Terraprobe Inc.

Consulting Geotechnical and Environmental Engineering
Construction Materials Engineering, Inspection and Testing

Geotechnical Investigation, Engineering, & Design

Pavement Evaluation & Design

Environmental Assessment & Remediation Services

Hydrogeology

Dam Safety & Assessment

Building Systems & Sciences

Construction Materials Inspection & Testing

Earthworks, Design, Inspection & Compaction Testing

CSA Certified Concrete Testing

CCIL Certified Aggregates & Asphalt Testing

CWB Certified Welding & Structural Steel Inspection

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Brampton Office

AUSABLE BAYFIELD CONSERVATION AUTHORITY
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Attention: **Mr. Alec M. Scott, P. Eng. Water and Planning Manager**

Subject: **SHORELINE MANAGEMENT PLAN UPDATE – GEOTECHNICAL SLOPE STABILITY CONSIDERATIONS Ausable-Bayfield Conservation Authority**

Dear Mr. Scott, P.Eng.:

As a result of our recent meeting and discussions with Aqua Solutions 5 Inc., please find our scope of work and cost estimate to conduct a geotechnical review of the available information (topographic maps, published geological conditions and existing plans) to assess geotechnical slope instability risks to the existing structures/dwellings located near the crest of Lake Huron shoreline bluff/slopes, within Ausable-Bayfield Conservation Authority jurisdiction area. This Slope Stability Assessment would comprise a two-stage process, summarized as follows:

Stage 1:
A desktop review of the available information (topographic maps provided by the client, aerial photographic data and published geological subsurface information comprising shoreline slopes) and consultation with Aqua Solutions 5 Inc. to identify the Areas of Concern within the study limits requiring further assessment.

Stage 2:
A higher level review of the available information for the Areas of Concern in conjunction with site visit, slope mapping, site measurements of the setbacks of selected structures from the existing crest, and consultation with Aqua Solutions 5 Inc., to categorize zone of Significant (Zone of Pending Failure) and Zone of Higher Slope Instability Risks.

BACKGROUND

The Ausable-Bayfield Conservation Authority's shoreline reach is about 80-kilometre's long, predominantly comprising glacial deposits. Information from the last several ABCA Shoreline Management Plans indicates that over the past 50 years, the erosion rates along the bluff varies from zero to 1 .3 metres per year. Because of the natural exposed shoreline conditions and the sediment transport processes these glacial deposits of generally cohesive materials continue to erode along the bluffs and the nearshore lake bottom. The downcutting of the nearshore controlling cohesive substrate as well as slope toe erosion due to wave action affect the stability of the bluff slopes.

The typical slope instability phenomenon in case of a toe erosion condition generally starts from erosion/undercutting of the slope toe, resulting in a localized over-steepened slope zone thus triggering a localized slump/slide. Subsequent to the initial slide, the slope above the failure zone becomes over-steepened and the process progressively repeats itself until reaching the slope crest. Other modes of instability may (including but not limited to) consist of global slope failure (generally not common) or slope instabilities associated with drainage issues.

We understand that as a part of the Shoreline Management Plan Review (currently in progress), Aqua Solutions 5 Inc. recently carried out a general observation of the shoreline conditions. The assessment concluded that there are a substantial number of homes (approximately 52 percent) within the slope stability hazard zone (3 horiz. to 1 vert. inclination, as defined in the MNR Guidelines). Considering this observation was made using mapping information that is over nine years old, it is important to note that the above conclusion excludes the erosion/crest recession occurred during these years.

In light of the magnitude and potential for slope instability risks in these areas and possible public safety concerns, Terraprobe was requested to provide a proposal to outline the scope of work to complete an assessment of the shoreline reach within the study area to identify the Areas of Concerns (Stage 1) and conduct a more detailed review to further categorize the degree of slope instability risks and potential implications to properties and public safety. Terraprobe was included in the ABCA Collaborative proposal team and was to be called in under a separate contract if the general shoreline evaluation resulted in the need for geotechnical expertise.

Project Team and Organization

Terraprobe will provide an experienced and capable study team for the project. Each member of the study team has had direct experience on similar projects. A brief description of the study team members is presented below. The internal peer review of the work will be carried out by **Mr. Michael Tanos, P. Eng.** Mr. Tanos is the President of Terraprobe, and a Designated Consulting Engineer with a graduate degree in geotechnical engineering. **Mr. Billy Singh, M.A.Sc., P. Eng.** will act as team lead and review principal for the study. Terraprobe has extensive experience in geotechnical engineering and

slope stability, and slope stabilization. Terraprobe was the consultant that prepared the **Provincial** Geotechnical Principles for Stable Slopes **Manual** (Geotechnical Principles for Stable Slopes, Great Lakes - St. Lawrence River) for the **Ontario Ministry of Natural Resources**. Terraprobe is familiar with local subsurface conditions and regulatory requirements.

