

<b>MEMORANDUM</b>	<b>Proposed Highway 16 East Gate Expansion Jasper National Park, Alberta Geotechnical Assessment</b>
<b>Report Date:</b>	<b>December 19, 2016</b>
<b>McElhanney No.</b>	<b>2511-00763-00</b>

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## 1.0 Introduction

This memorandum presents a summary of the subsurface conditions observed during the field excavation program and geotechnical recommendations for the Jasper National Park Highway 16 East Gate Expansion project. McElhanney Consulting Services Ltd. (McElhanney) has prepared this geotechnical assessment in memorandum form in accordance with our proposal, dated August 10, 2016.

McElhanney understands that the Jasper National Park (JNP) East Gate is to be upgraded and expanded in its existing location, with the addition of 1-2 gate kiosk buildings, and westbound traffic lanes. The expansion area currently is road embankment and highway right-of-way area, with minimal improvements present other than underground utilities and signage. The existing adjacent Highway 16 to the south is a secondary highway which functions as the main east access to the park, as well as an arterial connector between the northern Alberta and northern BC, as well as Banff National Park to the south. The highway and park are open to traffic year round.

This memorandum describes the geotechnical assessment completed for the project, and describes the recommended geotechnical design parameters to support the geometric design of the East Gate upgrade.

## 2.0 Scope of Work

The scope of work for the geotechnical assessment included:

- Preparation of a geotechnical assessment plan;
- Completion of an Alberta One Call, prior to commencement of the subsurface testing;
- Commissioning and completion of Utility Locates onsite to ensure test hole clearance;

- Completion of a geotechnical excavation program which consisted of a total of nine (9) testholes (three boreholes and six test pits) directly adjacent to the north of the nearby highway and gate;
- Completion limited geotechnical laboratory testing on representative samples;
- Prepared this memorandum providing a summary of the subsurface conditions encountered and geotechnical recommendations for roadway and small building design.

The purpose of the geotechnical assessment was to evaluate the existing road embankment and sub-surface ground conditions, and in conjunction with McElhanney's civil design services provide preliminary and final geometric design and paving gradation and material thickness for roads, and recommendations for building construction, prior to putting the project to Tender.

### **3.0 Field Assessment and Laboratory Testing**

McElhanney completed a geotechnical excavation assessment adjacent the gate, kiosks and highway east and west of the gate. The intent of the field program was to characterize the existing subsurface conditions. The assessment was carried out October 19<sup>th</sup> to 21<sup>st</sup>, 2016 and consisted of six testpits (TH16-01, TH16-02, and TH16-06 through TH16-09) and three boreholes (TH16-03 through TH16-05) at locations shown on the appended Testhole Plan (Drawing 00763-G01). Seven testholes (TH16-01 through TH16-03, and TH16-06 through TH16-09) were excavated and drilled adjacent the existing highway in the area of proposed highway widening locations, and two testholes (TH16-04 and TH16-05) were drilled in the future proposed location of the gate kiosk(s). The testholes were excavated using a Hitachi 210W excavator, and drilled using a M5 Unimog, and ranged in depth from 2.3 to 14.9 meters below ground surface (mbgs).

McElhanney supervised the utility locating, excavation and drilling, and logged and sampled the testholes. The subsurface soils were sampled primarily in situ from test pits, grab samples off of the auger, and split spoon samples during SPT testing. SPT testing was completed regularly in each borehole, and Dynamic Cone Penetrometer testing was also performed by McElhanney as each test pit advanced. The results of those tests are appended to this report. A summary of the subsurface conditions encountered are provided on the testhole summary logs included in Appendix A. Following completion of the testholes, the holes were backfilled with the native soil. A PVC standpipe temporary monitoring well was installed in TH16-05 to a depth of 15m.

Soil samples were transported to Artech's laboratory in Cranbrook, BC where selected samples were submitted for index testing including moisture content, gradation sieve analysis and Atterberg Limits. The laboratory results are included on the borehole logs and detailed results are included in Appendix B. The soils encountered were classified in accordance with the Modified Unified Classification System for soils included in Appendix A.

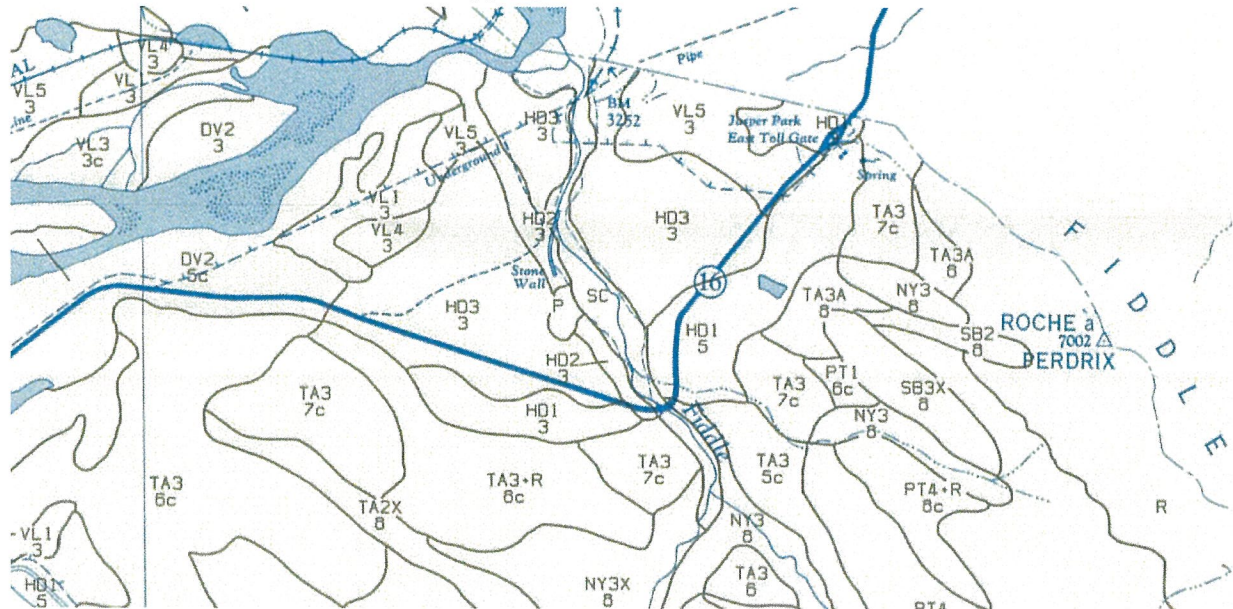




## 4.0 Subsurface Conditions

### 4.1 Background Geology

**Figure 4-1 Site Location with Soil Mapping Information:**



**Reference #1: "Jasper National Park – 10-1 Map Sheet"**

The site is positioned within the broad historical floodplain of the Athabaska River, at the mouth of the western Rockies slopes near the Athabaska river and Brule lake to the north. The area is a relatively level landscape in all directions, and is gently sloping towards the east with the river valley. To the south, steep mountainous sideslopes and valleys, and exposed rock above are visible from the site, with the lower sideslope beginning approximately 0.5km to the south. The valley bottom itself typically comprised of fluviolacustrine and fluvial materials, and the site contains outwash fluvial/alluvial fan deposits from nearby Fiddle Creek to the south. These deposits are typically comprised of "sand, gravel and alluvium". This brief description was obtained from Reference #1: *WD Holland, GM Coen (1983). Report No.44 and Mapping of the Alberta Soil Survey, Ecological (Biophysical) Land Classification of Banff and Jasper National Parks. Edmonton, AB: Environment Canada, Agriculture Canada, Alberta Institute of Pedology.*

Observations are consistent with this description. We anticipate that, based on the location of the site at the broad valley bottom and its nearby location to the Fiddle creek, that a mixture of fluvial/alluvial, glaciofluvial, and fluvioglaciolacustrine materials are likely present at various depths at the site. The native soils observed are consistent with typical fluvial and lacustrine materials of the area (layered soils deposited by water).

### 4.2 Subsurface Observations

In general, the soils encountered during field excavation program consisted of fills, organics and fluvial sands and gravels with variable silt content, however; lacustrine clayey silt material at depth were also observed in the deeper bore hole (TH16-05), underlain by further gravels. Test holes adjacent the highway in the embankment/boulevard contained surficial layer(s) of deleterious and structural fills, debris and topsoil. A summary of subsurface soils are provided in Table 4-1 and detailed below.



**Table 4-1: Testhole Summary**

Test Hole	Depth of Hole (m)	Topsoil / Deleterious Fill (m)	Sandy / Silty / Organic Fill (m)	Silts and Sands (m)	Sandy Gravels (m)	Clayey Silt (m)	Gravel / Sand (m)	Ground Water (m)
16-01	2.5	0-0.35	0.35-0.8	-	0.8-2.5+	-	-	NE
16-02	2.4	0-0.2	0.2-0.4	-	0.4-2.4+	-	-	NE
16-03	6.1	0-0.2	0.2-2.1	-	2.1-6.1+	-	-	NE
16-04	6.4	-	0-0.9	0.9-2.4	2.4-6.4+	-	-	NE
16-05	14.9	-	0-1.5	-	1.5-6.7	6.7-11.6	11.6-14.9+	8.1
16-06	2.4	0-0.2	0.2-0.8	-	0.8-2.4+	-	-	NE
16-07	2.5	0-0.2	0.2-1.6	1.6-2.0	2.0-2.5+	-	-	NE
16-08	2.5	0-0.15	0.15-0.4	-	0.4-2.5+	-	-	NE
16-09	2.3	0-0.2	0.2-0.5	0.5-1.4	1.4-2.3+	-	-	NE

NE = Not encountered

- **Surficial Topsoil/Deleterious Fill:** Organic silt with gravel, debris, and wood waste was observed in most testholes, excluding TH16-04 and TH16-05 in the boulevard area adjacent to the existing kiosks. This layer ranged in thickness from 150-350mm.
- **Sandy/Silty Organic Fill:** A variable fill layer typically underlying the topsoil was observed in all testholes. This layer ranges in thickness from 0.2-1.9m, and typically can be referred to as highway boulevard embankment fills. They vary in consistency and classification, from gravelly silts to sandy silts, and contain organics to varying degrees.
- **Sands:** These materials appear to be native soils, and vary in composition from silt and sand to clean sand. They were observed in TH16-04, TH16-07 and TH16-09. They were viewed to be compact and containing occasional organics (such as rootlets).
- **Fluvial Sand and/or Gravels:** Deposits of sand and gravel and/or sandy gravels were encountered in all of the testholes to varying degrees, ranging from at least 0.5m to 4.0+m thick. These units contained variable silt/clay content (ranging from trace to some) and were compact to dense, brown and generally damp-moist. Generally the subgrade strength of the granular layers was very good, with CBR values between 8-28%, and SPT N values between 19-64 (and higher when stuck on rock). Another gravel and sand layer was encountered in the deeper borehole (TH16-05) at 11.6 mbgs, underlying the lacustrine clayey silt horizon noted below. All testholes terminated in sand and gravel.
- A summary of the sieve analyses completed on representative samples is included in Table 4-2.



**Table 4-2: Summary of Sieve Analyses**

Borehole	Sample Depth (m)	Moisture Content (%)	Soil Classification	Gradation (%)		
				Gravel	Sand	Fines (Silt/Clay)
TH16-01	0.8	24.0	ML/OL	18	23	59
TH16-01	1.2	4.3	GP-GM	64	25	11
TH16-02	0.4	2.9	GP-GM	73	20	7
TH16-02	1.9	3.3	GP-GM	71	23	6
TH16-03	1.2	28.7	ML/OL	4	20	76
TH16-03	2.1	5.4	GM	61	24	15
TH16-04	0.5	4.1	SW-SM/GW-GM	49	40	11
TH16-04	0.9	6.2	GW-GM	51	31	18
TH16-04	2.1	15.1	SM/ML	19	43	38
TH16-04	3.7	5.2	GP	62	24	14
TH16-05	13.0	7.6	SW-SM/GW-GM	47	41	12
TH16-06	1.0	5.1	GM	64	20	16
TH16-07	1.1	4.8	GP-GM	68	21	11
TH16-08	0.5	6.7	GM/SM	43	38	19
TH16-09	1.0	4.9	SW	20	75	5

- **Lacustrine Silt:** A deposit of Clayey Silt was observed in one testhole (TH16-05) beginning at 6.7 mbgs, and extending down to 11.6 mbgs. This layer is anticipated to be present at depth below TH16-03 and TH16-04, and possibly other locations as well, and is within the proposed area of the kiosks. The Silt was predominately silt and clay, with some sand to sandy, and was firm to stiff, light brown, and moist to wet. SPT N values ranged from 5-13. This material was observed to have slight to low cohesion. A summary of the Atterberg Limits completed on representative samples is included in Table 4-3.

**Table 4-3: Summary of Atterberg Limit Analyses – Lacustrine Silt**

Testhole	Sample Depth (m)	Soil Classification	Sample Moisture	Moisture (%)	
				Plastic Limit	Liquid Limit
TH16-05	6.9	ML	32.1	23	29
TH16-05	11.4	ML	33.7	23	27

### 4.3 Groundwater Conditions

Groundwater was encountered at a depth of 8.2 mbgs in TH16-05 at the time of the field assessment, and had stabilized to a depth of 8.1 mbgs 45 minutes following the completion of the borehole. Following the assessment, a further reading was attempted on October 29<sup>th</sup> with a 7m measuring tape, and the groundwater level was not encountered, indicating that the groundwater level remains at a depth exceeding 7 mbgs and is likely static at the initial measurement. Groundwater levels will likely fluctuate due to seasonal variations, such as after periods of heavy rainfall or snow melt.

## 5.0 Discussion and Recommendations

The following sections provide geotechnical recommendations for support of geometric road design for the project, as well as the construction of the gate/kiosk building. The recommendations in this report should be read in conjunction, unless otherwise noted, with the most current Alberta Transportation (AT) Standard Specifications for Highway Construction, and with the final detailed geometric design drawings by McElhanney.

### 5.1 Subgrade Conditions

Based on the assessment the anticipated subgrade conditions for the road upgrade are expected to be predominately granular soils (sand and gravel, gravelly sand and/or sandy gravel) with variable silt content. Areas of organic fills on the embankment side slopes were encountered in all testholes at depth, and such soils may also be encountered in some areas during subgrade preparation. The compact to dense granular soils underlying the organic fills and topsoil surficial conditions are suitable for the proposed road and building upgrades.

### 5.2 Subgrade Preparation

Stripping of organic soils and sub-excavation of loose/soft subgrade soils will be required in the footprints of the proposed road construction. The following recommendations are provided:

1. To facilitate construction of the new road, a minimum 400mm sub-excavation into the existing ground is necessary. In the footprint of the proposed roadways or new structures, any existing loose/soft/wet soils at or immediately below subgrade elevations should be removed down to compact to dense native granular subgrade conditions.
2. All stripped and/or sub excavated foundation subgrades should be reviewed in the field by a geotechnical engineer or their representative, to confirm that loose/soft, wet, weakened and organic soils and/or fills have been appropriately removed prior to pavement structure construction. Proof-rolling will be necessary.
3. Subject to field review at the time of construction, any completed sub-excavated areas should be backfilled with fill as approved by the geotechnical engineer. The fill material should be compacted to a minimum of 99% Standard Proctor Maximum Dry Density (SPMDD), unless identified differently in subsequent sections of this report.
4. Any soils within the upper 300 mm beneath pavement structure should be compacted to 100% SPMDD.
5. The finished subgrade should be crowned or sloped at a minimum 2% cross fall to promote drainage.



### 5.3 Pavement Structure

The accel/deccel vehicle lanes (road) are relatively high volume roads with an annual estimated ESAL vehicle count of approximately 500 (2016) to 900 (2035) ESAL/day westbound. The road speed will be low to slow and stop at the gatehouse, and an anticipated average speed at 30 km/hour. The decel/acceleration lanes to enter and exit the gatehouse will split advancing westbound to the gate kiosks (proposed 3-4), and will merge further westbound to contain the same volume of traffic. For the purposes of this report, we have estimated the average 20 year design ESAL value to be 40% of the total for the new lane(s). This results in a value of 280 ESAL/day, or approximately 100,000 ESAL/year. Over a 20 year lifespan, the design Target Traffic value used equals 2,000,000 ESALs.

It is understood the new pavement structure will be matched at or near flush with the adjacent highway grade. Based on the testholes completed the subgrade soils appear to consist of predominately topsoil and organic fills overlying suitable granular soils.

For the purposes of design the following is recommended:

1. Based on the anticipated vehicle volumes and the anticipated loading, the following pavement structure is recommended:

**Table 5-1 Recommended Pavement Structure Options**

Pavement Layer	Minimum Thickness	Geosynthetic Specification
<b>Conventional Structure:</b>		
Asphalt Concrete	100 mm	-
Granular Base Course	250 mm	-
Granular Sub-Base Course	300 mm	-
<b>Geosynthetic Stabilized Structure:</b>		
Asphalt Concrete	100 mm	-
Granular Base Course	150 mm	-
Geosynthetic Reinforcement*	N/A	Geogrid Tensar TX 160 or approved equivalent.
Granular Sub-Base Course	200 mm	-

\* A geosynthetic reinforcement has been considered in order to reduce granular structure that would be required to support the anticipated vehicle loading.

2. Asphalt concrete mix and aggregate should meet AT specifications.
3. Granular Base Course should meet AT specifications for Well Graded Base (WGB), or an approved equivalent.
4. Base course shall be placed not to exceed a compacted lift thickness of 150 mm and within 3% of the optimum moisture conditions as determined by the optimum moisture-soil density relationship (ASTM D698) and compacted to at a minimum 100% SPMDD.



**Table 5-2 Specifications for Granular Base Course**

Sieve Designation (mm)	Granular Base Course 25 mm Minus
25	100
19	80-100
9.5	50-85
4.75	35-70
2.36	25-50
1.18	15-35
0.300	5-20
0.075	0-5

5. Frequency and locations of testing shall be as directed by the Engineer. All fill placement and compaction operations should be observed by the geotechnical engineer or their representative and conform to the AT Standard Specifications for Highway Construction.
6. A medium grade non-woven geotextile (Nilex 4551 or approved equivalent) should be installed if finer grained subgrade soils (fine sands, silt/clay) are encountered to provide separation from the granular base course.

The non-woven geotextile should meet the following specifications:

Grab Tensile Strength (N) <sup>(1)</sup>	>700
Trapezoidal Tear (N) <sup>(2)</sup>	>250
CBR Puncture Strength (N) <sup>(3)</sup>	>1800
Apparent Opening Size (µm) <sup>(4)</sup>	150<EOS<220

(1) ASTM D-4632\*

(2) ASTM D-4533\*

(3) ASTM D-6241\*

(4) ASTM D-4751

\* Based on Minimum Average Roll Values (ASTM C-4759)

## 5.4 Future Road Maintenance

It should be noted that pavement surfaces will deteriorate and exhibit cracking overtime and routine maintenance (ie. crack sealing) will assist in maximizing the life expectancy of the pavement structure. To improve the pavement life expectancy it is recommended that regular maintenance including filling and sealing of cracks before wetter seasons be considered to reduce the potential of increased pavement damage occurring from surface water infiltration into cracks and subgrade soils.

