Oscar Creek Prospect #1

Quarry Development Plan v.1.1

November 2024

Plan Maintenance and Control

Plan Document History

Version #	Section(s) Revised	Description of Revision	Prepared by	Issue Date
0	n/a	Submitted to support applications to the SLWB	K'alo-Stantec	2024-05-14
1.1	1	Updated introductory text on regulatory requirements.	K'alo-Stantec	2024-11-01

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Abbreviations

ARD	acid rock drainage
DFO	Fisheries and Oceans Canada
ECC	Environment and Climate Change
GNWT	Government of the Northwest Territories
INF	Department of Infrastructure
kM	Kilometre marker
m	metre
ML	metal leaching
the Project	Mackenzie Valley Highway Project
QDP	Quarry Development Plan
SLWB	Sahtu Land and Water Board

1 Introduction

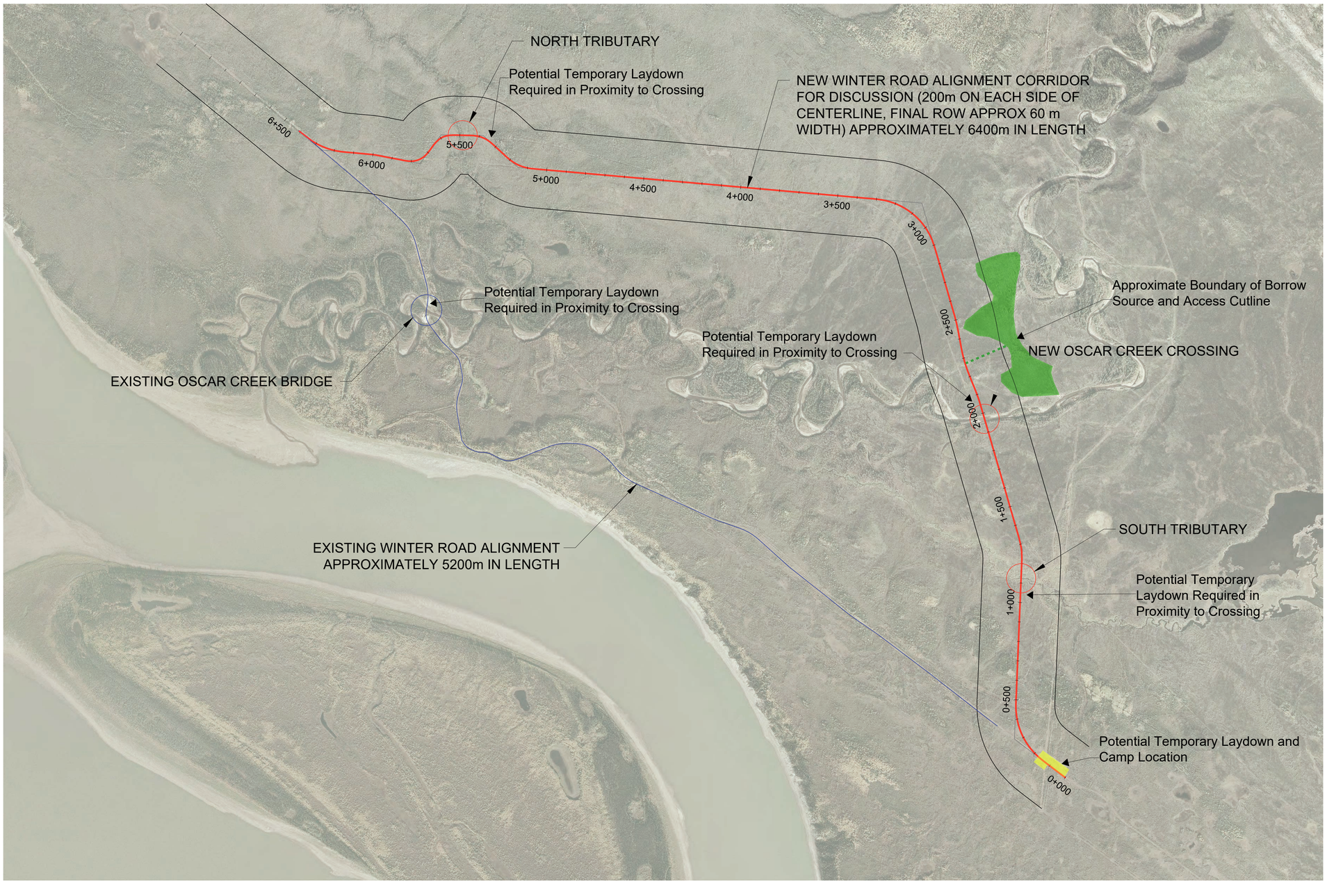
This Quarry Development Plan (QDP) for Oscar Creek Prospect 1 has been developed to support the proposed Oscar Creek Bridge Relocation Project (the Project) by the Government of the Northwest Territories (GNWT) Department of Infrastructure (INF). The Project is located in the Sahtu Region of the Northwest Territories.

The Project includes the relocation of the Oscar Creek Bridge located at KM1054.4 of the Mackenzie Valley Winter Road (MVWR) to a location 2.9 kilometres (km) to the east (upstream), and re-alignment of the MVWR from approximately KM1051 to KM1056 to connect with the new bridge location. The re-alignment requires construction of additional watercourse crossings of the North and South tributaries of Oscar Creek. The Project includes the development of the Prospect Borrow Source to obtain granular material (Figure 1-1). Prospect 1 is located on Sahtu Lands as defined in the Sahtu Dene and Métis Comprehensive Land Claim Agreement.

This QDP was developed in accordance with applicable guidelines and best practices in the Northwest Territories (NWT) and is one of several plans developed for the Project. This QDP is a requirement of, and is complementary to, terms and conditions contained in Land Use Permit S24E-006, Water Licence S24L8-003 issued to the GNWT, and terms as may be included in a Quarry Agreement with the Tulita District Land Corporation.

The primary goal of this QDP is to prevent or mitigate potential effects of quarry operations. It has been developed based on the GNWT's *Northern Land Use Guidelines - Pits and Quarries* (GNWT, 2015a).

The QDP will be reviewed and updated annually. Revisions will also be performed, as needed, to adapt and incorporate any changes related to environmental factors, pertinent project-specific changes during construction (e.g., site conditions and design modifications), the GNWT Department of Instructure (INF) and contractor practices, experiences, and policies, and include results from ongoing engagement with Indigenous Governments, Indigenous Organizations, and other affected parties, including regulatory agencies.



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Notes

Revision	By	Appd	YYYY.MM.DD

Issued	By	Appd	YYYY.MM.DD
File Name: 78486-R-P1.dwg	GE Dwn.	Dsgn.	2021.09.24 Chkd. YYYY.MM.DD

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

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Client/Project Logo

Government of Northwest Territories / Gouvernement des Territoires du Nord-Ouest

Client/Project
DEPARTMENT OF INFRASTRUCTURE
GOVERNMENT OF NORTHWEST TERRITORIES

MACKENZIE VALLEY WINTER ROAD -
- OSCAR CREEK BRIDGE RELOCATION

Title
PROJECT OVERVIEW

Project No.	Scale
113678486	1:10,000
Revision Sheet	Drawing No.
	FIGURE 1-1

1.1 Project Contacts

Key contacts include:

Primary [Contractor] contact:	**Primary GNWT-INF contact:**
[Insert Name]	Chaudary Murtaza Manager, Structures-Bridges
[Title]	Department of Infrastructure
[Company name]	Government of the Northwest Territories
[mailing address]	PO BOX 1320, 5015 49th Street, Yellowknife, NT X1A 2L9
[Phone]	(867) 767-9086 Ext. 31127
[Fax]	
[Email]	Chaudary_Murtaza@gov.nt.ca

1.2 Roles and Responsibilities

The Contractor is responsible for implementing the QDP and complying with all permits and licences issued to the GNWT-INF. Roles and responsibilities are outlined in Table 1-1.

Table 1-1 Roles and Responsibilities

Entity	Responsibility
Contractor	• Implement this QDP under the direction of the Contractor Supervisor • Continue implementing the QDP until responsibility is transferred under the authority of the GNWT
Contractor Supervisor	• Supervise the contractor team • Verify that this QDP and related plans are available onsite at all times • Verify that the measures in the QDP are adequately applied • Liaise with GNWT Inspector, GNWT Water Resources Officer and Engineer
Contractor Project Manager	• Maintain records of construction, mitigation, and worksite inspection activities • Report issues or deviations to the QDP to GNWT Project contacts and the Contract Supervisor • Oversee completion of the Project • Support the Contractor Supervisor, as required
Department of Infrastructure, Government of the Northwest Territories (GNWT INF)	• Support the Contractor with compliance to all permits and licences • Develop press releases and liaise with media directly (if required) • Liaise with GNWT Inspector, GNWT Water Resources Officer, government agencies, and public and Indigenous Governments and Indigenous Organizations (as required) • Confirm all spill reports and clean up are completed as required by authorizations

1.3 Distribution List

The QDP [will be] distributed to the following key Project contacts and regulators:

- Project Contactor and Personnel: Contractor Supervisor, Contractor Project Manager, Contractor Camp Manager, Contractor Lead Hands
- Water Resources Officer, Government of the Northwest Territories - Environment and Climate Change (GNWT-ECC)
- Inspector, GNWT-ECC
- Sahtu Land and Water Board
- Norman Wells Renewable Resources Council
- Tulita District Land Corporation
- Applicable GNWT-INF staff

1.4 Legislation, Guidelines and Policy

This plan has been developed in consideration of the applicable legislation and guidelines, including:

- Northern Land Use Guidelines - Pits and Quarries (GNWT, 2015a)
- Northern Land Use Guidelines – Access Roads and Trails (GNWT, 2015b)

1.5 Regulatory Approvals

The approvals / authorizations expected to be required for Prospect 1 are identified in Table 1-2.

Table 1-2 Approvals / Authorizations Applicable to Prospect 1

Activity	Authority	Approval / Authorization
Use of equipment, excavation, clearing	Sahtu Land and Water Board	Type “A” Land Use Permit
Access to Sahtu Lands	Tulita District Land Corporation (TDLC)	Agreement with TDLC
Material extraction from Sahtu Lands	Tulita District Land Corporation	Quarry Agreement with TDLC

2 Description of the Borrow Source

2.1 Geotechnical Report

A geotechnical assessment of Prospect 1 was completed in 2020 by Tetra Tech Canada Inc. (Tetra Tech 2020). The report of this assessment is included in Appendix A to this QDP.

Eight test pits were excavated to a depth of between 3.0 and 4.0 metres below ground surface. Test pits were logged, sampled and photographed on site as described in Section 3.4 of Appendix A. Geotechnical laboratory testing was completed as described in Section 3.5 of Appendix A. Material properties are described in Sections 3.5.1 to 3.5.4 of Appendix A.

Material encountered is predominantly sand and gravel with a considerable amount (10 to 30%) of cobble and boulder sized materials (Tetra Tech 2020). Overburden thickness ranged from 0.1 to 0.6 m.

Based on the material characteristics, granular material encountered has been recommended to be suitable for use as common fill, backfill or aggregate, with material with higher fines content recommended to be used as common fill only (Tetra Tech 2020). A selected area within the borrow source (around TP03 to TP08) was identified as having material suitable for production of granular aggregate, requiring screening, crushing and/or washing (Tetra Tech 2020).

Moisture contents encountered in test pits in the Prospect 1 borrow source were low, indicating that material can be placed and compacted in winter. Ground ice content decreased with depth (Tetra Tech 2020).

2.2 Acid Rock Drainage and Metal Leaching Potential Assessment

Material was tested for acid rock drainage (ARD) and metal leaching (ML) potential. Results showed that neutralization potential is high and minor exceedance of fluoride only above applicable guidelines. The report concludes that the ARD/ML potential of material from Prospect 1 is low.

Though no further mitigation for ARD/ML is required, the following best practices should be applied to management of pit water:

- Borrow source development will not extend below the groundwater table
- Borrow source operations will be located a minimum of 100 m from the ordinary high-water mark of any waterbody.
- Excavated spoil material will be placed at least 30 m from a watercourse.
- Material stockpiles will be kept a minimum of 30 m from a watercourse or waterbody.
- Ponded water will be directed away from watercourses.
- The pit floor will be maintained to prevent formation of a pit lake.

2.3 Material Quantities

Based on the geotechnical assessment (Tetra Tech 2020), the volume available in Prospect 1 is estimated at 185,000 cubic metres (m^3), based on developing an area of 50,000 square metres (m^2) to a depth of granular material of 3.7 m (3.8 to 4.3 m below ground surface).

The design (K'alo-Stantec 2023) estimates the following material requirements for the Project, summarized in Table 2-1. The material requirements may be reduced through use of material obtained from a cut at the approach to the North Tributary crossing.

Table 2-1 Oscar Creek Bridge Relocation Project Material Requirements (m^3) (K'alo-Stantec 2023)

	South Tributary Crossing	Oscar Creek Crossing	North Tributary Crossing	Total
Embankment Fill	7,579	17,411	7,579	**32,569**
Granular Base	521	687	520	**1,728**
Total	8,100	18,097	8,100	**34,297**

3 Site Conditions

The borrow source is located near a meander of Oscar Creek, on a glaciofluvial terrace. Areas of the borrow source have moderate to dense tree cover dominated by white spruce (*Picea glauca*) or black spruce (*Picea mariana*), and shrubs composed of dwarf birch (Betula nana), and Labrador tea (Rhododendron tomentosum, Rhododendron groenlandicum). Dwarf birch and mixed spruce stands are common in areas regenerating from recent burns. Most of the area has burned in the last 20 years. Burned areas in the LSA have shrublands or young regenerating forest and are vegetated with dwarf birch, green alder and Alaska paper birch, or regenerating mixed black and white spruce and Alaska paper birch communities.

There are no plant species listed under the *Species at Risk Act*, COSEWIC, or the *Species at Risk (NWT) Act* as At Risk, May Be at Risk or Special Concern with potential to be present in the borrow source. There are five invasive alien species with potential to be present in the borrow source: common dandelion (Plantago major), common plantain (Plantago major), timothy (Phleum pratense), lamb's quarters (Chenopodium album) and maple leaf goosefoot (Chenopodiastrum simplex).

The borrow source provides winter habitat for moose, boreal caribou, wolf, wolverine, grizzly bear, and muskox. A mammal den survey was completed by GNWT ENR Environment and Natural Resources ([ENR], now Environment and Climate Change [ECC]) on November 5, 2019. One potential den was identified more than 800 m from the borrow source. Numerous bird species have potential to use the borrow source development area during the migratory bird season. Mitigation measures for protection of wildlife and wildlife habitat are identified in Table 4-1.

Based on archaeological overview assessment (AOA) and review of previous archaeological impact assessments (AIA), there are no heritage resources within 100 m of the borrow source development area.

A traditional trail is located east of Oscar Creek and outside of the borrow source development area. Local land users may be present in the area during the winter.

4 Site Preparation

The borrow source will be accessed by an approximately 220 m access trail, which will connect to a project winter road being constructed to support the relocation of the Oscar Creek Bridge, and which will become the new right-of-way for the Mackenzie Valley Winter Road. The access trail will be cleared to 10 m width. The areas of the borrow source to be developed will be stripped for development.

Clearing must be completed during the period between September 1 and April 30 only, to protect migratory birds and bats. Any clearing completed in April must confirm no presence of raptor stick nests, as determined by a qualified person.

Trees more than 12 cm diameter at breast height should be limbed and cut to 2 m lengths, and stacked for community salvage in a safe area accessible by the Mackenzie Valley Winter Road. Other brush and trees are to be windrowed at the edge of the clearing. Organic soil and unusable overburden will be stockpiled for future reclamation.

A topographic survey is to be completed once stripping has been completed.

Mitigation measures to protect the environment during site preparation are identified in Table 4-1.

Table 4-1 Mitigation Measures Applicable to Site Preparation

Potential Effect	Mitigation Measure
Clearing and equipment operation causes permafrost degradation, rutting, ponding and soil compaction	• Activities will be restricted to workspaces and access roads. Prior to the start of construction, the boundaries of the work area, staging areas and access roads will be staked and/or flagged. • Clearing of new areas will be completed when the ground is frozen to limit disturbance to soils and permafrost. • Clearing will not be conducted during high rainfall or runoff events. • Trees will be felled toward the cleared areas wherever possible. • Postpone soil salvage during wet weather or high winds to prevent erosion and/or damage to the soil structure. • A minimum of 10 cm of packed snow will be maintained on winter travel surfaces. • Construction equipment will be operated on designated winter roads or constructed embankment. Construction will be avoided on highly saturated soil (primarily during freshet) where practical or suitable ground equipment will be utilized to prevent unnecessary soil damage through rutting, etc. • Surface disturbance to undisturbed terrain will be minimized as much as possible. Project work will be confined to the Project Area.

Potential Effect	Mitigation Measure
Clearing causes direct loss of wildlife habitat or mortality to wildlife	• Removal of vegetation will be limited to the width of the ROW and workspaces. • Vegetation clearing will be completed outside the migratory bird nesting period of May 4 to August 22 (Zone B8; ECCC 2023, GNWT 2020) and will consider the Critical Breeding Periods for Raptor Species of the Northwest Territories (Shank and Poole 2016) to avoid disturbing species that breed prior to the migratory bird nesting periods. • Vegetation clearing will be completed outside the core maternity roosting period for bats of May 1 to August 31. If habitat tree removal or general tree clearing is required during the maternity roosting period, a qualified biologist will review the trees to make a determination on bat occupancy before removal. • Breaks of approximately 10 m in width should be left in the windrow at approximately 300 m intervals to reduce blockage of wildlife movement. • Travel of construction vehicles will be confined to existing infrastructure roads and trails as much as possible to avoid disturbing vegetated areas. • Pre-construction raptor stick nest surveys and bear den surveys will be completed, if necessary, pending consultation with GNWT- ECC. • Organic material will be stockpiled for use during reclamation.
Clearing causes erosion and sedimentation, leading to degradation of water quality	• The Erosion and Sedimentation Control Plan will be followed. • Clearing will not occur within 30 m of any waterbody. • Excavated spoil material will be placed at least 30 m from a watercourse. • Soil stripping will be conducted under the guidance of a qualified environmental or engineering professional. • Soils stripping will be postponed on borrow areas on coarse textured soil during windy conditions to reduce deterioration of soil conditions.
Use of equipment introduces invasive alien plant species	• Equipment originating from outside of the Northwest Territories will be cleaned prior to mobilization to avoid introduction of invasive species.
Public and Worker Safety	• Signage and physical barriers will be used to identify areas of active construction and to provide separation between workspaces and the public use areas. • Access to construction areas will be limited to Project personnel only for safety reasons.

5 Pit Operation

The borrow source development plan is illustrated in Figure 5-1. Borrow source development is to adhere to the following objectives:

- Reduce development disturbance
- Reduce direct and indirect (sensory) disturbance to wildlife
- Manage adverse effects of permafrost degradation
- Protect water quality in Oscar Creek
- Protect public and worker safety

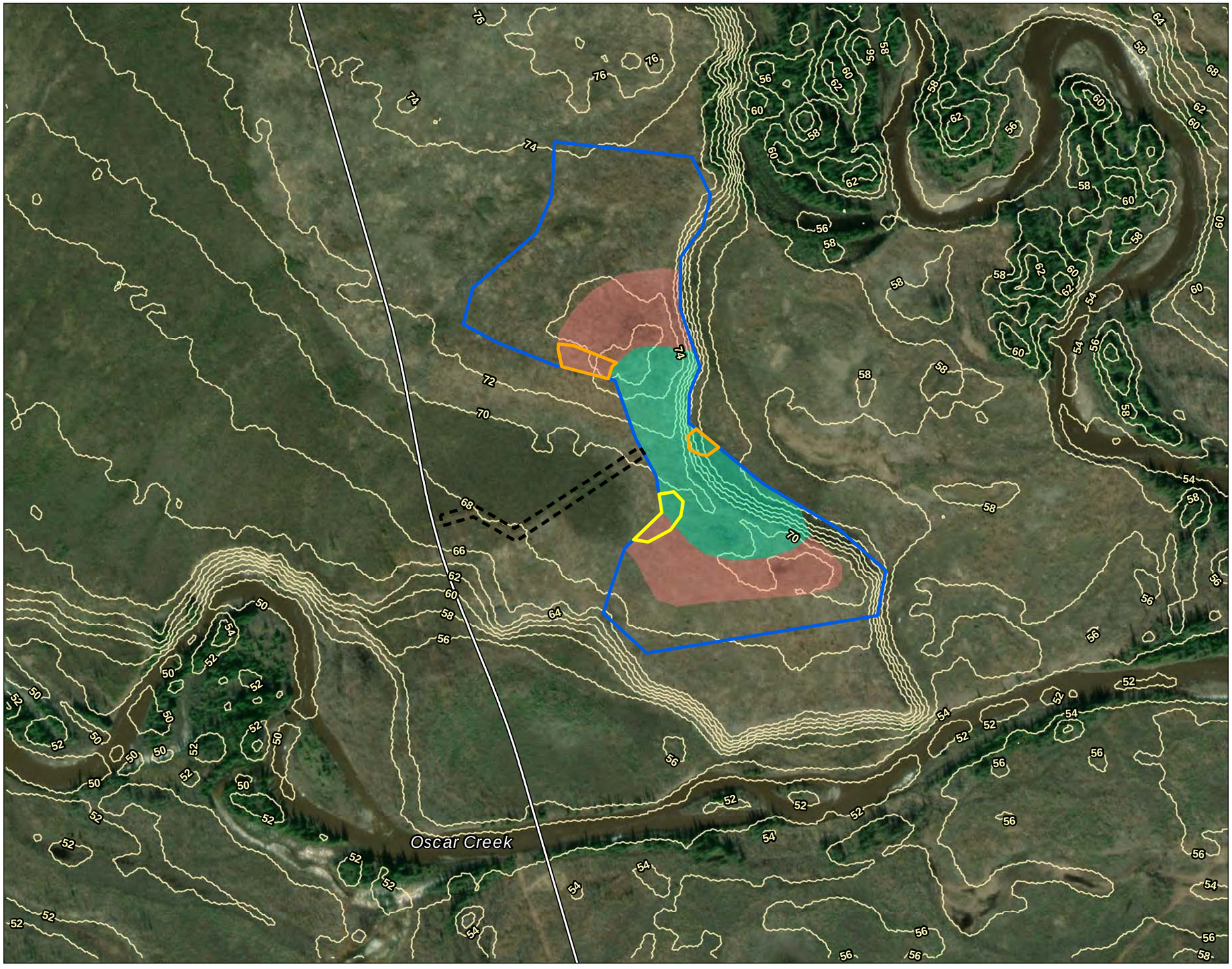
The central areas of the borrow source are likely to be developed first, in accordance with the test pit results reported in Tetra Tech (2020). Additional areas to the north and south may be developed if the need arises.

Material is expected to be able to be excavated using mechanical means (i.e., without use of explosives), due to its low moisture content. **Use of explosives is discouraged**. Should use of explosives be needed, mitigation measures applicable to wildlife and fish and fish habitat protection will be followed, and the appropriate permits will be obtained from NWT regulators.

Material will be excavated to a depth of up to approximately 4.0 m and screened on site. Sorted material will be stockpiled at identified locations for removal and use at the construction sites. Material suitable for crushing (if applicable), will be set aside.

During winter operations, water management is not applicable. Prior to closure of the borrow source at the end of the construction season (April 1), the pit floor will be graded and sloped to prevent ponding within the pit floor, and to direct passive drainage towards the west, away from Oscar Creek.

Mitigation measures for environmental protection during borrow source operation are identified in Table 5-1.



K'alo-Stantec

Legend

- MVWR re-alignment
- Access
- Devleopment Extent
- Potential Organic Stockpile Area
- Potential Stockpile Area
- First Stage Development
- Additional Development Area
- Ground surface elevation contours (masl)

Note: Interpretation of this Figure is dependent on coloured symbols. View in colour.

N

0 40 80 Metres

(At original document size of 11x17)
1:4,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 9N
2. Base Data Sources: Government of NWT, Government of Canada
3. Imagery Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Project Location
Northwest of Norman Wells, NWT

Prepared by ACampigotto on 2023-10-24
Technical Review by EB on 2023-10-24

Client/Project 113678486
Government of Northwest Territories
Oscar River Bridge Relocation Project
Prepared by: K'alo-Stantec Limited

Figure No.
5-1

Title
Prospect 1 Development Plan

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Table 5-1 Mitigation Measures Applicable to Borrow Source Operation

Potential Effect	Mitigation Measure
Excavation causes ponding and permafrost degradation	• Borrow source development will not occur below the groundwater table • If ice-rich permafrost is identified during excavation activities, suitable measures will be taken to protect permafrost and ground ice encountered during material extraction activities.
Borrow source development leads to erosion	• Best management practices for erosion control will be implemented according to the Erosion and Sedimentation Control Plan. • Erosion and sedimentation control measures will be maintained until disturbed areas are revegetated or until such areas have been permanently stabilized by other effective measure. • Borrow source floors will be sloped to reduce ponding of water.
Erosion and sedimentation causes degradation of water quality	• Only material with low acid rock drainage (ARD) and metal leaching (ML) potential will be used for the Project. • Borrow source operations will be located a minimum of 100 m from the ordinary high-water mark of any waterbody. • Excavated spoil material will be placed at least 30 m from a watercourse. • Ponded water and runoff will be directed away from watercourses. • Material stockpiles will be kept a minimum of 30 m from a watercourse or waterbody with the appropriate erosion control mitigation in place to prevent sediment from entering a watercourse or waterbody.
Borrow source operations cause sensory disturbance to wildlife and increase mortality risk	• Blast mats will be used when/if blasting • Caribou and moose will have the right of way in all project areas. • Borrow development activities will adhere to the applicable recommended setbacks and timing restrictions outlined in the WMMP.
Blasting causes death of fish	• Blasting will not occur within 100 m of fish-bearing waterbodies such that instantaneous pressure will be less than 50 kilopascals (kPa) where fish may be present and particle velocity will be less than 13 mm/s (millimetres/second) near a spawning bed where eggs or larval fish may be present.

Potential Effect	Mitigation Measure
Contamination due to accidental releases / spills	• Spill contingency measures will be implemented in accordance with the Spill Contingency Plan. • Mobile equipment will be refueled more than 100 m away from the bank ordinary highwater mark of a watercourse or waterbody. • Emergency spill response kits will be kept in vehicles and at fuel storage locations. • Fuel handling and refueling will be in accordance with an Operating Procedure to be included in the Spill Contingency Plan. • Fuel will be stored in containers with secondary containment capable of containing 110% of the largest container. • Equipment such as vehicles, generators and pumps will have secondary containment installed capable of containing fuel drips or leaks during operations and refueling. • All equipment stationary for more than 2 hours will have appropriately placed drip trays. • Machinery will be maintained and regularly inspected for fuel, oil, or other fluid leaks. Machinery found to be leaking will be withdrawn from service until repaired.
Public and worker safety	• Quarry design, development and closure will take into account public safety. • Public access to the active borrow source and associated access roads will be restricted. • Access to construction areas will be limited to Project personnel only for safety reasons.

6 Closure and Reclamation

The borrow source will be progressively reclaimed at the end of each construction season. Areas not needed for in the subsequent year for additional material or workspace within the borrow source will be reclaimed by replacing organic material.

The objective of **progressive site closure** will be to reduce risks to wildlife and people, and to mitigate for permafrost degradation and erosion.

The objective of **final site closure** will be to approximate pre-development conditions to the extent possible, and to reduce risks to the environment from permafrost degradation and erosion.

Table 6-1 Closure and Reclamation Commitments

Closure Phase	Closure and Reclamation Commitment
Progressive site closure: at the end of each construction season	• Equipment, wastes and contaminated soils will be removed at the end of each construction season. • Stockpiles will be left at slope of no steeper than 1:1, and shall be located in an area of positive drainage. • Excavations will be contoured at the end of each construction season to reduce steep slopes. • Ice-rich soils or materials that are susceptible to physical erosion encountered during excavation will be covered to reduce permafrost degradation. • Organic material stockpiled during stripping will be re-applied to areas not needed for ongoing borrow source operations, where possible.
Final site closure: at the end of the project	• Equipment, wastes and contaminated soils will be removed once construction is completed. • Stockpiles will be removed / graded • All temporary erosion protection measures will be removed. • Temporary access roads, quarries and workspaces not needed after construction will be closed and allowed to revegetate naturally. • Equipment, wastes and contaminated soils will be removed once construction is completed. • Organic material will be stockpiled and re-applied where possible. • A final survey will be completed.

7 Monitoring and Reporting

During operation of the borrow source, all material quantities removed shall be recorded. At the end of the project, a final survey will be completed to confirm material quantities removed.

The site will be visited once during the summer following each construction season to observe performance of environmental protection measures and overall site stability.

A final inspection of the site to confirm that all materials have been removed and the site is acceptable to the Inspector.

A final plan will be submitted in accordance with the Land Use Permit.

8 References

GNWT (Government of Northwest Territories). 2015a. Northern Land Use Guidelines: Pits and Quarries. GNWT. Yellowknife, NT. Available at: https://www.lands.gov.nt.ca/sites/lands/files/resources/nlug_-_pits_and_quarries_-_16_september_2015.pdf. Accessed August 2020.

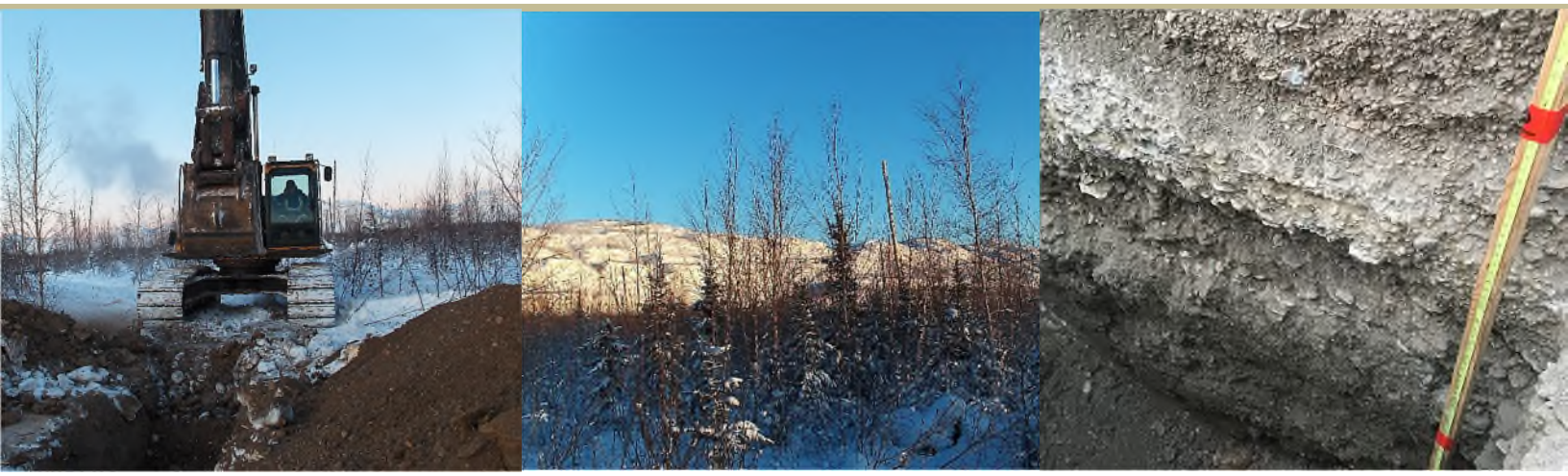
GNWT. 2015b. Northern Land Use Guidelines: Roads and Trails. GNWT. Yellowknife, NT. Available at: https://www.gov.nt.ca/sites/ecc/files/resources/nlug_roadstrails_2015_english_16_sept_2015.pdf Accessed August 2021.

K'alo-Stantec. 2023. Project Description Report for the Oscar Creek Bridge Relocation Project. Submitted to the Sahtu Land and Water Board.

Tetra Tech 2020. Oscar Creek Granular Prospects Geotechnical Assessment Report Oscar Creek, Northwest Territories. Submitted to Government of the Northwest Territories Department of Infrastructure, October 19, 2020. 137 pp.

