



## Appendix D: Guidelines for Geotechnical Investigation

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### 1.0 PURPOSE

These guidelines are intended to summarize the requirements of the Cataraqui Region Conservation Authority (CRCA) for the preparation of geotechnical investigation reports. These reports are prepared by qualified Professional Engineers and Professional Geoscientists for development that is proposed on lands subject to erosion hazards associated with shorelines and defined valleys within its jurisdiction. It is intended to facilitate the preparation of reports that will meet the intent of provincial policy, thereby ensuring sound development practice. The guidelines reflect provincial technical guidelines (e.g., Ministry of Natural Resources natural hazards technical guides) and regional engineering studies (e.g., J.D. Paine Engineering Inc., 1995). These guidelines may or may not satisfy the specific requirements of other agencies. This document will be updated from time to time.

This document is Appendix D to the CRCA Land Use Planning Policies (2015), and should be read in conjunction with the policies.

### 2.0 POLICY CONTEXT

Section 3.1 of the Provincial Policy Statement, 2014 (PPS) states that “development shall be directed away from areas of natural or human-made hazards where there is an unacceptable risk to public health or safety or of property damage.”

The PPS addresses flooding hazards, erosion hazards, dynamic beach hazards, and hazardous sites. The preference is to avoid the hazard entirely, thereby avoiding or minimizing the potential for property damage or risks to personal health and safety. The PPS allows for some flexibility for development and site alteration in those situations in which the hazard is considered to be minor and can be addressed in an environmentally sound manner.

The specific interests of the CRCA regarding erosion hazards include the following:

- the effect of increases in loading on slope stability/failure;
- the effect of infiltration of surface water on slope stability/failure;
- erosion from surface water on the slope;
- erosion of the toe of slope;
- evaluation of the susceptibility of slopes above or adjacent to a development to failure /movement; and
- the use of appropriate and environmentally-sound protection works.

### 3.0 TECHNICAL GUIDELINES

There are detailed provincial technical guidelines that define the erosion hazard limit, and establish standards and procedures to refine the hazard through regional and site-specific investigations on Lake Ontario and the St. Lawrence River (MNR, 2001) and on river and stream systems (MNR, 2002). The Geotechnical Principles for Stable Slopes (Terraprobe and Aqua Solutions, 1998) support the MNR technical guides. All three of these documents support the implementation of Section 3.1 of the PPS.

Within the CRCA jurisdiction, the erosion hazard limit for the Lake Ontario and St. Lawrence River shoreline was refined to consist of a stable slope allowance and erosion allowance based on a report prepared by J. D. Paine Engineering Inc. (1995). This information is summarized in Appendix C.

On river and stream systems, the erosion hazard limit is defined as a *toe erosion allowance* plus a *stable slope allowance* plus an *erosion access allowance* (MNR, 2002). The stable slope allowance is normally defined as being no steeper than 1(h):1(v) for bedrock shorelines and 3(h):1(v) for till, where there is no evidence of shoreline erosion. A minimum erosion access allowance of 6 metres is used from the top of the stable slope allowance.

A site specific geotechnical investigation is required in situations where development is proposed within the applicable erosion hazard limit as defined above.

### 4.0 REPORT CONTENT

The report must explicitly outline how the investigation methods and recommendations are consistent with the Provincial Policy Statement, and the applicable supporting provincial technical guides and/or the J. D. Paine Engineering Inc. report (1995). It must include the stamp and signature of a qualified Professional Engineer or Professional Geoscientist.

The report should include the content and general format that is outlined in Sections 8 and 9 of Geotechnical Principles for Stable Slopes (GPSS) (Terraprobe and Aqua Solutions, 1998). It should also include a completed Slope Inspection Record (Table 7.4) and Slope Stability Rating Chart (Table 8.1) from the GPSS. These tables are attached to this appendix. These items should be used to determine the required level of investigation. Only SI (metric) units should be used.

We recommend that the report be broken into two parts. The first part would include the factual data, while the second part would include recommendations based on the proposed construction. Reports may be deemed incomplete unless they include all of the content listed below.

#### Content of Part One

- Terms of reference
- Reference to applicable, established erosion hazard limits

- Details of site conditions and field investigations
  - Slope configuration/profile - height, inclination and shape, scaled cross-section drawing
  - Subsurface conditions (actual and inferred) - soil stratigraphy and layering, soil type and composition, soil density and strengths, groundwater levels/observations, seepage
  - External loadings - structures, traffic, earthquakes, trees, fill
  - Site drainage - surface runoff, ditches, channels, seepage, creeks, rivers, lakes, excavation
  - Erosion - location, extent, severity, rates, wave action
  - Vegetative cover and species
  - History of instability
- Site inspection record
- Field and laboratory test results
- Photographs
- Borehole logs and piezometer monitoring data
- Discussion of site inspection and measurements taken
- Scaled site plan, with the relation to:
  - Existing and proposed structures
  - Current water's edge
  - Top of bank, toe of slope, and other topographic information
  - Required water or top of bank setbacks as specified in the applicable Zoning By-law
  - Regulatory flood plain (where defined)
  - Drainage features, erosion features, indicators of past instability or movement
  - Vegetation cover

## **Content of Part Two**

- Design bearing values
- Caisson/pile/foundation designs
- Potential settlement
- Potential causes of instability
- Safe slopes of banks and excavation walls
- Earth pressures for shoring
- Soil stabilization methods and comparison of benefits
- Relation of hazards to proposed development
- Long-term stable slope crest position and inclination
- Factor of safety
- Failure surfaces
- Methods for soil erosion/sedimentation control
- Methods by which to minimize impact on vegetation, and root systems
- Timing of site works
- Long term monitoring requirements

## **5.0 REVIEW PROCESS**

The CRCA will assess a cost-recovery fee for its review of a geotechnical report, based on the approved Plan Review Service Fee Schedule, as amended from time to time. Straightforward

proposals (such as minor development on adjacent lands) will normally be reviewed at the staff level. More complex proposals may be subject to a peer review, at the expense of the proponent, by a third party professional who will be retained by the municipality.