## 5.5 Building Recommendations

McElhanney understands that the proposed gate house structure will consist of a 1 storey conventionally constructed building, with a crawlspace beneath. The following recommendations are provided for:

### 5.5.1 Building Siting and Site Preparation

1. All deleterious fill and any organics/topsoil, as well as any silty, soft or unsuitable material shall be removed from the building site down to compact to dense sand and gravel horizon. Based on Testholes TH16-04 and TH16-05 we anticipate this depth to range



between 1.5-2.4 mbgs. This layer shall be compacted to minimum 99% Standard Proctor Density and verified by a qualified geotechnical engineer.

#### 5.5.2 Foundations

Shallow foundations (i.e. strip and/or spread footings) are considered suitable at the site. The recommendations for shallow foundations are provided below:

1. A factored Ultimate Limit State (ULS) soil bearing resistance of 160 kPa is recommended for shallow footings, when placed at a depth of 2.5m or less below the surface.
2. A maximum Serviceability Limit State (SLS) soil bearing resistance of 125 kPa for strip and spread footings on approved bearing subgrade of dense sand and gravel. The recommended soil bearing resistances are expected to have settlements of less than the maximum of 25 mm for strip and spread footings constructed with a minimum width of 0.6m (24") and maximum width of 1.2m, provided the soil bearing in accordance with the above noted recommendations.
3. ULS and SLS bearing resistance values calculated in accordance with the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 2006).
4. We recommend that footings for permanently heated structures have a minimum of 1.4m of cover below finished grade for frost protection. Isolated and/or unheated footings shall extend to 1.9m below finished grade.
5. Footings for the proposed buildings must be founded on approved, undisturbed, unfrozen, inorganic, native soil.
6. We recommend that additional reinforcing steel be placed in the strip footing at the crossing location of any planned utility (water/sewer) service trench. We recommend that 5-15M reinforcing bars extending 1m beyond the edge of trench each way be placed at such locations.
7. We recommend the excavation and building siting be confirmed by a qualified geotechnical engineer prior to foundation placement.
8. Seepage or surface water runoff must not be allowed to enter foundation excavations. Any water or snow that collects in the footing excavation must be removed and subgrade soils be allowed to dry prior to construction of the footings.
9. Concrete footings must not be placed on frozen soils, nor should soils beneath the footing be allowed to freeze during or after construction; therefore, the footing subgrade must be protected from freezing during and after construction.
10. Concrete footings should be protected from freezing and proper curing conditions should be provided as per Canadian Standard Association (CSA) concrete specifications.
11. We understand that the building may contain a basement or crawlspace. If a portion of the structure will be set below grade, then we recommend a drain tile and drainrock (groundwater collection) system be installed along the base of the footings outside the

building footprint, and discharge down below the building. The system should, at a minimum meet the National Building Code requirements. We further recommend that:

- The pipe is placed approx. 0-100mm below footing grade, and preferably directly on top of geotextile fabric;
- Drintile pipe be placed along the perimeter and connect to a header pipe along the edge;
- Pipe is min. 100mm dia. perforated, with perforations at 4 and 8 o'clock;
- Pipe should slope at minimum 1% and drain to a solid collector pipe and discharge to a frost-free outfall downslope of the structure;
- Extend drainrock a min. 300mm over pipe, and ensure geotextile is wrapped over the drainrock on the exterior of the foundation back to the wall before backfill;
- We recommend that PVC SDR 28 or 35 pipe be used.

### 5.5.3 Foundation Wall Backfill and Waterproofing

For foundation walls the following recommendations are provided:

1. Foundation wall backfill should be sufficiently compacted such that future settlement is mitigated.
2. In order to reduce the potential for unbalanced lateral pressures on the foundation walls the placement and compaction of wall backfill should be carried simultaneously in the inside and outside of the walls. For foundation wall backfill above slab-on-grade we recommend that the main floor system be installed prior to exterior backfill.
3. Final grades along the external foundation wall should be designed with a gradient of at least 5% over a distance of 1.5m to direct water away from the building. Surface water, including build-up of snow and ice, cannot be allowed to be present up against or within 1m of the foundation walls above slab.
4. For any foundation walls above slab elevation of which are backfilled with the native soils, we recommend that two layers of emulsified asphalt waterproofing product be applied with a drainboard (Delta MS or approved equivalent) as a minimum.
5. Backfill around foundation walls shall be free-draining compacted granular material.

### 5.5.4 Grade Supported Floor Slabs

The following recommendations are provided for grade supported floor slabs:

1. Concrete slab on grades should be placed over a compacted granular pad. Where additional grade is necessary, we recommend that it be backfilled with engineered fill compacted to 99% standard proctor density in 200mm lifts.
2. We recommend a minimum of 125 mm thick crushed gravel base layer (*or drainrock*) be placed below the underside of the floor slab prior to concrete placement. The base course should be compacted as per above.
3. If there are backfilled foundation walls above a sub slab or crawlspace elevation, we recommend that a heavy-duty vapour barrier – min 8mil poly – should be provided on the underside of the building floor slab with sealed joints and be sealed back to the



foundation wall. Any penetrations through the poly (plumbing, etc) shall be sealed and waterproof.

#### 5.5.5 Suitability of Existing Soil

For backfill outside of the structure, it is recommended that the topsoil, silty organic gravel, and any silt/clay soils should not be used in areas where the owner wishes to minimize future potential for saturation, settlement and frost heave. Such areas may be under landscape improvements, sidewalks, parking areas, and other surface improvements. These soils are known to be sensitive to moisture in a remoulded state (backfill), and are not recommended for structural backfill purposes.

#### 5.5.6 Lateral Earth Pressures for Retaining/Foundation Walls

For the purposes of any required retaining wall (or foundation wall) design, it is recommended that the following design criteria is considered. For seismic conditions, the total active thrust will likely be the determining factor in the wall design.

**Table 5-3: Summary of Retaining Wall Lateral Pressure Design Parameters**

Anticipated Soil Backfill Parameters				Coulomb Earth Pressure Coefficients			
Friction Angle (°)	Cohesion (kPa)	Dry Density (kg/m <sup>3</sup> )	Friction Angle of Wall-Backfill Interface (°)	K <sub>O</sub> (at rest)	K <sub>A</sub> (active)	K <sub>P</sub> (passive)	K <sub>AE</sub> (dynamic active)
34	0	1920	24	0.56	0.28	3.55	0.35

K<sub>AE</sub> was calculated using the Peak Ground Acceleration (as obtained from the National Resource Canada seismic website) for the site location (53.22N, -117.84W) which was determined to be:

[Ref: [http://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index\\_2015-en.php](http://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2015-en.php), for 2015 National Building Code Seismic Hazard Calculations]

PGA = 0.132g

Backfill behind the retaining wall shall be free-draining in order to reduce frost action up against the wall and facilitate drainage. We recommend the use of clean site granular fills or drain rock for this purpose. For the above noted values, it is assumed that the backfill slope is relatively level, the back face of the wall is near vertical, and the backfill is a clean, cohesionless granular material.

#### 5.5.7 Site Seismic Classification

The parameters for Site Classification for the Seismic Site Response are based on the viewed and available density and consistency of the granular fills and underlying morainal soils. Given the observed dense native soils encountered in the test holes, it is recommended that the project site be considered Site Class D for the purposes of foundation design as per the National Building Code 2015 (Section 4.1.8.4).

## 6.0 Closure

This report has been prepared by McElhanney Consulting Services Ltd. for the benefit of Parks Canada Agency. This report is based on the results of geotechnical assessment and limited laboratory testing completed at the project site as noted. Note that possibly different and/or poorer soil conditions than those described in this report may be encountered between the test locations and in areas not specifically tested. The information and data contained herein represent McElhanney's best professional judgment in light of the knowledge and information available to McElhanney at the time of preparation. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the client, its officers and employees.

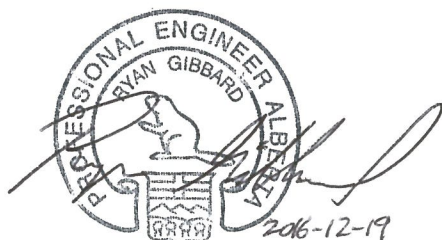
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This document was prepared in accordance with generally accepted geotechnical engineering principles and practice. No other warranty, expressed or implied, is made.

Should you have any queries, please do not hesitate to contact the undersigned.

Respectfully submitted,

McElhanney Consulting Services Ltd.

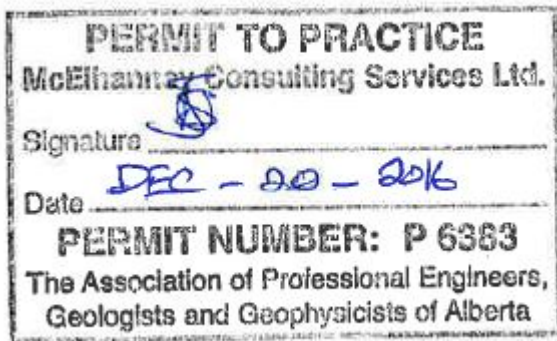


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### ATTACHMENTS

Drawings: Testhole Plans (Drawing No. 2511-00763-00, Sheet 101 and 102)  
Appendix A: Borehole Logs (TH16-01 through TH16-09)  
Appendix B: Laboratory Test Results and DCP Test Results





## **Drawings**

Testhole Plans (Drawing No. 2511-00763-00, Sheet 101 and 102)







## **Appendix A**

Testhole Logs (TH16-01 through TH16-09)





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## TEST HOLE LOG

TEST HOLE No: # 16-01

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
PROJECT: Jasper Park Gates ELEVATION DATUM: 1002.8m  
REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil - Organics, dark brown, with gravel fill, damp, loose.		
0.35			Fill - Sandy silt/clay with some gravel and organics, (low cohesion), cobbles, occasional boulders up to 0.3m throughout, moist, firm.		
0.8			Sandy gravel with some silt, some clay, occasional cobbles, medium brown, damp to moist, slight cohesion, compact. Note: gravels are sub-rounded to sub-angular.	S-1 0.8m	DCP 1 @ 0.8m CBR = 12 Gradation @ 0.8m = 18% gravel, 23% sand, 59% silt/clay, moisture = 24%
				S-2 1.2m	DCP 2 @ 1.1m CBR = 28 Gradation @ 1.1m = 64% gravel, 25% sand, 11% silt/clay, moisture = 4.3%
2.5			Excavation discontinued @ 2.5m No groundwater encountered		



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Cranbrook, B.C. V1C 7H9

PH (250) 489 3013  
FAX (250) 489 4522

## TEST HOLE LOG

TEST HOLE No: # 16-02

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
PROJECT: Jasper Park Gates ELEVATION DATUM: 1002.1m  
REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil - Organics, dark brown, with gravel fill, damp, loose.		DCP 1 @ 0.4m CBR = 7.7 Gradation @ 0.4m = 73% gravel, 20% sand, 7% silt/clay, moisture = 2.9%
0.2			Fill - Gravelly sands with silt and clay (low cohesion), cobbles, occasional boulders up to 0.3m throughout, moist,	S-1 0.4m	
0.4			Gravels with some coarse to fine sand, trace silt, and clay, cobbles, occasional boulders to 0.3m, grey/med brown, compact.		
0.8			Sandy gravel with trace silt and clay, occasional cobbles, medium brown, damp to moist, slight cohesion, compact. Note: gravels are sub-rounded to sub-angular.	S-2 1.9m	DCP 2 @ 1.1m CBR = 21 Gradation @ 1.1m = 71% gravel, 23% sand, 6% silt/clay, moisture = 3.3%
2.4			Excavation discontinued @ 2.4m No groundwater encountered		





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## BORE HOLE LOG

BORE HOLE No: # 16-03

McElhanney # 2511-00763-00 TEST LOCATION: See Sketch DATE: October 20, 2016  
 PROJECT: Jasper Park Gates ELEVATION DATUM: 1001.8m  
 REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Unimag MS - Mobile Auger

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil - Organic silt		
0.2			Gravelly silts with some clay, frequent organics, fibrous wood/roots present, dark brown, damp, firm.		
				0.8m S-1	SPT 12/10/8
				1.1m	
				1.2m S-2	Gradation @ 1.2m = 4% Gravel, 20% sand, 76% silt/clay, moisture = 28.7%
				1.5m	
				1.5m S-3	SPT 12/17/40 - Ref. in rock @ 1.9m
				2.0m	
2.1					SPT @ 2.3 - Refusal
			Sandy gravel, some silt, trace clay, occasional cobble, medium brown, damp, compact.	2.1m S-4	Gradation @ 2.1m = 61% Gravel, 24% sand, 15% silt/clay, moisture = 5.4%
				2.3m	
				2.4m S-5	No SPT, drilled through rock @ 2.4m.
				2.7m	
				3.0m S-6	SPT 11/36/70
				3.4m	
			Some to trace fines @ 3.6m.		
				3.7m S-7	
				4.3m	
				4.6m S-8	SPT 7/9/16
			Transitions to grey/brown @ 4.8m.	5.0m	
				5.2m S-9	
				5.8m	
6.1					Borehole sloughing in.
			Drilling discontinued @ 6.1m No groundwater encountered		

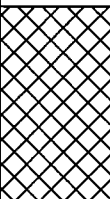





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# BORE HOLE LOG

BORE HOLE No: # 16-04

McElhanney # 2511-00763-00 TEST LOCATION: See Sketch DATE: October 20, 2016  
 PROJECT: Jasper Park Gates ELEVATION DATUM: 1002.3m  
 REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Unimag MS - Mobile Auger

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Fill - sand and gravel, trace to some fines, medium brown, damp, compact-dense.	0.5m S-1 0.8m	Gradation @ 0.5m = 49% gravel, 40% sand, 11% silt/clay. Moisture = 4.1%
0.9			Sandy gravel, some fines, medium brown, damp, compact.	0.8m S-2 1.2m 1.2m S-3 1.5m	SPT 21/14/26 Gradation @ 0.9m = 51% gravel, 31% sand, 18% silt/clay. Moisture = 6.2%
1.6			Silt and sand, some gravel, some clay, brown, moist, compact, slight cohesion.	1.5m S-4 2.0m 2.1m S-5 2.3m	SPT 8/10/9 Gradation @ 2.1m = 19% gravel, 43% sand, 38% silt/clay. Moisture = 15.1%
2.4			Sandy gravel, some fines, brown/grey, damp, compact, slight cohesion.	2.7m S-6 3.0m S-8 3.5m 3.7m S-9 4.3m 4.6m S-10 5.0m 5.2m S-11 5.8m 6.1m S-12 6.4m	S-7 @ 2.4m SPT 7/9/14  SPT 3/8/33  Gradation @ 3.7m = 62% gravel, 24% sand, 14% silt/clay. Moisture = 5.2%  SPT 21/11/8
6.4			Drilling discontinued @ 6.4m No groundwater encountered		SPT 26/50/refusal





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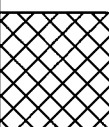




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## BORE HOLE LOG

BORE HOLE No: # 16-05

McElhanney # 2511-00763-00 TEST LOCATION: See Sketch DATE: October 20, 2016  
 PROJECT: Jasper Park Gates ELEVATION DATUM: 1001.6m  
 REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Unimag MS - Mobile Auger

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Fill - sandy/gravel, trace fines, dark brown, damp, compact.	0.6m S-1	
1.5			Sand and gravel, some fines, medium brown, damp, compact.	1.5m S-2	
			compact to dense @ 3.4m.	2.3m S-3	SPT 9/13/12
			Transitions to brown/grey @ 4.6m.	3.8m S-4	SPT 9/20/27
				5.3m S-5	SPT 20/32/32
6.7			Fine Sandy Clayey Silt - brown, moist to wet, firm, low cohesion.	6.9m S-6	SPT 2/2/3 Atterberg Limits @ 6.9m = LL = 29%, PL = 23%, Moisture = 32.1%.
			Wet @ 8.1m.	8.4m S-7	SPT 3/3/3
			Stiff @ 9.8m.	9.9m	SPT 7/6/7 (No Sample)
11.6			Gravel and sand, trace to some fines, brown, wet, dense.	11.4m S-8	SPT 1/2/7 Atterberg Limits @ 11.4m = LL = 27%, Moisture = 32%.
				12.2m S-9	(Blow-back sample)
				13.0m S-10	SPT 13/27/33 Gradation @ 13.0m = 47% Gravel, 41% Sand, 12% silt/ Clay, Moisture = 7.6%.
14.9			Drilling discontinued @ 14.9m No groundwater encountered	114.5m S-11	SPT 14/17/22  NOTE: Monitoring well installed. Depth to water 1 hour after completion is 8.1m.



