



THURBER ENGINEERING LTD.

FINAL MEMORANDUM

To: Cedar Leung, P.Eng.
LEA Consulting Limited

April 15, 2024

From: Christopher Murray, M.A.Sc., P.Eng.
(Reviewed by Dr. Fred Griffiths, P.Eng.)

Thurber File No.: 35062

TECHNICAL MEMORANDUM STEEP COBBLE SLOPE, GULLY EROSION MITIGATION HIGHWAY 129, 37.4 KM NORTH OF HIGHWAY 554 AGREEMENT NO. 5020-E-0012, WORK ITEM #17 GWP 5161-18-00

GEOCRES NO: 41J-144

1. Introduction

This memorandum presents a foundation assessment of alternatives for erosion mitigation measures for two gullies identified in the existing earth cut within the project area and provides recommendations for the tender of the technically preferred alternative. The discussions provided in this memorandum are based on the interpretation of the factual data obtained from a foundation investigation which included hand auger investigation completed by Thurber Engineering Limited (Thurber) as presented in a Foundation Investigation and Design Report dated April 2023 and also referenced as GEOCRES Number 41J-144. Thurber carried out the assignment as a sub-consultant to a McIntosh Perry | LEA Consulting Joint Venture (MPLJV) under Agreement No. 5020-E-0012, Work Item No. 17.

The interpretation and recommendations contained within this technical memorandum are intended for the use of the Ministry of Transportation, McIntosh Perry Consulting Engineers and LEA Consulting Limited and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data presented under GEOCRES Number 41J-144. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

It is a condition of this memorandum that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.



2. Site Description

For project purposes, Highway 129 and the crest of the slope are herein described as oriented north-south. The site is located on the east side of Highway 129 approximately 37.35 km to 37.52 km north of Highway 554 (Station 19+180 to 19+400 RT) in Dagle Township. The Mississagi River runs on the west side of Highway 129, near parallel to the highway alignment with flow to the south. The area in the vicinity of the site is generally undeveloped and densely vegetated with coniferous and deciduous trees. The regional terrain is relatively rugged.

Within the project limits, Highway 129 is a two-lane undivided highway and has a posted speed limit of 80 km/h. The traffic volume is understood to have been 350 AADT in 2016. The centerline profile of Highway 129 gradually slopes upwards from Station 19+150 to 19+275 (elev. 303.7 to 307.5 m). North of Station 19+275, the highway surface slopes gradually downward to approximately elevation 305.3 m at Station 19+350. No guiderails are present on either side of the highway at the site.

It is understood that ongoing erosion have occurred within the two identified gullies at this site. In addition, it is noted that the existing ditches at the base of the gullies are very shallow, thus cobbles rolling down the slope have come to rest on the travelled portion of the highway.

3. Site Visit

A site visit was completed on November 14, 2023 to determine the locations and extent of the two gullies. Selected photographs from the site visit are appended to this memo.

A gully was identified from approximately Station 19+176 to 19+188; for the purposes of this memo this gully will be referred to as the South Gully. The average slope from the crest to the toe at the South Gully was measured to be approximately 1.34H:1V and the depth of the gully was estimated to be 1.5 m. The vertical height of the gully was measured to be approximately 21.4 m. There is very limited vegetation within the gully, the surficial material consisted of sand with round cobbles and was estimated to be very loose in consistency. A significant number of cobbles were present at the toe of slope at the time of the site visit. Along the south side of the gully, the possible formation of an increased slope crest was observed creating a detached vegetated area that is less stable and at risk of sliding down the slope. The potential failure of this formation would result in the limit of the gully expanding along the south side of the gully to approximately Station 19+170.

The second gully was identified from approximately Station 19+370 to 19+384; for the purposes of this memo this gully will be referred to as the North Gully. The average slope from the crest to



the toe at this location was measured to be approximately 1.39H:1V and the depth of the gully was estimated to be 1.5 m. The vertical height of the gully was measured to be approximately 21.8 m. Some vegetation was observed within this gully which is a possible indication that the North Gully is less active than the South Gully. The surficial material consisted of sand with silt containing frequent round cobbles and was estimated to be very loose in consistency. Cobbles were present at the toe of slope within the ditch at the time of the site visit.