The completion and acceptance of a geotechnical report by the CRCA shall not guarantee that a development or site alteration proposal will automatically be approved by the municipality. Also, approvals from other agencies may be required.

Any approved development or site alteration shall be constructed in accordance with the recommendations of the approved geotechnical report. These recommendations should be incorporated into applicable plans such as plans of subdivision, plans of condominium, and/or site plans, and related agreements, as appropriate.

## REFERENCES

J.D. Paine Engineering Inc. 1995. Cataraqui Region Conservation Authority: Methodology for Defining the Regulatory Erosion Standard of Great Lakes Shorelines. Westbrook, Ontario.

Ontario Ministry of Natural Resources. 2001. Great Lakes - St. Lawrence River System and Large Inland Lakes: Technical Guides for Flooding, Erosion and Dynamic Beaches in Support of Natural Hazards Policies 3.1 of the Provincial Policy Statement. Queen's Printer for Ontario.

Ontario Ministry of Natural Resources. 2002. Technical Guide – River and Stream Systems: Erosion Hazard Limit. Queen's Printer for Ontario.

Terraprobe Limited and Aqua Solutions. 1998. Geotechnical Principles of Stable Slopes.

## FOR MORE INFORMATION

Please contact the CRCA at 613-546-4228 or [info@crca.ca](mailto:info@crca.ca), or visit our website at [www.crc.ca](http://www.crc.ca).

TABLE 8.1 - SLOPE STABILITY RATING CHART

Site Location:		File No.	
Property Owner:		Inspection Date:	
Inspected By:		Weather:	
1.	<b>SLOPE INCLINATION</b> degrees	horiz. : vert.	Rating Value
a)	18 or less	3 : 1 or flatter	0
b)	18 - 26	2 : 1 to more than 3 : 1	6
c)	more than 26	steeper than 2 : 1	16
2.	<b>SOIL STRATIGRAPHY</b>		
a)	Shale, Limestone, Granite (Bedrock)		0
b)	Sand, Gravel		6
c)	Glacial Till		9
d)	Clay, Silt		12
e)	Fill		16
f)	Leda Clay		24
3.	<b>SEEPAGE FROM SLOPE FACE</b>		
a)	None or Near bottom only		0
b)	Near mid-slope only		6
c)	Near crest only or, From several levels		12
4.	<b>SLOPE HEIGHT</b>		
a)	2 m or less		0
b)	2.1 to 5 m		2
c)	5.1 to 10 m		4
d)	more than 10 m		8
5.	<b>VEGETATION COVER ON SLOPE FACE</b>		
a)	Well vegetated; heavy shrubs or forested with mature trees		0
b)	Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4
c)	No vegetation, bare		8
6.	<b>TABLE LAND DRAINAGE</b>		
a)	Table land flat, no apparent drainage over slope		0
b)	Minor drainage over slope, no active erosion		2
c)	Drainage over slope, active erosion, gullies		4
7.	<b>PROXIMITY OF WATERCOURSE TO SLOPE TOE</b>		
a)	15 metres or more from slope toe		0
b)	Less than 15 metres from slope toe		6
8.	<b>PREVIOUS LANDSLIDE ACTIVITY</b>		
a)	No		0
b)	Yes		6
	<b>SLOPE INSTABILITY RATING</b>	<b>RATING VALUES TOTAL</b>	<b>INVESTIGATION REQUIREMENTS</b>
1.	Low potential	< 24	Site inspection only, confirmation, report letter.
2.	Slight potential	25-35	Site inspection and surveying, preliminary study, detailed report.
3.	Moderate potential	> 35	Boreholes, piezometers, lab tests, surveying, detailed report.
<b>NOTES:</b>			
a)	Choose only one from each category; compare total rating value with above requirements.		
b)	If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.		
<b>TOTAL</b>		<b>TOTAL</b>	



7. SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types) TOP  FACE  BOTTOM
8. WATER COURSE FEATURES (circle and describe) SWALE, CHANNEL  GULLY  STREAM, CREEK, RIVER  POND, BAY, LAKE  SPRINGS  MARSHY GROUND
9. VEGETATION COVER (grasses, weeds, shrubs, saplings, trees) TOP  FACE  BOTTOM
10. STRUCTURES (buildings, walls, fences, sewers, roads, stairs, decks, towers, ) TOP  FACE  BOTTOM
11. EROSION FEATURES (scour, undercutting, bare areas, piping, rills, gully) TOP  FACE  BOTTOM
12. SLOPE SLIDE FEATURES (tension cracks, scarps, slumps, bulges, grabens, ridges, bent trees) TOP  FACE  BOTTOM
13. PLAN SKETCH OF SLOPE
14. PROFILE SKETCH OF SLOPE