Michael Tanos, P. Eng. - Principal

Mr. Tanos is Founding Principal of Terraprobe, and will be responsible for senior review and guidance on the project. Mr. Tanos has over 30 years of engineering consulting experience in a variety of geotechnical engineering fields. Mr. Tanos is a recognized expert in the field of geotechnical engineering, slope stability, rehabilitation, stabilization, as well as slope stability and erosion risk assessments; and has conducted/supervised hundreds of such assignments in Southern Ontario. He has provided peer review and consulting services, and has been the main author of the technical document and guidelines preparation team for the Ministry of Natural Resources "Geotechnical Principles for Stable Slopes" subsequently included in the Great Lakes-St. Lawrence River Shoreline Policy.

Billy Singh, M.A.Sc., P. Eng. - Review Principal

Mr. Singh is a senior geotechnical engineer and Principal with Terraprobe. Mr. Singh will act as review principal for the study. Mr. Singh is a professional engineer with graduate and postgraduate degrees in geotechnical engineering, and has worked on similar projects involving shoreline slope stability, policy interpretation and application. Mr. Singh is a recognized expert in the field of geotechnical engineering, slope stability, rehabilitation, stabilization, as well as slope stability and erosion risk assessments; and has conducted/supervised hundreds of such assignments in Southern Ontario and projects in Caribbean. Mr. Singh has provided peer reviews and served as expert witness on Conservation Authority, Environmental Review Tribunal and Ontario Municipal Board hearings. He has worked closely with various local Conservations Authorities. Mr. Singh has presented slope stability training seminars to local conservation Authority and businesses as well as guest lectures at the University of Waterloo.

Mr. Singh has also provided geotechnical guidance for the recent Elgin County Shoreline Management Plan Update and proposed the approach which was used to identify the key areas at risk (i.e. Zone of Pending Failure and Zone of High Risk).

Other engineering and field staff will be supplied as required

Selected Project Experience

Terraprobe has successfully completed slope stability and erosion studies and is very familiar with the MNR policy guidelines and Provincial Policy documents for the design of stable slopes. Selected relevant projects are presented below:

Client: **Ontario Ministry of Natural Resources (MNR)**
Client Contact: Ms. Pearl Mc Keen

Assignment: Preparation of the technical documents for "Accepted Geotechnical Practice for Design of Stable Slopes" subsequently included in the Great Lakes-St. Lawrence River Shoreline Policy.

Client: **Toronto and Region Conservation Authority**
Client Contact: Mr. Nick Saccone, Mr. Brian Denny

Assignment: Detailed slope stability and erosion studies of the Lake Ontario Scarborough Bluffs. Delineation of the Long-term Stable Slope Crest location and preparation of constraint mapping.

Client: **County of Elgin**
Client Contact: Mr. Clayton D. Watters, P. Eng.
Assignment: Geotechnical engineering assessment of slope stability and erosion along the Lake Erie shoreline near Port Burwell. Slope mapping, slope stability analyses and erosion risk assessment and preparation of geotechnical report.

Client: **County of Elgin**
Client Contact: Mr. Pete Zuzek, P. Geo.
Assignment: **Policy Development** - Geotechnical engineering input and considerations for the Elgin County Shoreline Management Plan update.

In addition, Terraprobe has also completed significant slope stability studies in the area as follows:

Client: **Pollutech EnviroQuatics Limited**
Assignment: Geotechnical slope stability assessment of St. Clair river bed conditions (nearshore) for supplemental assessment to Dredge Feasibility Study.

Client: **St. Clair Region Conservation Authority**
Assignment: Comprehensive stability study of the easterly slope of the St. Clair River from Corunna to Mooretown (File No. 93201-A, dated May 10, 1994).

Client: **Bluewater Developments Inc.**
Assignment: Shoreline slope stability study (Lake Huron) in the Town of Plympton-Wyoming.

Work Methodology and Cost Estimate

As noted above, the assessment would be carried out in two stages:

Stage 1 Methodology:

This component of the study would consist of a desktop review of the available information (topographic maps provided by the client, aerial photographic data and published geological subsurface information comprising shoreline slopes) and consultation with Aqua Solutions 5 Inc. to identify the Areas of Concern within the study limits requiring further assessment. The general areas of potential slope instability risks to existing structures/infrastructure as well as to public will be marked on the PDF plans provide by the client for further assessment.

Cost

The cost breakdown is provided as follows:

Stage 1 Cost:

Aqua Solutions 5 Inc. (12 hrs @ $150 per hour)..... $1,800.00
Terraprobe
Principal Engineer (15 hrs @ $175/hour)..... $2,625.00
Project Engineer (40 hrs @ $110/hour)..... $4,400.00
Draftsman (20 hrs @ $60/hour)..... $1,200.00

The estimated total cost for the Stage 1 component of the work would range from $9,000 to $10,000 (excluding tax). All efforts would be made to keep the costs at the reduced amount.

Stage 2 Methodology:

The Stage 2 work would consist of a higher level review of the available information (topographic maps provided by the client, aerial photographic data and published geological subsurface information comprising shoreline slopes) for the Areas of Concern (as identified in Stage 1) in conjunction with minimal site visits in order to ensure adequate slope mapping and site measurements of the setbacks of selected structures from the existing crest, are provided in order to be able to make recommendations for the two main Risk Zones. Stage 2 will also include consultation with Aqua Solutions 5 Inc. throughout the process of the site work and recommended risk zones. The Stage 2 study will categorize the zones of Significant (Zone of Pending Failure) and Zone of Higher Slope Instability Risks.