4. Geotechnical Considerations

Based on the results of the previously completed field and laboratory investigation (Geocres Number 41J-144), the November 2023 site observations, and the information provided by the MPLJV with regards to the proposed project requirements, the geotechnical design considerations include:

- The existing gullies are steep (1.34H:1V at the South Gully and 1.39H:1V at the North Gully).
- The existing gullies are high (~21.4 m in elevation at the South Gully and ~21.8 m at the North Gully).
- The existing gullies have a long unimpeded run (~35.8 m length at the South Gully and ~37.3 m at the North Gully) along the flow path.
- There is minimal existing vegetation cover within the existing gullies.
- As reported in Geocres Report 1J-144, particle size analysis on samples of the existing cut slope materials indicate that the matrix material (sand and silt) has a low to moderate potential for soil erodibility (Wischmeier Nomograph factor, K ranging from 0.06 to 0.28).
- The existing gullies are thought to be caused by erosion from the flow of water from snowmelt and/or precipitation from a large drainage area above the cut slope exacerbated by the existing slope height, inclination and the length which results in a long, unimpeded run for surface water.
- The presence of cobbles within the cut slope soils is an inherent highway hazard with cobbles rolling down the slope and into the near driving lane. The cobbles are released from the slope as the surrounding soil matrix is eroded away by flowing water.
- Actions are recommended to reduce erosion of the earth and granular materials in the gullies. However, it is understood that due to property constraints, it is not feasible to implement drainage control measures such as an interceptor ditch (OPSD 200.010) above the crest of slope.



5. Evaluation of Design Options

Fundamental to the mitigation of the cut performance at this site is improvement to drainage. Limiting water flow down the slope with ditching at the top of the slope would significantly improve conditions. An interceptor ditch such as that indicated on OPSD 200.010 has been considered at the top of the slope to direct overland flow away from the gullies and cut slope. However, it is understood that due to property constraints and the substantial tree clearing required for access, an interceptor ditch is not feasible. Mitigation of the observed erosion in the two identified gully areas is recommended.

Given the geometry and composition of soils, the following options were considered for control of erosion within the gullies:

- Terracing
- Granular Sheeting
- Rock Protection
- Turf Reinforcement Mat
- Anchored Wire Mesh

These alternatives are discussed in the following paragraphs and evaluated from a geotechnical perspective in terms of their respective advantages, disadvantages, risks and consequences. The evaluation is summarized in a table attached to this memo. A preferred erosion mitigation alternative from a geotechnical engineering perspective is identified.

- Terracing
Terracing the existing gullies to include a number of benches and establishing vegetation could be considered as an erosion mitigation measure. Terracing would involve substantial earth works and likely require heavy equipment access at the crest of the existing slope to complete the required earth work. This option would reduce the unimpeded flow of water within the gullies and thus the erosion of the existing soil. Furthermore, the benches would provide intermediate catchment zones if cobbles do come free along the slope due to erosion.

The drawbacks of this technique include the fact that the existing gullies are already extremely steep (likely at the angle of repose of the existing soil) and terracing will require cutting the existing slope back to a slope of 2H:1V. Detailing and constructing the tie ins to the existing slope along both sides of the terraced gullies will be very difficult and could result in zones of concentrated surface water flow and therefore the entire length of slope

may need to be terraced. Continued maintenance may also be required because terrace abandonment increases the risk of erosion at the foot of each terrace compared to natural slopes.

- Granular Sheeting

Granular sheeting is an uncompacted graded granular aggregate material intended for use as a protective surface layer on erodible soil slopes. It is not typically recommended for slopes steeper than 2H:1V.

Based on the specification for granular sheeting material in OPSS.PROV 1004 there is no percent crushed requirement for granular sheeting material. Thus, the friction angle of granular sheeting material, which is placed uncompacted, may be lower than the existing material. Placement of the granular sheeting material would be difficult given the slope geometry and steep slope. This approach would also not incorporate benches or have any impact to reduce the substantial length of unimpeded water flow.

- Rock Protection

Slope armoring could be provided by a rock protection layer. Rock protection comprised of a well graded fractured rock as described in OPSS.PROV 1004 could be used to provide a protective layer over the entire gully to secure the existing sand and cobbles. The friction angle of rock protection material would be higher than the existing soils and the unit weight would be lower. A geotextile separation layer would be required between the rock protection and existing soils to prevent undermining of the rock protection layer and migration of fines. Placement of the rock protection would be difficult given the slope geometry and steep slope. This approach would not incorporate benches or have any impact to reduce the substantial length of unimpeded water flow, however, the coarseness of the rock protection material may slightly reduce runoff velocity.

