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX B
SYMBOLS AND TERMS USED IN THE REPORT



RELATIVE PROPORTIONS

Term	Range
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder ---------- > 200 mm
Cobble ---------- 80 mm – 200 mm
Gravel -
Coarse ---------- 19 mm – 80 mm
Fine ---------- 4.75 mm – 19 mm
Sand -
Coarse ---------- 4.75 mm – 2 mm
Medium -------- 2 mm – 0.425 mm
Fine ---------- 0.425 mm – 0.75 mm
Silt ---------- 0.075 mm – 0.002 mm
Clay ---------- < 0.002 mm

DENSITY OF NON-COHESIVE SOILS

Descriptive Term	Relative Density	Standard Penetration Test
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50 Blows Per 300 mm Penetration

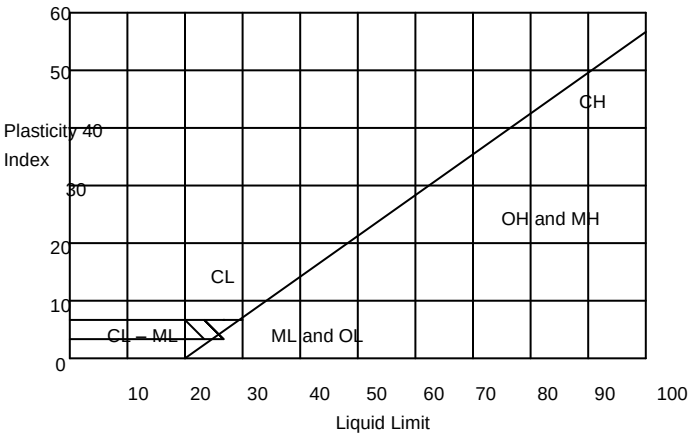
CONSISTENCY OF COHESIVE SOILS

Descriptive Term	Undrained Shear Strength kPa (psf)	N Value Standard Penetration Test	Remarks
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

APPENDIX B CONTINUED
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

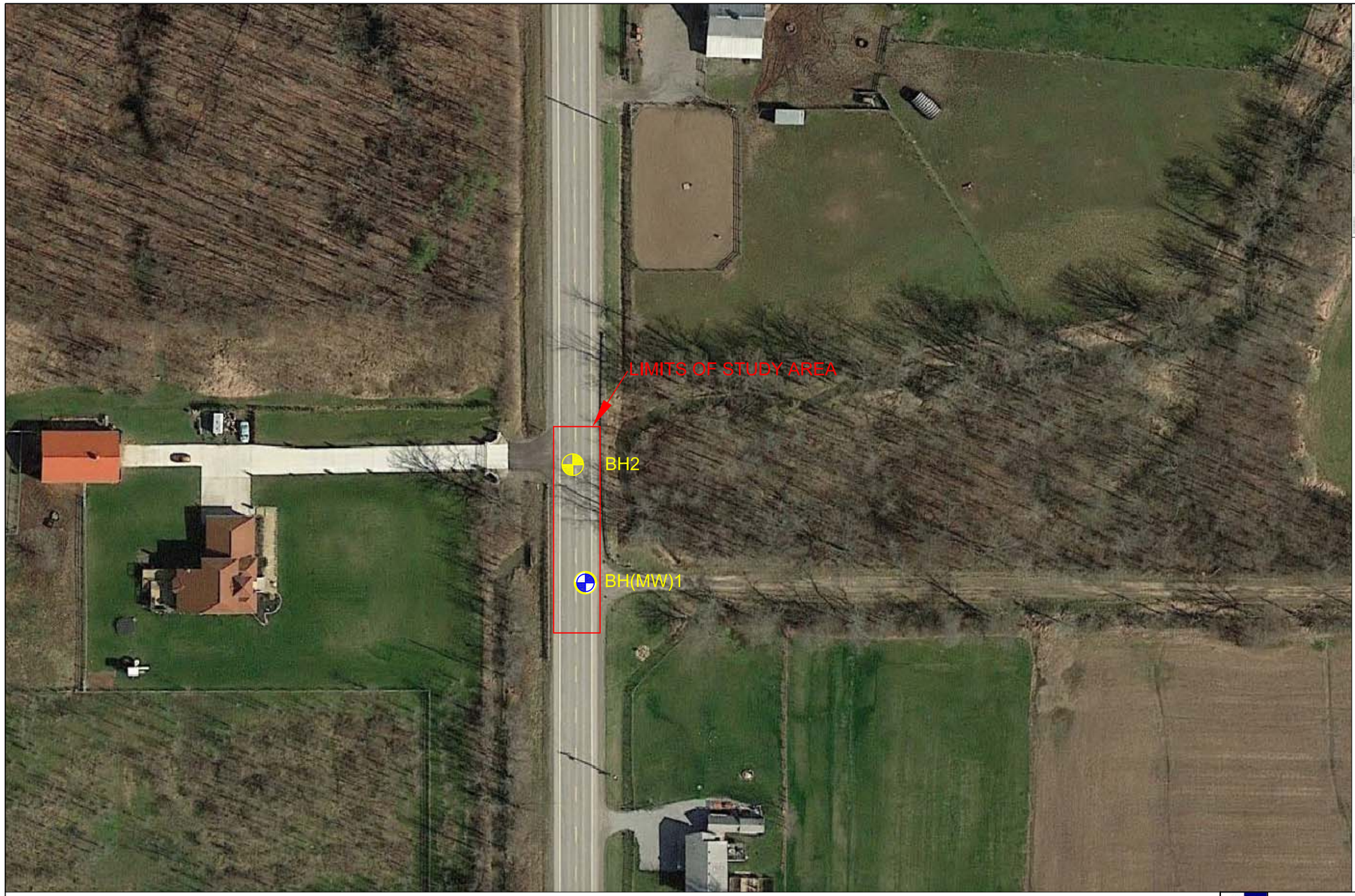
Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 4 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; C_z = $(D30)^2$/(D10xD60) between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; C_z = $(D30)^2$/ (D10xD60) between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20)		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		

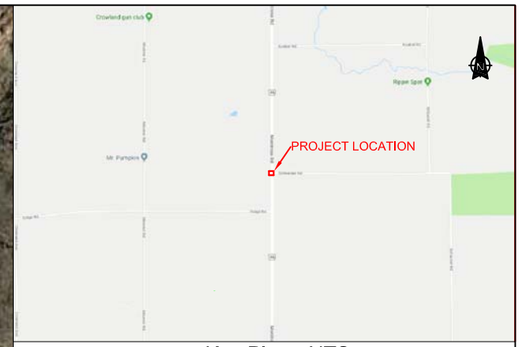


APPENDIX C

DRAWING 1 - SITE PLAN SHOWING BOREHOLE LOCATIONS

LOGS OF BOREHOLES





Key Plan - NTS

LEGEND

- Approximate location of boreholes drilled by Landtek Limited on February 22, 2018.
- Approximate location of monitoring well installed by Landtek Limited on February 22, 2018.

NOTES

1. Base plan provided by google maps.
2. Borehole locations are considered approximate.

N

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DRAWING:	Borehole Location Plan
PROJECT:	Geotechnical Investigation Report Montrose Road and Schneider Road, Niagara Falls, Ontario

SCALE:	NTS	**PROJECT NO.**	18025
DATE:	May, 2018	**DRAWING NO.**	3

LANDTEK LIMITED

BH/MW 1

Project No.:	18025	Drill Date:	February 22, 2018
Project:	Geotechnical Investigation Report	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Montrose Road, Niagara Falls, Ontario	Datum:	Existing Pavement Surface

Material Description	Elev. Depth	Samples No.	Type	SPT "N" Value	Soil Moisture (%)	GWL	Test Data
Ground Surface							Flushmount
±165 mm of Asphalt	0.0						
± 510 mm Sand and Gravel (Fill)							
FILL: silty clay, some gravel, brown and black, compact, moist	0.68						
at 1.8 m: wet		1	SS	20	16	WL = 2.0m April 13, 2018	
SILTY CLAY: brown and reddish brown, very stiff, moist	3.0	2	SS	20	26		bentonite backfill to ground level
4.5 m to 7.9 m: homogeneous, brown, stiff to very stiff, moist		3	SS	15	29		
		4	SS	16	20		
7.9 m to 10.7 m: grey, very moist		5	SS	12	33		sand backfill to 7.4 m; 7.6 m; 3.0 m of slotted 50 mm dia. PVC pipe
CLAYEY SILT: brown and grey, stiff, very moist	10.7	6	AUG	10	31		10.6 m
END OF BOREHOLE	11.2						

Notes:
1. On completion, borehole open to 10.6 m.
2. Water seepage encountered at 9.4 m.
3. Water level reading: WL at 2.0 m depth on April 13, 2018.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

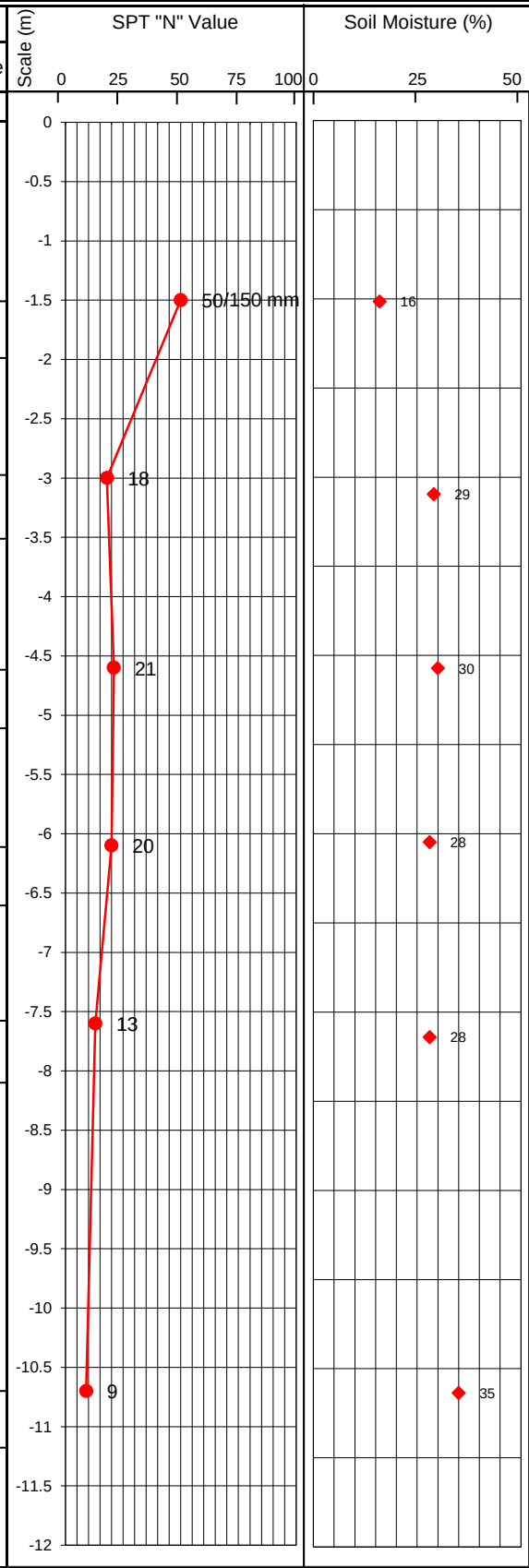
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LANDTEK LIMITED

BH 2

Project No.:	18025	Drill Date:	February 22, 2018
Project:	Geotechnical Investigation Report	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Montrose Road, Niagara Falls, Ontario	Datum:	Existing Pavement Surface

Material Description	Elev. Depth	Samples No.	Samples Type	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface								
±180 mm of Asphalt	0.0							
± 450 mm of Sand and Gravel (FILL)								
FILL: silty clay and limestone fragments, brown, very dense, moist	0.63	1	SS	50/150 mm	16			
SILTY CLAY: trace shale, brown and grey, very stiff, moist	3.0	2	SS	18	29			
		3	SS	21	30			
		4	SS	20	28			
7.5 m to 11.1 m: stiff		5	AUG	13	28			
10.6 m to 11.1 m: grey, very moist		6	AUG	9	35			
END OF BOREHOLE	11.1							



