January 19, 2016 Reference No. 11114440

Township of Douro-Dummer
Public Works
1422 County Road 4
Warsaw, Ontario
K0L 3A0

Attention: Harold Nelson (publicworks@dourodummer.on.ca)

Re: Test Pit Investigation of Gravel Roads in the Township of Douro-Dummer

1. Scope of Project

GHD was contacted to conduct an investigation of various gravel surfaced township roads to ascertain the causes of poor condition in the roads. The strength of a gravel road is affected by the gradation (a stronger material is obtained when there is a scattering of grain sizes through the sand and gravel size range), and the ability of the material to drain water through it. The gravel is meant to spread tire loads sufficiently such that the underlying fine grained soil doesn't form ruts. When gravel becomes flooded the tire loads are not spread but are transferred straight to the subgrade.

Salt is a necessary addition to the roads in winter for safety. However when the salt dissolves in the resulting melt water it infiltrates the sand and gravel in the road and when the water evaporates bonds with smaller particles. This is referred to as capilliarization, and forms a very hard road surface when dry. The surface can then be broken up by wheel loads or grading but still have silt sized particles bound making the material behave weaker. When water is added by rain the salt dissolves forming a plug in the granular and weakening the road. From the description of the conditions given, the roads under investigation are prone to forming a surface-slurry after rainfall and/or deteriorate after regrading at faster than expected rates. As per the original request and through phone discussions with Harold Nelson, GHD's scope of work included the following items:

1. Road base investigation on the following roads of concern in the following target locations:
    a. 12th Line of Dummer (3 sample locations)
    b. Douro 2nd Line, north of CR-4 (3 sample locations)
    c. Centre Road (1 sample location)
    d. Douro 7th Line, north of Nassau Road (1 sample location)
2. Comparative sampling was carried out at any one representative location on the following roads that are of newer construction and are not showing the slurry or deterioration:
    a. Carlow Line
    b. Douro 1st Line Rd
    c. Cedar Cross Rd

3. Measurement of cross section of roads at each sample location
4. Laboratory analysis of field samples for concerned roads (8 samples) and comparative roads (3 samples) for sieve analysis (gradation specification) and SAR (sodium adsorption rate including calcium, sodium, and potassium content)
5. Summary report including a discussion of field conditions, laboratory results, and provide any immediate remediation concerns

For this assignment, GHD used its Peterborough office and laboratory facilities to provide all technical support, consultation, field testing, and laboratory testing services. The Peterborough Laboratory is certified by CCIL as a Type A and B Asphalt (Marshall and Superpave), Type C and D Aggregate, Type D Soils and CSA Category 2+ Additional Concrete testing facility. The Sodium Adsorption Ratio (SAR) testing was completed by SGS Laboratories in Lakefield.

2. Field Processes

Locations for the test pit investigations were determined by visual observation of areas most severely affected. The Township supplied the mini excavator and an operator to conduct the test pit excavations. The upper 50-75mm of the granular was sampled and sealed in bags. Excavation was continued in each test pit to determine the underside of the base granular layer. In all test pits, subbase granular/fill was found on each road with no amount of organics noted in the subbase soils.

Table 2.1 – Test Pit Identification and Sample Locations

Test Pit No.	Road Name	Sample Location
TP-1	12th Line of Dummer	Approximate to house #174, 2.5m Rt (NBL)
TP-2	12th Line of Dummer	Approximately 600m north of Madeline, 2.2m Rt (NBL)
TP-3	12th Line of Dummer	Approximately 100m south of Hannon, 1.8m Lt (SBL)
TP-4	Carlow Line	Approximately 800m south of CR-8, 1.8m Lt (SBL)
TP-5	Douro 1st Line	Approximately 50m south of house #49, 1.5m Rt (NBL)
TP-6	Douro 2nd Line	Between houses #837 and #831, 1.8m Rt (NBL)
TP-7	Douro 2nd Line	Approximate to house #952, 1.9m Rt (NBL)
TP-8	Douro 2nd Line	Approximate to house #1059, 1.5m Rt (NBL)
TP-9	Cedar Cross Road	Approximately 300m east of 2nd Line, 1.8m Rt (EBL)
TP-10	Centre Road	Approximately 600m west of 4th Line, 1.7m Lt (WBL)
TP-11	Douro 7th Line	Between houses #427 and #513, 1.7m Rt (NBL)

Cross-sectional measurements of the road at each sample location were conducted to identify possible trending with surface drainage and condition of the road. Each cross-section was measured using a laser level assuming the centre-line of the road was the high point. Each measurement is represented in difference of elevation to the centre-line of road. Additionally, measurements were taken of ditches and of the widths of the lanes. Where ditches were too deep to be measured without transit, the measurement is given as “Deep”.

