

REPORT



July 24, 2023

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Condo Corp. 124
105 Copper Road
Whitehorse, YT Y1A 2Z7

Attention: Denali Gaetz – Operations Manager

Lansing Point Condominiums Preliminary Geotechnical Evaluation Whitehorse, Yukon

1. INTRODUCTION

AM2 Geotechnical Inc. (AM2) was retained by Condo Corp. 124 (CC-124) to conduct a geotechnical evaluation of the parking areas at the Lansing Point Condominiums (Lansing Point). Denali Gaetz of Gray Management Services is the project manager for CC-124 and is AM2's contact person for the work. This report details AM2's geotechnical investigation of the parking areas and provides preliminary recommendations for reconstructing the parking lot.

2. BACKGROUND

AM2 met with CC-124 and Denali before this project to discuss the parking lot and gather background information. The condominiums comprise a 20-unit development between two buildings completed in 2008. J.R. Paine & Associates Ltd. Completed a foundation report for the development. However, it has not been provided to AM2 because it cannot be found.

In 2011, EBA Engineering Consultants Ltd. (EBA) was retained by W.A. Marsh Engineering Ltd. (Marsh) after Building B exhibited structural damage in the form of cracks in interior drywall and garage slabs and bulging of the perimeter parking lot asphalt. EBA provided a report on November 4, 2011, titled "*Geotechnical Evaluation – Frost Heave Potential, 134 Seine Square*" that identified the following:

- There were notable areas of frost heave along Building B;
- Evidence of frost heave at south entrance doors; and
- Subsurface conditions comprise 0.9 m of wet to saturated granular fill overlying wet and soft frost-susceptible silt.

Remedial work was undertaken in 2012 following EBA's recommendations. AM2 understands that the remedial work proved effective and that Building B's foundation has performed adequately.

Lansing Point's paved parking areas have exhibited poor performance associated with frost heave. However, no remedial works have been completed to limit the heave. CC-124 indicated they wish to repave the parking areas but do not want to proceed unless frost heave effects can be reduced or eliminated.

3. GEOTECHNICAL INVESTIGATION

3.1 Surficial Geology

Takhini South overlies the lake bottom sediments from Glacial Lake Laberge that were deposited approximately 10,000 years ago. Overlying these glaciolacustrine sediments are deltaic fluvial and aeolian sands. The sands are typically non-frost susceptible (NFS). However, the glaciolacustrine soils are highly frost-susceptible.

3.2 Fieldwork

AM2 completed the geotechnical investigation on June 24, 2023, using Donjeck Drilling's truck-mounted auger drill. Three solid stem boreholes were advanced along the northern side of the parking areas. Boreholes were not advanced between the buildings or along the southern side due to City and owner utilities. Figure 1 shows the borehole locations.