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## TEST HOLE LOG

TEST HOLE No: # 16-06

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
PROJECT: Jasper Park Gates ELEVATION DATUM: 1001.8m  
REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil – Organics, dark brown, with gravel fill, damp, loose.		DCP 1 @ 1.0m CBR = 11 Gradation @ 1.0m = 64% gravel, 20% sand, 16% silt/clay, moisture = 5.1%
0.2			Fill – Sandy silts with gravel, trace fines, medium brown, damp, loose to firm.		
0.5			Fill – Gravels, some silt/clay, occasional cobbles, dark brown, damp, compact.		
0.8			Sandy gravel some silt and clay, cobbles, grey/med. brown, damp to moist, slight cohesion compact. Observed some rootlets to 1.5m. Note: gravels are sub-rounded to sub-angular.	S-1 1.0m	
2.4			Excavation discontinued @ 2.4m No groundwater encountered		





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## TEST HOLE LOG

TEST HOLE No: # 16-07

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
 PROJECT: Jasper Park Gates ELEVATION DATUM: 1003.7m  
 REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil – Organics, dark brown, with gravel fill, damp, loose.		DCP 1 @ 1.1m CBR = 5.1 Gradation @ 1.1m = 68% gravel, 21% sand, 11% silt/clay, moisture = 4.8%
0.2			Fill – Medium to fine sandy gravel, some to trace silts/clay, cobbles, occasional boulders to 0.5m, asphalt debris observed 0.7m, grey/med. brown, damp, loose to firm.	S-1 1.1m	
1.6			Coarse to medium grained sands, some small gravels, damp to moist, brown, firm, some roots to 1.7m.	S-2 1.7m	
2.0			Gravels with coarse to fine sand, with some silt, some clay, occasional cobbles, medium brown, damp to moist, slight cohesion, compact. Note: gravels are sub-rounded to sub-angular.		
2.5			Excavation discontinued @ 2.5m No groundwater encountered		



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TEST HOLE LOG

TEST HOLE No: # 16-08

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
PROJECT: Jasper Park Gates ELEVATION DATUM: 1007.2m  
REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil - Organics, dark brown, with gravel fill, damp, loose.		DCP 1 @ 0.4m CBR = 14 Gradation @ 0.5m = 43% gravel, 38% sand, 19% silt/clay, moisture = 6.7%
0.15			Sands with silts and roots, occasional small gravel, brown, damp, loose.		
0.4			Gravels with coarse to fine sand, with some silt and some clay, cobbles, dark brown, damp, slight cohesion, firm. Observed some rootlets to 1.3m. Note: gravels are sub-rounded to sub-angular.	S-1 0.5m	
1.3			Sandy gravels with some silt and clay, cobbles, medium to dark brown, damp to moist, slight cohesion, compact.  Note: gravels are sub-rounded to sub-angular.		DCP 2 @ 1.4m CBR = 8
				S-2 1.8m	TH sloughing at 1.8m.
2.5			Excavation discontinued @ 2.5m No groundwater encountered		



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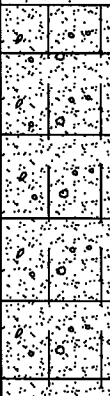

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## TEST HOLE LOG

TEST HOLE No: # 16-09

McElhanney # 2511-00763-00 TEST LOCATION: See sketch DATE: October 20, 2016  
PROJECT: Jasper Park Gates ELEVATION DATUM: 1010.8m  
REGION: Park gates Jasper/Hinton INVESTIGATION METHOD: Zaxis 210W rubber tire excavator

DEPTH (meters)	ELEV. (meters)	SOIL PROFILE	SOIL DESCRIPTION	TEST SAMPLES	OTHER TEST COMMENTS
0.0			Topsoil – Organics, dark brown, with gravel fill, damp, loose.		DCP 1 @ 0.5m CBR = 8  Gradation @ 1.0m = 20% gravel, 75% sand, 5% silt/clay, moisture = 4.9%  DCP 2 @ 1.2m CBR = 6
0.2			Gravels with silts and sand, dark brown, dark brown, loose to firm.		
0.5			Well graded sand with some gravel, trace silt/clay, roots, brown, damp, firm.	S-1 1.0m	
1.4			Gravels with coarse to fine sand, some silts, some clay, cobbles, occasional boulders to 0.5m, grey/med brown, compact.		
2.3		Excavation discontinued @ 2.3m No groundwater encountered			





## **Appendix B**

Laboratory Test Results  
DCP Test Results



**MATERIALS TESTING AND INSPECTION SERVICES**  
 229 Industrial Road F, Cranbrook, BC V1C 6N4  
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 Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH1 S1

**Material type:** Sandy silt/clay with some gravel (contained some organics)

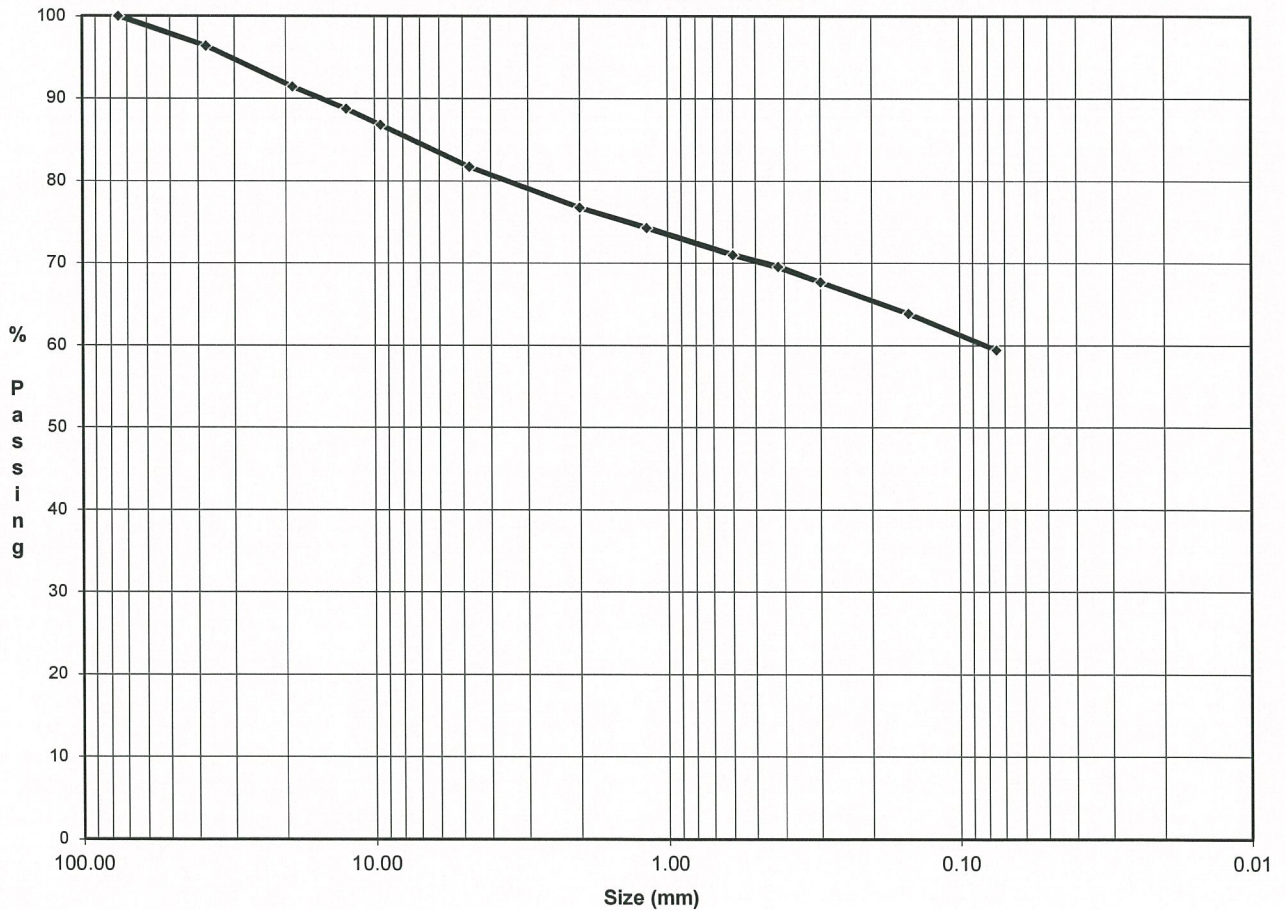
**Lab No:** S16-576

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	76.8	Medium sand
75.0	100.0	Gravel	1.180	74.3	
37.5	96.4		0.600	71.0	
19.0	91.4		0.420	69.6	Fine sand
12.5	88.7		0.300	67.7	
9.5	86.8		0.150	63.9	
4.75	81.7	Coarse sand	0.075	59.4	Silt/clay

**% PASSING VS GRAIN SIZE**



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 24.0

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**



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 Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH1 S2

**Material type:** Sandy gravel with some silt/clay

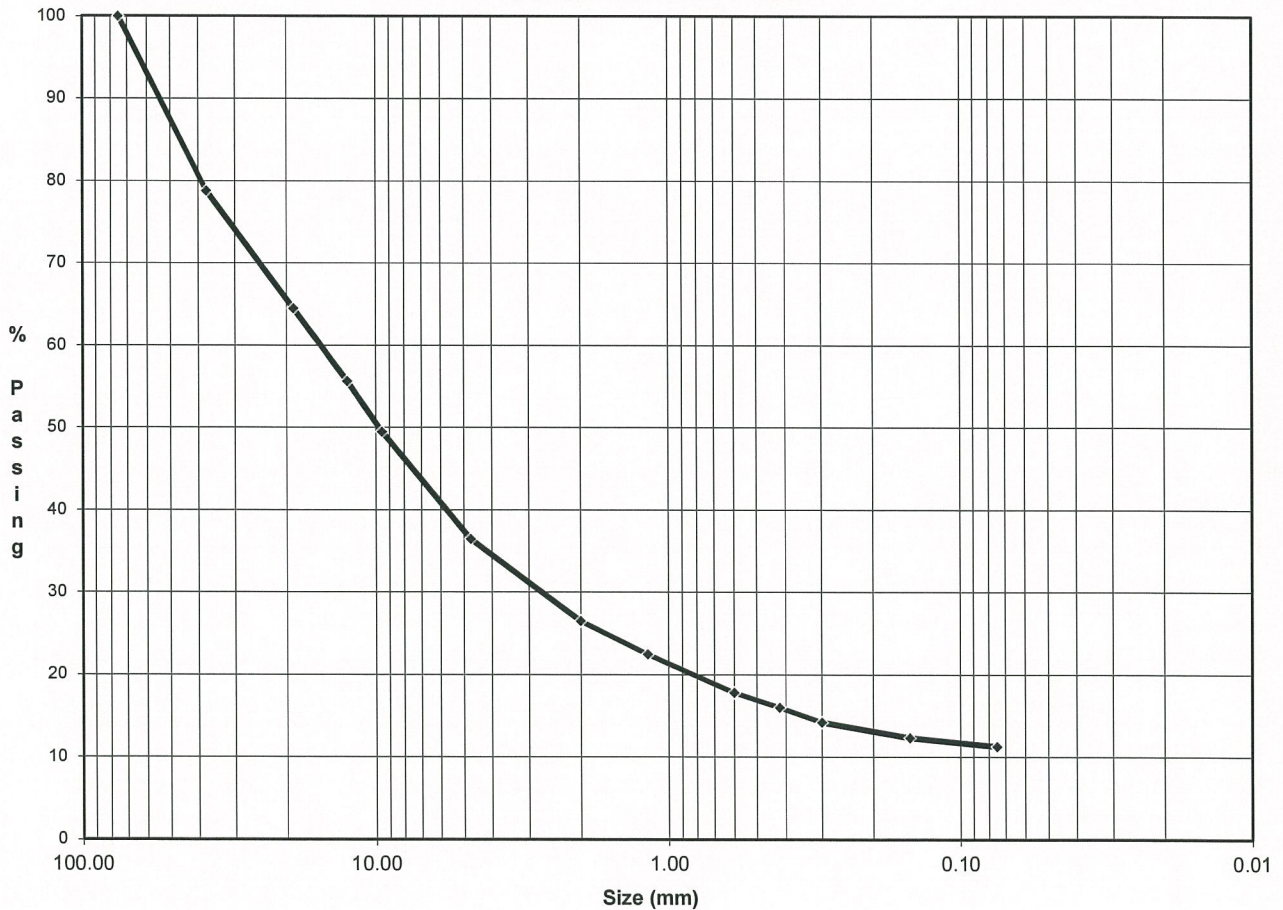
**Lab No:** S16-577

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	26.5	Medium sand
75.0	100.0	Gravel	1.180	22.4	
37.5	78.8		0.600	17.8	
19.0	64.5		0.420	16.0	Fine sand
12.5	55.6		0.300	14.2	
9.5	49.5		0.150	12.4	
4.75	36.4	Coarse sand	0.075	11.3	Silt/clay

**% PASSING VS GRAIN SIZE**



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 4.3

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH2 S1

**Material type:** Gravel with some cobble and sand, trace silt/clay

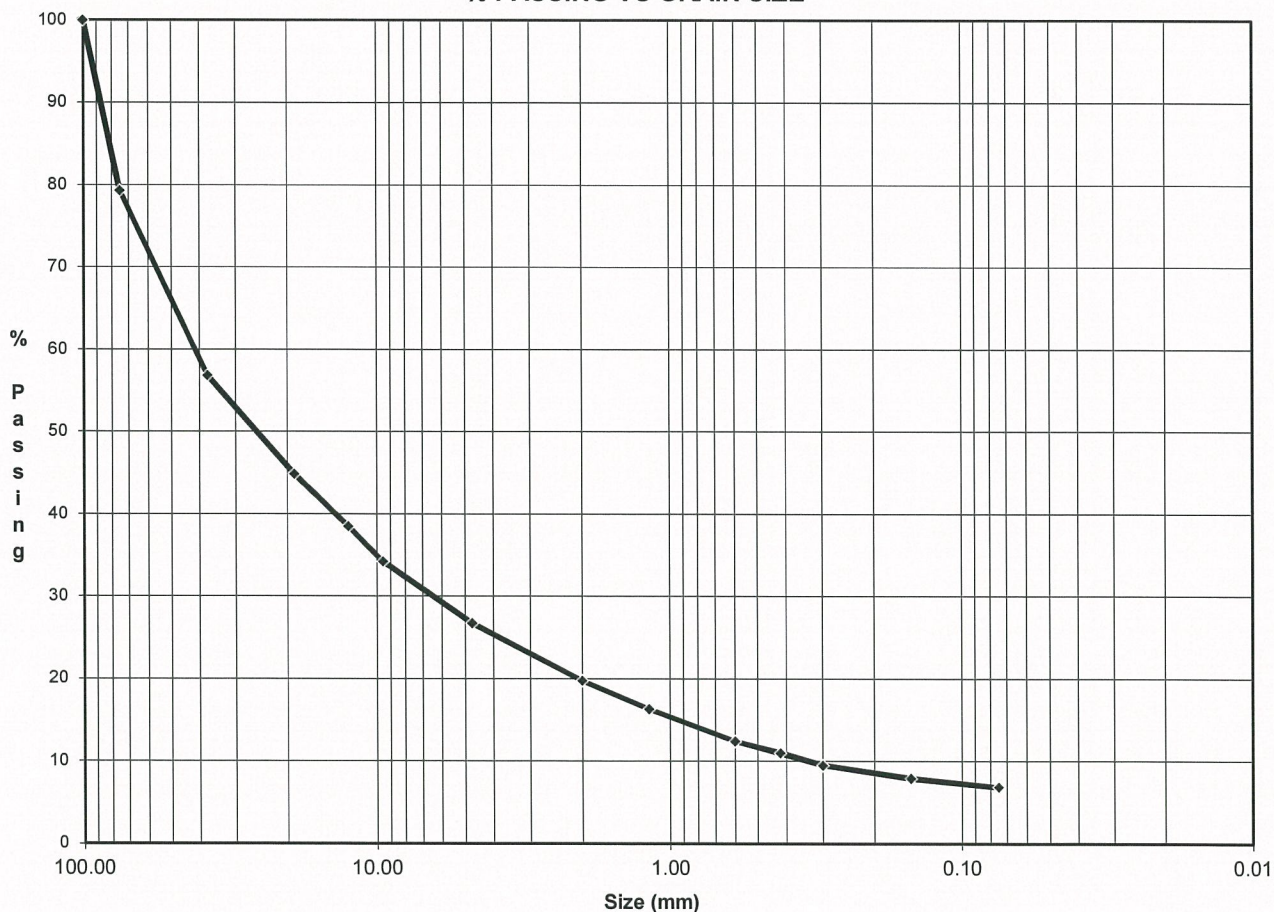
**Lab No:** S16-578

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0	100.0	Cobble	2.00	19.8	Medium sand
75.0	79.3	Gravel	1.180	16.3	
37.5	56.8		0.600	12.4	
19.0	44.9		0.420	11.0	Fine sand
12.5	38.5		0.300	9.5	
9.5	34.2		0.150	7.9	
4.75	26.7	Coarse sand	0.075	6.8	Silt/clay

**% PASSING VS GRAIN SIZE**



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 2.9

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH2 S2

**Material type:** Sandy gravel with trace silt/clay

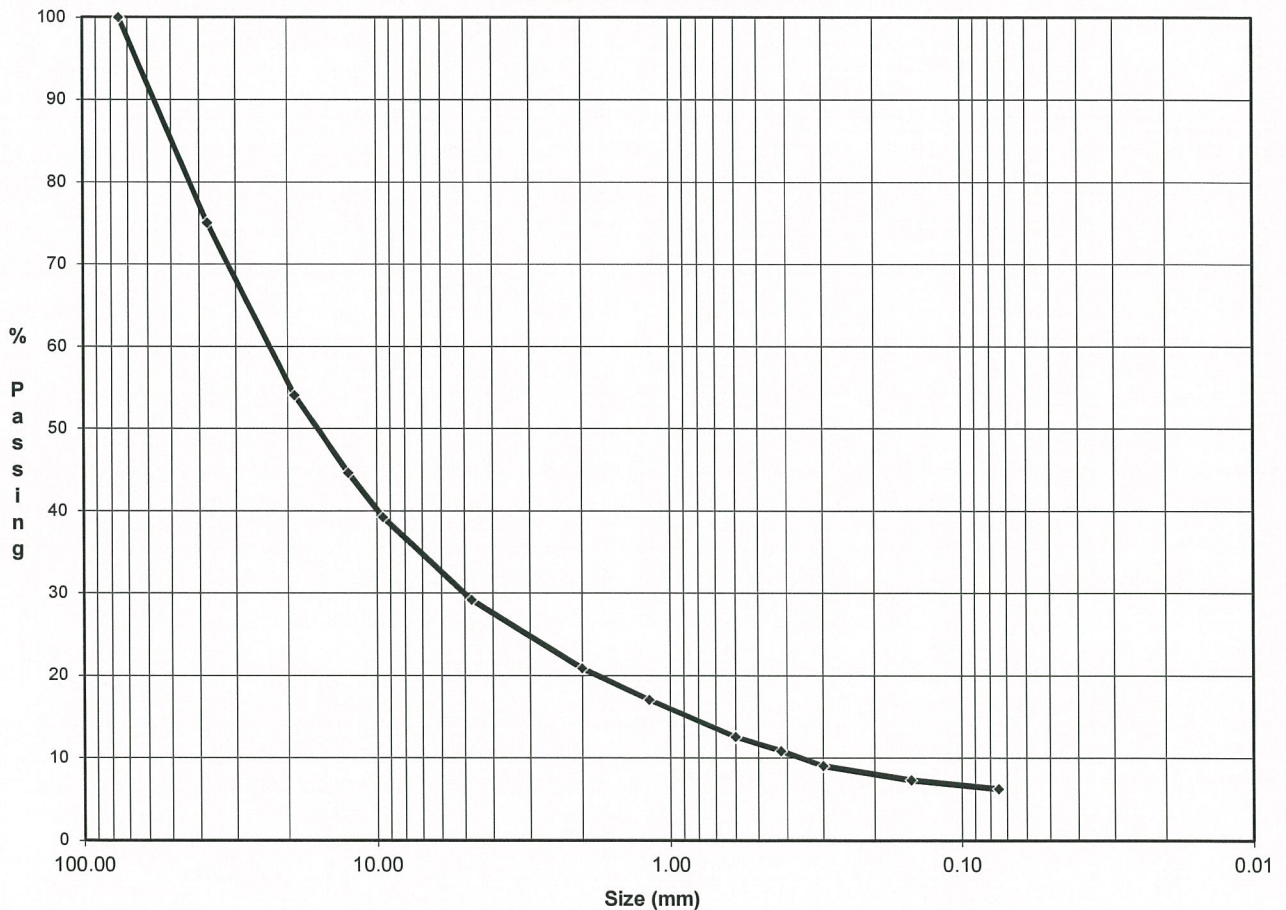
**Lab No:** S16-579

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	20.9	Medium sand
75.0	100.0	Gravel	1.180	17.1	
37.5	75.0		0.600	12.5	
19.0	54.1		0.420	10.8	Fine sand
12.5	44.6		0.300	9.0	
9.5	39.2		0.150	7.3	
4.75	29.2	Coarse sand	0.075	6.3	Silt/clay