Notes:
1. On completion, borehole open to 10.6 m.
2. No groundwater encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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APPENDIX D

ENVIRONMENTAL ANALYTICAL REPORT

ANALYTICAL REPORT

Summary of Guideline Exceedances

ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit
Guideline						
Ontario Regulation 153/04 - April 15, 2011 Standards - T3-Soil-Ind/Com/Commu. Property Use (Fine)						
L2062209-1	BH1-SS1	Physical Tests	Conductivity	3.37	1.4	mS/cm
L2062209-2	BH1-SS2	Physical Tests	Conductivity	1.96	1.4	mS/cm
L2062209-3	BH1-SS2 AND SS3	Physical Tests	Conductivity	2.89	1.4	mS/cm

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Sample Preparation - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
Analyte	**Unit**	**Guide Limits #1**	**#2**	
Initial pH	pH units	-	-	9.23
Final pH	pH units	-	-	5.86

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Physical Tests - SOIL

		Guide Limits						
Analyte	**Unit**	**#1**	**#2**					
Lab ID				L2062209-1	L2062209-2	L2062209-3	L2062209-5	L2062209-6	L2062209-7
Sample Date				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
Sample ID				BH1-SS1	BH1-SS2	BH1-SS2 AND SS3	BH2-SS2 AND SS3	BH2-SS4	BH2-SS4
Conductivity	mS/cm	1.4	-	3.37	1.96	2.89	0.724	0.885	0.742
% Moisture	%	-	-	19.4	18.6	22.1	26.1	22.5	23.6
pH	pH units	-	-	7.22	7.74	7.77	7.58	7.63	7.73
Redox Potential	mV	-	-			314			318
Resistivity	ohm*cm	-	-			346			1350

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Leachable Anions & Nutrients - SOIL

			Lab ID	L2062209-3	L2062209-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS2 AND SS3	BH2-SS4
		Guide Limits			
Analyte	**Unit**	**#1**	**#2**		
Chloride	ug/g	-	-	175	23.1

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Anions and Nutrients - SOIL

			Lab ID	L2062209-3	L2062209-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS2 AND SS3	BH2-SS4
		Guide Limits			
Analyte	**Unit**	**#1**	**#2**		
Sulphate	mg/kg	-	-	13100	970

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Cyanides - SOIL

		Guide Limits					
			Lab ID	L2062209-1	L2062209-2	L2062209-5	L2062209-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
Analyte	Unit	#1	#2				
Cyanide, Weak Acid Diss	ug/g	0.051	-	<0.050	<0.050	<0.050	<0.050

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Inorganic Parameters - SOIL

		Guide Limits			
Lab ID				L2062209-3	L2062209-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH1-SS2 AND SS3	BH2-SS4
Analyte	**Unit**	**#1**	**#2**		
Acid Volatile Sulphides	mg/kg	-	-	<0.20	<0.20

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

Saturated Paste Extractables - SOIL

		Guide Limits					
Lab ID				L2062209-1	L2062209-2	L2062209-5	L2062209-6
Sample Date				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
Sample ID				BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
Analyte	**Unit**	**#1**	**#2**				
SAR	SAR	12	-	2.40	1.34	0.56	0.46
Calcium (Ca)	mg/L	-	-	504	127	64.1	84.6
Magnesium (Mg)	mg/L	-	-	94.3	172	20.9	36.3
Sodium (Na)	mg/L	-	-	224	98.6	20.3	19.9

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Metals - SOIL

			Lab ID	L2062209-1	L2062209-2	L2062209-5	L2062209-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
		Guide Limits					
Analyte	Unit	#1	#2				
Antimony (Sb)	ug/g	50	-	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	ug/g	18	-	8.8	5.8	7.1	13.5
Barium (Ba)	ug/g	670	-	58.5	165	196	142
Beryllium (Be)	ug/g	10	-	0.77	1.04	1.41	1.14
Boron (B)	ug/g	120	-	20.3	17.6	25.5	19.7
Boron (B), Hot Water Ext.	ug/g	2	-	0.34	0.19	0.37	0.43
Cadmium (Cd)	ug/g	1.9	-	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)	ug/g	160	-	21.7	27.1	38.5	31.7
Cobalt (Co)	ug/g	100	-	11.8	13.6	18.8	24.2
Copper (Cu)	ug/g	300	-	11.3	21.1	24.3	25.0
Lead (Pb)	ug/g	120	-	26.6	10.7	12.9	11.3
Mercury (Hg)	ug/g	20	-	0.0530	0.0147	0.0187	0.0189
Molybdenum (Mo)	ug/g	40	-	<1.0	<1.0	<1.0	<1.0
Nickel (Ni)	ug/g	340	-	31.0	29.9	39.2	36.6
Selenium (Se)	ug/g	5.5	-	<1.0	<1.0	<1.0	<1.0
Silver (Ag)	ug/g	50	-	<0.20	<0.20	<0.20	<0.20
Thallium (Tl)	ug/g	3.3	-	<0.50	<0.50	<0.50	<0.50
Uranium (U)	ug/g	33	-	<1.0	<1.0	<1.0	<1.0
Vanadium (V)	ug/g	86	-	38.2	39.8	52.6	45.1
Zinc (Zn)	ug/g	340	-	49.2	62.2	79.4	70.1

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Speciated Metals - SOIL

		Guide Limits					
			Lab ID	L2062209-1	L2062209-2	L2062209-5	L2062209-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
Analyte	Unit	#1	#2				
Chromium, Hexavalent	ug/g	10	-	<0.20	<0.20	0.29	0.30

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

TCLP Extractables - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Cyanide, Weak Acid Diss	mg/L	-	-	<0.10
Fluoride (F)	mg/L	-	-	<10
Nitrate and Nitrite as N	mg/L	-	-	<4.0
Nitrate-N	mg/L	-	-	<2.0
Nitrite-N	mg/L	-	-	<2.0

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

TCLP Metals - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Arsenic (As)	mg/L	-	-	<0.050
Barium (Ba)	mg/L	-	-	0.70
Boron (B)	mg/L	-	-	<2.5
Cadmium (Cd)	mg/L	-	-	<0.0050
Chromium (Cr)	mg/L	-	-	<0.050
Lead (Pb)	mg/L	-	-	<0.050
Mercury (Hg)	mg/L	-	-	<0.00010
Selenium (Se)	mg/L	-	-	<0.025
Silver (Ag)	mg/L	-	-	<0.0050
Uranium (U)	mg/L	-	-	<0.25

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

TCLP VOCs - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
1,1-Dichloroethylene	mg/L	-	-	<0.025 VTHS
1,2-Dichlorobenzene	mg/L	-	-	<0.025 VTHS
1,2-Dichloroethane	mg/L	-	-	<0.025 VTHS
1,4-Dichlorobenzene	mg/L	-	-	<0.025 VTHS
Benzene	mg/L	-	-	<0.025 VTHS
Carbon tetrachloride	mg/L	-	-	<0.025 VTHS
Chlorobenzene	mg/L	-	-	<0.025 VTHS
Chloroform	mg/L	-	-	<0.10 VTHS
Dichloromethane	mg/L	-	-	<0.50 VTHS
Methyl Ethyl Ketone	mg/L	-	-	<1.0 VTHS
Tetrachloroethylene	mg/L	-	-	<0.025 VTHS
Trichloroethylene	mg/L	-	-	<0.025 VTHS
Vinyl chloride	mg/L	-	-	<0.050 VTHS
Surrogate: 4-Bromofluorobenzene	%	-	-	91.0

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Volatile Organic Compounds - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Surrogate: 1,4-Difluorobenzene	%	-	-	91.9

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
VTHS	Volatile test was conducted on sample with headspace. Results may be biased low.

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-TCLP-WT	Waste	Cyanide for O. Reg 347	APHA 4500CN C E
CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

F-TCLP-WT	Waste	Fluoride (F) for O. Reg 347	APHA 4110 B-Ion Chromatography
HG-200.2-CVAA-WT	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

HG-TCLP-WT	Waste	Mercury (CVAA) for O.Reg 347	SW846 7470A
LEACH-TCLP-WT	Waste	Leachate Procedure for Reg 347	EPA 1311

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**

Inorganic and Semi-Volatile Organic contaminants are leached from waste samples in strict accordance with US EPA Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP). Test results are reported in leachate concentration units (normally mg/L).

MET-200.2-CCMS-WT	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

MET-TCLP-WT	Waste	O.Reg 347 TCLP Leachable Metals	EPA 200.8
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
N2N3-TCLP-WT	Waste	Nitrate/Nitrite-N for O. Reg 347	APHA 4110 B-Ion Chromatography
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
VOC-TCLP-WT	Waste	VOC for O. Reg 347	SW846 8260

A sample of waste is leached in a zero headspace extractor at 30–2 rpm for 18–2.0 hours with the appropriate leaching solution. After tumbling the leachate is analyzed directly by headspace technology, followed by GC/MS using internal standard quantitation.

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody Numbers:

17-616807

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

ANALYTICAL REPORT

Summary of Guideline Exceedances

ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit	Guideline

Federal & Provincial Waste Regulations (MAR, 2008) - Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90

(No parameter exceedances)

Federal & Provincial Waste Regulations (MAR, 2008) - Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

(No parameter exceedances)

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Sample Preparation - WASTE

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID: L2062209-4 Sample Date: 23-FEB-18 Sample ID: BH2-SS1 AND SS2
Initial pH	pH units	-	-	9.23
Final pH	pH units	-	-	5.86

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Physical Tests - SOIL

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID	Sample Date	Sample ID					
				L2062209-1	L2062209-2	L2062209-3	L2062209-5	L2062209-6	L2062209-7
				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				BH1-SS1	BH1-SS2	BH1-SS2 AND SS3	BH2-SS2 AND SS3	BH2-SS4	BH2-SS4
Conductivity	mS/cm	-	-	3.37	1.96	2.89	0.724	0.885	0.742
% Moisture	%	-	-	19.4	18.6	22.1	26.1	22.5	23.6
pH	pH units	-	-	7.22	7.74	7.77	7.58	7.63	7.73
Redox Potential	mV	-	-			314			318
Resistivity	ohm*cm	-	-			346			1350

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Leachable Anions & Nutrients - SOIL

			Lab ID	L2062209-3	L2062209-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS2 AND SS3	BH2-SS4
		Guide Limits			
Analyte	**Unit**	**#1**	**#2**		
Chloride	ug/g	-	-	175	23.1

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Anions and Nutrients - SOIL

		Guide Limits			
Lab ID				L2062209-3	L2062209-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH1-SS2 AND SS3	BH2-SS4
Analyte	**Unit**	**#1**	**#2**		
Sulphate	mg/kg	-	-	13100	970

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Cyanides - SOIL

		Guide Limits					
			Lab ID	L2062209-1	L2062209-2	L2062209-5	L2062209-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
Analyte	Unit	#1	#2				
Cyanide, Weak Acid Diss	ug/g	-	-	<0.050	<0.050	<0.050	<0.050

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Inorganic Parameters - SOIL

		Guide Limits			
Lab ID				L2062209-3	L2062209-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH1-SS2 AND SS3	BH2-SS4
Analyte	**Unit**	**#1**	**#2**		
Acid Volatile Sulphides	mg/kg	-	-	<0.20	<0.20

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Saturated Paste Extractables - SOIL

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID	Sample Date	Sample ID	
				L2062209-1	L2062209-2	L2062209-5	L2062209-6
				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
SAR	SAR	-	-	2.40	1.34	0.56	0.46
Calcium (Ca)	mg/L	-	-	504	127	64.1	84.6
Magnesium (Mg)	mg/L	-	-	94.3	172	20.9	36.3
Sodium (Na)	mg/L	-	-	224	98.6	20.3	19.9