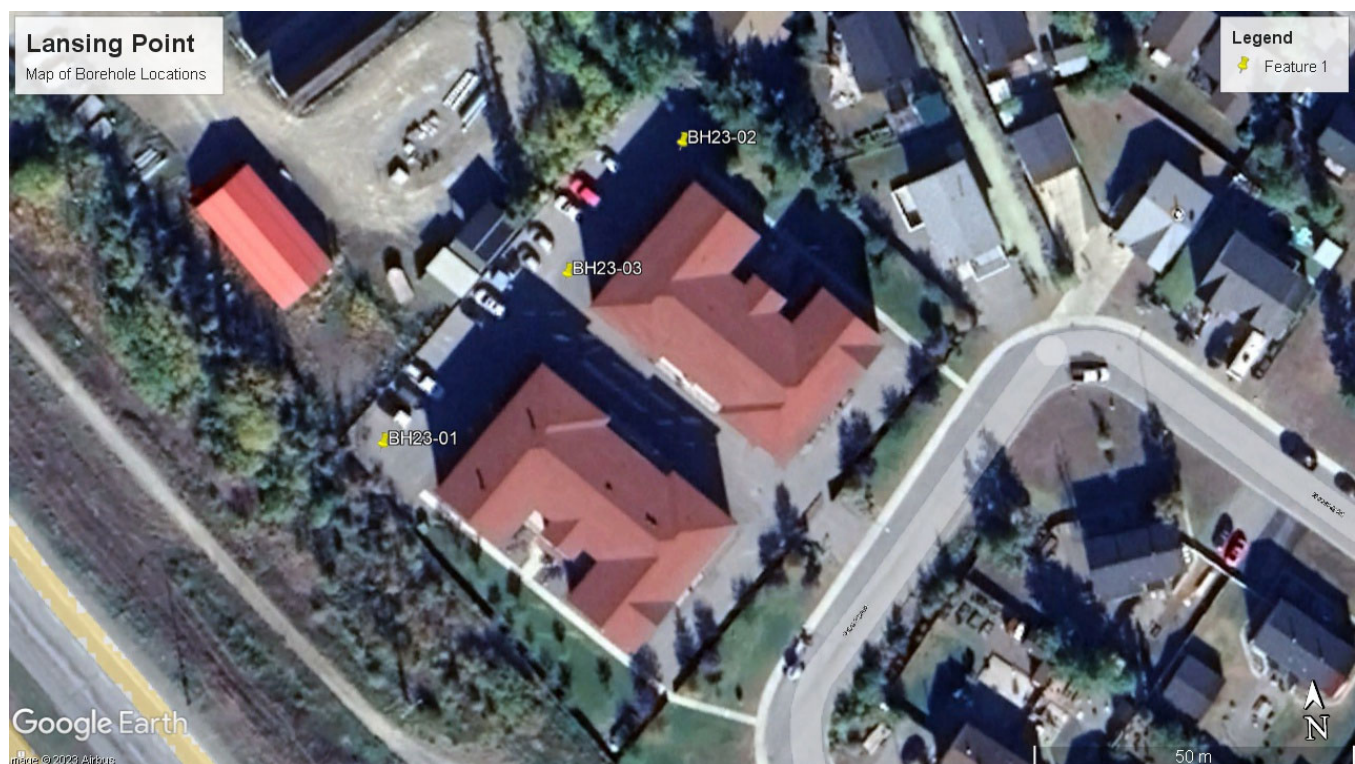


Figure 1: Google Earth image showing borehole locations

AM2 installed a groundwater monitoring well at borehole BH23-01 to evaluate groundwater using a flush-mount wellhead. All boreholes were backfilled using cuttings and sealed on the surface using concrete mixed on-site.

AM2 collected samples at nominal 1.5 m intervals or when a change in the material was encountered. However, AM2 did not identify a need to conduct laboratory testing for the purposes of this document.

3.3 Soil Conditions

Soil conditions varied across the boreholes, as shown in Table 1.

Table 1: Summary of borehole soil stratigraphy

Soil Type	Borehole		
	BH23-01	BH23-02	BH23-03
Asphalt	0 – 0.05	0 – 0.05	0 – 0.05
Sand & Gravel (Fill)	0.05 – 0.9	0.05 – 0.9	0.05 – 0.9
Sand–trace silt	-	0.9 – 1.5	0.9 – 1.5
Sand - silty	0.9 – 3.0	-	-
End of Borehole	3.0	1.5	1.5

Note that the stratigraphy shown in Table 1 is generalized to convey the important information for this report.

3.4 Groundwater Conditions

Groundwater was encountered in BH23-01 at the interface between the fill and silty sand. The silty sand below is damp, suggesting that the groundwater sits on the interface with little vertical movement.

3.5 Discussion

The soil and groundwater conditions that AM2 encountered during the subsurface investigation confirm AM2's initial hypothesis that frost-susceptible soils would be present within the frost line and an available source of free moisture to drive frost heave. These conditions lead to the surface distress and heave seen in the parking areas.

AM2 noted during drilling that evidence of heave dissipates moving eastward from Building B. The subsurface conditions at boreholes BH23-02 and BH23-03 suggest that the lack of heave is due to natural NFS sands present below the fill. AM2 encountered a minor lens of silty material above the sand. However, the lack of moisture means that this layer will tend not to drive frost heave but a change in moisture conditions would lead to minor heave.

4. PARKING AREA SURFACE EVALUATION

AM2 evaluated the state of the asphalt surface at all the parking areas and found cracking within all the red areas in Figure 2.



Figure 2: Google Earth image showing pavement cracking areas in red and areas of little to no cracking in green

Pavement cracking was most pronounced in the northwest corner and around the northern catch basin. The following photos show areas of significant damage.