**% PASSING VS GRAIN SIZE**



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 3.3

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH3 S2

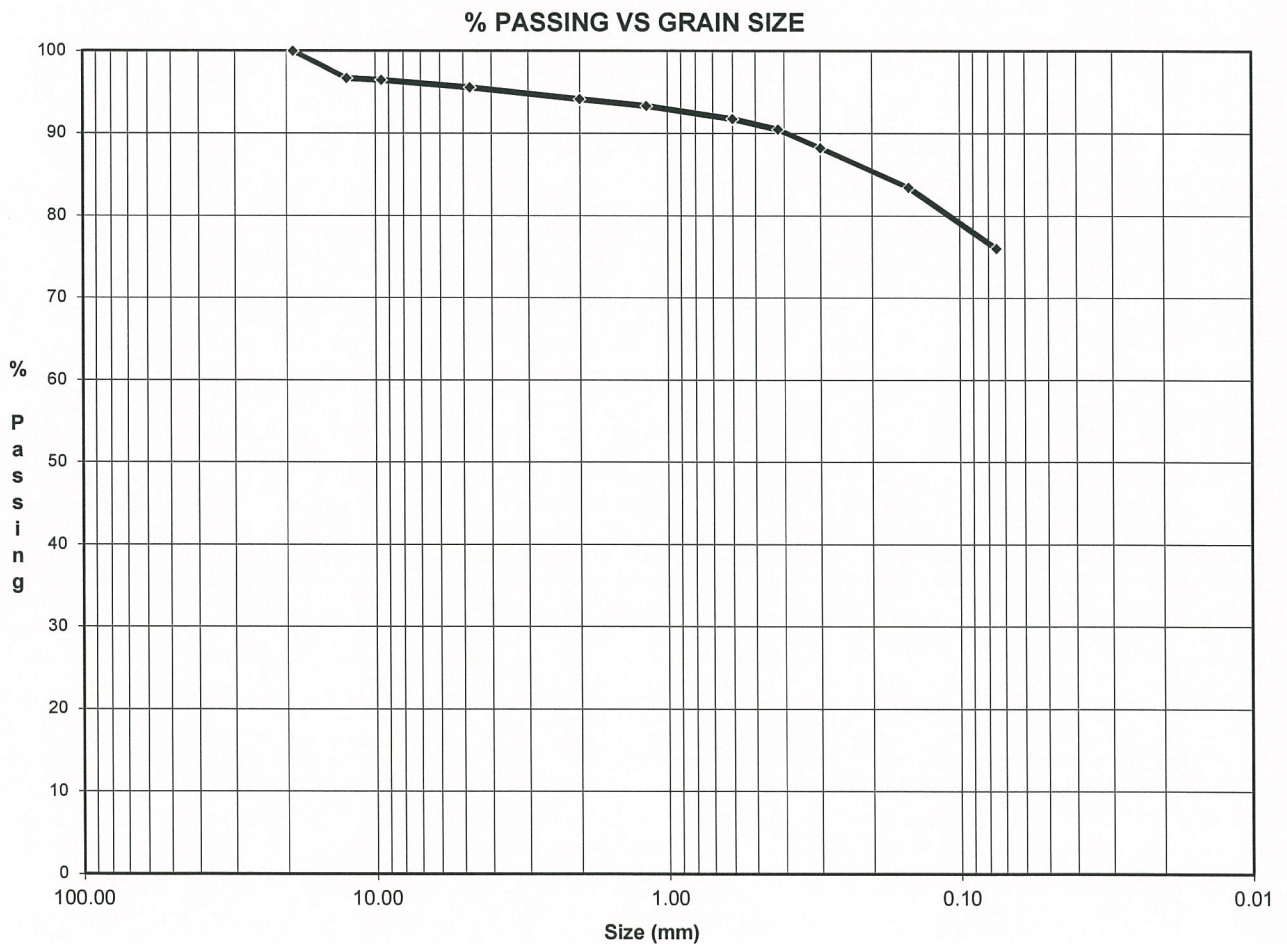
**Material type:** Silt/clay with some sand, trace gravel (contained some organics)

**Lab No:** S16-580

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	94.1	Medium sand
75.0		Gravel	1.180	93.3	
37.5			0.600	91.7	
19.0	100.0		0.420	90.5	Fine sand
12.5	96.7		0.300	88.2	
9.5	96.5		0.150	83.4	
4.75	95.6	Coarse sand	0.075	76.0	Silt/clay



Tested in accordance with ASTM C136, C117 (washed gradation)

**Moisture Content of Sample (%):** 28.7

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**



**GRADATION REPORT**
**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH3 S4

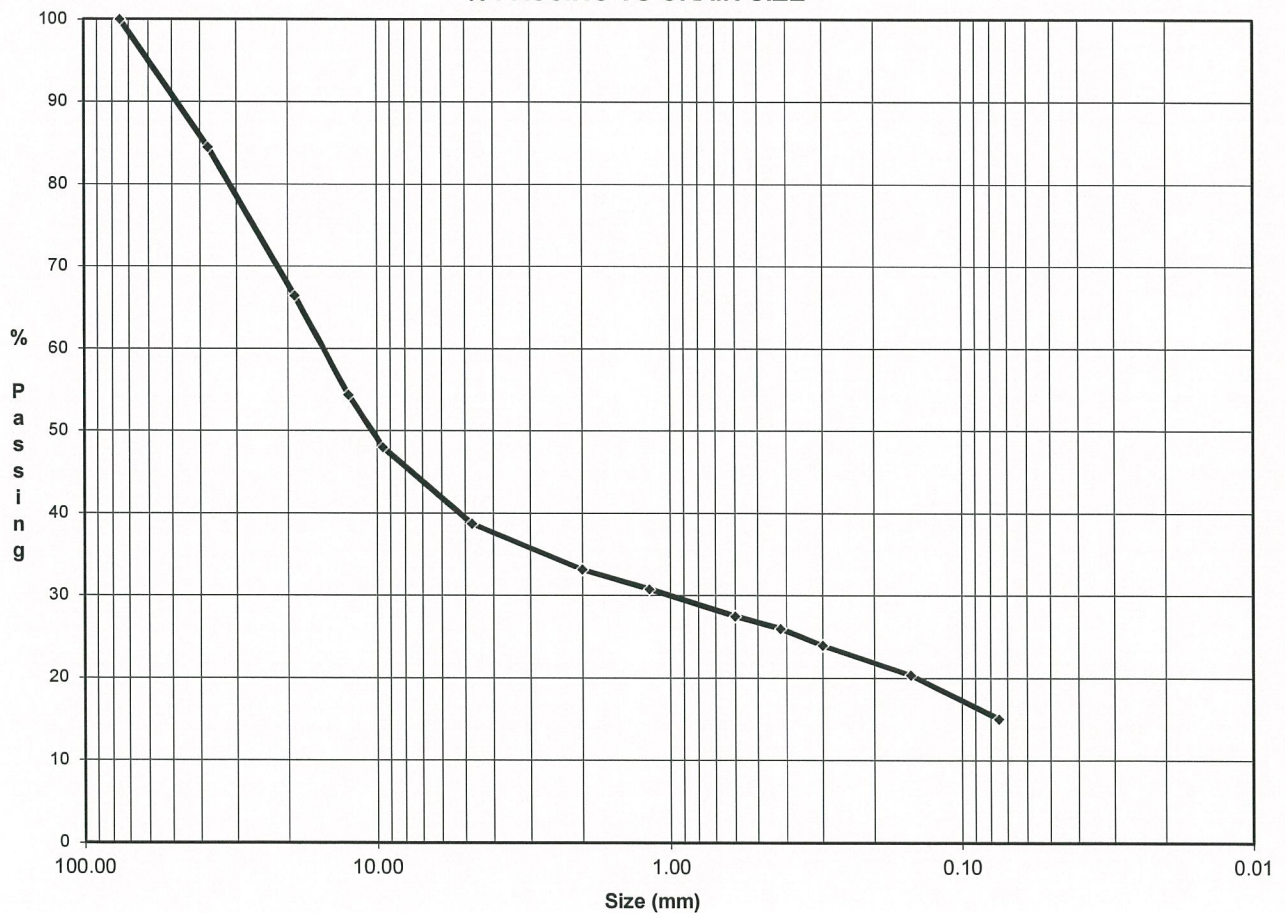
**Material type:** Sandy gravel with some silt/clay

**Lab No:** S16-581

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	33.2	Medium sand
75.0	100.0	Gravel	1.180	30.8	
37.5	84.5		0.600	27.5	
19.0	66.5		0.420	26.0	Fine sand
12.5	54.4		0.300	23.9	
9.5	48.0		0.150	20.3	
4.75	38.7	Coarse sand	0.075	15.1	Silt/clay

**% PASSING VS GRAIN SIZE**

*Tested in accordance with ASTM C136, C117 (washed gradation)*
**Moisture Content of Sample (%):** 5.4

**Reports:** McElhanney - R. Gibbard

**c.c.:**
**Report Date:** November 2, 2016

**Per:**






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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH4 S1

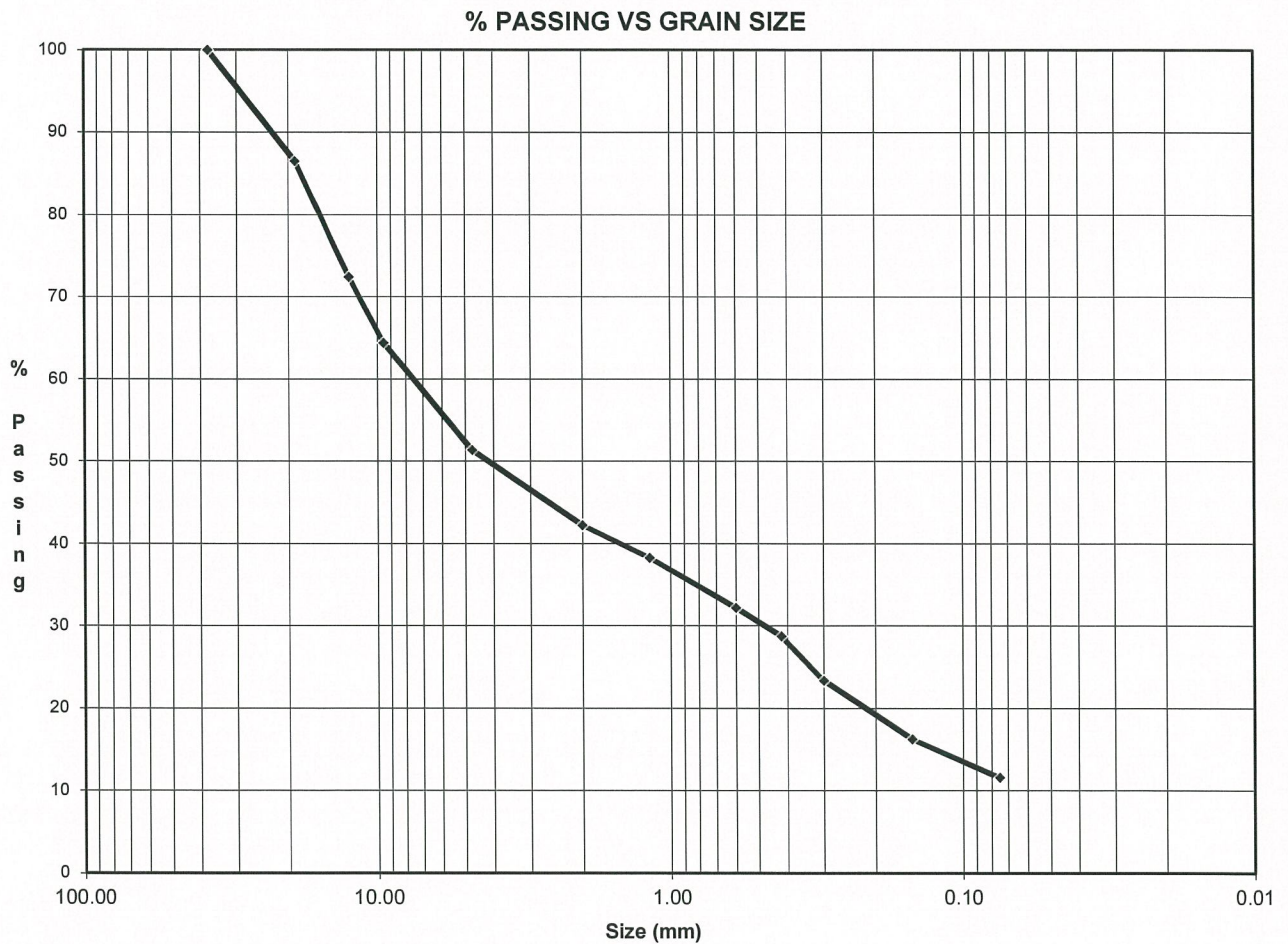
**Material type:** Gravel and sand, some silt/clay

**Lab No:** S16-582

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	42.2	Medium sand
75.0		Gravel	1.180	38.2	
37.5	100.0		0.600	32.2	
19.0	86.5		0.420	28.7	Fine sand
12.5	72.4		0.300	23.4	
9.5	64.4		0.150	16.2	
4.75	51.3	Coarse sand	0.075	11.5	Silt/clay



Tested in accordance with ASTM C136, C117 (washed gradation)

**Moisture Content of Sample (%):** 4.1

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH4 S3

**Material type:** Sandy gravel with some silt/clay

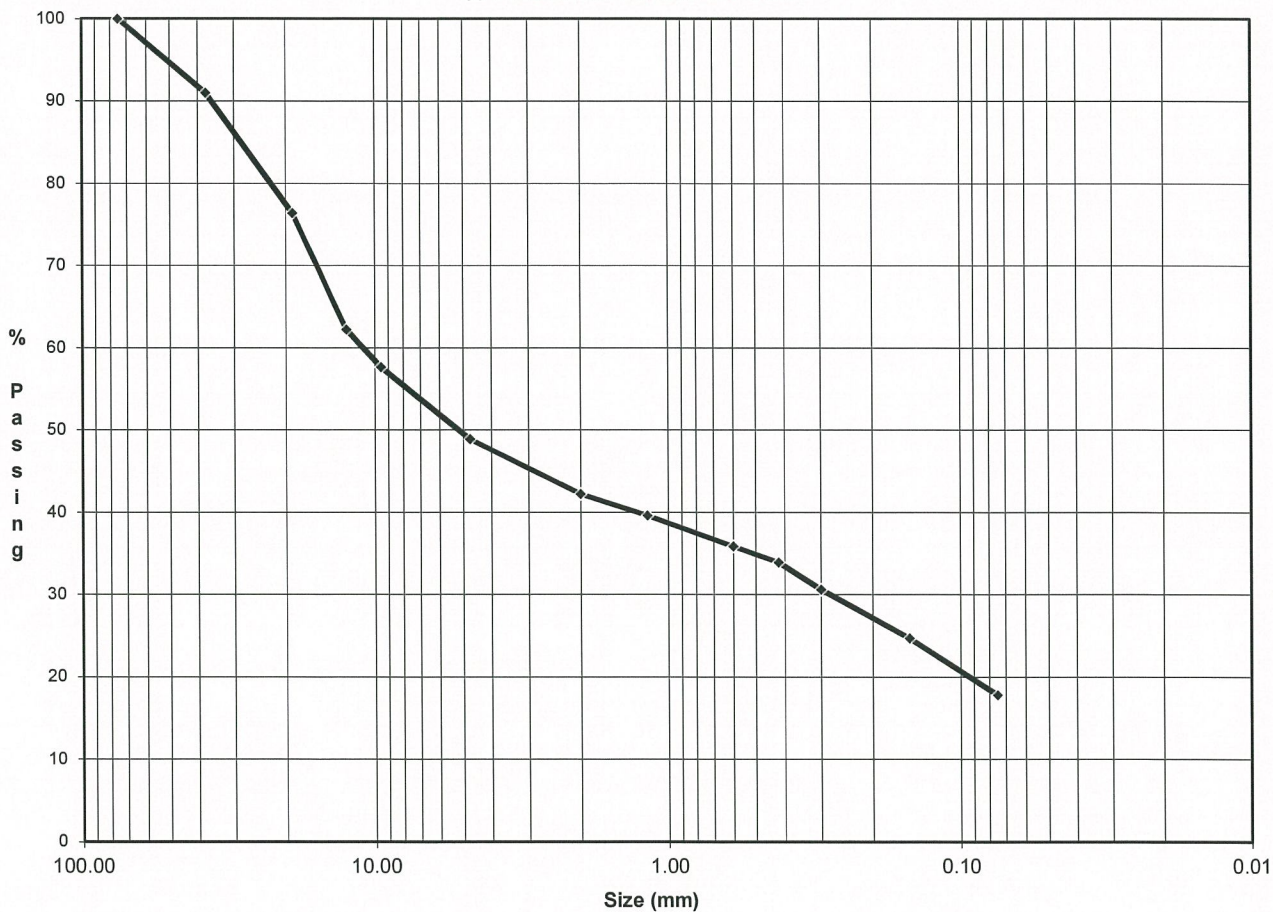
**Lab No:** S16-583

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	42.2	Medium sand
75.0		Gravel	1.180	39.6	
37.5	91.0		0.600	35.9	
19.0	76.4		0.420	33.9	Fine sand
12.5	62.2		0.300	30.6	
9.5	57.6		0.150	24.7	
4.75	48.9	Coarse sand	0.075	17.8	Silt/clay

**% PASSING VS GRAIN SIZE**



Tested in accordance with ASTM C136, C117 (washed gradation)

**Moisture Content of Sample (%):** 6.2

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





**MATERIALS TESTING AND INSPECTION SERVICES**  
 229 Industrial Road F, Cranbrook, BC V1C 6N4  
 Ph: 250/489-1940; Fax: 250/489-1667;  
 Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH4 S5