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Metals - SOIL

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID	Sample Date	Sample ID		
				L2062209-1	L2062209-2	L2062209-5	L2062209-6	
				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	
				BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4	
Antimony (Sb)	ug/g	-	-	<1.0	<1.0	<1.0	<1.0	
Arsenic (As)	ug/g	-	-	8.8	5.8	7.1	13.5	
Barium (Ba)	ug/g	-	-	58.5	165	196	142	
Beryllium (Be)	ug/g	-	-	0.77	1.04	1.41	1.14	
Boron (B)	ug/g	-	-	20.3	17.6	25.5	19.7	
Boron (B), Hot Water Ext.	ug/g	-	-	0.34	0.19	0.37	0.43	
Cadmium (Cd)	ug/g	-	-	<0.50	<0.50	<0.50	<0.50	
Chromium (Cr)	ug/g	-	-	21.7	27.1	38.5	31.7	
Cobalt (Co)	ug/g	-	-	11.8	13.6	18.8	24.2	
Copper (Cu)	ug/g	-	-	11.3	21.1	24.3	25.0	
Lead (Pb)	ug/g	-	-	26.6	10.7	12.9	11.3	
Mercury (Hg)	ug/g	-	-	0.0530	0.0147	0.0187	0.0189	
Molybdenum (Mo)	ug/g	-	-	<1.0	<1.0	<1.0	<1.0	
Nickel (Ni)	ug/g	-	-	31.0	29.9	39.2	36.6	
Selenium (Se)	ug/g	-	-	<1.0	<1.0	<1.0	<1.0	
Silver (Ag)	ug/g	-	-	<0.20	<0.20	<0.20	<0.20	
Thallium (Tl)	ug/g	-	-	<0.50	<0.50	<0.50	<0.50	
Uranium (U)	ug/g	-	-	<1.0	<1.0	<1.0	<1.0	
Vanadium (V)	ug/g	-	-	38.2	39.8	52.6	45.1	
Zinc (Zn)	ug/g	-	-	49.2	62.2	79.4	70.1	

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Speciated Metals - SOIL

			Lab ID	L2062209-1	L2062209-2	L2062209-5	L2062209-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH1-SS1	BH1-SS2	BH2-SS2 AND SS3	BH2-SS4
		Guide Limits					
Analyte	Unit	#1	#2				
Chromium, Hexavalent	ug/g	-	-	<0.20	<0.20	0.29	0.30

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

TCLP Extractables - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	Unit	#1	#2	
Cyanide, Weak Acid Diss	mg/L	20	-	<0.10
Fluoride (F)	mg/L	150.0	-	<10
Nitrate and Nitrite as N	mg/L	1000	-	<4.0
Nitrate-N	mg/L	-	-	<2.0
Nitrite-N	mg/L	-	-	<2.0

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

TCLP Metals - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Arsenic (As)	mg/L	2.5	-	<0.050
Barium (Ba)	mg/L	100	-	0.70
Boron (B)	mg/L	500	-	<2.5
Cadmium (Cd)	mg/L	0.5	-	<0.0050
Chromium (Cr)	mg/L	5.0	-	<0.050
Lead (Pb)	mg/L	5.0	-	<0.050
Mercury (Hg)	mg/L	0.1	-	<0.00010
Selenium (Se)	mg/L	1.0	-	<0.025
Silver (Ag)	mg/L	5.0	-	<0.0050
Uranium (U)	mg/L	10	-	<0.25

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

TCLP VOCs - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
1,1-Dichloroethylene	mg/L	1.4	-	<0.025 VTHS
1,2-Dichlorobenzene	mg/L	20.0	-	<0.025 VTHS
1,2-Dichloroethane	mg/L	0.5	-	<0.025 VTHS
1,4-Dichlorobenzene	mg/L	0.5	-	<0.025 VTHS
Benzene	mg/L	0.5	-	<0.025 VTHS
Carbon tetrachloride	mg/L	0.5	-	<0.025 VTHS
Chlorobenzene	mg/L	8	-	<0.025 VTHS
Chloroform	mg/L	10	-	<0.10 VTHS
Dichloromethane	mg/L	5.0	-	<0.50 VTHS
Methyl Ethyl Ketone	mg/L	200.0	-	<1.0 VTHS
Tetrachloroethylene	mg/L	3	-	<0.025 VTHS
Trichloroethylene	mg/L	5	-	<0.025 VTHS
Vinyl chloride	mg/L	0.2	-	<0.050 VTHS
Surrogate: 4-Bromofluorobenzene	%	-	-	91.0

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

ANALYTICAL REPORT

Volatile Organic Compounds - WASTE

			Lab ID	L2062209-4
			Sample Date	23-FEB-18
			Sample ID	BH2-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Surrogate: 1,4-Difluorobenzene	%	-	-	91.9

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
VTHS	Volatile test was conducted on sample with headspace. Results may be biased low.

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-TCLP-WT	Waste	Cyanide for O. Reg 347	APHA 4500CN C E
CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

F-TCLP-WT	Waste	Fluoride (F) for O. Reg 347	APHA 4110 B-Ion Chromatography
HG-200.2-CVAA-WT	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

HG-TCLP-WT	Waste	Mercury (CVAA) for O.Reg 347	SW846 7470A
LEACH-TCLP-WT	Waste	Leachate Procedure for Reg 347	EPA 1311

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**

Inorganic and Semi-Volatile Organic contaminants are leached from waste samples in strict accordance with US EPA Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP). Test results are reported in leachate concentration units (normally mg/L).

MET-200.2-CCMS-WT	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

MET-TCLP-WT	Waste	O.Reg 347 TCLP Leachable Metals	EPA 200.8
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
N2N3-TCLP-WT	Waste	Nitrate/Nitrite-N for O. Reg 347	APHA 4110 B-Ion Chromatography
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
VOC-TCLP-WT	Waste	VOC for O. Reg 347	SW846 8260

A sample of waste is leached in a zero headspace extractor at 30–2 rpm for 18–2.0 hours with the appropriate leaching solution. After tumbling the leachate is analyzed directly by headspace technology, followed by GC/MS using internal standard quantitation.

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody Numbers:

17-616807

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

APPENDIX E

LABORATORY TEST RESULTS (SIEVE ANALYSIS)

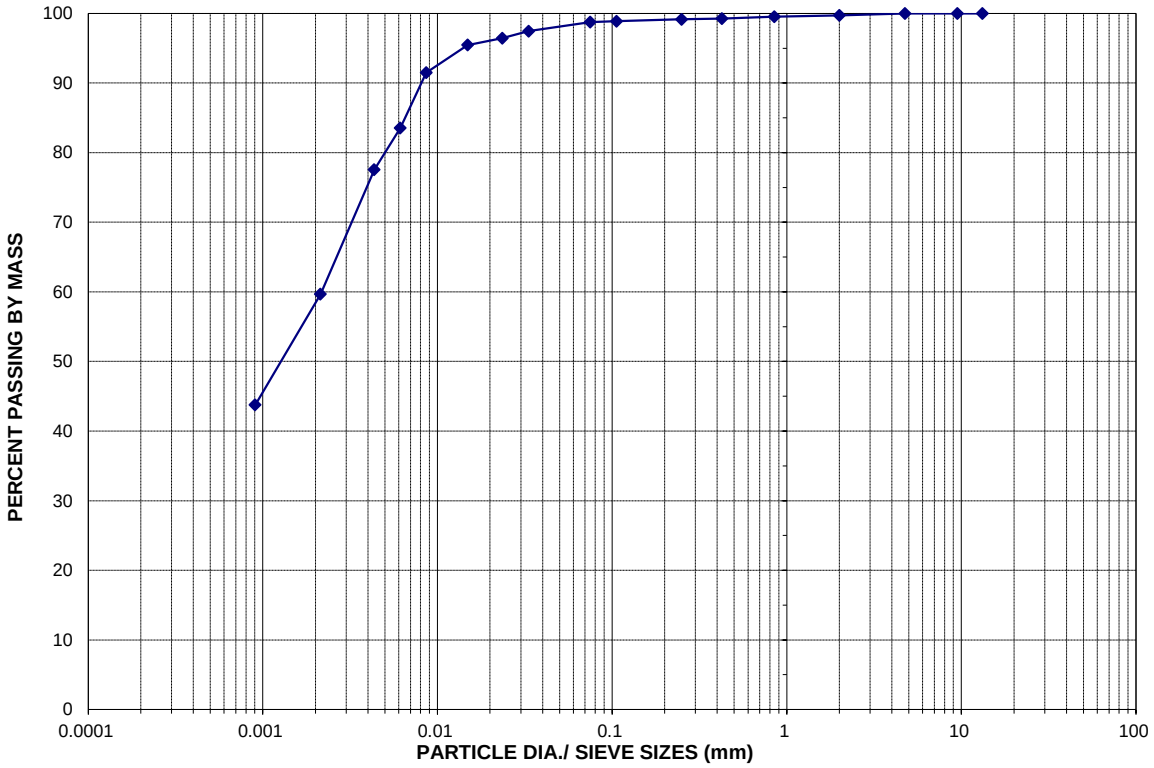
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Montrose & Schneider Road, Niagara Falls, Ontario
LOCATION: Montrose & Schneider Road, Niagara Falls, Ontario
CLIENT : Regional Municipality of Niagara
SOIL TYPE: Silty Clay (CL-ML)
SOURCE: On Site

FILE NO.: 18025
LAB SAMPLE NO.: BH1-SS4
SAMPLE DATE: February 22, 2018
SAMPLED BY: V.H.

PARTICLE SIZE DISTRIBUTION



←	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	COARSE
CLAY	SILT			SAND			GRAVEL	

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	
9.5	100.0	
4.75	100.0	
2.0	99.7	
0.850	99.5	
0.425	99.3	
0.250	99.1	
0.106	98.9	0.0% Gravel
0.075	98.7	1.3% Sand
0.0332	97.5	39.0% Silt
0.0235	96.5	59.7% Clay
0.0149	95.5	
0.0086	91.5	
0.0061	83.5	
0.0043	77.6	
0.0021	59.7	
0.0009	43.8	

LANDTEK LIMITED IS CERTIFIED FOR TESTING BY THE CANADIAN COUNCIL OF INDEPENDENT LABORATORIES (CCIL)

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Geotechnical Investigation
Proposed Culvert Rehabilitation
Montrose Road, Niagara Falls, Ontario

Prepared for:

The Regional Municipality of Niagara
Campbell West Building
1815 Sir Isaac Brock Way
Thorold, Ontario, L2V 4T7

Landtek File: 18025
May 18, 2018

EXECUTIVE SUMMARY

SCOPE OF SERVICES

Scope	The Regional Municipality of Niagara is intending to rehabilitate the existing culvert located on Montrose Road and approximately 310 m south of Koabel Road. The proposed new culvert will be an open-base type structure founded on spread footings.. No grade changes to the creek channel or road profile are proposed, with a 'restore-to-existing' reconstruction anticipated.
Report Deliverables	The purposes of the Geotechnical Investigation were to confirm the subsurface conditions at the site and to provide recommendations with regards to the installation and construction of the proposed culvert, and assess the characteristics of the soils to be excavated and their suitability for reuse.

SITE DETAILS AND SETTING

UTM 17T Coordinates	653078, 4760509	**Geodetic Elevation**	176 m
Site Description	The project site is situated approximately 320 m south of Koabel Road and about 520 m north of Schneider Road. The area surrounding the project site is covered predominately by farm fields, unmaintained grasses and some dense clusters of trees.		
Geology	A pavement structure consisting of about 150 mm to 160 mm of asphalt overlying approximately 350 mm to 380 mm of sand and gravel was encountered at the surface of the boreholes. Underlying the existing pavement structure is fill material comprised primarily of silty clay. Native silty clay deposits were encountered underlying the fill material and extend to the maximum drill depth of about 11.0 m. No bedrock was encountered during this investigation.		