Photo 1: Pavement cracking in northwest corner



Photo 2: Pavement cracking along 2012 remedial repairs



Photo 3: Heave/settlement around northern catch basin



Photo 4: Pavement cracking continuing towards borehole BH23-02 with BH23-03 in the foreground

AM2 advanced borehole BH23-03 to evaluate soil conditions at the edge of the cracking and found suitable soils, yet heave occurs in the area. The distress could be driven by the heave/settlement of soils away from the borehole and generating overall movement.

The catch basin in Photo 3 exhibits ground settlement around the structure or the structure itself has heaved. Water was noted in the catch basin at the elevation of the outlets, which are approximately 1 m below the surface.

A fence anchored into a concrete footing surrounds the property and exhibits the effects of frost heave along its length.

5. GROUNDWATER SOURCES

The availability of groundwater around fine-grained soils is the primary cause of frost heave in the parking areas, and some sources can be mitigated while others cannot. The rock sumps are one of the largest inputs into the site's groundwater as they pass all surface water into the subsurface. AM2 understands that CC-124 has contacted the City of Whitehorse in the past regarding the rock pits and that the City of Whitehorse granted permission to tie the drainage system into the stormwater system on the street.

CC-124 noted that during freshet, water pools along the western side of the property from highway snow melt, with some years seeing standing water in the landscaped area between the fence and building B. This surface water source dissipates through evaporation and ground infiltration. However, its input into the groundwater beneath the property begins in the spring and is gone well before winter conditions arrive.

A secondary source of groundwater observed was downspouts off the buildings. While this input is less than other sources, they can locally saturate the soils in landscaped areas or flow onto the asphalt and into the catch basins.

6. PRELIMINARY RECOMMENDATIONS

6.1 Nature of Recommendations

The recommendations outlined in the sections below serve as preliminary recommendations for understanding core requirements to mitigate frost heave if CC-124 resurfaces the parking lot with new asphalt. AM2 has taken this approach because of the potential costs associated with the work and the option to "do nothing."

In reading this report, CC-124 should consider the do-nothing option: leave the parking area surfacing as is and conduct remedial repairs as required. This option is discussed further in Section 6.12 below.

6.2 Requirements for Frost Heave

Frost heave occurs when the following conditions have been satisfied:

- Frost-susceptible soils are present;
- Ambient air temperatures permit sustained freezing temperatures within the subsurface; and
- Soils are at or near 100% saturation, and free moisture is available during freezing.

AM2 notes that the above conditions cannot be eliminated, only mitigated using accepted northern practices. Mitigation does not guarantee the elimination of heave but reduces the potential to low or very low.

6.3 Site Preparation

This section details the recommendations to remove the existing asphalt and remediate/replace soils beneath the parking areas to reduce the potential for frost heave. Site preparation should be undertaken under the following recommendations:

- Remove the existing asphalt surface.
- Subexcavate the structural backfill to its base and stockpile for reuse. Care must be taken not to mix frost-susceptible soils with the structural backfill.
- Subexcavate all frost-susceptible soils to a minimum depth of 1.7 m below final grade. The subexcavation should not go past the installed perimeter insulation surrounding the buildings. If the insulation is disturbed, it must be restored to its original specifications.
- Care should be taken not to disturb the subgrade surface. If the subgrade is disturbed, the disturbed soil should be removed, not recompacted.
- A geotechnical engineer licensed to practice in the Yukon should be retained to inspect the prepared subgrade before backfill begins to verify that the conditions are consistent with those described in this report. Additional subexcavation may be required if the inspection yields deleterious or disturbed materials.
- Before backfilling, non-woven geotextile should be placed on the prepared subgrade with a minimum overlap of 600 mm if the subgrade is soft, according to the geotechnical engineer, to limit the engineered fill from sinking into the soils.
- 200 mm Pit Run (Engineered Fill) conforming to the specifications in Table 2 should be placed in maximum 300 mm lifts, moisture conditioned, and compacted using compaction equipment of sufficient size to achieve 95% standard Proctor maximum dry density (SPMDD, as per ASTM D698) for backfill below 1.0 m from final grade and 98% SPMDD for backfill within 1.0 m from final grade.

