Appendix H

Environmental Impact Statement for SWM Pond Expansion in East Urban Community Mixed Use Centre

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Submitted To:

Richcraft
2280 St. Laurent Blvd. Suite 201
Ottawa, Ontario
K1G 4K1

AND

Caivan Communities
2934 Baseline Road, Suite 302
Ottawa, ON
K2H 8T5

KILGOUR & ASSOCIATES LTD.
2285C St. Laurent Blvd. Unit 16
Ottawa, Ontario,
K1G 4Z6
Canada
613-260-5555
www.kilgourassociates.com
Project Number: Rich 724

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1.0 INTRODUCTION

Kilgour & Associates Ltd. (KAL) was initially retained by Richcraft Homes Ltd. (Richcraft) and Caivan Communities (Caivan) to prepare a Tree Conservation Report (TCR) to assess the natural heritage impacts of tree removal associated with the expansion of an existing SWM pond in the East Urban Community Mixed Use Centre area. In conducting that study (KAL, 2018), it was recognized that the potential for natural heritage impacts extended beyond the presence of trees on site and that and EIS was required to more fully assesses the proposed expansion.

The existing pond was constructed in 2011 within a 6.2 ha wooded area that had originally been identified as a portion of UNA #97 (Navan Road at Page Road). All wooded areas of the UNA occurring north of the hydro corridor (along with most of the wooded area south of the corridor) were listed as "Development Approved" within the City's *Urban Natural Features Strategy* map of UNA areas from 2011. None of these "Development Approved" areas are now indicated protected spaces within Schedule B of the City Official

The construction of that pond removed over 2 ha of the wooded area north of the hydro corridor, splitting the remainder into two separate woodlots (herein, the north and south woodlots).

In 2017, the north woodlot was cut back along its north side to allow for residential development at 3490 Innes Road (Orleans Village). In early 2018, that woodlot was again cut back - on both the north and east sides - to allow for the connection of stormwater infrastructure from Orleans Village to the SWM pond. Only 2.76 ha remain of the original UNA#97 area north of the hydro corridor, though the forest edges have crept beyond that original boundary in places. The north woodlot now covers approximately 1.99 ha, while the south woodlot covers 0.84 ha. The proposed SWM pond expansion required under the East Urban Community Mixed Use Centre CDP would result in the removal of the south woodlot and part of the north woodlot. The CDP has not yet received final approval. No changes are proposed to portions of UNA #97 south of hydro corridor.

This EIS investigates the potential presence of, and/or impacts to, species-at-risk (SAR) and significant wildlife habitat within the remaining woodlot areas, and the ecological values of the feature(s) as significant woodland. This report also includes a TCR, detailing the trees present on site.

2.0 PROPERTY INFORMATION

The subject properties are two lots (GLOUCESTER; PINS 044041304 and 044041305) surrounding the storm water pond north of Brian Coburn Blvd. and east of Nature Trail Crescent.

The remnant woodlots are currently zoned for light industrial (IL2 H(14)-h) usage (Ottawa, 2018). Through OPA 180 however, these lands have been re-designated from Employment to General Urban and are part of the EUC MUC CDP, which is currently underway.

459425 m

459625 m

5031775 m

5031775 m

R9

R12

R7

R7

North Woodlot

South Woodlot

NATURE TRAIL CRES

459425 m

459625 m

Figure 1 Existing site conditons.

Legend

ELC

- FOD2-1
- FOD7
- FOD8-1
- Previously Cleared

Stream setbacks

- 15/30 m Setback
- Hazard Limit
- Top of Slope

Exisitng Pond

- Operational Extent
- Pond Contour

Tree Labels

DBH 20- 30cm- blue
DBH 30- 40cm- white
DBH 40- 50cm- yellow
DBH 50- 60cm- orange
DBH >60- red

N

0 50 m

Project: RICH 724
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Universal Transverse Mercator - Zone 18 (N)
Printed on: 2018-09-05

KILGOUR & Associates

3.0 SITE TREES AND ENVIRONMENT

3.1 Landform, Soils and Geology

The property is located within the Ottawa Valley Clay Plains, which are composed of areas of Champlain Sea deposits, glacial deposits and drumlins, glaciofluvial deposits, shallow and exposed bedrock, and peat and muck from wetlands (Schut and Wilson, 1979). The properties lie on soils of the Manotick Series, which are comprised of a strongly acid, coarse-textured marine, estuarine and fluvial veneer that is 25 to 100 cm thick. This series is composed of Orthic Sombric Brunisols, Gleyed Sombric Brunisols, Gleyed Humo-Ferric Podzols, Orthic Humic Gleyols, and Rego Gleysols with gently sloping and undulating but predominately level topography. The Mud Creek Subwatershed Summary Report categorized surficial geology as 48% sand, 45% clay, 3% diamicton, 2% bedrock, and 2 % organic soils (RVCA, 2012).

There are no rocky outcrops on the property and no Earth Science Areas or Natural and Scientific Interest as designated by the Ministry of Natural Resources identified in OP Schedule K (Ottawa, 2014).

3.2 Surface Water, Groundwater and Fish Habitat

The site lies within the Mud Creek Subwatershed (RVCA, 2016). The most prominent aquatic feature is on site is the existing SWM pond, which collects surface water runoff from lands to the north east. A forest stream and a smaller branch channel, located in the western portion of the north woodlot, lead into it. These features were previously described an evaluated within the Head Water Drainage Feature Assessment (KAL 2017a) and the EIS (KAL 2017b) for Orleans Village.

A stream leading from the southwest corner of Orleans Village (Reach 9) emerges from its ravine-like walls at the south edge of that residential community into the main channel of the forest stream (Reach 7 within the HDFA), becoming a highly sinuous, permanent stream through the mature deciduous forest of the north woodlot. This stream meanders through the forest following a natural riffle/pool sequence to the existing SWM pond, the operational extent (i.e. the 100-year flood level) of which includes channel's lower end (most of which is also within the pond's 5-year flood level). Strong flows in April diminished steadily to a trickle in July when the stream was less than 5 cm deep, and with the wetted width decreasing from 2.5 m to 30 cm or less. One Creek Chub and Seven Brook Stickleback were observed in 2016 at the bottom end of this reach near its confluence with the SWM pond (KAL 2017a). The HDFA management recommendation for this feature was that it be preserved with a 30 m setback. As no subwatershed study exists for this area, this setback is consistent with OP Policy 4.7.3-2.

A second, small channel (Reach 12 per the HDFA) is an 85 m erosion gully through the forest, conveying spring freshet water from the woodlot to its confluence with Reach 7. Instream vegetation is absent. Both banks are dominated by trees with some shrubs. The HDFA management recommendation for this feature was for "Conservation", meaning that it can be maintained with a 15 m setback or may be removed or altered so long as its ecological functions are replicated elsewhere. The reduced setback of 15 m is permissible under OP Policy 4.7.3-6b, which applies to minor tributary that serves primarily a surface water function and that may have only an intermittent flow. A setback of 15 m was similarly applied to other retained tributary channels to the forest stream within Orleans Village.

The geotechnical limit of hazard for both reaches occurs within the recommended 15 and 30 m setbacks (Golder, 2018).

The nearest Provincially Significant Wetland is Mer Bleue located approximately 2km to the south.

3.3 Site Flora / Land Cover

The Mud Creek Subwatershed contains the property and surrounding areas (RVCA, 2016). According to the Mud Creek Subwatershed Summary Report (RVCA, 2012), the primary lands use of this area is agriculture (48%) and urban development (23%). Forest areas make up the next highest land use category at 22%, while rural land-use, wetlands, and unclassified make up 2%, 5%, and 1%; respectively.

The proposed development area includes only the existing SWM pond and the north and south remnant woodlots.

3.3.1 Forest Cover - Forest Significance

Some of the eastern portions of the north woodlot predate 1965 and, as such, the feature includes some larger trees. The north woodlot consists mostly of a 2.16 ha Fresh-Moist Lowland Deciduous Forest (FOD7). Trees here are predominantly Red Maple (*Acer rubrum*), White Birch (*Betula papyrifera*), Silver Maple (*Acer saccharinum*), (*Fagus grandifolia*), and Yellow Birch (*Betula alleghaniensis*) with subordinate tree species of Green Ash (*Fraxinus pennsylvanica)*, Black Cherry (*Prunus serotina*), American Basswood (*Tilia americana*), and Sugar Maple (*Acer saccharum*). Occasional patches of Sugar Maples on higher points in the woodland could be considered as very small Fresh-Moist Sugar Maple Deciduous Forest Ecotype (FOD6) inclusions, but the area is best described overall as FOD7 (Figure 1). The eastern-most edge of this woodlot is a 0.16 ha remnant area of young Dry-Fresh Oak-Red Maple Deciduous Forest (FOD2-1), that had extended down from the property parcel to the north (Figure 1). This ecosite developed after 1976. Most of the trees within that ecosite were removed during the 2017 and 2018 clearings for Orleans Village and its connection to the SWM pond. More detailed tree lists are included in Section 3.3.2.

The area of the planned pond expansion within the FOD7 wooded area contains many trees greater than 30 cm in diameter, and six trees >50 cm DBH. The north woodlot was recognized as having potential to support SAR bat roosting habitat. As the FOD7 portion of this feature is located within the urban area, is not subject to a fully completed and approved CDP, is >0.8 ha in size, and existed as a forested in area in 1976, it constitutes a significant woodland under the City's recent revision of OP 2.4.2. The FOD2-1 portion, being much younger, does not constitute Significant Woodland.

The south woodlot, a Fresh – Moist Poplar Deciduous Forest (FOD8-1) ecosite (Figure 1), extends off the property slightly to include a total forested area of 0.84 ha. Trees here consist almost entirely of Trembling Aspen (*Populus tremuloides*). This is consistent with a young, early successional forest. The area had no trees in 1976 and only sapling cover by 1991. Other trees species there include Large-toothed Aspen (*Populus grandidenta*), Red Maple and Basswood and White Pine, but only in very small numbers. No trees of notable size (*i.e.* >50 cm DBH), quality, or species were observed in this forest area. The smaller, younger, healthier trees here do not provide potential as high-quality bat habitat (having only four snags per ha). While this feature is also located within the urban area, it is not subject to a fully completed and approved CDP, and is >0.8 ha in size, it is too young to constitute significant woodland under the revised OP 2.4.2. Similarly, the FOD2-1 ecosite within the north woodlot is also too young to constitute significant woodland.

The north wooded area was initially considered to have the potential to provide some nesting habitat for listed bird species such as Wood Thrush (*Hylocichla mustelina*) and Eastern Wood-pewee (*Contopus virens*). Previous surveys of the property to the north of the site had observed Eastern Wood-pewee within the north forest.

3.3.2 Site Trees

All trees on site within the areas to be impacted were reviewed by KAL biologist Terry Hams during a field visit on December 7, 2017. Trees on site with a DBH (diameter at breast height 1.3 m above ground level) of 30 cm or more were assessed specifically during the field visit and are included in Table 1 and Figure 1. Smaller trees and saplings were too numerous to mark individually within this report, though all species present were identified.

A single Butternut snag was observed on site during the December 7th, site visit. That appeared to be heavily infested by Butternut Canker (*Sirococcus clavigignenti-juglandacearum*), but a Butternut Health Assessment (BHA) was not completed at the time due to the lateness of the season. A BHA was completed on June 20, 2018 by KAL biologist Rob Hallett. A thorough re-searching of the area during the BHA found a second Butternut. Both Butternuts were found to be non-retainable.

Of the 194 trees specifically cataloged on site – some of which have already been removed – only 24 are designated to be retained. The remaining surveyed trees, along with many trees less than 30 cm in diameter, will be removed to support the SWM pond expansion. This will remove a majority of the tree in the north and south woodlots. A 65 m wide swath of the oldest portion of the north woodlot, however will be retained between the new SWM pond and the adjacent community to the west (Figure 2). This is the portion in which the forest stream (i.e. Reach 7) is located.

Table 1: Site trees.

Tree Number	Common Name	Scientific Name	Quantity	DBH	Comments	Fate
1	Sugar Maple	*Acer saccharinum*	1	40		To be removed
2	White Spruce	*Picea glauca*	1	42		To be removed
3	Yellow Birch	*Betula alleghaniensis*	1	33		To be removed
4	Yellow Birch	*Betula alleghaniensis*	1	31		To be removed
5	White Pine	*Pinus strobus*	1	60*		To be removed
6	Yellow Birch	*Betula alleghaniensis*	1	38		To be removed
7	Green Ash	*Fraxinus pennsylvanica*	1	39	EAB	To be removed
8	Yellow Birch	*Betula alleghaniensis*	1	41		To be retained
9	Yellow Birch	*Betula alleghaniensis*	1	46	Sickly	To be removed
10	Green Ash	*Fraxinus pennsylvanica*	1	49	EAB	To be removed
11	Green Ash	*Fraxinus pennsylvanica*	1	34	EAB	To be retained
12	Yellow Birch	*Betula alleghaniensis*	1	32		To be retained
13	White Birch	*Betula papyrifera*	1	30		To be retained
14	White Birch	*Betula papyrifera*	1	38	Sickly	To be removed
15	Silver Maple	*Acer saccharinum*	1	32, 39	Double-stem	To be removed
16	Green Ash	*Fraxinus pennsylvanica*	1	42	EAB	To be removed
17	White Birch	*Betula papyrifera*	1	31		To be removed
18	Green Ash	*Fraxinus pennsylvanica*	1	34	EAB	To be removed
19	Sugar Maple	*Acer saccharinum*	1	32		To be removed
20	Silver Maple	*Acer saccharinum*	1	39		To be removed
21	American Beech	*Fagus grandifolia*	1	30		To be removed
22	Sugar Maple	*Acer saccharinum*	1	31		To be removed
23	Red Oak	*Quercus rubra*	1	33		To be removed
24	White Spruce	*Picea glauca*	1	36	Sickly	To be removed
25	Sugar Maple	*Acer saccharinum*	1	32		To be removed
26	Red Maple	*Acer rubrum*	1	32		To be removed
27	Sugar Maple	*Acer saccharinum*	1	42		To be removed

Tree Number	Common Name	Scientific Name	Quantity	DBH	Comments	Fate
28	White Spruce	*Picea glauca*	1	44	Sickly	To be removed
29	Green Ash	*Fraxinus pennsylvanica*	1	31	EAB	To be removed
30	Trembling Aspen	*Populus tremuloides*	1	41		To be retained
31	Red Maple	*Acer rubrum*	1	34		To be retained
32	Red Maple	*Acer rubrum*	1	38		To be retained
33	Sugar Maple	*Acer saccharinum*	1	20 - 37	Multi-stem	To be retained
34	Black Ash	*Fraxinus nigra*	1	40	EAB	Already removed
35	Red Maple	*Acer rubrum*	1	20 - 40	Multi-stem	To be removed
36	Black Ash	*Fraxinus nigra*	1	37	EAB	To be removed
37	Black Ash	*Fraxinus nigra*	1	31	EAB	To be removed
38	Red Maple	*Acer rubrum*	1	34		Already removed
39	Red Maple	*Acer rubrum*	1	32		Already removed
40	Trembling Aspen	*Populus tremuloides*	2	40, 44		Already removed
41	Trembling Aspen	*Populus tremuloides*	1	32		Already removed
42	Trembling Aspen	*Populus tremuloides*	1	30		Already removed
43	Trembling Aspen	*Populus tremuloides*	1	32		Already removed
44	Trembling Aspen	*Populus tremuloides*	1	31		Already removed
45	Trembling Aspen	*Populus tremuloides*	2	33, 41		Already removed
46	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
47	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
48	Trembling Aspen	*Populus tremuloides*	1	39		To be removed
49	Green Ash	*Fraxinus pennsylvanica*	1	55	EAB, mostly dead	Already removed
50	Trembling Aspen	*Populus tremuloides*	1	38		To be removed
51	Trembling Aspen	*Populus tremuloides*	1	31	Mostly dead	To be removed
52	Trembling Aspen	*Populus tremuloides*	1	41		To be removed
53	Trembling Aspen	*Populus tremuloides*	1	35		To be removed
54	Trembling Aspen	*Populus tremuloides*	1	33		To be removed
55	Red Oak	*Quercus rubra*	1	42		To be removed
56	Trembling Aspen	*Populus tremuloides*	1	31	Sickly, mostly dead	To be removed
57	Trembling Aspen	*Populus tremuloides*	1	33		To be removed
58	Red Maple	*Acer rubrum*	1	26, 48	Double-stem	To be removed
59	Black Ash	*Fraxinus nigra*	1	38	Snag	To be removed
60	Trembling Aspen	*Populus tremuloides*	1	40		To be removed
61	Yellow Birch	*Betula alleghaniensis*	1	31	Sickly	To be removed
62	Red Oak	*Quercus rubra*	1	35		To be removed
63	Trembling Aspen	*Populus tremuloides*	1	42	Sickly	To be removed
64	Red Maple	*Acer rubrum*	1	33		To be removed
65	Red Maple	*Acer rubrum*	1	30 - 45	Multi-stem	To be removed
66	Green Ash	*Fraxinus pennsylvanica*	1	37	EAB	To be removed
67	Red Maple	*Acer rubrum*	1	37		To be removed
68	Red Oak	*Quercus rubra*	1	49, 62*	Double-stem	To be removed
69	Red Oak	*Quercus rubra*	1	67*		To be removed
70	American Basswood	*Tilia americana*	1	36, 39	Double-stem	To be removed
71	Trembling Aspen	*Populus tremuloides*	2	35, 42		To be removed
72	White Spruce	*Picea glauca*	1	32	Sickly	To be removed
73	Sugar Maple	*Acer saccharinum*	1	31		To be removed
74	Yellow Birch	*Betula alleghaniensis*	1	37	Sickly	To be removed
75	White Spruce	*Picea glauca*	1	33	Sickly	To be removed
76	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
77	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
78	White Pine	*Pinus strobus*	1	34		To be removed
79	Red Maple	*Acer rubrum*	1	33		To be removed
80	Red Maple	*Acer rubrum*	1	40		To be removed
81	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
82	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
83	Trembling Aspen	*Populus tremuloides*	1	33		To be removed
84	Trembling Aspen	*Populus tremuloides*	1	34		To be removed
85	White Birch	*Betula papyrifera*	1	31		To be removed
86	Black Ash	*Fraxinus nigra*	1	33	Mostly dead	To be removed
87	Black Cherry	*Prunus serotina*	1	30		To be removed
88	Red Maple	*Acer rubrum*	1	46		To be removed
89	American Basswood	*Tilia americana*	1	35		To be removed
90	Red Oak	*Quercus rubra*	1	30		To be removed

Tree Number	Common Name	Scientific Name	Quantity	DBH	Comments	Fate
91	Red Oak	*Quercus rubra*	1	44		To be removed
92	Black Ash	*Fraxinus nigra*	1	32	EAB	To be removed
92	Red Maple	*Acer rubrum*	1	25 - 44	Multi-stem	To be removed
93	Black Ash	*Fraxinus nigra*	1	30	EAB	To be removed
94	Red Maple	*Acer rubrum*	1	10 - 37	Multi-stem	To be removed
95	Red Maple	*Acer rubrum*	1	36		To be removed
96	Black Ash	*Fraxinus nigra*	1	33	EAB	To be removed
97	Red Maple	*Acer rubrum*	1	42		To be removed
98	Red Maple	*Acer rubrum*	1	31		To be removed
99	Red Maple	*Acer rubrum*	1	30		To be removed
100	Red Maple	*Acer rubrum*	1	51*	Fused double-stem	To be removed
101	White Spruce	*Picea glauca*	1	46		To be removed
102	White Spruce	*Picea glauca*	1	41		To be removed
103	White Spruce	*Picea glauca*	1	42		To be removed
104	White Spruce	*Picea glauca*	1	39		To be removed
105	White Spruce	*Picea glauca*	1	36		To be removed
106	Red Oak	*Quercus rubra*	1	47		To be removed
107	Red Oak	*Quercus rubra*	1	39		To be removed
108	American Basswood	*Tilia americana*	1	36		To be removed
109	American Basswood	*Tilia americana*	1	30		To be removed
110	Green Ash	*Fraxinus pennsylvanica*	1	33	EAB	To be removed
111	Red Maple	*Acer rubrum*	1	50*		To be removed
112	Red Maple	*Acer rubrum*	1	10, 39	Double-stem	To be removed
113	American Beech	*Fagus grandifolia*	1	33		To be removed
114	Trembling Aspen	*Populus tremuloides*	1	63*		To be removed
115	Black Cherry	*Prunus serotina*	1	36		To be removed
116	Red Maple	*Acer rubrum*	1	30		To be removed
117	Trembling Aspen	*Populus tremuloides*	1	40		To be removed
118	Sugar Maple	*Acer saccharinum*	1	55	Mostly dead	To be removed
119	Butternut	*Juglans cinerea*	1	35	Snag – non retainable	To be removed
120	Yellow Birch	*Betula alleghaniensis*	1	38		To be removed
121	Yellow Birch	*Betula alleghaniensis*	1	37		To be removed
122	Green Ash	*Fraxinus pennsylvanica*	1	31	EAB, mostly dead	To be removed
123	Red Maple	*Acer rubrum*	1	65	Sickly	To be removed
124	White Pine	*Pinus strobus*	1	25		To be removed
125	White Pine	*Pinus strobus*	1	24		To be removed
126	Trembling Aspen	*Populus tremuloides*	1	42		To be removed
127	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
128	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
129	Trembling Aspen	*Populus tremuloides*	1	20 -33	Multi-stem	To be removed
130	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
131	Trembling Aspen	*Populus tremuloides*	1	44		To be removed
132	Trembling Aspen	*Populus tremuloides*	1	10 - 32	Multi-stem	To be removed
133	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
134	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
135	White Pine	*Pinus strobus*	1	33		To be removed
136	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
137	Trembling Aspen	*Populus tremuloides*	1	35		To be removed
138	Trembling Aspen	*Populus tremuloides*	1	44		To be removed
139	Trembling Aspen	*Populus tremuloides*	1	32		To be removed
140	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
141	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
142	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
143	Trembling Aspen	*Populus tremuloides*	1	30, 32	Double-stem	To be removed
144	Trembling Aspen	*Populus tremuloides*	1	35		To be removed
145	Trembling Aspen	*Populus tremuloides*	1	15 - 30	Multi-stem	To be removed
146	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
147	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
148	Trembling Aspen	*Populus tremuloides*	1	32		To be removed
149	Trembling Aspen	*Populus tremuloides*	1	35		To be removed
150	Trembling Aspen	*Populus tremuloides*	1	36		To be removed