ENGINEERING CONSIDERATIONS

Foundations	It is considered by Landtek that bearing conditions to support a lightly loaded structure on concrete footings can be provided by the native silty clay soils.
Settlements	The general limiting of the total settlement of 25 mm and the differential settlement to 19 mm by the recommended geotechnical reaction at the SLS is considered appropriate for the native soils at the site.
Earthquake Considerations	The subject property is considered to be an 'D' Site Class

CONSTRUCTION CONSIDERATIONS

Excavations	The subsurface soils to be encountered during excavation at the site are expected, in general, to behave as Type "2" and Type "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the generally loose to compact fill material. The stiff to very stiff silty clay soils are considered Type "2" soils.
Dewatering	It is expected that construction measures will be required to address both surface water and ground water control. Water levels in the watercourse will vary with the season of the year and groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction.

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1.0 INTRODUCTION

Landtek Limited (herein "*Landtek*") is pleased to submit the geotechnical investigation report for the proposed culvert rehabilitation on Montrose Road in Niagara Falls, Ontario. Authorization to proceed with the work was received from Mr. Brian Ellis of Ellis Engineering Inc. herein ("*Ellis*") on behalf of the Regional Municipality of Niagara (herein "*Niagara Region*") in February 2018.

It is understood that the existing culvert, located on Montrose Road and approximately 310 m south of Koabel Road is to be rehabilitated. The proposed new culvert will be an open-base type structure founded on spread footings. No grade changes to the creek channel or road profile are proposed, with a "*restore-to-existing*" reconstruction anticipated.

The primary objectives of this investigation were:

- To confirm the subsurface soil and groundwater conditions for the culvert design and construction;
- Provide installation and construction recommendations with regards to the proposed culvert; and,
- Assess the characteristics of the soils to be excavated and their suitability for reuse on site.

This report has been prepared for Niagara Region, their nominated engineers, designers, and project managers for the proposed culvert rehabilitation. Further dissemination of this report is not permitted without Landtek's prior written approval. Further details of the limitations of this report are presented in Appendix A.

2.0 METHODOLOGY

Fieldwork undertaken at the site by Landtek included clearance of underground services, borehole layout, borehole drilling and soil sampling, field supervision, and traffic management. A total of two boreholes (boreholes BH/MW3 and BH4) were drilled through the existing road surface on Montrose Road on February 22, 2018. All boreholes were logged using those standard symbols and terms defined in Appendix B. The borehole location plan, Drawing 3, and the borehole logs are provided in Appendix C.

Boreholes BH1, BH2, BH5 and BH6 were drilled adjacent to two additional culvert structures located on Effingham Street and Montrose Road, in conjunction with this investigation. A geotechnical investigation report was prepared for each of the three (3) culvert sites.

All boreholes were drilled using a truck mount drilling rig equipped with continuous flight, hollow stem augers, and were advanced to a maximum depth of about 11.0 m below existing pavement surface.

One, 50 mm diameter monitoring well was installed in borehole BH/MW3 to a depth of approximately 10.6 m below existing pavement surface to monitor groundwater conditions. The monitoring well consisted of new/sealed 50 mm polyvinyl chloride (PVC) screen with No.10 slots threaded onto a matching riser. The screens and riser were pre-threaded including o-ring seals such that no glues or solvents were used to connect the pipe sections. The annular space between the PVC well and the borehole was backfilled to approximately 0.6 m above the top of the screen section with sand pack, and then with borehole cuttings and bentonite to approximately 0.1 m below existing pavement surface. A J-Plug lockable air-tight cap was installed on the riser, and an aluminum flush mount casing then placed over the well and sealed with concrete. The borehole logs in Appendix C present the monitoring well installation details and the results of a subsequent water monitoring visit completed on April 13, 2018.

The soil samples were then transported to Landtek's in-house, Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture contents were carried out on all samples. Sieve testing for soil samples from each borehole was undertaken and selected composite soil samples taken from each borehole were submitted for chemical analyses to ALS Environmental.

Borehole strata depths are referenced to the top of the existing pavement surface at each respective location, and borehole locations have been established by Landtek relative to site measurements.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Location

The site is located on Montrose Road in Niagara Falls, Ontario, and is centered at approximate grid reference 653078, 4760509 (UTM 17T coordinates). The Geodetic elevation of the ground surface at the boreholes is approximately 176 m.

The site location is shown in Figure 1 below.



Figure 1
Site Location

The project site is situated approximately 320 m south of Koabel Road and about 520 m north of Schneider Road. The area surrounding the project site is covered predominately by farm fields, unmaintained grasses and some dense clusters of trees.

3.2 Subsurface Conditions

Based on published geological information[1,2] and previous geotechnical experience[3] for the area, the predominant native overburden soils consist of glaciolacustrine deeper water clay and silt deposits. The bedrock in the area is identified as argillaceous dolostone and shale of the Salina Formation.

The borehole information is generally consistent with the geological data, and the predominant soils comprise of clay and silt deposits. No bedrock was encountered during this investigation. The detailed borehole logs are presented in Appendix C, and the ground conditions encountered by the boreholes are discussed further in the following sections.

Existing Pavement Structure

All boreholes were drilled through the existing pavement structure on Montrose Road. The asphalt thickness ranges from 150 mm to 160 mm at the borehole locations. Pavement granular material was encountered in all boreholes underlying the asphalt, and consisted of approximately 350 mm to 380 mm of sand and gravel.

Fill

Fill material comprising predominantly of silty clay was encountered in all the boreholes underlying the existing pavement structure and extends to a depth of approximately 3.0 m below existing pavement surface. The fill contains some limestone fragments and is primarily brown in colour. SPT 'N' values of 8 to 9 were reported, indicating the fill to be of a loose condition. Moisture contents range from 8 % to 20 %.

Silty Clay

Silty clay deposits were encountered underlying the fill material in all boreholes at depths of 3.0 m and extend to the terminus of the boreholes at a depth of approximately 11.1 m below the existing pavement surface. The silty clay is brown and occasionally grey in colour. SPT 'N' values of 8 to 25 were reported, indicating the silty clay to be of a firm to very stiff, but generally very stiff condition. Moisture contents range from 24 % to 35 %.

The particle size analysis results indicate that the soil is comprised of approximately the following characteristics:

BH3/SS4 0.0 % Gravel; 0.9 % Sand; 44.4 % Silt; 54.7 % Clay

Based on the above, the soil is classified as a CL-ML (Silty Clay) type soil according to the Unified Soil Classification Chart (ASTM D2487-06-Table 1).

The hydraulic conductivity of the Silty Clay is approximately 1 $x10^{-6}$ cm/s, and the estimated percolation (T time) is expected to be approximately 40 min/cm.

Bedrock

Bedrock was not encountered during this investigation.

Groundwater

Groundwater was not observed during drilling in all boreholes, however a monitoring well was installed in borehole BH/MW3, and a water level was subsequently measured from the installed monitoring well on April 13, 2018. A water level reading in the monitoring well was recorded and is summarized in Table 1.

Groundwater conditions and surface water flow conditions in the existing creek are expected to vary according to the time of the year and seasonal changes in precipitation. Water seepage is also expected from soil fissures above the water table in the fill.

Table 1: Summary of Water Level Measurements

Borehole ID	Date Drilled	Water Strike	Measured Water Level	
		(mbps*)	Depth (mbps*)	Date
BH/MW3	February 22, 2018	-	3.5	April 13, 2018

* mbps metres below existing pavement surface

4.0 CULVERT DESIGN CONSIDERATIONS

It is understood from Ellis that the new culvert structure is to be an open-base type structure founded on spread footings. It is anticipated that the existing culvert and associated infrastructure located on site will be removed in full, and no grade changes are proposed.

4.1 Culvert Foundation Considerations

The fill encountered in the boreholes is not considered suitable as a bearing stratum due to the high risk of unacceptable settlements. The underlying native soil represents a satisfactory bearing stratum, with negligible settlements anticipated under the weight of the new culvert structure. As such, it is deemed that deep foundation solutions will not be required. It is considered by Landtek that the culvert structure can be adequately supported by reinforced concrete spread footings founded in the native silty clay soil for a geotechnical reaction at the SLS of 150 kPa, and a factored geotechnical resistance at the ULS of 225 kPa

Subsurface conditions can vary over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. Therefore, a Geotechnical Engineer should be engaged during construction to examine the exposed sub-soil quality and condition, and confirm the subsurface conditions are consistent with design assumptions. This is in compliance with field review requirements in the National Building Code, Volume 1, Clause 4.2.2.3.

4.2 Support Considerations for Box Culverts

Subgrade preparation work will be required to provide suitable bearing and ground support conditions. The design should include a granular pad of Ontario Provincial Standard Specification (herein "*OPSS*") 1010 Granular A to provide a working mat to facilitate placement of the box sections and a more uniform support condition under the box structure. The minimum thickness of the layer should be 300 mm.

In the event that there is significant water seepage into the excavation it may be an advantage to substitute clear 19 mm stone in place of Granular A for the granular pad. The clear stone fill should allow for the free movement of water through the construction area and should meet the requirements of OPSS 1004 for Type 2, 19 mm clear stone.

It is recommended that the clear stone base layer receive mechanical compaction however the density of clear stone cannot be reliably measured with conventional nuclear density testing equipment such that the required amount of compaction effort will be a field judgment based on the compaction equipment used, the lift thickness, and the type of clear stone material.

4.3 Culvert Settlement Considerations

It is anticipated that of the loads to be applied to the ground by the replacement culvert structure will be of a generally low intensity. As such, associated settlements of the footings on undisturbed native soils are expected to be within the normally tolerated limits of 25 mm total, and 19 mm differential movement for the recommended geotechnical reaction at the SLS.

It is recommended that wherever possible the bearing stratum should be the same throughout the entire footprint of the structure to minimize the potential for differential settlement.

4.4 Seismic Design Considerations

In accordance with Section 4.4.3 and Table 4.1 of the CHBDC S6-14 the subject property is considered to be a “D” Site Class. The corresponding site coefficients, F(T), F(PGA), and F(PGV), should be determined from Tables 4.2 to 4.9 of the CHBDC for the above recommended Site Class.

4.5 Frost Susceptibility

The native superficial soils encountered at the site comprise silt and clay and are considered sensitive to water and frost; i.e. their physical and mechanical properties are dependent on in-situ moisture content. As such, the shallow soils at the site are considered to have a moderate to high frost susceptibility, being classified as Frost Group “*F4*” (Table 13.1 of the “*Canadian Foundation Engineering Manual*”, 4th Edition). The maximum depth for frost penetration is 1.2 m in the Niagara Region area. It will be important to ensure that any proposed, shallow seated footings will have a minimum of 1.2 m of soil cover, or equivalent insulation product, for frost protection.

4.6 Concrete Placement Considerations

The water levels in the watercourse at the site are expected to vary depending upon precipitation levels and the time of the year. In high flow periods appropriate construction methods will have to be implemented to divert and control water flow in order to facilitate placing concrete and/or granular materials for new foundations.

5.0 LATERAL EARTH PRESSURE CONSIDERATIONS FOR WINGWALLS

The earth pressure, p, acting on abutments and soil retaining wall systems at any depth, h, in metres below the ground surface assumes an equivalent triangular fluid pressure distribution and may be calculated using expression (1) below. It is assumed that granular material is used as backfill in the road. Allowances for pressure due to compaction operations should be included in the earth pressure determinations as per CHBDC Commentary clause C6.12.3. A value of 12 kPa is applicable for a vibratory compactor and granular material.

If the structure retaining soil can move slightly, the active earth pressure case can be used in determining the lateral earth pressure. For restrained structures and no yielding an “at rest” earth pressure condition should be used. The determination of the earth pressures should be based on the following expression:

$$p = K (\delta h + q) \qquad (1)$$

where:

p = the pressure in kPa acting against any subsurface wall at depth, h, in metres (feet) below the ground surface;

K = the earth pressure coefficient considered appropriate for subsurface walls; (see Table 2).