- The final 150 mm should be 20 mm crushed basecourse gravel conforming to the specifications in Table 2 to provide a smooth level bearing surface for concrete placement, moisture conditioned, and compacted to 98% SPMDD.

6.4 Recommended Granular Material Specifications

Table 2 presents AM2's recommended granular material specifications to be used as backfill beneath the parking areas.

Table 2: Recommended Granular Material Gradations

200 mm Pit Run Gravel		20 mm Crushed Basecourse Gravel	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
200.0	100	-	-
80.0	75 – 100	-	-
25.0	55 – 100	20.0	100
12.5	42 – 84	12.5	64 – 100
5.0	26 – 65	5.0	36 – 72
1.25	11 – 47	1.25	12 – 42
0.315	3 – 30	0.315	4 – 22
0.080	0 – 8	0.080	3 – 6

6.5 Material Reuse

Engineered fill placed during construction is likely suitable for reuse and should be stockpiled on-site or nearby. A geotechnical engineer should inspect and sample the stockpile to ensure the soil is still considered NFS. Care must be taken by the contract to not contaminate the stockpile with fine-grained soils, which could lead to the rejection of the entire stockpile.

6.6 Alternatives to Subexcavation

Rigid board insulation could be used to limit frost penetration. However, the required thickness would be at least 125 mm and likely cost prohibitive compared to subexcavation.

6.7 Surface Water Drainage

AM2 recommends removing the rock pits and using the City of Whitehorse storm system to control surface drainage and manage water. The installed catch basins and drain rock would be removed and the catch basins replaced with new ones or repurposed to become a sealed system to catch and direct surface water away from the property. AM2 cannot directly design the surface water collection and storm system but can retain a qualified small engineering firm to provide designs.

While the ponding water along the highway does impact the groundwater, its impact is limited to the spring. No matter its impact, measures should be taken to limit its impact on the property, such as regrading the YG highway right-of-way. While not in AM2's current scope, AM2 is able to go into conversation with the Yukon Government, Highways and Public Works to discuss the issues and seek a solution.

Downspouts from each building should be configured to direct water as far from the foundation elements of the buildings as possible. Where asphalt exists, the water can be allowed to spill onto the asphalt. Still, downspouts adjacent to landscaped areas should seek to terminate at least 2.4 m away from the foundation or direct onto surfaces that readily flow water away from the buildings.

6.8 Areas Requiring Remedial Work

CC-124 can likely avoid subexcavation where the existing asphalt surface has not cracked, as identified in Figure 2. These areas have not heaved significantly enough to crack the asphalt, suggesting that the below conditions do not promote frost heave. Evidence for the performance comes from drilling borehole BH23-02 and encountering medium-grained sand with trace silt, which pushes the groundwater elevation deeper and is an NFS material. During subexcavation, a geotechnical engineer should evaluate the areas to provide final recommendations of where subsurface conditions meet the guidance provided in this report.

6.9 2023 Remedial Actions

AM2 recommends sealing cracks in the asphalt within 2.4 m from the foundation elements of the building to limit the potential for increased moisture conditions beneath them. As the rock pits provide the greatest groundwater input, crack sealing in other areas will not be as effective at limiting heave. However, sealing all the cracks is a net benefit to reducing some heave.

6.10 Fence Foundations

AM2 expects ground conditions below the fence footings to be similar to the parking lot and insufficient NFS soils below them. The fence footings could be protected with perimeter insulation. However, perimeter insulation would have to be installed on both sides and is likely impossible due to other property owners. The recommended remedial actions would be to install 1.7 m of NFS soils beneath the fence footings, similar to the parking area recommendations. Alternatively, CC-124 can leave the footings alone and repair the fence as required.

6.11 Groundwater Cutoff

AM2 does not suggest trying to cut off the groundwater flow into the property using cutoff walls or similar as it is a costly option and still requires remedial works to the parking area subsurface to ensure its long-term performance. Similarly, a sump system that pulls the groundwater below the frost penetration depth of 2.4 m may have to operate continuously and pump into the City storm system to be effective.

6.12 Do Nothing Option

CC-124 indicated that the foundation performance of both buildings has been good since the perimeter insulation was installed. This allows CC-124 to decide whether to repair part or all of the parking areas, stage the remedial works over multiple years, or leave the existing asphalt and repair the cracks as they form. The frost heave does not appear to put any utilities at risk or the buildings at this time.