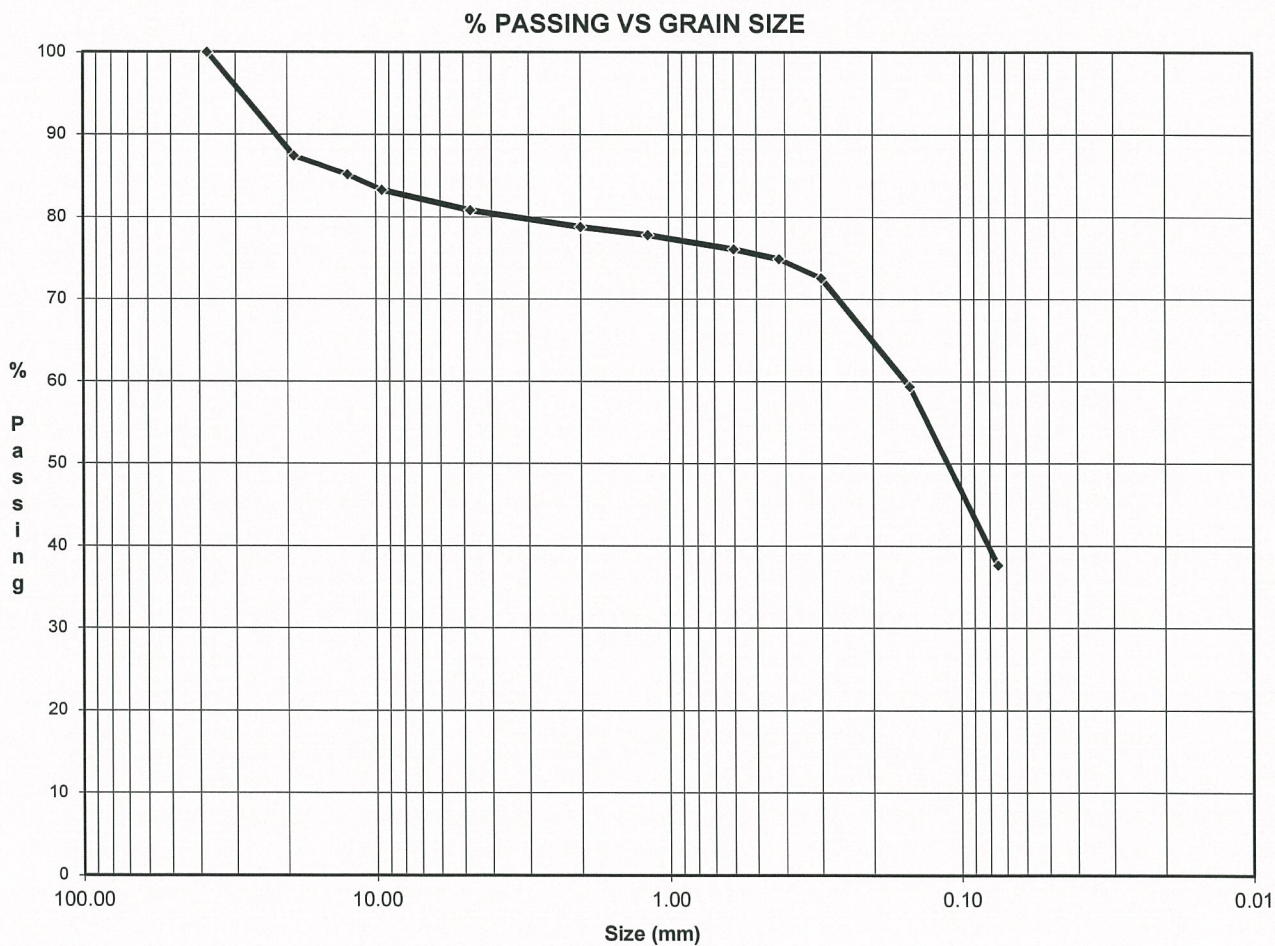
**Material type:** Sand and silt/clay with some gravel

**Lab No:** S16-584

**Our File:** 2016-11

**Region:** Jasper, AB

<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>	<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>
100.0		Cobble	2.00	78.8	Medium sand
75.0		Gravel	1.180	77.8	
37.5	100.0		0.600	76.1	
19.0	87.4		0.420	74.9	Fine sand
12.5	85.2		0.300	72.5	
9.5	83.3		0.150	59.4	
4.75	80.8	Coarse sand	0.075	37.6	Silt/clay



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 15.1

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH4 S9

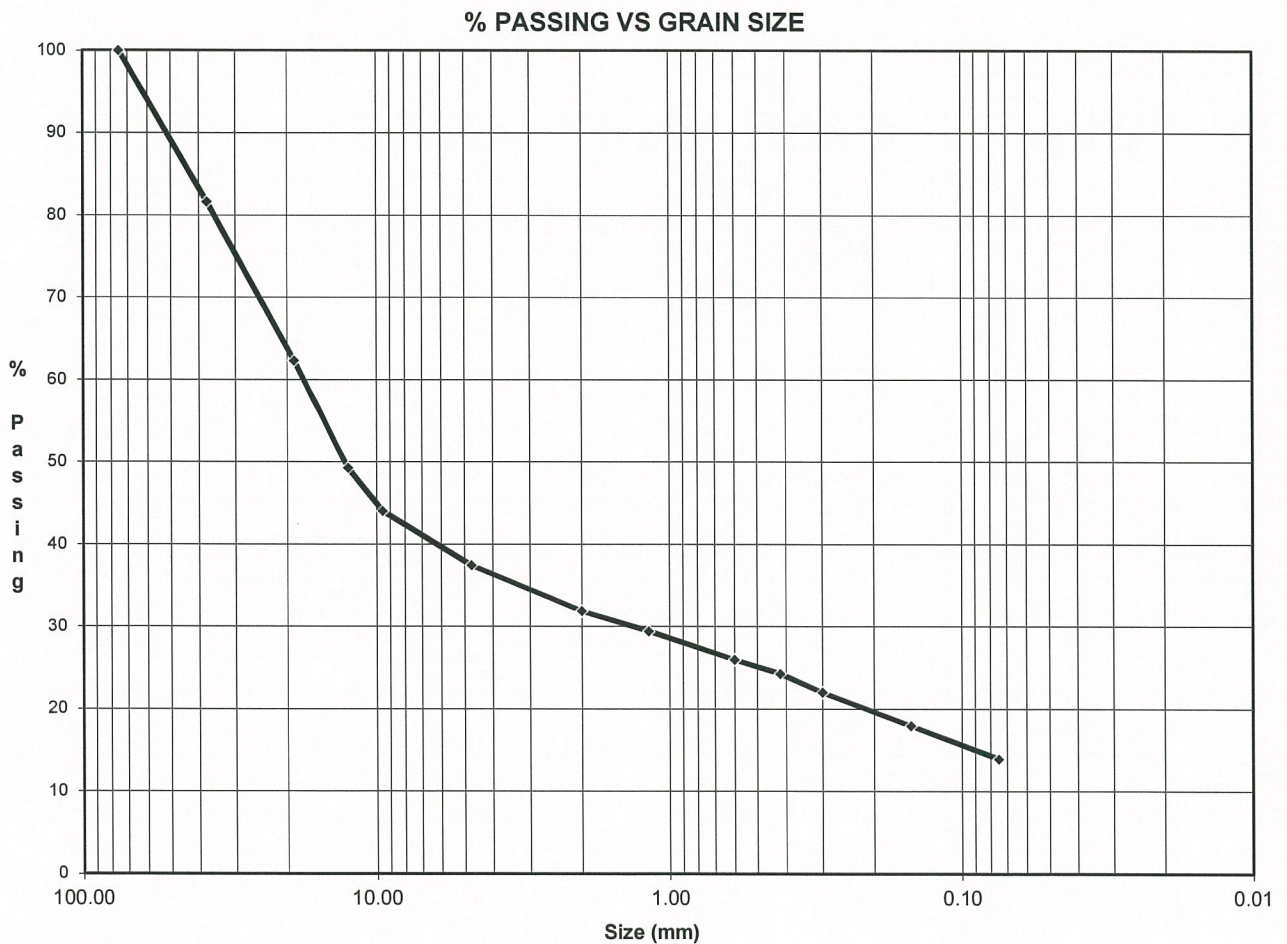
**Material type:** Sandy gravel with some silt/clay

**Lab No:** S16-585

**Our File:** 2016-11

**Region:** Jasper, AB

<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>	<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>
100.0		Cobble	2.00	31.9	Medium sand
75.0	100.0	Gravel	1.180	29.4	
37.5	81.6		0.600	25.9	
19.0	62.3		0.420	24.3	Fine sand
12.5	49.3		0.300	22.0	
9.5	44.0		0.150	17.9	
4.75	37.5	Coarse sand	0.075	13.9	Silt/clay



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 5.2

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH5 S10

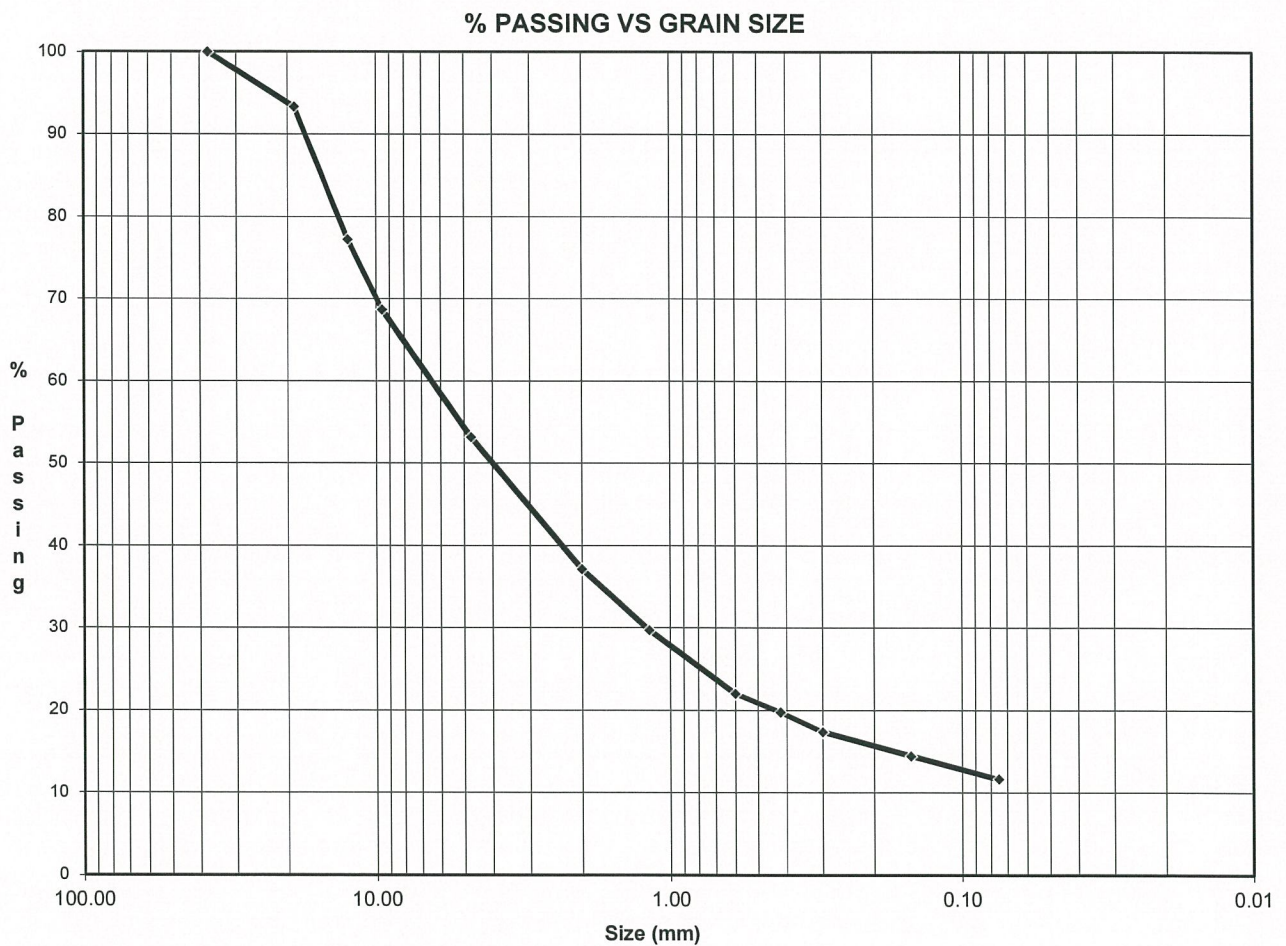
**Material type:** Gravel and sand with some silt/clay

**Lab No:** S16-588

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	37.1	Medium sand
75.0		Gravel	1.180	29.7	
37.5	100.0		0.600	22.0	
19.0	93.3		0.420	19.7	Fine sand
12.5	77.2		0.300	17.4	
9.5	68.6		0.150	14.4	
4.75	53.2	Coarse sand	0.075	11.6	Silt/clay



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 7.6

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





# MATERIALS TESTING AND INSPECTION SERVICES

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Email: info@artechconsulting.ca

## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH6 S1

**Material type:** Sandy gravel with some cobble and silt/clay

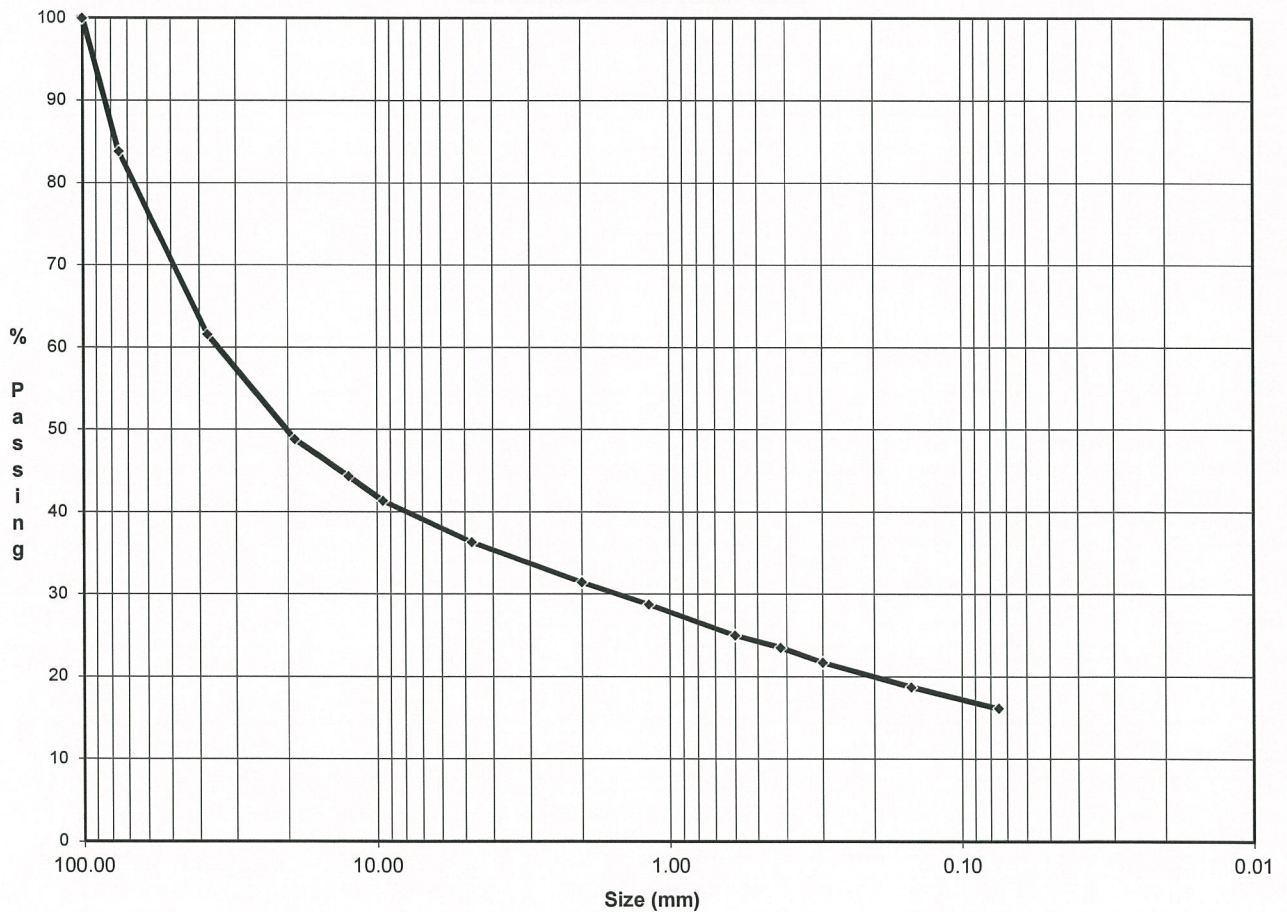
**Lab No:** S16-589

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0	100.0	Cobble	2.00	31.5	Medium sand
75.0	83.8	Gravel	1.180	28.8	
37.5	61.5		0.600	25.0	
19.0	48.8		0.420	23.5	Fine sand
12.5	44.3		0.300	21.7	
9.5	41.3		0.150	18.7	
4.75	36.3	Coarse sand	0.075	16.1	Silt/clay

**% PASSING VS GRAIN SIZE**



Tested in accordance with ASTM C136, C117 (washed gradation)

**Moisture Content of Sample (%):** 5.1

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH7 S1

**Material type:** Sandy gravel with some cobble and silt/clay

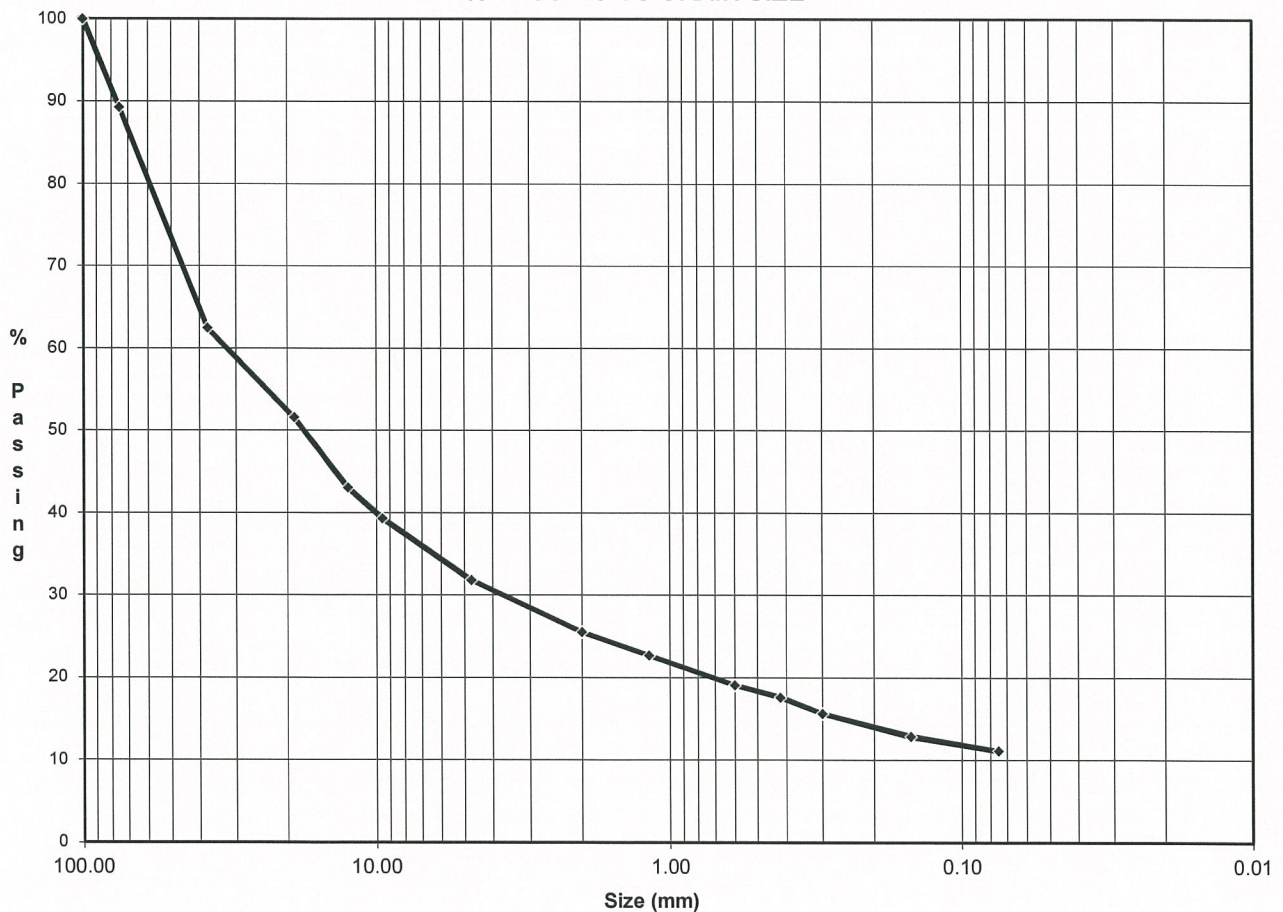
**Lab No:** S16-590

**Our File:** 2016-11

**Region:** Jasper, AB

<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>	<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>
100.0	100.0	Cobble	2.00	25.5	Medium sand
75.0	89.2	Gravel	1.180	22.7	
37.5	62.4		0.600	19.1	
19.0	51.6		0.420	17.6	Fine sand
12.5	43.1		0.300	15.6	
9.5	39.3		0.150	12.8	
4.75	31.8	Coarse sand	0.075	11.1	Silt/clay