Appendix A – Geotechnical Report

Oscar Creek Granular Prospects
Geotechnical Assessment Report
Oscar Creek, Northwest Territories



PRESENTED TO

Government of the Northwest Territories
Department of Infrastructure

OCTOBER 19, 2020
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FILE: 704-ENG.YARC03255-01

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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Government of the Northwest Territories, Department of Infrastructure (GNWT) to conduct a granular investigation and assessment of three selected granular prospects in support of the Oscar Creek Bridge (OCB) Relocation project, approximately 28 km northwest of Norman Wells, Northwest Territories (NT). The project involves relocating the existing OCB at km 1054 of the Mackenzie Valley Winter Road (MVWR) and constructing two new associated tributary crossings (Tributary 1 and Tributary 2) along a realignment of the winter road between km 1051 and km 1056. The objective of the granular investigation program was to assess three undeveloped granular prospects to ensure suitable granular materials and aggregate are available to the project for crossings and highway construction. This report presents data collected during the investigation including a summary of the subsurface conditions, testpit logs, laboratory test results, estimated material quantities, and assessments of each potential granular source.

The granular investigation program was completed between January 11 to 13, 2020. Testpit logging, sampling, and onsite supervision was completed by Atif Rafiq, from Tetra Tech's Yellowknife office. Construction of site access and excavation of the testpits was completed by HRN Contracting Ltd. of Norman Wells, NT, as a subcontractor to Tetra Tech. Initial site layout and survey support for the project was provided by Sub-Arctic Geomatics Ltd. from Yellowknife, NT. Onsite environmental and wildlife monitoring was provided throughout the project by the Norman Wells Renewable Resource Council. All work was carried out in accordance with the project's Land Use Permit S18X-004, obtained by the GNWT.

Three granular prospects were investigated and a total of 22 testpits were excavated using a John Deere 270D LC excavator. Locations of each testpit were staked by the survey team prior mobilizing to site. Testpits were excavated to the base of the target deposits or to the maximum reach of the excavator (approximately 4.5 m below grade). Excavations were then measured with a graduated metric rod and photographed. Testpits were logged, sampled, and photographed at each excavation location to ensure accurate classification of the granular materials and ground ice encountered. As each testpit was excavated, representative soil samples were obtained from each stratigraphic layer for offsite geotechnical and geochemical laboratory testing. Samples were typically collected from the backwall of the testpit, using the excavator's bucket, and were retrieved once brought to the surface.

Ground conditions at all three prospects generally consist of glaciofluvial and fluvial deposits of sand and gravel underlain by sedimentary bedrock and overlain by organic topsoils. Glaciofluvial materials are sediments deposited by the meltwater from the front of a glacier (outwash), usually in patterns similar to that of braided streams. Fluvial materials are those deposited by flowing water in modern channels such as Oscar Creek. Sedimentary bedrock, expected to be underlying the overburden materials, was not encountered in any of the testpits excavated. Surface organics generally comprised of topsoil and are not suitable materials for construction but could be used in non-engineering applications (i.e., landscaping). Organic layer thicknesses were relatively thin at all three prospect sites ranging from 0.1 m to 0.4 m thick.

The three types of granular materials sought for the project and their criteria were presented in the request for proposal: common fill, granular backfill, and granular aggregates. Overburden materials suitable for common (borrow) fill were identified in all three granular prospects. All material layers investigated would be acceptable for use as common fill, excluding the surface organics. The well-graded glaciofluvial sands and gravels would be better utilized for engineered materials such as granular backfill or aggregate, where required.

Glaciofluvial sands and gravels, suitable for granular backfill, were encountered in all three prospect locations. The deposits in Prospects 2 and 3 generally consist of well-graded gravels with components of coarse-grained sands up to depths of 4.5 m. Prospect 1 predominantly consists of well-graded gravels and sands up to depths of 4.0 m.

Prospect 3 is recommended as the best source for granular backfill due to having the lowest estimated proportions of fines and oversized materials.

Findings from the investigation program show select areas in each prospect suitable for extracting and processing granular aggregates. All three prospects yielded Los Angeles abrasion losses below 50%, meeting the material criteria; however, crush (fracture) count results showed several areas within each prospect that did not meet the minimum requirement of 50%. Based on this, a select area within Prospect 1 is the only recommended material source for granular aggregate. Material extraction should focus around testpits PR1-TP03 to PR1-TP08 as these locations had favourable crush counts.

Granular material quantities were estimated by delineating boundaries for each granular prospect based on a desktop review of air photos, historical borehole logs, and satellite imagery of the Oscar Creek area. Combining this information with results from the testpitting program, volumes were calculated based on a 50 m radius limit from each suitable testpit. Testpit findings are assumed to be representative of the subsurface within this radius and in areas may extend well beyond the 50 m radius. It is estimated that the total quantity of available granular materials from the sites investigated is approximately 465,000 m^3, including 185,000 m^3 in Prospect 1, 60,000 m^3 in Prospect 2, and 220,000 m^3 in Prospect 3. The development of granular prospects should follow recommendations provided in the GNWT's *Northern Land Use Guidelines: Pits and Quarries* (GNWT 2015).

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ABA	Acid-Base Accounting
ARD	Acid Rock Drainage
ASTM	American Society for Testing and Materials
CCME	Canadian Council of Ministers of the Environment
CSA	Canadian Standards Association
GNWT	Government of the Northwest Territories, Department of Infrastructure
HRN	HRN Contracting Ltd.
ha	Hectare
km	Kilometres
m	Metre
mm	Millimetre
ML	Metal Leaching
MVWR	Mackenzie Valley Winter Road
NAD83	North American Datum 1983
NAG	Non-Acid Generating
NPR	Neutralization Potential Ratios
NT	Northwest Territories
OCB	Oscar Creek Bridge
SFE	Shake Flask Extraction
Tetra Tech	Tetra Tech Canada Inc.
UTM	Universal Transverse Mercator

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of the Northwest Territories and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the Government of the Northwest Territories, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix A.

1.0 INTRODUCTION

1.1 General

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Government of the Northwest Territories, Department of Infrastructure (GNWT) to conduct a granular investigation and assessment of three selected granular prospects in support of the Oscar Creek Bridge (OCB) Relocation project, approximately 28 km northwest of Norman Wells, Northwest Territories (NT). The project involves relocating the existing OCB at km 1054 of the Mackenzie Valley Winter Road (MVWR) and constructing two new associated tributary crossings (Tributary 1 and Tributary 2) along a realignment of the winter road between km 1051 and km 1056.

The objective of the granular investigation program was to assess three undeveloped granular prospects to ensure suitable granular materials and aggregate are available to the project for crossings and highway construction. This report presents data collected during the investigation including a summary of subsurface conditions, testpit logs, geotechnical and geochemical laboratory test results, estimated quantities, and assessments of each potential source.

Tetra Tech also completed a geotechnical investigation program for the project's three potential watercourse crossings: Oscar Creek, Tributary 1, and Tributary 2. The results and findings from this program are presented in a separate Tetra Tech data report titled *Oscar Creek Bridge Relocation Geotechnical Investigation Data Report* (Tetra Tech 2020a). Geotechnical recommendations for the OCB and its two associated crossings are presented in Tetra Tech's recommendations report titled *Oscar Creek Bridge Relocation and Tributary Crossings Geotechnical Recommendations Report* (Tetra Tech 2020b).

1.2 Project Description

The MVWR is a 483 km long public winter road that connects the Sahtu Region of the Northwest Territories. It extends from Wrigley (km 690) to Fort Good Hope (km 1173). The winter road is constructed and maintained by the GNWT on an annual basis and typically operates from late January to mid-March. One of the major crossings along the MVWR between Norman Wells (km 1026) and Fort Good Hope (km 1173) is at Oscar Creek near km 1054. The project involves potentially relocating the existing OCB upstream of the current location and realigning a section of the MVWR between km 1051 and km 1056.

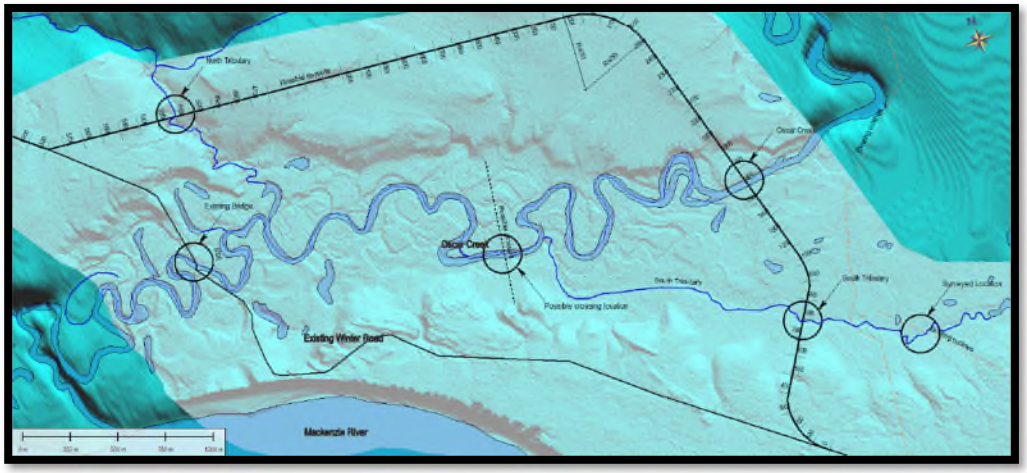

Figure A: Proposed Oscar Creek Bridge Relocation.

The project area is located northeast of the existing Oscar Creek crossing, at approximate coordinates of 575,400 m Easting and 7,258,600 m Northing in Zone 9 of the Universal Transverse Mercator (UTM) Grid. The horizontal datum for the project is the North American Datum 1983 (NAD83), CSRS (2010). The project location is shown in Figure 1.

The granular investigation program was completed between January 11 to 13, 2020. Testpit logging, sampling, and onsite supervision was completed by Atif Rafiq, from Tetra Tech's Yellowknife office. Construction of site access and excavation of the testpits was completed by HRN Contracting Ltd. (HRN) of Norman Wells, NT, as a subcontractor to Tetra Tech. Initial site layout and survey support for the project was provided by Sub-Arctic Geomatics Ltd. from Yellowknife, NT. Onsite environmental and wildlife monitoring was provided throughout the project by the Norman Wells Renewable Resource Council. All work was carried out in accordance with the project's Land Use Permit S18X-004, obtained by the GNWT.

1.3 Scope of Work

Tetra Tech's scope of work involved conducting a granular investigation to assess and quantify granular resources at each granular prospect. Based on Tetra Tech's proposal (dated February 21, 2019) the following tasks were undertaken for each prospect site:

- Review available background information including historical borehole logs, air photos, and other imagery;
- Subcontract a team to provide site access, testpitting, and survey support during the project;
- Undertake testpitting at three prospective granular sources to assess the availability of granular material for the project, including 33,000 m^3 of Common Fill and 700 m^3 each of Granular Class 1 and Class 3 materials;
- Describe surficial and subsurface conditions encountered during the granular investigation and prepare testpit logs;
- Complete geotechnical and geochemical laboratory testing on samples collected from the investigation program including moisture contents, particle size distributions, petrographic analyses, and Los Angeles abrasion testing as well as metal leaching (ML) and acid rock drainage (ARD) testing; and
- Prepare a geotechnical assessment report summarizing the investigation results, including testpit locations, logs, laboratory results, site stratigraphy, volume estimations, aggregate assessments, and prospect development recommendations.

2.0 SITE DESCRIPTION

Oscar Creek drains a large catchment area that extends from the Discovery Ridge mountain range. The large watershed results in substantial stream flows through the summer and fall, particularly during spring freshet. In winter, there is continuous (perennial) flow of water under the ice. The creek features numerous active flood plains along the inner bends of its meanders that are composed of alluvial sands and gravels. Exposed bars of alluvial materials are also scattered throughout the stream channel. The surrounding terrain consists of densely vegetated lowlands with occasional swampy areas. All three prospects were within an area previously impacted by forest fires.

2.1 Regional Geology

Oscar Creek lies within the Mackenzie Plain, an accessible mid-section within the Mackenzie Valley that extends north and south of Norman Wells. Mackenzie Plain overlies the southern peel trough between the arc of the Cordillera (Mackenzie Mountains) to the west and the flank of the Keele Arch (Franklin Mountains) to the east. A

westward thickening wedge of Cretaceous-Tertiary strata overlies a broad Lower Paleozoic syncline with a gently dipping eastern limb and a more steeply dipping western limb rising to outcrop as the front ranges of the Mackenzie Mountains. Lower Paleozoic strata outcropping in the Franklin Mountains border the peel trough to the east.

The trough widens to the northwest where the Mackenzie Mountains swing westwards. The Mackenzie Foldbelt in this northern area extends beneath Mackenzie Plain. To the south, the trough becomes increasingly constricted as the Franklin Mountains reach a terminus close to the Mackenzie Mountain front at about 64°N. The entire region has been affected by compressional tectonics, expressed as long wavelength folds (especially in the north), bedding-parallel detachments (beneath Mackenzie Plain), and thrust faults outcropping in the Franklin Mountains.

2.2 Permafrost Conditions

The project area is located within the extensive discontinuous permafrost zone (NRC 2009). The extensive discontinuous zone indicates that permafrost is commonly present over 50% to 90% of the area. Permafrost in this zone is only expected in undisturbed, poorly drained areas with organic cover. Where present, the average temperature of the permafrost is expected to be very close to 0°C. The seasonal active layer in the area is estimated to be up to 3.0 m thick (EBA 1974).

Frozen ground conditions, below the depth of seasonal freezing, was identified in several testpits during the granular prospects investigation. Other recent geotechnical investigations by Tetra Tech at the proposed Oscar Creek and Tributary 2 crossings, found frozen conditions in four out of the five boreholes drilled. Measured ground temperatures at both of these locations indicate that the permafrost is warm with temperatures just below freezing between -0.1°C and -0.9°C (Tetra Tech 2020a).

2.3 Climate

Environment Canada operates a meteorological station at Norman Wells with records available from 1944 to today. The mean annual air temperature for the period of record is -5.6°C, which has been gradually increasing since first recorded. The temperature warming trend was analyzed using linear interpolation of the average annual temperature data between 1944 to 2019. The average rate of increase has been 0.03°C/year over the period of record, with the biggest increase occurring between the months of October to April. Over the past 30 years, the mean annual air temperature has been -4.8°C.

For the period of record, the freezing index has decreased by about 12.8°C-days/year, while the thawing index has increased by about 2.6°C-days/year. Using the published data from Environment Canada, it is determined that Norman Wells has an average freezing index of 3,542°C-days/year and an average thawing index of 1,816°C-days/year over the past 30 years (1990 to 2019). The freezing index has decreased by about 31°C-days/year and the thawing index has increased by about 4°C-days/year over the past 30 years, though there is a lot of variability in the data. The mean annual total precipitation over the period of record (1944 to 2019) is about 313 mm/year.

3.0 GRANULAR PROSPECTS INVESTIGATION

3.1 Site Access

The project area, northeast of the proposed OCB, has many existing cutlines that were established for past seismic and granular resource investigations. Older cutlines were used, where possible, to access each prospect. The main south-north trail from the MVWR splits in two directions near the Tributary 1 crossing. The west cutline leads to the proposed OCB crossing location and Prospect 1 while the other cutline continues north to Prospects 2 and 3.

HRN provided slashing crews to establish cutline access to each prospect. Cutlines were leveled and compacted with a tracked bulldozer to allow access for testpitting equipment and pickup trucks.

3.2 Testpit Locations

Three granular prospects were investigated and a total of 22 testpits were excavated. Testpit locations are shown on plan views for each prospect in Figures 2, 3, and 4. Testpit coordinates and elevations are shown in the Tables section and summarized in Table 3-1 below.

Table 3-1: Testpit Information Summary

Prospect No.	Testpit No.	Coordinates [UTM NAD83 Z9, CSRS (2010)]		Ground Surface Elevation (m)	Excavated Depth (m)
		Northing (m)	Easting (m)		
1	PR1-TP01	7,258,088	575,262	71	4.0
	PR1-TP02	7,258,111	575,333	66	4.0
	PR1-TP03	7,258,131	575,395	67	3.0
	PR1-TP04	7,258,164	575,325	65	4.0
	PR1-TP05	7,258,409	575,189	71	4.0
	PR1-TP06	7,258,218	575,218	72	4.0
	PR1-TP07	7,258,370	575,152	74	4.0
	PR1-TP08	7,258,321	575,197	72	4.0
2	PR2-TP01	7,259,615	576,659	101	4.0
	PR2-TP02	7,259,603	576,601	99	4.0
	PR2-TP03	7,259,639	576,578	102	4.2
	PR2-TP04	7,259,602	576,527	104	4.5
	PR2-TP05	7,259,636	576,502	104	4.2
3	PR3-TP01	7,259,927	575,127	111	4.2
	PR3-TP02	7,259,947	575,055	107	4.0
	PR3-TP03	7,260,013	575,172	109	4.0
	PR3-TP04	7,260,023	575,071	105	4.5
	PR3-TP05	7,260,844	575,345	116	4.0
	PR3-TP06	7,260,908	575,336	117	4.5
	PR3-TP07	7,260,890	575,309	117	3.5
	PR3-TP08	7,260,947	575,291	114	4.5
	PR3-TP09	7,260,981	575,247	112	4.0

Following the completion of excavating, the testpit locations were recorded with a handheld Garmin global positioning system (GPS) receiver. The testpit coordinates as well as ground surface and completion elevations are presented on the testpit logs in Appendix B.

3.3 Testpitting Methodology

Testpitting was completed using a John Deere 270D LC excavator, owned and operated by HRN, at all three granular prospects. Locations of each testpit were staked by the survey team prior mobilizing to site. Testpits

were excavated to the base of the target deposits or to the maximum reach of the excavator (approximately 4.5 m below grade). Excavations were then measured with a graduated metric rod and photographed.

Following completion, each testpit was backfilled with the excavated material and nominally compacted and shaped by bucket to match the original ground surface. In locations where topsoil or other organics were present, the organic material was stockpiled separately during testpitting was replaced over the backfilled excavation. Backfill was mounded over the areas of the excavation to compensate for settling of the replaced soil.

3.4 Geotechnical Logging and Sampling

Testpits were logged, sampled, and photographed at each excavation location to ensure accurate classification of the granular materials and ground ice encountered. The thickness of each stratigraphic layer was measured and recorded during the excavation of each testpit.

Granular materials were logged according to the Modified Unified Soil Classification system and Tetra Tech's Work Method *WM4400 – Geotechnical Soil Classification*. Frozen state of the soils were described according to the NRCC Ground Ice Classification system and Tetra Tech's Work Method *WM4102 – Logging of Perennially Frozen Soils and Ground Ice for Engineering Purposes*. Geotechnical logging consisted of identifying the following parameters:

- Soil Composition;
- Particle Size;
- Angularity/Shape;
- Moisture;
- Consistency;
- Plasticity;
- Colour;
- Odour;
- Frozen/Unfrozen State; and
- Ground Ice Description.

Testpit logs and a summary of the classification systems are included in Appendix B. Select photographs of recovered samples are included in the Photographs section of this report.

As each testpit was excavated, representative soil samples were obtained from each stratigraphic layer for offsite laboratory analysis. A minimum of five samples per 100,000 m^3 of estimated borrow fill were collected for testing. Samples were typically collected from the backwall of the testpit, using the excavator's bucket, and were retrieved once brought to the surface. The disturbed bulk samples were then placed in plastic bags, double-bagged for moisture preservation, and transported to Tetra Tech's materials laboratory in Yellowknife for geotechnical laboratory testing.

3.5 Geotechnical Laboratory Testing

Geotechnical laboratory testing was completed in Tetra Tech's Yellowknife and Edmonton laboratories to gauge the material's suitability for use as granular fill and aggregate. The geotechnical laboratory testing program included the following:

- Moisture Contents;
- Particle Size Analyses (Sieves) with Crush (Fracture) Counts;
- Los Angeles Abrasion of Small-Size Coarse Aggregates; and
- Petrographic Analyses of Coarse Aggregates.

A summary of all geotechnical laboratory testing completed for the program is presented in the Tables section of this report and shown on the testpit logs in Appendix B. Detailed laboratory results for all geotechnical testing are available in Appendix C.

3.5.1 Moisture Contents

Moisture contents were determined on 50 soil samples from all 22 testpits and were tested in accordance with ASTM D2216. Moisture content results are included on the geotechnical laboratory test results summary in the Tables section and are presented on the testpit logs in Appendix B.

3.5.2 Particle Size Analyses with Crush Counts

Particle size analyses (sieves) were performed on selected samples to characterize the granular materials sampled throughout the investigation. Thirty-one sieve analyses were completed in accordance with ASTM D422 and C136. Crush (fracture) counts for two faces were also determined on 28 samples during the analyses. Sieve test results and crush counts are summarized in Table 3-2 below.

Table 3-2: Particle Size Analyses Test Results

Prospect No.	Testpit No.	Depth (m)		Moisture Content (%)	Fine Grained (%)		Coarse Grained (%)			Crush Count (2 Faces) (%)
		From	To		Clay	Silt	Sand	Gravel	Cobbles	
1	PR1-TP01	1.0	4.0	4.4	1		59	40	0	14
	PR1-TP02	0.4	2.0	11.4	4		86	10	0	31
	PR1-TP03	0.4	3.0	4.7	15		55	30	0	77
	PR1-TP04	0.4	4.0	2.1	2		27	71	0	68
	PR1-TP05	1.0	2.0	4.1	1		81	18	0	61
	PR1-TP06	2.8	4.0	3.4	6		59	35	0	66
	PR1-TP07	1.0	4.0	2.8	5		34	61	0	75
	PR1-TP08	1.5	4.0	3.1	4		52	44	0	66
2	PR2-TP01	0.4	2.0	9.3	16		6	78	0	21
		2.0	4.0	8.2	29		35	36	0	51
	PR2-TP02	0.8	1.5	6.0	9		14	51	26	97
		1.5	4.0	3.9	5		40	55	0	33
	PR2-TP03	1.0	1.8	5.5	9		19	72	0	90
		1.8	4.2	4.9	8		22	61	9	92
	PR2-TP04	1.2	4.5	4.1	3		57	40	0	26
	PR2-TP05	1.6	4.2	5.3	6		47	47	0	42

Table 3-2: Particle Size Analyses Test Results

Prospect No.	Testpit No.	Depth (m)		Moisture Content (%)	Fine Grained (%)		Coarse Grained (%)			Crush Count (2 Faces) (%)
		From	To		Clay	Silt	Sand	Gravel	Cobbles	
3	PR3-TP01	1.4	4.2	4.1	2		22	76	0	-
	PR3-TP02	1.0	1.3	18.0	66		31	3	0	56
		1.3	4.0	4.5	5		32	63	0	16
	PR3-TP03	0.5	1.6	2.5	2		23	75	0	31
		1.6	4.0	2.9	2		24	74	0	19
	PR3-TP04	0.6	4.5	3.7	2		18	80	0	-
	PR3-TP05	0.4	2.0	3.2	2		17	81	0	71
		2.0	4.0	4.1	1		35	64	0	9
	PR3-TP06	2.0	3.5	4.6	4		76	20	0	82
		3.5	4.5	2.7	1		26	73	0	10
	PR3-TP07	0.6	3.5	6.2	5		22	73	0	-
	PR3-TP08	1.2	3.8	5.2	4		60	36	0	87
		3.8	4.5	3.2	3		27	70	0	81
	PR3-TP09	1.0	2.0	3.2	2		23	75	0	83
		2.0	4.0	4.8	4		68	28	0	88

It should be noted that particle size analyses were typically undertaken only on samples with particle sizes less than 20 mm in diameter. All gradation estimates over 20 mm in diameter are based on visual field observations and may not be an accurate representation.

3.5.3 Los Angeles Abrasion

Los Angeles Abrasion testing of small-size coarse aggregates was performed on combined samples from each granular prospect. Testing was completed in accordance with ASTM C131 and results are summarized in Table 3-3 below.

Table 3-3: Los Angeles Abrasion Test Results

Prospect No.	Combined Sample No.	Mass of Indicated Sizes (g)				Loss (%)
		40 – 25 mm	25 – 20 mm	20 – 12.5 mm	12.5 – 10 mm	
1	2 – 16	1,260.7	1,252.4	1,249.8	1,244.2	30
2	18 – 30	1,241.3	1,248.8	1,253.0	1,252.2	33
3	34 – 52	1,264.4	1,258.9	1,250.5	1,243.1	31

3.5.4 Petrographic Analyses

Petrographic Analyses of coarse aggregates were performed on combined testpit samples from each granular prospect. Analyses were completed in accordance with Canadian Standards Association (CSA) A23.2-15A and results are summarized below in Table 3-4.

Table 3-4: Petrographic Analyses Test Results

Prospect No.	Combined Sample No.	Petrographic Number				
		25 – 19 mm	19 – 12.5 mm	12.5 – 9.5 mm	9.5 – 4.75 mm	Weighted Average
1	2 - 16	Not Tested	141	133	143	140
2	18 - 30	Not Tested	Not Tested	129	119	125
3	34 - 52	205	234	185	164	204

3.6 Geochemical Characterization Testing

Preliminary geochemical characterization analyses were completed for each prospect to identify ML and ARD potential of the granular materials. Geochemical testing for ML and ARD potential was completed by ALS Canada Ltd. of North Vancouver, British Columbia.

Nine samples of the excavated materials from Prospects 1, 2, and 3 were submitted for acid-base accounting (ABA) analysis, trace element analysis by Inductively Coupled Plasma Mass Spectrometry, and shake flask extraction (SFE) analysis. All samples are described as granular materials with variable parent lithological sources. Detailed results and lab certifications from ML/ARD testing carried out on samples from Prospect 1, 2, and 3 are presented in Appendix D.

The ABA results indicate that all samples submitted are Non-Acid Generating (NAG) based upon either Sobek Neutralization Potential Ratios (NPR) or Carbonate NPR values. The average Sobek NPR value for the samples is 392 and the average Carbonate NPR value is 406. Sulphur content is low to moderate with most of the sulphur in the form of sulphides, with a maximum total sulphur content of 0.12% in any of the samples. The carbonate contents in the samples are moderate to high. Sobek Neutralization potential and Carbonate Neutralization potential are approximately the same, indicating that most NPR comes from carbonate and not a lot is contributed from silicates or other sources.

The results of the total elemental analysis were compared against average crustal abundance values for all rock types. Elemental concentrations exceeding the average crustal abundance values by greater than an order of magnitude are flagged for further consideration. Concentrations of various elements including Silver (Ag), Arsenic (As), Molybdenum (Mo), Thallium (Th), Barium, Beryllium (Be), Calcium (Ca), Cadmium (Cd), Manganese (Mn), Sulphur (S), antimony (Sb), and Uranium (U) are elevated above the average crustal abundance in select samples. Molybdenum (Mo) is greater than the average crustal abundance value by slightly more than an order of magnitude in samples PR2 CS3 and PR3 CS1. Selenium (Se) is greater than the average crustal abundance value by more than an order of magnitude in all samples.

The results of the SFE analysis were compared against the Canadian Council of Ministers of the Environment (CCME) *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2017) and the British Columbia Ministry of Environment approved water quality guidelines (BC 2019) for freshwater aquatic life as reference points for dissolved concentrations in the leachate from the test samples. Concentrations exceeding the guideline values by greater than an order of magnitude are flagged for further consideration. Elevated concentrations of dissolved metals in the SFE analysis do not necessarily result in elevated constituents in a field setting; however, it can be used to identify which leachable constituents may be of future concern. This test work and analysis does not take into account the water chemistry, dilution volumes, or long-term metal dissolution for evaluating the impact of ML potential on surface water receptors. Concentrations of dissolved Fluoride (F) show minor exceedances above the CCME guideline value in all samples, the guideline value for fluoride is 0.12 mg/L,

and values from sample analyses range from 0.12 mg/L to 0.49 mg/L. Concentrations of leachable Aluminium (Al) are elevated above the CCME guideline in samples from Prospect 2 (PR2-CS1, PR2-CS2) and Prospect 3 (PR3-CS3), the guideline value for aluminum is 0.10 mg/L and concentrations in samples exceeding the guideline range from 0.11 mg/L to 0.18 mg/L. Concentrations of leachable Selenium (Se) are elevated above the CCME guideline in samples from Prospect 2 (PR2-CS3) and Prospect 3 (PR3-CS1, PR3-CS2, PR3-CS3), the guideline value for selenium is 0.0010 mg/L and concentrations in samples exceeding the guideline range from 0.0017 mg/L to 0.0023 mg/L.

The materials represented by the samples in this characterization program are at a low risk of producing ML and ARD. The risks associated with ML/ARD will depend on the final excavated and placed material volumes, construction uses, and location of placement. Larger volumes of disturbed rock materials may translate to increased metal loading. The risks to aquatic life associated with ML and ARD are increased when the disturbed rock materials are placed proximal to surface water receptors. If required, ML/ARD risks can be mitigated by placing construction materials sub-aqueously to limit the reactions and weathering which produce ML/ARD.

4.0 GRANULAR PROSPECT CONDITIONS

Surface and subsurface conditions for each granular prospect are summarized herein based on results from the geotechnical investigation. The locations of each granular prospect relative to the Oscar Creek site are shown in Figure 1. A plan view of each granular prospect showing locations of the testpits excavated are presented in Figures 2, 3, and 4. Geotechnical data is shown on the testpit logs in Appendix B and laboratory test results in Appendix C.

4.1 Prospect 1

Prospect 1 is located approximately 2.4 km north of the MVWR and about 500 m past the proposed OCB location. A plan view of the granular prospect showing locations of the testpits excavated are presented in Figure 2.

4.1.1 Surface Conditions

The Prospect 1 site covers a 12.4 hectare (ha) area that encompasses alluvial plains from nearby Oscar Creek (PEMCAN 1973). The site is characterized by several shallow terraces that border the active stream channel, which meanders north to south at the location. The terraces contain alluvial deposits comprised of sands, gravels, and silts. Several scarps are present along the edges of the plain adjacent to the creek. Topsoils and organic silts support relatively dense growths of spruce, poplar, and various smaller brush.

4.1.2 Subsurface Conditions

A total of eight testpits (PR1-TP01 to PR1-TP08) were excavated in Prospect 1 to profile the subsurface. The granular materials encountered predominantly consisted of sands and gravels with trace silt components and up to 30% cobble and boulder-sized particles. Sands were typically well-graded and brown to grey in colour. Gravels were fine-grained and subrounded to rounded in shape. The area features organic topsoil layers at the surface that were up to 300 mm thick. Table 4-1 below presents a summary of the estimated granular distributions from each Prospect 1 testpit.

Table 4-1: Prospect 1 Estimated Granular Properties

Testpit No.	Granular Material Depth (m)		Fine Grained (%)		Coarse Grained (%)			Crush Count (2 Faces) (%)
	From	To	Clay	Silt	Sand	Gravel	Cobbles	
PR1-TP01	0.2	4.0	1		41	28	30	14
PR1-TP02	0.1	4.0	4		77	9	10	31
PR1-TP03	0.2	3.0	12		44	24	20	77
PR1-TP04	0.2	4.0	1		19	50	30	68
PR1-TP05	0.4	4.0	1		69	15	15	61
PR1-TP06	0.3	4.0	5		50	30	15	66
PR1-TP07	0.2	4.0	4		27	49	20	75
PR1-TP08	0.1	4.0	3		47	40	10	66
Prospect 1 Average			**4**		**47**	**30**	**19**	**57**

Cobbles and boulders proportions (i.e., material greater than 19 mm in diameter) were based on field observations and could not be representatively sampled. Los Angeles Abrasion testing loss was 30% and the weighted average Petrographic Number was 140 for a combined, 19 mm minus sample from all Prospect 1 testpits.

4.2 Prospect 2

Prospect 2 is located immediately adjacent to the east bank of Oscar Creek, approximately 3.4 km north of the MVWR. It is bounded by Oscar Creek to the west and the steep escarpment of the Franklin Mountains to the north and east. A plan view of Prospect 2 showing locations of the completed testpits is presented in Figure 3.

4.2.1 Surface Conditions

The Prospect 2 site consists of terraced deposits that are likely remnants of a previous glaciofluvial delta (PEMCAN 1973). The prospect covers an area approximately 36.9 ha with several existing cutlines throughout. The area and adjacent terrain appears to be well-drained to the south and west. Granular materials within the terrace remnants consist of clean gravels and sands overlain by a thin topsoil layer. The area is densely forested with spruce, birch, and poplar trees up to 12 m in height as well as smaller brush and grass growth.