δ = the moist bulk unit weight of the retained backfill (see Table 3).

and,

q = the value for any adjacent surcharge in kPa which may be acting close to wall

h = the depth, in m, at which the pressure is calculated

The backfill behind retaining structures is assumed to meet an OPSS 1010 Granular B Type 1 pit-run sand and gravel material as a minimum specification. Should an OPSS 1010 Granular A material be used, then the effective angle of friction should be taken as approximately 37°, with a corresponding at rest earth pressure coefficient, K_O, of 0.40. This is based on a backfill compaction specification with a target of 98 % Standard Proctor Maximum Dry Density (herein “*SPMDD*”) and no individual tests below 96 % SPMDD.

Table 2: Recommended Unfactored Earth Pressure Parameters

Earth Pressure Condition	Unfactored Earth Pressure Parameters			
	OPSS 1010 Granular B Type I		OPSS 1010 Granular A	
	Earth Pressure Coefficient	Estimated Moist Unit Weight	Earth Pressure Coefficient	Estimated Moist Unit Weight
Active	$K_a = 0.31$	22 kN/m^3	$K_a = 0.25$	23 kN/m^3
At-Rest	$K_0 = 0.47$		$K_0 = 0.40$	

6.0 SUBSURFACE CONCRETE

6.1 Soil Corrosivity

A total of two selected soil samples were submitted for chemical analyses to ALS Environmental for analysis of PH, soil conductivity and redox potential, and concentrations of sulphides and chlorides.

The American National Standards Institute (ANSI)/ American Water Works Association (AWWA) 10-point scoring method was used to determine the soil corrosivity potential. For each given soil sample, points were assigned to the different parameters to evaluate their contribution towards the corrosivity of soil.

Corrosion protection for buried metallic improvements or steel are recommended, when a score of 10 points or greater is reported. The test results are provided in Appendix D and are summarized in Table 3 below, with the respective ANSI/AWWA point rating.

Table 3: Results of Soil Corrosivity Potential

Sample ID	Composite Sample Depth	Parameters Analysed	Measured Value	ANSI/AWWA Point Rating	Total ANSI/AWWA Points
BH3-SS3 AND SS4	4.5 m – 6.5 m	Sulphide (%)	<0.20	0	10
		pH (ph units)	7.83	0	
		Resistivity (ohm.cm)	791	8	
		Redox Potential (mV)	298	0	
		Moisture (%)	22.2	2	
BH4-SS4 AND SS5	6.2 m – 8.2 m	Sulphide (%)	<0.20	0	10
		pH (ph units)	7.96	0	
		Resistivity (ohm.cm)	876	8	
		Redox Potential (mV)	230	0	
		Moisture (%)	20.5	2	

Based on the total ANSI/AWWA values of 10 within the native soils, it is considered that the soils at the site have a corrosion potential. Therefore corrosion protection is recommended for buried metallic improvements or steel in the soil.

The contribution of chloride ions to soil corrosivity towards buried metallic improvements or reinforced concrete structures is very significant. According to the Corrosion Guidelines (Caltrans, January 2015, version 2.1), a site is considered corrosive if, "*chloride concentration is 500 ppm or greater, sulphate concentration is 2000 ppm or greater, or the pH is 5.5 or less*. "

In addition, the Canadian Standards Association (CSA) A23.1-09 "*Concrete materials and methods of concrete construction*", Table 3, "*Additional requirements for concrete subjected to sulphate attack*", states that design requirements for sulphate resistant concrete are only necessary when the water soluble sulphate content of the soil in which the concrete is to be embedded is greater than 0.1 % (1,000 mg/kg).

The representative soil samples at the site contain sulphate and chloride ion concentrations of up to 1620 mg/kg and 20.6 µg/g respectively. This given, the soil environment within native soils should be considered "*moderately*" corrosive towards concrete.

6.2 Concrete Class Considerations

The water level in the creek at the site is expected to vary depending upon precipitation levels and the time of the year. In high flow periods appropriate construction methods will have to be implemented to divert and control water flow in order to facilitate placing concrete for new foundations.

The requirements for subsurface concrete subject to a sulphate environment are presented in Canadian Standards Association (CSA) specification CAN/CSA-A3000-13. The results of chemical tests indicate that the soils have a low chloride concentration and generally moderate sulphate environment. It is recommended that subsurface concrete at the site have the following characteristics for an S-3 exposure class:

- minimum 28-day compressive strength = 25 MPa;
- minimum 56-day strength = 30 MPa;
- maximum water to cement ratio = 0.50;
- cementing materials:
  MS hydraulic cement or MSb; as per tables 3 and 4 respectively in CSA A23.1-14; and,
- air content:
  4 – 7 % for 14 mm to 20 mm nominal size coarse aggregate
  3 – 6 % for 28 mm to 40 mm nominal size coarse aggregate

The concrete should be placed without segregation and should be consolidated to achieve a uniform dense mass.

6.3 Methods for Specifying Concrete

Alternative methods of specifying concrete for a project are outlined in CSA A23.1-14 and allow for "*Performance*" or "*Prescription*" based methods. Each method attaches different levels of responsibility to the owner, the contractor, and the concrete supplier. The pros and cons of each method should be examined prior to completion of the specifications for the project.

7.0 EXCAVATION AND BACKFILL CONSIDERATIONS

7.1 Excavation Considerations

All temporary excavations and unbraced side slopes in the soils should conform to standards set out in the Occupational Health and Safety Act, Ontario Regulation 213/91 "*Construction Projects*" (herein "*OHSA*"). The subsurface soils to be encountered during excavation at the site are expected, in general, to behave as Type "2" and Type "3" materials according to the OHSA classification in Part III. Type 3 materials are characteristic of the generally loose to compact fill material. The stiff to very stiff silty clay soils are considered Type "2" soils.

It should be possible to excavate the overburden soils with a hydraulic backhoe. Moist Type 3 and Type 2 soils are expected to be stable for short construction periods at slopes of approximately 45° to the horizontal (i.e. 1V:1H). In Type 2 soil, the sides of a trench will remain vertical for a short period of time with no apparent tension cracks, and trench walls should be sloped to within 1.2 m of the trench bottom. According to the OHSA the excavation slope should be cut and shaped to meet the OHSA requirements for the soil with the highest classification number

It is expected that construction measures will be required to address both surface water and ground water control. Water levels in the watercourse will vary with the season of the year and groundwater seepage is expected to be variable and will depend upon the depth of the excavations, the time of year, and precipitation levels preceding construction. Water seepage in open cut excavations should be expected below the watercourse water level. The ground water seepage rate will depend upon the thickness and frequency of permeable layers and seams in the existing fill and native soils. Contractors bidding on construction should be prepared to address variable surface water flow conditions as well as variable ground water seepage control conditions.

7.2 Excavation Dewatering Considerations

Where groundwater dewatering volumes are to be in excess of 50,000 litres per day but less than 400,000 litres per day, then a construction project will require registration online with the MOECC Environmental Activity and Sector Registry (EASR). For amounts greater than 400,000 litres per day a Category 3 Permit To Take Water (herein "*PTTW*") will be required.

In order to enable the construction of the proposed culvert, it is anticipated that temporary surface water control will be in the form of sheet piles; diverting the surface water flow and allowing the work area for construction to be exposed. In this circumstance, and assuming a suitably watertight sheet pile construction, groundwater volumes are anticipated to be below the threshold for water pumping permitting (i.e. less than 50,000 litres per day), and will be manageable using sump pumps per standard construction dewatering practices.

Based on the groundwater conditions encountered and the permeability of the soils present beneath the site it is anticipated that any excavation to be extended below the reported water seepage levels can be dewatered using sump pumps per standard construction dewatering practices. As such, construction dewatering volumes in excess of 50,000 litres per day are not anticipated.

7.3 Embankment Fill Materials

Embankment fill can consist of clean compactable earth fill that meets suitable environmental soil quality limits, or imported granular. If imported granular is used it should meet OPSS 1010 Granular B Type 1 specifications as a minimum requirement.
Embankment fill such as commercial grade granular materials can be expected to undergo settlements in the order of 1 % of the fill height, with the majority of the fill settlement expected to occur during the construction period of the new structure. Additional long-term consolidation settlement of embankment fill areas is expected to be negligible.

Embankment fill placement should be in accordance with the following recommendations:

1. Embankment fill should only be placed in an area that has been satisfactorily prepared by stripping surface organic soils and vegetation, and proof-rolling the native exposed soil with at least 5 passes of a minimum 10 ton static pad-foot steel drum type roller. Construction of embankment fill areas should be undertaken in a tiered progressive operation with the bottom foundation layer being compacted first;

2. Fill should be placed in maximum 300 mm loose lifts. The target compaction value should be 97 % SPMDD on each lift, with no individual tests being less than 95 % SPMDD. The placement and compaction of each lift should be monitored full time by Landtek Limited, with in-place compaction determined using nuclear moisture/density testing equipment; and,

3. Fill layers that do not meet the compaction requirements, or become wet or frozen, should not be approved for the placement of additional material.

7.4 Embankment Fill Stability and Side Slopes

Embankment side slopes with earth fill should be designed at a long term stable slope of 1V:3H, or approximately 18° to the horizontal.

Where imported granular materials are used for the embankment fill the estimated angle of repose for Granular B Type I material is expected to be in the range of 30° to 32° to the horizontal, such that side slopes should be at approximately 1V:2H.

8.0 ENVIRONMENTAL CONSIDERATIONS AND SOIL MANAGEMENT

Soil samples taken from each borehole were submitted for chemical analyses to ALS Environmental to determine a variety of parameters including metals and inorganic properties *(Regulation 153/04*) and analysis of Ontario Regulation 347/90 Toxicity Characteristics Leaching Procedure (herein "*TCLP*") for metal and inorganics, polychlorinated biphenyls (herein *"PCBs") and* volatile organic compounds *(herein "VOCs").*

The test results are provided in Appendix D and are summarized in Table 4 of this report in relation to the Industrial/Commercial/Community (ICC) land use soil quality standards given in the Table 3 of the MOECC document, "*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*", dated April 15, 2011.

Table 4: Summary of O. Reg. 153 Metals & Inorganics Test Data

Sample ID	Sample Depth	Parameters Analyzed	MOECC Table Comparison	
			Table 3 (ICC)	Exceedance
BH3-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 153 Metals & Inorganics	×	EC*
BH3-SS3	4.5 m – 4.9 m	O. Reg. 153 Metals & Inorganics	×	EC*
BH4-SS3	4.5 m – 5.1 m	O. Reg. 153 Metals & Inorganics	×	EC*
BH4-SS4 and SS5	6.0 m – 8.0 m	O. Reg. 153 Metals & Inorganics	✓	-

* Electrical Conductivity
✓ Meets MOECC Table 3 soil quality guidelines

The test results for metals and inorganic parameters indicate that the selected subgrade soil samples obtained from the boreholes all meet soil quality requirements for MOECC Table 3 ICC, with the exception of the Electrical Conductivity (EC) levels that exceed Table 3 ICC requirements.

Elevated Electrical Conductivity (EC) values are commonly associated with impacted conditions from long term use of road salt. Section 2 of Ontario Regulation 339 of the Revised Regulations of Ontario, 1990 (Classes of Contaminants – Exemptions) indicates that elevated residual road salt parameters in soils within the road allowance that result from winter salting that was placed to address safety issues are not regarded as an environmental problem that requires remediation. Based on the results of the chemical analysis, the soils represented by the samples analysed with EC impacts may be reused within the site area as the site is to remain a Municipal right of way (or "*highway*", as defined by the Highway Traffic Act).

Some variability in soil quality parameters may occur within a given sample as well as throughout a site. If excavated subgrade soils with EC impacts are to be disposed of off-site it should be noted that there may be soil quality criteria established for the site that is to receive the excavated materials. As such, the owners or operators of potential receiving sites must be notified of the environmental quality of the material and must agree in writing to accept the material. Some variability in soil quality parameters may occur along the length of a road section, and the contractor may be required to complete testing to address a designated list of chemical parameters for the receiving site.

One sample was analyzed for waste classification by ALS Environmental in accordance with Ontario Regulation 347/90 TCLP procedures for metals and inorganics, PCBs, and VOCs for landfill acceptance. The test results are provided in Appendix D and are summarized in Table 5.