6.13 Cost Estimate for Remedial Work

AM2 has prepared an order-of-magnitude cost table, which is presented below.

Task	Unit	Unit Price	Total
Remove asphalt and subexcavate to 1.7 m below ground surface	3,400 m ³	\$30/m ³	\$85,000
Load, haul, place new NFS soil	1,800 m ³	\$60/m ³	\$108,000
Load, haul, place reuse stockpile	1,600 m ³	\$20/m ³	\$32,000
Engineering and QC during construction	-	-	\$5,000
TOTAL			\$225,000

The above cost estimate does not include the cost of the storm system or account for any increased excavation due to rock pit removal because it is unknown how large they are. Also, the above cost estimate is based on historical knowledge of rates. It is not meant as a detailed cost estimate for construction purposes

but to convey an idea of costs to CC-124 to allow them to make informed decisions. AM2 recommends that CC-124 use the volumes provided and seek quotes from qualified contracting companies.

6.14 Immediate Actions

In a meeting with CC-124 and GMS on July 14, 2023, to discuss the report, CC-124 requested a discussion surrounding actions that can be taken now to reduce the effects of frost-related ground movement until a permanent solution is chosen.

The manhole barrels should be pumped out using a vac truck to remove sediment and prepare them for remedial measures. After the water and sediment is removed, the barrels should be sealed to prevent water migration into the rock pits. CC-124 will have to manage storm and melt water by pumping out the manholes and directing the water to the City of Whitehorse storm system. CC-124 should confirm whether the City will allow this water management procedure.

Sealing of all asphalt cracks will reduce water input into the subsurface and help direct it to the storm management system. Crack sealing should be performed in a manner that fully seals the crack and the crack sealing monitored for performance and repaired as necessary. AM2 noted that the asphalt surface around the northwest manhole barrel catch basin has separated due to frost heave. The area surrounding the catch basin should be sealed as well to prevent water from infiltrating into the rock pit on the outside of the manhole barrel.

All drainage from the buildings should be redirected to allow the water to flow on the asphalt and to the catch basins once they are sealed. Water into landscaped areas could penetrate into the subsurface and add to the groundwater causing heave.

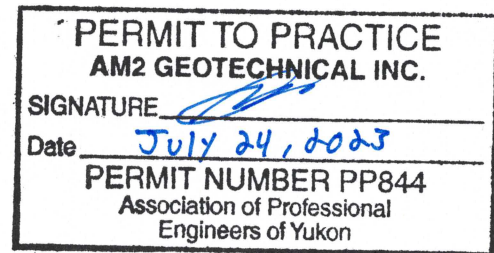
7. NEXT STEPS

After CC-124 reviews the report, AM2 suggests a meeting with the board to discuss the report and determine how the board wishes to proceed. This report satisfies the recommendations for the subexcavation of the parking areas. However, additional design (e.g., the stormwater system) is likely required for any option chosen and a final report generated including these items.

8. CLOSURE

We trust this proposal satisfies your current requirements. If you have any questions or comments, please get in touch with the undersigned below.

Respectfully submitted,
AM2 Geotechnical Inc.



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Enclosure:
Limitations on the Use of this Document

LIMITATIONS ON THE USE OF THIS DOCUMENT

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AM2 has prepared the Professional Document with the standard level of care consistent with other professional members practicing under similar conditions in the jurisdiction where the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty expressed or implied is made.

If the Client or an Authorized Party discovers an error or omission, it must be brought to the attention of AM2 within a reasonable time.

3. GENERAL LIMITATIONS

This Professional Document was prepared based solely on the conditions presented and data available during the Contract term from data collected in the field and available databases.

This Professional Document is of a summary nature. It is not intended to stand alone without reference to the instructions given by the Client to AM2, communications between AM2 and the Client, and any other reports prepared by AM2 for the Client relative to the specific site described in this report. This Professional Document cannot be relied upon when any party uses portions of the report without reference to the entire report, for which AM2 cannot be held responsible when not used in whole.