4.2.2 Subsurface Conditions

Five testpits were excavated within Prospect 2 to interpret the subsurface conditions. The materials encountered primarily consisted of gravel and cobbles with some sand and trace fine components. Gravels were coarse grained and subrounded to rounded. Particles larger than 19 mm in diameter (i.e., cobbles and boulders) made up to 55% of the subsurface in some areas of the prospect. Sands were poorly graded and grey-brown in colour. The area was overlain with organics (topsoil) and underlying sandy silts up to a total thickness of 400 mm. A summary of the estimated granular distribution for Prospect 2 is included in Table 4-2 below.

Table 4-2: Prospect 2 Estimated Granular Properties

Testpit No.	Granular Material Depth (m)		Fine Grained (%)		Coarse Grained (%)			Crush Count (2 Faces) (%)
	From	To	Clay	Silt	Sand	Gravel	Cobbles	
PR2-TP01	0.4	4.0	19		18	48	15	36
PR2-TP02	0.3	4.0	5		14	26	55	65
PR2-TP03	0.3	4.2	7		14	44	35	91
PR2-TP04	0.3	4.5	2		40	28	30	26
PR2-TP05	0.4	4.2	4		33	33	30	42
Prospect 2 Average			**7**		**24**	**36**	**33**	**57**

The proportions of granular material greater than 19 mm in size (i.e., cobbles and boulders) were estimated visually in the field as they could not be representatively sampled. Los Angeles Abrasion testing loss was 33% for a combined, 19 mm minus sample from all Prospect 2 testpits. The same combined sample had a weighted average Petrographic Number of 125.

4.3 Prospect 3

Prospect 3 is located at the base of the Franklin Mountain range and on the west side of the Oscar Creek. The summit of Mount Morrow rises sharply from the northwest corner of the site. Access to the prospect is approximately 4.3 km north of the MVWR. Figure 4 shows a plan view of Prospect 3 including locations of the completed testpits.

4.3.1 Surface Conditions

Prospect 3 also consists primarily of granular deposits from glaciofluvial delta remnants, similar to Prospect 2 (PEMCAN 1973). The prospect covers an area approximately 181.1 ha and contains several existing cutlines. Granular materials comprise of well-graded sands and gravels with trace silt components. Granular materials are overlain by a thin layer of organic topsoil. The site is fully forested and contains dense growth of spruce, birch, and poplar trees as well as smaller shrubs and grasses. The terrain slopes gradually to the southwest, and the terraces overlooking Oscar Creek feature elevation changes of up to 20 m. The site area and adjacent terrain show good surface drainage to the east and southwest.

4.3.2 Subsurface Conditions

Prospect 3 was investigated with nine testpits to classify the subsurface. Granular materials encountered in the testpits consisted of gravel with sandy and some cobble components. Gravels were coarse grained and subrounded to rounded. Sands were poorly graded and brown in colour. Cobbles and larger diameter particles made up to 25% of the subsurface in some areas of the prospect. Prospect 3 was overlain with organics (topsoil) and underlying sandy silts up to a combined thickness of 1.0 m. A summary of the estimated granular distribution for Prospect 3 is included in Table 4-3 below.

Table 4-3: Prospect 3 Estimated Granular Properties

Testpit No.	Granular Material Depth (m)		Fine Grained (%)		Coarse Grained (%)			Crush Count (2 Faces) (%)
	From	To	Clay	Silt	Sand	Gravel	Cobbles	
PR3-TP01	0.1	4.2	1		17	57	25	-
PR3-TP02	0.3	4.0	4		27	54	15	36
PR3-TP03	0.5	4.0	2		17	56	25	25
PR3-TP04	0.6	4.5	2		14	64	20	-
PR3-TP05	0.4	4.0	1		24	65	10	40
PR3-TP06	0.5	4.5	2		41	37	20	46
PR3-TP07	0.6	3.5	4		18	58	20	-
PR3-TP08	0.5	4.5	3		35	42	20	84
PR3-TP09	1.0	4.0	2		39	44	15	86
Prospect 3 Average			**2**		**26**	**53**	**19**	**53**

Cobbles and boulders proportions (i.e., material greater than 19 mm in diameter) were based on field observations and could not be representatively sampled. Los Angeles Abrasion testing loss was 31% and the weighted average Petrographic Number was 204 for a combined, 19 mm minus sample from all Prospect 3 testpits.

5.0 GRANULAR PROSPECTS ASSESSMENT

Findings from the geotechnical investigation of the Oscar Creek granular prospects confirmed the availability of granular materials at all three sources and are generally consistent with historical information from previous investigations carried out in 1973 (PEMCAN) and 1974 (EBA). All recommendations provided herein are based on the material criteria outlined in Section 5.1 (below) and the geotechnical laboratory test results presented in Appendix C.

5.1 Material Criteria

The three material types and criteria presented in the request for proposal are outlined below. The suitability of a specific material within a granular prospect depends on the material's gradation, moisture (ice) content, proportion of oversized particles or deleterious materials, if present, and compactability. Criteria for each material type, included:

- Common Fill
  - Low ice and moisture contents; and
  - Free of deleterious materials (i.e., organics).
- Granular Backfill
  - Non-frost susceptible (i.e., thaw stable).
- Granular Aggregates
  - Free of deleterious materials (i.e., organics, low ice content);

- Non-frost susceptible (i.e., thaw stable);
- Crush Count (two fracture faces) of no less than 50%;
- Los Angeles abrasion testing of no greater than 50% loss; and
- Materials must have acceptable percentages of flat and elongated particles.

5.2 Material Availability

Ground conditions at all three prospects generally consist of glaciofluvial and fluvial deposits of sand and gravel underlain by bedrock and overlain by organics. Glaciofluvial materials are sediments deposited by the meltwater from the front of a glacier (outwash), usually in patterns similar to that of braided streams. Fluvial materials are those deposited by flowing water in channels such as Oscar Creek. The sedimentary bedrock underlying the granular materials was not encountered in any of the testpits excavated. The surface organics generally comprised topsoil and peat. The organics are not suitable materials for construction but could be used in non-engineering applications (i.e., landscaping). Organic layer thicknesses were relatively thin at all three prospect sites ranging in thickness from 0.1 m to 0.4 m, averaging 0.2 m.

5.2.1 Common Fill

Overburden materials suitable for common (borrow) fill were identified in all three granular prospects. The material layers investigated would be acceptable for use as common fill, excluding all organic and deleterious materials. The well-graded glaciofluvial sands and gravels would be better utilized for engineered materials such as granular backfill or aggregate, where required.

The materials with higher fines content should be utilized for common fill as these are not suitable for other purposes. The ground ice content observed within these layers was low and decreased with depth, and moisture contents were low (dry to moist) meaning the material can readily be placed and compacted during the winter months. The well-graded sand materials can be compacted to a relatively dense state in unfrozen conditions.

5.2.2 Granular Backfill

Glaciofluvial sands and gravels, suitable for granular backfill, were encountered in all three prospect locations. The deposits in Prospects 2 and 3 generally consist of well-graded gravels and with components of coarse-grained sands up to depths of 4.5 m. Prospect 1 predominantly consists of well-graded gravels and sands up to depths of 4.0 m.

Low fines content materials are generally considered to be non-frost susceptible and thaw stable. The glaciofluvial materials generally exhibit a low fines content (less than 9%), except within one testpit in Prospect 1 (PR1-TP03) and one testpit in Prospect 2 (PR2-TP01). All three deposits were noted to have varying proportions of cobble and boulder-sized particles (visual estimates of 10% to 55% by volume). Materials larger than 25 mm diameter would need to be screened or crushed prior to use as granular backfill.

All three granular prospects exhibited materials suitable for use as granular backfill; however, Prospect 3 is recommended as the best source for granular backfill due to having the lowest estimated proportions of fines and oversized materials. Prospect 1 is considered the second best source for granular backfill, followed by Prospect 2.

5.2.3 Granular Aggregates

Findings from the investigation program show select areas in each prospect suitable for extracting and processing granular aggregates. All three prospect locations yielded Los Angeles abrasion losses below 50%, meeting the

material criteria; however, crush (fracture) count results showed several areas within each prospect that did not meet the minimum requirement of 50%. Two testpits in Prospect 1 (PR1-TP01, PR1-TP02), three testpits in Prospect 2 (PR2-TP01, PR2-TP04, PR2-TP05), and four testpits in Prospect 3 (PR3-TP02, PR3-TP03, PR3-TP05, PR3-TP06) did not meet the minimum crush count following testing.

Based on this, a select area within Prospect 1 is the only recommended material source for granular aggregate. Material extraction should focus around testpits PR1-TP03 to PR1-TP08 as these locations had favourable crush counts. The production of quality granular aggregates, such as surfacing coarse and concrete aggregates, will require selective excavation in these areas if Prospect 1 is to be developed. Producing quality granular aggregates will likely still require some amount of processing (i.e., screening, crushing, and/or washing) to ensure aggregate properties meet specified construction requirements.

5.3 Estimated Material Quantities

Inferred boundaries for each granular prospect were delineated based on a desktop review of air photos, historical borehole logs, and satellite imagery of the Oscar Creek area, as shown in Figure 1. Combining this information with results from the testpitting program, volumes were calculated based on a 50 m radius limit from each testpit. Testpit findings are assumed to be representative of the subsurface within this radius and in areas may extend well beyond the 50 m radius.

Based on the above, it is estimated that the total quantity of available granular materials from Prospects 1, 2, and 3 is approximately 465,000 m^3. The estimated granular material quantities for each prospect are summarized below in Table 5-1.

Table 5-1: Estimated Granular Material Quantities

Prospect No.	Investigated Surface Area (m^2)	Average Granular Material Thickness (m)	Estimated Material Quantity (m^3)	Potential Material Usage		
				Common Fill	Granular Backfill	Granular Aggregate
1	50,000	3.7	185,000	✓	✓	✓
2	15,000	4.0	60,000	✓	✓	
3	55,000	4.0	220,000	✓	✓	
Total	120,000	3.9	465,000	-		

It was previously estimated that Prospects 2 and 3 had available granular materials of 1,146,000 m^3 and 7,645,000 m^3, respectively (PEMCAN 1973); however, these quantities were not able to be verified by this assessment.

6.0 DEVELOPMENT CONSIDERATIONS

The development of granular prospects should follow recommendations provided in the GNWT's *Northern Land Use Guidelines: Pits and Quarries* (GNWT 2015). The following operational guidelines should also be considered during the development of new granular sources:

- Prospects 1 and 2 are located in close proximity to Oscar Creek and appropriate sediment and erosion control measures should be implemented if developed;

- Organics and vegetation should be maintained between prospect areas and Oscar Creek to protect from erosion and sedimentation near the active stream channel;
- Organics and vegetation overlying excavation areas should be cleared, removed, and stockpiled adjacent to the prospect in designated areas;
- Production of higher quality granular aggregates, such as concrete aggregates, will likely require additional processing (i.e., screening, crushing, and/or washing) to ensure aggregates meet the specified construction requirements; and
- Additional geotechnical laboratory testing is recommended if granular aggregates are to be considered for concrete aggregate production, including but not limited to:
  - Clay Lumps (CSA A23.2-2019 3A);
  - Low Density Granular Materials (CSA A23.2-2019 4A);
  - Material Finer than 80µm (CSA A23.2-2019 5A);
  - Soundness of Aggregates using Magnesium Sulphate (CSA A23.2-2019 9A);
  - Percentage of Flat and Elongated Particles (CSA A23.2-2019 13A);
  - Resistance of Coarse Aggregate to Freezing and Thawing (CSA A23.2-2019 24A);
  - Alkali Aggregate Reactivity (CSA A23.2-2019 27A); and
  - Micro Deval Abrasion (CSA A23.2-2019 23A, 29A).

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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TABLES

TABLE A: TESTPIT INFORMATION SUMMARY

Project:	Oscar Creek Granular Prospects Assessment	UTM Zone:	9
Project No.:	704-ENG.YARC03255-01	Program Dates:	January 11 to 13, 2020
Client:	Government of the Northwest Territories	Logged By:	Atif Rafiq
Location:	Oscar Creek, Northwest Territories	Total Testpits:	22

TETRA TECH

Prospect No.	Testpit No.	Coordinates (UTM NAD 83)		Ground Surface Elevation (m)	Excavated Depth (m)	Completion Elevation (m)	Organic Layer Thickness (m)	Excavation Date
		Northing (m)	Easting (m)					
1	PR1-TP01	7,258,088	575,262	71.0	4.0	67.0	0.2	January 13, 2020
	PR1-TP02	7,258,111	575,333	66.0	4.0	62.0	0.1	January 13, 2020
	PR1-TP03	7,258,131	575,395	67.0	3.0	64.0	0.2	January 13, 2020
	PR1-TP04	7,258,164	575,325	65.0	4.0	61.0	0.2	January 13, 2020
	PR1-TP05	7,258,218	575,218	71.0	4.0	67.0	0.4	January 13, 2020
	PR1-TP06	7,258,321	575,197	72.0	4.0	68.0	0.3	January 13, 2020
	PR1-TP07	7,258,409	575,189	74.0	4.0	70.0	0.2	January 13, 2020
	PR1-TP08	7,258,370	575,152	72.0	4.0	68.0	0.1	January 13, 2020
2	PR2-TP01	7,259,615	576,659	101.0	4.0	97.0	0.1	January 11, 2020
	PR2-TP02	7,259,603	576,601	99.0	4.0	95.0	0.3	January 11, 2020
	PR2-TP03	7,259,639	576,578	102.0	4.2	97.8	0.3	January 11, 2020
	PR2-TP04	7,259,602	576,527	104.0	4.5	99.5	0.3	January 11, 2020
	PR2-TP05	7,259,636	576,502	104.0	4.2	99.8	0.1	January 11, 2020
3	PR3-TP01	7,260,013	575,172	111.0	4.2	106.8	0.1	January 12, 2020
	PR3-TP02	7,260,023	575,071	107.0	4.0	103.0	0.1	January 12, 2020
	PR3-TP03	7,259,927	575,127	109.0	4.0	105.0	0.2	January 12, 2020
	PR3-TP04	7,259,947	575,055	105.0	4.5	100.5	0.1	January 12, 2020
	PR3-TP05	7,260,844	575,345	116.0	4.0	112.0	0.1	January 12, 2020
	PR3-TP06	7,260,908	575,336	117.0	4.5	112.5	0.1	January 12, 2020
	PR3-TP07	7,260,890	575,309	117.0	3.5	113.5	0.2	January 12, 2020
	PR3-TP08	7,260,947	575,291	114.0	4.5	109.5	0.1	January 12, 2020
	PR3-TP09	7,260,981	575,247	112.0	4.0	108.0	0.1	January 12, 2020

TABLE B: GEOTECHNICAL LABORATORY TEST RESULTS SUMMARY

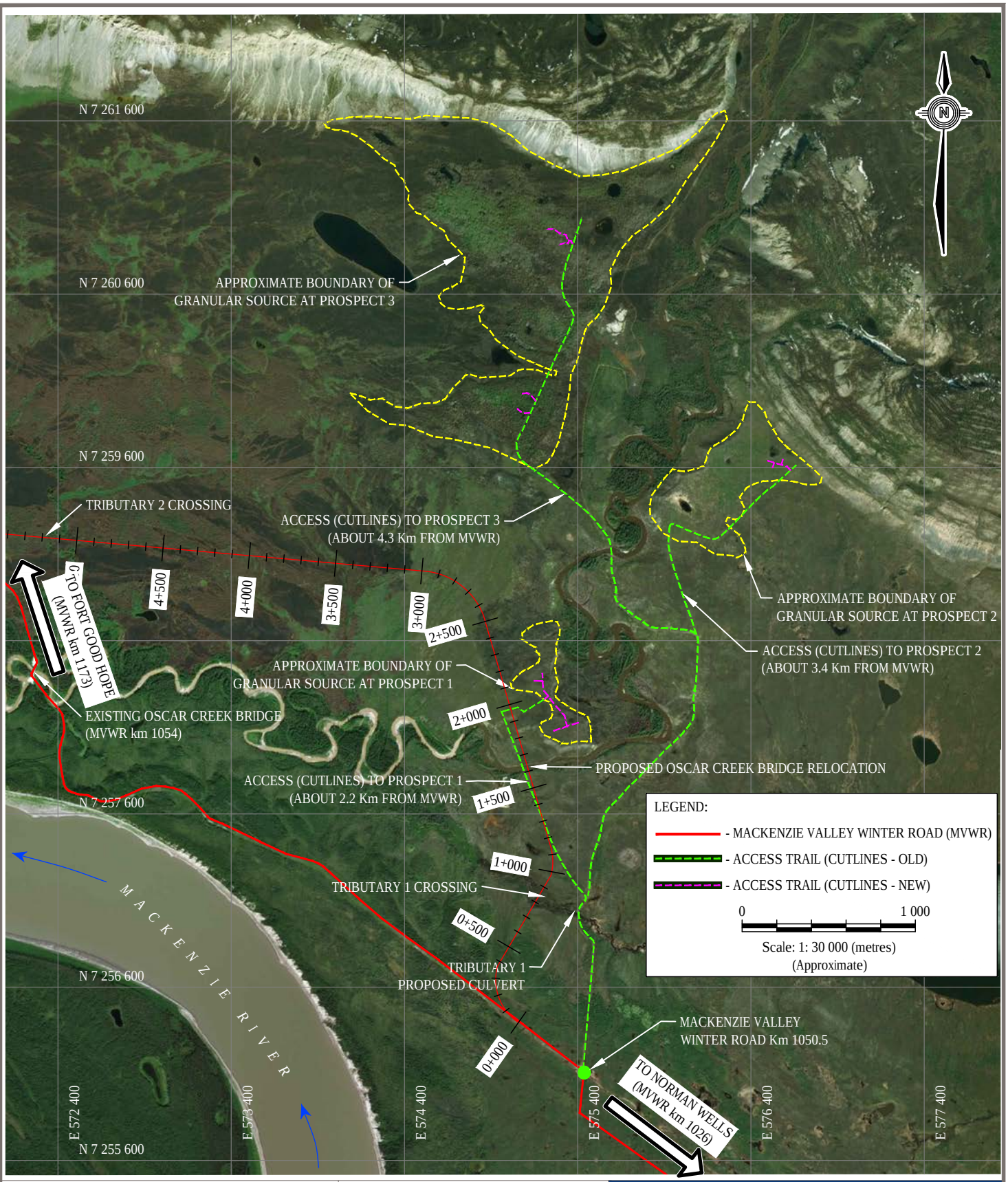
Project:	Oscar Creek Granular Prospects Assessment	UTM Zone:	9
Project No:	704-ENG.YARC03255-01	Program Dates:	January 11 to 13, 2020
Client:	Government of the Northwest Territories	Sampled By:	Atif Rafiq
Location:	Oscar Creek, Northwest Territories	Tested By:	Yellowknife & Edmonton Material Labs

TETRA TECH

Prospect No.	Testpit No.	Sample No.	Sample Depth (m)		Moisture Content	Particle Size Distribution (%)					Crush Count (2 Faces) (%)	Los Angeles Abrasion Loss (%)	Petrographic Number			
			From	To	(%)	Cobbles	Gravel	Sand	Silt	Clay			19 - 12.5 mm	12.5 - 9.5 mm	9.5 - 4.75 mm	Weighted Average
1	PR1-TP01	1	0.0	1.0	19.8							30	141	133	143	140
		2	1.0	4.0	4.4	0	40	59	1		14					
	PR1-TP02	3	0.0	0.4	15.7											
		4	0.4	2.0	11.4	0	10	86	4		31					
	PR1-TP03	5	0.0	0.4	18.4											
		6	0.4	3.0	4.7	0	30	55	15		77					
	PR1-TP04	7	0.0	0.4	9.7											
		8	0.4	4.0	2.1	0	71	27	2		68					
	PR1-TP05	9	0.5	1.0	12.4											
		10	1.0	2.0	4.1	0	18	81	1		61					
	PR1-TP06	11	1.8	2.5	3.4	0	35	59	6		66					
		12	2.8	4.0												
	PR1-TP07	13	0.4	1.0	20.4											
		14	1.0	4.0	2.8	0	61	34	5		75					
	PR1-TP08	15	1.0	1.5	2.6											
		16	1.5	4.0	3.1	0	44	52	4		66					
2	PR2-TP01	17	0.0	0.4	18.8							33	N/A	129	119	125
		18	0.4	2.0	9.3	0	78	6	16		21					
		19	2.0	4.0	8.2	0	36	35	29		51					
	PR2-TP02	20	0.2	0.8	4.5											
		21	0.8	1.5	6.0	26	51	14	9		97					
		22	1.5	4.0	3.9	0	55	40	5		33					
	PR2-TP03	23	0.4	1.0	4.2											
		24	1.0	1.8	5.5	0	72	19	9		90					
		25	1.8	4.2	4.9	9	61	22	8		92					
	PR2-TP04	26	0.0	0.3	22.4											
		27	0.3	1.2	4.0											
		28	1.2	4.5	4.1	0	40	57	3		26					
	PR2-TP05	29	0.4	1.6	2.8											
		30	1.6	4.2	5.3	0	47	47	6		42					

Prospect No.	Testpit No.	Sample No.	Sample Depth (m)		Moisture Content	Particle Size Distribution (%)					Crush Count (2 Faces) (%)	Los Angeles Abrasion Loss (%)	Petrographic Number			
			From	To	(%)	Cobbles	Gravel	Sand	Silt	Clay			19 - 12.5 mm	12.5 - 9.5 mm	9.5 - 4.75 mm	Weighted Average
3	PR3-TP01	31	0.4	1.0	3.0											
		32	1.4	4.2	4.1	0	76	22	2							
	PR3-TP02	33	0.3	1.0	3.0											
		34	1.0	1.3	18.0	0	3	31	66		56	31	234	185	164	204
		35	1.3	4.0	4.5	0	63	32	5		16					
	PR3-TP03	36	0.5	1.6	2.5	0	75	23	2		31					
		37	1.6	4.0	2.9	0	74	24	2		19					
	PR3-TP04	38	0.0	0.6	3.9											
		39	0.6	4.5	3.7	0	80	18	2							
	PR3-TP05	40	0.4	2.0	3.2	0	81	17	2		71					
		41	2.0	4.0	4.1	0	64	35	1		9					
	PR3-TP06	42	0.5	2.0	4.2											
		43	2.0	3.5	4.6	0	20	76	4		82					
		44	3.5	4.5	2.7	0	73	26	1		10					
	PR3-TP07	45	0.0	0.6	6.7											
		46	0.6	3.5	6.2	0	73	22	5							
	PR3-TP08	47	0.5	1.2	3.9											
		48	1.2	3.8	5.2	0	36	60	4		87					
		49	3.8	4.5	3.2	0	70	27	3		81					
	PR3-TP09	50	0.0	1.0	15.5											
		51	1.0	2.0	3.2	0	75	23	2		83					
		52	2.0	4.0	4.8	0	28	68	4		88					

FIGURES



NOTES:

BASE IMAGE OBTAINED FROM ESRI DIGITAL GLOBE

HORIZONTAL DATUM: UTM ZONE 9 [NAD83 CSRS (2010)]

TESTPIT COORDINATES OBTAINED BY HANDHELD GPS ARE APPROXIMATE

APPROXIMATE BOUNDARIES ARE INFERRED BASED ON DESKTOP REVIEW OF PREVIOUS STUDIES IN THE AREA, FIELD OBSERVATIONS AND GEOMORPHOLOGY ASSESSED THROUGH SATELLITE IMAGERY

CLIENT

Northwest Territories

TETRA TECH

GRANULAR PROSPECTS GEOTECHNICAL ASSESSMENT OSCAR CREEK, NORTHWEST TERRITORIES

PROJECT LOCATION

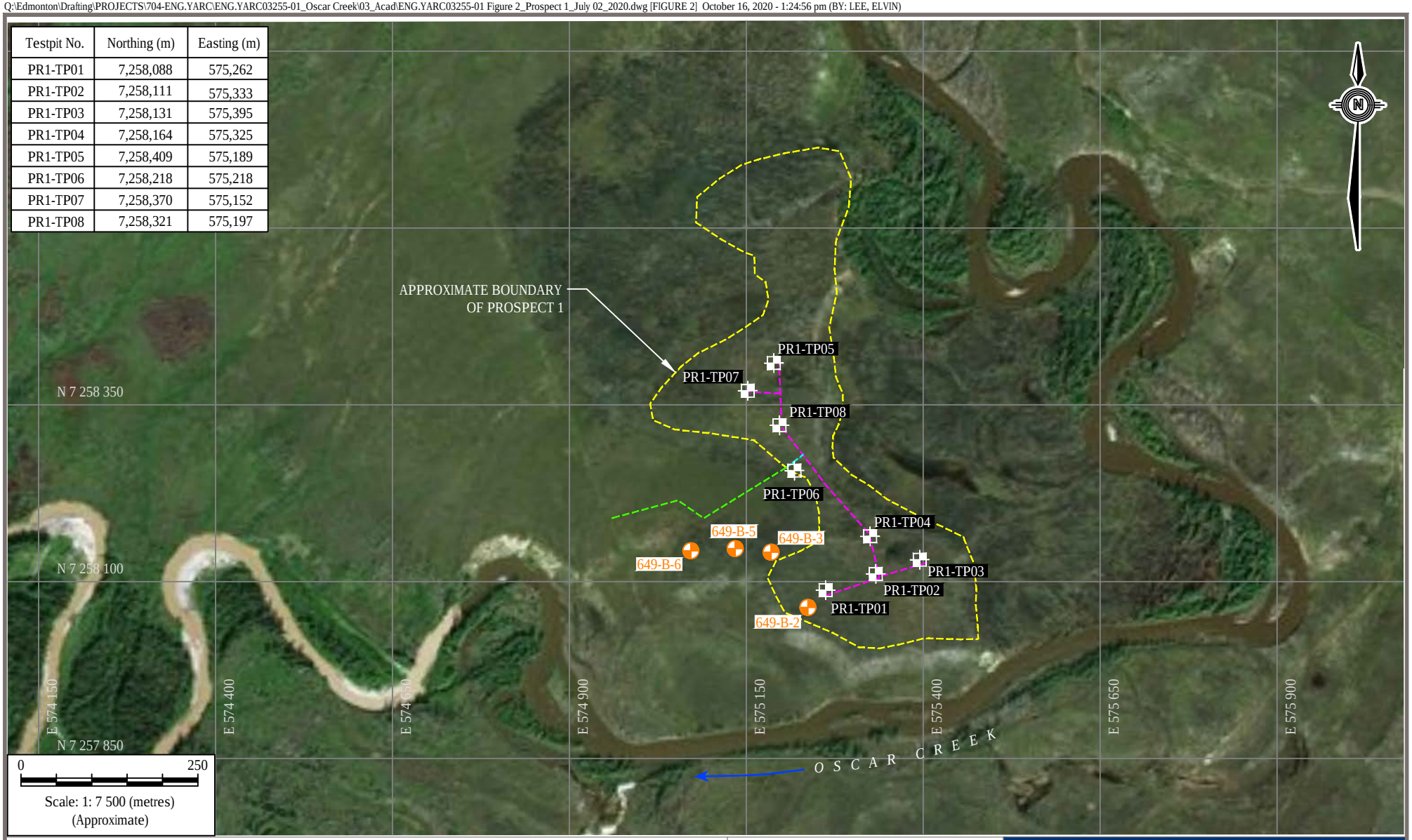
PROJECT NO.	DWN	CKD	REV
ENG.YARC03255-01	DBD	AR	IFU

OFFICE	DATE
Edmonton	OCTOBER 2020

Figure 1

Q:\Edmonton\Drafting\PROJECTS\704-ENG.YARC\ENG.YARC03255-01_Oscar Creek\03_Acad\ENG.YARC03255-01 Figure 2_Prospect 1_July 02_2020.dwg [FIGURE 2] October 16, 2020 - 1:24:56 pm (BY: LEE, ELVIN)

Testpit No.	Northing (m)	Easting (m)
PR1-TP01	7,258,088	575,262
PR1-TP02	7,258,111	575,333
PR1-TP03	7,258,131	575,395
PR1-TP04	7,258,164	575,325
PR1-TP05	7,258,409	575,189
PR1-TP06	7,258,218	575,218
PR1-TP07	7,258,370	575,152
PR1-TP08	7,258,321	575,197



LEGEND:

- TESTPIT LOCATION
- BOREHOLE LOCATION (PWC 1973)
- ACCESS TRAIL (CUTLINES - OLD)
- ACCESS TRAIL (CUTLINES - NEW)

NOTES:

BASE IMAGE OBTAINED FROM ESRI DIGITAL GLOBE

HORIZONTAL DATUM: UTM ZONE 9 [NAD83 CSRS (2010)]

TESTPIT COORDINATES OBTAINED BY HANDHELD GPS ARE APPROXIMATE

APPROXIMATE BOUNDARIES ARE INFERRED BASED ON DESKTOP REVIEW OF PREVIOUS STUDIES IN THE AREA, FIELD OBSERVATIONS AND GEOMORPHOLOGY ASSESSED THROUGH SATELLITE IMAGERY

CLIENT

Northwest Territories

TETRA TECH

GRANULAR PROSPECTS GEOTECHNICAL ASSESSMENT OSCAR CREEK, NORTHWEST TERRITORIES

TESTPIT LOCATION PLAN (PROSPECT 1)

PROJECT NO.	DWN	CKD	REV
ENG.YARC03255-01	DBD	AR	IFU

OFFICE	DATE
Edmonton	OCTOBER 2020

Figure 2

Q:\Edmonton\Drafting\PROJECTS\704-ENG.YARC\ENG.YARC03255-01_Oscar Creek\03_Acad\ENG.YARC03255-01 Figure 3_Prospect 2_July 02_2020.dwg [FIGURE 3] October 16, 2020 - 1:25:08 pm (BY: LEE, ELVIN)

Testpit No.	Northing (m)	Easting (m)
PR2-TP01	7,259,615	576,659
PR2-TP02	7,259,603	576,601
PR2-TP03	7,259,639	576,578
PR2-TP04	7,259,602	576,527
PR2-TP05	7,259,636	576,502

LEGEND:

- TESTPIT LOCATION
- ACCESS TRAIL (CUTLINES - OLD)
- ACCESS TRAIL (CUTLINES - NEW)

NOTES:

BASE IMAGE OBTAINED FROM ESRI DIGITAL GLOBE

HORIZONTAL DATUM: UTM ZONE 9 [NAD83 CSRS (2010)]

TESTPIT COORDINATES OBTAINED BY HANDHELD GPS ARE APPROXIMATE

APPROXIMATE BOUNDARIES ARE INFERRED BASED ON DESKTOP REVIEW OF PREVIOUS STUDIES IN THE AREA, FIELD OBSERVATIONS AND GEOMORPHOLOGY ASSESSED THROUGH SATELLITE IMAGERY

CLIENT

Northwest Territories

TETRA TECH

GRANULAR PROSPECTS GEOTECHNICAL ASSESSMENT OSCAR CREEK, NORTHWEST TERRITORIES

TESTPIT LOCATION PLAN (PROSPECT 2)

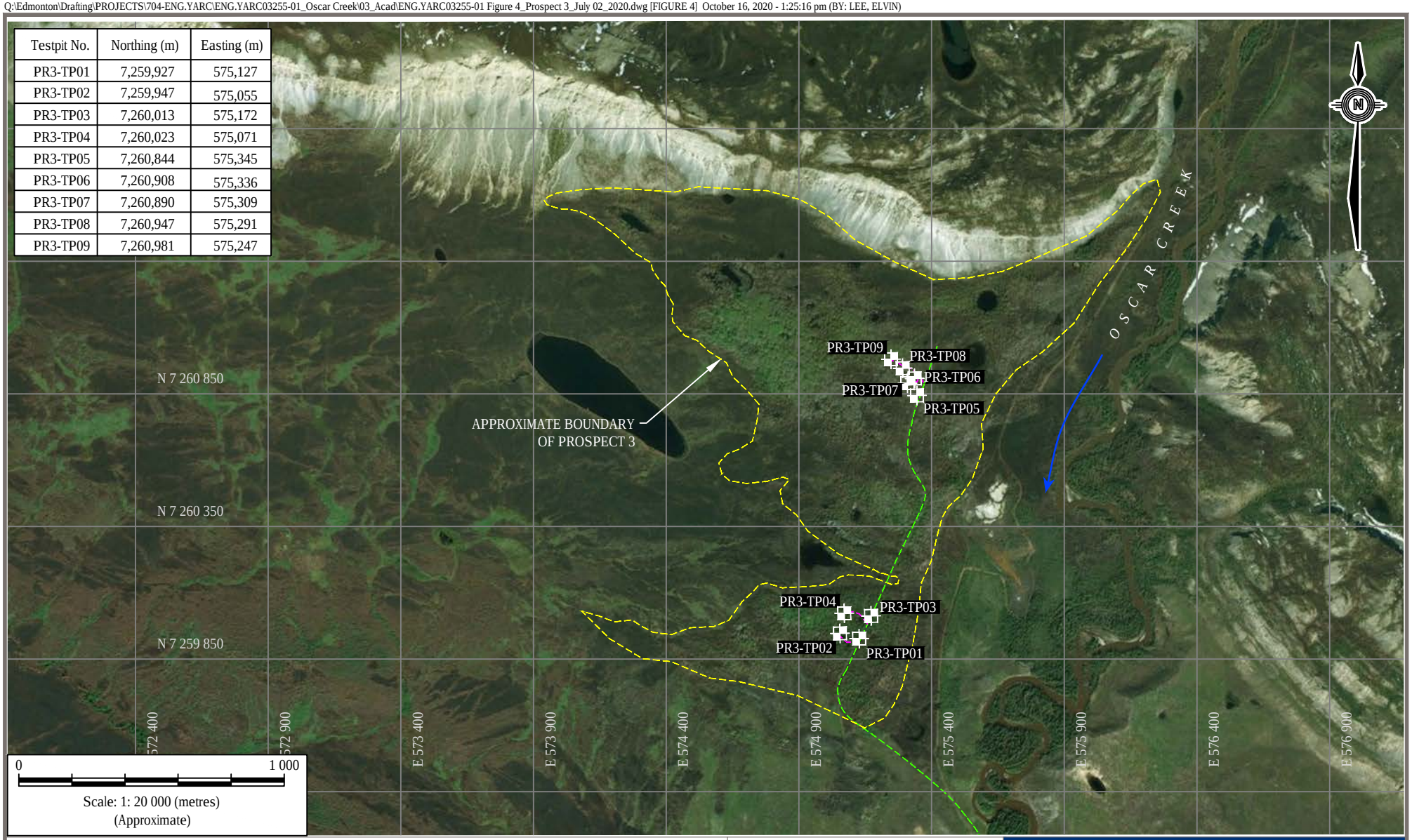
PROJECT NO.	DWN	CKD	REV
ENG.YARC03255-01	DBD	AR	IFU

OFFICE	DATE
Edmonton	OCTOBER 2020

Figure 3

Q:\Edmonton\Drafting\PROJECTS\704-ENG.YARC\ENG.YARC03255-01_Oscar Creek\03_Acad\ENG.YARC03255-01 Figure 4_Prospect 3_July 02_2020.dwg [FIGURE 4] October 16, 2020 - 1:25:16 pm (BY: LEE, ELVIN)

Testpit No.	Northing (m)	Easting (m)
PR3-TP01	7,259,927	575,127
PR3-TP02	7,259,947	575,055
PR3-TP03	7,260,013	575,172
PR3-TP04	7,260,023	575,071
PR3-TP05	7,260,844	575,345
PR3-TP06	7,260,908	575,336
PR3-TP07	7,260,890	575,309
PR3-TP08	7,260,947	575,291
PR3-TP09	7,260,981	575,247



LEGEND:

- TESTPIT LOCATION
- ACCESS TRAIL (CUTLINES - OLD)
- ACCESS TRAIL (CUTLINES - NEW)

NOTES:

BASE IMAGE OBTAINED FROM ESRI DIGITAL GLOBE

HORIZONTAL DATUM: UTM ZONE 9 [NAD83 CSRS (2010)]

TESTPIT COORDINATES OBTAINED BY HANDHELD GPS ARE APPROXIMATE

APPROXIMATE BOUNDARIES ARE INFERRED BASED ON DESKTOP REVIEW OF PREVIOUS STUDIES IN THE AREA, FIELD OBSERVATIONS AND GEOMORPHOLOGY ASSESSED THROUGH SATELLITE IMAGERY

CLIENT

Northwest Territories

TETRA TECH

GRANULAR PROSPECTS GEOTECHNICAL ASSESSMENT OSCAR CREEK, NORTHWEST TERRITORIES

TESTPIT LOCATION PLAN (PROSPECT 3)

PROJECT NO.	DWN	CKD	REV
ENG.YARC03325-01	DBD	AR	IFU

OFFICE	DATE
Edmonton	OCTOBER 2020

Figure 4

PHOTOGRAPHS

Photo 1: Cutline access from proposed Oscar Creek Bridge to Prospect 1.