Table 5: Summary of Ontario Regulation 347/90

Sample ID	Composite Sample Depth	Parameters Analyzed	Ontario Regulation 347/90	
			Waste Regulation	Exceedance
BH4-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 347/90 Metals & Inorganics	✓	-
BH4-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 558 PCBs	✓	-
BH4-SS1 and SS2	1.5 m – 3.5 m	O. Reg. 558 VOCs	✓	-

✓ Meets Ontario Regulation 347/90-Leachate Quality Criteria

The test results for soil samples obtained from borehole BH4 at depths of between 1.5 m and 3.5 m indicate that the selected soil samples meet the Ontario Regulation 347/90 requirements for landfill acceptance.

9.0 PAVEMENT REINSTATEMENT

9.1 Pavement Structure Recommendations

The pavement structure thicknesses presented in Table 6 are defined by the City of Niagara Falls standard section for the class of road, and are based on a 20-year design life. Though no traffic data or pavement design criteria were available, the pavement design section does take into account the accepted design practice that the total pavement structure thickness should be as close as practicable to or exceed one-half the anticipated depth of frost penetration for the geographical area, being 1.2 m in the City of Niagara Falls area (i.e. 600 mm).

Table 6: Pavement Structure Layer Thicknesses

Pavement Structure Layer	Pavement Structure Layer Thicknesses City of Niagara Falls Standard Section	
Hl 3 Surface Course Asphalt	40 mm	
Hl 8 Binder Course Asphalt	80 mm	
Granular Base (OPSS Granular A)	150 mm	450 mm
Granular Subbase (OPSS Granular B Type II)	300 mm	-
Total Thickness	570 mm	

Granular Base Course and Subbase

The granular base course materials should meet OPSS Granular “A” specifications. Quarried 20 mm limestone, crushed to Granular "A" gradation specifications is recommended. If the option with granular subbase material is used, the granular subbase should meet OPSS Granular B Type II requirements for 100 percent crushed quarried bedrock (50 mm crusher-run limestone).

Hot Mix Asphalt

The binder course asphalt should meet current OPSS 1150 specifications for HL 8.The surface course asphalt should meet current OPSS 1150 requirements for HL 3. Pavement asphalt transitions from new to existing should be in accordance with OPSS 310.

The standard asphalt binder grade for the climate conditions in Niagara Falls is PG 58-28. Given the anticipated low volume of commercial truck traffic it is considered that there is no requirement for a bump up to a higher PG grade of asphalt cement.

Compaction

Granular base course and subbase course fill material should be compacted to 100 percent Standard Proctor Density. Hot mix asphalt should be compacted to the criteria set out in the City of Niagara Falls Engineering Design Guidelines Manual, Section 2.

9.2 Subgrade Preparation

The subgrade conditions and bearing strength may be variable along the road section and some subgrade repairs should be anticipated. It is recommended that prior to the placement of pavement granular fill, the exposed subgrade soil should be inspected and proof-rolled using a loaded tandem axle truck to traverse the exposed subgrade and provide for full coverage. The proof-rolling should be monitored by a geotechnical representative of this office to delineate any soft areas which may require repair. Repairs should be undertaken to avoid creating "*bathtub*" conditions in the subgrade within the pavement structure.

9.3 Reclamation and Reuse of Existing Pavement Materials

The existing bituminous material and granular could be considered for reclamation and reuse however it may not be practical and cost-effective since the quality of the recovered material is expected to be quite variable.

10.0 CLOSURE

The Limitations of Report, as stated in Appendix A, are an integral part of this report.

Soil samples will be retained and stored by Landtek for a period of three months after the report is issued. The samples will be disposed of at the end of the three month period unless a written request from the client to extend the storage period is received.

We trust this report will be of assistance with the design and construction of the proposed development. Should you have any questions, please do not hesitate to contact our office.

Yours sincerely,

LANDTEK LIMITED

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[2] Liberty, B.A., Feenstra, B.H. and Telford, P. G. 1976. Paleozoic Geology, Niagara, southern Ontario; Ontario Division of Mines, Map 2344, Geol. 1: 50 000.

[3] Geotechnical Investigation Report, Proposed Warren Woods Phase 5, Niagara Falls, Landtek Limited Report #16416, April 10, 2017.

APPENDIX A
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

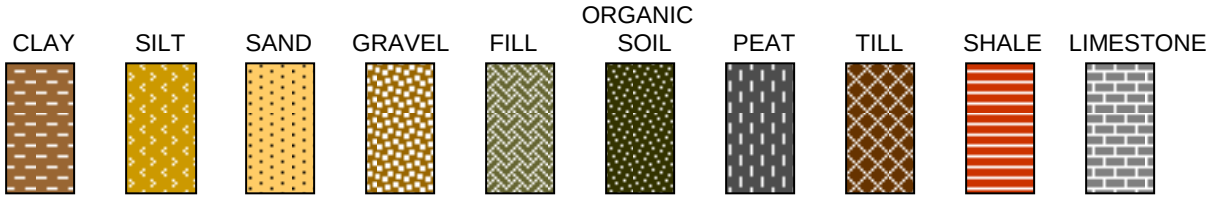
The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of Boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Additionally, bedrock contact depths throughout the site may vary significantly from what was encountered at the exact borehole locations. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the 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, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX B
SYMBOLS AND TERMS USED IN THE REPORT



RELATIVE PROPORTIONS

Term	Range
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder ---------- > 200 mm
Cobble ---------- 80 mm – 200 mm
Gravel -
Coarse ---------- 19 mm – 80 mm
Fine ---------- 4.75 mm – 19 mm
Sand -
Coarse ---------- 4.75 mm – 2 mm
Medium -------- 2 mm – 0.425 mm
Fine ---------- 0.425 mm – 0.75 mm
Silt ---------- 0.075 mm – 0.002 mm
Clay ---------- < 0.002 mm

DENSITY OF NON-COHESIVE SOILS

Descriptive Term	Relative Density	Standard Penetration Test
Very Loose	0 – 15%	0 – 4 Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10 Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30 Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50 Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50 Blows Per 300 mm Penetration

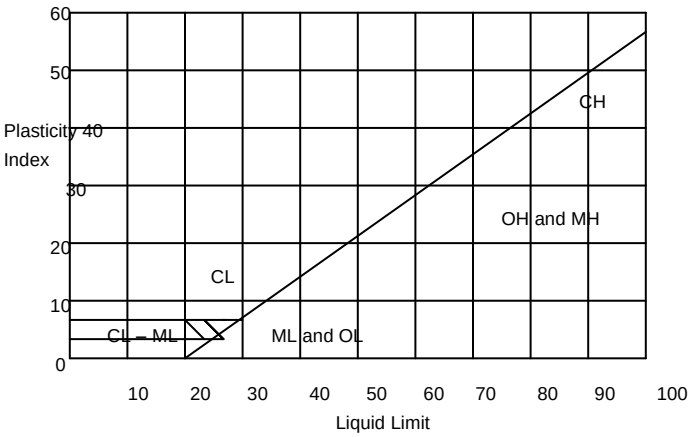
CONSISTENCY OF COHESIVE SOILS

Descriptive Term	Undrained Shear Strength kPa (psf)	N Value Standard Penetration Test	Remarks
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

APPENDIX B CONTINUED
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 4 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; C_z = $(D30)^2$/(D10xD60) between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; C_z = $(D30)^2$/ (D10xD60) between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20)		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		

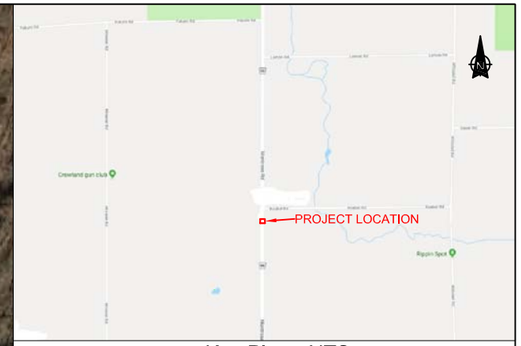


APPENDIX C

DRAWING 1 - SITE PLAN SHOWING BOREHOLE LOCATIONS

LOGS OF BOREHOLES





Key Plan - NTS

LEGEND

- Approximate location of boreholes drilled by Landtek Limited on February 22, 2018.
- Approximate location of monitoring well installed by Landtek Limited on February 22, 2018.

NOTES

1. Base plan provided by google maps.
2. Borehole locations are considered approximate.

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CONSULTING ENGINEERS
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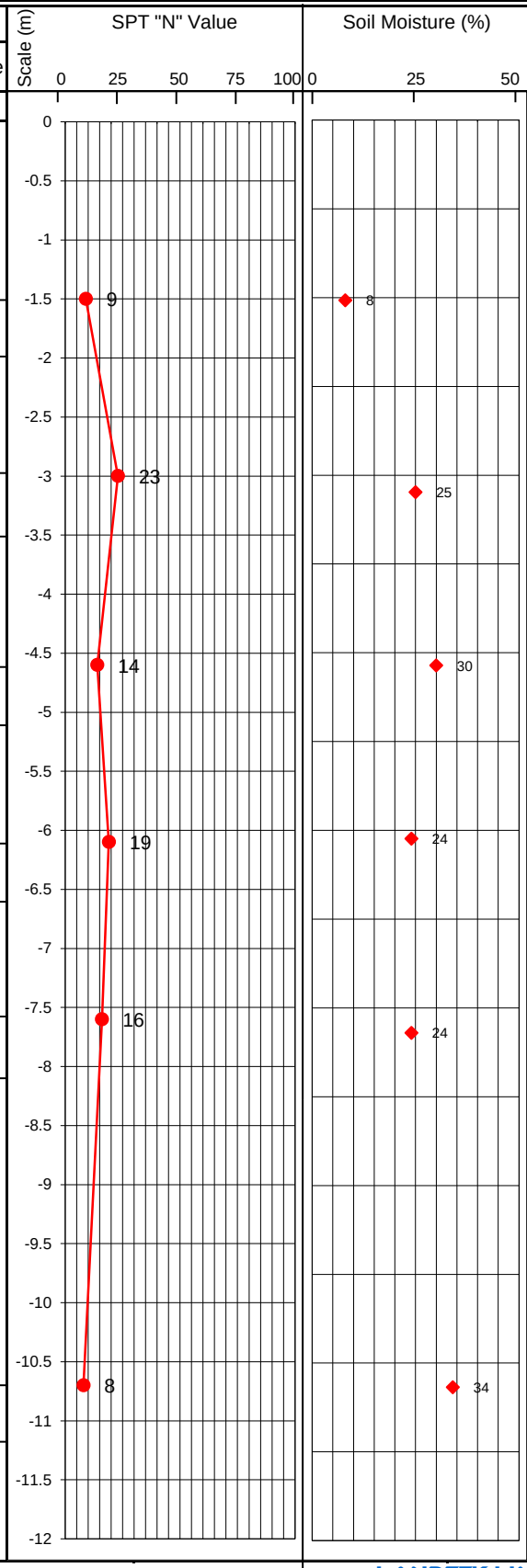
DRAWING:	Borehole Location Plan		
PROJECT:	Geotechnical Investigation Report Montrose Road, Niagara Falls, Ontario		
SCALE:	NTS	**PROJECT NO.**	18025
DATE:	May, 2018	**DRAWING NO.**	2

LANDTEK LIMITED

BH/MW 3

Project No.:	18025	Drill Date:	February 22, 2018
Project:	Geotechnical Investigation Report	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Montrose Road, Niagara Falls, Ontario	Datum:	Existing Pavement Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Test Data
Ground Surface					Flushmount
±150 mm of asphalt		0.0			
± 350 mm granular					
FILL: silty clay, some limestone fragments, brown, loose, moist		0.5	1	SS	bentonite backfill to ground level
SILTY CLAY: brown and grey, very stiff, moist		3.0	2	SS	WL = 3.5m April 13, 2018
4.5 m to 5.5 m: stiff			3	SS	
			4	SS	
			5	SS	sand backfill to 7.1 m
10.5 m to 11.1 m: grey, firm to stiff			6	AUG	7.6 m; 3.0 m of slotted 50 mm dia. PVC pipe; 10.6 m
END OF BOREHOLE		11.1			