Tree Number	Common Name	Scientific Name	Quantity	DBH	Comments	Fate
151	Green Ash	*Fraxinus pennsylvanica*	1	34	EAB, mostly dead	To be removed
152	Green Ash	*Fraxinus pennsylvanica*	1	37	EAB	To be removed
153	Sugar Maple	*Acer saccharinum*	1	33		To be removed
154	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
155	Ash species	*Fraxinus sp.*	1	43	EAB, snag	To be removed
156	Trembling Aspen	*Populus tremuloides*	1	42		To be removed
157	Trembling Aspen	*Populus tremuloides*	1	38		To be removed
158	Trembling Aspen	*Populus tremuloides*	1	35		To be removed
159	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
160	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
161	Trembling Aspen	*Populus tremuloides*	1	35	Mostly dead	To be removed
162	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
163	Trembling Aspen	*Populus tremuloides*	1	31, 34	Double-stem	To be removed
164	Trembling Aspen	*Populus tremuloides*	1	40		To be removed
165	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
166	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
167	Red Maple	*Acer rubrum*	1	34		To be removed
168	White Spruce	*Picea glauca*	1	35		To be removed
169	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
170	Trembling Aspen	*Populus tremuloides*	1	32		To be removed
171	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
172	Large-toothed Aspen	*Populus grandidentata*	1	38		To be removed
173	Trembling Aspen	*Populus tremuloides*	1	39		To be removed
174	Trembling Aspen	*Populus tremuloides*	1	34		To be removed
175	Trembling Aspen	*Populus tremuloides*	1	37		To be removed
176	Trembling Aspen	*Populus tremuloides*	1	33		To be removed
177	Trembling Aspen	*Populus tremuloides*	1	28, 31	Double-stem	To be removed
178	Trembling Aspen	*Populus tremuloides*	1	39		To be removed
179	Trembling Aspen	*Populus tremuloides*	1	30		To be removed
180	Trembling Aspen	*Populus tremuloides*	1	42		To be removed
181	Red Maple	*Acer rubrum*	1	37		To be removed
182	Red Maple	*Acer rubrum*	1	34, 36	Double-stem	To be removed
183	Red Maple	*Acer rubrum*	1	26, 30	Double-stem	To be removed
184	American Basswood	*Tilia americana*	1	31		To be removed
185	Trembling Aspen	*Populus tremuloides*	1	32		To be removed
186	Red Maple	*Acer rubrum*	1	25, 33	Double-stem	To be removed
187	Red Maple	*Acer rubrum*	1	18, 36	Double-stem	To be removed
188	Trembling Aspen	*Populus tremuloides*	1	31		To be removed
189	Trembling Aspen	*Populus tremuloides*	1	38		To be removed
190	Trembling Aspen	*Populus tremuloides*	1	36		To be removed
191	Trembling Aspen	*Populus tremuloides*	1	37	Sickly	To be removed
192	Green Ash	*Fraxinus pennsylvanica*	1	34	EAB	To be removed
193	Green Ash	*Fraxinus pennsylvanica*	1	32	EAB, mostly dead	To be removed
194	Large-toothed Aspen	*Populus grandidentata*	1	35		To be removed
195	Butternut	*Juglans cinerea*	1	35	Non-retainable	To be removed

EAB = Emerald Ash Borer evidence

* Distinctive tree (i.e. greater than 50 cm DBH and in good health)

3.4 Site Fauna

3.4.1 Amphibians

Methods

Amphibian surveys followed the protocols set forth by the Marsh Monitoring Program (Bird Studies Canada, 2003). Three surveys were completed to identify early, mid, and, late season breeding amphibian species in April, May, and June; respectfully. Surveys were completed on nights of calm weather with

temperatures above 5°C, 10°C, and 17°C for each of the three respective survey periods. Surveys began a half hour after sunset and finished by midnight with a five-minute recording period at each survey station. Amphibian species were recorded at each point along with estimated distance from observers, abundance code, estimate of individuals, and estimated direction.

Results

Amphibian surveys were performed on April 23, May 30, and June 21, 2018. One station was surveyed along the south edge of the north woodlot, which covered the entire site**.** Weather characteristics for the surveys are presented in Table 1. No amphibians were observed on the site during amphibian surveys. These findings are consistent with those in the Orleans Village EIS (KAL 2017b), which noted limited numbers of frogs in wetter areas, north of the current site, but none in the north woodlot. The south woodlot has no wet areas and no frogs were ever heard calling here.

Table 2: Weather conditions during amphibian surveys in 2018.

Date	Temperature (°C)	Weather conditions	Wind speed (km/hr)
23-Apr-18	10	Clear	4
30-May-17	22	Mostly cloudy	11 - 14
21-Jun-17	14 – 17 *	Clear	7 - 11

* Temperatures had been >17°C for several consecutive nights prior to the survey

3.4.2 Breeding Bird Surveys

Methods

Two rounds of breeding bird surveys were completed on site in 2018. Breeding bird surveys (BBS) followed guidelines from Bird Studies Canada (Bird Studies Canada, 2001). The period for BBS in the Ottawa regions begins on May 24 and ends on July 10, and each BBS round was a minimum of 10 days apart.

The two surveys are conducted on calm weather days with no precipitation between one half hour before sunrise and 10:00 am. Surveys are five minutes in duration with a two-minute habituation period preceding the surveys. All birds seen and heard are recorded along with associated breeding codes, and the estimated distance from the observer.

Results

Two rounds of BBS were completed at the site on June 19 and July 5, 2018 (16°C and 22°C respectively). Breeding bird surveys were completed at two survey stations that covered all habitats on site. These were both completed on calm weather days with light wind (less than 3 on the Beaufort scale) and no precipitation. Surveys were completed between ~06:00 and 06:30 each day.

Overall, 23 bird species were observed on site during the two rounds of surveys (Table 2). All of the birds observed were common species in the Ottawa region. Song Sparrow (*Melospiza melodia*) was the most abundant species on site followed by Common Grackle (*Quiscalus quiscula*) and Red-winged Blackbird (*Agelaius phoeniceus*).

One listed species, Eastern Wood-pewee (*Contopus virens*), was observed using the forest on site. This species is listed as special concern under the ESA (Ontario, 2007). A single individual was

observed using the larger trees along the west portion of the north woodlot adjacent to stream, which will not be altered during project development.

Table 3: bird species observed on site in 2018.

Common Name	Scientific Name	Breeding Potential	Common Name	Scientific Name	Breeding Potential
American Crow	*Corvus brachyrhynchos*	Probable	House Wren	*Troglodytes aedon*	Likely
American Goldfinch	*Spinus tristis*	Likely	Northern Flicker	*Colaptes auratus*	Likely
American Robin	*Turdus migratorius*	Likely	Red-breasted Nuthatch	*Sitta canadensis*	Likely
Baltimore Oriole	*Icterus galbula*	Likely	Red-eyed Vireo	*Vireo olivaceus*	Likely
Black-capped Chickadee	*Poecile atricapillus*	Likely	Red-winged Blackbird	*Agelaius phoeniceus*	Likely
Common Grackle	*Quiscalus quiscula*	Likely	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Likely
Common Yellowthroat	*Geothlypis trichas*	Likely	Song Sparrow	*Melospiza melodia*	Likely
Downy Woodpecker	*Dryobates pubescens*	Likely	Warbling Vireo	*Vireo gilvus*	Likely
Eastern Kingbird	*Tyrannus tyrannus*	Likely	White-breasted Nuthatch	*Sitta carolinensis*	Likely
Eastern Wood-pewee *	*Contopus virens*	Likely	Yellow Warbler	*Setophaga petechia*	Likely
Gray Catbird	*Dumetella carolinensis*	Likely	Veery	*Catharus fuscescens*	Likely
Great Crested Flycatcher	*Myiarchus crinitus*	Likely	--	--	--

* = Species is listed as Threatened under the *ESA* (Ontario, 2007).
Breeding Potential = Likely: Breeding behaviour observed and preferred nesting habitat on site; Probable: preferred habitat occurs on site but no breeding behaviour observed; Unlikely: lack of suitable breeding habitat and no breeding behaviour observed

3.4.3 Eastern Whip-poor-will Surveys

Methods

Eastern Whip-poor-will (EWPW) surveys followed the protocols defined in the draft EWPW survey plan developed by the Ontario Ministry of Natural Resources and Forestry (MNRF, 2014). Three rounds of surveys were completed, which were correlated with the full moon cycle of May and June (Table 3). The surveys entailed two observers recording EWPW calls and orientation from survey stations that give thorough coverage of the site (i.e., approximately 300 meters apart). Surveys occurred at least a half hour after dusk and within five days of the full moon (May 29 and June 28, 2018), while the moon was above the horizon, and during the EWPW breeding season from May 18 through July 10.

Results

Eastern Whip-poor-will surveys took place on the nights of May 30, June 21, and 25, 2018. Only one survey station was used due to the small size of the site. The Eastern Whip-poor-will Draft Survey Protocol allows for two of the three surveys to be performed in the same lunar cycle. Environmental variables (e.g., cloud cover, temperature, wind speed) were recorded for each round of surveys and are presented in Table 3. No EWPW were observed on site during the three rounds of surveys.

Table 4: Weather and moon phase data for Eastern Whip-poor-will surveys at site in 2018.

Date	Temperature range (°C)	Weather	Precipitation	Wind speed (km/hr)	Moon Phase (%)	Moon Visibility (%)
May 30, 2018	21 – 22	Mostly Cloudy	None	11 – 13	100	50
June 21, 2018	14 – 17	Clear	None	7 – 11	67	100
June 25, 2018	16 – 17	Clear	None	2 – 7	96	100

3.4.4 Bat Surveys

Methods

Little Brown Myotis, Northern Myotis, and Tri-colored Bat were listed as endangered under the *SARA* (Canada, 2002) in 2012. These bat species have suffered severe population declines associated with white-nose syndrome. These species are also listed as endangered under the *ESA* (Ontario, 2007), along with an additional bat species, the Eastern Small-footed Myotis, which is listed as endangered in Ontario but not under *SARA*.

These SAR bats typically emerge from hibernation in May to seek out roosting and foraging habitat for the summer. Pregnant females locate maternity roosts, either solitary or in colonies, were they give birth and raise their pups. Males spend their summers using day roosts separated from females and pups, which can change constantly. Bats move back to hibernaculum in late August or September where they perform swarming behaviours and mating before beginning hibernation in mid- to late October.

Each SAR species has different preferences for summer roosting habitat. Eastern Small-footed Myotis prefer to roosts in rock piles, cervices and holes in cliffs, and sometimes anthropomorphic structures. Little Brown Myotis has the most diverse habitat preferences for roosting and use dead and dying trees, rock crevices, and buildings. Northern Myotis females mainly roost in large trees, both alive and dead, but males will also roost in buildings. Tri-colored Bats roost mainly in larges trees typically in mature forests often near streams and rivers where they prefer to forage.

The forest habitats on and adjacent to the site, have the potential to provide roosting habitat for SAR bat species. Therefore, an acoustic monitoring survey was performed on the site in June, 2018 to determine the potential for SAR bat presence.

3.4.5 Acoustic Monitoring Surveys

To assess SAR bat presence and possible roosting on site, acoustic monitoring surveys were completed within the forest. This entailed the installation of a SM3Bat (Wildlife Acoustics Inc.) acoustic monitoring unit on site to passively monitoring and record bats as the used the site. The unit was installed in June and allowed to run for a minimum of 10 days as required by the 2015 MRNF protocol.

The data recorded by the acoustic monitor were processed using the Kaleidoscope program (Wildlife Acoustics Inc.) This program analyses bat calls and assigns species classification based on diagnostic characteristics. Conservative identification criteria were assigned to the program, which results in better classification of species but also many more sound-files being classified under noise or no identification categories.

Results

The SM3BAT unit was installed on site from 19 June until 5 July, exceeding the 10-day requirement from the MNRF. Four bat species were recorded using the site during the acoustic monitoring (Table 4). Numbers under the bat headings in Table 4 represent the numbers of calls recorded (approximately equal to the number of times a bat flew past the microphone), not the number of bats observed. Silver-haired Bat and Hoary Bat had the greatest number of passes on site and are both common bat species in the

Ottawa region. Given that recordings were taken continuously, all night, for 17 nights, there were an average of 36 passes per night for Silver-haired bats. This suggests the presence of a very small number of bats within the forest area as bats will tend to fly back and forth along the edge of tree line, or over the pond as they hunt. Only a few passes were classified as Big Brown Bat and Eastern Red Bat. No SAR bats were detected during the acoustic monitoring.

Table 5: number of bat passes near acoustic monitoring station on site in 2018.

Noise	No Identification	Big Brown Bat	Eastern Red Bat	Hoary Bat	Silver-haired Bat
1132	818	61	10	568	644

3.5 Species at Risk

KAL submitted a natural heritage information request to the Kemptville MNRF office for the property. The MNRF identified three listed species as potentially present on site: Bobolink, Butternut and Henslow's Sparrow. For due diligence, we formulated a further list of SAR with the potential to occur on site using information gathered from the NIHC database, OBBA, and other species atlases for Ontario (Section 2.1). Table 5 indicates the habitat requirements of these SAR plus others SAR potentially present within the broader area and whether the property may provide significant habitat.

Two Butternut were found on site, though both trees were found to be non-retainable. As such they are not subject to the *ESA* and are considered SAR. No other SAR protected under the *ESA* were found to be present on or adjacent on the property during field surveys.

A single Eastern Wood-pewee was observed in the western half of the north woodlot. This species is not protected under the *ESA*, but is subject to the federal Species at Risk Act (*SARA*). As a species of Special Concern, its habitat is considered to be Significant Wildlife Habitat (SWH).

Table 6. Species at risk with potential to occur at the Carlington Park Site in 2018.

Species Name	Provincial (ESA) Status	Habitat Requirement	Presence/Habitat on Site	Project Concerns Associated with Habitat on Site
Birds				
Bank Swallow (*Riparia riparia*)	Threatened	Colonial nester; burrows in eroding silt or sand banks, sand pit walls, and other similar habitats	No nesting habitat on or adjacent to the property, but it could forage over the SWM pond. None observed.	Negligible potential for presence. The pond expansion would only increase its potential foraging areas. No potential to impact nesting areas. Not a concern for this project.
Barn Swallow (*Hirundo rustica*)	Threatened	Species prefers to nest on manmade structures such and bridges, barns, and buildings near open terrestrial and aquatic habitats where it forages.	Limited potential for nesting is located on manmade structures associated with the SWM pond. The species could forage over the pond. None observed.	Low potential for presence. The pond expansion would only increase its potential foraging areas. No potential to impact nesting areas. Not a concern for this project.
Bobolink (*Dolichonyx oryzivorus*)	Threatened	Periodically mown, dry meadow for nesting. Habitat (meadow) should be > 10 ha, and preferably > 30 ha before bobolink are attracted to the site. Not near tall trees.	No preferred habitat exists on or adjacent to site. None observed.	Negligible potential for presence. Not a concern for this project.
Eastern Meadowlark (*Sturnella magna*)	Threatened	Prefers grasslands and pastures >5 ha in area with moderately tall grasses (25 to 50 cm) and abundant litter cover. High proportion of grasses to forbs and shrubs (<35% forbs and shrubs).	No preferred habitat exists on or adjacent to site. None observed.	Negligible potential for presence. Not a concern for this project.
Eastern Whip-poor-will (*Caprimulgus vociferus*)	Threatened	Species prefers areas that are a mix of open and forested habitats such as savannahs, open woodlands, or forest openings. It nests on the ground or forest floor and has cryptic coloured eggs and are hidden from visual predators.	Limited potentially-suitable breeding habitat near the on the site though the species is not known to occur in the vicinity.	None observed. Negligible potential for presence. Not a concern to the project.
Eastern Wood-pewee (*Contopus virens*)	Special Concern	Prefers mature and intermediate-aged deciduous and mixed forest with an open understory. Often nests and forages near open areas and forest edges.	The western half of the north woodlot provides preferred nesting habitat for species. A single specimen was observed there.	The species is not currently protected under the *ESA* but its presence designates north woodlot (or at least the western side of it) as a Significant Wildlife Habitat. The project will retain 0.95 ha of the prime habitat area, which is sufficient to provide habitat for a single nesting pair, i.e. equivalent to the current population on site. Mitigations will be required to prevent direct harm to individuals.
Henslow's Sparrow (*Ammodramus henslowii*)	Endangered	Species prefers open fields with tall grass and flowering plants with few scattered shrubs.	No preferred habitat exists on or adjacent to site. The species has not been observed in Ottawa for over 20 years.	Negligible potential for presence. Not a concern for this project.
Wood Thrush (Hylocichla mustelina)	Special Concern*	Moist deciduous hardwood or mixed forests with trees >16 m in height, a closed canopy (>70%), moderate sub-canopy and shrub layer, fairly open forest floor, and moist soil.	Forest on site has some potential for provide nesting habitat, although species has not been observed on site during field surveys.	Some potential for presence but, with no site usage by the species, it is not a concern for this project.

Species Name	Provincial (ESA) Status	Habitat Requirement	Presence/Habitat on Site	Project Concerns Associated with Habitat on Site
Mammals				
Little Brown Myotis (*Myotis lucifuga*)	Endangered	Widespread, roosting in trees and buildings. Hibernate in caves or abandoned mines.	Some large snags with cavities were observed on the property; however, not at the ≥10 snags (≥25 cm DBH) per hectare abundance that is required for potential maternity roosts. No potential hibernacula observed on the property.	Low potential for presence. Property is unlikely to meet criteria for maternity roost habitat, and species not recorded on site during acoustic monitoring surveys. Not a concern for this project.
Northern Long-eared Myotis (*Myotis septentrionalis*)	Endangered	Associated with boreal forests, choosing to roost under loose bark and in the cavities of trees. Hibernate in caves or abandoned mines.	Some large snags with cavities were observed on the property; however, not at the ≥10 snags (≥25 cm DBH) per hectare abundance that is required for potential maternity roosts. No potential hibernacula observed on the property.	Low potential for presence. Property is unlikely to meet criteria for maternity roost habitat, and species not recorded on site during acoustic monitoring surveys. Not a concern for this project.
Eastern Small-footed Myotis (*Myotis leibii*)	Endangered	Species roosts in a range of habitats including under rocks, rocky outcroppings, buildings, under bridges, caves, mines, and hollow trees. Hibernate in smaller caves subject to air movement.	No rocky outcroppings were observed on or adjacent to the property, but some large snags were observed on the property.	Low potential for presence. Property is unlikely to meet criteria for maternity roost habitat, and species not recorded on site during acoustic monitoring surveys. Not a concern for this project.
Tri-colored Bat (*Pipistrellus subflavus*)	Endangered	Prefers to roost in trees in old forests but sometimes uses buildings. Forage over water courses or open fields with large trees nearby. They never forage in deep woods. Hibernate in caves or abandoned mines.	Some large snags with cavities were observed on the property; however, not at the ≥10 snags (≥25 cm DBH) per hectare abundance that is required for potential maternity roosts. No potential hibernacula observed on the property.	Low potential for presence. Property is unlikely to meet criteria for maternity roost habitat, and species not recorded on site during acoustic monitoring surveys. Not a concern for this project.
Trees				
Butternut (*Juglans cinerea*)	Endangered	Found in various forest and open habitats that are moist to moderately dry with well-drained rich soils, but is intolerant of shade and requires full sunlight.	Potential habitat is available on site in tree edges and two trees were observed on site.	Two Butternuts were observed on site during field surveys. Both trees were found to be non-retainable through a BHA. As such neither tree is protected under the *ESA*. Not a concern for this project.

= Species observed on site.

3.6 Significant Wildlife Habitat

Following the MNRF's Significant Wildlife Habitat Ecoregion 6E Criterion guide, SWH for various species or species groups is generally defined based on combinations of factors such as a minimum area of suitable habitat and presence of sufficient number of individuals of a sufficient number of species. SWH for bats will include hibernacula, or roosting areas (within forested areas) known to support multiple individuals (e.g. > 10 Big Brown Bats). No hibernacula were noted on site or are considered possible within the proposed development area. The small number of bats present in the area does not indicate the adjacent forest as a SWH for roosting.

SWH for Breeding Frogs requires multiple frog species to be present in number generally of at least 20 or more. With no frogs observed in the woodlots, neither constitutes a SWH for Breeding Frogs.

The final category within the SWH Ecoregion 6E Criterion guide provides a "catch-all"; any habitat that actively supports a species of Special Concern may also be identified as SWH. A single Eastern Wood-Pewee inhabits the western half of the north woodlot. This is the same location and number of individuals noted in previous studies of the area (KAL 2017b). The north woodlot should thus be considered as SWH though only the western portion appears to be used. No wood-pewees have been observed in the younger eastern half.

4.0 PROJECT DESCRIPTION

The proposed project is the expansion of the existing SWMP needed to support additional residential development in the surrounding area. The pond expansion will result in the removal of a total 2.19 ha of wooded area. This includes, all of the FOD2-1 and FOD8-1 ecosites, which do not constitute Significant Woodland, and 0.89 ha (41%) of the FOD7 ecosite, which is Significant Woodland. This retains 1.27 ha of the oldest portion of the FOD7 forest area along the forest stream through the western portion of that feature.