The information and recommendations in this Professional Document pertain to the subject site and specific development and cannot be relied upon when used for other developments or sites. Any variation in site conditions, development configuration, or assumed conditions that form the basis of this Professional Document, at or on the development proposed as of the date of the Professional Document, requires a supplementary exploration, investigation, and assessment.

The recommendations and opinions given in this Professional Document are for the Client's guidance in designing a specific project. Investigations for design purposes are of less scope than if conducted to determine all of the relevant conditions that may affect construction costs. Contractors bidding on or undertaking the work should rely on their own investigations and interpretations of the factual data presented in the Professional Document.

4. DISCLOSURE OF INFORMATION BY THE CLIENT

The Client acknowledges that they have disclosed all relevant information to the project and has not withheld any pertinent information from AM2, with all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site.

5. INFORMATION PROVIDED BY OTHERS

AM2 seeks to verify the accuracy of information provided by third parties other than the Client. However, AM2 accepts no responsibility for such information's accuracy or reliability if provided by credible sources, even if any impacts to recommendations, design, or other deliverables cause the Client or Authorized Party loss or damage.

6. SOIL, ROCK, AND GROUNDWATER DESCRIPTIONS

Commonly accepted systems, methods, and standards of professional geotechnical practice are used to classify soils and rocks. Using these methods involves judgment on limited field data where boundaries between soil/rock types and units may be transitional rather than abrupt. AM2 does not warrant or guarantee the exactness of the descriptions beyond the inferred accuracy that is common in practice.

AM2's descriptions are based on the exact locations of the subsurface investigation techniques and cannot guarantee that conditions between subsurface investigation points still are as interpreted. Soil and groundwater conditions shown in the factual data and described in the Professional Document are the observed conditions at the time of the determination or measurement. Activities or seasonal changes after data collection may alter the conditions described in this Professional Document.

Suppose subsurface conditions encountered during development differ from those described in this Professional Document. In that case, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

7. TESTHOLE LOGS

Testhole logs are prepared based on a compilation of site-specific field data, classification of soils and rocks from investigations, and laboratory testing of selected samples. The logs do not indicate the overall site conditions and serve as information for engineering judgment and determination. However, further investigation and review will be required if the Client requires a detailed site characterization.

Stratigraphic and geological information in this report is inferred from logs of subsurface investigation methods. Stratigraphy is only known at the testhole location or exposure. The conditions presented by AM2 are not exact, and the Client accepts that variations exist and does not hold AM2 responsible for variations encountered beyond testholes.

8. CONSTRUCTION MONITORING

A geotechnical engineer should undertake observations during site preparation, excavation, and construction, as these observations serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

9. PROTECTION OF SITE CONDITIONS

AM2 does not accept responsibility for changes in site conditions after the investigation is complete and their effects on recommendations or factual information in this Professional Document unless disclosed by the Client, and AM2 is given the opportunity to review the changes and update the Professional Document.

Unless otherwise stated in the Professional Document, excavation subgrades and walls must be protected from the elements, particularly moisture, desiccation, frost action, and construction traffic.

Unless otherwise stated in the Professional Document, the Client must support ground and structures adjacent to the anticipated construction and preserve adjacent ground and structures from the adverse impact of development activities.

A geotechnical engineer should be consulted about construction activities' impact on adjacent infrastructure once the final design, construction techniques, and construction sequencing are known.

AM2 accepts no responsibility for the effects of drainage or dewatering if it has an adverse effect on temporary or permanent installations unless specifically involved in the system's detailed design and construction monitoring.

10. DESIGN PARAMETERS

Design parameters in this Professional Document relate to a specific soil or rock type and condition. Construction or environmental circumstances can materially change the conditions, and structural elements must be in and/or upon geological materials of the type and in the condition used in this Professional Document. The Client's responsible for retaining a geotechnical engineer to verify site conditions match those described in this report during construction.

11. CODES, STANDARDS, GUIDELINES, AND BEST PRACTICES

This Professional Document has been prepared based on all current and applicable codes, standards, guidelines, or best practices. AM2 cannot be held responsible for future changes to codes or standards and their effect on the assessment, design, or analyses included in this Professional Document.

12. SAMPLES

AM2 will discard soil and rock samples after 90 days of storage unless other arrangements are made by the Client by written request. The Client accepts that storage fees may apply for more extended storage periods.