- Turf Reinforcement Mat

Slope protection within the gullies could be provided by a Turf Reinforcement Mat. These mats are proprietary systems that are anchored into the slope to provide immediate erosion protection and long-term site armoring. Although the systems can either be vegetated or unvegetated, vegetation is recommended to reduce the exposure of the turf reinforcement mat to UV rays and increase the design life. Turf Reinforcement Mats can assist in the establishment of permanent reinforcement by vegetation in applications where the force exerted by water exceeds the shear limits of unreinforced vegetation such as unimpeded water flow over a long slope. Given the existing slope inclination and length of unimpeded water flow within the gullies, a high-performance turf reinforcement mat

consisting of a three-dimensional woven polypropylene geotextile and ground anchors would likely be required. Installation of this system can be completed with pully systems rather than heavy equipment. Coir logs could be considered to reduce the unimpeded water flow down the slope to reduce erosion of topsoil during the establishment of vegetation.

- Anchored Wire Mesh

An alternative slope armoring technique to the turf reinforcement mat discussed above would be an anchored wire mesh which is a proprietary steel woven wire mesh installed and anchored above a coconut fiber mat to establish vegetation and contain the sand with silt to reduce the potential for undermining due to erosion (similar to a geotextile). The benefit of this type of system is that the wire mesh can be tensioned to provide increased support to the slope when compared to a turf reinforcement mat. These systems also generally have a longer design life than turf reinforcement mats alone. The installation can be completed with pully systems rather than heavy equipment. Anchored wire mesh systems are suitable for rock control but the system would need to be vegetated to prevent continued erosion of the existing sand with silt. Given that, Coir logs should still be considered in conjunction with this system to aid in the establishment of vegetation.

6. Recommended Erosion Mitigation Alternative

Based on an evaluation of the erosion mitigation design alternatives and the geometry of the existing gullies, the recommended erosion mitigation option, from a foundation engineering perspective, is to install rock protection within the gully locations with a geotextile separation layer. It is noted that since no drainage improvements will be carried out the rock protection will need to provide erosion control as well as serve as an armored drainage channel.

7. Geotechnical Recommendations

Foundation recommendations for the preferred alternative are presented within the following sections.

7.1 Materials

Rock protection material must consist of a well-graded fractured rock in accordance with OPSS.PROV 1004. The geotextile separation layer must be a Class II non-woven geotextile with a Filtration Opening Size (FOS) between 50 and 100 µm in accordance with OPSS.PROV 1860.



7.2 Site Preparation

Prior to placement of the geotextile, the area within the gully must be cleared with close-cut clearing of tree stumps and bush. The near vertical faces at the crest and along the edges of the gully must be flattened to the inclination of the adjacent slope and no steeper than 1.5H:1V perpendicular to the gully along the edges. The detached vegetated area at risk of sliding down the slope identified within the South Gully should be removed and the slope flattened to match the adjacent slope. The surface that receives the geotextile should be smooth and free of debris. Any depressions or soft spots should be filled or repaired using Granular B Type II.

7.3 Geotextile Placement

Geotextile placement must be carried out in accordance with OPSS.PROV 511.

At the time of installation, damaged or deteriorated fabric has to be replaced or patched. The geotextile must be covered with rock protection quickly and should not be exposed to sunlight for more than 72 hours following removal of the protective wrap. If the rolls have been left exposed to UV light, the outer wraps should be checked for deterioration and, if necessary, the affected material removed.

The fabric should be laid smoothly, free of tension, and with sufficient slack around irregularities to allow for readjustment without tearing. Due to the inclination of the slope it is expected that the entire geotextile will need to be sufficiently pinned with metal pins prior to the placement of rock protection. A minimum 500 mm pinned overlap is required at all seams and the geotextile must be wrapped down into the ground a minimum depth of 300 mm as well as pinned at termination points.

Foot traffic may be permitted on the fabric, but not vehicles or construction equipment. To minimize damage, rockfill should not be dropped on the fabric but rather placed by hand.

7.4 Rock Protection Placement

Placement of a minimum thickness of 1.0 m of rock protection must be carried out in accordance with OPSS.PROV 511.