The current proposed pond configuration is a modification of the original design concept, which required the removal of the same amount of forest area, but left less of a buffer along the forest stream and a narrower forest swath nearest to the existing houses to the west.

459425 m

459625 m

5031775 m

Figure 2 Proposed development

Legend

ELC - Post-Development
FOD7

Stream setbacks
15/30 m Setback
Hazard Limit
Top of Slope

Exisitng Pond
Operational Extent
Pond Contour

SW Pond expansion
Pond Access Pathway

N

0 50 m

Project: RICH 724
Created By: TH
Checked By: AF
Universal Transverse Mercator - Zone 18 (N)
Printed on: 2018-09-05

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5.0 IMPACT ASSESSMENT

5.1 Impacts to Surface Water Features

The main channel of the forest stream (Reach 7) will remain, unaltered, within the retained forest area. This will provide a forested riparian buffer of 30-45 m between the channel and the new pond expansion, except at the very bottom end of the reach, where the channel is already functionally part of the exiting SWM pond. The smaller side channel (Reach 12), will begin at the edge of the cleared forest, and can still be anticipated to conduct spring meltwater from the forested area to the main channel. The mainline of this channel will be located 15 m or more from the forest edge. As such, no negative impacts are anticipated to these features.

5.2 Impacts to Trees / Significant Woodlands / UNA #97

All trees within the south woodlot (FOD8-1) and the FOD2-1 portion of the north woodlot will be removed as neither of these areas constitute Significant Woodland in their own right. The eastern 0.9 ha of the FOD7 ecosite of the north woodlot (which does constitute Significant Woodland) will also be fully removed to accommodate the required pond expansion. The western half of the feature (the oldest portion), which provides habitat for Eastern Wood-pewee and protects the forest stream located there, will be retained.

5.3 Impacts to Species at Risk

No SAR protected under the ESA were found to be present on or adjacent on the property during field surveys. Therefore, no impacts to SAR or SAR habitats are anticipated from the project. Impacts to listed species not subject to the ESA are discussed in Section 5.4.

5.4 Impacts to Significant Wildlife Habitat

The north woodlot provinces SWH for Eastern Wood-pewee, though only the western portion appears to be used. No wood-pewees have been observed in the younger eastern half. The average home range of a wood-pewee is approximately 1 ha. The 1.3 ha western potion of the woodlot will be retained, along with a southwestward extension of the feature along the western end of the SWM pond. Retention of this area is anticipated to be sufficient to maintain the current wood-pewee population on the site. Active nest and individual birds of this species are protected under both *SARA* and the *Migratory Bird Convention Act*. Active nest and individuals will be protected by flowing standard wildlife mitigations indicated in Section 6.4.

6.0 MITIGATIONS

6.1 Mitigations for Surface Water Features

While appropriate setbacks will be maintained on the retained headwater channels within the western half of the north woodlot to protect the features in the long term, an erosion and sediment control (ESC) plan consistent with standard best practices must be designed and implemented to protect the features during construction of the pond. During area construction, the ESC plan must require at minimum:

- a multi-barrier approach to provide erosion and sediment control;

- retention of existing vegetation and stabilize exposed soils with vegetation where possible;
- limiting the duration of soil exposure and phase construction;
- limiting the size of disturbed areas by minimizing nonessential clearing and grading;
- minimizing slope length and gradient of disturbed areas;
- maintaining overland sheet flow and avoid concentrated flows; and
- storing/stockpiling all soil away (e.g. greater than 15 metres) from watercourses, drainage features and top of steep slopes.

6.2 Mitigations for Trees/ Significant Woodlands

Please note that the City's acceptance of this report does not constitute permission under the Municipal Trees and Natural Areas Protection By-law 2006-279 to remove any trees. Removal of trees can only be undertaken upon the issuance of a tree removal permit from the City of Ottawa. This report may be used to support the application for that permit and to advise mitigation measures imposed by the permit. Removal permits should only be issued for trees indicted for removal within this report and not before such time as their removal is required to accommodate specific site development activities. Accordingly, to minimize impact to the remaining trees adjacent to the property, the following protection measures are indicated as necessary during construction:

- Tree removal on site should be limited to that which is necessary to accommodate site construction.
- To minimize impact to remaining trees during future site development:
    - Erect a fence beyond the critical root zone (CRZ, i.e. 10 x the trunk diameter at breast height) of trees. The fence should be highly visible (e.g. orange construction fence) and paired with erosion control fencing. Pruning of branches is recommended in areas of potential conflict with construction equipment;
    - Do not place any material or equipment within the CRZ of the tree;
    - Do not attach any signs, notices or posters to any tree;
    - Do not raise or lower the existing grade within the CRZ without approval;
    - Tunnel or bore when digging within the CRZ of a tree;
    - Do not damage the root system, trunk or branches of any tree; and
    - Ensure that exhaust fumes from all equipment are NOT directed towards any tree's canopy.

The *Migratory Bird Convention Act* (Canada, 1994) protects the nests and young of migratory breeding birds in Canada. The City of Ottawa guidelines require no clearing of trees or vegetation between April 1 and August 15, unless a qualified biologist has determined that no nesting is occurring within 5 days prior to the clearing (Ottawa, 2017).

To mitigate the loss of 0.9 ha of significant woodland from the east end of the north woodlot, it is recommended that an area of treed space equivalent to at least half the lost forest cover (i.e. 0.45 ha) be included within the EUC MUC CDP. This amount of treed space could be, but is not necessarily required to be, a contiguous natural wooded area to be preserved elsewhere with in the CDP area. It could also be comprised of one or more park or other public areas having significant tree planting as part of their overall landscape plan. In this instance, significant tree planting would mean an area of trees planted at sufficient density such that a partially closed canopy should be anticipated at maturity. Ideally, any such treed areas should be located within or immediately adjacent to residential areas. Specific tree species to be planted will depend upon their ultimate location, but should consist only of species native to the Ottawa area.

6.3 Mitigations for Species at Risk

No SAR (as per the *ESA*) or their habitats were observed on site. No specific mitigations beyond standard mitigations to protect wildlife (Section 6.4) are thus required here. Individuals of other listed species (i.e. Eastern Wood-pewee) will also be appropriately protected by these mitigations.

6.4 Mitigations for Wildlife

Common wildlife species were observed on site during the field visit. The following mitigation measures shall be implemented during construction of the project on site:

- Areas shall not be cleared during sensitive time of the year for wildlife, unless mitigation measures are implemented and/or the habitat has been inspected for a qualified biologist.
- Site clearing should begin at the north end of the site and proceed southward and eastward to drive any wildlife towards undeveloped lands.
- Do not harm, feed, or unnecessarily harass wildlife.
- Food wastes and other garbage – effective mitigation measures include waste control (prevent littering); keeping all trash secured in wildlife-proof containers, and prompt removal from the site (especially in warm weather).
- Drive slowly and avoid hitting wildlife where possible.
- Shelter – effective mitigation measures include covering or containing piles of soil, fill, brush, rocks and other loose materials; capping ends of pipes where necessary to keep wildlife out; ensuring that trailers, bins, boxes, and vacant buildings are secured at the end of each work day to prevent access by wildlife.
- Checking the work site (including previously cleared areas) for wildlife, prior to beginning work each day;
- Inspecting protective fencing or other installed measures daily and after each rain event to ensure their integrity and continued function; and,
- Monitoring construction activities to ensure compliance with the project-specific protocol (where applicable) or any other requirements.

7.0 SUMMARY AND RECOMMENDATIONS

Tree clearing is required to support the expansion of the SWM pond. This will result in clearing of forests to the north and south. Species at risk bird and bat population will not be impacted as a large significant woodland patch exists less than 300 m to the south of the site. Mitigation measures will be implemented to protect wildlife and retain trees, and clearing will take place outside of the active season for species at risk birds and bats (October through April).

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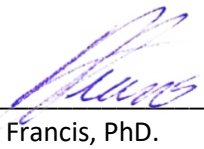

Anthony Francis, PhD.
Senior Ecologist/Project Director

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Appendix 1
Qualifications of Report Author

Anthony Francis, PhD

Dr. Francis is an ecologist with over 18 years of experience in both terrestrial and aquatic projects. His doctoral thesis work on global plant diversity patterns included conducting tree surveys across North America. As a consulting ecologist he has worked on diverse ecological projects including literature reviews of forestry management and species-at-risk; environmental studies of contaminants (metals and suspended particulates); geomatic and statistical analyses for federal and provincial ministries as well as for private industry; and aquatic and terrestrial species inventories. He has contributed to environmental impact statements and federal environmental screening assessments for creek realignments and other infrastructure projects across Ontario.

Kilgour & Associates Ltd.
Environmental Consultants
2285C St. Laurent Blvd., Unit 16, Ottawa, Ontario, K1G 4Z6, 613.260.5555

Technical Memorandum

June 14, 2019 Our File: CAIV761

TO: Laura Maxwell
FROM: Anthony Francis

RE: Updated boundary for significant woodland

This memo provides a brief update to the significant woodland boundaries as presented in the *Environmental Impact Statement for SWM Pond Expansion in East Urban Community Mixed Use Centre* dated September 5, 2018 (herein the EIS) by Kilgour & Associates Ltd. (KAL).

The ESI noted that the remaining (i.e. current) FOD7 ecosite portion of forested area located within the wooded area north of the SWM Pond in the East Urban Community Mixed Use Centre existed as a forested in area in 1976. As the FOD7 ecosite is larger than 0.8 ha, it was deemed in the EIS to constitute significant woodland under the City's planned revision to OP 2.4.2., as proposed at the time of the report. The significant woodland boundary as it pertains to any discussion of a SWM pond expansion was thus defined as being contiguous with the FOD7 ecosite boundary.

Since the writing of the EIS, the City has again amended its definition of significant woodland within the urban area. Under the City's newest version of the policy, significant woodlands in the urban area are defined as wooded features, greater than 0.8 ha, that have been continuously vegetated with forest cover (i.e. as per either ELC or Forestry Act definitions of forest) for sixty or more years. While much of the FOD7 ecosite identified in EIS is older than sixty years of age, the eastern edges are not. Therefore, under the City's current policy, the boundary of the significant woodland should be established somewhat inside of the eastern edge of the FOD7 ecosite. The new line presented here was established based on the forest edge as evident in 1958 air photos, which is identical to the forest edge in 1968 (and thus is the same as sixty years ago in 1959). This edge is different from the forest edge in the 1976 air photo, i.e. the imagery used to establish the significant woodland edge in the EIS. Figure 1 below compares the two lines. Figure 2 below shows your proposed SWM pond expansion in relation to the updated line.

Please call me any time if you have any questions regarding these comments.

Regards,

KILGOUR & ASSOCIATES LTD.

Anthony Francis, PhD

Figure 1. A comparison of the extent of significant woodland under previous and current City policies

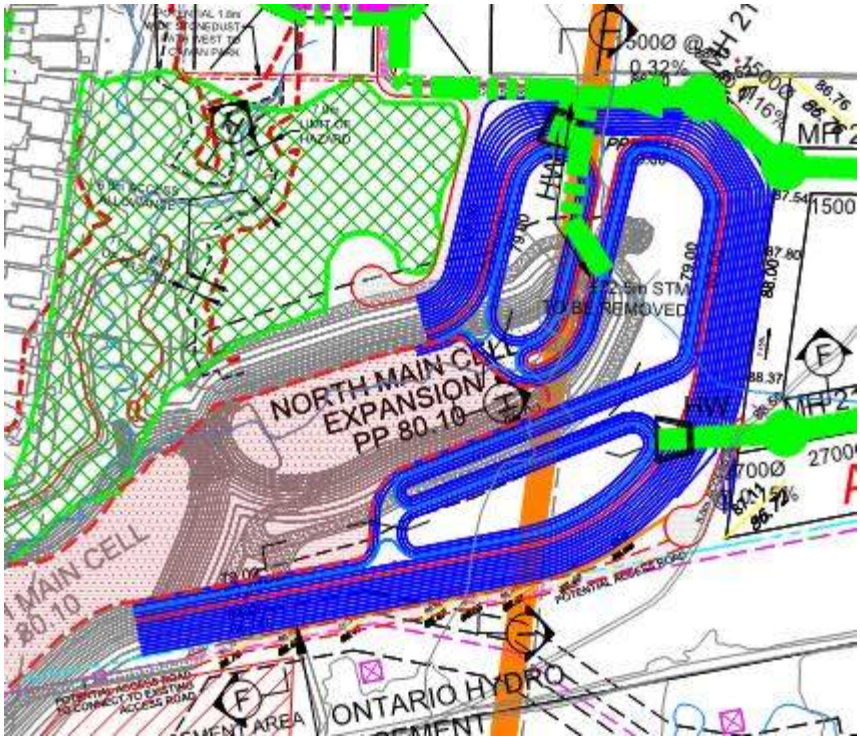

Figure 2. The most recent SWM pond expansion concept in relation to the updated significant woodland boundary

REPORT

Slope Stability Assessment
Reaches 7 and 12
Storm Water Management Pond Block
3490 Innes Road Development

Ottawa, Ontario

Submitted to:

Caivan (Orleans Village) Limited
2934 Baseline Road
Ottawa, Ontario
K2H 1B2

Submitted by:

Golder Associates Ltd.
1931 Robertson Road
Ottawa, Ontario, K2H 5B7

1660030 Rev.07

March 2020

Distribution List

1 e-copy - Caivan (Orleans Village) Limited

1 e-copy - Golder

Table of Contents

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Caivan (Orleans Village) Limited to carry out a slope stability assessment for Reaches 7 and 12 that run through the proposed Storm Water Management Pond Block and the proposed expansion of the Storm Water Management Pond (SWMP) to be located south of the proposed residential development at 3490 Innes Road in Ottawa, Ontario.

The purpose of this assessment was to re-evaluate the stability of the existing slopes along the ravine and to establish the Limit of Hazard Lands (i.e., set-back) for the SWMP, and assess the global stability of the SWMP side slopes. It is understood that the location of the SWMP has been revised based on the results of the Limit of Hazard Lands report provided by Golder in June 2019. The revised location and design of the SWMP were provided in the revised plans prepared by David Schaeffer Engineering Limited (DSEL):

- East Urban Community Phase 3 Area, Community Design Plan, City of Ottawa" dated October 2019 (Project Number 14-733)

The reader is referred to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared for a residential and commercial development to be located at 3490 Innes Road in Ottawa, Ontario (see Site Plan, Figure 1).

The following is understood about the project and site:

- The property is roughly rectangular in shape with a maximum width and length of approximately 320 and 950 m, respectively (i.e., about 30 hectares in area).
- The site has a gently sloping topography, with ground surface elevations decreasing from north to south in the range of about 91.0 to 86.5 m.
- The site primarily consists of undeveloped vacant and/or agricultural land, with the exception of the northernmost portion of the site along Innes Road, which is occupied by a driving range and a parking area for school buses.
- The northern portion of the property is proposed to be developed with commercial buildings. The southern portion is proposed to be developed as a residential subdivision.
- The southwest boundary of the property is marked by a ravine which flows along the edge of the site in an approximately 2 to 4 metre deep valley. The stability of the ravine slopes needs to be evaluated so that the extent of potential Hazard Lands (which are generally un-developable) can be identified.

Golder has carried out two previous subsurface investigations on this site; one included a total of 25 boreholes drilled in 2016, and the other included 5 boreholes drilled in 2005. Other investigations carried out by Golder, near this site for the Cumberland Transitway were also referenced to supplement the site information. The results of these previous investigations are provided in the following reports:

- Report to City of Ottawa Planning and Growth Management Department titled "*Preliminary Geotechnical Investigation, Proposed Orleans Business Park, Ottawa, Ontario"* dated December 2005 (Report No. 05-1120-163).

- Report to Innes Road Development Corporation titled "*Geotechnical Investigation, Commercial and Residential Development, 3490 Innes Road, Ottawa, Ontario*" dated December 2016 (Report No. 1660030).
- Report to Stantec Consulting Ltd. titled "*Geotechnical Investigation Pavements and Services, Cumberland Transitway: West of Innes Road to East of Tenth Line Road, Ottawa, Ontario*" dated January 2013 (Report No. 09-1121-0049-4000-9/10).
- Report to Stantec Consulting Ltd. titled "*Geotechnical Investigation, Pond 1 Ravine Crossing and Partial Ravine Filling, West of Page Road, Cumberland Transitway: West of Innes Road to East of Tenth Line Road, Ottawa, Ontario*" dated August 2013 (Report No. 09-1121-0049-4000-5)

Based on published geological mapping and previous investigations carried out at this and nearby sites, the subsurface conditions on this site are indicated to vary significantly from north to south. To the north at Innes Road, the subsurface conditions consist of fill and glacial till overlying shallow limestone bedrock (less than about 2 m deep). To the south, the bedrock is deeper (25 to 50 m) and the glacial till is overlain by a thick deposit of sensitive silty clay. In general, the sensitive silty clay thickens to the south and west. At the location of the ravine, the subsurface conditions consist of a thick deposit of silty clay. The underlying bedrock is indicated to consist of limestone of the Bobcaygeon and Lindsay Formations.

3.0 SITE RECONNAISSANCE

A reconnaissance of the site was carried out on May 17 and 29, 2018 to view the site conditions along the ravines (at the southwest portion of the property), measure slope geometry, and to observe the state of erosion at the toes of the slopes, at then proposed location of SWMP Block at Reaches 7 and 12. A total of seven slope cross sections were surveyed at locations along the ravine . The survey was carried out using a handheld GPS unit, and the slope angles and heights were measured with a hand clinometer. The approximate locations of the surveyed slope cross sections (named AA to GG) along with the crest of slopes are shown on Figure 1.and the surveyed slope geometries are illustrated on Figures 2 to 6.

Two additional cross-sections for Reaches 7 and 12 along the then proposed SWMP expansion (named H-H and I-I) were assessed based on the topographic mapping provided by DSEL. The location of Cross-Sections H-H and I-I are also are shown on Figure 1 and the slope geometries are illustrated on Figures 7 and 8.

4.0 SUBSURFACE CONDITIONS

Information on the subsurface conditions near the ravines discussed herein are provided on the Record of Borehole 16-19 from Golder's 2016 investigation, provided in Appendix A.

At the borehole location, a thin surficial deposit of native silty sand exists below the topsoil. The silty sand is up to about 0.6 m in thickness and extends to a depth of 0.5 m below the existing ground surface.

The silty sand layer is underlain by a thick deposit of sensitive silty clay. The upper portion of the silty clay deposit has been weathered to a very stiff to stiff grey brown crust that extends to about 3.1 m depth. Below the weathered zone, the silty clay is grey in colour and is indicated to be firm to very stiff in consistency, with measured undrained shear strength values ranging from about 30 to 42 kilopascals. The silty clay was not fully penetrated in the borehole but was proven to extend to at least 8.8 m depth.

Based on published geological mapping and previous investigations, the depth of the bedrock surface at this location is indicated to range between about 25 and 50 m. The bedrock is expected to be overlain by a layer of glacial till.

A monitoring well was installed in Borehole 16-19, to observe the stabilized groundwater level at the site. The final groundwater level was measured on November 26, 2016 at a depth of 3.4 m, corresponding to Elevation 83.2 m.

It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events.

The permanent ground water elevation in the SWMP is expected to be at about elevation 80.1 m.

5.0 DISCUSSION

5.1 General

This section of the report provides an assessment of the stability of the existing slope geometries and the corresponding extent of Hazard Lands.

5.2 Seismic Site Class

Multichannel Analysis of Surface Waves (MASW) geophysical testing was carried out to evaluate the average shear wave velocity profile of the upper 30 m of soil/bedrock at the site. The shear wave velocities measured at the site are presented in the technical memorandum provided in Appendix B and indicate that the average shear wave velocity in the upper 30 m of the subsurface stratigraphy at the MASW locations ranges from about 181 to 273 m/s.

Based on these values, it is considered that a Site Class D would be applicable for the design of the residential development and for estimation of the horizontal seismic coefficient for the slope stability assessment.

The soils at this site are not considered liquefiable.

5.3 Slope Stability Assessment

This assessment includes the evaluation of the stability of the existing slopes along the critical sections of Reaches 7 and 12 of the ravine to establish a horizontal limit of developable land (i.e., Limit of Hazard Lands associated with the slopes), based on the geometry of the slopes at both surveyed locations.

5.3.1 Results of Slope Mapping

As discussed in Section 3.0, mapping of the slopes along Reaches 7 and 12 were carried out using a hand-held GPS unit and a hand clinometer. The measured cross section geometries are provided on Figures 2 to 8. The cross-sections surveyed along Reach 7 are illustrated on Figures 2to 4, 7, and 8 while Figures 5 and 6 show the cross-sections surveyed along Reach 12. These cross-sections were selected as the most representative of the critical slopes along these reaches (i.e., highest and deepest) based on visual observation during the site reconnaissance.

In general, the slopes of the ravine are about 2.5 to 4.0 m in height along Reach 7 and 1.5 to 2.0 m in height along Reach 12. Slope inclination of ranges from 30 to 90° and between 35 to 45° from the horizontal for Reach 7 and Reach 12, respectively.

At the time of the site visits on May 17 and 29, 2018, evidence of active erosion was observed at the toes of the slopes along Reach 7, particularly in the areas at Cross Sections A-A, C-C, F-F and G-G.

Cross-sections H-H and I-I were assessed based on the topographic mapping of Reaches 7 and 12 along with the proposed SWMP expansion. Based on the drawing provided by DSEL, the SWMP expansion would have the side walls sloped at an angle of 3 horizontal to 1 vertical (3H:1V). Based on discussions with DSEL, it was assumed that the SWMP expansion would be located at a distance away from the Reaches equal to the Limit of Hazard Lands.