The deliverables for Stage 2 will be the identification of the risk zones on the topographic plans provided by the client (AutoCAD format). It is assumed that the final plotting on the ABCA GIS mapping system will be completed by ABCA staff in order to keep costs to a minimum.

Please note that we are assuming that permission for access to the private properties will be supplied by Municipalities for the site work.

The scope of Stage 2 work will depend on the findings of Stage 1 and therefore the cost for this work will vary based on the scale of the Areas of Concern. Site visits will be carried out in conjunction with Aqua Solutions 5 Inc.

Cost

A preliminary cost range for the Stage 2 work is provided below. We cannot guarantee the cost because of the current uncertainty of the required work until Stage 1 is completed. However from our experience in similar types of projects, the following is our recommended costs:

Stage 2 Cost:

Aqua Solutions 5 Inc. ..……$3,000 to $4,000

Terraprobe……$22,000 to $25,000

The estimated total cost for the Stage 2 component of the work would range from $25,000 to $29,000 (excluding tax). All efforts would be made to keep the costs to a minimum.

The updated cost can be provided once the results of Stage 1 Study are available.

Insurance

Terraprobe maintains Professional Errors & Omissions and Commercial General Liability insurances. A copy of the certificates can be provided upon request.

Closure

Our policy is to submit monthly invoices for the work completed to date and a final invoice at the time of submission of the draft report. We trust the foregoing information is sufficient for your present requirements. If you have any questions, or need any additional information please do not hesitate to contact us.

Yours truly,

Terraprobe Inc.

B. Singh, M.A.Sc., P. Eng.
Principal

Michael Tanos, P. Eng.
Principal

TERMS AND CONDITIONS OF WORK AND PAYMENT

Having read the above proposal and understanding the nature and extent of the work and the terms of payment, I find it to be satisfactory and do hereby authorize Terraprobe to carry out the work as described

date	signature
company or owner	name typed or printed
address	phone/fax

1. Any changes to the scope of work or to the terms and conditions must be confirmed in writing.

2. Any changes to the nature of the project (location, size, etc.) must be reported to Terraprobe, as they may affect the work scope or engineering advice provided under the terms of this engagement.

3. If not paid by VISA account, regular invoices for the work will be submitted monthly or upon completion of the work. Terms: Payment is due in full within 30 days of receipt of invoice. When an account is more than 30 days old, interest will accrue at a rate of 1½% per month.

4. All work will be conducted in a manner consistent with the level of care and skill ordinarily provided by members of the profession currently practising under similar conditions. No other warranty, guarantee, or certification is expressed, implied, or made. This agreement is made with Terraprobe both on its own behalf and as agent on behalf of its employees and principals.

5. In the event that any employee of Terraprobe is required or requested to attend any court action, legal proceedings, arbitration, or mediation, all time and expenses shall be billed to the client in accordance with the Standard Fee Schedule in effect at the time.

6. The start date for any statute of limitations or limitation period for any claim, shall be deemed to be the last date on any invoice issued Terraprobe for work provided.

7. The work carried out by Terraprobe, in no way absolves or excuses any other party from responsibility or liability for their own respective work obligations.

8. Unless specifically retained to investigate contamination or pollution by hazardous materials, Terraprobe will not be held responsible to detect or report on such or other related matters.

9. It has been assumed that the client will arrange for legal access by Terraprobe, to the site for the purposes of preparing for and carrying out the work stated herein. There may be some minor disturbance to the site ground conditions in order to carry out the work and, this proposal does not include any provision for restoration which would be at additional cost. Furthermore unless specifically stated, this proposal does not include any provisions or costs for obtaining permits (occupancy, repair, police, security, escort) or other related fees which may be necessary to carry out the field work, and any such costs are extra.

10. Terraprobe's (including officers, employees, and agents) total cumulative liability for all claims (whether sound in contract or in tort) pursuant to this work, shall not exceed the limits of insurance carried for such reasons and only to the extent such insurance is available. Terraprobe Ltd. shall not be liable (held harmless) for any indirect or consequential damages such as loss of use, business interruption, loss of

profit, or delay. It is expressly agreed that Terraprobe's employees and principals shall have no personal liability in respect of a claim whether in contract, tort or any other cause of action in law.

11. In the event of a dispute over the services or over perceived damages, all parties agree to participate and co-operate in a mediation process or Alternate Dispute Resolution process. All costs so associated will be borne by the respective parties participating.

12. Disputes regarding any given invoice must be made in writing within 30 days of the invoice date.

13. All documents produced by Terraprobe under this agreement, are instruments of Terraprobe's professional service. They may not be used by the client for any other purpose without the prior written consent of Terraprobe.

14. In the event of termination of this contract for any reason whatsoever, the client will pay Terraprobe for all services rendered to the date of termination and all reimbursable expenses incurred prior to termination, and reasonable termination expenses incurred as the result of termination.