Photo 2: Prospect 1 viewed from cutline access.

Photo 3: Excavating Testpit 6 at Prospect 1.

Photo 4: John Deere 270D LC excavator used for testpitting.

Photo 5: Prospect 1, Testpit 1.
Gravel, sandy below 1.0 m depth.

Photo 6: Prospect 1, Testpit 2.
Gravel and Sand.

Photo 7: Prospect 1, Testpit 3.
Sand, silty underlain by topsoil.

Photo 8: Prospect 1, Testpit 4.
Gravel at approximately 1.0 m depth underlain by gravelly sand.

Photo 9: Prospect 1, Testpit 5.
Alternating layers of sandy gravel and silty sand.

Photo 10: Prospect 1, Testpit 6.
Alternating layers of sandy gravel and silty sand.

Photo 11: Prospect 1, Testpit 7.
Sand, silty underlain by topsoil and gravels to about 1.0 m depth.

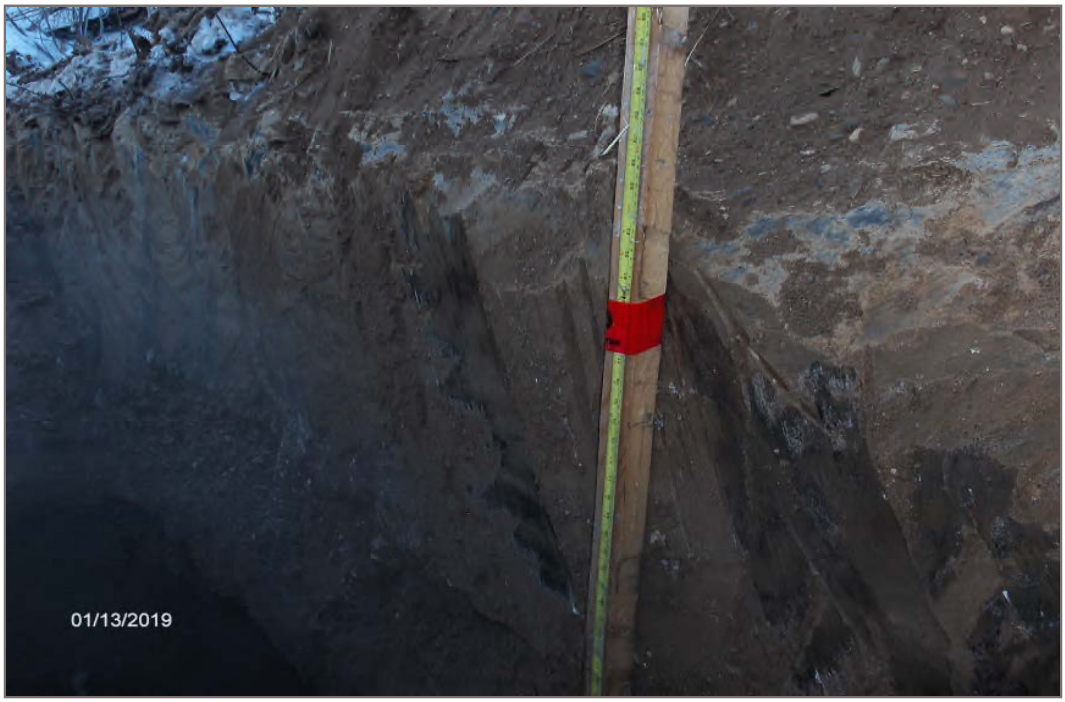


Photo 12: Prospect 1, Testpit 8.
Sand, silty underlain by gravel starting at about 1.5 m depth.

Photo 13: Prospect 2, Testpit 1.
Gravel, sandy from 0.4 m to 2.0 m depth.

Photo 14: Prospect 2, Testpit 2.
Boulder can be seen in left wall.

Photo 15: Prospect 2, Testpit 2.
Gravel from 0.8 m to 1.5 m depth.

Photo 16: Prospect 2, Testpit 3.
Gravel, sandy from 0.3 m to 4.2 m depth.

Photo 17: Prospect 2, Testpit 3.
Gravel, sandy from 0.3 m to 4.2 m depth.

Photo 18: Prospect 2, Testpit 4.
Gravel, sandy from 0.3 m to 1.2 m depth.

Photo 19: Prospect 2, Testpit 4.
Gravel, sandy from 0.3 m to 1.2 m depth.

Photo 20: Prospect 3, Testpit 1.
Gravel, sandy from 0.4 m to 2.0 m depth.

Photo 21: Prospect 3, Testpit 1.
Gravel, sandy from 0.4 m to 4.2 m depth.

Photo 22: Prospect 3, Testpit 2.
Gravel, sandy from 0.3 m to 4.0 m depth.

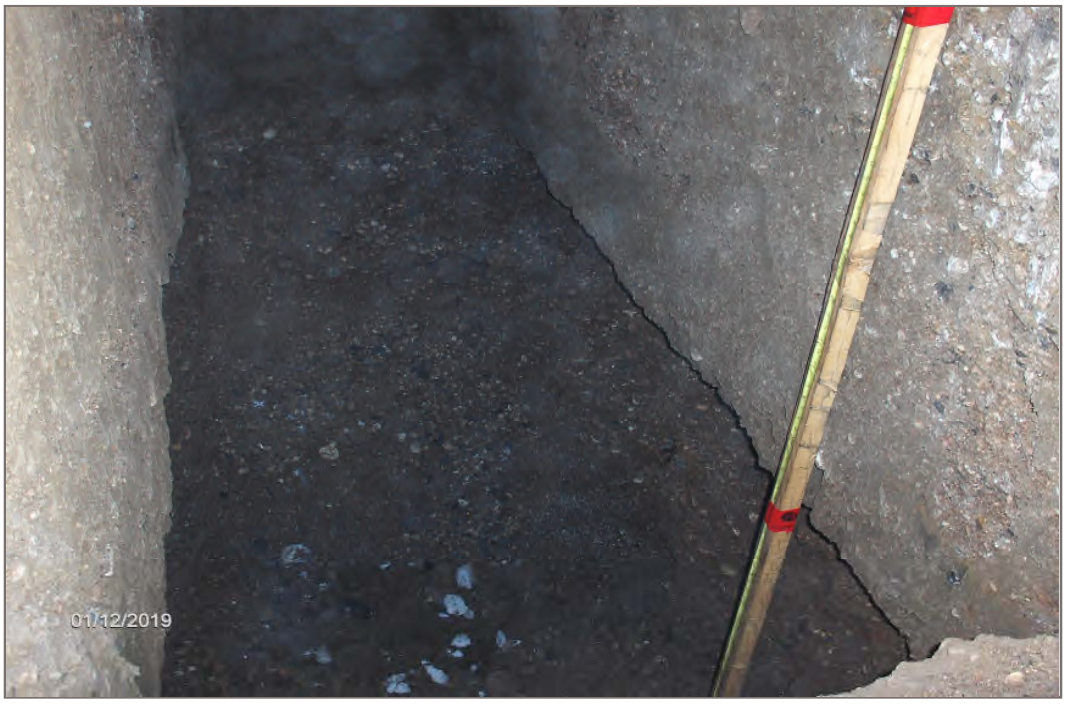


Photo 23: Prospect 3, Testpit 2.
Gravel, sandy from 0.4 m to 4.2 m depth.

Photo 24: Prospect 3, Testpit 3.
Coarse-grained materials from 0.5 m to 1.6 m depth.

Photo 25: Prospect 3, Testpit 4.
Gravel from 0.6 m to 4.5 m depth.

Photo 26: Prospect 3, Testpit 5.
Gravel, sandy from 0.4 m to 4.0 m depth.

Photo 27: Prospect 3, Testpit 6.
Sand and gravel from 0.5 m to 4.5 m depth.

Photo 28: Prospect 3, Testpit 7.
Gravel, sandy from 0.6 m to 1.5 and sand, gravelly from 1.5 m to 3.5 m depth.

Photo 29: Prospect 3, Testpit 8.
Gravel and sand from 0.5 m to 4.5 m depth.

Photo 30: Prospect 3, Testpit 9.
Gravel, sandy and sand from 1.0 m to 4.0 m.

APPENDIX A

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

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Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

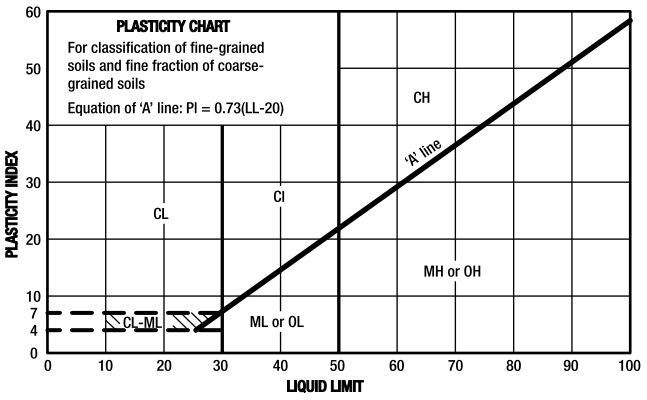
This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B

TESTPIT LOGS

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines (GW, GP, SW, SP, GM, GC, SM, SC Borderline Classification requiring use of dual symbols; Less than 5% Pass 75 µm sieve, More than 12% Pass 75 µm sieve, 5% to 12% Pass 75 µm sieve): $C_U = D_{60}/D_{10}$ Greater than 4; $C_c = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits plot above "A" line or plasticity index greater than 7
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_U = D_{60}/D_{10}$ Greater than 6; $C_c = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above "A" line or plasticity index greater than 7
					Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS Liquid limit <50		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity	
	SILTS Liquid limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
	CLAYS Above "A" line on plasticity chart negligible organic content; Liquid limit <30		CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays	
	CLAYS Liquid limit 30-50		CI	Inorganic clays of medium plasticity, silty clays	
	CLAYS Liquid limit >50		CH	Inorganic clays of high plasticity, fat clays	
	ORGANIC SILTS AND CLAYS Liquid limit <50		OL	Organic silts and organic silty clays of low plasticity	
	ORGANIC SILTS AND CLAYS Liquid limit >50		OH	Organic clays of medium to high plasticity	
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils	



* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

SOIL COMPONENTS

FRACTION	SIEVE SIZE PASSING	SIEVE SIZE RETAINED	DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS: PERCENTAGE	DESCRIPTOR
GRAVEL				
coarse	75 mm	19 mm	>35 %	"and"
fine	19 mm	4.75 mm	21 to 35 %	"y-adjective"
SAND				
coarse	4.75 mm	2.00 mm	11 to 20 %	"some"
medium	2.00 mm	425 µm		
fine	425 µm	75 µm	>0 to 10 %	"trace"
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded	
COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm
Not rounded	
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

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GROUND ICE DESCRIPTION

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
V	Vx	Individual ice crystals or inclusions		
	Vc	Ice coatings on particles		
	Vr	Random or irregularly oriented ice formations		
	Vs	Stratified or distinctly oriented ice formations		
	Vu	Ice formations uniformly distributed throughout frozen soil		

ICE NOT VISIBLE

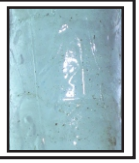
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
N	Nf	Poorly-bonded or friable		
	Nbn	No excess ice, well-bonded		
	Nbe	Excess ice, well-bonded		

LEGEND: Soil ☐ Ice ■

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

VISIBLE ICE GREATER THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
ICE	ICE + Soil Type	Ice with soil inclusions (greater than 25 mm thick)		
	ICE	Ice without soil inclusions (greater than 25 mm thick)		

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TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075 mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

descriptive term	relative density	n (blows per 0.3 m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51 mm O.D. split spoon sampler of a 63.5 kg weight falling 0.76 m, required to drive the sampler a distance of 0.3 m from 0.15 m to 0.45 m.

FINE GRAINED SOILS (major portion passing 0.075 mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

descriptive term	unconfined compressive strength (kPa)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

BOREHOLE KEYSHEET

Water Level Measurement

 Measured in standpipe, piezometer or well

 Inferred

Sample Types

 A-Casing

 Core

 Disturbed, Bag, Grab

 HQ Core

 Jar

 Jar and Bag

 75 mm SPT

 No Recovery

 Split Spoon/SPT

 Tube

 CRREL Core

Backfill Materials

 Asphalt

 Bentonite

 Cement/ Grout

 Drill Cuttings

 Grout

 Gravel

 Sand

 Slough

 Topsoil Backfill

Lithology - Graphical Legend[1]

 Asphalt

 Bedrock

 Cobbles/Boulders

 Clay

 Coal

 Concrete

 Fill

 Gravel

 Limestone

 Mudstone

 Organics

 Peat

 Sand

 Sandstone

 Shale

 Silt

 Siltstone

 Conglomerate

 Topsoil

 Till

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

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Testpit No: **PR1-TP01**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 71 m
Oscar Creek, Northwest Territories	UTM: 575262 E; 7258088 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - sandy, rootlets, brown, (200 mm thick)	Frozen, Vx, Vc				71
		SAND - gravelly, trace silt, trace rootlets			19.8		
1		SAND AND GRAVEL - trace silt, well graded, subrounded gravel, field estimate for greater than 20 mm diameter: 20-35% by volume	Nbn				70
2	Excavated	- (Gravel - 40%; Sand - 59%; Silt & Clay - 1%)			4.4		69
3							68
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					67
5							66

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Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP02**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 66 m
Oscar Creek, Northwest Territories	UTM: 575333 E; 7258111 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - sandy, trace gravel, rootlets, brown, (100 mm thick)	Frozen, Vx, Vc				66
		SAND - some gravel, trace silt, rootlets, grey to brown			15.7		
1		- (Gravel - 10%; Sand - 86%; Silt & Clay - 4%)			11.4		65
2	Excavated	- gravelly, no visible rootlets, field estimate for greater than 20 mm diameter: 10-15% by volume	Nbn Vc				64
3							63
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					62
5							61

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

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Testpit No: **PR1-TP03**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 67 m
Oscar Creek, Northwest Territories	UTM: 575395 E; 7258131 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - sandy, trace gravel, rootlets, brown, (200 mm thick)	Frozen, Vx, Vc				67
		SAND - gravelly, some silt, rootlets, grey to brown			18.4		
1	Excavated	- subrounded gravel, field estimate for greater than 20 mm diameter: 20-25% by volume	Vc				66
		- (Gravel - 30%; Sand - 55%; Silt & Clay - 15%)			4.7		
2							65
3		END OF TESTPIT (3.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					64
4							63
5							62

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 3 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP04**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 65 m
Oscar Creek, Northwest Territories	UTM: 575325 E; 7258164 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - sandy, trace gravel, rootlets, brown, (200 mm thick)	Frozen, Vx, Vc				65
		GRAVEL - sandy, trace silt, grey to brown, fine gravel			9.7		
1		-- poorly graded, subrounded gravel, field estimate for greater than 20 mm diameter: 15-50% by volume	Nbn				64
2	Excavated	- (Gravel - 71%; Sand - 27%; Silt & Clay - 2%)			2.1		63
3							62
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					61
5							60

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP05**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 74 m
Oscar Creek, Northwest Territories	UTM: 575189 E; 7258409 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - trace gravel, rootlets, brown	Frozen, Vx, Vc				74
		GRAVEL - sandy, trace silt, poorly graded, brown, fine subrounded gravel			12.4		
1		SAND - some gravel, trace silt, fine gravel, field estimate for greater than 20 mm diameter: 10-15% by volume	Vc				73
		- (Gravel - 18%; Sand - 81%; Silt & Clay - 1%)			4.1		
2	Excavated						72
3							71
4		END OF BOREHOLE (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					70
5							69

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP06**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 71 m
Oscar Creek, Northwest Territories	UTM: 575218 E; 7258218 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - trace gravel, rootlets, brown, (300 mm thick)	Frozen, Vx, Vc				71
		SAND AND GRAVEL - trace silt, well graded, brown, field estimate for greater than 20 mm diameter: 10-15% by volume					
1	Excavated						70
2							69
		- (Gravel - 35%; Sand - 59%; Silt & Clay - 6%)			3.4		
3							68
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					67
5							66

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP07**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 72 m
Oscar Creek, Northwest Territories	UTM: 575152 E; 7258370 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - sandy, rootlets, brown, (200 mm thick)	Frozen, Vx, Vc				72
		SAND - trace gravel, trace silt, trace roots, brown to grey			20.4		
1		GRAVEL - sandy, trace silt, poorly graded, subrounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Nbn				71
2	Excavated	- (Gravel - 61%; Sand - 34%; Silt & Clay - 5%)			2.8		70
3							69
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					68
5							67

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR1-TP08**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 1	Ground Elev: 72 m
Oscar Creek, Northwest Territories	UTM: 575197 E; 7258321 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - trace gravel, rootlets, brown, (100 mm thick)	Frozen, Nbn				72
		SAND - trace gravel, trace silt, rootlets, brown to grey	Vx, Vc				
1		GRAVEL - sandy, trace silt, poorly graded, subrounded gravel	Nbn		2.6		71
	Excavated	SAND AND GRAVEL - trace silt, poorly graded, greyish brown, field estimate for greater than 20 mm diameter: 5-10% by volume					
2							70
		- (Gravel - 44%; Sand - 52%; Silt & Clay - 4%)			3.1		
3							69
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 30% Petrographic Number (Weighted Average) = 140					68
5							67

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 13
Logged By: AR	Completion Date: 2020 January 13
Reviewed By: EG	Page 1 of 1

Testpit No: **PR2-TP01**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 2	Ground Elev: 101 m
Oscar Creek, Northwest Territories	UTM: 576659 E; 7259615 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, rootlets, dark brown, (100 mm thick)	Frozen, Vx, Vc				101
		SILT - sandy, trace gravel, brown, (300 mm thick)	Nbn		18.8		
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimated for greater than 20 mm diameter: 15-20% by volume	Vx, Vc				
1		- (Gravel - 78%; Sand - 6%; Silt & Clay - 16%)			9.3		100
2	Excavated	GRAVEL AND SAND - silty, trace clay, poorly graded	Nbn				99
3		- (Gravel - 36%; Sand - 35%; Silt & Clay - 29%)			8.2		98
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 33% Petrographic Number (Weighted Average) = 125					97
5							96

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 11
Logged By: AR	Completion Date: 2020 January 11
Reviewed By: EG	Page 1 of 1

Testpit No: **PR2-TP02**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 2	Ground Elev: 99 m
Oscar Creek, Northwest Territories	UTM: 576601 E; 7259603 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (300 mm thick)	Frozen, Vx, Vc				99
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimated for greater than 20 mm diameter: 15-20% by volume			4.5		
1		GRAVEL AND COBBLES - some sand, trace silt, trace boulders, coarse gravel, field estimate for greater than 20 mm diameter: 50-60% by volume - (Cobbles - 26%; Gravel - 51%; Sand - 14%; Silt & Clay - 9%)			6		98
		GRAVEL AND SAND - trace silt, poorly graded, subrounded gravel	Nbn				
2	Excavated						97
		- (Gravel - 55%; Sand - 40%; Silt & Clay - 5%)			3.9		
3							96
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 33% Petrographic Number (Weighted Average) = 125					95
5							94

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 11
Logged By: AR	Completion Date: 2020 January 11
Reviewed By: EG	Page 1 of 1

Testpit No: **PR2-TP03**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 2	Ground Elev: 102 m
Oscar Creek, Northwest Territories	UTM: 576578 E; 7259639 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (300 mm thick)	Frozen, Vx, Vc				102
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 20-25% by volume			4.2		
1		GRAVEL AND COBBLES - some sand, trace silt, coarse gravel, field estimate for greater than 20 mm diameter: 60-65% by volume - (Gravel - 72%; Sand - 19%; Silt & Clay - 9%)			5.5		101
2	Excavated	GRAVEL - sandy, trace silt, trace cobbles, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 20-25% by volume	Nbn				100
3		- (Cobbles - 9%; Gravel - 61%; Sand - 22%; Silt & Clay - 8%)			4.9		99
4							98
5		END OF TESTPIT (4.2 metres) Notes: LA Abrasion Loss = 33% Petrographic Number (Weighted Average) = 125					97

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4.2 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 11
Logged By: AR	Completion Date: 2020 January 11
Reviewed By: EG	Page 1 of 1

Testpit No: **PR2-TP04**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 2	Ground Elev: 104 m
Oscar Creek, Northwest Territories	UTM: 576527 E; 7259602 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (300 mm thick)	Frozen, Vx, Vc		22.4		104
		GRAVEL - sandy, trace silt, trace cobbles and boulders, well graded, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 30-35% by volume			4		
1		SAND AND GRAVEL - trace silt, poorly graded, subrounded gravel	Vc				103
2	Excavated						102
		- (Gravel - 40%; Sand - 57%; Silt & Clay - 3%)			4.1		
3							101
4							100
		END OF TESTPIT (4.5 metres) Notes: LA Abrasion Loss = 33% Petrographic Number (Weighted Average) = 125					
5							99

Contractor: HRN Contracting Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 11
Logged By: AR	Completion Date: 2020 January 11
Reviewed By: EG	Page 1 of 1

Testpit No: **PR2-TP05**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 2	Ground Elev: 104 m
Oscar Creek, Northwest Territories	UTM: 576502 E; 7259636 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, rootlets, dark brown, (100 mm thick)	Frozen, Vx, Vc				104
		SILT - sandy, brown, (300 mm thick)					
		GRAVEL - sandy, trace silt, well graded, greyish brown, coarse subrounded to rounded gravel, field estimate for grater than 20 mm diameter: 30-35% by volume					
1					2.8		103
		SAND AND GRAVEL - trace silt, poorly graded, subrounded gravel	Nbn				
2	Excavated						102
		- (Gravel - 47%; Sand - 47%; Silt & Clay - 6%)					
3					5.3		101
4							100
		END OF TESTPIT (4.2 metres) Notes: LA Abrasion Loss = 33% Petrographic Number (Weighted Average) = 125					
5							99

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4.2 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 11
Logged By: AR	Completion Date: 2020 January 11
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP01**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 109 m
Oscar Creek, Northwest Territories	UTM: 575127 E; 7259927 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vc				109
		SILT - sandy, trace gravel, brown, (300 mm thick)	Nbn				
		GRAVEL - sandy, trace silt, poorly graded, brown, black flaky shale particles, coarse gravel, field estimate for greater than 20 mm diameter: 30-35% by volume	Vc		3		
1							108
		- field estimate for greater than 20 mm diameter: 15-20% by volume	Nbn				
2	Excavated						107
					4.1		
3		- (Gravel - 76%; Sand - 22%; Silt & Clay - 2%)					106
4							105
		END OF TESTPIT (4.2 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					
5							104

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4.2 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP02**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 105 m
Oscar Creek, Northwest Territories	UTM: 575055 E; 7259947 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vc, Vx Nbn				105
		SILT - sandy, trace gravel, brown, (200 mm thick)					
		GRAVEL - sandy, trace silt, poorly graded, brown, black flaky shale particles, coarse gravel, field estimate for greater than 20 mm diameter: 15-20% by volume			3		
1		SILT - sandy, trace gravel, brown - (Gravel - 3%; Sand - 31%; Silt & Clay - 66%)			18		104
	Excavated	GRAVEL - sandy, trace silt, poorly graded, brown					
2							103
		- (Gravel - 63%; Sand - 32%; Silt & Clay - 5%)			4.5		
3							102
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					101
5							100

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

TETRA TECH

Testpit No: **PR3-TP03**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 111 m
Oscar Creek, Northwest Territories	UTM: 575172 E; 7260013 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (200 mm thick)	Frozen, Vc, Vx				111
		SILT - sandy, trace gravel, brown, (300 mm thick)	Nbn				
		GRAVEL - sandy, trace silt, poorly graded, brown, black flaky shale particles, coarse gravel, field estimate for greater than 20 mm diameter: 30-35% by volume	Vx, Vc				
1		- (Gravel - 75%; Sand - 23%; Silt & Clay - 2%)			2.5		110
		- field estimate for greater than 20 mm diameter: 15-20% by volume	Nbn				
2	Excavated						109
		- (Gravel - 74%; Sand - 24%; Silt & Clay - 2%)			2.9		
3							108
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					107
5							106

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP04**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 107 m
Oscar Creek, Northwest Territories	UTM: 575071 E; 7260023 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vx, Vc				107
		SILT - sandy, trace gravel, brown	Nbn		3.9		
		GRAVEL - some sand, trace silt, poorly graded, brown, black flaky shale particles, coarse subrounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Vx, Vc				
1							106
2	Excavated						105
		- (Gravel - 80%; Sand - 18%; Silt & Clay - 2%)			3.7		
3							104
4							103
		END OF TESTPIT (4.5 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					
5							102

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP05**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 116 m
Oscar Creek, Northwest Territories	UTM: 575345 E; 7260844 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vx, Vc				116
		SILT - sandy, trace gravel, brown, (300 mm thick)	Nbn				
		GRAVEL - some sand, trace silt, poorly graded, fine subrounded gravel, field estimate for greater than 20 mm diameter: 5-10% by volume					
1	Excavated	- (Gravel - 81%; Sand - 17%; Silt & Clay - 2%)			3.2		115
2		- sandy, coarse gravel					114
3		- (Gravel - 64%; Sand - 35%; Silt & Clay - 1%)			4.1		113
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					112
5							111

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

TETRA TECH

Testpit No: **PR3-TP06**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 117 m
Oscar Creek, Northwest Territories	UTM: 575336 E; 7260908 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vx, Vc				117
		SILT - sandy, trace gravel, brown	Nbn				
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Vx, Vc				
1					4.2		116
2	Excavated	SAND - some gravel, trace silt, grey to brown	Vc				115
		- (Gravel - 20%; Sand - 76%; Silt & Clay - 4%)			4.6		
3							114
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Nbn				
		- (Gravel - 73%; Sand - 26%; Silt & Clay - 1%)					
4					2.7		113
		END OF TESTPIT (4.5 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					
5							112

Contractor: HRN Contracting Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP07**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 117 m
Oscar Creek, Northwest Territories	UTM: 575309 E; 7260890 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (200 mm thick)	Frozen, Vx, Vc				117
		SILT - sandy, trace gravel, brown	Nbn		6.7	●	
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume					
1							116
	Excavated						
		- (Gravel - 73%; Sand - 22%; Silt & Clay - 5%)					
2					6.2	●	115
3							114
		END OF TESTPIT (3.5 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					
4							113
5							112

TETRA TECH

Contractor: HRN Contracting Ltd.	Completion Depth: 3.5 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

Testpit No: **PR3-TP08**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 114 m
Oscar Creek, Northwest Territories	UTM: 575291 E; 7260947 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Nbn				114
		SILT - sandy, trace gravel, brown					
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Vc				
1					3.9		113
		SAND AND GRAVEL - trace silt, grey to brown	Nbn				
2	Excavated						112
		- (Gravel - 36%; Sand - 60%; Silt & Clay - 4%)			5.2		
3							111
		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume - (Gravel - 70%; Sand - 27%; Silt & Clay - 3%)					
4					3.2		110
		END OF TESTPIT (4.5 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					
5							109

Contractor: HRN Contracting Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

NORTHERN ZONE9.GPJ EBA.GDT 20-10-13

Testpit No: **PR3-TP09**

Project: Oscar Creek Granular Prospects Assessment	Project No: ENG.YARC03255-01
Location: Prospect 3	Ground Elev: 112 m
Oscar Creek, Northwest Territories	UTM: 575247 E; 7260981 N; Z 9

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		TOPSOIL - silty, trace gravel, rootlets, dark brown, (100 mm thick)	Frozen, Vc				112
		SILT - sandy, trace gravel, brown	Nbn		15.5		
1		GRAVEL - sandy, trace silt, greyish brown, coarse subrounded to rounded gravel, field estimate for greater than 20 mm diameter: 15-20% by volume	Vc				111
		- (Gravel - 75%; Sand - 23%; Silt & Clay - 2%)			3.2		
2	Excavated	SAND - gravelly, trace silt, grey to brown	Nbn				110
		- (Gravel - 28%; Sand - 68%; Silt & Clay - 4%)			4.8		
3							109
4		END OF TESTPIT (4.0 metres) Notes: LA Abrasion Loss = 31% Petrographic Number (Weighted Average) = 204					108
5							107

Contractor: HRN Contracting Ltd.	Completion Depth: 4 m
Drilling Rig Type: John Deere 270D LC Excavator	Start Date: 2020 January 12
Logged By: AR	Completion Date: 2020 January 12
Reviewed By: EG	Page 1 of 1

TETRA TECH

APPENDIX C

GEOTECHNICAL LABORATORY TEST RESULTS

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Oscar Creek Bridge Geotechnical Invest.	Sample No.:	7198
Project No.:	704-ENG.YARC03255-01	Date Tested:	April 7, 2020
Client:	Government of Northwest Territories	Tested By:	SI
Address:	Near MVWR km 1054, Prospect 1	Page:	1 of 1

B.H. Number	Depth (m)	Moisture Content (%)	Visual Description of Soil
TP 01	0.0 - 1.0	19.8	CLAY, silty, sandy, organics, rootlets, brown
TP 02	0.4 - 2.0	15.7	CLAY, silty, sandy, organics, rootlets, brown
TP 03	0.0 - 0.4	18.4	CLAY, silty, some sand, occasional gravel, reddish brown
TP 04	0.0 - 0.4	9.7	SAND, silty, clayey, some gravel, brown
TP 05	0.5 - 1.0	12.4	SILT and SAND, some clay, trace gravel, light brown
TP 07	0.4 - 1.0	20.4	SILT and SAND, some clay, trace gravel, light brown
TP 08	1.0 - 1.5	2.6	SAND and GRAVEL, trace silt, brown

Reviewed By: _____ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Oscar Creek Bridge Geotechnical Invest.	Sample No.:	7199
Project No.:	704-ENG.YARC03255-01	Date Tested:	April 7, 2020
Client:	Government of Northwest Territories	Tested By:	SI
Address:	Near MVWR km 1054, Prospect 2	Page:	1 of 1

B.H. Number	Depth (m)	Moisture Content (%)	Visual Description of Soil
TP 01	0.0 - 4.0	18.8	CLAY, silty, some sand, trace gravel, organics, rootlets, orangey brown
TP 02	0.2 - 0.8	4.5	GRAVEL and SAND, some silt, trace clay, rootlets, brown
TP 03	0.4 - 1.0	4.2	GRAVEL, some sand, trace silt, brown
TP 04	0.0 - 0.3	22.4	CLAY, silty, some sand, trace gravel, mottled orange and brown, medium plasticity
TP 04	0.3 - 1.2	4.0	SAND, some gravel, trace silt, brown
TP 05	0.4 - 1.6	2.8	GRAVEL, trace sand, trace silt, brown

Reviewed By: _____ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Oscar Creek Bridge Geotechnical Invest.	Sample No.:	7200
Project No.:	704-ENG.YARC03255-01	Date Tested:	April 8, 2020
Client:	Government of Northwest Territories	Tested By:	SI
Address:	Near MVWR km 1054, Prospect 3	Page:	1 of 1

B.H. Number	Depth (m)	Moisture Content (%)	Visual Description of Soil
TP 01	0.4 - 1.0	3.0	GRAVEL and SAND, trace silt, brown
TP 01	1.4 - 4.2	4.1	GRAVEL, some sand, trace silt/clay, brown
TP 02	0.3 - 1.0	3.0	GRAVEL, some sand, trace silt/clay, brown
TP 04	0.0 - 0.6	3.9	GRAVEL, some sand, trace silt/clay, brown
TP 04	0.6 - 4.5	3.7	GRAVEL, some sand, trace silt/clay, brown
TP 06	0.5 - 2.0	4.2	SAND, some gravel, trace silt, brown
TP 07	0.0 - 0.6	6.7	SAND, trace silt, brown
TP 07	0.6 - 3.5	6.2	GRAVEL, sandy, trace silt/clay, brown
TP 08	0.5 - 1.2	3.9	SAND, gravelly, trace silt, brown
TP 09	0.0 - 1.0	15.5	SAND, trace gravel and silt and clay, reddish brown

Reviewed By: _____ P.Eng.