5.3.2 Analysis

Limit equilibrium slope stability analyses were carried out to assess the stability of the existing slopes with the addition of the proposed SWMP expansion and the global stability of the SWMP side slopes. For this assessment, one cross section for each Reach was selected for detailed analysis, based on the highest slope and steepest inclination, along the bank of the ravine.

In general, slope failures occur when the forces (or rotational moments) generated by the weight of the soil in a slope and external loads exceed the shear strength of the soil. The six main parameters involved in the engineering analysis of the stability of a slope are:

1) The geometry of the slope.

2) The subsurface stratigraphy within the slope (i.e., the composition of the various soil layers within the slope and their depth, thickness, and orientation).

3) The groundwater conditions (the groundwater levels and the hydraulic gradient/flow conditions).

4) The strength parameters for the soils.

5) The unit weights (i.e., densities) of the soils within the slope.

6) External loads on the slope, such as from foundations of structures, filling above the slope, or earthquakes.

For this site, the geometries of the slopes were based on the slope mapping, as described previously.

For the original analysis, the subsurface stratigraphy used in the analysis was based on Borehole 16-19(see Section 4 for further details). The stratigraphy in the analysis was modelled as a layer of stiff weathered crust over firm silty clay. The thin layer of sand observed at borehole 16-19 was not considered to have a material effect on the analysis results and was therefore neglected for this analysis. This was an overly conservative approach assuming that the shear strength of the silty clay remained constant for the full depth of the deposit.

The subsurface stratigraphy was refined in subsequent analyses based on the conditions indicated for the deeper portions of the grey sensitive clay, based on nearby investigations that extended below a depth of 9 m. That information was used to better define the depth of the silty clay layer and to model the increase of shear strengths with depth for the silty clay deposit.

Static and seismic slope stability analyses were carried out with the commercially available SLOPE/W software (produced by Geo-Studio 2007), using the soil parameters given Table 1.

Table 1: Geotechnical Design Parameters for Stability Analysis

Material	Static Drained Parameters		Seismic Undrained Shear Strength (kPa)	Unit Weight (kN/m3)
	Effective Angle of Internal Friction (°)	Effective Cohesion (kPa)		
Weathered Silty Clay Crust	35	5	55	17.5
Grey Silty Clay	29.6	7.4	35 to 110	15.5

The groundwater conditions within the slopes for static conditions were conservatively assumed to be at the ground surface (i.e., fully saturated slopes), which is a condition that may occur during periods with prolonged precipitation (e.g., spring).

The groundwater conditions within the slopes for seismic conditions were conservatively assumed to be at about Elevation 84 m (i.e., at or just above the bottom of the weathered crust layer).

The stability of the slopes was evaluated for:

- Drained (i.e., long-term, static conditions for the side slopes within the SWMP), for which effective stress soil parameters were used for Reaches 7 and 12 and the SWMP;
- Undrained drawdown conditions; and,
- Seismic conditions (i.e., the dynamic loading conditions during an earthquake), for which undrained shear strength parameters were used. A horizontal seismic coefficient of 0.19 was used for the analyses. This value is based on the peak horizontal ground acceleration for Ottawa specified in the 2012 Ontario Building Code (with half that value being used, per standard practice).

The stability of the slopes was evaluated using limit equilibrium methods and the SLOPE/W software. The Morgenstern-Price method was used to compute the Factor of Safety (FOS). The FOS is defined as the ratio of the magnitude of the forces/moments tending to resist failure to the magnitude of the forces/moments tending to cause failure. Theoretically, a slope with a FOS of less than 1.0 will fail and one with a FOS of 1.0 or greater will stand. However, because the modeling is not exact and natural variations exist for all of the parameters affecting slope stability, a FOS of 1.5 is used to define a stable slope (for static loading conditions), and/or to define the ‘safe’ set-back distance from an unstable slope. For seismic loading conditions, a FOS of 1.1 is typically used.

5.3.3 Results

The result of the stability analyses carried out for drained (i.e., static) conditions indicates that the FOS against global instability of the existing slopes are greater than 1.5 for Reaches 7 and 12 and the proposed SWMP expansion, and the slopes are therefore considered stable from a geotechnical perspective.

The FOS against instability under *seismic* loading was determined to be greater than 1.1 for Reaches 7 and 12 and the proposed SWMP expansion, and therefore the slopes are considered to have an adequate FOS during a seismic event.

The results of the static and seismic analyses are provided on Figures 11 to 14.

Analyses for drawn down conditions and to assess the potential impacts if the ground between the Reaches’ and the pond acted as a dam were found to not govern the Reaches’ stability.

Hazard Lands associated with unstable slopes, as defined by Ministry of Natural Resources (MNR) guidelines and provincial planning policies, are unsuitable for development with either publicly owned infrastructure or private development. In accordance with the MNR guidelines, the set-back distance from the crest of an unstable slope to the Limit of Hazard Lands should include three components, as appropriate, namely:

1) A “Stable Slope Allowance”, which is determined as the limit beyond which there is an acceptable FOS (i.e., greater than about 1.5 for static) against the table land being impacted by a slope failure.

2) An “Erosion Allowance”, to account for future movement of the slope toe, in the table land direction, as a result of erosion along the slope toe/creek bank. The magnitude of the Erosion Allowance depends upon the type of soil being eroded at the slope toe, the severity of the erosion, and the water course characteristics.

3) An “Access Allowance” of 6 m, to allow a corridor by which equipment could travel to access and repair a future slope failure. This Erosion Access Allowance is included in the determination of the Limit of Hazard Lands wherever the development could restrict future slope access.

Stable Slope Allowance

For this site, the Stable Slope Allowance is not required at this site since the the results of the stability analysis indicate that the FOS against global instability of the slopes under static and seismic conditions are greater than 1.5 and 1.1, respectively.

Any filling of the table land area could negatively impact on the stability of the adjacent ravine slope and increase the required set-back. If any filling is considered inside the Limit of Hazard Lands, the stability of the slopes must be reassessed.

The FOS against global instability of the SWMP side walls sloped at an inclination of 3H:1V are greater than 1.5 and 1.1, respectively, and therefore will not need any additional measures to reduce the risk of slope failure from a geotechnical point of view.

Erosion Allowance

An Erosion Allowance needs to be applied wherever there is active erosion, or the potential for active erosion based on the flow velocities. Based on the observations of the current erosion conditions, it is considered that the magnitude of the *Erosion Allowance* for this site, based on the MNR guidelines, would be 5 m for Reach 7 and 1 metre for Reach 12 (no active erosion was observed along Reach 12 at the time of the site reconnaissance).

However, if erosion protection were to be installed along the ravine bank, then, at least for those specific sections of bank and slope where erosion protection were installed, an *Erosion Allowance* need not be included in the determination of the Limit of Hazard Lands.

Detailed guidelines on the nature of the erosion protection are not provided in this report. However, conceptually, the erosion protection could consist of rip-rap, placed on a maximum 2H:1V front slope up to the 100 year flood level, and underlain by a non-woven geotextile. Further guidelines on erosion protection options can be provided, if required.

If erosion protection is to be considered, other studies and regulatory approvals could be required, such as with respect to environmental impacts, fish habitat, and alterations to the waterway. The feasibility of obtaining these approvals has not been evaluated.

Access Allowance

The Access Allowance included in the MNR procedures for determining the Limit of Hazard Lands is intended to provide a corridor of sufficient width across the table land that equipment could access the site of a future slope failure to undertake a repair. The width of the Access Allowance that will need to be provided on this site will be 6 m.

Limit of Hazard Land Summary

Table 2 provides a summary of the various “set-back” components which are applicable for determining the total set-back for this site.

Table 2: Computed Set-backs

Location	Stable Slope Allowance (m)	Erosion Allowance (m)	Access Allowance (m)	Total Set-Back (m)
Reach 7	0	5(1)	6	11
Reach 12	0	1(1)	6	7

Notes: [1] Assumes that erosion protection will not be provided. This allowance can be reduced to 0 m if erosion protection is provided.

The 11 metre and 7 metre set-back lines for Reach 7 and Reach 12, respectively are shown on Figure 1.

5.4 Construction Considerations

Plans are being prepared for the installation of the 200 mm diameter sanitary sewer (invert elevation of about 85.4 m) and the 1,800 mm diameter storm sewer (invert elevation ranging from about 81.6 to 80.7 m) adjacent to the north and east portions of the SWMP. The proposed sewers will be located within about 2 to 10 m of the crest of the SWMP.

To reduce the potential for slope instability of the SWMP, the native silty clay below the side walls should not be disturbed, as much as practical. Consideration should be given to limiting the width of the trench for the installation of the sewers by using vertical side walls supported by shoring or with workers protected by steel trench boxes and steel sheeting.

6.0 ADDITIONAL CONSIDERATIONS

The assessment provided in this report is based on there being no filling on the table land area adjacent to the slope. These guidelines will therefore need to be confirmed once the site grading has been designed.

7.0 CLOSURE

We trust this report contains sufficient information for your present requirements. If you have any questions concerning this report, or if we can be of further service to you on this project, please contact the undersigned.

Golder Associates Ltd.

Kenton C. Power, P.Eng.
Geotechnical Engineer

William Cavers, P.Eng.
Associate, Senior Geotechnical Engineer

KCP/WC/hdw
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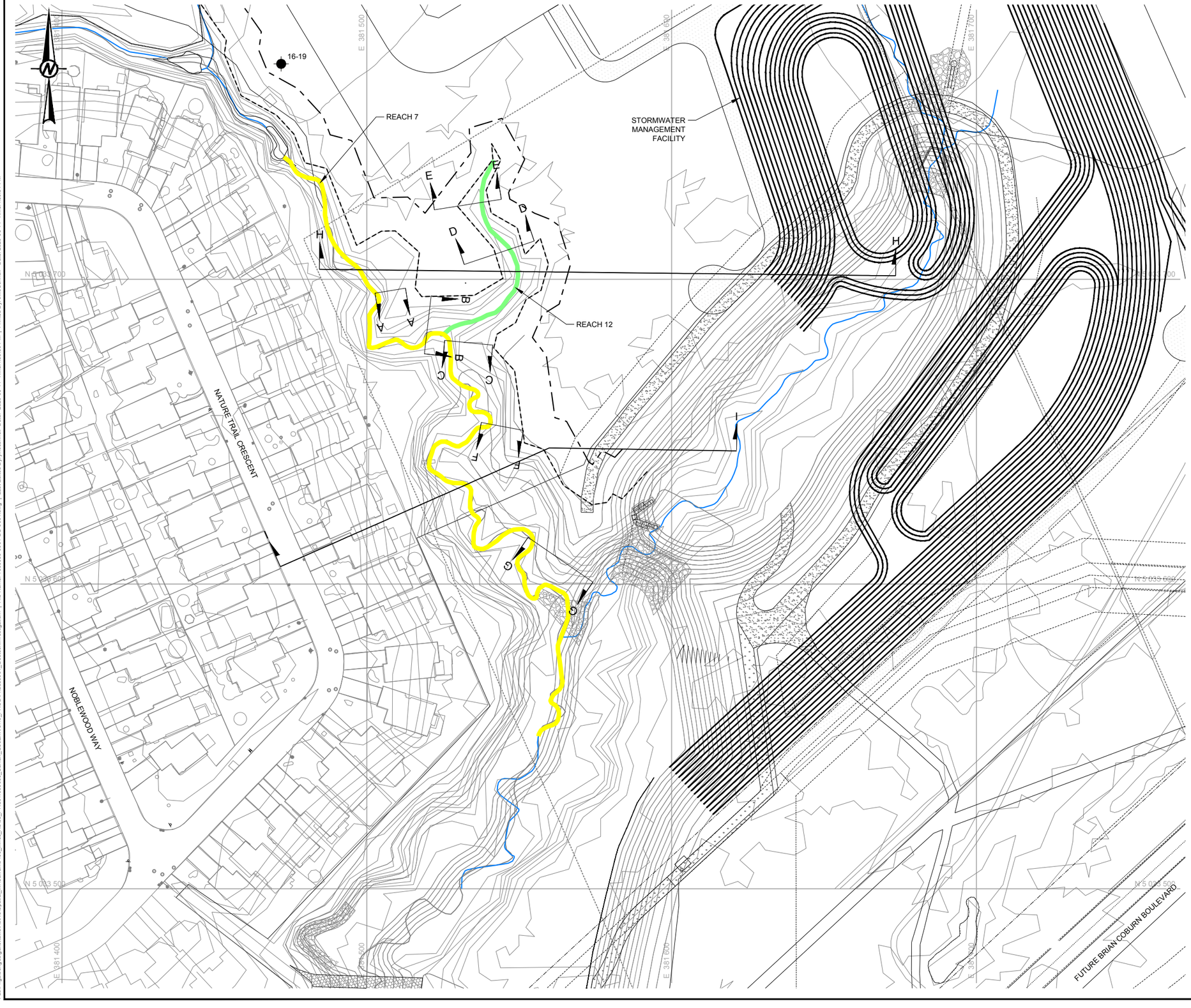

KEY MAP

SCALE 1:50,000

LEGEND

- APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., TECHNICAL MEMORANDUM NO. 1660030-3000 (DEC. 16, 2016)
- A — CROSS-SECTION LOCATION
- REACH 7
- REACH 12
- LIMIT OF HAZARD LANDS BASED ON TOP OF CREEK SLOPE (EROSION, STABLE SLOPE, AND ACCESS ALLOWANCE)
- TOP OF SLOPE

REFERENCE(S)

1. BASE PLAN SUPPLIED BY DSEL ON FEB. 27, 2020, FILE NO. 733_Base_Opt1.dwg
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 25 50
1:1,250 METRES

CLIENT
CAIVAN DEVELOPMENT CORPORATION

PROJECT
SLOPE STABILITY ASSESSMENT
3490 INNES ROAD, OTTAWA, ONTARIO

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-11
DESIGNED	---
PREPARED	ZS/JM
REVIEWED	KCP
APPROVED	WC

PROJECT NO.	PHASE	REV.		FIGURE
1660030	6000	1	H41	1

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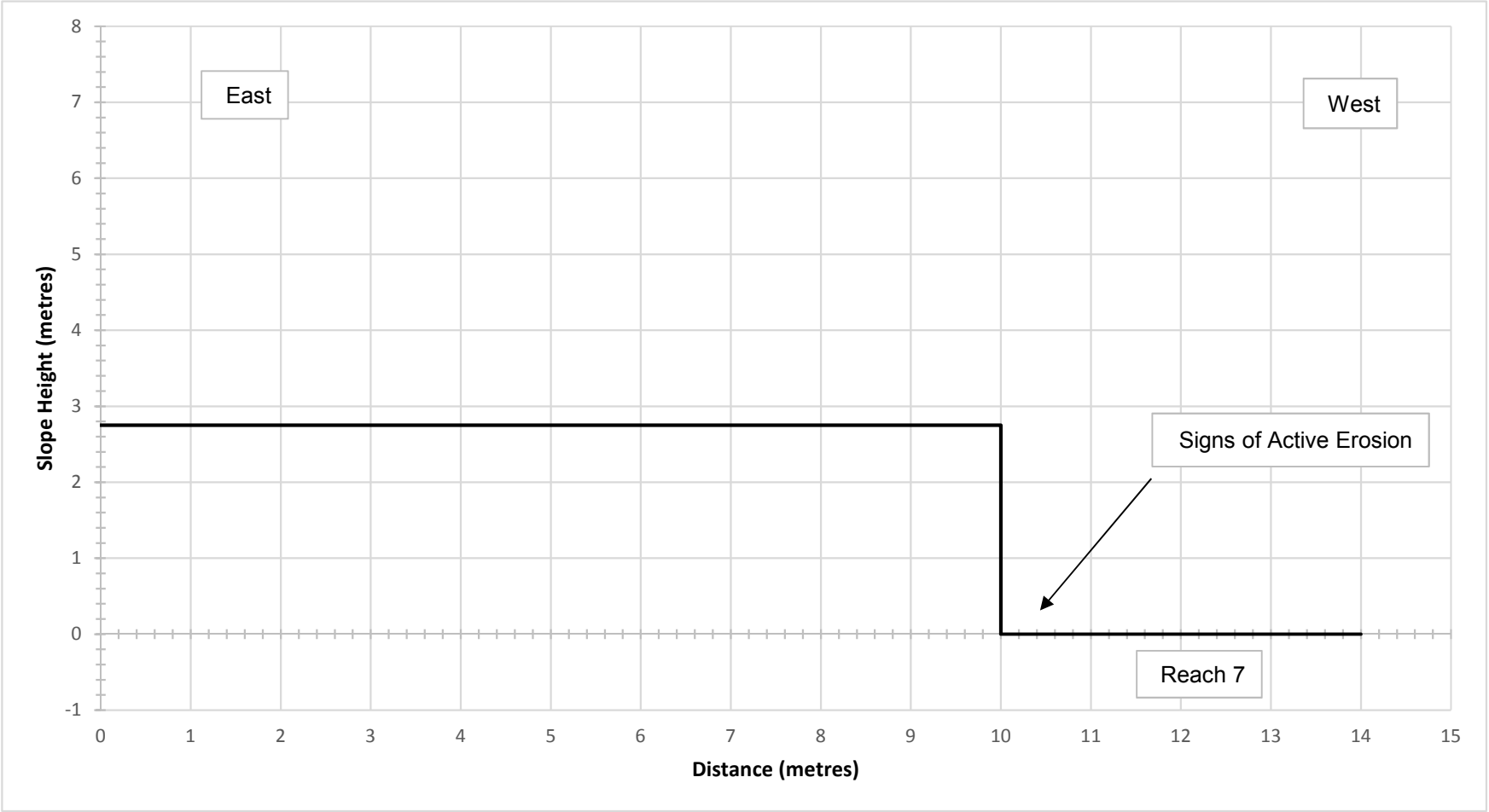
A-A



GOLDER

SLOPE CROSS SECTION

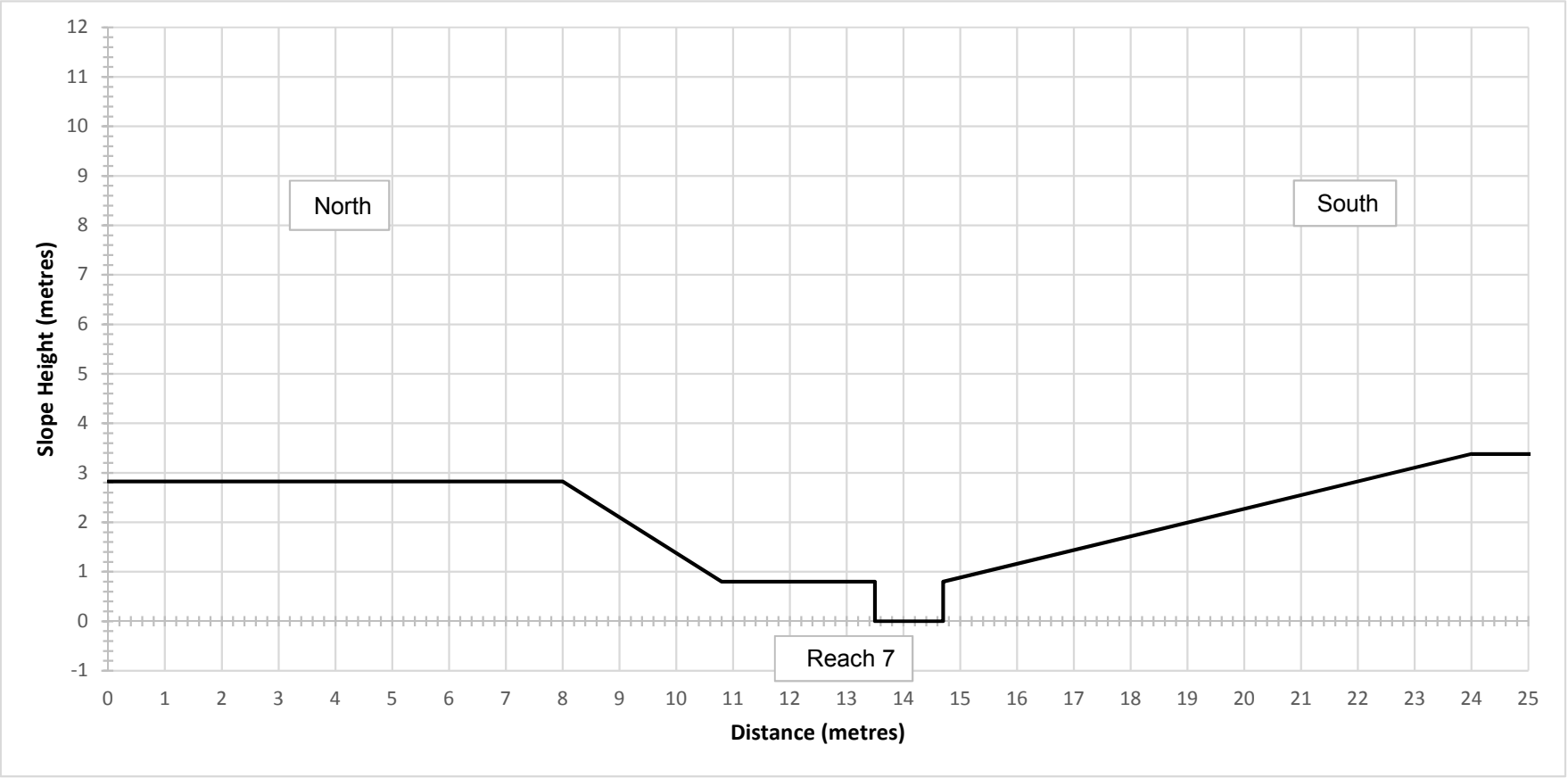
PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	BB
Date:	24/05/2018
Checked:	CRG
Review:	KSL