A 0.5 m deep trench should be excavated below the toe of the slope and levelled to receive the geotextile and the first layer of the rock protection. Placement of rock protection should be completed by hand to protect the geotextile but can be aided by mechanical means such as a crane or small equipment to protect the geotextile layer. Placement must be started at the bottom of the slope, using the large stones for the bottom courses and for headers of the upper portions.



The stones should be placed with the maximum dimension, perpendicular to the face of the slope. The final rock protection surface should have a uniform appearance.

7.5 Slope Stability

We have completed a slope stability assessment; a copy of the output is appended to this memo. The existing slopes are marginally stable with a factor of safety of 1.18. A second analysis has also been completed and is also appended which shows that the rock protection will have a negligible impact on overall slope stability. Thus, the slope will not achieve the typical MTO target factor of safety.

7.6 Constructability

Construction of rock protection within the gullies will be difficult. The means and methods remain the responsibility of the Contractor, but a few key issues and considerations are listed below:

- Covering the geotextile within 72 hours may not be possible if the geotextile is placed over an entire gully prior to the placement of rock protection. The geotextile will likely need to be placed in stages.
- Given the steep slope and relatively loose surficial materials, the geotextile will need to be sufficiently pinned to secure the geotextile in place until placement of the rock protection can be completed.
- If construction access beyond the crest of slope can be provided for equipment, such as a long reach excavator, it would allow for more expedient placement of the rock protection and would likely be more cost effective. It is understood that this option would likely require a temporary limited interest on the adjacent property and tree clearing.
- If no access can be provided for construction equipment to the crest of the slope. A relatively large crane will likely be required to lift small equipment and materials onto the upper slope and the rock protection will need to be maneuvered into place by hand. This could substantially slow construction of the rock protection.
- If a crane is required, a crane pad will need to be constructed at the base of slope which could take up a large portion of the available roadway width making it more difficult to maintain traffic during construction.



8. Closure

Engineering analysis and preparation of this technical memorandum were carried out by Mr. Darlan Amorim Pereira and Mr. Christopher Murray, P.Eng. The report was reviewed Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.
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Attachments:

- Statement of Limitations and Conditions
- Site Photographs
- Comparison Table of Erosion Mitigation Measures
- Slope Stability Assessment Figures

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



Photo 1. South Gully Sta. 19+176 to 19+188 (looking east) [taken Nov. 2023]



Photo 2. South Gully crest (looking east) [taken Nov. 2023]