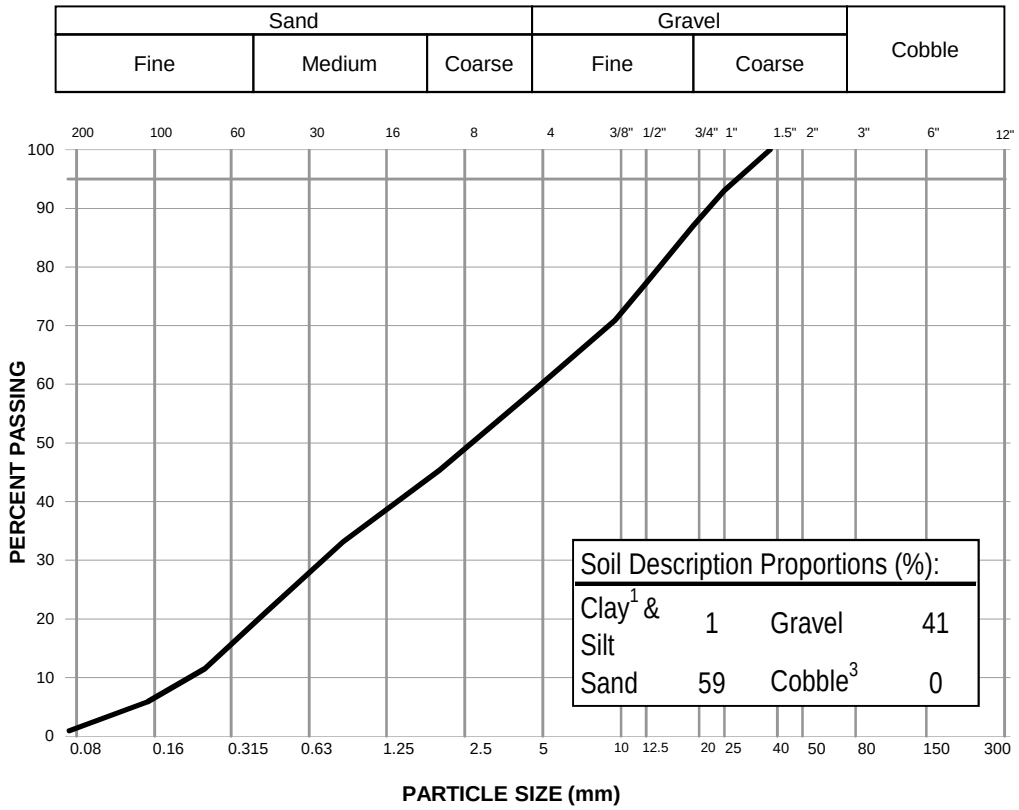
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	2
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP01
Client:	Government of Northwest Territories	Sample Depth:	1.0-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: LL	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 22.4
Moisture Content:	4.4%		Cc: 0.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	93
19	87
12.5	77
9.5	71
4.75	59
2	45
0.85	33
0.425	21
0.25	12
0.15	6
0.075	0.9



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 14%

Reviewed By: JDR P.Eng.

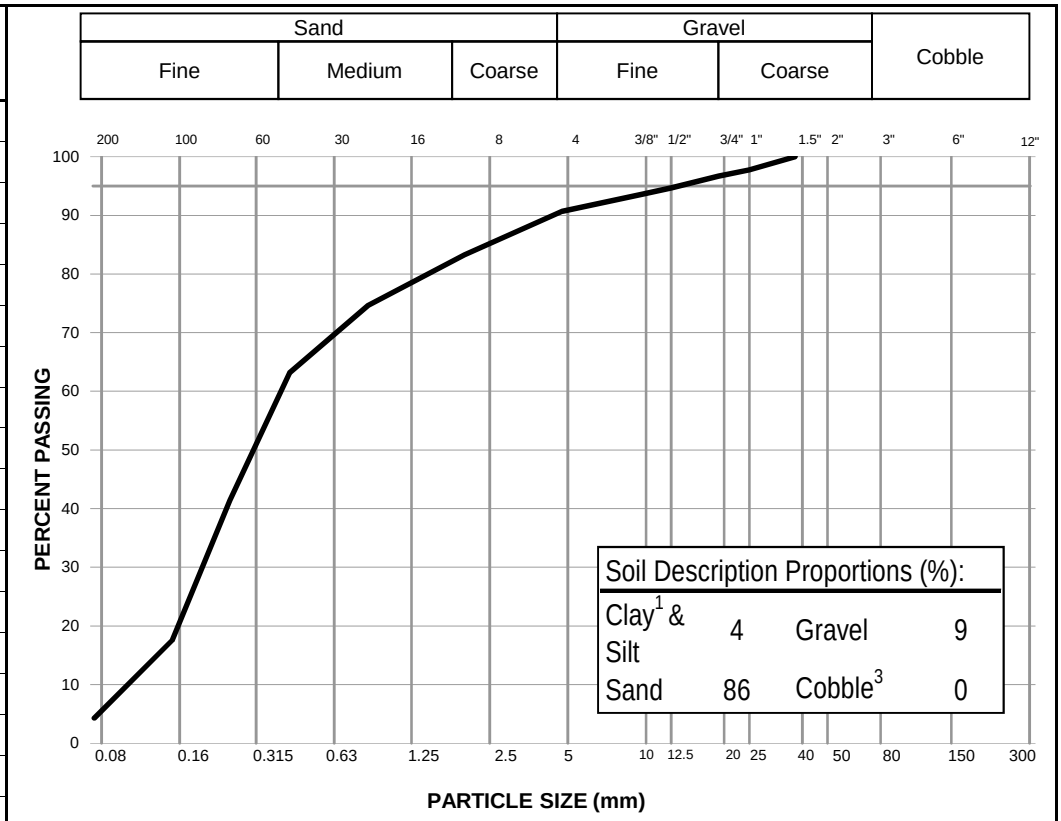
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	4
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP02
Client:	Government of Northwest Territories	Sample Depth:	0.4-2.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: LL	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND, trace gravel, silt, brown	Sampled By:	AR
		USC Classification:	Cu: 3.7
Moisture Content:	11.4%		Cc: 1.0

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	98
19	97
12.5	95
9.5	93
4.75	91
2	83
0.85	75
0.425	63
0.25	41
0.15	18
0.075	4.3



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 31%

Reviewed By: _____ P.Eng.

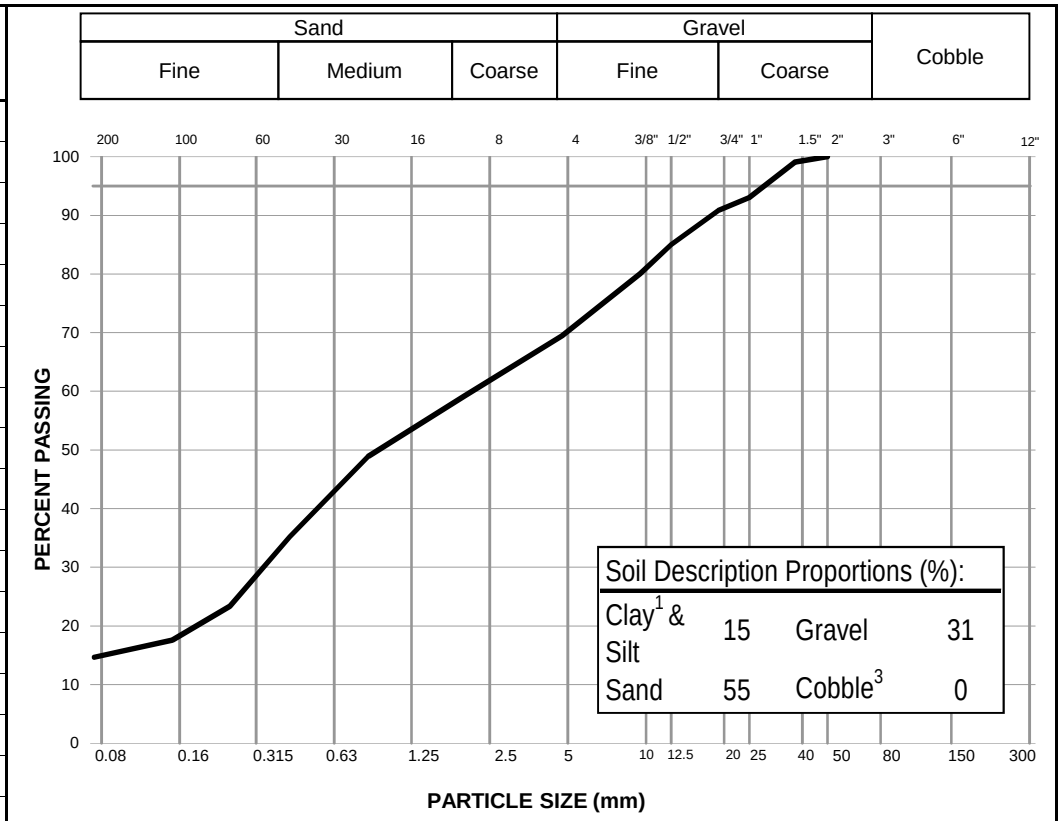
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	6
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP03
Client:	Government of Northwest Territories	Sample Depth:	0.4-3.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: SG	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND, gravelly, some silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: #N/A
Moisture Content:	4.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	99
25	93
19	91
12.5	85
9.5	80
4.75	69
2	59
0.85	49
0.425	35
0.25	23
0.15	18
0.075	14.7



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 77%

Reviewed By: JDR P.Eng.

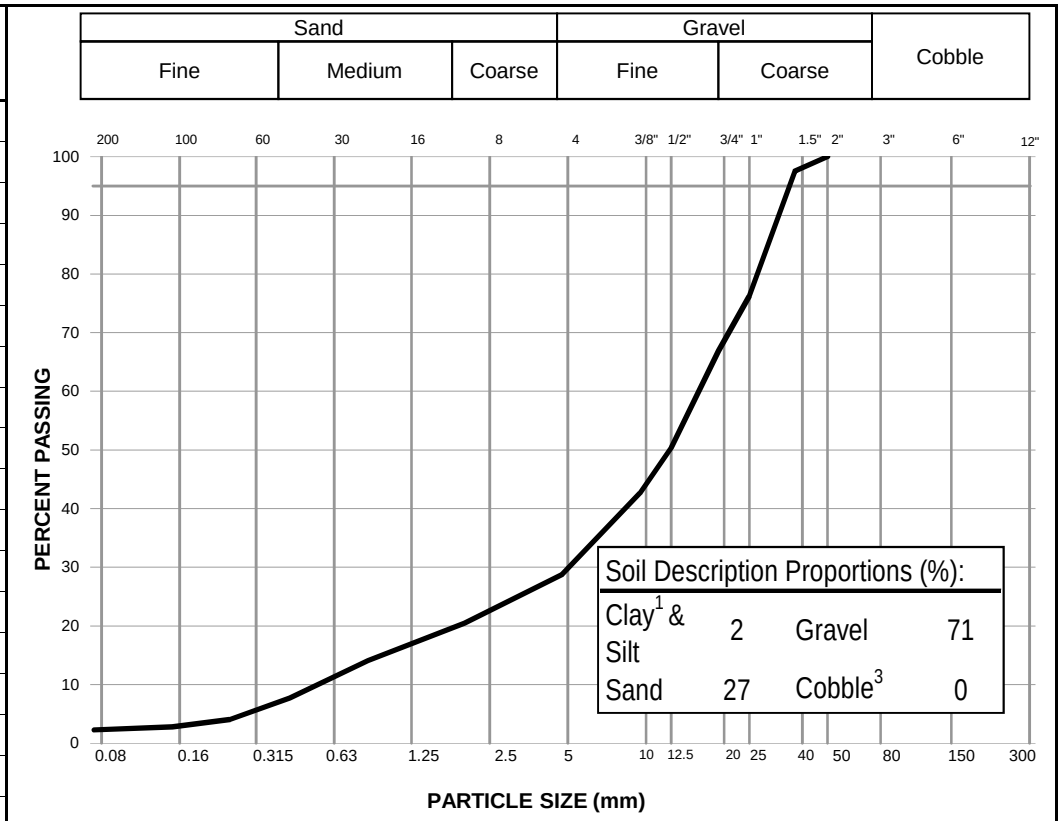
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	8
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP04
Client:	Government of Northwest Territories	Sample Depth:	0.4-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: SG	Date Sampled:	January 13, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 28.2
Moisture Content:	2.1%		Cc: 2.8

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	98
25	76
19	67
12.5	50
9.5	43
4.75	29
2	20
0.85	14
0.425	8
0.25	4
0.15	3
0.075	2.3



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 68%

Reviewed By: JDR P.Eng.

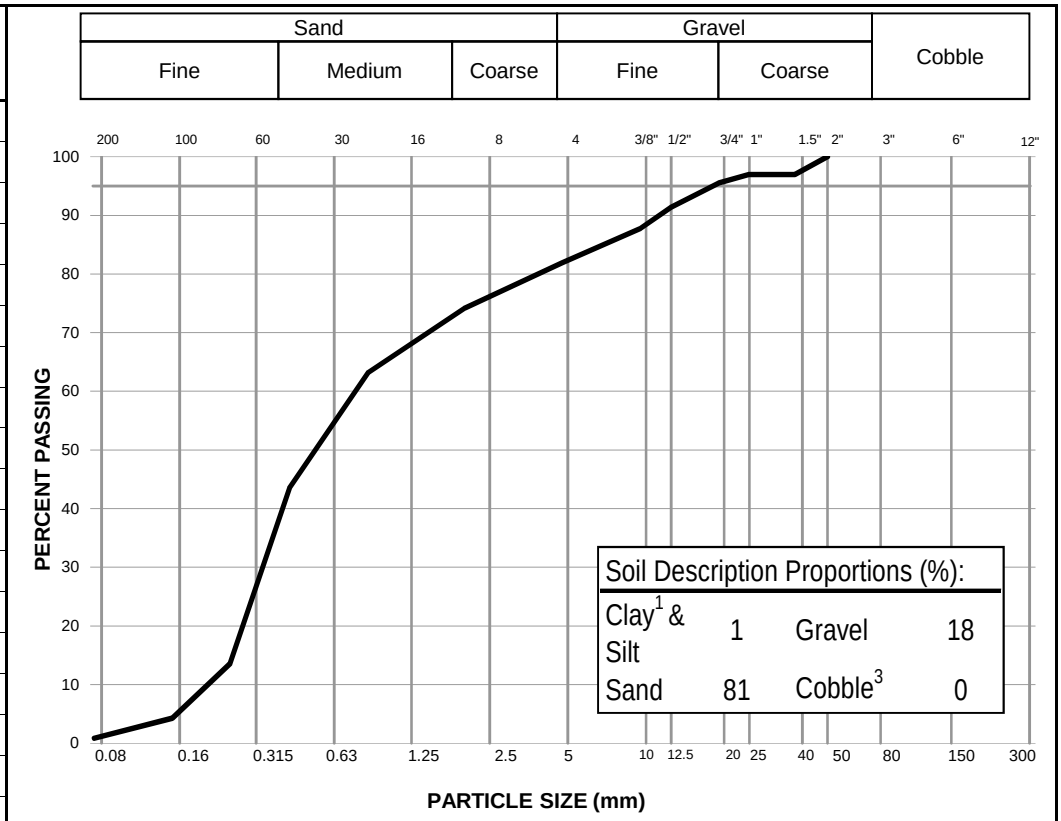
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	10
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP05
Client:	Government of Northwest Territories	Sample Depth:	1.0-2.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: LL	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND, some gravel, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 3.7
Moisture Content:	4.1%		Cc: 0.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	97
25	97
19	95
12.5	91
9.5	88
4.75	82
2	74
0.85	63
0.425	44
0.25	14
0.15	4
0.075	0.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 61%

Reviewed By: JDR P.Eng.

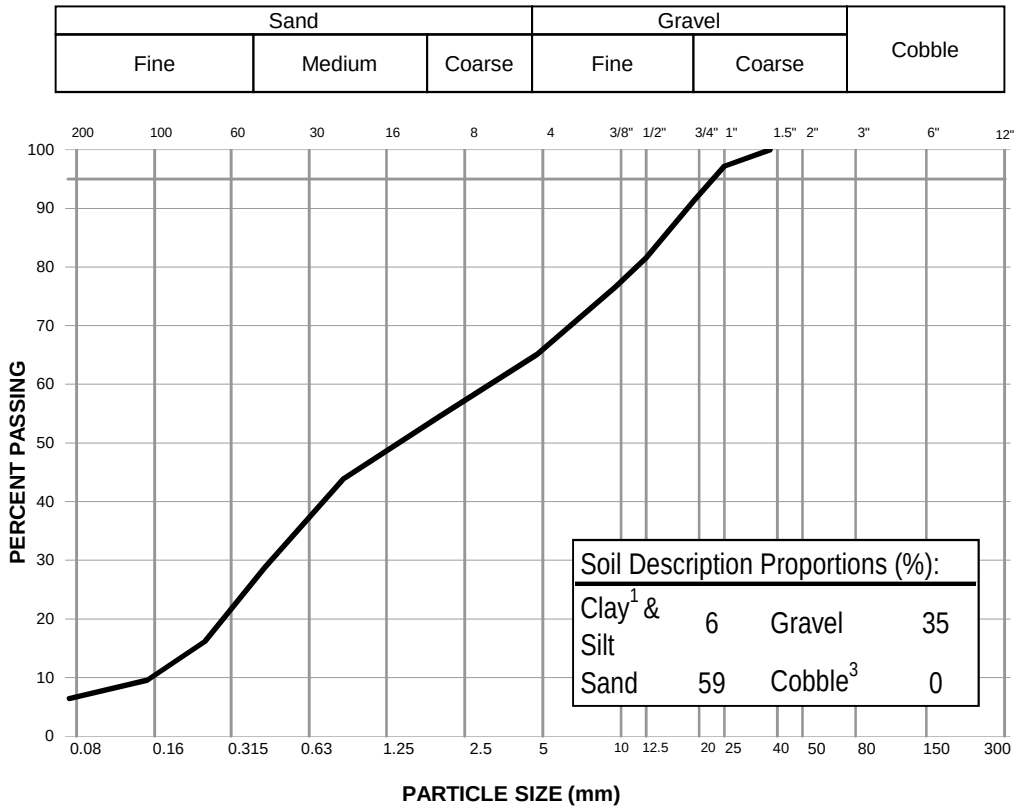
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	11 & 12 Combined
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP06
Client:	Government of Northwest Territories	Sample Depth:	1.8-2.4 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: SG	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 21.8
Moisture Content:	3.4%		Cc: 0.4

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	97
19	91
12.5	82
9.5	77
4.75	65
2	55
0.85	44
0.425	29
0.25	16
0.15	10
0.075	6.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 66%

Reviewed By: JDR P.Eng.

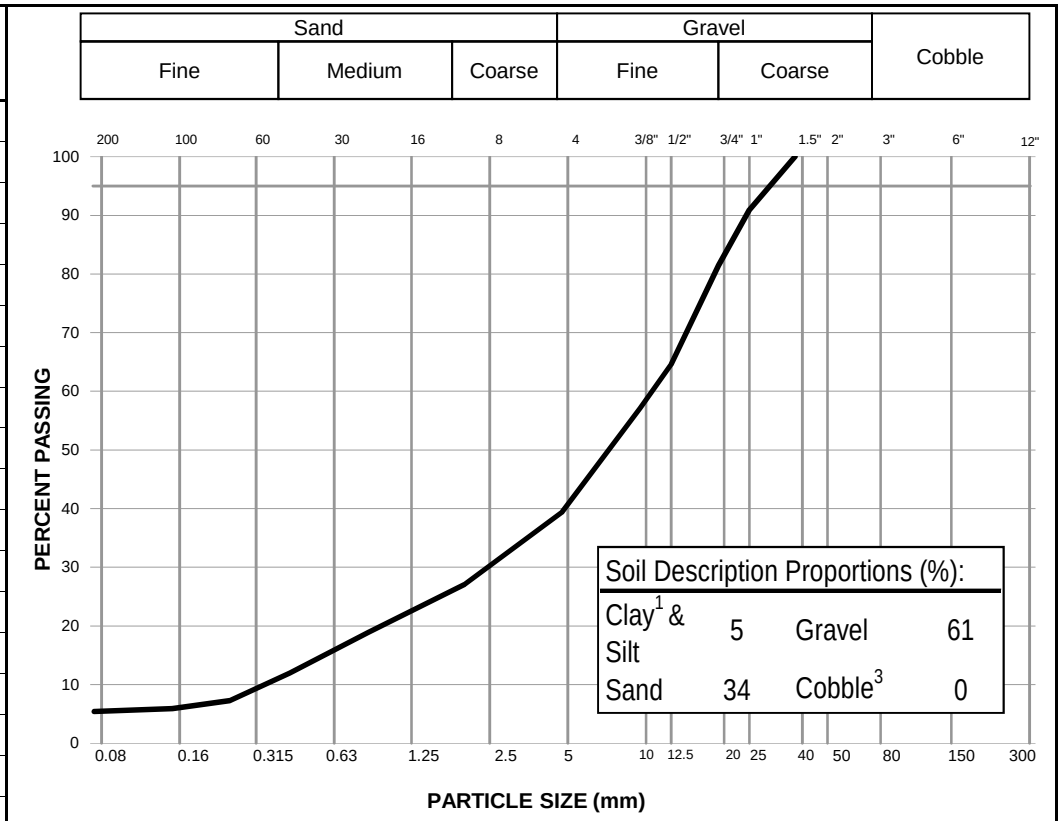
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	14
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP07
Client:	Government of Northwest Territories	Sample Depth:	1.0-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: SG	Date Sampled:	January 13, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 30.3
Moisture Content:	2.8%		Cc: 1.9

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	91
19	81
12.5	65
9.5	57
4.75	39
2	27
0.85	19
0.425	12
0.25	7
0.15	6
0.075	5.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 75%

Reviewed By: JDR P.Eng.

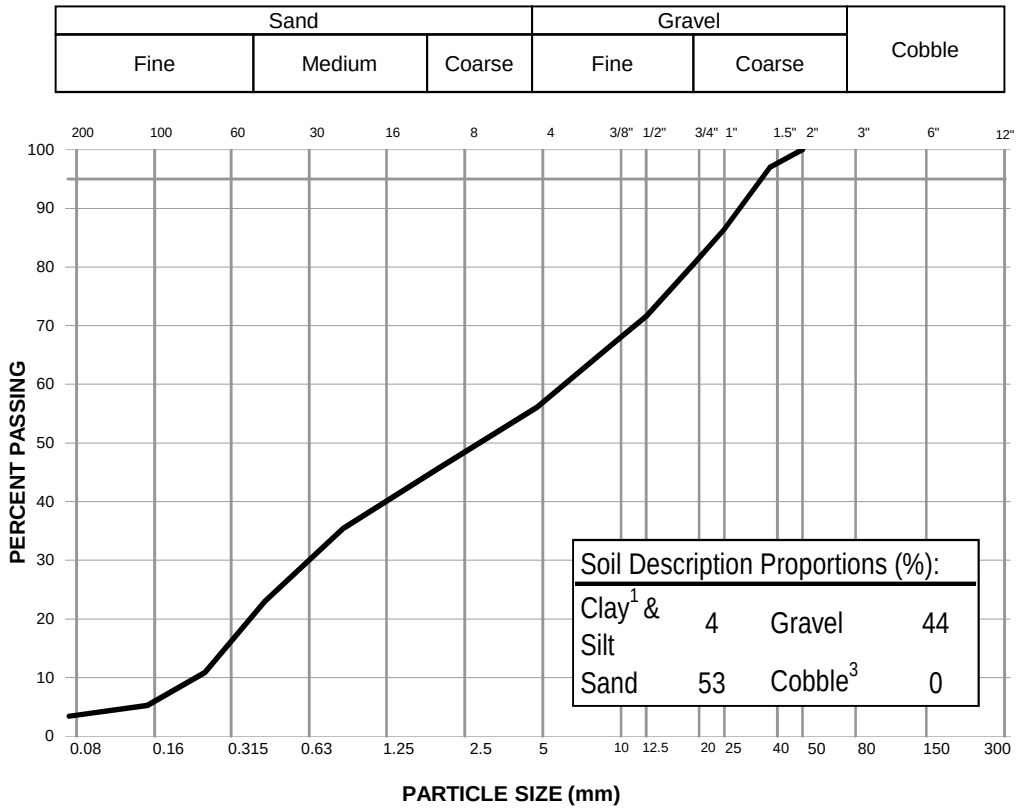
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	16
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 1, TP08
Client:	Government of Northwest Territories	Sample Depth:	1.5-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: SG	Date Sampled:	January 13, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 27.4
Moisture Content:	3.1%		Cc: 0.3

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	97
25	86
19	80
12.5	72
9.5	67
4.75	56
2	46
0.85	35
0.425	23
0.25	11
0.15	5
0.075	3.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 66%

Reviewed By: JDR P.Eng.

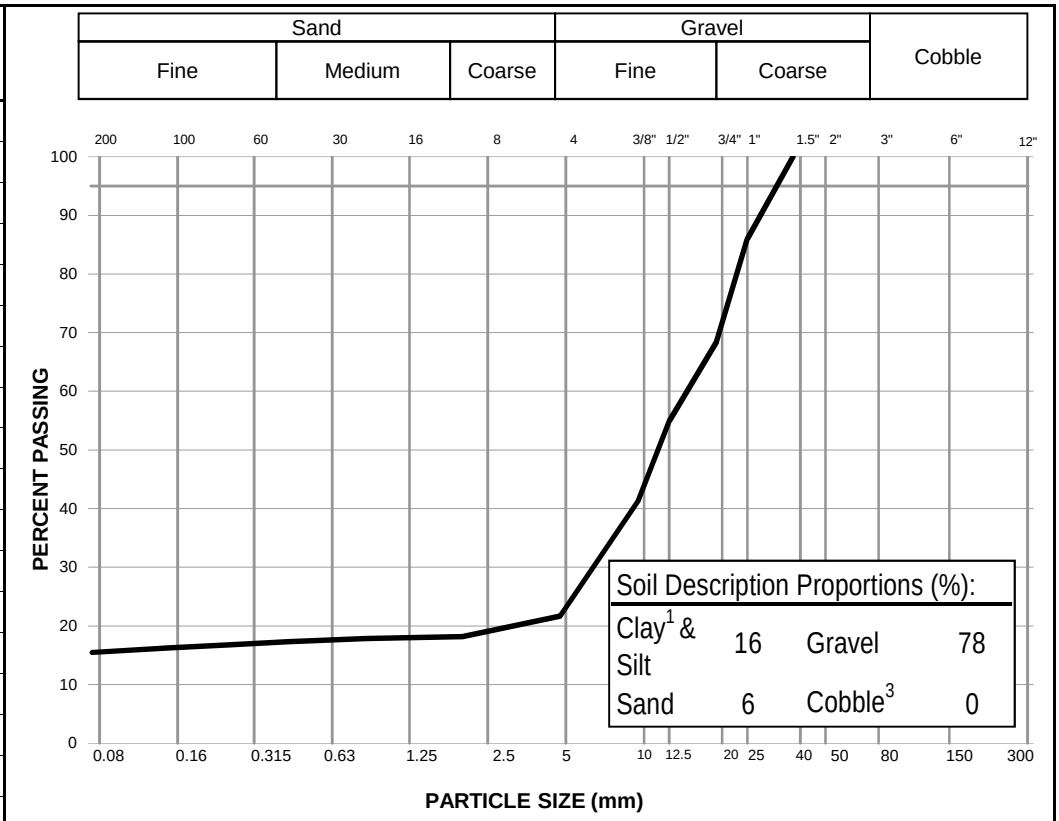
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	18
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP01
Client:	Government of Northwest Territories	Sample Depth:	0.4-2.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: LL	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL, some silt/clay, trace sand, brown	Sampled By:	AR
		USC Classification:	Cu: #N/A
Moisture Content:	9.3%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	86
19	68
12.5	55
9.5	41
4.75	22
2	18
0.85	18
0.425	17
0.25	17
0.15	16
0.075	15.5



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 21%

Reviewed By: JDR P.Eng.