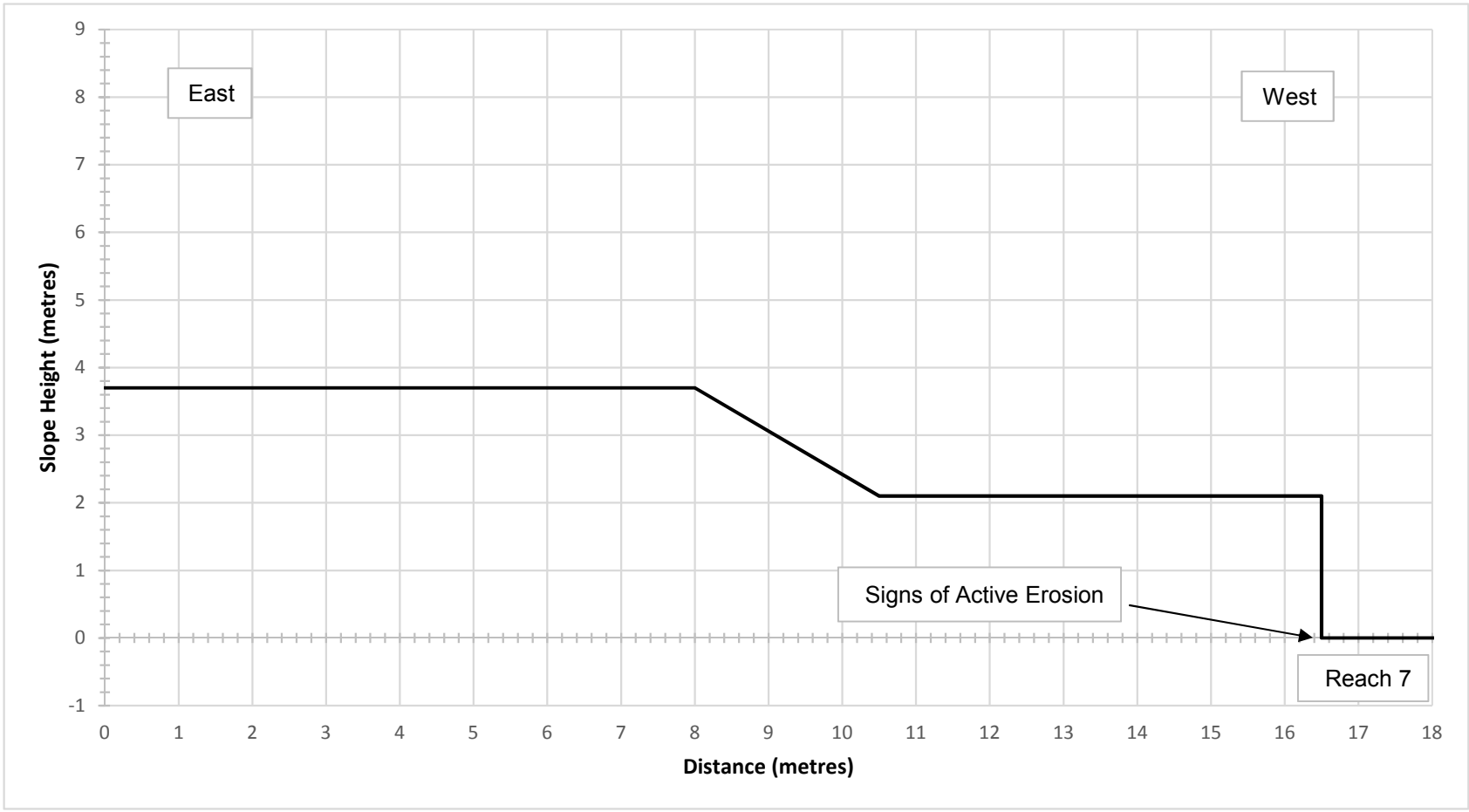
FIGURE 2

B-B



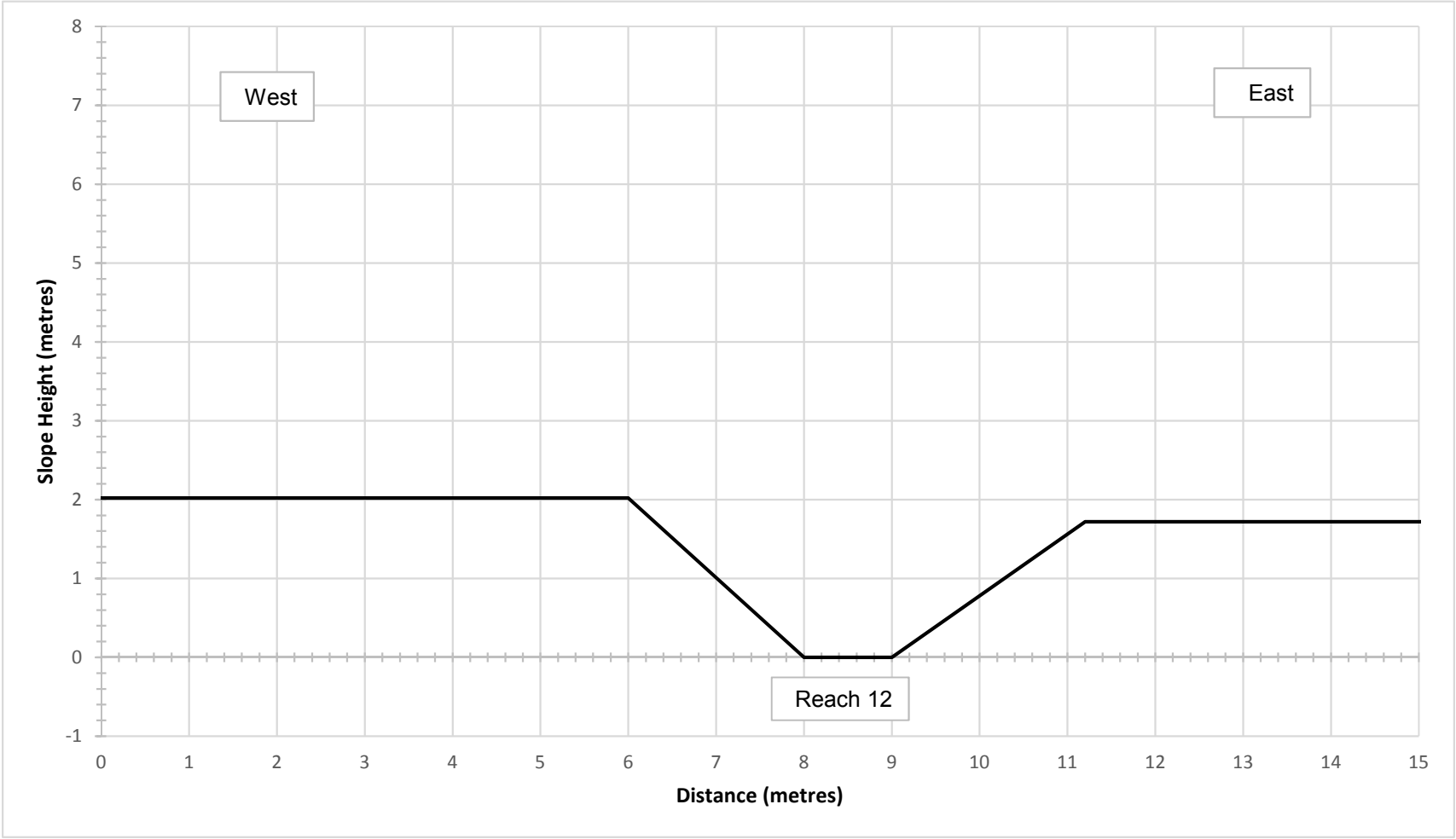
GOLDER	**SLOPE CROSS SECTION** **PROPOSED STORM WATER MANAGEMENT POND BLOCK** **3490 INNES ROAD, OTTAWA**	Project No. 1660030-6000 Drawn: BB Date: 24/05/2018 Checked: CRG Review: KSL	**FIGURE 3**

C-C



GOLDER	**SLOPE CROSS SECTION** **PROPOSED STORM WATER MANAGEMENT POND BLOCK** **3490 INNES ROAD, OTTAWA**	Project No. 1660030-6000 Drawn: BB Date: 24/05/2018 Checked: CRG Review: KSL	**FIGURE 4**

D-D



GOLDER

SLOPE CROSS SECTION

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
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Date:	24/05/2018
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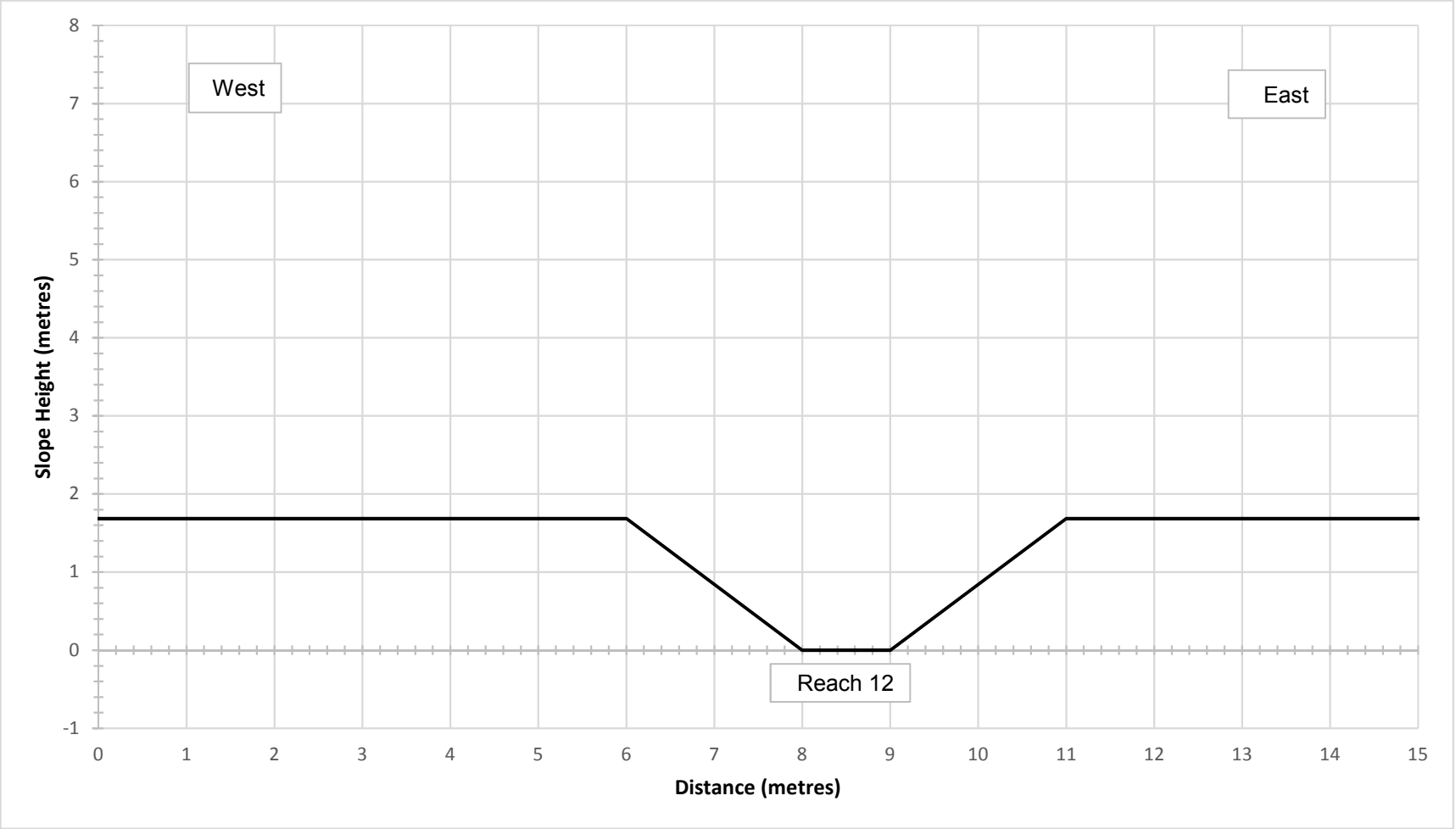
FIGURE 5

E-E



GOLDER

SLOPE CROSS SECTION

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
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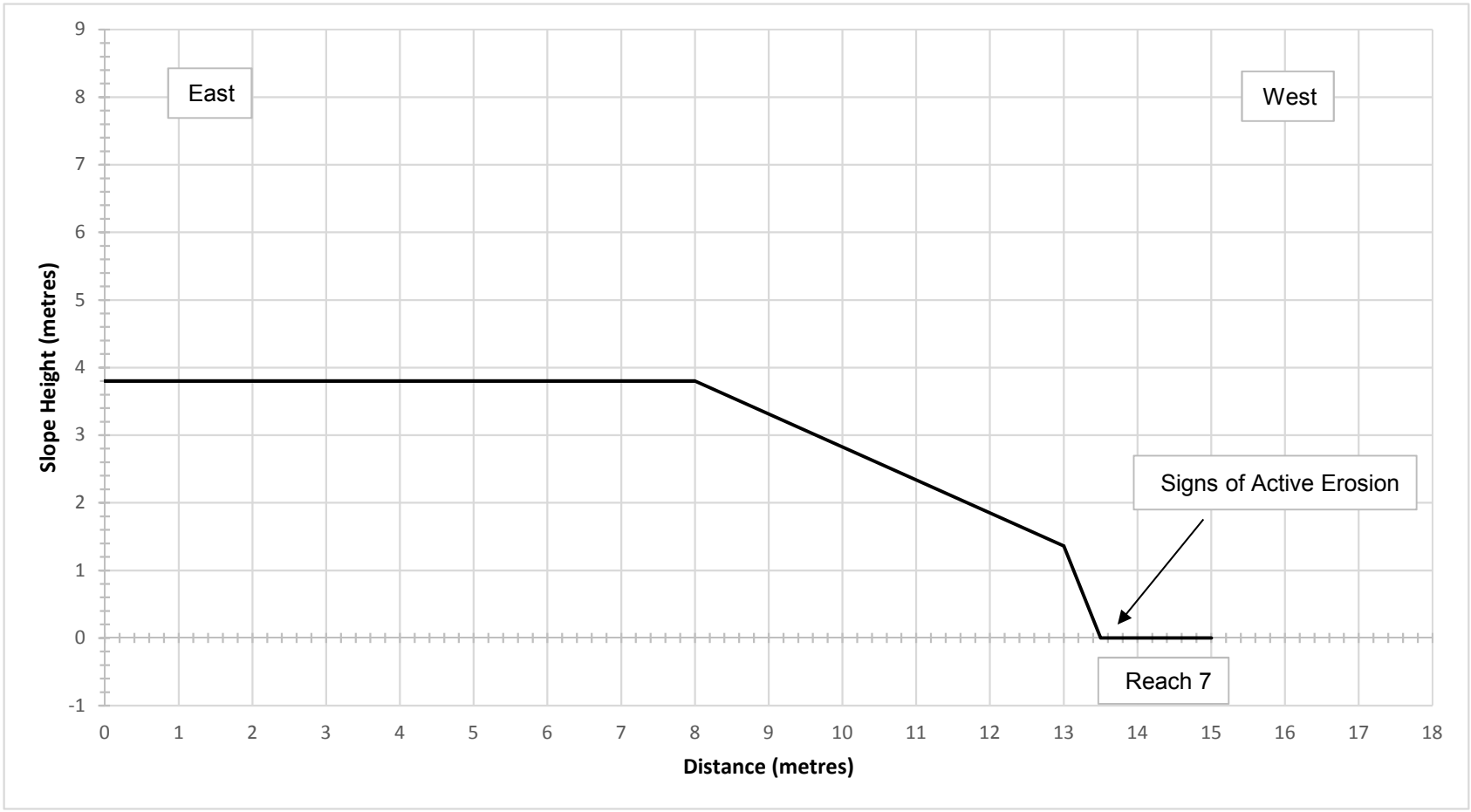
FIGURE 6

F-F



GOLDER

SLOPE CROSS SECTION

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

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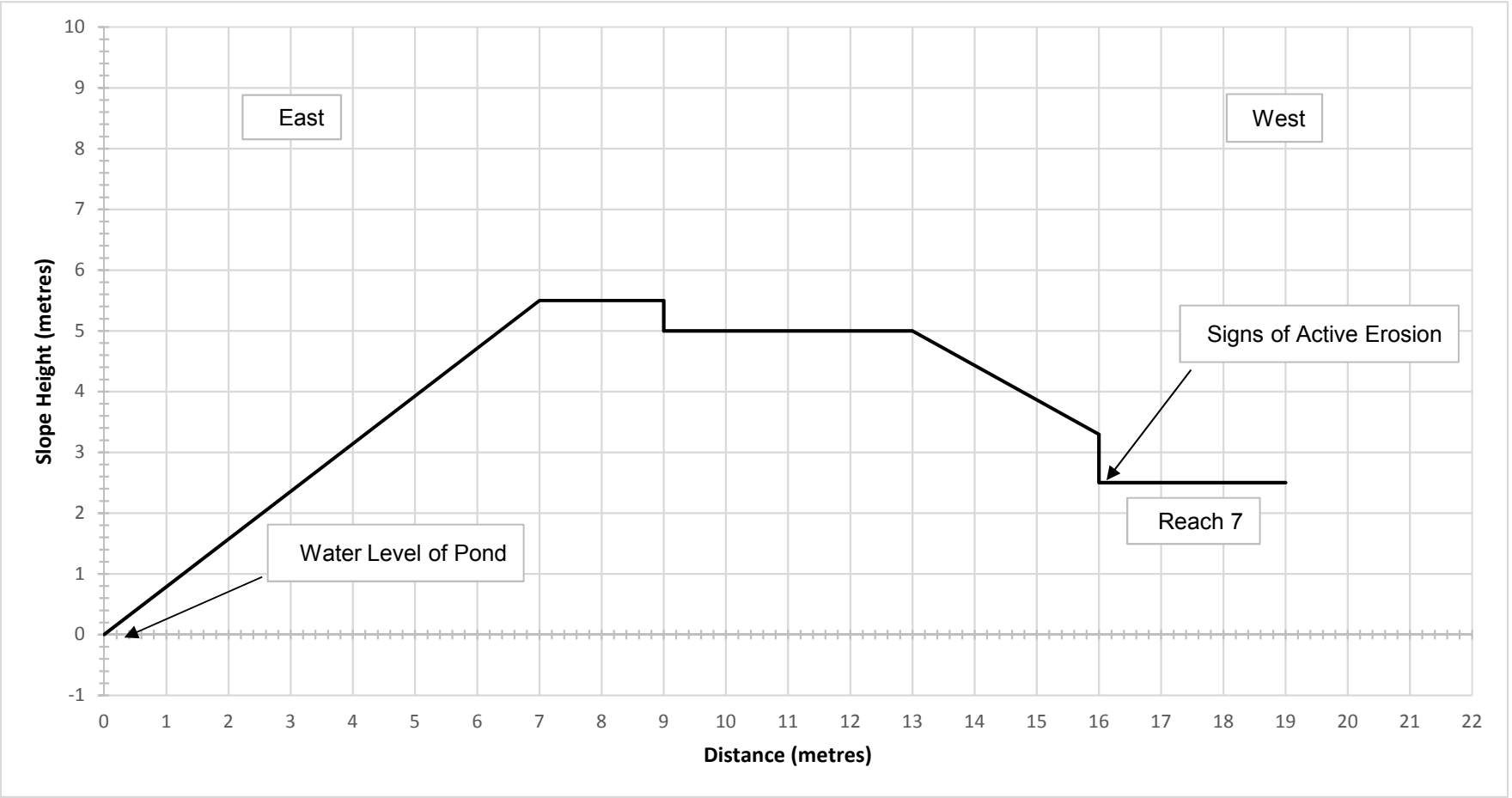
Drawn:	CRG
Date:	24/05/2018
Checked:	KSL
Review:	WC