Notes:
1. On completion, borehole open to 10.6 m.
2. No groundwater encountered.
3. Water level reading: WL at 3.5 m depth on April 13, 2018.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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LANDTEK LIMITED

BH 4

Project No.:	18025	Drill Date:	February 22, 2018
Project:	Geotechnical Investigation Report	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Montrose Road, Niagara Falls, Ontario	Datum:	Existing Pavement Surface

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	Scale (m)	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface										
±160 mm of asphalt		0.0								
± 380 mm of sand and gravel (FILL)										
FILL: silty clay, some limestone fragments, brown, loose, moist		0.54	1	SS		8	20			
SILTY CLAY: brown and grey, very stiff, moist		3.0	2	SS		25	26			
4.5 m to 5.5 m: stiff			3	SS		14	28			
			4	SS		20	24			
7.6 m to 11.1 m: very moist			5	AUG		16	24			
10.6 m to 11.1 m: grey, firm to stiff			6	AUG		8	35			
END OF BOREHOLE		11.1								

SPT "N" Value: 0 25 50 75 100 | Soil Moisture (%): 0 25 50 | Scale (m): 0 -0.5 -1 -1.5 -2 -2.5 -3 -3.5 -4 -4.5 -5 -5.5 -6 -6.5 -7 -7.5 -8 -8.5 -9 -9.5 -10 -10.5 -11 -11.5 -12

Notes:
1. On completion, borehole open to 10.6 m.
2. No groundwater encountered.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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APPENDIX D

ENVIRONMENTAL ANALYTICAL REPORT

ANALYTICAL REPORT

Summary of Guideline Exceedances

ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit
Guideline						
Ontario Regulation 153/04 - April 15, 2011 Standards - T3-Soil-Ind/Com/Commu. Property Use (Fine)						
L2062211-1	BH3-SS1 AND SS2	Physical Tests	Conductivity	1.56	1.4	mS/cm
L2062211-2	BH3-SS3	Physical Tests	Conductivity	1.93	1.4	mS/cm
L2062211-5	BH4-SS3	Physical Tests	Conductivity	1.95	1.4	mS/cm

ANALYTICAL REPORT

Sample Preparation - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
Analyte	**Unit**	**Guide Limits #1**	**#2**	
Initial pH	pH units	-	-	9.29
Final pH	pH units	-	-	6.39

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Physical Tests - SOIL

		Guide Limits							
Lab ID				L2062211-1	L2062211-2	L2062211-3	L2062211-5	L2062211-6	L2062211-7
Sample Date				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
Sample ID				BH3-SS1 AND SS2	BH3-SS3	BH3-SS3 AND SS4	BH4-SS3	BH4-SS4 AND SS5	BH4-SS4 AND SS5
Analyte	**Unit**	**#1**	**#2**						
Conductivity	mS/cm	1.4	-	1.56	1.93	1.26	1.95	1.11	1.14
% Moisture	%	-	-	17.6	21.4	22.2	23.9	17.7	20.5
pH	pH units	-	-	7.80	7.83	7.83	7.86	7.84	7.96
Redox Potential	mV	-	-			298			230
Resistivity	ohm*cm	-	-			791			876

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Leachable Anions & Nutrients - SOIL

			Lab ID	L2062211-3	L2062211-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH3-SS3 AND SS4	BH4-SS4 AND SS5
		Guide Limits			
Analyte	**Unit**	**#1**	**#2**		
Chloride	ug/g	-	-	19.9	20.6

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Anions and Nutrients - SOIL

			Lab ID	L2062211-3	L2062211-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH3-SS3 AND SS4	BH4-SS4 AND SS5
		Guide Limits			
Analyte	**Unit**	**#1**	**#2**		
Sulphate	mg/kg	-	-	1620	1470

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Cyanides - SOIL

		Guide Limits					
				Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
				Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
Analyte	Unit	#1	#2					
Cyanide, Weak Acid Diss	ug/g	0.051	-		<0.050	<0.050	<0.050	<0.050

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Inorganic Parameters - SOIL

		Guide Limits			
Lab ID				L2062211-3	L2062211-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH3-SS3 AND SS4	BH4-SS4 AND SS5
Analyte	**Unit**	**#1**	**#2**		
Acid Volatile Sulphides	mg/kg	-	-	<0.20	<0.20

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Saturated Paste Extractables - SOIL

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID: L2062211-1 / Sample Date: 23-FEB-18 / Sample ID: BH3-SS1 AND SS2	Lab ID: L2062211-2 / Sample Date: 23-FEB-18 / Sample ID: BH3-SS3	Lab ID: L2062211-5 / Sample Date: 23-FEB-18 / Sample ID: BH4-SS3	Lab ID: L2062211-6 / Sample Date: 23-FEB-18 / Sample ID: BH4-SS4 AND SS5
SAR	SAR	12	-	1.42	1.67	1.73	1.43
Calcium (Ca)	mg/L	-	-	130	116	118	55.7
Magnesium (Mg)	mg/L	-	-	81.6	166	158	68.5
Sodium (Na)	mg/L	-	-	83.8	119	122	67.5

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Metals - SOIL

		Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
		Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
		Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
		Guide Limits				
Analyte	Unit	#1	#2				
Antimony (Sb)	ug/g	50	-	<1.0	<1.0	<1.0	<1.0
Arsenic (As)	ug/g	18	-	6.1	5.6	4.9	4.7
Barium (Ba)	ug/g	670	-	155	160	170	129
Beryllium (Be)	ug/g	10	-	0.98	1.18	1.24	0.86
Boron (B)	ug/g	120	-	17.5	20.3	18.8	17.4
Boron (B), Hot Water Ext.	ug/g	2	-	0.21	0.76	0.71	1.32
Cadmium (Cd)	ug/g	1.9	-	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)	ug/g	160	-	26.3	31.4	34.6	24.9
Cobalt (Co)	ug/g	100	-	14.0	16.2	16.9	12.2
Copper (Cu)	ug/g	300	-	21.7	23.7	24.3	22.2
Lead (Pb)	ug/g	120	-	9.0	10.6	10.8	8.4
Mercury (Hg)	ug/g	20	-	0.0136	0.0155	0.0147	0.0152
Molybdenum (Mo)	ug/g	40	-	<1.0	<1.0	<1.0	<1.0
Nickel (Ni)	ug/g	340	-	29.7	34.4	36.6	27.7
Selenium (Se)	ug/g	5.5	-	<1.0	<1.0	<1.0	<1.0
Silver (Ag)	ug/g	50	-	<0.20	<0.20	<0.20	<0.20
Thallium (Tl)	ug/g	3.3	-	<0.50	<0.50	<0.50	<0.50
Uranium (U)	ug/g	33	-	<1.0	<1.0	<1.0	<1.0
Vanadium (V)	ug/g	86	-	39.2	45.2	47.9	35.3
Zinc (Zn)	ug/g	340	-	61.9	66.9	72.6	58.2

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Speciated Metals - SOIL

			Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
		Guide Limits					
Analyte	Unit	#1	#2				
Chromium, Hexavalent	ug/g	10	-	0.24	<0.20	<0.20	0.25

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

TCLP Extractables - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Cyanide, Weak Acid Diss	mg/L	-	-	<0.10
Fluoride (F)	mg/L	-	-	<10
Nitrate and Nitrite as N	mg/L	-	-	<4.0
Nitrate-N	mg/L	-	-	<2.0
Nitrite-N	mg/L	-	-	<2.0

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

TCLP Metals - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
Analyte	**Unit**	**Guide Limits #1**	**#2**	
Arsenic (As)	mg/L	-	-	<0.050
Barium (Ba)	mg/L	-	-	0.75
Boron (B)	mg/L	-	-	<2.5
Cadmium (Cd)	mg/L	-	-	<0.0050
Chromium (Cr)	mg/L	-	-	<0.050
Lead (Pb)	mg/L	-	-	<0.050
Mercury (Hg)	mg/L	-	-	<0.00010
Selenium (Se)	mg/L	-	-	<0.025
Silver (Ag)	mg/L	-	-	<0.0050
Uranium (U)	mg/L	-	-	<0.25

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

TCLP VOCs - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	Unit	#1	#2	
1,1-Dichloroethylene	mg/L	-	-	<0.025
1,2-Dichlorobenzene	mg/L	-	-	<0.025
1,2-Dichloroethane	mg/L	-	-	<0.025
1,4-Dichlorobenzene	mg/L	-	-	<0.025
Benzene	mg/L	-	-	<0.025
Carbon tetrachloride	mg/L	-	-	<0.025
Chlorobenzene	mg/L	-	-	<0.025
Chloroform	mg/L	-	-	<0.10
Dichloromethane	mg/L	-	-	<0.50
Methyl Ethyl Ketone	mg/L	-	-	<1.0
Tetrachloroethylene	mg/L	-	-	<0.025
Trichloroethylene	mg/L	-	-	<0.025
Vinyl chloride	mg/L	-	-	<0.050
Surrogate: 4-Bromofluorobenzene	%	-	-	104.5

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Volatile Organic Compounds - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
Analyte	**Unit**	**Guide Limits #1**	**#2**	
Surrogate: 1,4-Difluorobenzene	%	-	-	96.9

Guide Limit #1: T3-Soil-Ind/Com/Commu. Property Use (Fine)

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-TCLP-WT	Waste	Cyanide for O. Reg 347	APHA 4500CN C E
CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

F-TCLP-WT	Waste	Fluoride (F) for O. Reg 347	APHA 4110 B-Ion Chromatography
HG-200.2-CVAA-WT	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

HG-TCLP-WT	Waste	Mercury (CVAA) for O.Reg 347	SW846 7470A
LEACH-TCLP-WT	Waste	Leachate Procedure for Reg 347	EPA 1311

Inorganic and Semi-Volatile Organic contaminants are leached from waste samples in strict accordance with US EPA Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP). Test results are reported in leachate concentration units (normally mg/L).

MET-200.2-CCMS-WT	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

MET-TCLP-WT	Waste	O.Reg 347 TCLP Leachable Metals	EPA 200.8
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
N2N3-TCLP-WT	Waste	Nitrate/Nitrite-N for O. Reg 347	APHA 4110 B-Ion Chromatography
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

VOC-TCLP-WT	Waste	VOC for O. Reg 347	SW846 8260

A sample of waste is leached in a zero headspace extractor at 30–2 rpm for 18–2.0 hours with the appropriate leaching solution. After tumbling the leachate is analyzed directly by headspace technology, followed by GC/MS using internal standard quantitation.