Photo 3. South Gully viewed from crest (looking west) *[taken Nov. 2023]*



Photo 4. South Gully expansion to south (looking east) *[taken Nov. 2023]*



Photo 5. North Gully Sta. 19+370 to 19+384 (looking east) *[taken Nov. 2023]*



Photo 6. North Gully crest (looking east) *[taken Nov. 2023]*



Photo 7. North Gully viewed from crest (looking west) *[taken Nov. 2023]*

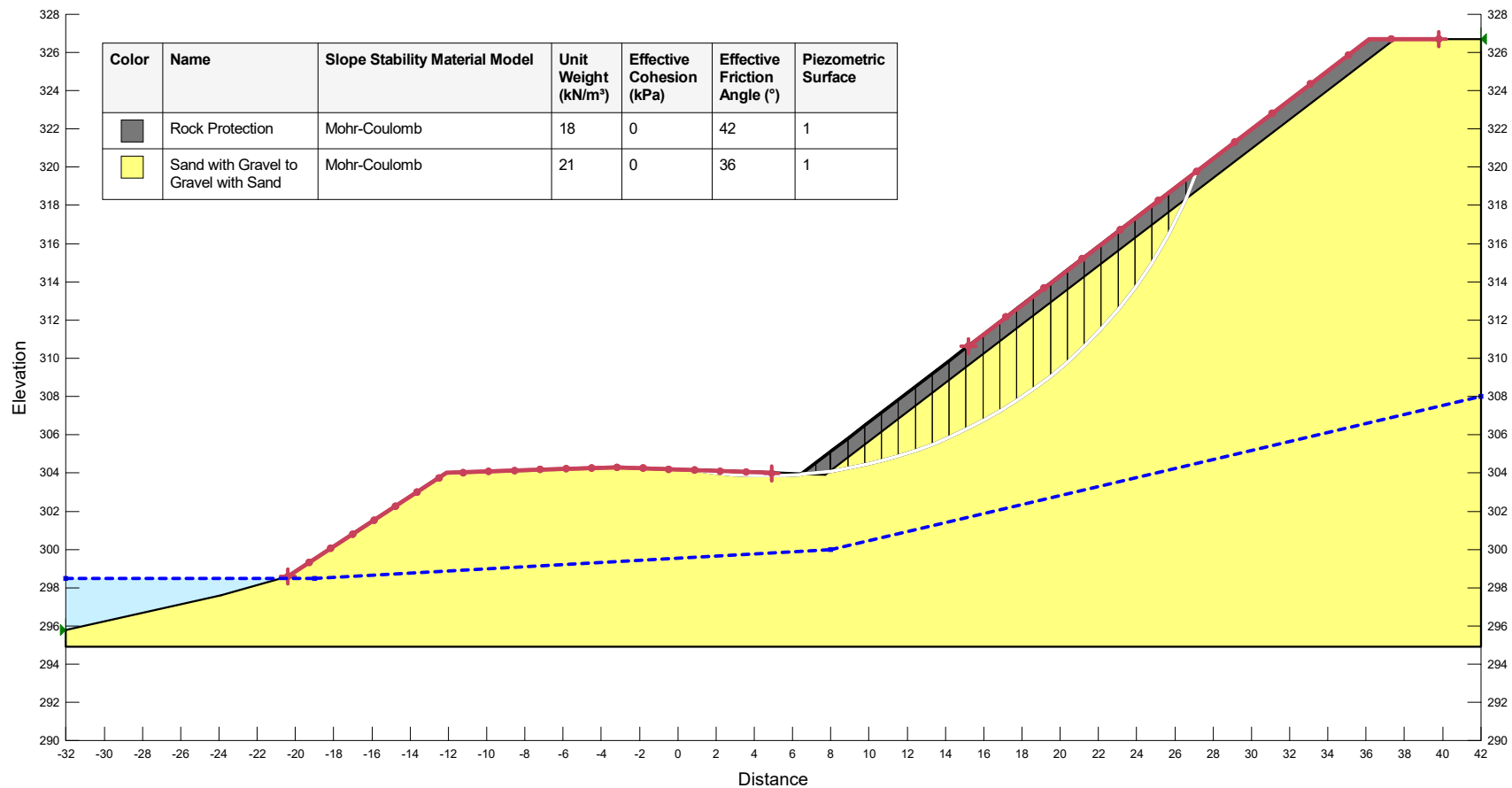


Photo 8. Cobbles up to 200 mm observed at toe of North Gully *[taken Nov. 2023]*

COMPARISON OF ERROSION MITIGATION ALTERNATIVES

	<i>Terracing</i>	<i>Granular Sheeting</i>	<i>Rock Protection</i>	<i>Turf Reinforcement Mat</i>	<i>Anchored Wire Mesh</i>
Description	<ul style="list-style-type: none">• Terracing the existing gullies with a number of benches and establishing vegetation to reduce the erosive process and the risk of cobbles falling onto the roadway.	<ul style="list-style-type: none">• Topping the existing slope in the gullies with a graded granular aggregate material intended for use as a protective surface layer on erodible soil slopes.	<ul style="list-style-type: none">• Slope armoring of the gullies provided by a geotextile separation layer topped with a rock protection layer comprised of a well graded fractured rock to secure the existing sand and cobbles.	<ul style="list-style-type: none">• Proprietary system placed on the existing slope in the gullies and providing immediate erosion protection. Given the existing slope inclination and slope length a high-performance turf reinforcement mat consisting of a three-dimensional woven polypropylene geotextile and ground anchors would likely be required.	<ul style="list-style-type: none">• Proprietary steel woven wire mesh installed, anchored and tensioned above a coconut fibre mat to establish vegetation and contain the sand with silt to reduce the potential for undermining due to erosion in the gullies
Advantages	<ul style="list-style-type: none">• Reduces the runoff draining down the slope toward a non-erosive velocity.• The flat terraces provide a more favorable environment for establishing vegetation.• Terracing offers improved global stability.	<ul style="list-style-type: none">• Can be used to reduce erosion potential of slopes.• Would provide a buffer layer to contain the existing cobbles.	<ul style="list-style-type: none">• Cost effective for erosion protection of existing slopes.• Vegetation not required for stability.• Rock protection has a higher angle of internal friction than the existing soils.• Can accommodate some surficial movement below the rock protection and remain functional.• Can be regraded if damaged.	<ul style="list-style-type: none">• Cost effective for erosion protection of existing slopes.• Can accommodate some surficial movement below the turf reinforcement mat and remain functional.• Can be repaired if damaged.	<ul style="list-style-type: none">• Suitable for both cobble control and erosion protection.• Can accommodate some surficial movement below anchored wire mesh and remain functional.• Reinforces the surface of the existing slope more than just a turf reinforcement mat since it can be tensioned.• Can be repaired if damaged.