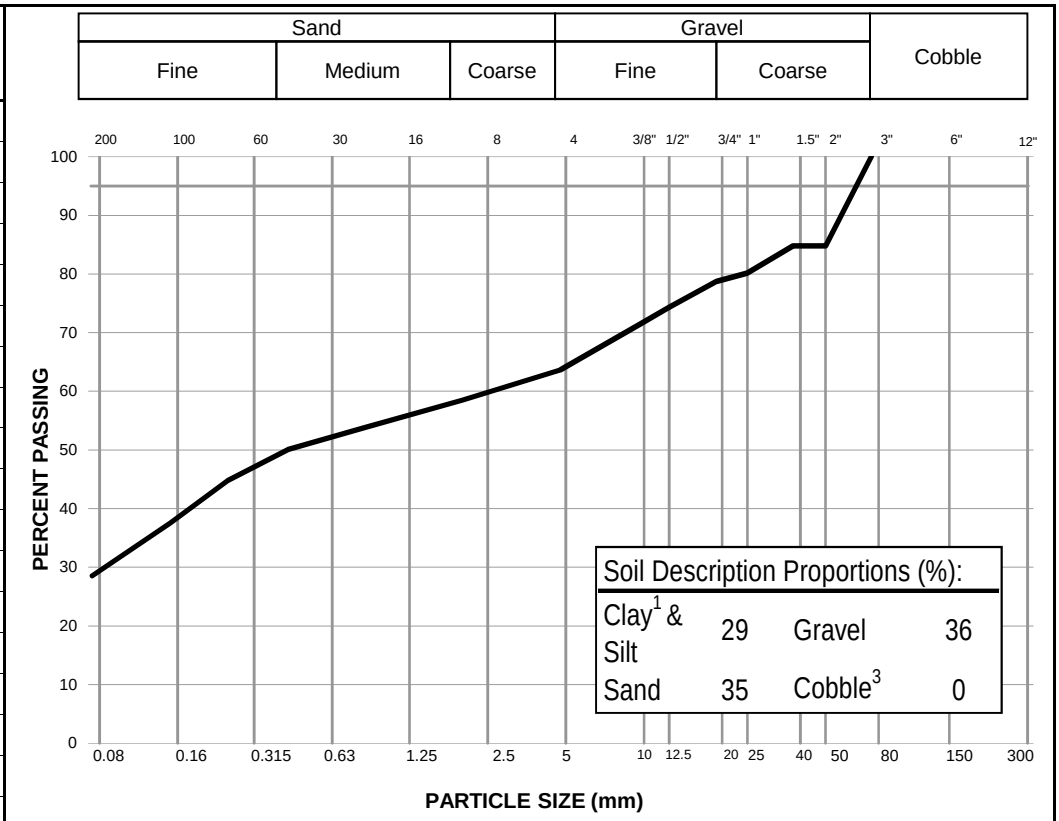
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	19
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP01
Client:	Government of Northwest Territories	Sample Depth:	2.0-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 22, 2020 By: LL	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL and SAND, silty/clayey, brown	Sampled By:	AR
		USC Classification:	Cu: #N/A
Moisture Content:	8.2%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	85
37.5	85
25	80
19	79
12.5	74
9.5	71
4.75	64
2	59
0.85	54
0.425	50
0.25	45
0.15	38
0.075	28.5



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 51%

Reviewed By: JDR P.Eng.

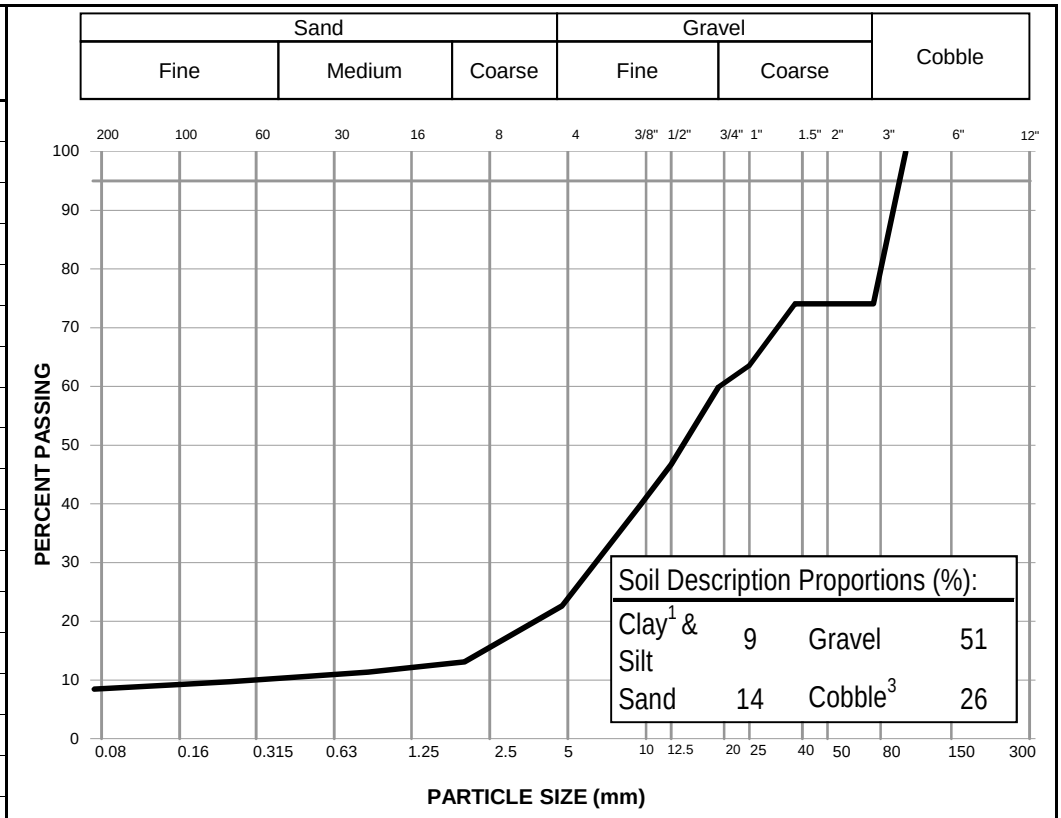
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	21
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP02
Client:	Government of Northwest Territories	Sample Depth:	0.8-1.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: SG	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL, cobbles, some sand, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 60.1
Moisture Content:	6.0%		Cc: 7.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	100
75	74
50	74
37.5	74
25	64
19	60
12.5	47
9.5	40
4.75	23
2	13
0.85	11
0.425	10
0.25	10
0.15	9
0.075	8.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 97%

Reviewed By: JDR P.Eng.

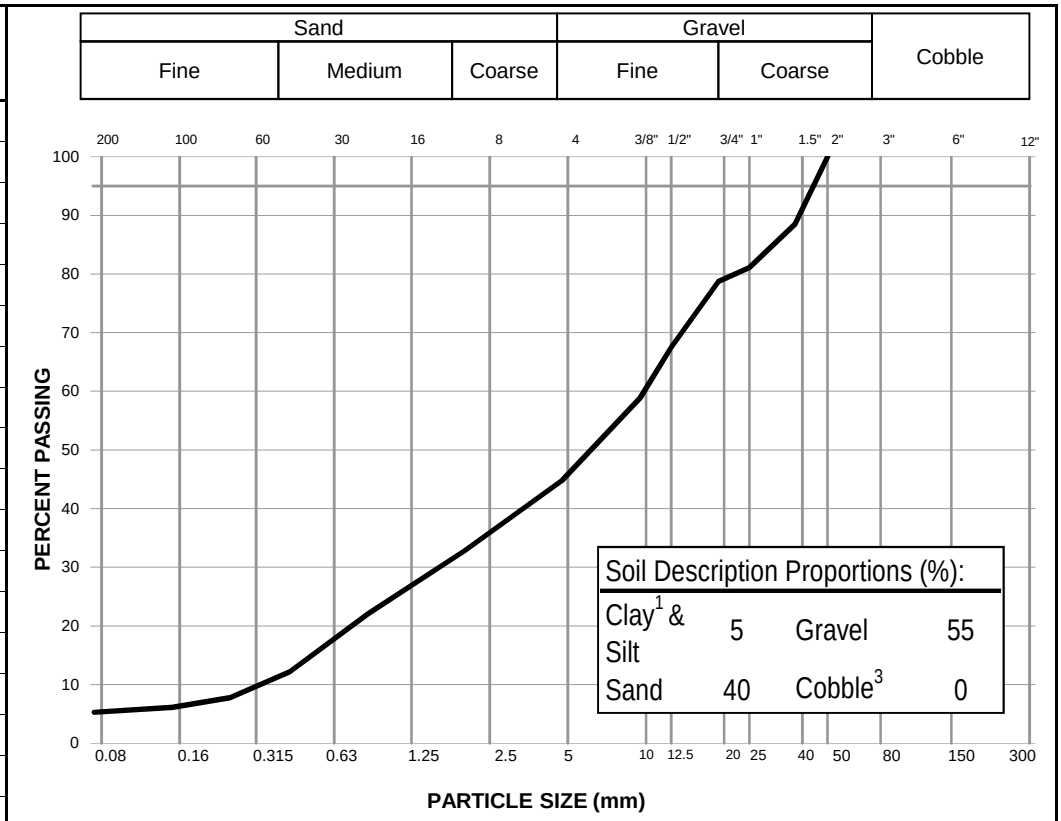
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	22
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP02
Client:	Government of Northwest Territories	Sample Depth:	1.5-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: JC	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL and SAND, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 29.2
Moisture Content:	3.9%		Cc: 0.9

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	88
25	81
19	79
12.5	68
9.5	59
4.75	45
2	33
0.85	22
0.425	12
0.25	8
0.15	6
0.075	5.3



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 33%

Reviewed By: JDR P.Eng.

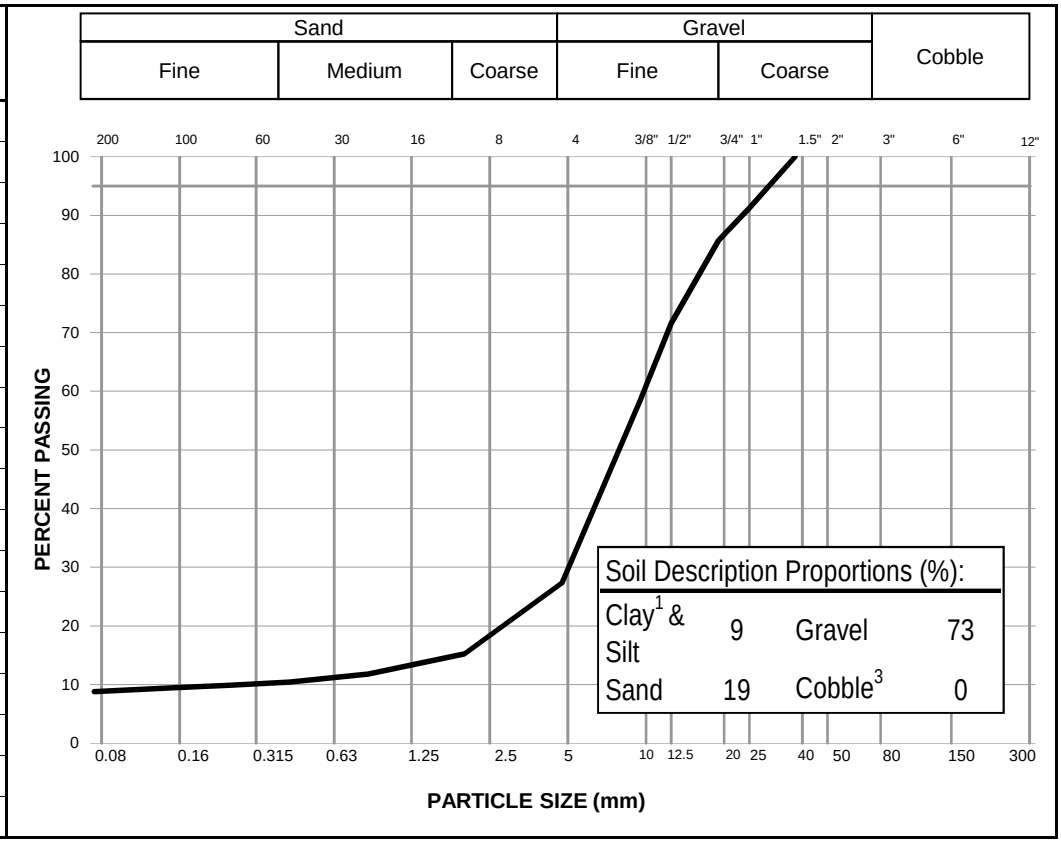
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	24
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP03
Client:	Government of Northwest Territories	Sample Depth:	1.0-1.8 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: SG	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL, some sand, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 34.7
Moisture Content:	5.5%		Cc: 9.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	91
19	86
12.5	72
9.5	58
4.75	27
2	15
0.85	12
0.425	10
0.25	10
0.15	9
0.075	8.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 90%

Reviewed By: JDR P.Eng.

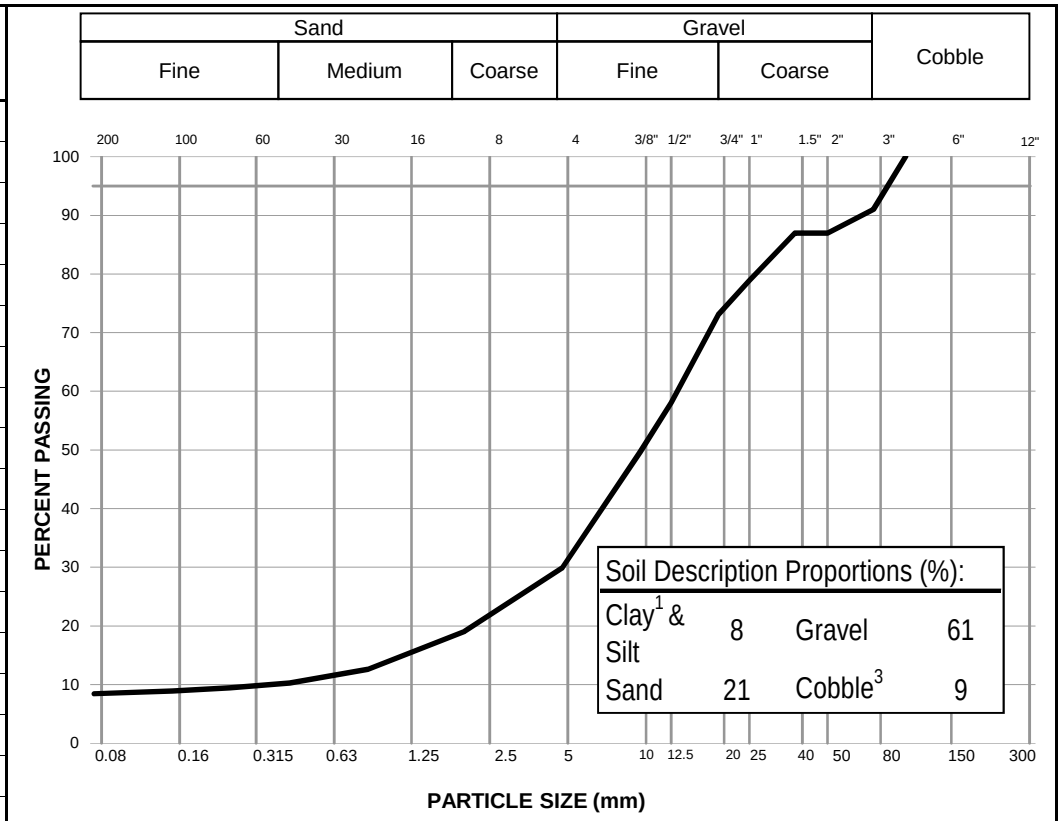
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	25
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP03
Client:	Government of Northwest Territories	Sample Depth:	1.8-4.2 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: SG	Date Sampled:	January 11, 2020
Soil Description[2]:	GRAVEL, sandy, trace cobbles, silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 36.3
Moisture Content:	4.9%		Cc: 4.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	100
75	91
50	87
37.5	87
25	79
19	73
12.5	58
9.5	50
4.75	30
2	19
0.85	13
0.425	10
0.25	9
0.15	9
0.075	8.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 92%

Reviewed By: JDR P.Eng.

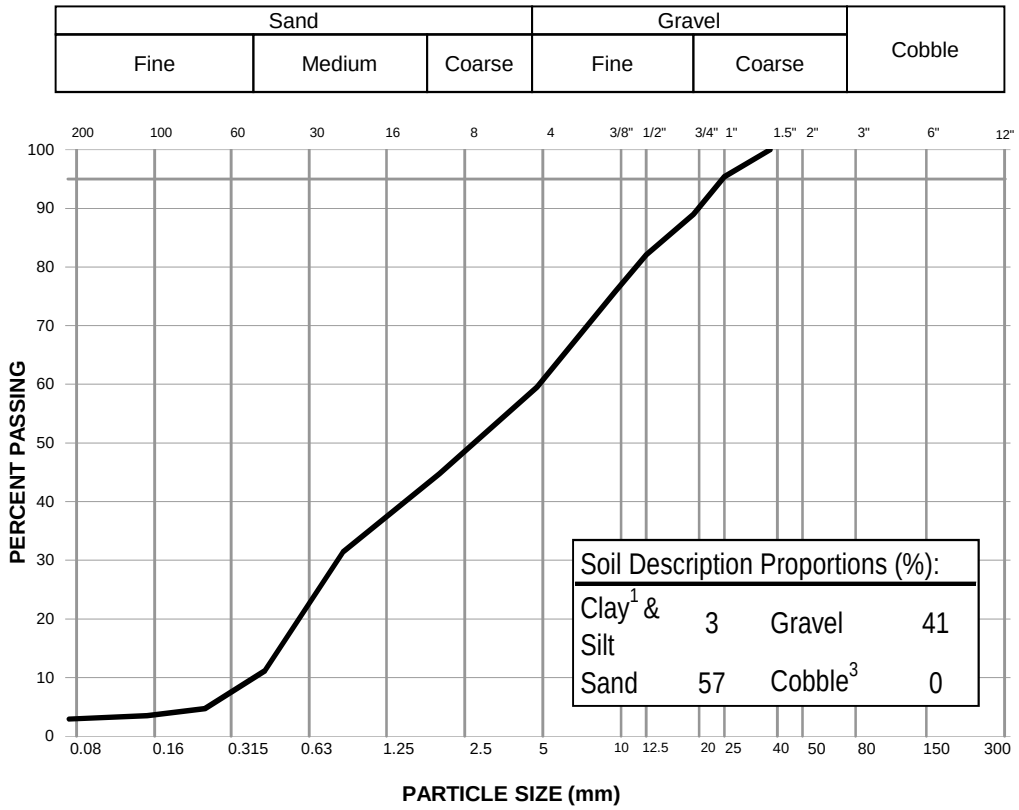
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	28
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP04
Client:	Government of Northwest Territories	Sample Depth:	1.2-4.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: JC	Date Sampled:	January 11, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 12.4
Moisture Content:	4.1%		Cc: 0.3

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	95
19	89
12.5	82
9.5	76
4.75	60
2	45
0.85	31
0.425	11
0.25	5
0.15	4
0.075	2.9



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 26%

Reviewed By: JDR P.Eng.

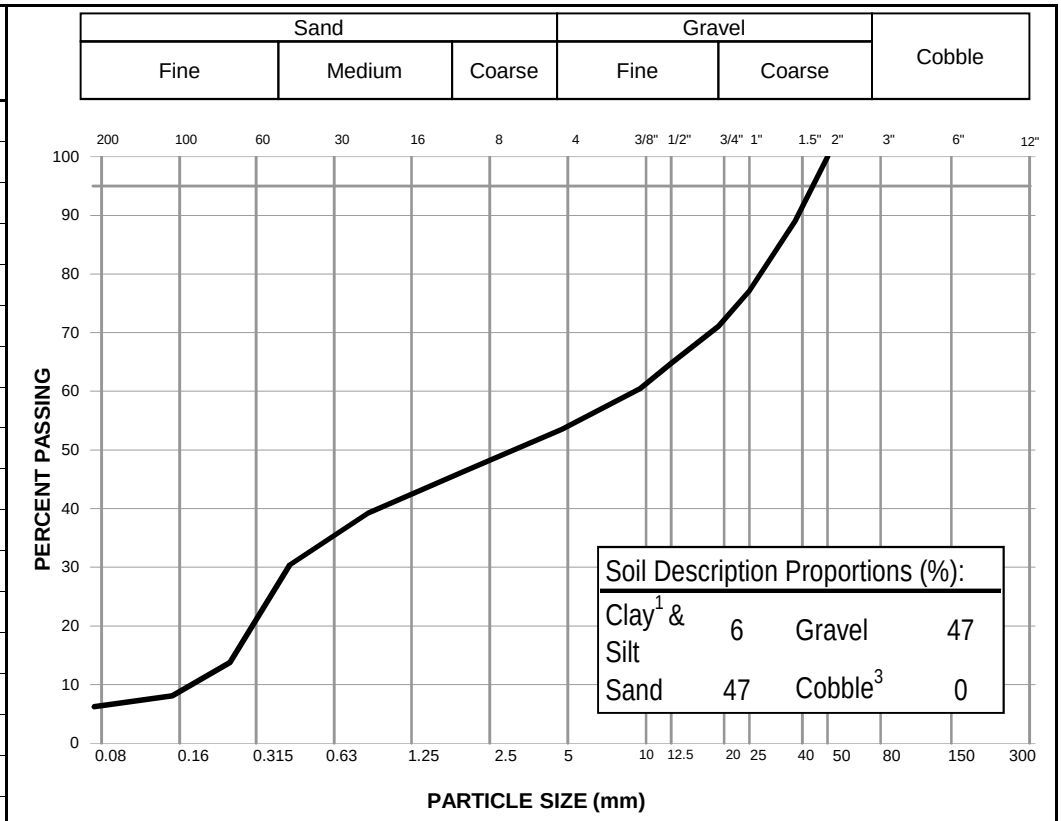
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	30
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 2, TP05
Client:	Government of Northwest Territories	Sample Depth:	1.6-4.2 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: JC	Date Sampled:	January 11, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 50.1
Moisture Content:	5.3%		Cc: 0.1

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	89
25	77
19	71
12.5	65
9.5	60
4.75	54
2	46
0.85	39
0.425	30
0.25	14
0.15	8
0.075	6.2



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 42%

Reviewed By: JDR P.Eng.

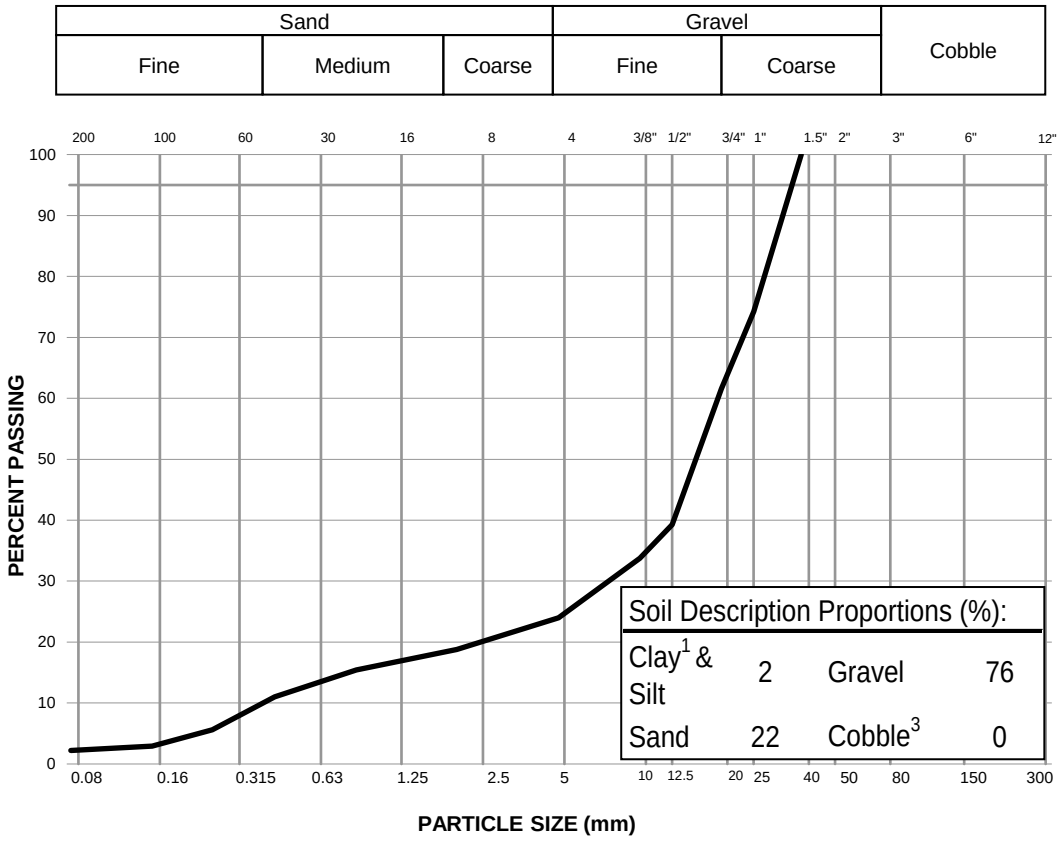
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	7200-02
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, Testpit 01
Client:	Government of Northwest Territories	Sample Depth:	1.4 - 4.2 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 8, 2020 By: SI	Date sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	GP Cu: 47.3
Moisture Content:	4.1%		Cc: 8.1

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	74
19	62
12.5	39
9.5	34
4.75	24
2	19
0.85	15
0.425	11
0.25	6
0.15	3
0.075	2.2



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

_____

Reviewed By: _____ P.Eng.

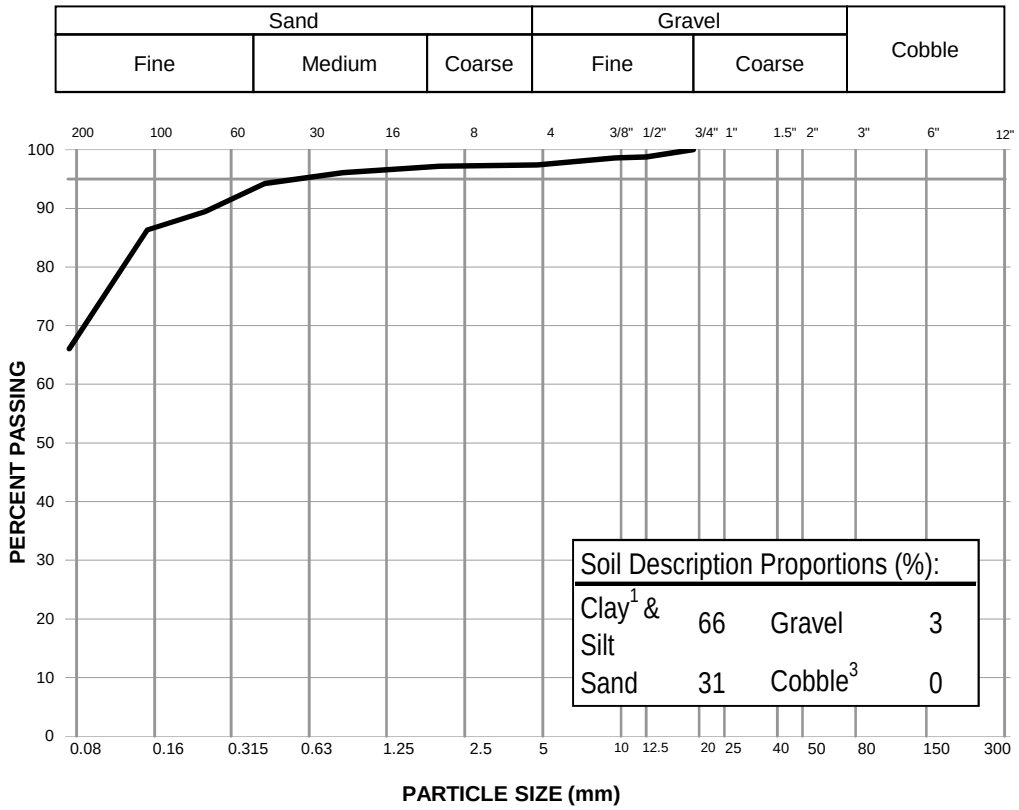
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	34
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP02
Client:	Government of Northwest Territories	Sample Depth:	1.0-1.3 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 24, 2020 By: JC	Date Sampled:	January 12, 2020
Soil Description[2]:	SILT/CLAY, sandy, trace gravel, brown	Sampled By:	AR
		USC Classification:	Cu: #N/A
Moisture Content:	18.0%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	
25	
19	100
12.5	99
9.5	99
4.75	97
2	97
0.85	96
0.425	94
0.25	89
0.15	86
0.075	66.1



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 56%

Reviewed By: JDR P.Eng.

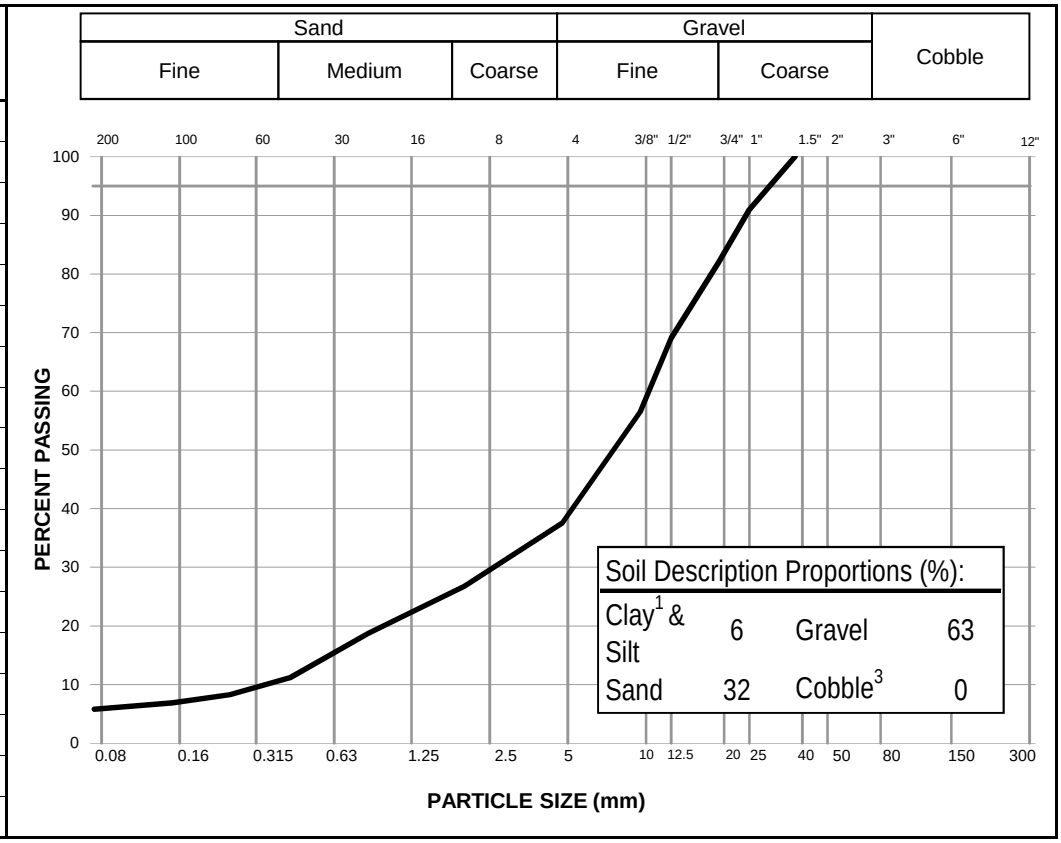
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	35
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP02
Client:	Government of Northwest Territories	Sample Depth:	1.3-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 23, 2020 By: JC	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 29.1
Moisture Content:	4.5%		Cc: 2.2

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	91
19	82
12.5	69
9.5	56
4.75	38
2	27
0.85	19
0.425	11
0.25	8
0.15	7
0.075	5.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 16%

Reviewed By: JDR P.Eng.