FIGURE 7

G-G



GOLDER

SLOPE CROSS SECTION

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

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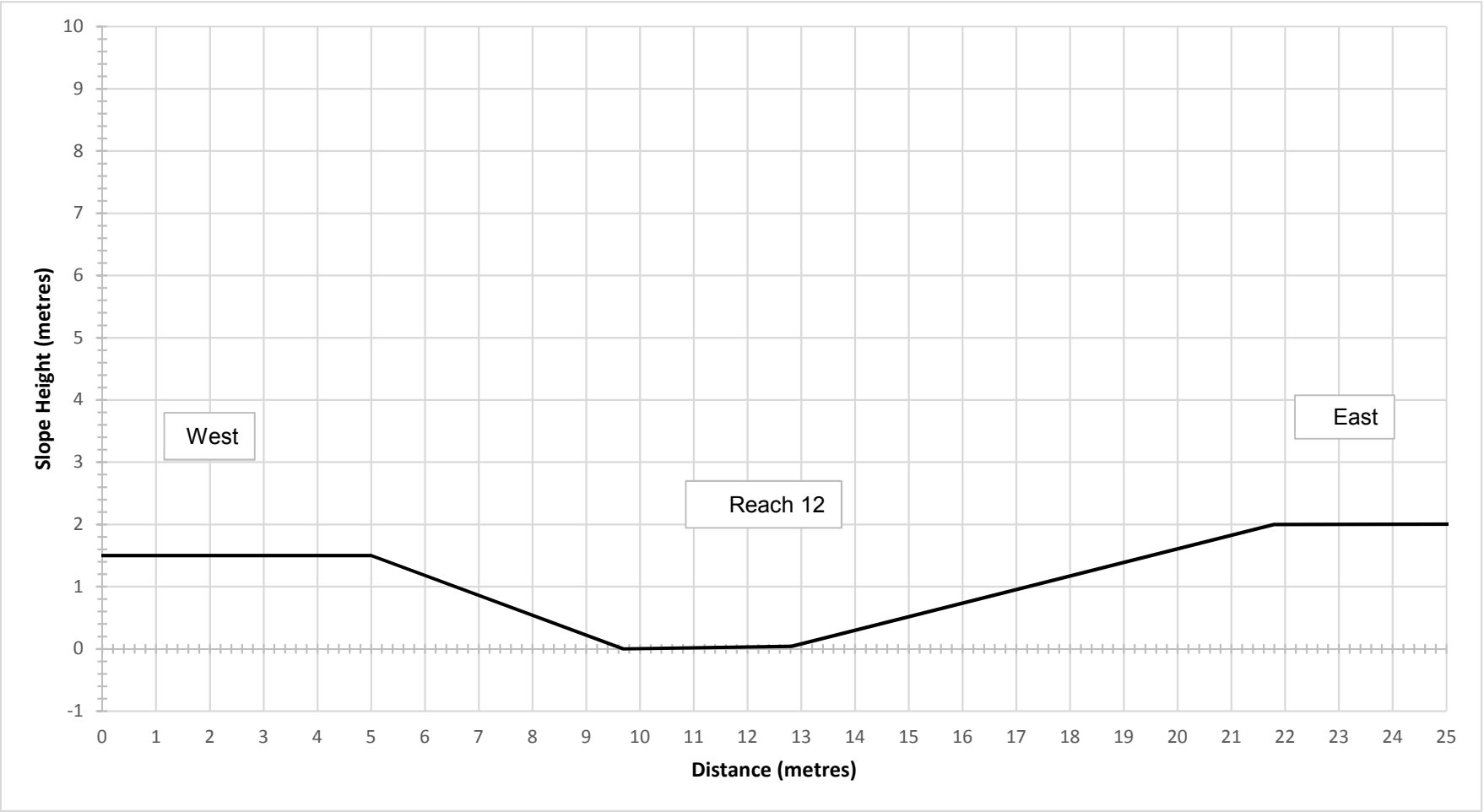
FIGURE 8

H-H



GOLDER

SLOPE CROSS SECTION

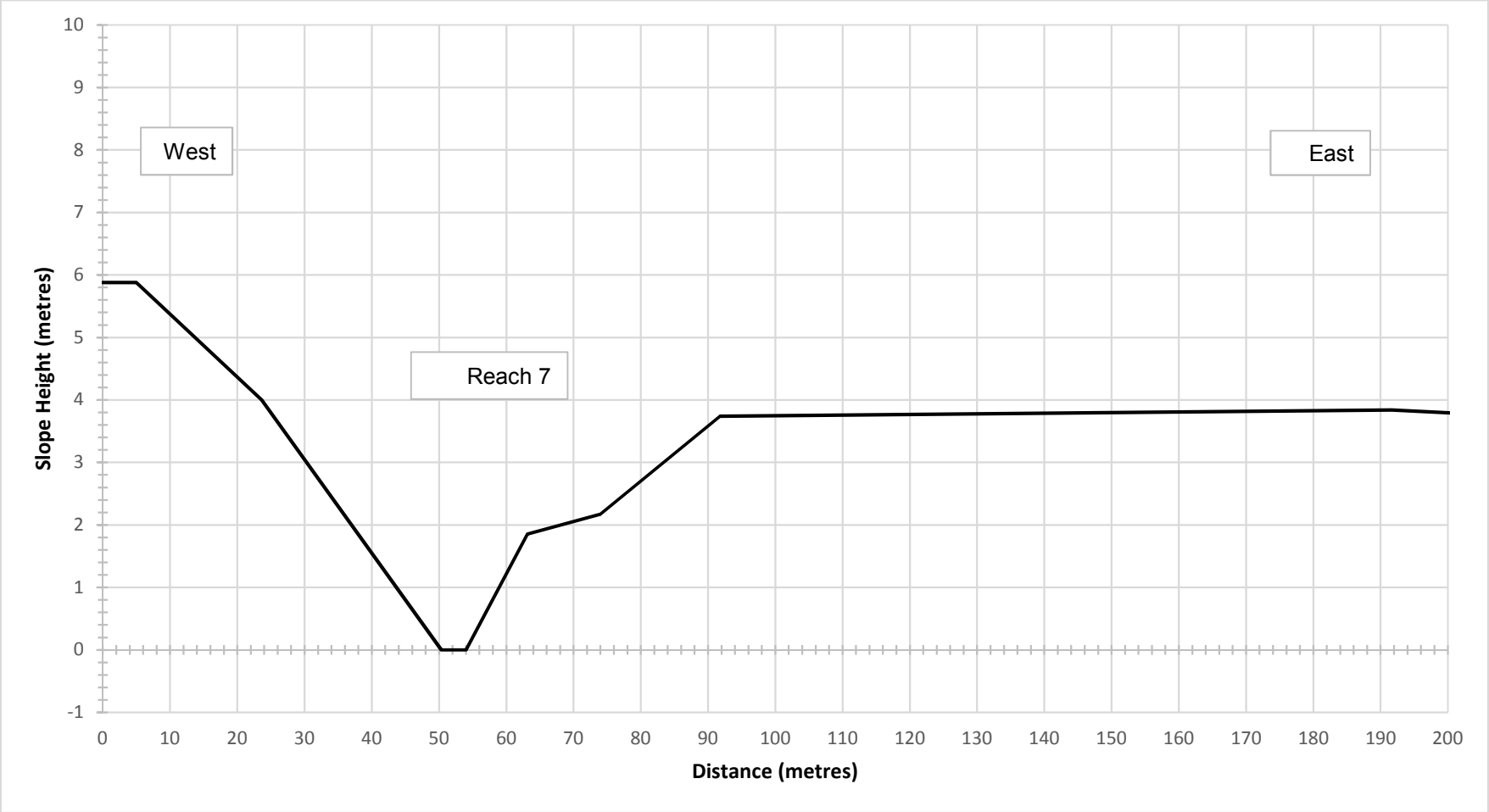
PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 9

I-I



GOLDER

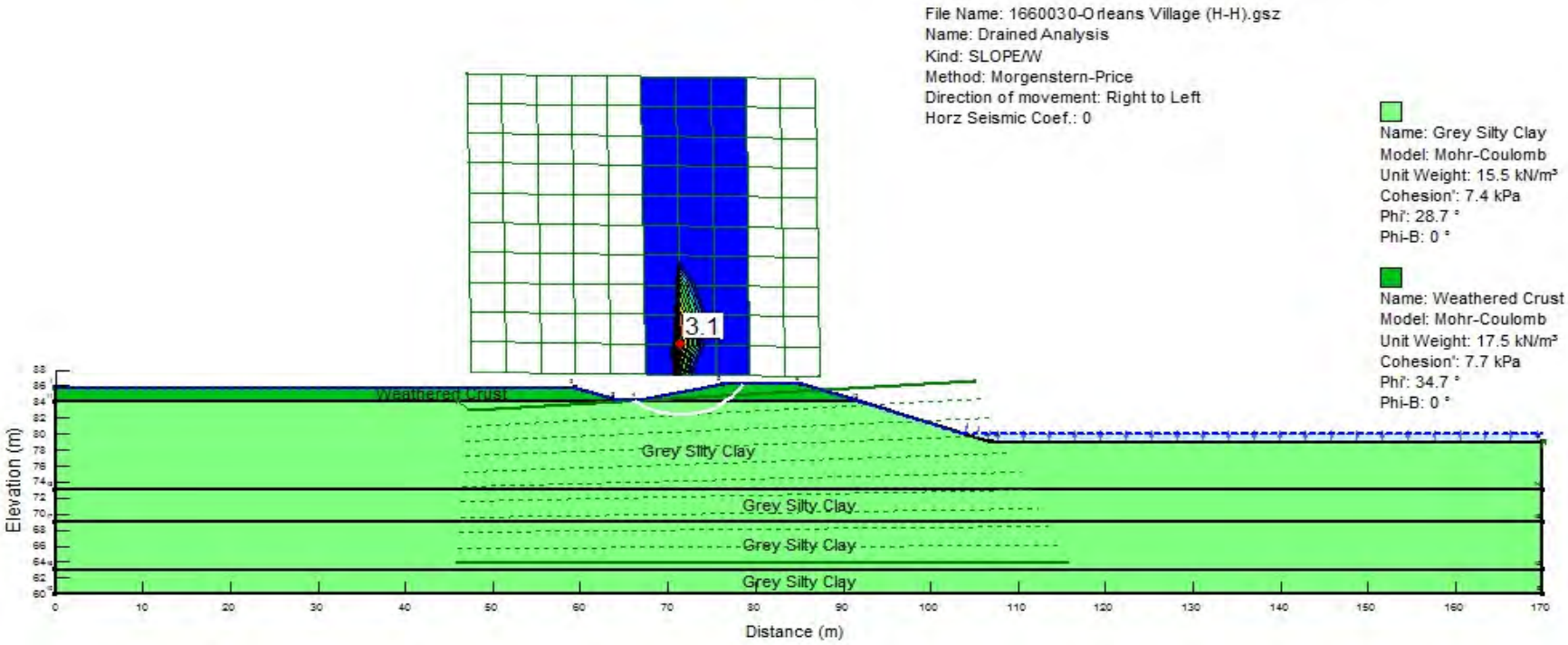
SLOPE CROSS SECTION

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 10



GOLDER

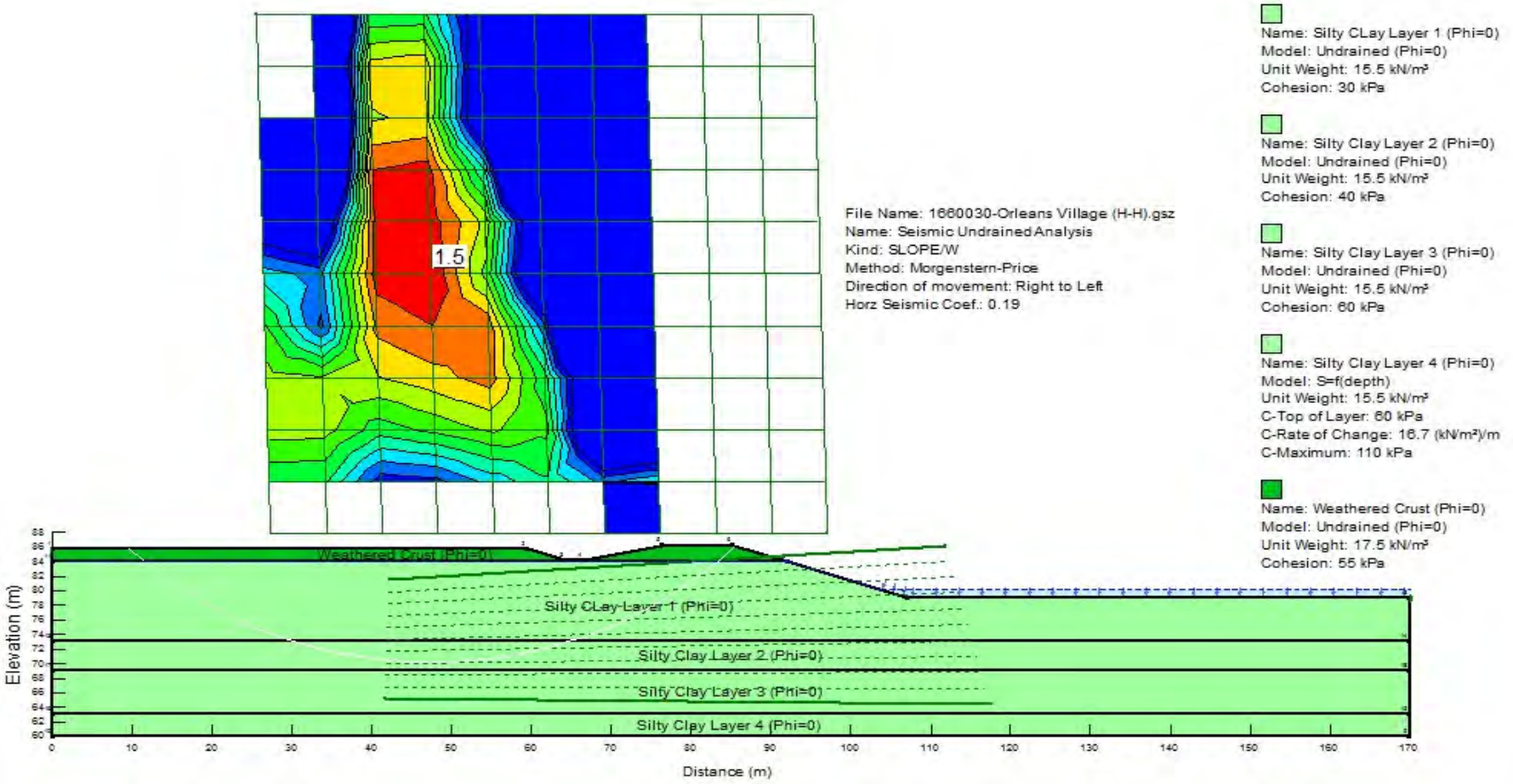
STATIC SLOPE ASSESSMENT - REACH 12 (SECTION H-H)

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 11



GOLDER

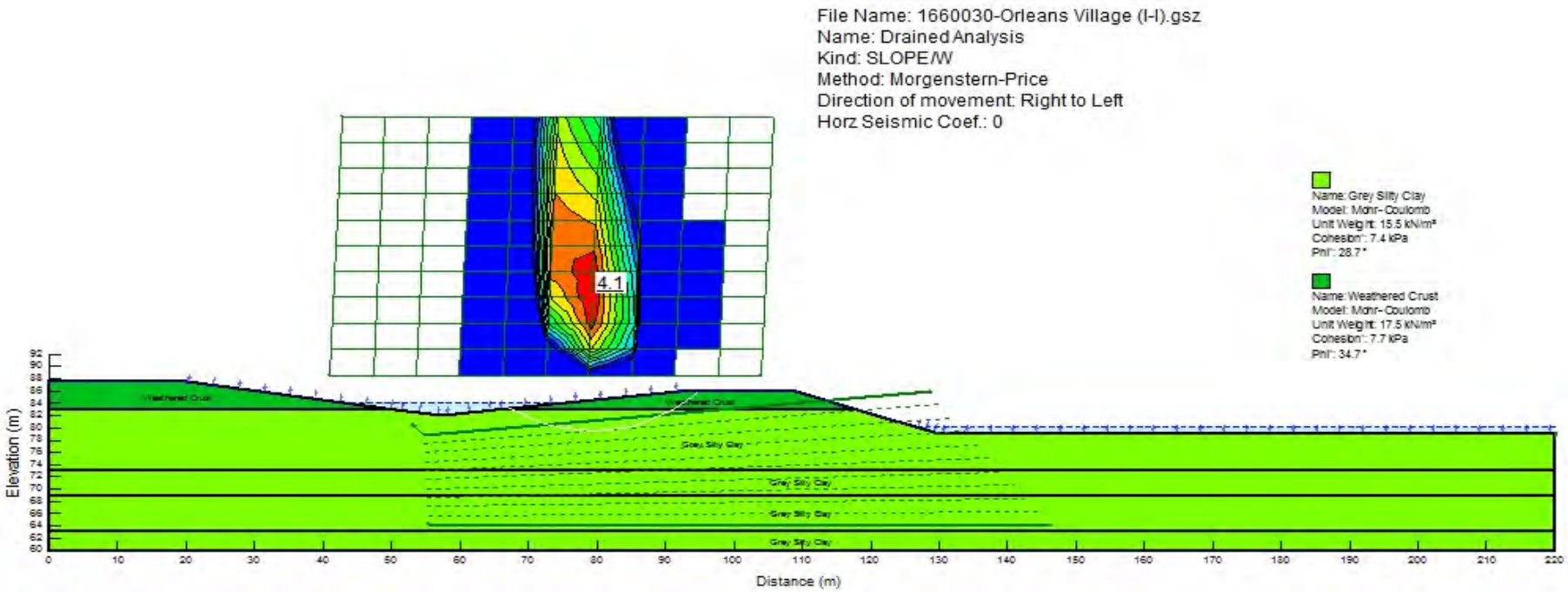
SEISMIC SLOPE ASSESSMENT - REACH 12 (SECTION H-H)

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 12



GOLDER

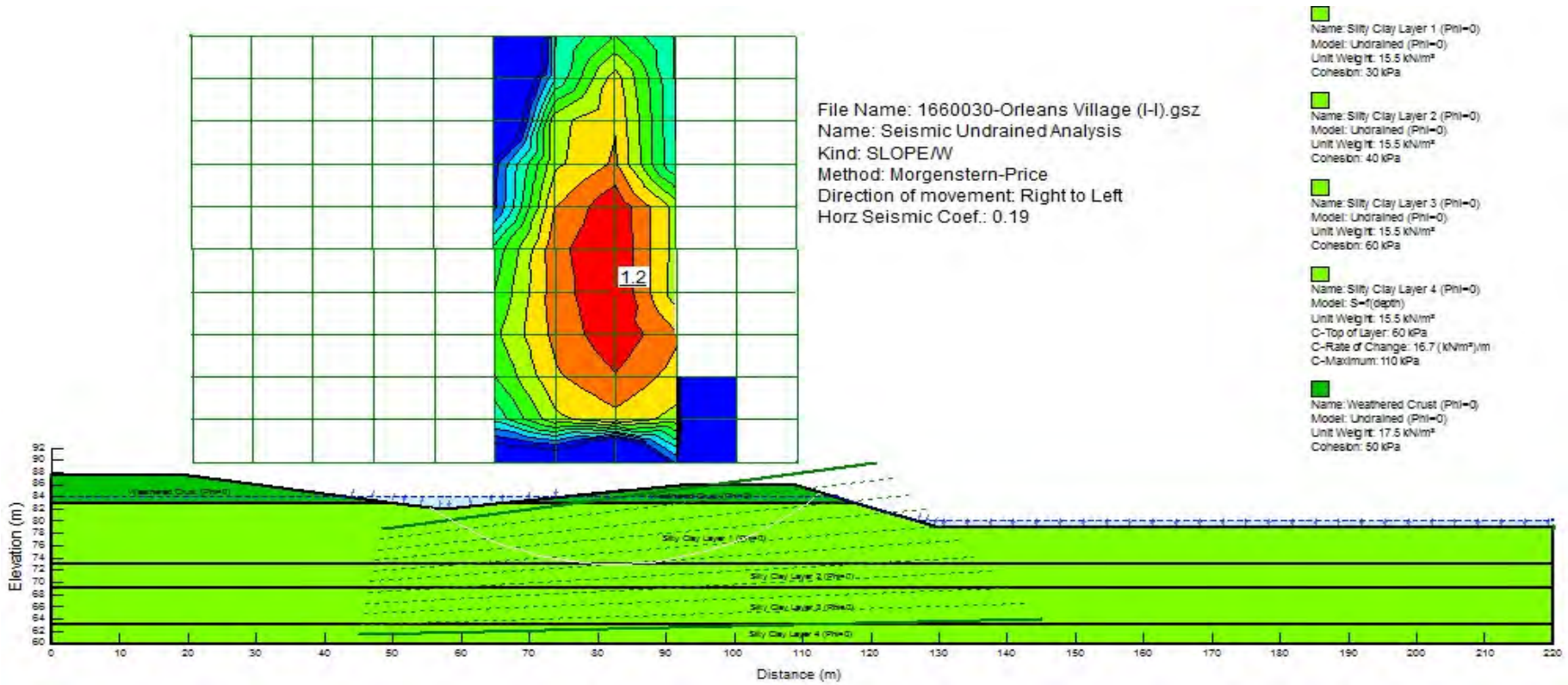
STATIC SLOPE ASSESSMENT - REACH 7 (SECTION I-I)

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 13



GOLDER

SEISMIC SLOPE ASSESSMENT - REACH 7 (SECTION I-I)

PROPOSED STORM WATER MANAGEMENT POND BLOCK

3490 INNES ROAD, OTTAWA

Project No.	1660030-6000
Drawn:	WAM
Date:	25/03/2019
Checked:	WC
Review:	WC

FIGURE 14

APPENDIX A

Previous Investigations

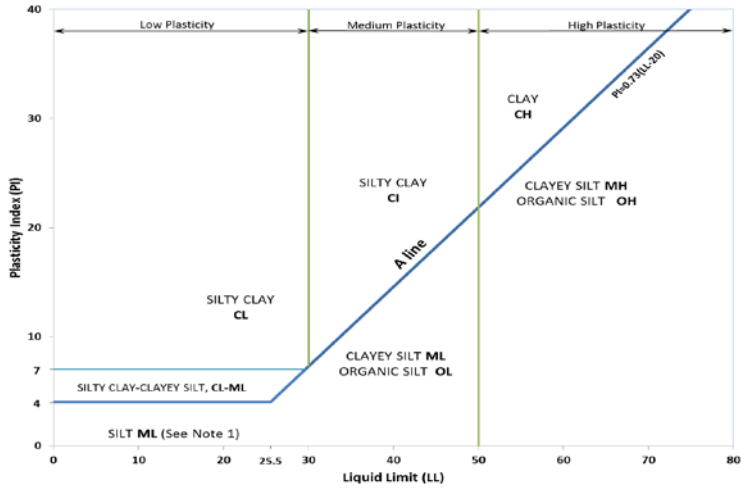
Record of Borehole 16-19

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1660030

RECORD OF BOREHOLE: 16-19

SHEET 1 OF 1

LOCATION: N 5033770.7 ;E 381471.9

BORING DATE: November 8, 2016

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.62							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; brown		0.00							
		(SM) SILTY SAND, fine; brown; non-cohesive, moist, loose		0.13 / 86.16	1	SS	5				
		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		0.46							
1					2	SS	9				
					3	SS	7				
2											Cuttings
					4	SS	3				
3				83.57							
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm		3.05	5	SS	WH				
4								⊕ +			
								⊕ +			
								⊕ +			Bentonite Seal
5								⊕ +			Silica Sand
					6	TP	PH				19 mm PVC Slot Screen
6								⊕ +			
								⊕ +			Cuttings
7								⊕ +			
								⊕ +			
					7	SS	WR				W.L. in Screen at Elev. 83.23 m on Nov. 23, 2016
8								⊕ +			
				77.78				⊕ +			
		End of Borehole		8.84							
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DWM

CHECKED: WAM

APPENDIX B

MASW Test Results and Report

Innes Rd, Ottawa Ontario

TECHNICAL MEMORANDUM

DATE June 7, 2018 **Project No.** 18100364/1000

TO Andrew Finnson, CAIVAN Communities

FROM Stephane Sol, Christopher Phillips **EMAIL** ssol@golder.com; cphillips@golder.com

NBCC SEISMIC SITE CLASS TESTING RESULTS
INNES RD, OTTAWA, ONTARIO

This technical memorandum presents the results of three Multichannel Analysis of Surface Waves (MASW) tests performed for the National Building Code of Canada (NBCC 2015). The seismic testing was carried out at Innes Rd in Ottawa, Ontario and location of each MASW line is shown on Figure 1. The geophysical testing was performed by Golder Associates Ltd. (Golder) personnel on May 16 and 17, 2018.