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Chain of Custody Numbers:

17-622115

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

Summary of Guideline Exceedances

ALS ID	Client ID	Grouping	Analyte	Result	Guideline Limit	Unit
Guideline						

Federal & Provincial Waste Regulations (MAR, 2008) - Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90

(No parameter exceedances)

Federal & Provincial Waste Regulations (MAR, 2008) - Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

(No parameter exceedances)

ANALYTICAL REPORT

Sample Preparation - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
Analyte	**Unit**	**Guide Limits #1**	**#2**	
Initial pH	pH units	-	-	9.29
Final pH	pH units	-	-	6.39

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Physical Tests - SOIL

		Guide Limits							
				Lab ID	L2062211-1	L2062211-2	L2062211-3	L2062211-5	L2062211-6	L2062211-7
				Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH3-SS3 AND SS4	BH4-SS3	BH4-SS4 AND SS5	BH4-SS4 AND SS5
Analyte	Unit	#1	#2							
Conductivity	mS/cm	-	-		1.56	1.93	1.26	1.95	1.11	1.14
% Moisture	%	-	-		17.6	21.4	22.2	23.9	17.7	20.5
pH	pH units	-	-		7.80	7.83	7.83	7.86	7.84	7.96
Redox Potential	mV	-	-				298			230
Resistivity	ohm*cm	-	-				791			876

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Leachable Anions & Nutrients - SOIL

		Guide Limits			
Lab ID				L2062211-3	L2062211-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH3-SS3 AND SS4	BH4-SS4 AND SS5
Analyte	**Unit**	**#1**	**#2**		
Chloride	ug/g	-	-	19.9	20.6

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Anions and Nutrients - SOIL

			Lab ID	L2062211-3	L2062211-7
			Sample Date	23-FEB-18	23-FEB-18
			Sample ID	BH3-SS3 AND SS4	BH4-SS4 AND SS5
		Guide Limits			
Analyte	Unit	#1	#2		
Sulphate	mg/kg	-	-	1620	1470

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Cyanides - SOIL

		Guide Limits					
				Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
				Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
Analyte	Unit	#1	#2					
Cyanide, Weak Acid Diss	ug/g	-	-		<0.050	<0.050	<0.050	<0.050

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Inorganic Parameters - SOIL

		Guide Limits			
Lab ID				L2062211-3	L2062211-7
Sample Date				23-FEB-18	23-FEB-18
Sample ID				BH3-SS3 AND SS4	BH4-SS4 AND SS5
Analyte	**Unit**	**#1**	**#2**		
Acid Volatile Sulphides	mg/kg	-	-	<0.20	<0.20

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Saturated Paste Extractables - SOIL

		Guide Limits					
Analyte	**Unit**	**#1**	**#2**				
Lab ID				L2062211-1	L2062211-2	L2062211-5	L2062211-6
Sample Date				23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
Sample ID				BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
SAR	SAR	-	-	1.42	1.67	1.73	1.43
Calcium (Ca)	mg/L	-	-	130	116	118	55.7
Magnesium (Mg)	mg/L	-	-	81.6	166	158	68.5
Sodium (Na)	mg/L	-	-	83.8	119	122	67.5

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Metals - SOIL

Analyte	Unit	Guide Limits #1	Guide Limits #2	Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
				Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
				Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
Antimony (Sb)	ug/g	-	-		<1.0	<1.0	<1.0	<1.0
Arsenic (As)	ug/g	-	-		6.1	5.6	4.9	4.7
Barium (Ba)	ug/g	-	-		155	160	170	129
Beryllium (Be)	ug/g	-	-		0.98	1.18	1.24	0.86
Boron (B)	ug/g	-	-		17.5	20.3	18.8	17.4
Boron (B), Hot Water Ext.	ug/g	-	-		0.21	0.76	0.71	1.32
Cadmium (Cd)	ug/g	-	-		<0.50	<0.50	<0.50	<0.50
Chromium (Cr)	ug/g	-	-		26.3	31.4	34.6	24.9
Cobalt (Co)	ug/g	-	-		14.0	16.2	16.9	12.2
Copper (Cu)	ug/g	-	-		21.7	23.7	24.3	22.2
Lead (Pb)	ug/g	-	-		9.0	10.6	10.8	8.4
Mercury (Hg)	ug/g	-	-		0.0136	0.0155	0.0147	0.0152
Molybdenum (Mo)	ug/g	-	-		<1.0	<1.0	<1.0	<1.0
Nickel (Ni)	ug/g	-	-		29.7	34.4	36.6	27.7
Selenium (Se)	ug/g	-	-		<1.0	<1.0	<1.0	<1.0
Silver (Ag)	ug/g	-	-		<0.20	<0.20	<0.20	<0.20
Thallium (Tl)	ug/g	-	-		<0.50	<0.50	<0.50	<0.50
Uranium (U)	ug/g	-	-		<1.0	<1.0	<1.0	<1.0
Vanadium (V)	ug/g	-	-		39.2	45.2	47.9	35.3
Zinc (Zn)	ug/g	-	-		61.9	66.9	72.6	58.2

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Speciated Metals - SOIL

			Lab ID	L2062211-1	L2062211-2	L2062211-5	L2062211-6
			Sample Date	23-FEB-18	23-FEB-18	23-FEB-18	23-FEB-18
			Sample ID	BH3-SS1 AND SS2	BH3-SS3	BH4-SS3	BH4-SS4 AND SS5
Analyte	Unit	Guide Limits #1	#2				
Chromium, Hexavalent	ug/g	-	-	0.24	<0.20	<0.20	0.25

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

TCLP Extractables - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Cyanide, Weak Acid Diss	mg/L	20	-	<0.10
Fluoride (F)	mg/L	150.0	-	<10
Nitrate and Nitrite as N	mg/L	1000	-	<4.0
Nitrate-N	mg/L	-	-	<2.0
Nitrite-N	mg/L	-	-	<2.0

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

TCLP Metals - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Arsenic (As)	mg/L	2.5	-	<0.050
Barium (Ba)	mg/L	100	-	0.75
Boron (B)	mg/L	500	-	<2.5
Cadmium (Cd)	mg/L	0.5	-	<0.0050
Chromium (Cr)	mg/L	5.0	-	<0.050
Lead (Pb)	mg/L	5.0	-	<0.050
Mercury (Hg)	mg/L	0.1	-	<0.00010
Selenium (Se)	mg/L	1.0	-	<0.025
Silver (Ag)	mg/L	5.0	-	<0.0050
Uranium (U)	mg/L	10	-	<0.25

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

TCLP VOCs - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
1,1-Dichloroethylene	mg/L	1.4	-	<0.025
1,2-Dichlorobenzene	mg/L	20.0	-	<0.025
1,2-Dichloroethane	mg/L	0.5	-	<0.025
1,4-Dichlorobenzene	mg/L	0.5	-	<0.025
Benzene	mg/L	0.5	-	<0.025
Carbon tetrachloride	mg/L	0.5	-	<0.025
Chlorobenzene	mg/L	8	-	<0.025
Chloroform	mg/L	10	-	<0.10
Dichloromethane	mg/L	5.0	-	<0.50
Methyl Ethyl Ketone	mg/L	200.0	-	<1.0
Tetrachloroethylene	mg/L	3	-	<0.025
Trichloroethylene	mg/L	5	-	<0.025
Vinyl chloride	mg/L	0.2	-	<0.050
Surrogate: 4-Bromofluorobenzene	%	-	-	104.5

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

ANALYTICAL REPORT

Volatile Organic Compounds - WASTE

			Lab ID	L2062211-4
			Sample Date	23-FEB-18
			Sample ID	BH4-SS1 AND SS2
		Guide Limits		
Analyte	**Unit**	**#1**	**#2**	
Surrogate: 1,4-Difluorobenzene	%	-	-	96.9

Guide Limit #1: Ontario Ministry of the Environment, General Waste Control Regulation No. 347/90
Guide Limit #2: Polychlorinated Biphenyls (PCBs) - Ontario Regulation 347/90

Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
Analytical result for this parameter exceeds Guide Limits listed. See Summary of Guideline Exceedances.

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-TCLP-WT	Waste	Cyanide for O. Reg 347	APHA 4500CN C E
CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

F-TCLP-WT	Waste	Fluoride (F) for O. Reg 347	APHA 4110 B-Ion Chromatography
HG-200.2-CVAA-WT	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

HG-TCLP-WT	Waste	Mercury (CVAA) for O.Reg 347	SW846 7470A
LEACH-TCLP-WT	Waste	Leachate Procedure for Reg 347	EPA 1311

Inorganic and Semi-Volatile Organic contaminants are leached from waste samples in strict accordance with US EPA Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP). Test results are reported in leachate concentration units (normally mg/L).

MET-200.2-CCMS-WT	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference**

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

MET-TCLP-WT	Waste	O.Reg 347 TCLP Leachable Metals	EPA 200.8
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
N2N3-TCLP-WT	Waste	Nitrate/Nitrite-N for O. Reg 347	APHA 4110 B-Ion Chromatography
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

VOC-TCLP-WT	Waste	VOC for O. Reg 347	SW846 8260

A sample of waste is leached in a zero headspace extractor at 30–2 rpm for 18–2.0 hours with the appropriate leaching solution. After tumbling the leachate is analyzed directly by headspace technology, followed by GC/MS using internal standard quantitation.

**ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Chain of Custody Numbers:

17-622115

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

APPENDIX E

LABORATORY TEST RESULTS (SIEVE ANALYSIS)

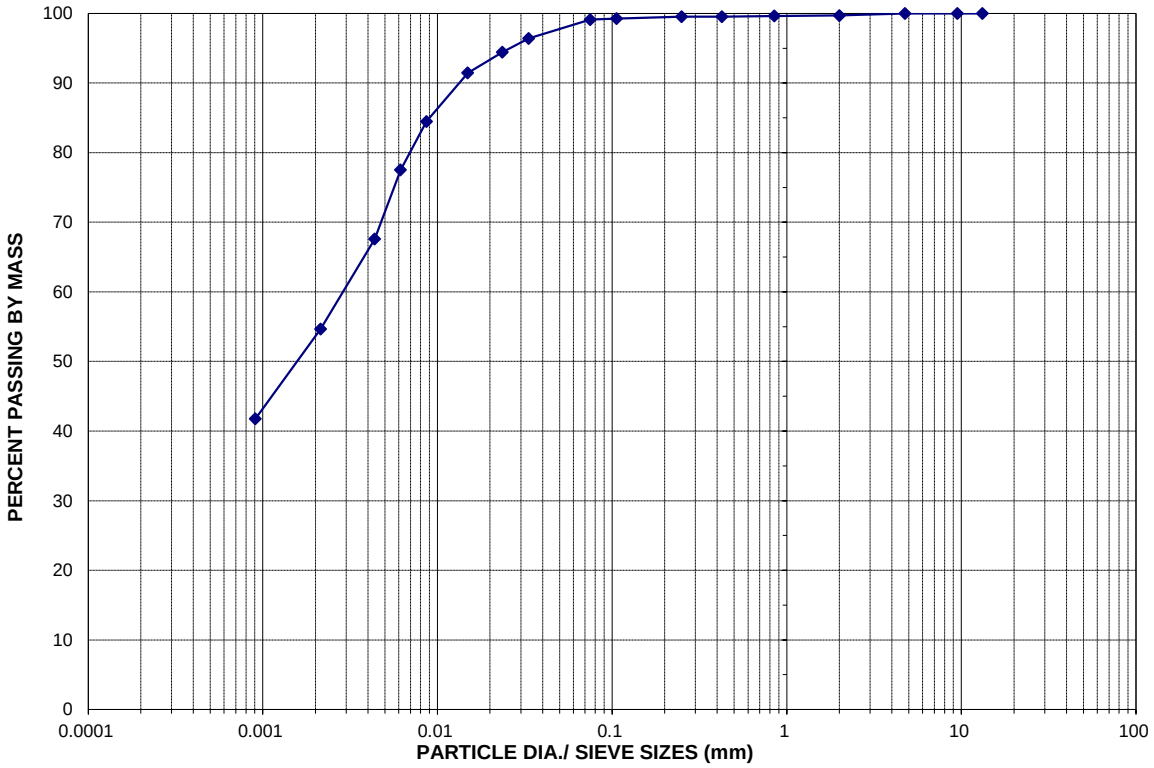
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Montrose Road, Niagara Falls, Ontario
LOCATION: Montrose Road, Niagara Falls, Ontario
CLIENT : Regional Municipality of Niagara
SOIL TYPE: Silty Clay (CL-ML)
SOURCE: On Site

FILE NO.: 18025
LAB SAMPLE NO.: BH3-SS4
SAMPLE DATE: February 22, 2018
SAMPLED BY: V.H.

PARTICLE SIZE DISTRIBUTION



←	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	COARSE
CLAY	SILT			SAND			GRAVEL	

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	
9.5	100.0	
4.75	100.0	
2.0	99.7	
0.850	99.6	
0.425	99.5	
0.250	99.5	0.0% Gravel
0.106	99.3	0.9% Sand
0.075	99.1	44.4% Silt
0.0333	96.4	54.7% Clay
0.0236	94.4	
0.0149	91.4	
0.0087	84.5	
0.0061	77.5	
0.0044	67.6	
0.0021	54.7	
0.0009	41.7	

LANDTEK LIMITED IS CERTIFIED FOR TESTING BY THE CANADIAN COUNCIL OF INDEPENDENT LABORATORIES (CCIL)