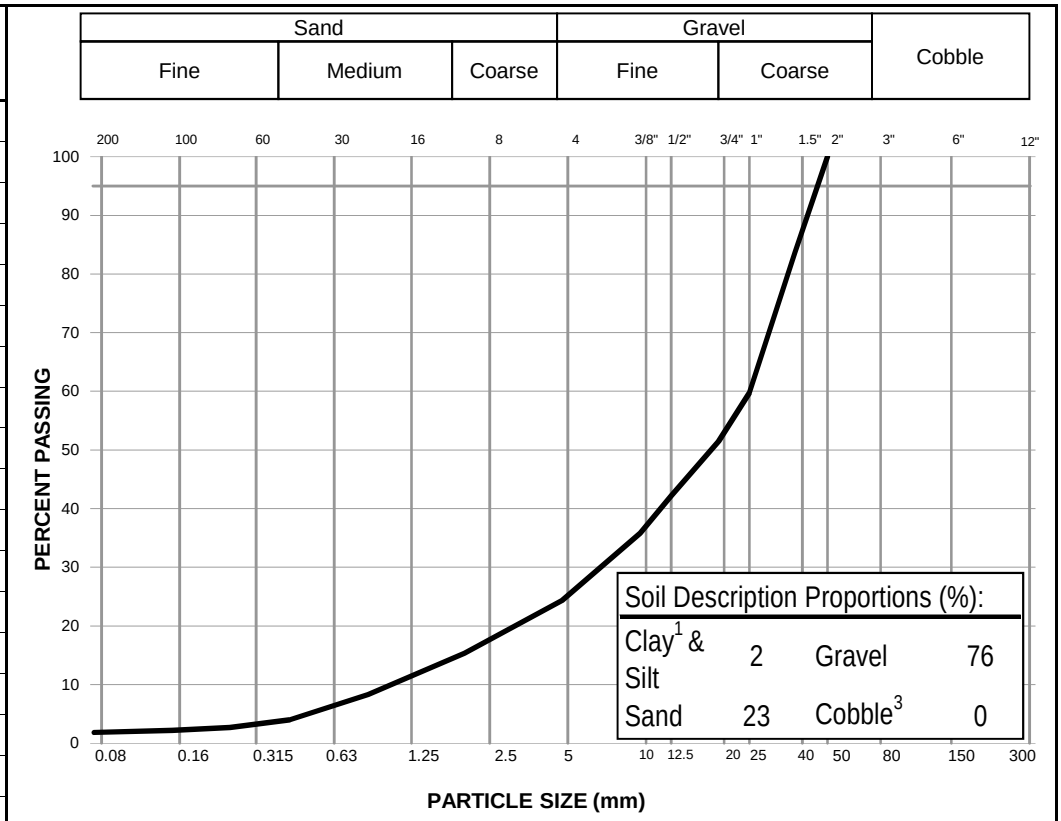
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	36
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP03
Client:	Government of Northwest Territories	Sample Depth:	0.5-1.6 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 24, 2020 By: JC	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 22.3
Moisture Content:	2.5%		Cc: 1.8

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	84
25	60
19	51
12.5	42
9.5	36
4.75	24
2	15
0.85	8
0.425	4
0.25	3
0.15	2
0.075	1.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 31%

Sample bag marked "0.3-0.6 m"

Reviewed By: JDR P.Eng.

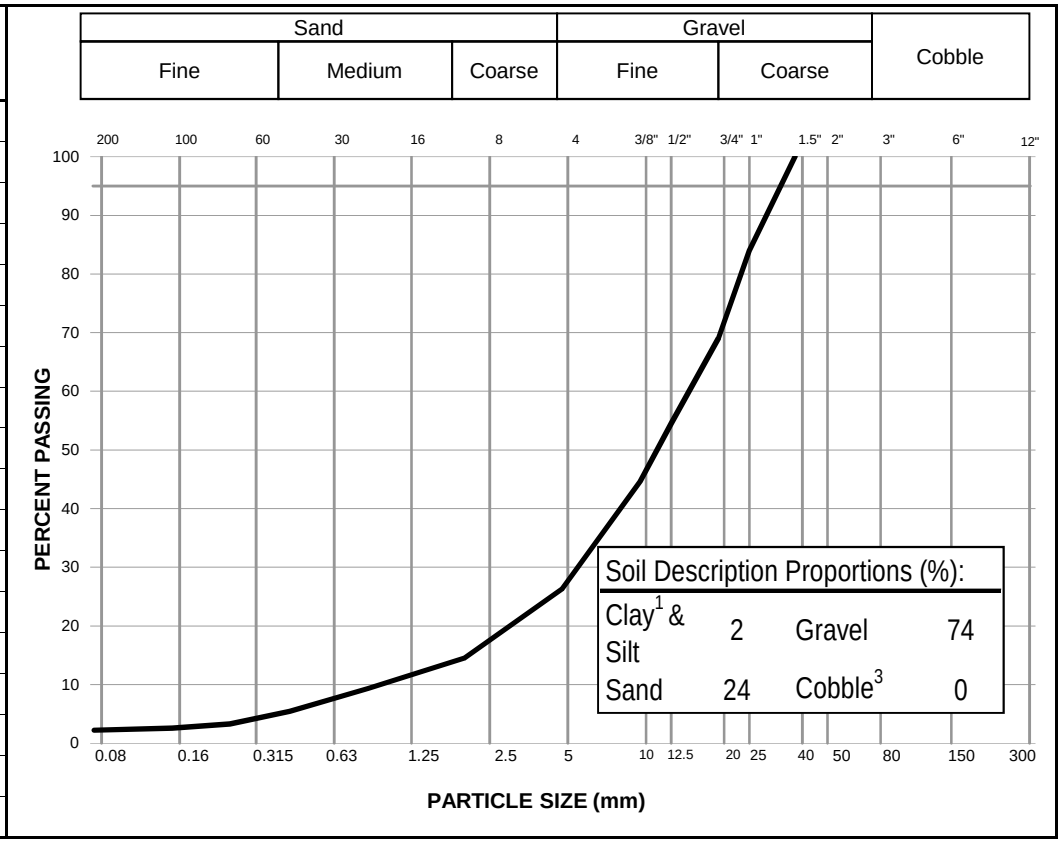
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	37
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP03
Client:	Government of Northwest Territories	Sample Depth:	1.6-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 24, 2020 By: JC	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 15.0
Moisture Content:	2.9%		Cc: 2.2

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	84
19	69
12.5	54
9.5	45
4.75	26
2	15
0.85	9
0.425	5
0.25	3
0.15	3
0.075	2.2



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 19%

Reviewed By: JDR P.Eng.

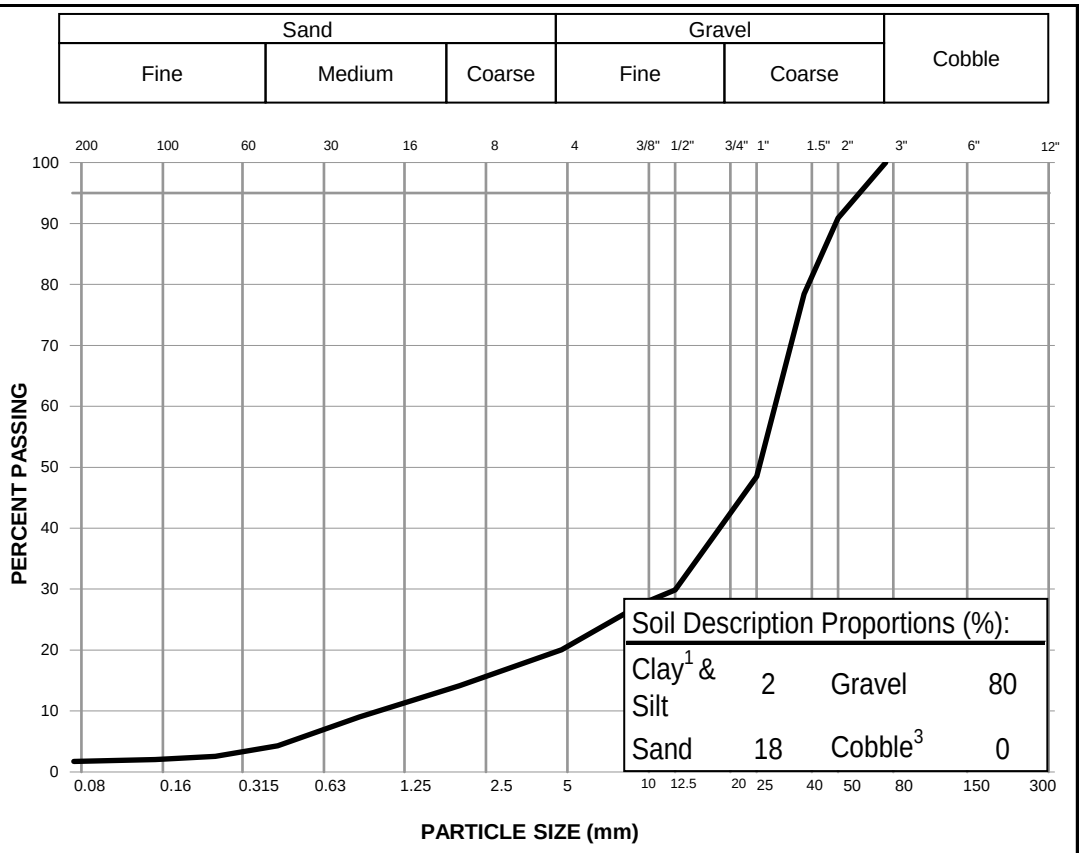
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	7200-09
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, Testpit 04
Client:	Government of Northwest Territories	Sample Depth:	0.6 - 4.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 8, 2020 By: SI	Date sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, some sand, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	GP Cu: 27.8
Moisture Content:	3.7%		Cc: 5.0

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	91
37.5	78
25	49
19	41
12.5	30
9.5	28
4.75	20
2	14
0.85	9
0.425	4
0.25	3
0.15	2
0.075	1.7



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

_____

Reviewed By: _____ P.Eng.

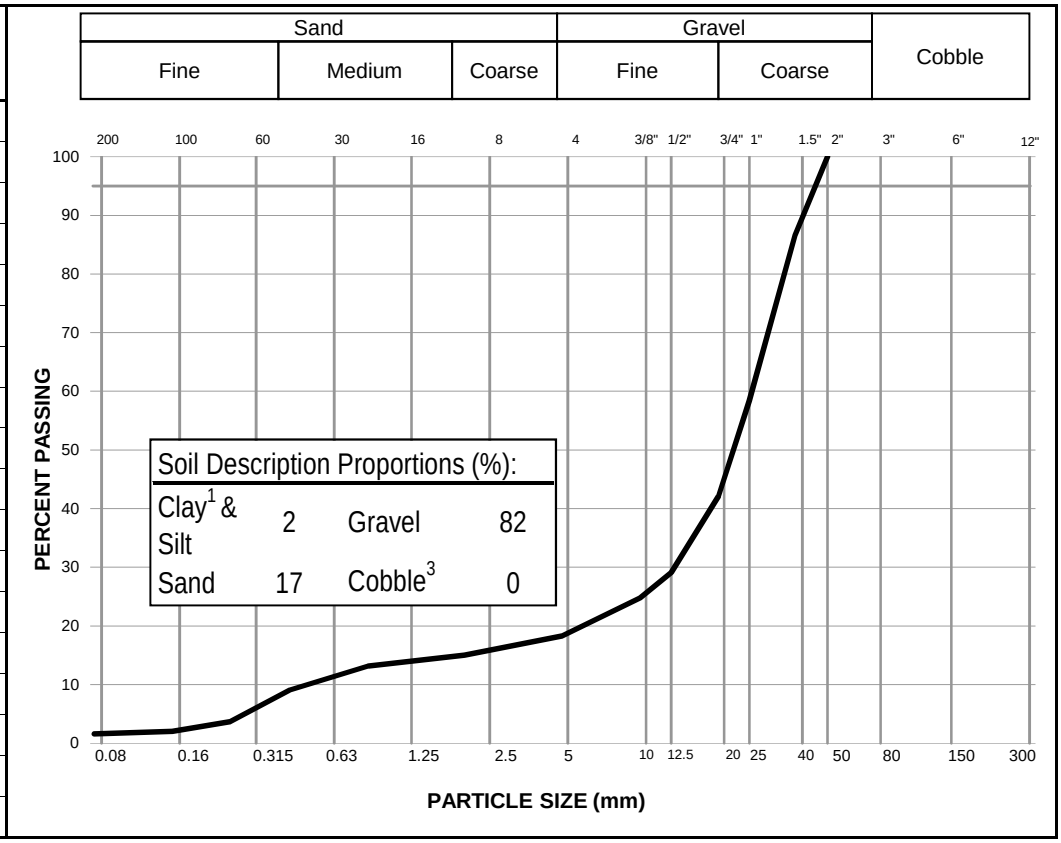
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	40
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP05
Client:	Government of Northwest Territories	Sample Depth:	0.4-2.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 25, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, some sand, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 49.2
Moisture Content:	3.2%		Cc: 12.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	87
25	58
19	42
12.5	29
9.5	25
4.75	18
2	15
0.85	13
0.425	9
0.25	4
0.15	2
0.075	1.6



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 71%

Reviewed By: JDR P.Eng.

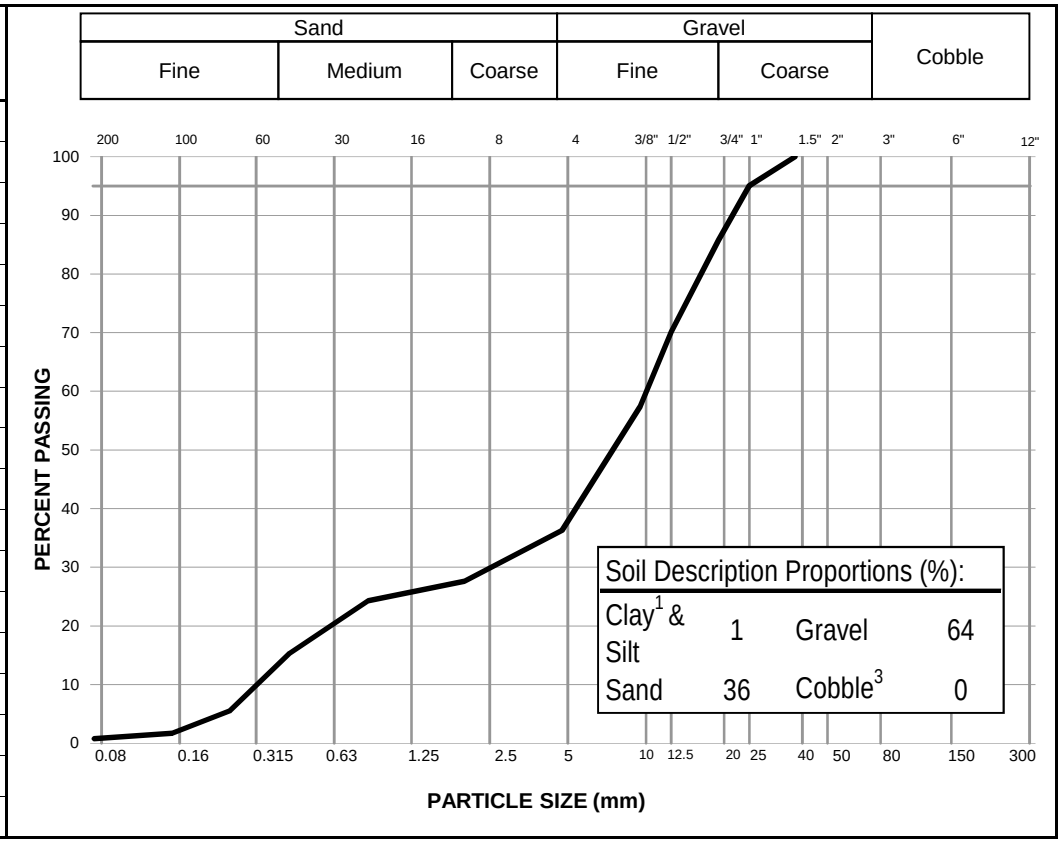
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	41
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP05
Client:	Government of Northwest Territories	Sample Depth:	2.0-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 27, 2020 By: LL	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL and sand, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 30.7
Moisture Content:	4.1%		Cc: 2.3

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	95
19	86
12.5	70
9.5	57
4.75	36
2	28
0.85	24
0.425	15
0.25	6
0.15	2
0.075	0.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 9%

Reviewed By: JDR P.Eng.

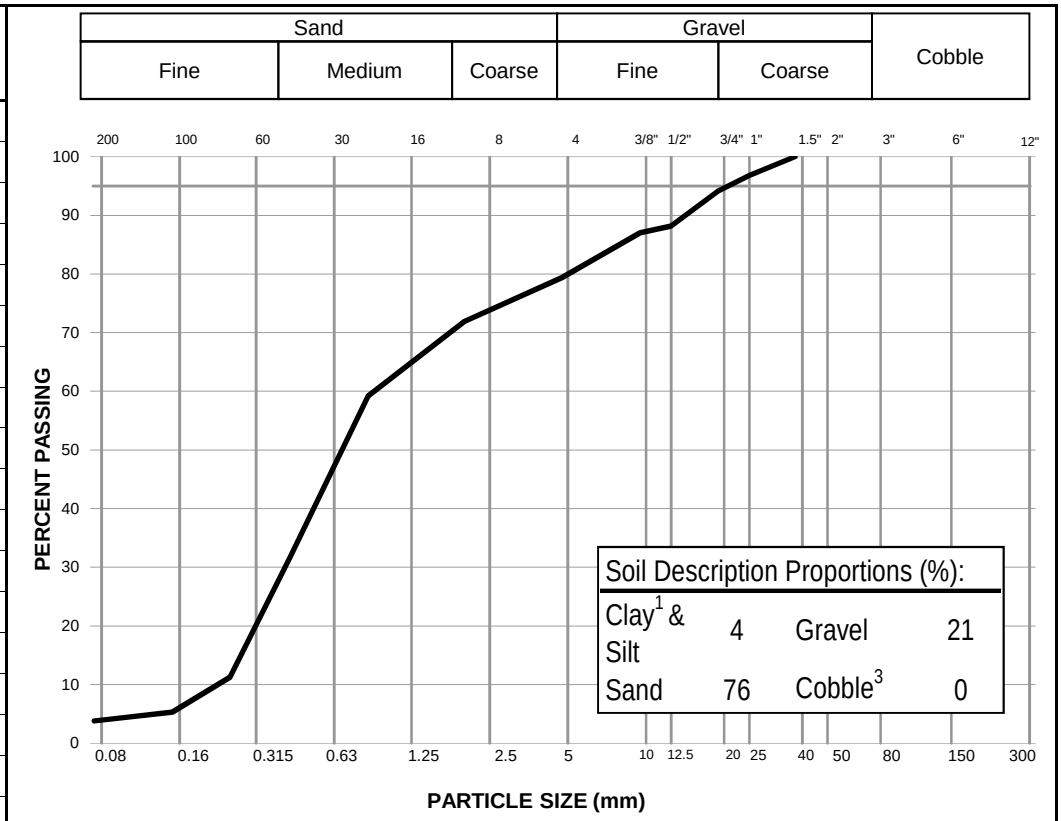
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	43
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP06
Client:	Government of Northwest Territories	Sample Depth:	2.0-3.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 27, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	SAND, gravelly, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 4.0
Moisture Content:	4.6%		Cc: 0.8

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	97
19	94
12.5	88
9.5	87
4.75	79
2	72
0.85	59
0.425	32
0.25	11
0.15	5
0.075	3.8



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 82%

Reviewed By: JDR P.Eng.

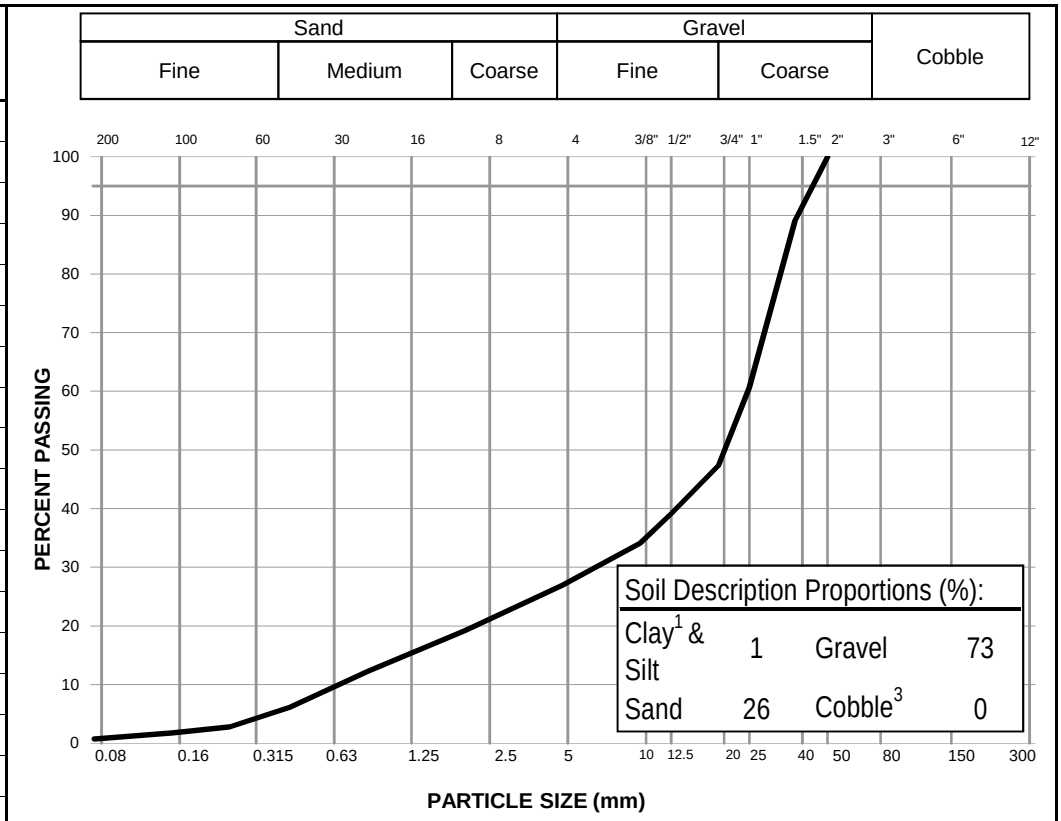
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	44
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP06
Client:	Government of Northwest Territories	Sample Depth:	3.5-4.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 27, 2020 By: LL	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 35.7
Moisture Content:	2.7%		Cc: 2.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	89
25	61
19	47
12.5	39
9.5	34
4.75	27
2	19
0.85	12
0.425	6
0.25	3
0.15	2
0.075	0.7



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 10%

Reviewed By: JDR P.Eng.

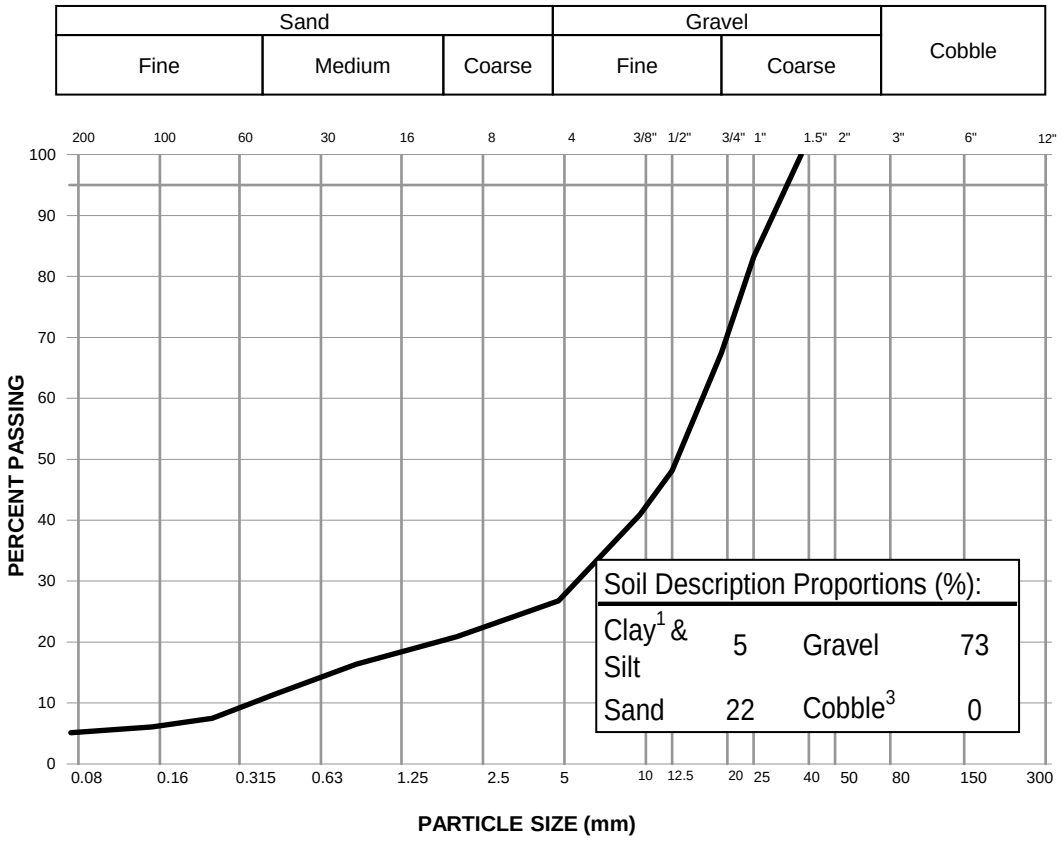
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	7200-16
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, Testpit 07
Client:	Government of Northwest Territories	Sample Depth:	0.6 - 3.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 8, 2020 By: SI	Date sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	GP Cu: 45.7
Moisture Content:	6.2%		Cc: 5.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	83
19	67
12.5	48
9.5	41
4.75	27
2	21
0.85	16
0.425	11
0.25	7
0.15	6
0.075	5.1



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

_____

Reviewed By: _____ P.Eng.

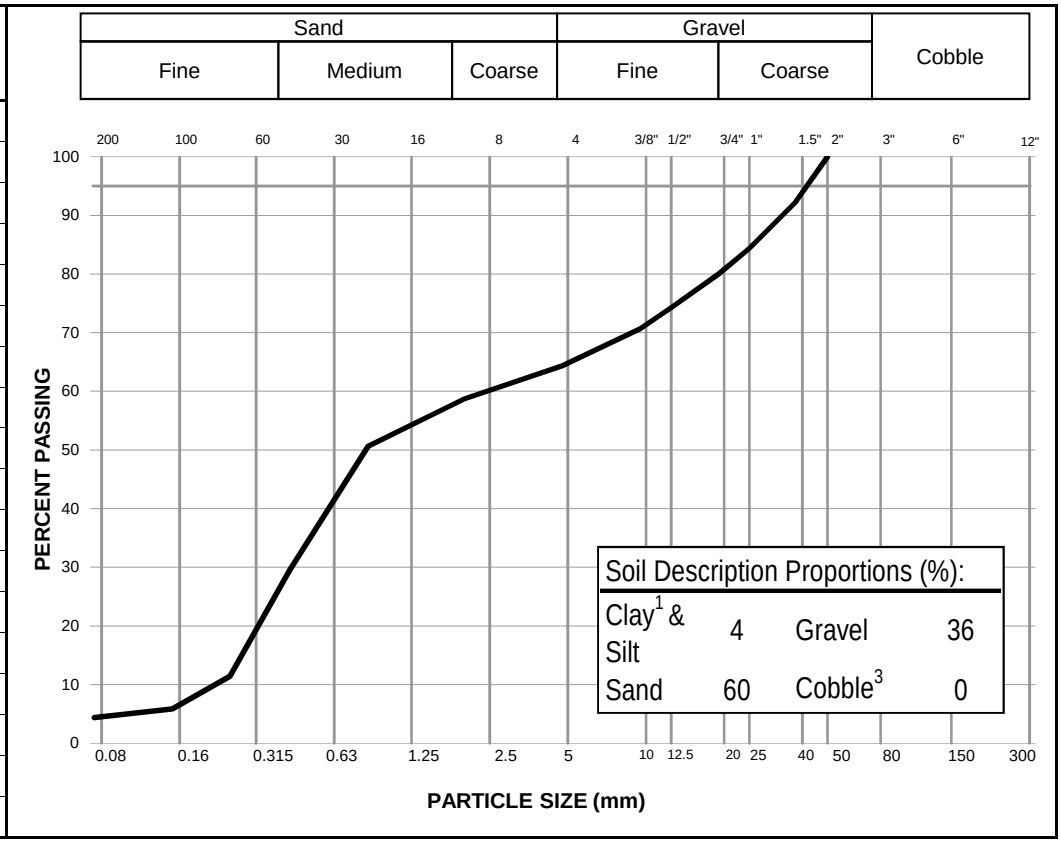
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	48
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP08
Client:	Government of Northwest Territories	Sample Depth:	1.2-3.8 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 27, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	SAND and GRAVEL, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 11.7
Moisture Content:	5.2%		Cc: 0.3

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	92
25	84
19	80
12.5	74
9.5	71
4.75	64
2	59
0.85	51
0.425	30
0.25	11
0.15	6
0.075	4.4



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 87%

Reviewed By: JDR P.Eng.

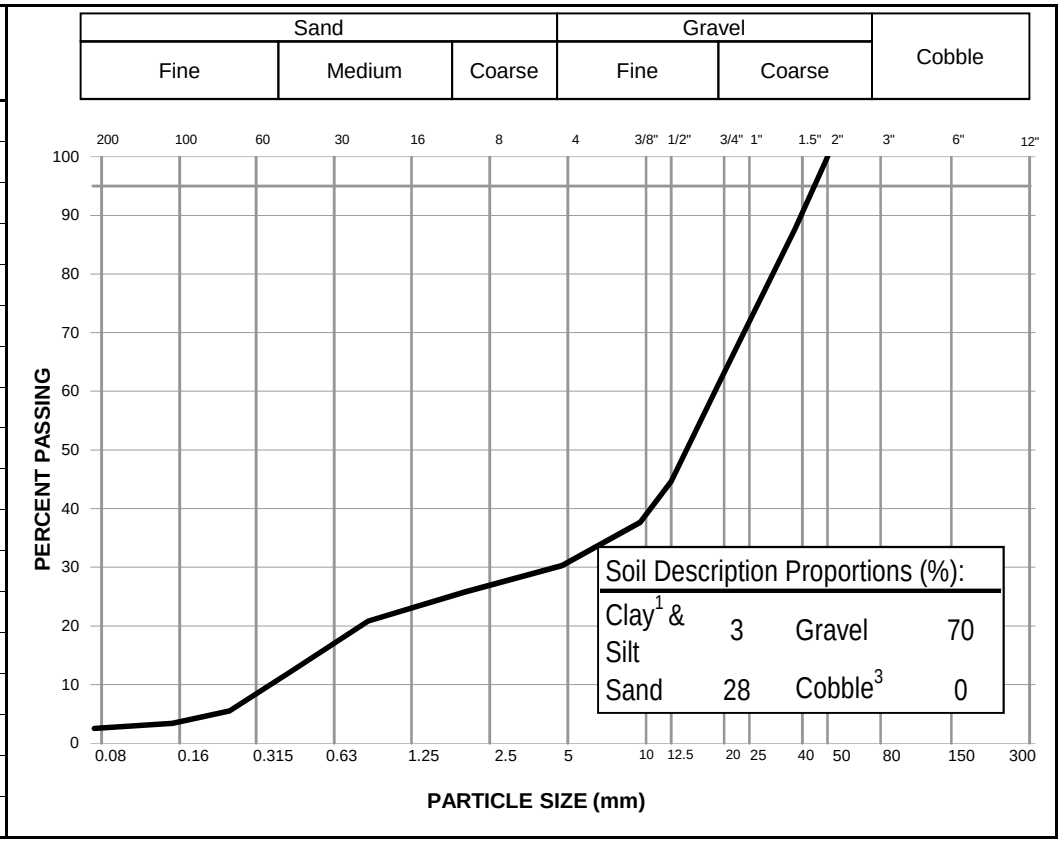
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	49
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP08
Client:	Government of Northwest Territories	Sample Depth:	3.8-4.5 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 25, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 50.2
Moisture Content:	3.2%		Cc: 3.1

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	100
37.5	88
25	72
19	61
12.5	45
9.5	38
4.75	30
2	26
0.85	21
0.425	12
0.25	6
0.15	3
0.075	2.5



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 81%

Reviewed By: JDR P.Eng.