Figure 1: MASW Location Site Map (MASW Lines in red)

Golder Associates Ltd.
6925 Century Avenue, Suite #100 Mississauga, Ontario, L5N 7K2 Canada T: +1 905 567 4444 +1 905 567 6561

Methodology

The MASW method measures variations in surface-wave velocity with increasing distance and wavelength and can be used to infer the rock/soil types, stratigraphy and soil conditions.

A typical MASW survey requires a seismic source, to generate surface waves, and a minimum of two geophone receivers, to measure the ground response at some distance from the source. Surface waves are a special type of seismic wave whose propagation is confined to the near surface medium.

The depth of penetration of a surface wave into a medium is directly proportional to its wavelength. In a non-homogeneous medium, surface waves are dispersive, i.e., each wavelength has a characteristic velocity owing to the subsurface heterogeneities within the depth interval that particular wavelength of surface wave propagates through. The relationship between surface-wave velocity and wavelength is used to obtain the shear-wave velocity and attenuation profile of the medium with increasing depth.

The seismic source used can be either active or passive, depending on the application and location of the survey. Examples of active sources include explosives, weight-drops, sledge hammer and vibrating pads. Examples of passive sources are road traffic, micro-tremors, and water-wave action (in near-shore environments).

The geophone receivers measure the wave-train associated with the surface wave travelling from a seismic source at different distances from the source.

The participation of surface waves with different wavelengths can be determined from the wave-train by transforming the wave-train results into the frequency domain. The surface-wave velocity profile with respect to wavelength (called the ‘dispersion curve’) is determined by the delay in wave propagation measured between the geophone receivers. The dispersion curve is then matched to a theoretical dispersion curve using an iterative forward-modelling procedure. The result is a shear-wave velocity profile of the tested medium with depth, which can be used to estimate the dynamic shear-modulus of the medium as a function of depth.

Field Work

The MASW field work was conducted on May 16 and 17, 2018, by personnel from the Golder Mississauga and Ottawa office. For the three MASW lines, a series of 24 low frequency (4.5 Hz) geophones were laid out at 3 metre intervals. Both active and passive readings were recorded along the MASW line. For the active investigation, a seismic drop of 45 kg and a 9.9 kg sledge hammer were used as seismic sources. Active seismic records were collected with seismic sources located 5, 10, and 15 metres from and collinear to the geophone array. Examples of active seismic record collected along each MASW line are shown on Figures 2, 3, and 4 below.

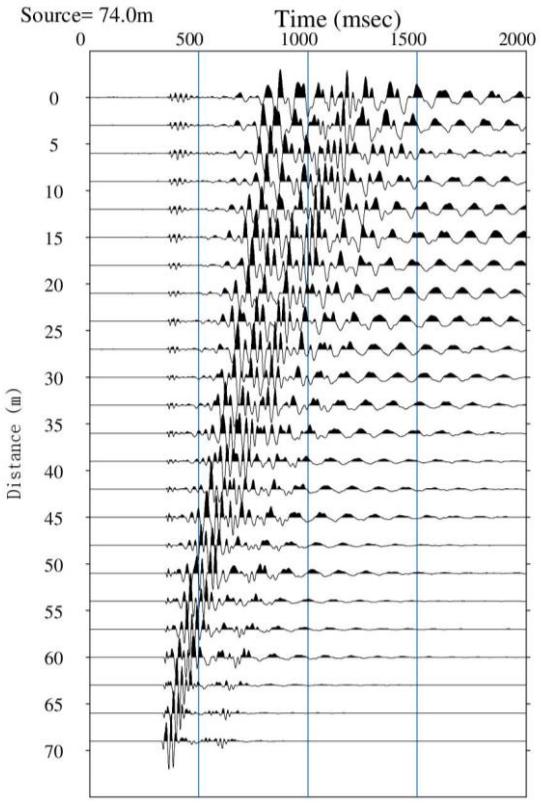


Figure 2: Typical seismic record collected at the site of the MASW Line 1.

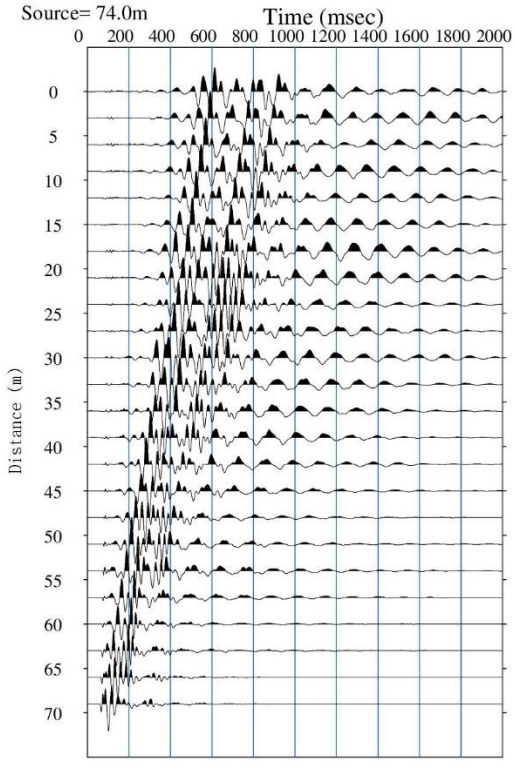


Figure 3: Typical seismic record collected at the site of the MASW Line 2.

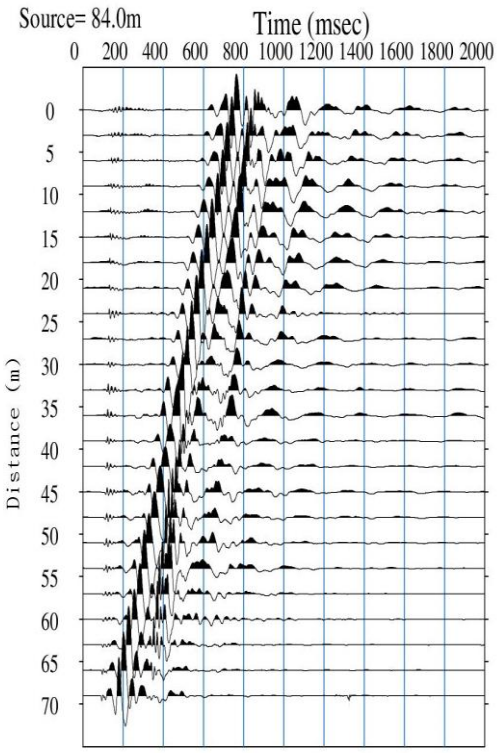


Figure 4: Typical seismic record collected at the site of the MASW Line 3.

Data Processing

Processing of the MASW test results consisted of the following main steps:

1) Transformation of the time domain data into the frequency domain using a Fast-Fourier Transform (FFT) for each source location;

2) Calculation of the phase for each frequency component;

3) Linear regression to calculate phase velocity for each frequency component;

4) Filtering of the calculated phase velocities based on the Pearson correlation coefficient (r2) between the data and the linear regression best fit line used to calculate phase velocity;

5) Generation of the dispersion curve by combining calculated phase velocities for each shot location of a single MASW test; and,

6) Generation of the stiffness profile, through forward iterative modelling and matching of model data to the field collected dispersion curve.

Processing of the MASW data was completed using the SeisImager/SW software package (Geometrics Inc.). The calculated phase velocities for a seismic shot point were combined and the dispersion curve generated by choosing the minimum phase velocity calculated for each frequency component as shown on Figures 5, 6, 7 for MASW Lines 1, 2, and 3, respectively. Shear wave velocity profiles were generated through inverse modelling to best fit the calculated dispersion curves. The active survey of MASW Line 1 provided a dispersion curve with a suitable frequency range (5 to 20 Hz). The active survey of MASW Line 2 provided a

dispersion curve with a suitable frequency range (4 to 21 Hz). The active survey of MASW Line 3 provided a dispersion curve with a suitable frequency range (2 to 22 Hz).

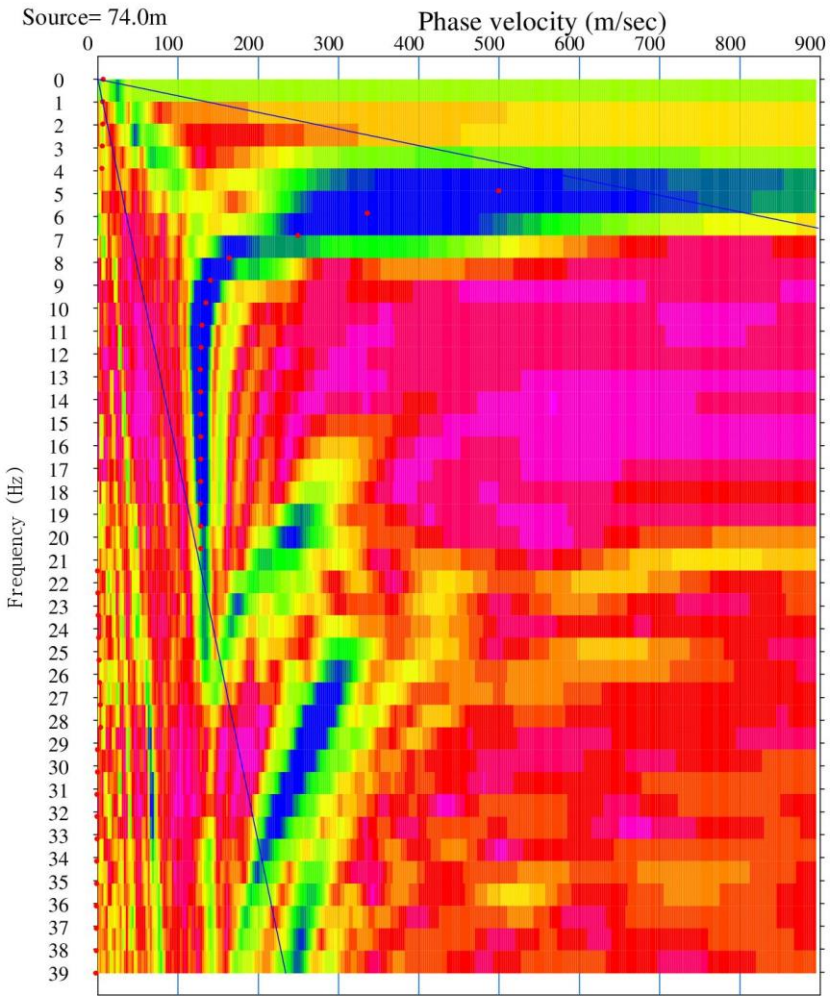


Figure 5: Active MASW Dispersion Curve Picks (red dots) along the MASW Line 1

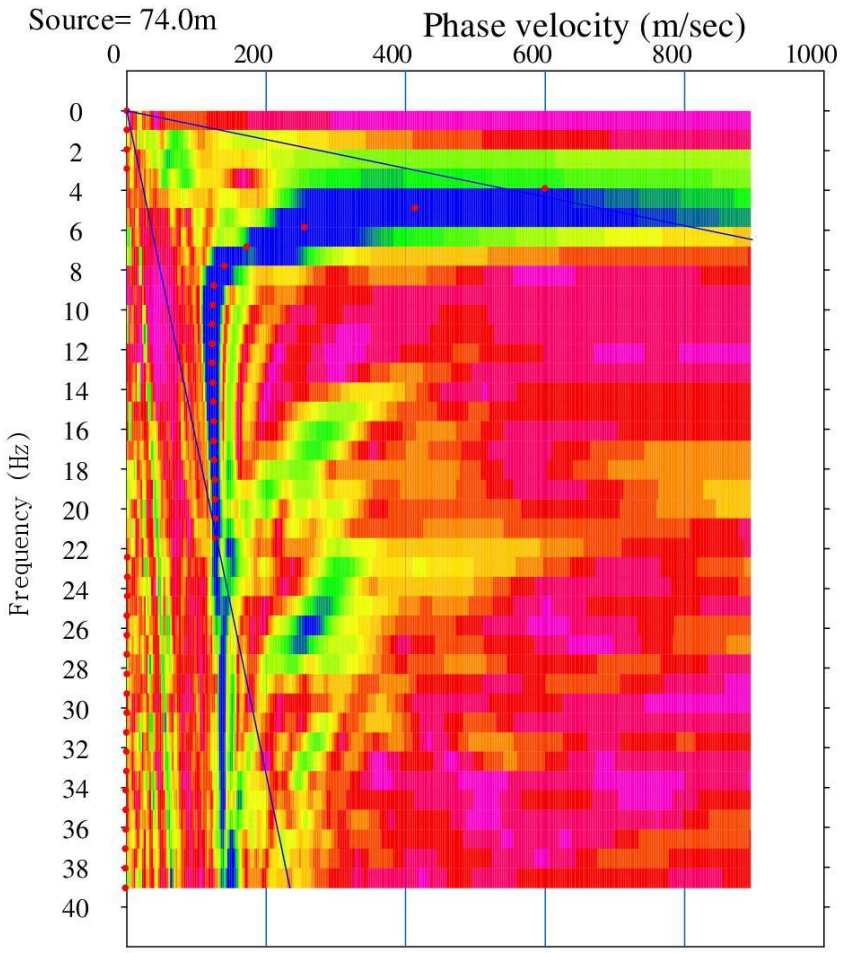


Figure 6: Active MASW Dispersion Curve Picks (red dots) along the MASW Line 2

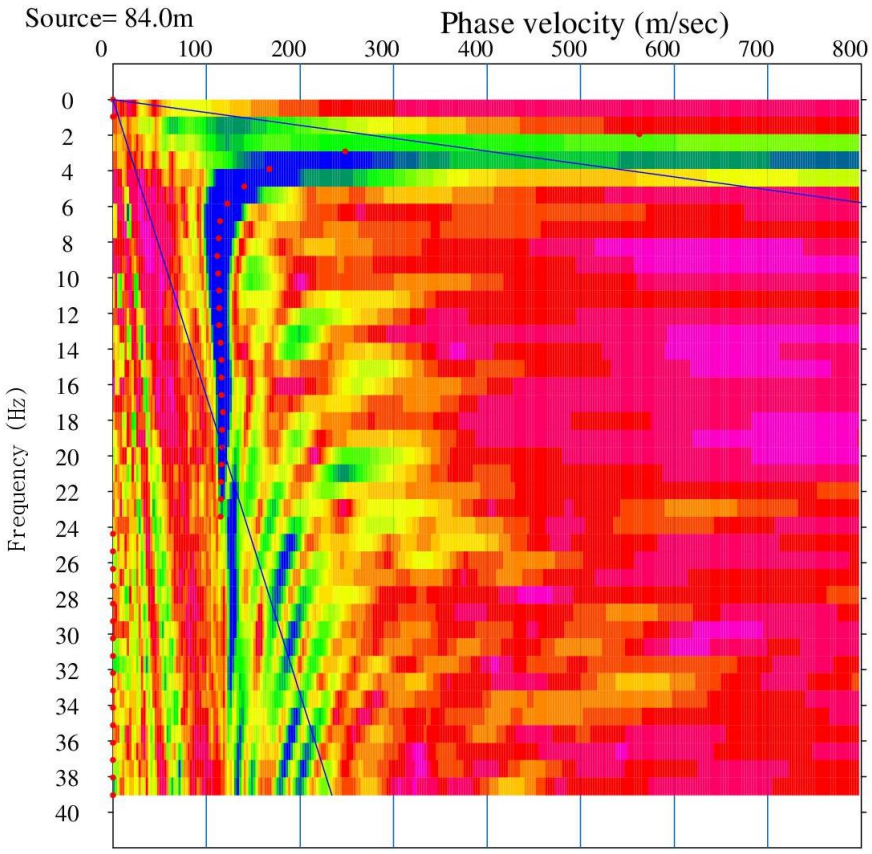


Figure 7: Active MASW Dispersion Curve Picks (red dots) along the MASW Line 3

Results

The MASW test results are presented in Figures 8, 9, and 10 for MASW Lines 1, 2 and 3, respectively. These results present the calculated shear wave velocity profiles derived from the field testing along each MASW line. The field collected dispersion curves are compared with the model generated dispersion curves on Figures 11, 12, 1nd 13 for MASW Lines 1, 2, and 3, respectively. There is a satisfactory correlation between the field collected and model calculated dispersion curves, with a root mean squared error of less than 3% along each MASW line.