**% PASSING VS GRAIN SIZE**



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 4.8

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH8 S1

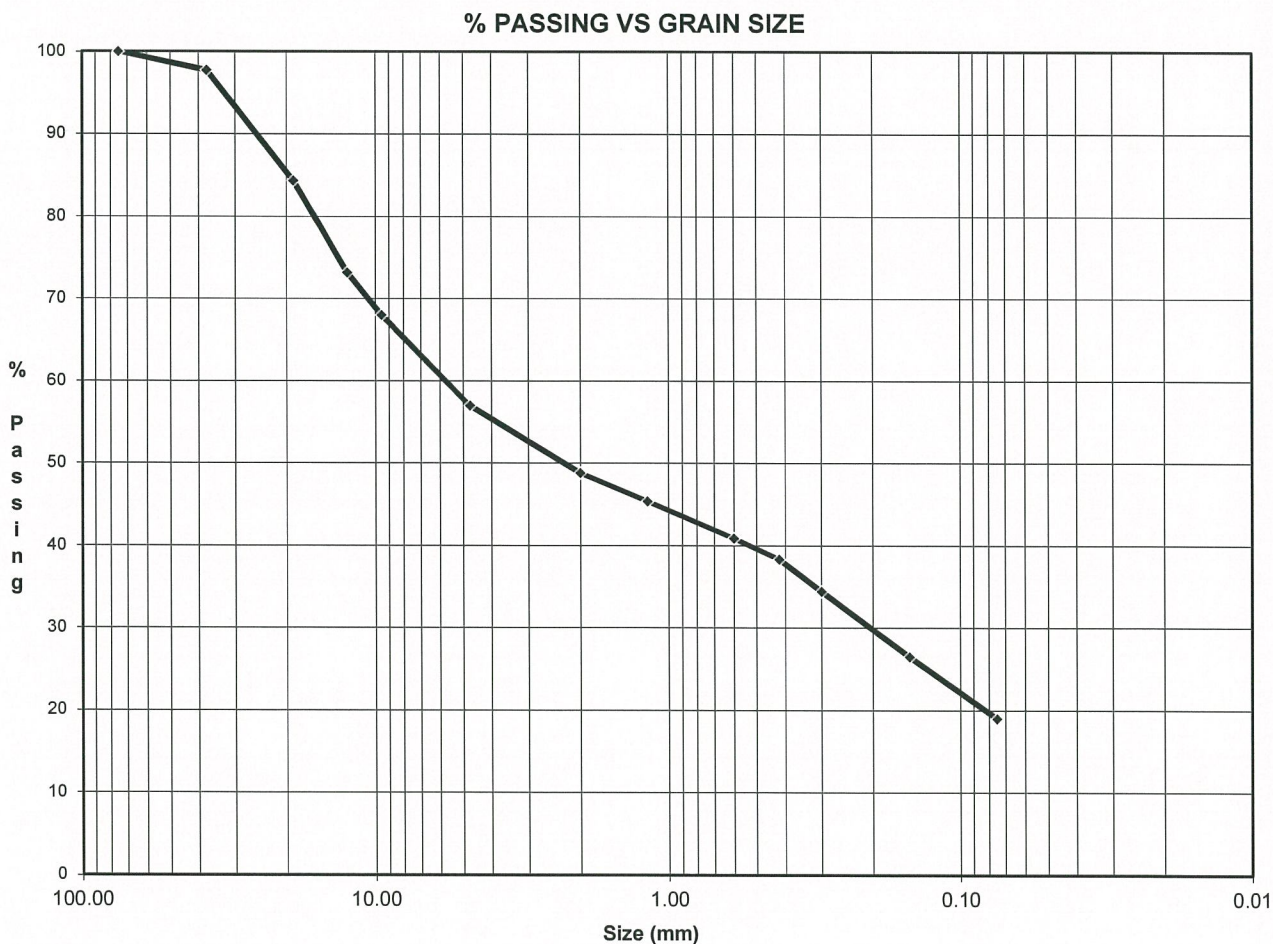
**Material type:** Gravel and sand with some silt/clay

**Lab No:** S16-591

**Our File:** 2016-11

**Region:** Jasper, AB

<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>	<u>Sieve Size</u>	<u>% Passing</u>	<u>Classification</u>
100.0		Cobble	2.00	48.8	Medium sand
75.0	100.0	Gravel	1.180	45.4	
37.5	97.8		0.600	40.8	
19.0	84.3		0.420	38.4	Fine sand
12.5	73.2		0.300	34.4	
9.5	68.0		0.150	26.5	
4.75	56.9	Coarse sand	0.075	19.0	Silt/clay



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 6.7

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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## GRADATION REPORT

**Project:** 2511-00763 Jasper East Gate

**Sampling details:** Geotechnical Investigation - TH9 S1

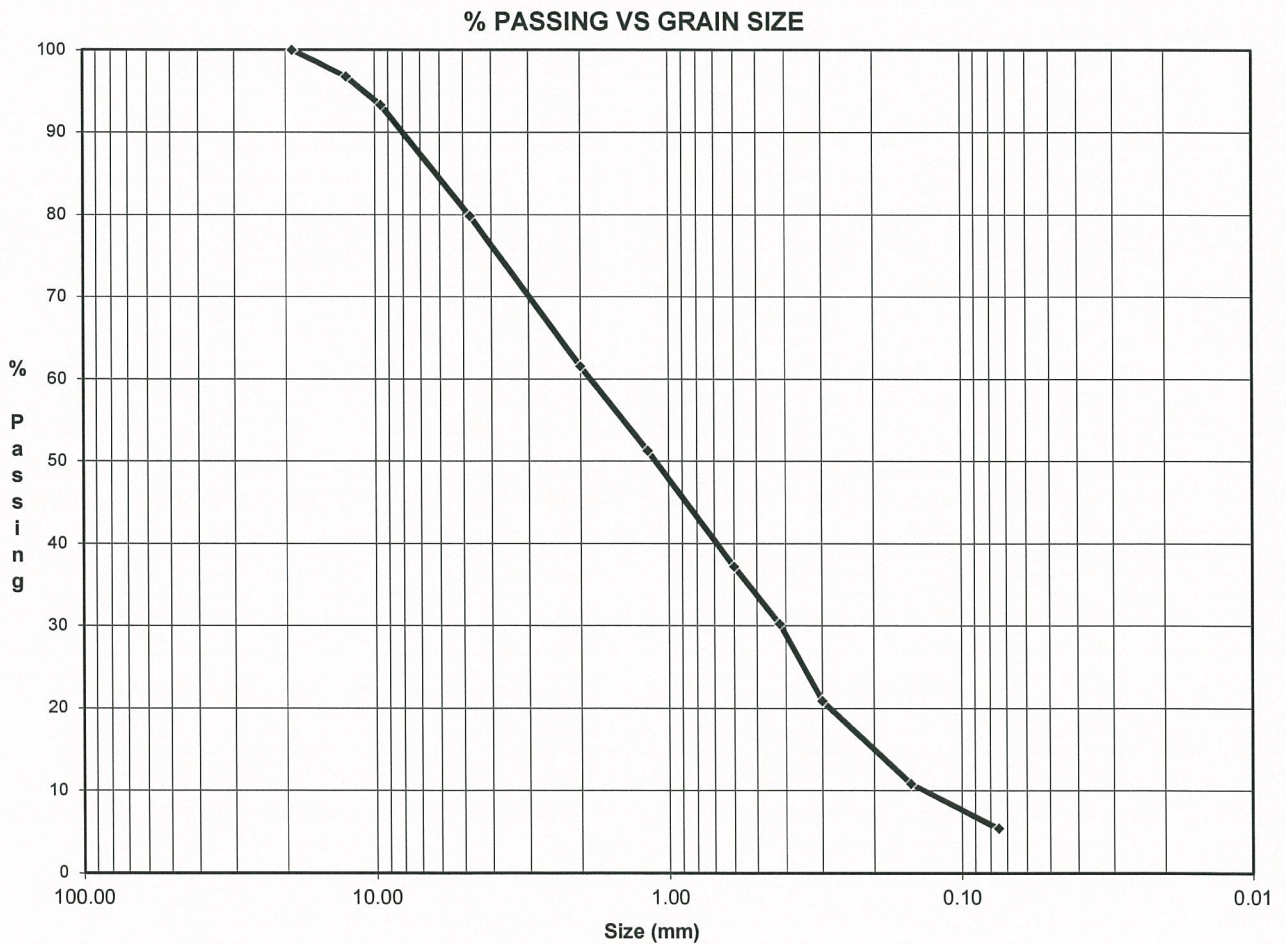
**Material type:** Sand with some gravel, trace silt/clay

**Lab No:** S16-592

**Our File:** 2016-11

**Region:** Jasper, AB

Sieve Size	% Passing	Classification	Sieve Size	% Passing	Classification
100.0		Cobble	2.00	61.6	Medium sand
75.0		Gravel	1.180	51.3	
37.5			0.600	37.2	
19.0	100.0		0.420	30.2	Fine sand
12.5	96.8		0.300	20.8	
9.5	93.3		0.150	10.9	
4.75	79.8	Coarse sand	0.075	5.4	Silt/clay



*Tested in accordance with ASTM C136, C117 (washed gradation)*

**Moisture Content of Sample (%):** 4.9

**Reports:** McElhanney - R. Gibbard  
**c.c:**

**Report Date:** November 2, 2016

**Per:**





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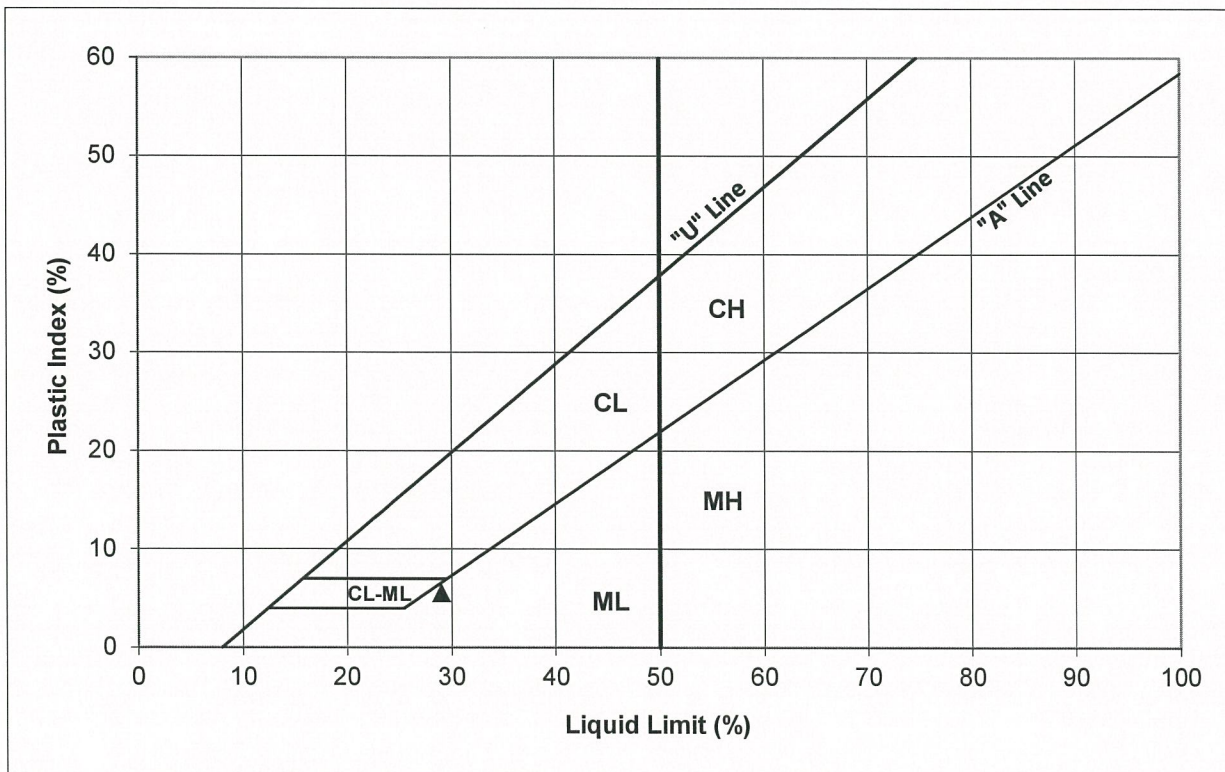
## ATTERBERG LIMITS REPORT

**Lab No:** S16-586

**Project:** 2511-00763 Jasper East Gate  
**Region:** Jasper, AB  
**Sampling Details:** Geotechnical Investigation

**Date:** October 25, 2016  
**File:** 2016-11

Sample	Soil Classification (USCS)	Sample Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %
TH5 S6	ML	32.1	29	23	6



*Tested in accordance with ASTM D4318-00 Methods for the determination of liquid limits, plastic limits and plasticity indices of soils*

**Reports:** McElhanney  
**c.c:**

**Report Date:** November 2, 2016  
**Per:**





**MATERIALS TESTING AND INSPECTION SERVICES**  
229 Industrial Road F, Cranbrook, BC V1C 6N4  
Ph: 250/489-1940; Fax: 250/489-1667;  
Email: info@artechconsulting.ca

## ATTERBERG LIMITS REPORT

**Lab No:** S16-587

**Project:** 2511-00763 Jasper East Gate

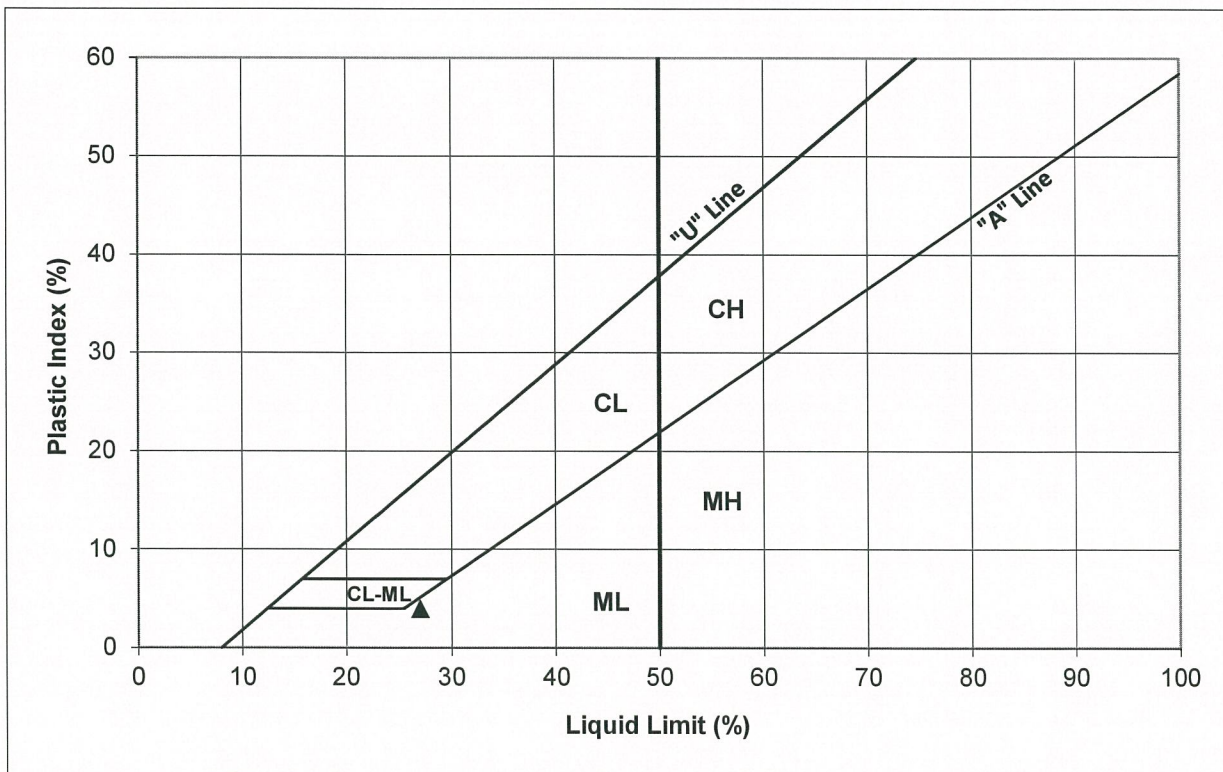
**Date:** October 25, 2016

**Region:** Jasper, AB

**File:** 2016-11

**Sampling Details:** Geotechnical Investigation

Sample	Soil Classification (USCS)	Sample Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %
TH5 S8	ML	33.7	27	23	4



*Tested in accordance with ASTM D4318-00 Methods for the determination of liquid limits, plastic limits and plasticity indices of soils*

**Reports:** McElhanney

**Report Date:** November 2, 2016

**c.c:**

**Per:**

DCP TEST DATA	
<b>Project:</b> <u>2511-00763-00</u>	<b>Date:</b> <u>20/10/2016</u>
<b>Location:</b> <u>TH-#1, DCP-1 @ 0.8m</u>	<b>Soil Type(s):</b> <u>Sandy Silt with Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used	<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils

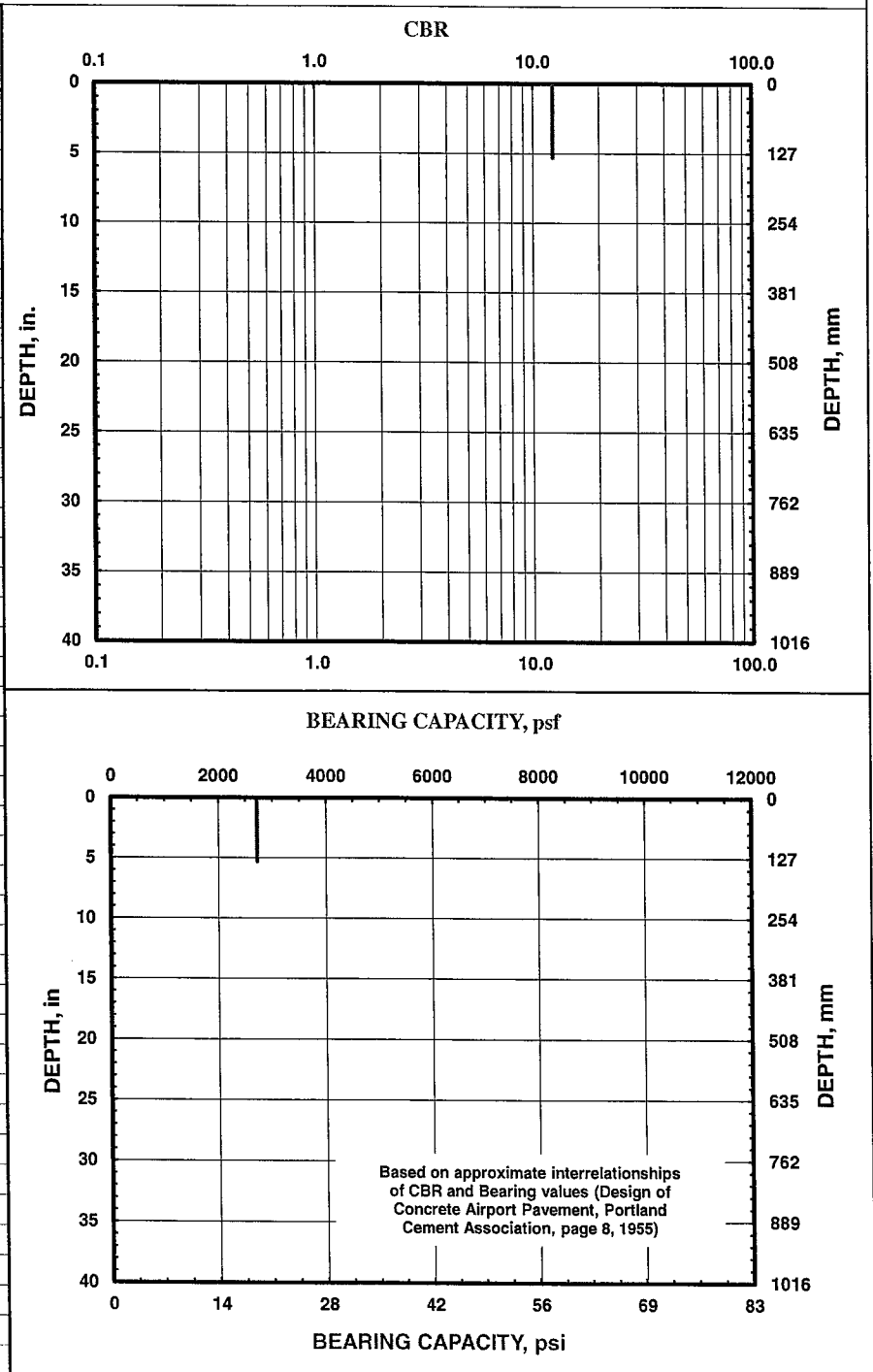
**Date:** 20/10/2016  
**Soil Type(s):** Sandy Silt with Gravels

Soil Type \_\_\_\_\_

☐ CH

☐ CL

☒ All other soils

[illegible]

DCP TEST DATA			
<b>Project:</b>	<u>2511-00763-00</u>	<b>Date:</b>	<u>20/10/2016</u>
<b>Location:</b>	<u>TH-#1, DCP-2 @ 1.1m</u>	<b>Soil Type(s):</b>	<u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used		<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils	

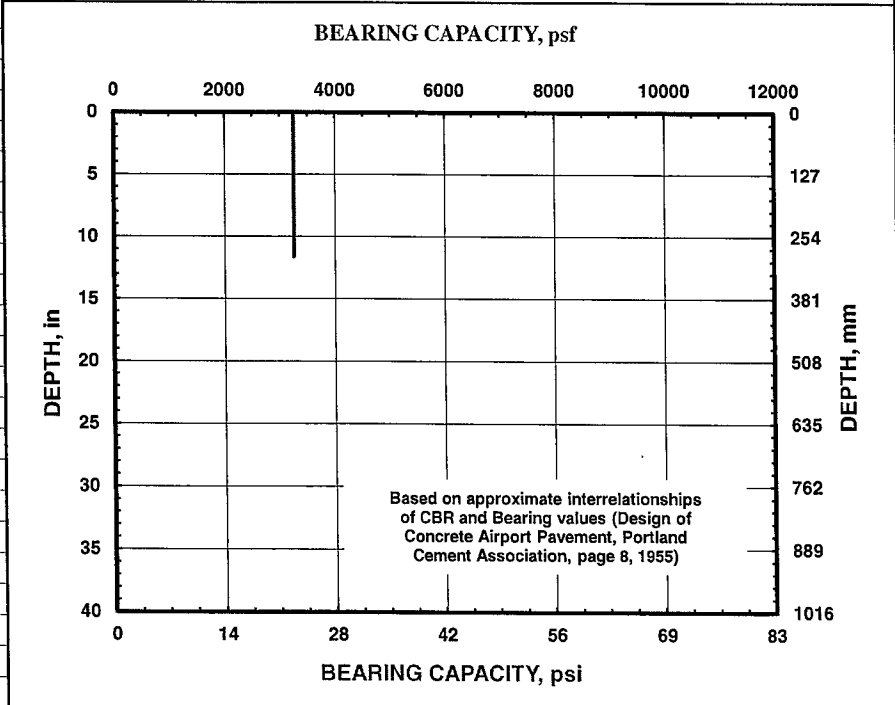
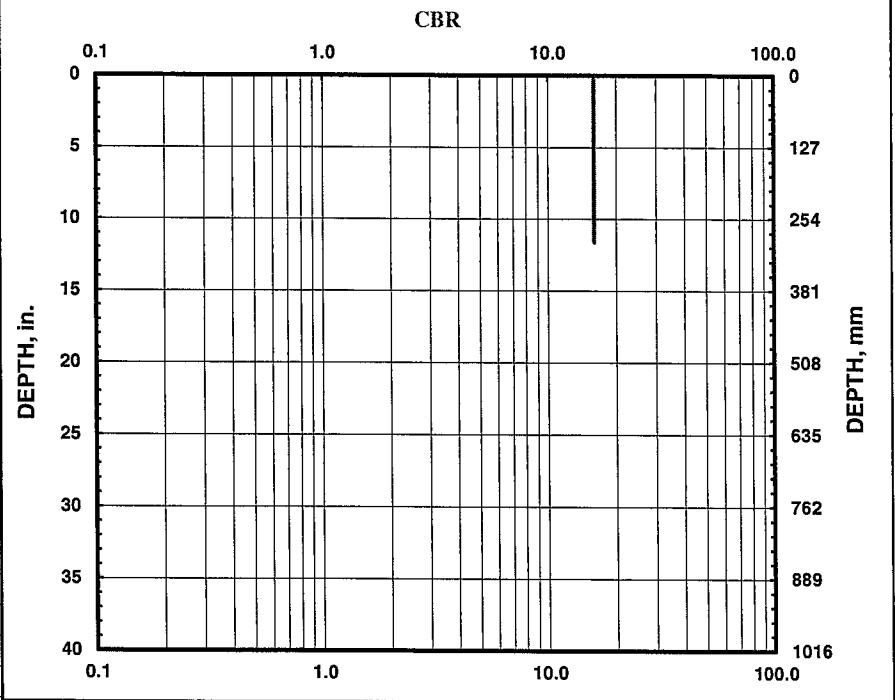
Date: 20/10/2016  
Soil Type(s): Gravels

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]



DCP TEST DATA	
<b>Project:</b> <u>2511-00763-00</u>	<b>Date:</b> <u>20/10/2016</u>
<b>Location:</b> <u>TH-#2, DCP-1 @ 0.4m</u>	<b>Soil Type(s):</b> <u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used	<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils

Date: 20/10/2016  
Soil Type(s): Gravels

Hammer \_\_\_\_\_

☐ 10.1 lbs.

☐ 17.6 lbs.

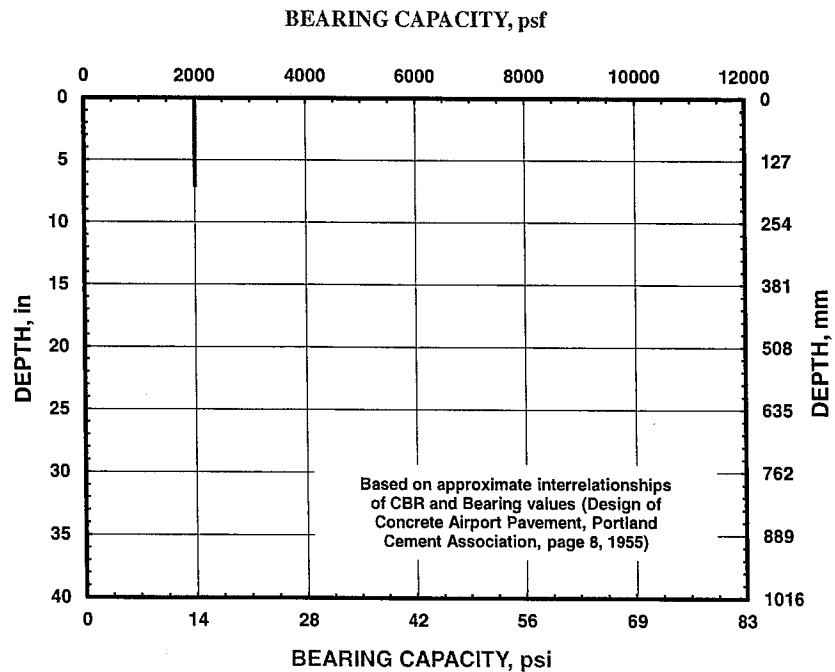
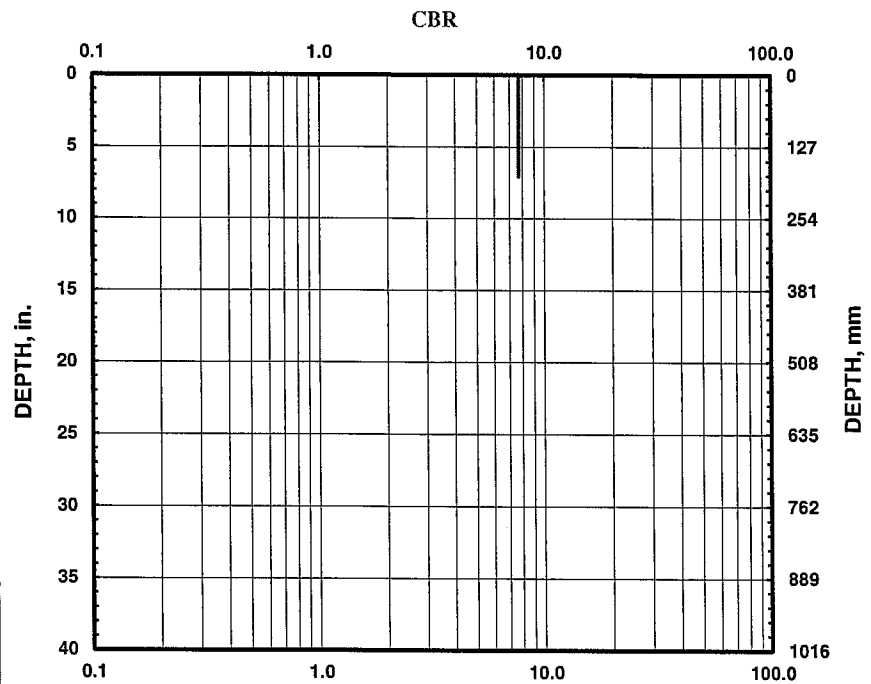
☒ Both hammers used

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

DCP TEST DATA			
<b>Project:</b>	<u>2511-00763-00</u>	<b>Date:</b>	<u>20/10/2016</u>
<b>Location:</b>	<u>TH-#2, DCP-2 @ 1.1m</u>	<b>Soil Type(s):</b>	<u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used		<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils	

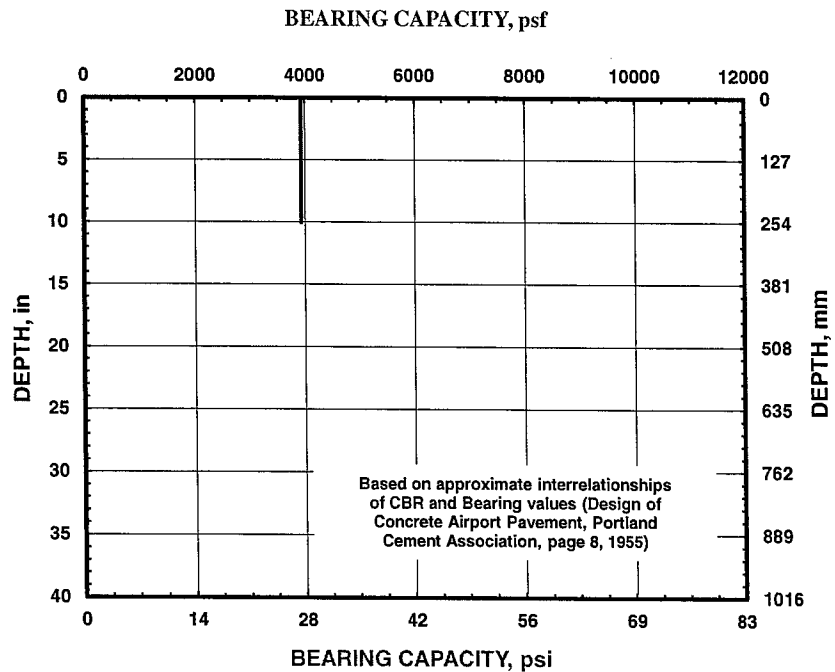
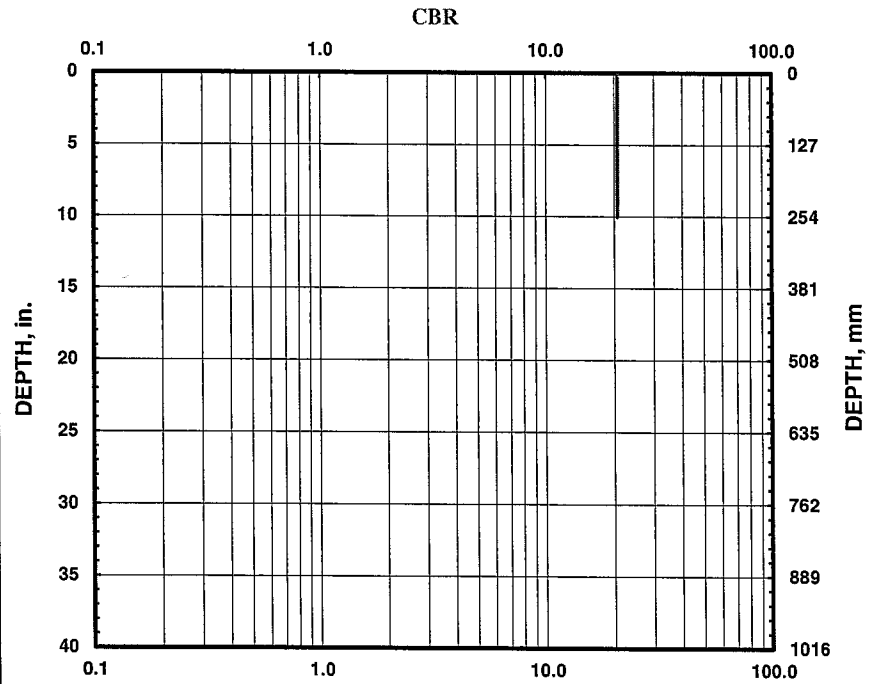
**Date:** 20/10/2016  
**Soil Type(s):** Gravels

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

DCP TEST DATA	
<b>Project:</b> <u>2511-00763-00</u>	<b>Date:</b> <u>20/10/2016</u>
<b>Location:</b> <u>TH-#6, DCP-1 @ 1.0m</u>	<b>Soil Type(s):</b> <u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used	<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils

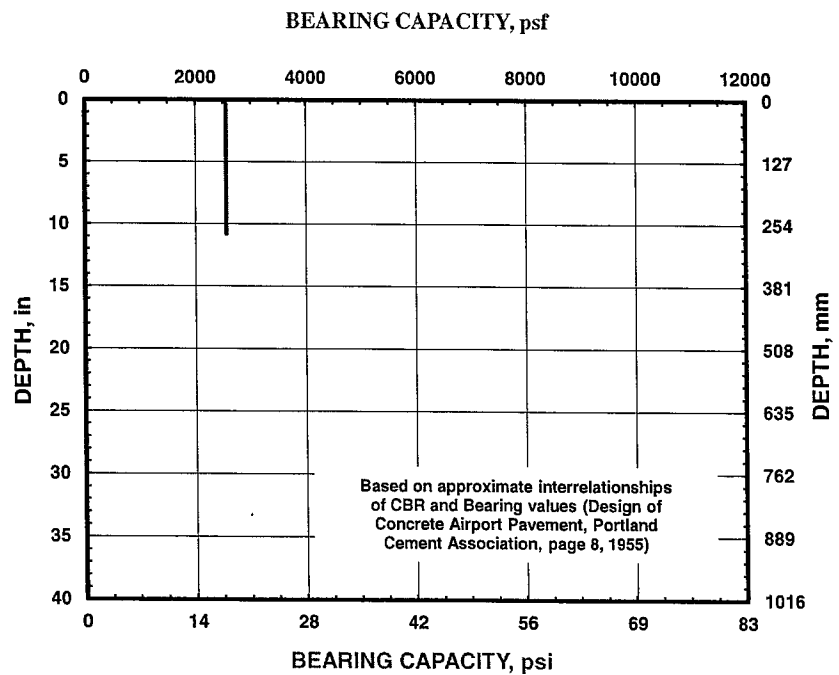
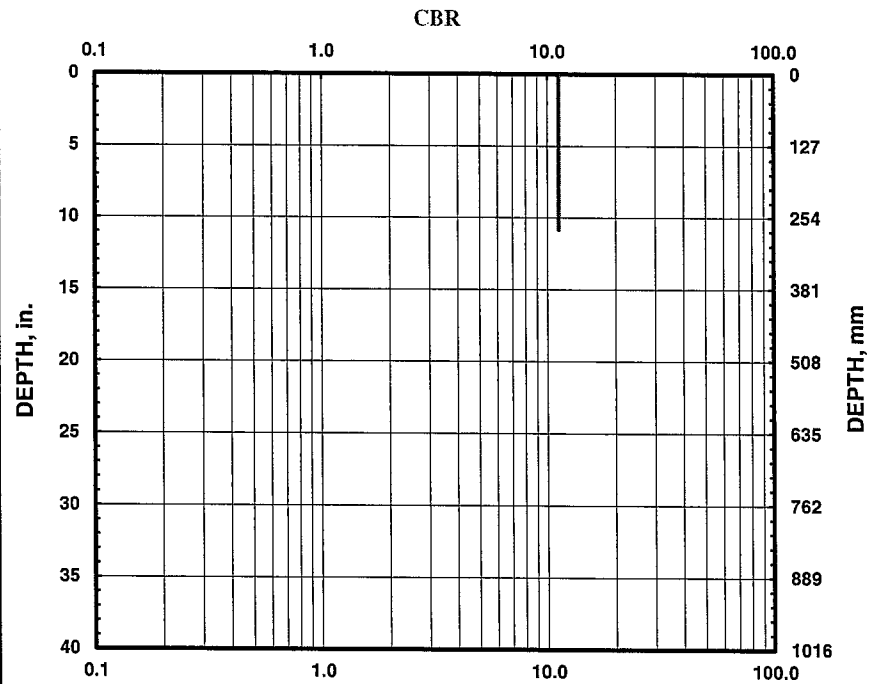
Date: 20/10/2016  
Soil Type(s): Gravels

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]



DCP TEST DATA	
<b>Project:</b> <u>2511-00763-00</u>	<b>Date:</b> <u>20/10/2016</u>
<b>Location:</b> <u>TH-#7, DCP-1 @ 1.1m</u>	<b>Soil Type(s):</b> <u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used	<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils

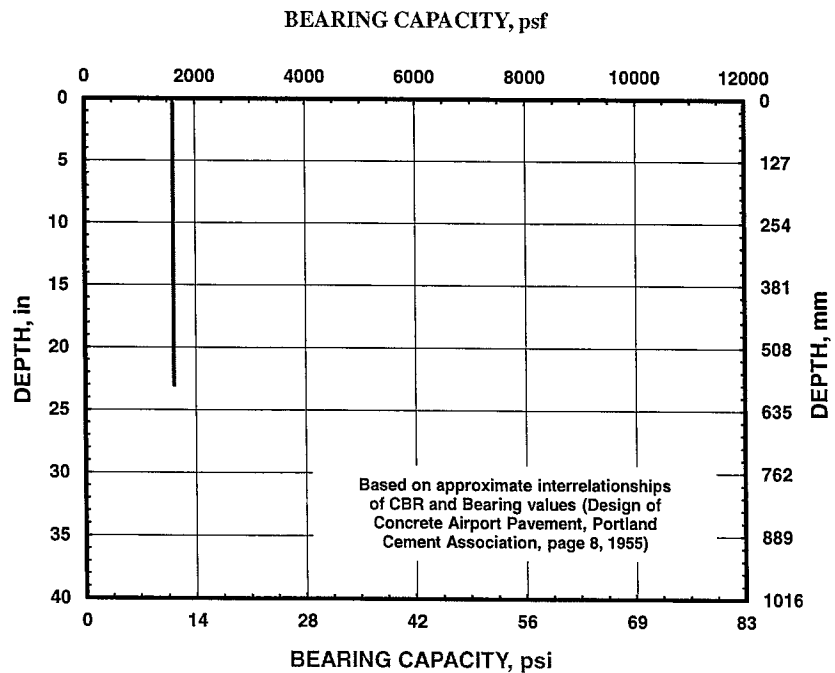
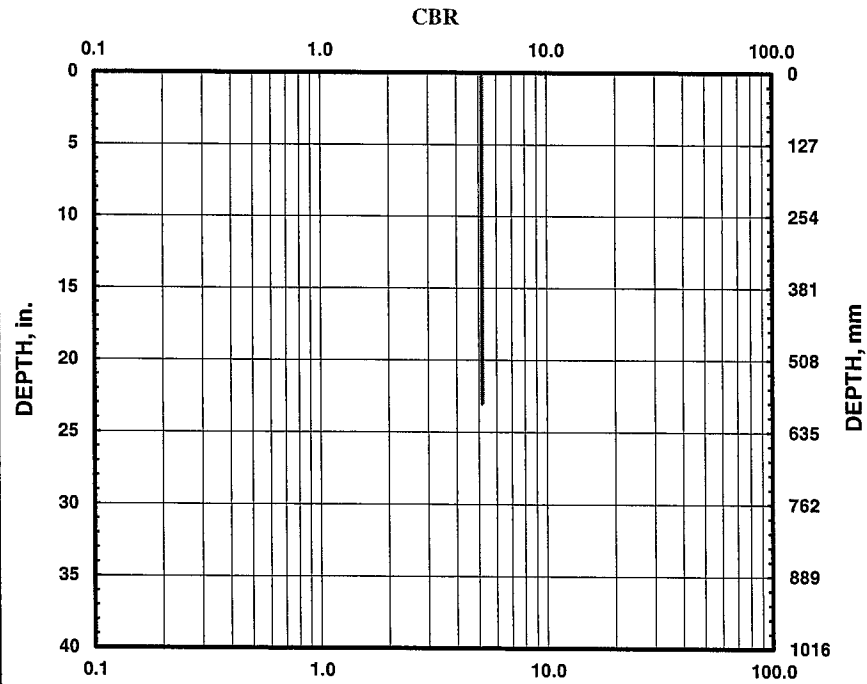
Date: 20/10/2016  
Soil Type(s): Gravels

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

DCP TEST DATA			
<b>Project:</b>	<u>2511-00763-00</u>	<b>Date:</b>	<u>20/10/2016</u>
<b>Location:</b>	<u>TH-#8, DCP-1 @ 0.4m</u>	<b>Soil Type(s):</b>	<u>Gravels</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used		<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils	

Date: 20/10/2016

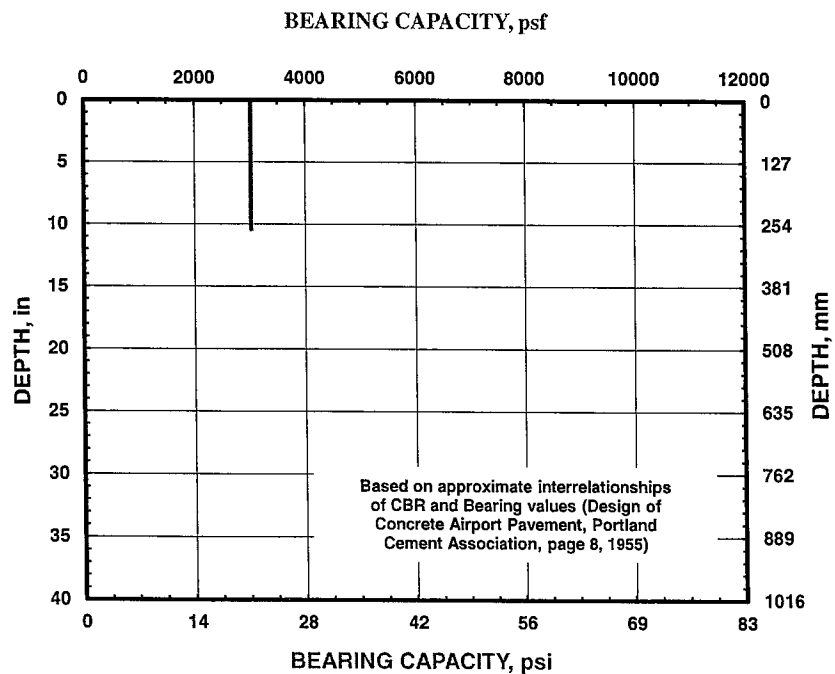
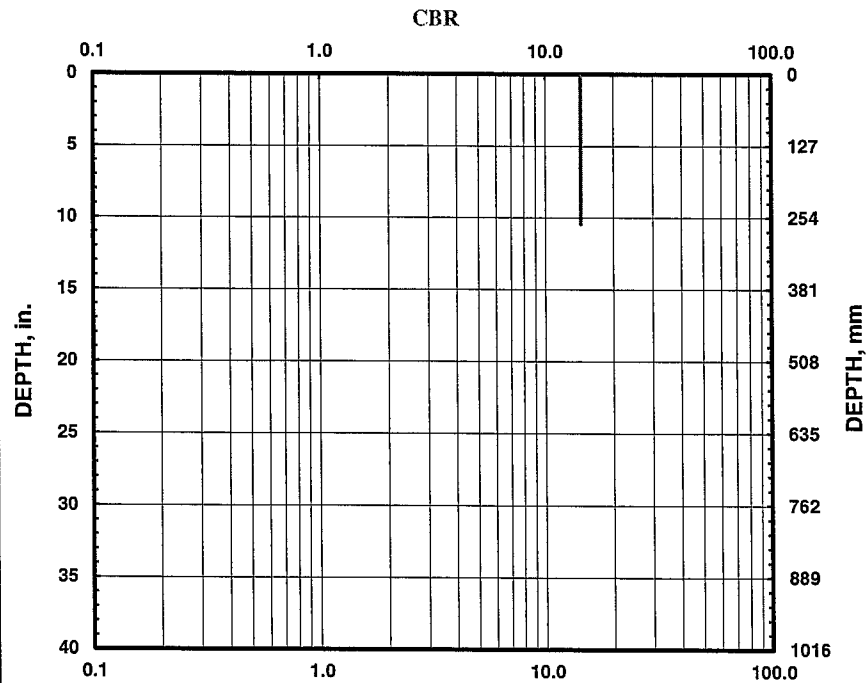
Soil Type(s): Gravels

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

## DCP TEST DATA

Project: 2511-00763-00  
Location: TH-#8, DCP-2 @ 1.4m

Date: 20/10/2016

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Soil Type(s): Gravels

Hammer \_\_\_\_\_

☐ 10.1 lbs.

☐ 17.6 lbs.

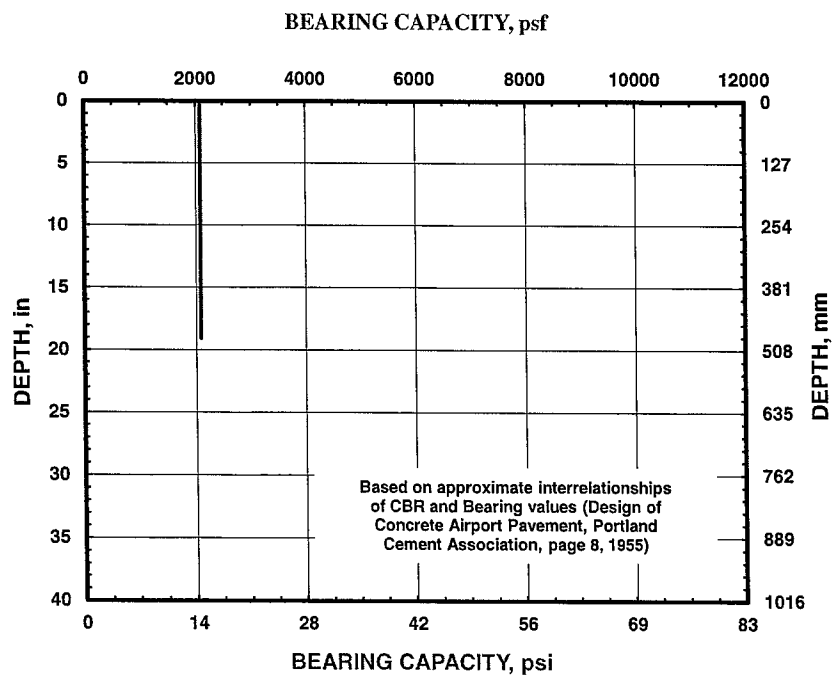
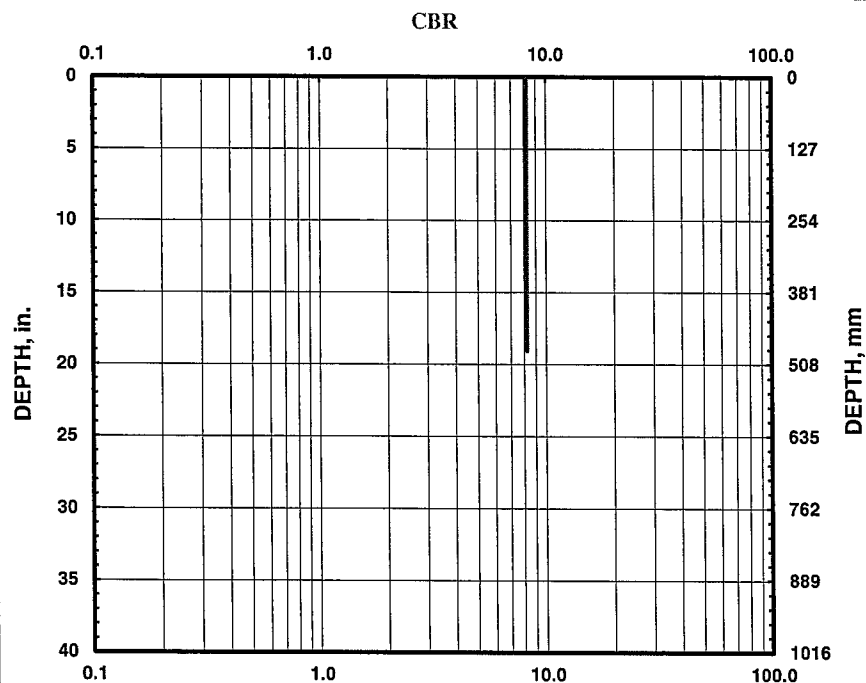
☒ Both hammers used

Soil Type \_\_\_\_\_

☐ CH

☐ CL

☒ All other soils

[illegible]



DCP TEST DATA			
<b>Project:</b>	<u>2511-00763-00</u>	<b>Date:</b>	<u>20/10/2016</u>
<b>Location:</b>	<u>TH-#9, DCP-1 @ 0.5m</u>	<b>Soil Type(s):</b>	<u>Sand</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used		<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils	

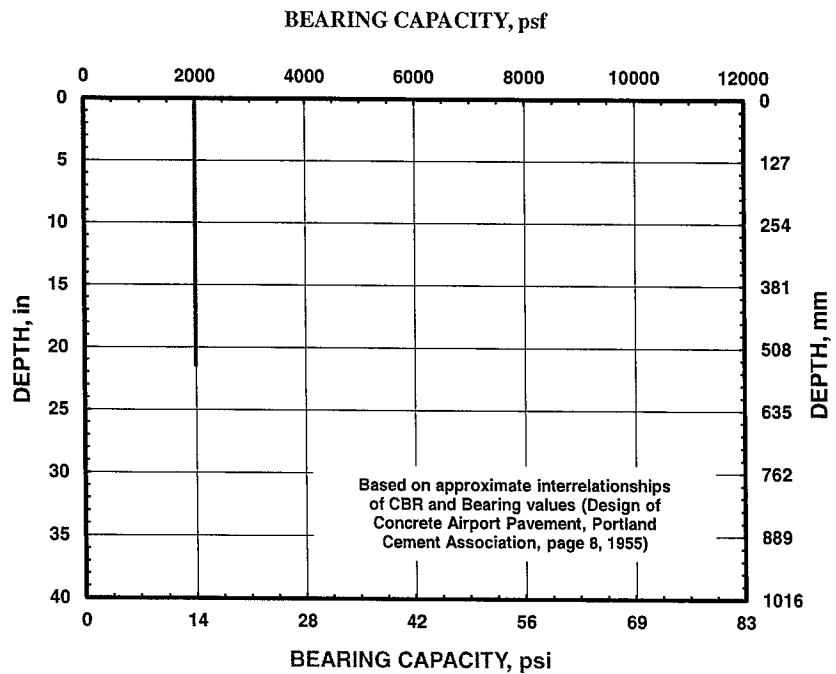
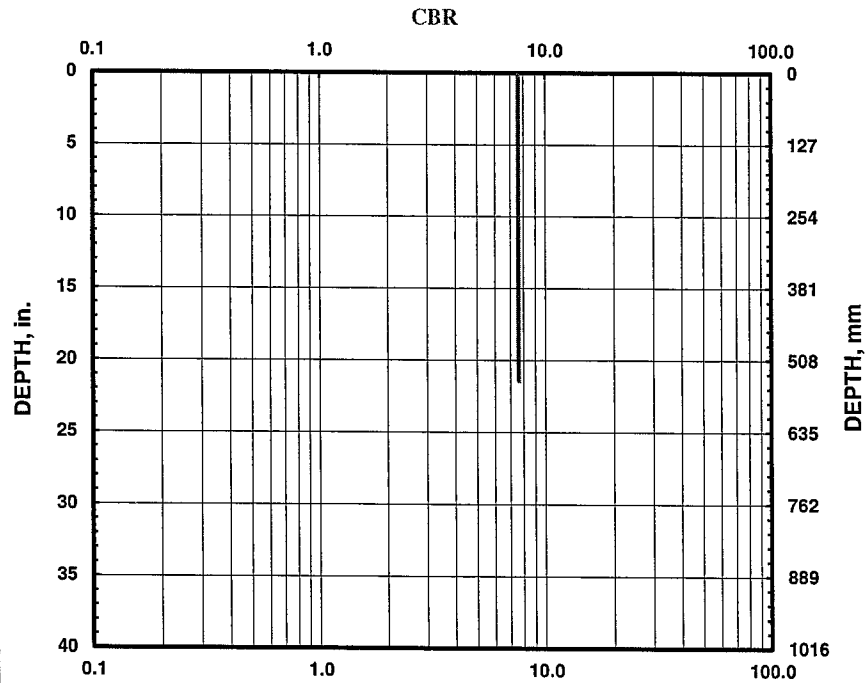
Date: 20/10/2016  
Soil Type(s): Sand

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

DCP TEST DATA	
<b>Project:</b> <u>2511-00763-00</u>	<b>Date:</b> <u>20/10/2016</u>
<b>Location:</b> <u>TH-#9, DCP-2 @ 1.2m</u>	<b>Soil Type(s):</b> <u>Sand</u>
<b>Hammer</b> <input type="radio"/> 10.1 lbs. <input type="radio"/> 17.6 lbs. <input checked="" type="radio"/> Both hammers used	<b>Soil Type</b> <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils

**Date:** 20/10/2016

**Soil Type(s):** Sand

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]