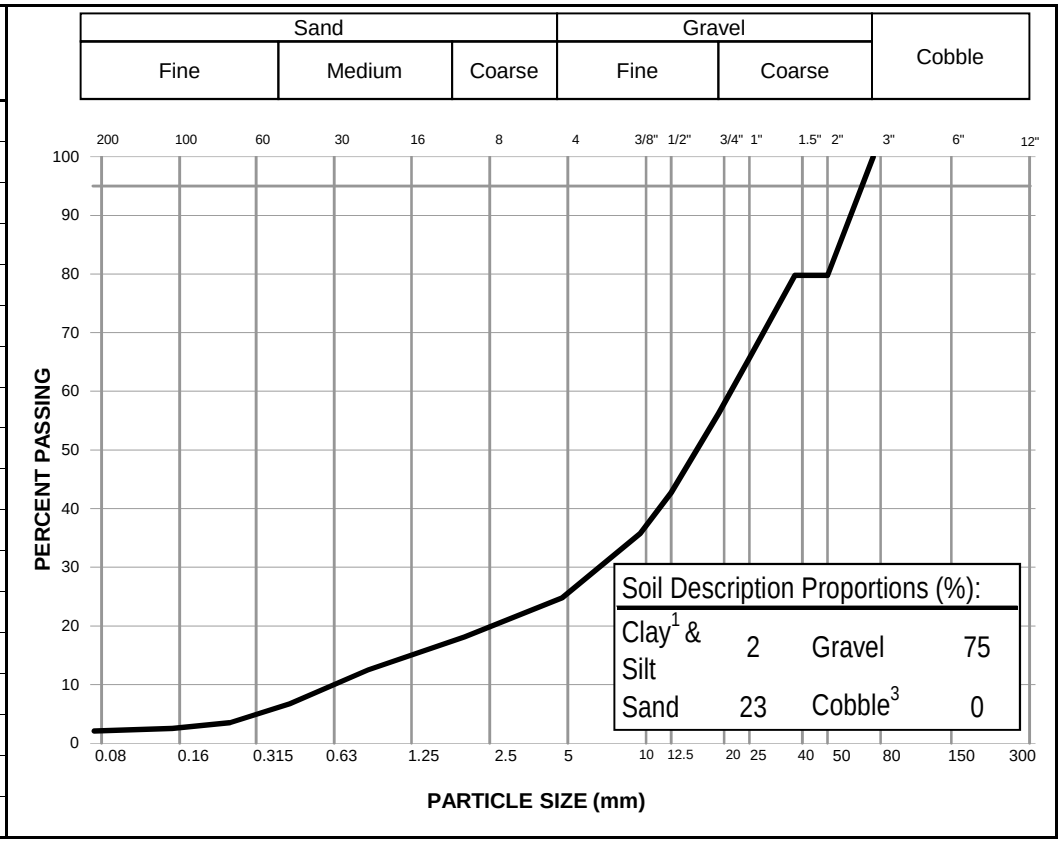
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	51
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP09
Client:	Government of Northwest Territories	Sample Depth:	1.0-2.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 25, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	GRAVEL, sandy, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 32.2
Moisture Content:	3.2%		Cc: 3.4

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	80
37.5	80
25	66
19	56
12.5	43
9.5	36
4.75	25
2	18
0.85	12
0.425	7
0.25	4
0.15	3
0.075	2.1



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 83%

Reviewed By: JDR P.Eng.

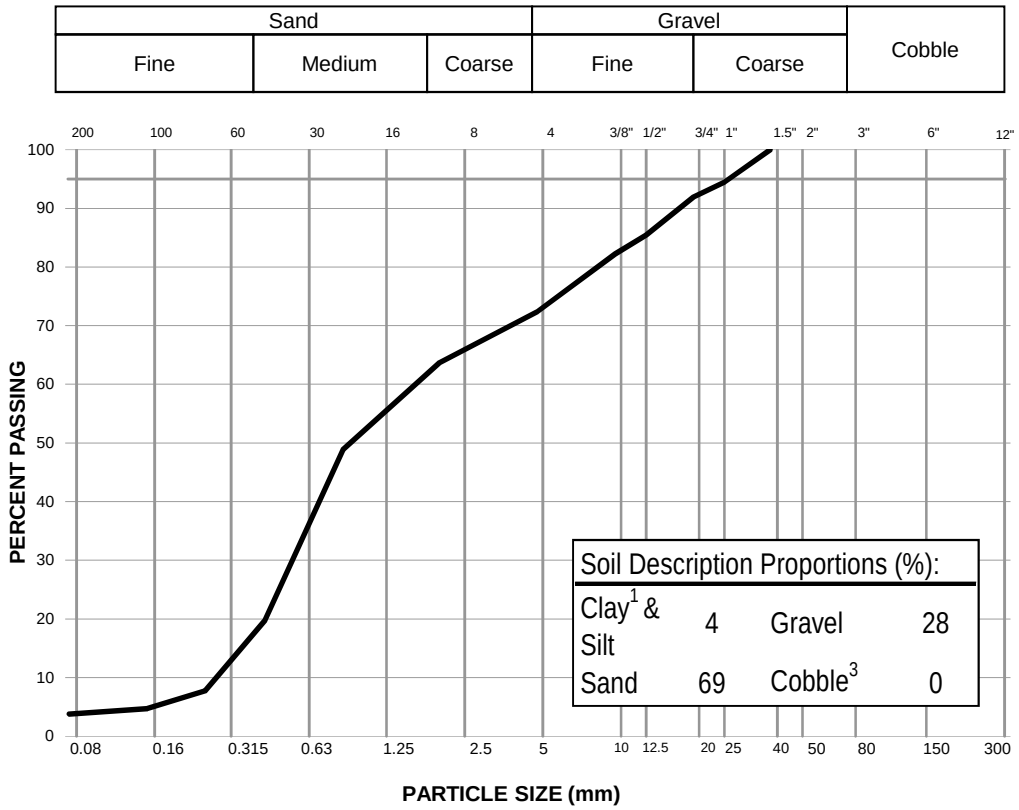
TETRA TECH

PARTICLE SIZE ANALYSIS (SIEVE) REPORT

ASTM D422 & C136

Project:	Oscar Creek Bridge Geotechnical Inv.	Sample No.:	52
Project No.:	704-ENG.YARC03255-01	Material Type:	Overburden
Site:	Near MVWR km 1054	Sample Loc.:	Prospect 3, TP09
Client:	Government of Northwest Territories	Sample Depth:	2.0-4.0 m
Client Rep.:	Terry Brookes	Sampling Method:	Grab
Date Tested:	April 24, 2020 By: SG	Date Sampled:	January 12, 2020
Soil Description[2]:	SAND, gravelly, trace silt/clay, brown	Sampled By:	AR
		USC Classification:	Cu: 6.0
Moisture Content:	4.8%		Cc: 0.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	100
25	94
19	92
12.5	85
9.5	82
4.75	72
2	64
0.85	49
0.425	20
0.25	8
0.15	5
0.075	3.8



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Crush Count (2 Faces) : 88%

Reviewed By: JDR P.Eng.

TETRA TECH

Los Angeles Abrasion of Small-Size Coarse Aggregate

ASTM C131 / AASTHO T-96

Project No:	704-ENG.YARC03255-01	**Sample No.:**	2-16 Combined
Project:	Oscar Creek Bridge Geotechnical Inv.	**Date Sampled:**	January 13, 2020
Client:	Government of Northwest Territories	**Sampled By:**	AR
		Date Tested:	July 10, 2020
Attention:	Terry Brookes **Ph:**	**Tested By:**	JC
Email:		**Office:**	Edmonton

Description:

Source: Near MVWR km 1054

Sample Location: Prospect 1 Combined

Supplier N/A

Test Grading		Mass of Indicated Sizes , g				
Sieve Size (mm)		Grading A	Grading B	Grading C	Grading D	Sample 2-16 Combined
Passing	Retained					
40	25	1250 ± 25	--	--	--	1260.7
25	20	1250 ± 25	--	--	--	1252.4
20	12.5	1250 ± 10	2500 ± 10	--	--	1249.8
12.5	10	1250 ± 10	2500 ± 10	--	--	1244.2
10	6.3	--	--	2500 ± 10	--	
6.3	5	--	--	2500 ± 10	--	
5	2.5	--	--	--	5,000 ± 10	
Total:		5,000 ± 10				5,007.1

Test Grading	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Loss (%)
A	5,007.1	3,510.5	1,496.6	**30**

Remarks:

Reviewed By: JPR P. Eng.

TETRA TECH

Los Angeles Abrasion of Small-Size Coarse Aggregate

ASTM C131 / AASTHO T-96

Project No:	704-ENG.YARC03255-01	**Sample No.:**	18-30 Combined
Project:	Oscar Creek Bridge Geotechnical Inv.	**Date Sampled:**	January 11, 2020
Client:	Government of Northwest Territories	**Sampled By:**	AR
		Date Tested:	July 24, 2020
Attention:	Terry Brookes **Ph:**	**Tested By:**	JC
Email:		**Office:**	Edmonton

Description:

Source: Near MVWR km 1054

Sample Location: Prospect 2 Combined

Supplier N/A

Test Grading		Mass of Indicated Sizes , g				
Sieve Size (mm)		Grading A	Grading B	Grading C	Grading D	Sample 18-30 Combined
Passing	Retained					
40	25	1250 ± 25	--	--	--	1241.3
25	20	1250 ± 25	--	--	--	1248.8
20	12.5	1250 ± 10	2500 ± 10	--	--	1253.0
12.5	10	1250 ± 10	2500 ± 10	--	--	1252.2
10	6.3	--	--	2500 ± 10	--	
6.3	5	--	--	2500 ± 10	--	
5	2.5	--	--	--	5,000 ± 10	
Total:		5,000 ± 10				4,995.3

Test Grading	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Loss (%)
A	4,995.3	3,328.0	1,667.3	**33**

Remarks:

Reviewed By: JPR P. Eng.

TETRA TECH

Los Angeles Abrasion of Small-Size Coarse Aggregate

ASTM C131 / AASTHO T-96

Project No:	704-ENG.YARC03255-01	**Sample No.:**	34-52 Combined
Project:	Oscar Creek Bridge Geotechnical Inv.	**Date Sampled:**	January 12, 2020
Client:	Government of Northwest Territories	**Sampled By:**	AR
		Date Tested:	July 7, 2020
Attention:	Terry Brookes **Ph:**	**Tested By:**	JC
Email:		**Office:**	Edmonton

Description:

Source: Near MVWR km 1054

Sample Location: Prospect 3 Combined

Supplier N/A

Test Grading		Mass of Indicated Sizes , g				
Sieve Size (mm)		Grading A	Grading B	Grading C	Grading D	Sample 34-52 Combined
Passing	Retained					
40	25	1250 ± 25	--	--	--	1264.4
25	20	1250 ± 25	--	--	--	1258.9
20	12.5	1250 ± 10	2500 ± 10	--	--	1250.5
12.5	10	1250 ± 10	2500 ± 10	--	--	1243.1
10	6.3	--	--	2500 ± 10	--	
6.3	5	--	--	2500 ± 10	--	
5	2.5	--	--	--	5,000 ± 10	
	Total:	5,000 ± 10				5,016.9

Test Grading	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Loss (%)
A	5,016.9	3,465.0	1,551.9	**31**

Remarks:

Reviewed By: JPR P. Eng.

TETRA TECH

Table:

Summary of Petrographic Analysis of Coarse Aggregate Test Report

CSA A23.2-15A

Project:	Oscar Creek Bridge Geotechnical Inv.	**Sample No.:**	2-16 Combined
Client:	Government of Northwest Territories	**Date Sampled:**	January 13, 2020
Project No.:	704-ENG.YARC03255-01	**Date Tested:**	July 9, 2020
Source:	Near MVWR km 1054, Prospect 1 Combined	**Petrographer:**	Olaoluwa Oluwatosin
Description:		**Office:**	Edmonton

Rock Type	Petrographic Multiplier	25-19 mm % in fraction	19-12.5 mm % in fraction	12.5-9.5 mm % in fraction	9.5-4.75 mm % in fraction	Weighted Average %
Good - High Strength						
Quartzite/Quartz	1		10.8	12.7	14.0	12.3
Chert	1		0.0	0.0	0.2	0.1
Granite/Gneiss	1		5.2	6.1	5.4	5.4
Basalt	1		9.4	16.1	17.3	13.3
Sandstone/Arkose	1		0.0	1.0	2.2	1.0
Carbonates	1		59.2	49.0	43.2	51.8
Fair - Medium Strength						
Granite/Gneiss	3		0.2	0.5	0.0	0.2
Sandstone/Arkose	3		0.0	0.2	0.0	0.0
Carbonates	3		0.0	0.4	0.0	0.1
Shale	3		12.3	13.2	16.5	14.0
Pumice	3		0.1	0.1	0.0	0.1
Poor - Low Strength						
Sandstone/Arkose	6		0.0	0.0	0.0	0.0
Shale	6		2.2	0.3	0.1	1.1
Deleterious						
Sandstone/Arkose	10		0.0	0.0	0.0	0.0
Ironstone	10		0.5	0.3	1.0	0.6
Petrographic Number :		**Not Tested**	**141**	**133**	**143**	
Percent of Fraction in Sample:		6.0	10.0	5.0	12.0	

Weighted Average Petrographic Number: **140**

Weighted Average Chert Content: **0.1 %** Weighted Average Ironstone Content: **0.6 %**

Note: Petrographic evaluation of coarse aggregate suitability/acceptance should be confirmed by the suite of CSA Table 12 testing and AAR testing

Remarks: Samples combined for analysis. Results not weighted for variations in sample size.

Reviewed By: _____ P.Eng.

TETRA TECH

Table:

Summary of Petrographic Analysis of Coarse Aggregate Test Report

CSA A23.2-15A

Project:	Oscar Creek Bridge Geotechnical Inv.	**Sample No.:**	18-30 Combined
Client:	Government of Northwest Territories	**Date Sampled:**	January 13, 2020
Project No.:	704-ENG.YARC03255-01	**Date Tested:**	July 16, 2020
Source:	Near MVWR km 1054, Prospect 2 Combined	**Petrographer:**	Olaoluwa Oluwatosin
Description:		**Office:**	Edmonton

Rock Type	Petrographic Multiplier	25-19 mm % in fraction	19-12.5 mm % in fraction	12.5-9.5 mm % in fraction	9.5-4.75 mm % in fraction	Weighted Average %
Good - High Strength						
Quartzite/Quartz	1			2.6	4.9	3.1
Granite/Gneiss	1			2.0	2.8	2.0
Basalt	1			5.3	9.2	6.0
Sandstone/Arkose	1			0.9	0.7	0.7
Siltstone	1			0.4	0.6	0.4
Carbonates	1			80.1	73.9	66.3
Fair - Medium Strength						
Carbonates	3			0.9	0.3	0.6
Shale	3			5.6	7.1	5.4
Poor - Low Strength						
Shale	6			0.8	0.0	0.4
Deleterious						
Ironstone	10			1.3	0.5	0.8
Petrographic Number :		**Not Tested**	**Not Tested**	**129**	**119**	
Percent of Fraction in Sample:		6.0	11.0	9.0	16.0	

Weighted Average Petrographic Number: **125**

Weighted Average Chert Content: **0.0 %** Weighted Average Ironstone Content: **0.8 %**

Note: Petrographic evaluation of coarse aggregate suitability/acceptance should be confirmed by the suite of CSA Table 12 testing and AAR testing

Remarks: Samples combined for analysis. Results not weighted for variations in sample size.

Reviewed By: _____ P.Eng.

TETRA TECH

Table:

Summary of Petrographic Analysis of Coarse Aggregate Test Report

CSA A23.2-15A

Project:	Oscar Creek Bridge Geotechnical Inv.	**Sample No.:**	34-52 Combined
Client:	Government of Northwest Territories	**Date Sampled:**	January 12, 2020
Project No.:	704-ENG.YARC03255-01	**Date Tested:**	July 3, 2020
Source:	Near MVWR km 1054, Prospect 3 Combined	**Petrographer:**	Olaoluwa Oluwatosin
Description:		**Office:**	Edmonton

Rock Type	Petrographic Multiplier	25-19 mm % in fraction	19-12.5 mm % in fraction	12.5-9.5 mm % in fraction	9.5-4.75 mm % in fraction	Weighted Average %
Good - High Strength						
Quartzite/Quartz	1	7.0	4.2	8.2	13.2	7.4
Chert	1	0.0	0.4	1.0	0.7	0.5
Granite/Gneiss	1	7.3	2.0	3.4	4.0	4.0
Basalt	1	4.0	7.5	14.2	16.1	9.4
Sandstone/Arkose	1	0.3	0.0	1.5	0.4	0.4
Carbonates	1	49.3	48.4	46.2	50.0	48.6
Fair - Medium Strength						
Sandstone/Arkose	3	0.5	0.0	0.1	0.1	0.2
Shale	3	18.1	18.3	14.3	5.7	15.1
Carbonates	3	0.0	0.0	0.1	0.2	0.1
Siltstone	3	0.0	0.2	0.2	0.4	0.2
Poor - Low Strength						
Sandstone/Arkose	6	0.0	0.0	0.0	0.0	0.0
Shale	6	13.5	18.3	10.6	8.1	13.7
Pumice	6	0.0	0.2	0.0	0.0	0.1
Siltstone	6	0.0	0.0	0.0	0.0	0.0
Deleterious						
Sandstone/Arkose	10	0.0	0.0	0.0	0.1	0.0
Ironstone	10	0.0	0.5	0.3	1.1	0.4
Petrographic Number :		**205**	**234**	**185**	**164**	
Percent of Fraction in Sample:		8.0	11.0	5.0	6.0	

Weighted Average Petrographic Number: **204**

Weighted Average Chert Content: **0.5 %** Weighted Average Ironstone Content: **0.4 %**

Note: Petrographic evaluation of coarse aggregate suitability/acceptance should be confirmed by the suite of CSA Table 12 testing and AAR testing

Remarks: Samples combined for analysis. Results not weighted for variations in sample size.

CCIL

Reviewed By: _____ P.Eng.

APPENDIX D

GEOCHEMICAL LABORATORY TEST RESULTS

ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 604 984 0221 Fax: +1 604 984 0218
www.alsglobal.com/geochemistry

To: **TETRA TECH CANADA INC.**
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

QC CERTIFICATE VA20169143

Project: Oscar Creek Granular Studies

P.O. No.: YARC03255-01

This report is for 9 Rock samples submitted to our lab in Vancouver, BC, Canada on 6-AUG-2020.

The following have access to data associated with this certificate:

SARA IRVINE LARA REGGIN	S. KINGSTON	ATIF RAFIQ

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
CRU-31	Fine crushing - 70% <2mm
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize up to 250g 85% <75 um
SPL-21X	Addnl Crush Split w No Analysis
SND-01	Send samples to external laboratory

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-ELE07	Paste pH	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
S-IR07	Sulphide Sulphur by Na2CO3 leach	LECO
C-GAS05	Inorganic Carbon (CO2)	
ME-MS61	48 element four acid ICP-MS	
OA-ELE08	1:1 Rinse pH	
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (IR Spectroscopy)	LECO

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Saa Traxler, General Manager, North Vancouver

ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 604 984 0221 Fax: +1 604 984 0218
www.alsglobal.com/geochemistry

To: **TETRA TECH CANADA INC.**
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-ELE07	S-IR08	S-IR07	C-GAS05	C-GAS05	S-GRA06a	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	Sulphide	C	CO2	S	Ag	Al	As	Ba
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOD	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.2	10
STANDARDS																
Buffer pH6							6.0									
Buffer pH6							6.1									
Target Range - Lower Bound							5.3									
Upper Bound							6.7									
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY										0.53	2.0					
Target Range - Lower Bound										0.42	1.5					
Upper Bound										0.64	2.4					
DS-1								2.66								
Target Range - Lower Bound								2.51								
Upper Bound								2.71								
GS313-8								1.25								
Target Range - Lower Bound								1.19								
Upper Bound								1.29								
KZK-1		2	25.0	35	60	2.40										
Target Range - Lower Bound			22.9	30	54	2.18										
Upper Bound			27.1	38	64	2.54										
MA-2c										1.66	6.1					
Target Range - Lower Bound										1.50	5.5					
Upper Bound										1.84	6.8					
MRGeo08													4.15	7.29	33.7	1080
Target Range - Lower Bound													3.93	6.64	29.5	920
Upper Bound													4.83	8.14	36.5	1270
NBM-1		2	8.8	42	51	5.83										
Target Range - Lower Bound			7.8	37	45	5.26										
Upper Bound			9.7	47	54	6.08										
OREAS 905													0.55	7.67	36.4	2870
Target Range - Lower Bound													0.46	6.67	31.0	2280
Upper Bound													0.58	8.17	38.4	3110
OREAS-75a									11.40							
Target Range - Lower Bound									10.85							
Upper Bound									12.00							
UTS-1												0.88				
Target Range - Lower Bound												0.81				
Upper Bound												0.95				
UTS-2									2.88							

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ALS Canada Ltd.
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To: **TETRA TECH CANADA INC.**
885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method Analyte Units LOD	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		3.36	0.63	2.64	2.04	68.4	20.2	91	13.00	610	3.92	17.75	0.20	3.1	0.158	3.07
Target Range - Lower Bound		2.98	0.58	2.35	2.00	66.2	17.7	81	11.20	587	3.55	17.50	<0.05	2.8	0.155	2.79
Upper Bound		3.76	0.73	2.90	2.48	81.0	21.9	102	13.80	675	4.37	21.5	0.27	3.6	0.201	3.43
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OREAS 905		3.17	5.59	0.62	0.33	98.4	14.3	19	6.98	1525	4.21	24.5	0.23	7.0	0.653	2.97
Target Range - Lower Bound		2.69	5.14	0.52	0.30	82.8	13.2	16	6.05	1425	3.66	22.5	<0.05	6.1	0.571	2.58
Upper Bound		3.39	6.30	0.66	0.42	101.0	16.4	22	7.51	1640	4.50	27.7	0.27	7.6	0.709	3.18
OREAS-75a																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																

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VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method Analyte Units LOD	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		32.7	32.2	1.30	550	14.50	1.95	21.7	697	1040	1085	192.5	0.009	0.30	4.08	11.1
Target Range - Lower Bound		31.1	29.5	1.17	497	13.65	1.76	19.0	622	930	971	173.5	0.004	0.27	3.89	11.1
Upper Bound		39.1	36.5	1.45	619	16.75	2.18	23.4	760	1160	1185	212	0.013	0.35	5.39	13.7
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OREAS 905		50.7	21.1	0.27	381	3.33	2.44	19.1	9.6	290	31.2	146.5	<0.002	0.07	1.90	5.1
Target Range - Lower Bound		40.9	17.8	0.24	333	2.89	2.15	16.2	8.4	240	26.9	124.0	<0.002	0.04	1.61	4.3
Upper Bound		51.1	22.2	0.31	418	3.65	2.65	20.0	10.7	320	33.9	152.0	0.004	0.09	2.29	5.5
OREAS-75a																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																

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VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method Analyte Units LOD	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5	OA-ELE08 pH Unity 0.1
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
Buffer pH6																6.0
Buffer pH6																6.1
Target Range - Lower Bound																5.3
Upper Bound																6.7
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		1	4.0	309	1.44	<0.05	18.80	0.488	1.04	5.0	109	4.5	24.7	790	103.0	
Target Range - Lower Bound		<1	3.5	277	1.39	<0.05	17.90	0.443	0.86	4.9	97	4.1	23.8	722	92.2	
Upper Bound		4	4.7	339	1.81	0.12	21.9	0.553	1.21	6.2	121	5.8	29.3	886	126.0	
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OREAS 905		3	4.1	166.0	1.30	0.08	13.75	0.126	0.73	5.0	10	2.7	17.0	140	264	
Target Range - Lower Bound		<1	3.4	141.0	1.16	<0.05	13.15	0.105	0.58	4.4	8	2.3	14.0	122	214	
Upper Bound		4	4.6	173.0	1.52	0.17	16.05	0.139	0.83	5.6	13	3.3	17.4	154	290	
OREAS-75a																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																

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885 DUNSMUIR STREET
VANCOUVER BC V6C 1N5

Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method Analyte Units LOD	OA-VOL08 FIZZ RAT Unity 1	OA-VOL08 MPA tCaCO3/1Kt 0.3	OA-VOL08 NNP tCaCO3/1Kt 1	OA-VOL08 NP tCaCO3/1Kt 1	OA-VOL08 Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-IR07 Sulphide % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	ME-MS61 Ag ppm 0.01	ME-MS61 Al % 0.01	ME-MS61 As ppm 0.2	ME-MS61 Ba ppm 10
STANDARDS																
Target Range - Lower Bound									2.78							
Upper Bound									3.10							
UTS-4												1.75				
Target Range - Lower Bound												1.61				
Upper Bound												1.87				
BLANKS																
BLANK										<0.05	<0.2					
Target Range - Lower Bound										<0.05	<0.2					
Upper Bound										0.10	0.4					
BLANK													<0.01	<0.01	<0.2	<10
Target Range - Lower Bound													<0.01	<0.01	<0.2	<10
Upper Bound													0.02	0.02	0.4	20
BLANK							6.0									
Target Range - Lower Bound							5.5									
Upper Bound							6.9									
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK												<0.01				
Target Range - Lower Bound												<0.01				
Upper Bound												0.02				
BLANK									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
BLANK								<0.01								
Target Range - Lower Bound								<0.01								
Upper Bound								0.02								

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Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method / Analyte / Units / LOD	ME-MS61 Be ppm 0.05	ME-MS61 Bi ppm 0.01	ME-MS61 Ca % 0.01	ME-MS61 Cd ppm 0.02	ME-MS61 Ce ppm 0.01	ME-MS61 Co ppm 0.1	ME-MS61 Cr ppm 1	ME-MS61 Cs ppm 0.05	ME-MS61 Cu ppm 0.2	ME-MS61 Fe % 0.01	ME-MS61 Ga ppm 0.05	ME-MS61 Ge ppm 0.05	ME-MS61 Hf ppm 0.1	ME-MS61 In ppm 0.005	ME-MS61 K % 0.01
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.05	0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	<0.05	0.05	<0.1	<0.005	<0.01
Target Range - Lower Bound		<0.05	<0.01	<0.01	<0.02	<0.01	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.1	<0.005	<0.01
Upper Bound		0.10	0.02	0.02	0.04	0.02	0.2	2	0.10	0.4	0.02	0.10	0.10	0.2	0.010	0.02
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method / Analyte / Units / LOD	ME-MS61 La ppm 0.5	ME-MS61 Li ppm 0.2	ME-MS61 Mg % 0.01	ME-MS61 Mn ppm 5	ME-MS61 Mo ppm 0.05	ME-MS61 Na % 0.01	ME-MS61 Nb ppm 0.1	ME-MS61 Ni ppm 0.2	ME-MS61 P ppm 10	ME-MS61 Pb ppm 0.5	ME-MS61 Rb ppm 0.1	ME-MS61 Re ppm 0.002	ME-MS61 S % 0.01	ME-MS61 Sb ppm 0.05	ME-MS61 Sc ppm 0.1
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.5	0.2	<0.01	<5	<0.05	<0.01	<0.1	0.2	<10	<0.5	<0.1	<0.002	<0.01	<0.05	<0.1
Target Range - Lower Bound		<0.5	<0.2	<0.01	<5	<0.05	<0.01	<0.1	<0.2	<10	<0.5	<0.1	<0.002	<0.01	<0.05	<0.1
Upper Bound		1.0	0.4	0.02	10	0.10	0.02	0.2	0.4	20	1.0	0.2	0.004	0.02	0.10	0.2
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

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Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method Analyte Units LOD	ME-MS61 Se ppm 1	ME-MS61 Sn ppm 0.2	ME-MS61 Sr ppm 0.2	ME-MS61 Ta ppm 0.05	ME-MS61 Te ppm 0.05	ME-MS61 Th ppm 0.01	ME-MS61 Ti % 0.005	ME-MS61 Tl ppm 0.02	ME-MS61 U ppm 0.1	ME-MS61 V ppm 1	ME-MS61 W ppm 0.1	ME-MS61 Y ppm 0.1	ME-MS61 Zn ppm 2	ME-MS61 Zr ppm 0.5	OA-ELE08 pH Unity 0.1
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	0.02	<0.1	<1	<0.1	<0.1	<2	<0.5	
Target Range - Lower Bound		<1	<0.2	<0.2	<0.05	<0.05	<0.01	<0.005	<0.02	<0.1	<1	<0.1	<0.1	<2	<0.5	
Upper Bound		2	0.4	0.4	0.10	0.10	0.02	0.010	0.04	0.2	2	0.2	0.2	4	1.0	
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																6.0
Target Range - Lower Bound																5.5
Upper Bound																6.9
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

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Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-ELE07	S-IR08	S-IR07	C-GAS05	C-GAS05	S-GRA06a	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	Sulphide	C	CO2	S	Ag	Al	As	Ba
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOD	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.2	10
DUPLICATES																
ORIGINAL										9.43	34.6					
DUP										9.60	35.2					
Target Range - Lower Bound										8.99	33.0					
Upper Bound										10.05	36.8					
PR1 CS3													0.14	2.57	12.8	730
DUP													0.12	2.54	13.1	720
Target Range - Lower Bound													0.11	2.42	12.1	660
Upper Bound													0.15	2.69	13.8	790
ORIGINAL		1	0.3	10	10	32.00	8.8	0.01	0.01			<0.01				
DUP		1	0.3	10	10	32.00	8.9	0.01	<0.01			<0.01				
Target Range - Lower Bound		<1	<0.3	9	9	30.39	8.3	<0.01	<0.01			<0.01				
Upper Bound		2	0.6	12	12	33.61	9.4	0.02	0.02			0.02				

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QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In	K
	Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%
	LOD	0.05	0.01	0.01	0.02	0.01	0.1	1	0.05	0.2	0.01	0.05	0.05	0.1	0.005	0.01
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
PR1 CS3		0.96	0.09	11.85	0.33	30.9	4.8	34	1.58	25.4	1.74	6.07	0.12	1.3	0.020	1.09
DUP		0.98	0.10	11.75	0.33	29.7	4.8	28	1.53	20.9	1.72	5.84	0.15	1.3	0.021	1.06
Target Range - Lower Bound		0.87	0.08	11.20	0.29	28.8	4.5	28	1.43	22.1	1.63	5.61	0.08	1.1	0.014	1.01
Upper Bound		1.07	0.11	12.40	0.37	31.8	5.1	34	1.68	24.2	1.83	6.30	0.19	1.5	0.027	1.14
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61
	Analyte	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Sc
	Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
	LOD	0.5	0.2	0.01	5	0.05	0.01	0.1	0.2	10	0.5	0.1	0.002	0.01	0.05	0.1
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
PR1 CS3		16.8	14.3	3.71	383	9.20	0.42	3.9	25.4	340	7.9	48.8	0.004	0.08	1.06	4.0
DUP		15.8	13.8	3.68	379	8.51	0.42	3.9	24.8	330	7.8	48.5	0.005	0.08	1.09	4.0
Target Range - Lower Bound		15.0	13.1	3.50	357	8.36	0.39	3.6	23.6	310	7.0	46.1	<0.002	0.07	0.94	3.7
Upper Bound		17.6	15.0	3.89	405	9.35	0.45	4.2	26.6	360	8.7	51.2	0.007	0.09	1.21	4.3
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

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QC CERTIFICATE OF ANALYSIS VA20169143

Sample Description	Method	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	ME-MS61	OA-ELE08
	Analyte	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr	pH
	Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	Unity
	LOD	1	0.2	0.2	0.05	0.05	0.01	0.005	0.02	0.1	1	0.1	0.1	2	0.5	0.1
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
PR1 CS3		1	0.9	202	0.27	0.05	3.81	0.112	0.82	3.5	88	0.5	11.0	67	46.5	
DUP		1	0.9	198.5	0.27	<0.05	3.85	0.111	0.77	3.5	87	0.5	10.8	65	49.5	
Target Range - Lower Bound		<1	0.7	190.0	0.21	<0.05	3.63	0.101	0.72	3.2	82	0.4	10.3	61	43.9	
Upper Bound		2	1.1	210	0.33	0.10	4.03	0.122	0.87	3.8	93	0.6	11.5	71	52.1	
ORIGINAL																9.2
DUP																9.2
Target Range - Lower Bound																8.6
Upper Bound																9.8

***** See Appendix Page for comments regarding this certificate *****

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Finalized Date: 2-SEP-2020
Account: TGM

Project: Oscar Creek Granular Studies

QC CERTIFICATE OF ANALYSIS VA20169143

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: REEs may not be totally soluble in this method.
ME-MS61

LABORATORY ADDRESSES

Applies to Method: Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

C-GAS05	CRU-31	LOG-22	ME-MS61
OA-ELE07	OA-ELE08	OA-VOL08	PUL-31
PUL-QC	S-GRA06a	S-IR07	S-IR08
SND-01	SPL-21	SPL-21X	WEI-21