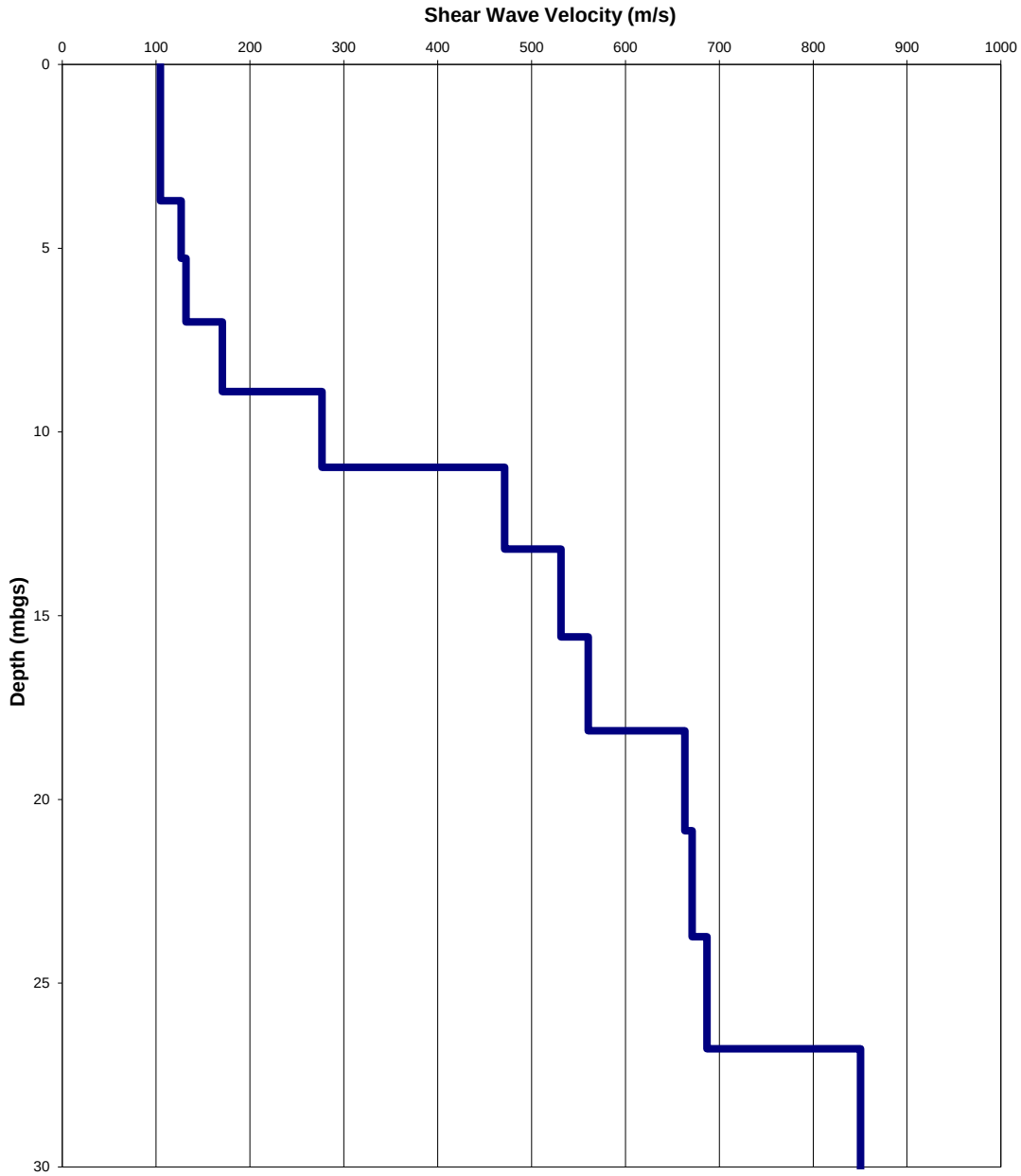


Figure 8: MASW Modelled Shear-Wave Velocity Depth profile along the MASW Line 1

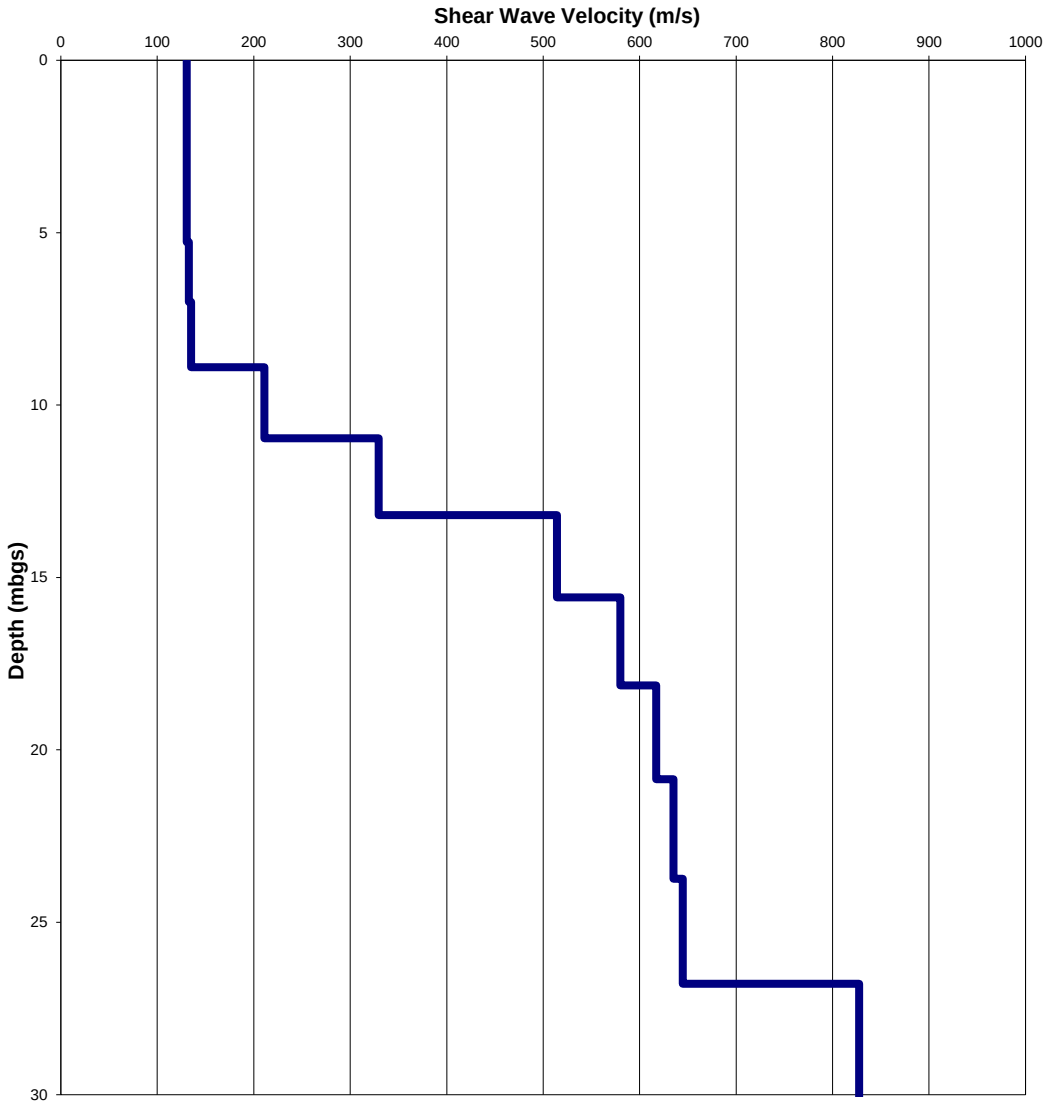


Figure 9: MASW Modelled Shear-Wave Velocity Depth profile along the MASW Line 2

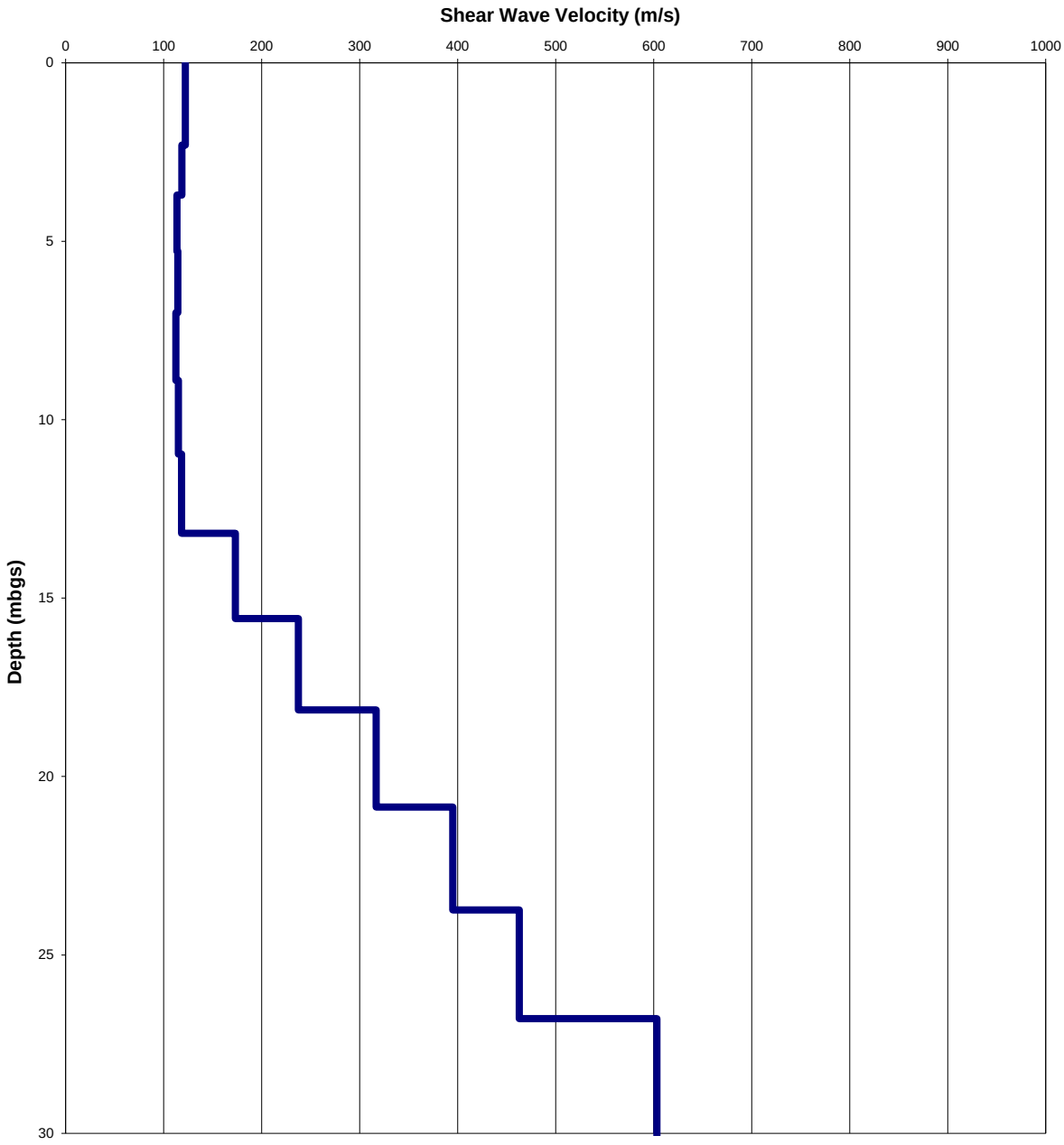


Figure 10: MASW Modelled Shear-Wave Velocity Depth profile along the MASW Line 3

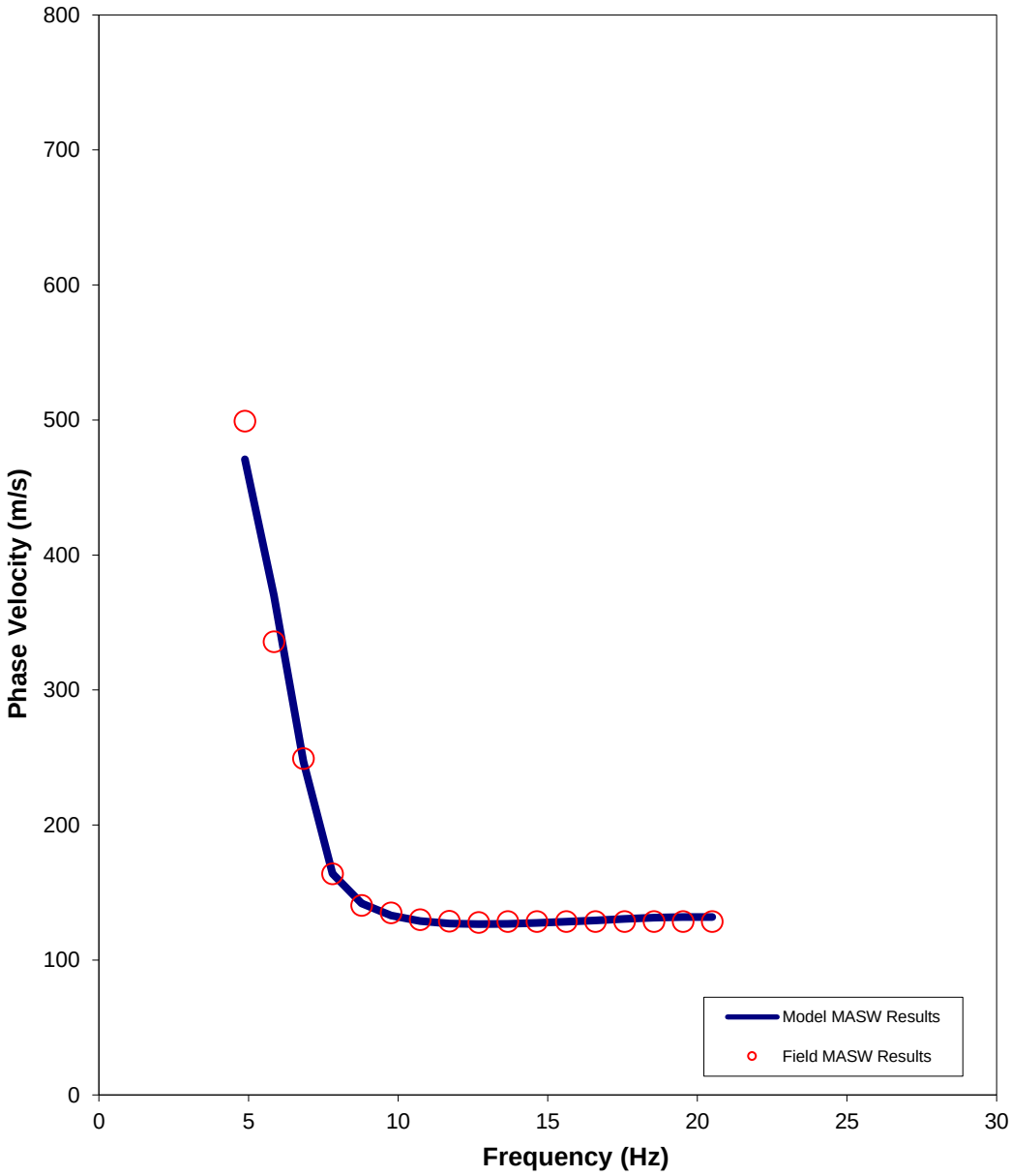


Figure 11: Comparison of Field (red dots) vs. Modelled Data (blue line) along the MASW Line 1

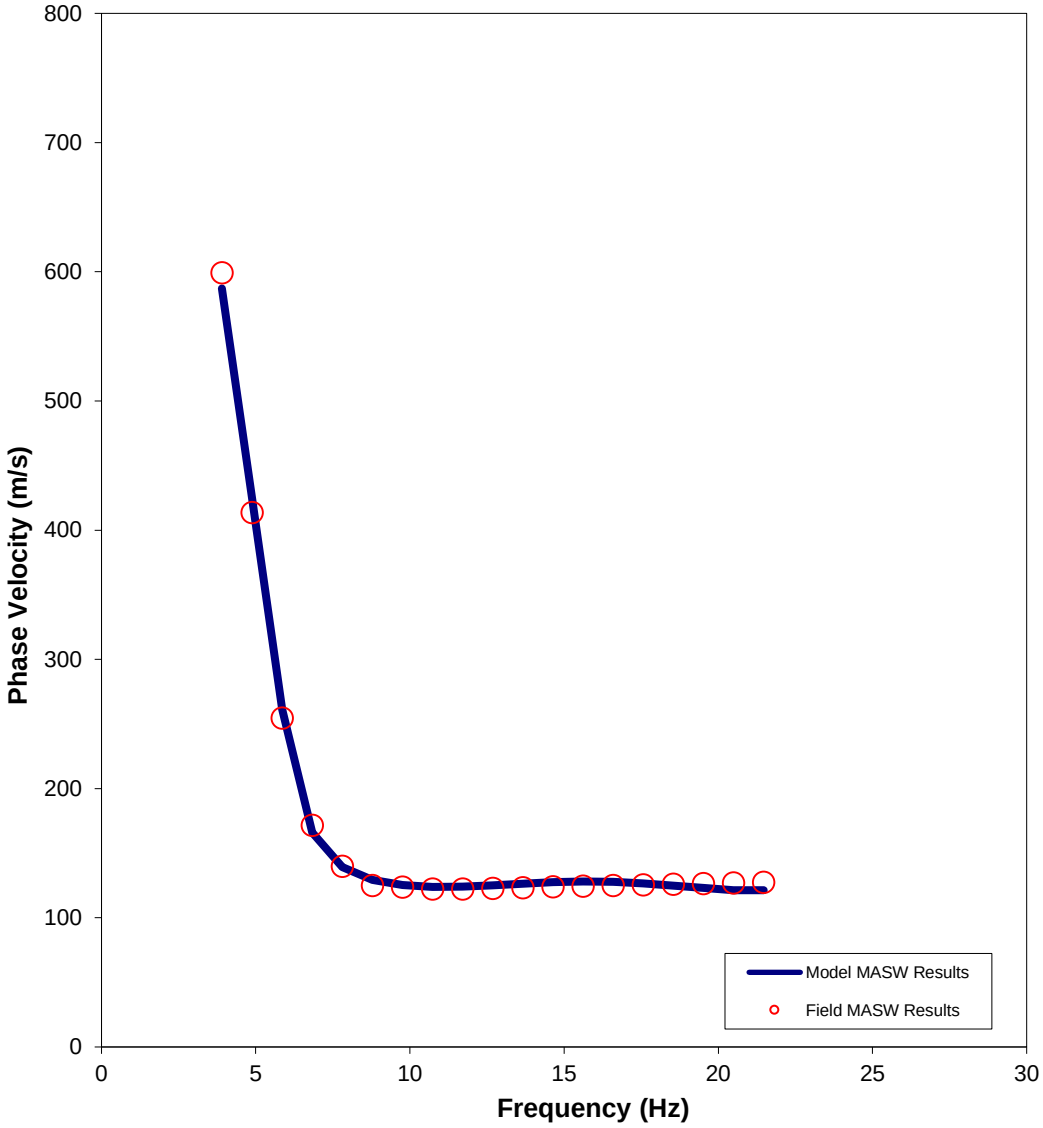


Figure 12: Comparison of Field (red dots) vs. Modelled Data (blue line) along the MASW Line 2

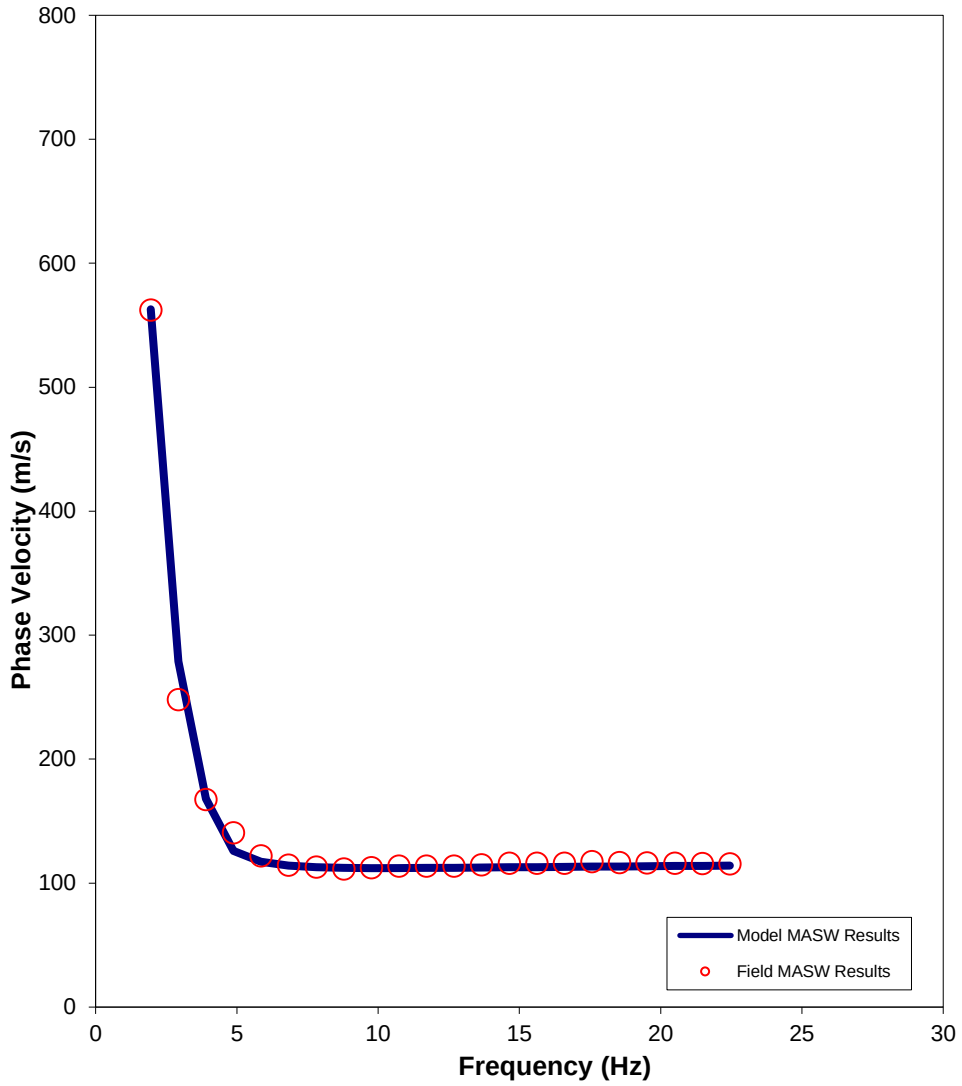


Figure 13: Comparison of Field (red dots) vs. Modelled Data (blue line) along the MASW Line 3

To calculate the average shear-wave velocity as required by the National Building Code of Canada (NBCC 2015), the results were modelled to 30 metres below ground surface. The average shear-wave velocity along MASW Line 1 was found to be 273 m/s (Table 1). The average shear-wave velocity along MASW Line 2 was found to be 271 m/s (Table 2). The average shear-wave velocity along MASW Line 3 was found to be 181 m/s (Table 3). The NBCC 2015 requires special site specific evaluation if certain soil types are encountered on the site, so the site classification stated here should be reviewed, and modified if necessary, according to borehole stratigraphy, standard penetration resistance results, and undrained shear strength measurements, if available for this site.

Table 1: Shear-Wave Velocity Profile along the MASW line 1

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	105	0.010249
1.07	2.31	1.24	105	0.011826
2.31	3.71	1.40	105	0.013403
3.71	5.27	1.57	127	0.012356
5.27	7.01	1.73	132	0.013128
7.01	8.90	1.90	171	0.011115
8.90	10.96	2.06	277	0.007447
10.96	13.19	2.23	471	0.004722
13.19	15.58	2.39	531	0.004499
15.58	18.13	2.55	560	0.004558
18.13	20.85	2.72	663	0.004101
20.85	23.74	2.88	671	0.004298
23.74	26.79	3.05	687	0.004439
26.79	30.00	3.21	850	0.003780
			Vs Average to 30 mbgs (m/s)	**273**

Table 2: Shear-Wave Velocity Profile along the MASW line 2

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	130	0.008211
1.07	2.31	1.24	130	0.009474
2.31	3.71	1.40	130	0.010737
3.71	5.27	1.57	130	0.012000
5.27	7.01	1.73	133	0.013042
7.01	8.90	1.90	135	0.014041
8.90	10.96	2.06	211	0.009761
10.96	13.19	2.23	330	0.006753
13.19	15.58	2.39	514	0.004647
15.58	18.13	2.55	580	0.004406
18.13	20.85	2.72	617	0.004408
20.85	23.74	2.88	635	0.004543
23.74	26.79	3.05	645	0.004730
26.79	30.00	3.21	827	0.003885
			Vs Average to 30 mbgs (m/s)	**271**

Table 3: Shear-Wave Velocity Profile along the MASW line 3

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	122	0.008767
1.07	2.31	1.24	122	0.010115
2.31	3.71	1.40	118	0.011826
3.71	5.27	1.57	114	0.013779
5.27	7.01	1.73	114	0.015127
7.01	8.90	1.90	113	0.016849
8.90	10.96	2.06	115	0.017890
10.96	13.19	2.23	118	0.018794
13.19	15.58	2.39	173	0.013798
15.58	18.13	2.55	238	0.010753
18.13	20.85	2.72	317	0.008587
20.85	23.74	2.88	395	0.007302
23.74	26.79	3.05	463	0.006587
26.79	30.00	3.21	603	0.005327
			Vs Average to 30 mbgs (m/s)	**181**

Limitations

This technical memorandum is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

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

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

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

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.

Stephane Sol, Ph.D., P. Geo.
Senior Geophysicist

Christopher Phillips, M.Sc., P. Geo.
Senior Geophysicist, Principal

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