Disadvantages	<ul style="list-style-type: none">• Terracing is typically installed on less steep slopes; based on terracing design guidelines, steeper slopes result in less flat terraces.• Mechanical stabilization of the intermittent steeper slopes would be required for local stability.• The existing soil is poor for establishing vegetation, topsoil would need to be placed.• Typically terracing is a whole slope solution; zones of concentrated surface water flow could result at the tie ins to the existing slope.	<ul style="list-style-type: none">• Not recommended for slopes steeper than 2H:1V.• Typically requires drains installed below the granular sheeting layer.• Does not improve runoff velocity.• Granular sheeting is placed uncompacted and may have a lower friction angle to the existing soil; a reduced slope stability factor of safety is likely.• Slope erosion is not fully mitigated on such a steep slope.• Vegetation could be difficult to establish. Coir logs may be required.	<ul style="list-style-type: none">• Geotextile separation layer is vital and would be difficult to repair if damaged.• On such a steep slope, rock protection must be placed carefully by hand.• Only reduces runoff velocity slightly.	<ul style="list-style-type: none">• Less suitable for cobble control than anchored wire mesh.• Unable to be tensioned like the anchored wire mesh.• Does not improve runoff velocity.• Due to the steepness and location of the slope, vegetation could be difficult to establish. Coir logs may be required.• Durability of the polypropylene is dependant on UV exposure and must be fully vegetated to meet the required service life.	<ul style="list-style-type: none">• Less cost effective than a turf reinforcement mat.• Does not improve runoff velocity.• Due to the steepness and location of the slope, vegetation could be difficult to establish. Coir logs may be required.
Constructability	<ul style="list-style-type: none">• Heavy equipment would be required for construction.• Access to the upper portion of the slope will be difficult.	<ul style="list-style-type: none">• Placement of uncompacted granular sheeting on such a steep slope would cause the material to slough excessively during placement.	<ul style="list-style-type: none">• Heavy equipment would be required for construction.• Care must be taken to secure the geotextile and place the rock protection to not cause damage to the geotextile.	<ul style="list-style-type: none">• Working on the existing steep slope required. Much of the installation would be done by hand.• Anchor installation through cobbles could be challenging	<ul style="list-style-type: none">• Working on the existing steep slope required. Much of the installation would be done by hand.• Anchor installation through cobbles could be challenging.• More labour-intensive installation than a turf reinforcement mat.
Maintenance	<ul style="list-style-type: none">• Regular maintenance would be required; terrace abandonment increases the risk of erosion.	<ul style="list-style-type: none">• Given the steepness of the slope, a significant amount of maintenance would be required.	<ul style="list-style-type: none">• Occasional inspections and regrading if necessary.	<ul style="list-style-type: none">• Occasional inspections of TRM and repair if necessary.	<ul style="list-style-type: none">• Occasional inspections of TRM and repair if necessary.
Relative Cost	<ul style="list-style-type: none">• High	<ul style="list-style-type: none">• Low to Moderate	<ul style="list-style-type: none">• Low to Moderate	<ul style="list-style-type: none">• Moderate	<ul style="list-style-type: none">• High
Recommendations	<ul style="list-style-type: none">• Not Recommended	<ul style="list-style-type: none">• Not Feasible	<ul style="list-style-type: none">• Recommended	<ul style="list-style-type: none">• Feasible, Not Recommended	<ul style="list-style-type: none">• Feasible, Not Recommended

1.18



Project		
Cobble Hill Slope		
Analysis		
0- Upper Slope with 1.0m rock protection		
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	02/26/2024, 01:03:48 PM	1:350

Additional Details

Figure 2