Table 2.2 – Cross-Section Measurements

Test Pit No.	Road/Sample	Ditch Left	Edge Left	Centre	Edge Right	Ditch Right	Lane Width
TP-1	12th Line A	-0.10m	-0.06m	0m	-0.12m	-0.02m	3.4m
TP-2	12th Line B	-0.77m	-0.15m	0m	-0.12m	Deep	3.3m
TP-3	12th Line C	-0.78m	-0.19m	0m	-0.18m	-0.89m	2.9m
TP-4	Carlow	-0.96m	-0.13m	0m	-0.07m	-0.66m	2.7m
TP-5	1st Line	-0.48m	-0.09m	0m	-0.08m	-0.66m	2.5m
TP-6	2nd Line A	-0.53m	-0.09m	0m	-0.12m	-0.71m	2.9m
TP-7	2nd Line B	-0.67m	-0.08m	0m	-0.13m	-0.66m	2.8m
TP-8	2nd Line C	-0.63m	-0.08m	0m	-0.10m	-0.59m	2.5m
TP-9	Cedar Cross	Deep	-0.10m	0m	-0.10m	Deep	3.0m
TP-10	Centre	-0.55m	-0.07m	0m	-0.13m	-0.53m	2.8m
TP-11	7th Line	-0.39m	-0.01m	0m	-0.06m	-0.43m	2.6m

Using the data from Table 2.2, the following cross-falls for each lane was calculated:

Table 2.3 – Cross-Fall Calculations

Test Pit No.	Road/Sample	Left Lane	Right Lane
TP-1	12th Line A	**1.8 %**	3.5 %
TP-2	12th Line B	4.5 %	3.6 %
TP-3	12th Line C	6.6 %	6.2 %
TP-4	Carlow	4.8 %	2.6 %
TP-5	1st Line	3.6 %	3.2 %
TP-6	2nd Line A	3.1 %	4.1 %
TP-7	2nd Line B	2.9 %	4.6 %
TP-8	2nd Line C	3.2 %	4.0 %
TP-9	Cedar Cross	3.3 %	3.3 %
TP-10	Centre	2.5 %	4.6 %
TP-11	7th Line	**0.4 %**	**2.3 %**

Upon returning to GHD laboratory, samples were submitted for testing. Each test pit sample was submitted for gradation testing to compare to Granular 'A' specifications. Each test pit sample was also submitted to SGS Laboratories in Lakefield for Sodium Adsorption Ratio (SAR) testing to determine salt content.

3. Laboratory Results

All laboratory test results are included in the appendices of this report. Appendix A contains the gradation sieve results, and Appendix B contains the SAR test results from SGS Laboratories.

3.1 Sieve Analysis

For all samples, the gradation test results show failure on multiple sieve sizes when compared to a quarry-sourced Granular 'A'. All samples failed to meet the criteria for Granular 'A', Granular 'B', and Granular 'M'. Common in all samples was a trend showing too much silt and too little medium-sized gravel. Of note, a trend is observed that for the comparison (control) road samples, the amount passing the 0.075mm sieve was lower than the roads of concern. This trend is further analyzed in Section 4 of this report, "Discussion".

3.2 Sodium Absorption Ratio (SAR) Analysis

Initial review of the results implies a relationship between the amounts of salt present in the samples and the general quality of the road. To confirm the correlation of the SAR results with the quality of the road sections, Spearman's Rank Correlation formula was used to compare each salt to a visual quality index of each road section determined through field observations.

$$(R) = 1 - \frac{6\sum d^2}{n^3 - n}$$

In determining the relevancy of the data that can be used in the calculation, two samples were ignored due to the composition of the gravel in the sample. For Douro 1st Line (TP-5), it is understood that the gravel came from a discontinued source that may not be present on the other roads. The source contained a higher level of intermediate igneous rock containing feldspar that is artificially inflating the sodium level in the test. In sample A of Douro 2nd Line (TP-6), a fresh surface repair was recently completed and the quality of the road section is lower for reasons likely not related to salt exposure.

The purpose (or hypothesis) of the ranked correlation is that the visually "worst" road section will contain the highest amount of salt. For the ranking in Table 3.1, the Visual Quality Index has been ranked in ascending order from "worst" to "best", and the SAR values are ranked in descending order from highest to lowest.

The ranked relationships for calcium and magnesium are not significant enough to conclude a relationship outside of pure chance. The ranked relationship for sodium, however, shows a strong relationship between the levels of sodium and the visual quality of the road 95% of the time.

Table 3.1 – SAR vs. Visual Quality Index Ranked Correlation

Test Pit No.	Road/Sample	Visual Quality Index	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
TP-1	12th Line A	2	2	8	1
TP-2	12th Line B	8	6	10	6
TP-3	12th Line C	5	8	11	7
TP-4	Carlow	11	4	3	11
TP-5	1st Line	9			
TP-6	2nd Line A	1			
TP-7	2nd Line B	6	5	4	4
TP-8	2nd Line C	7	9	6	8
TP-9	Cedar Cross	10	10	7	9
TP-10	Centre	3	1	1	3
TP-11	7th Line	4	3	5	5
Spearman's Rank Correlation Coefficient			0.400	-0.325	0.867

4. Discussion

Two trends were identified in the analysis of the soil samples:

1. The older roads of concern contained higher silt contents than the more recently repaired road sections (ie. more material passing the 0.075mm sieve)

2. The visually worse road section contained correlatively higher concentrations of sodium (salt) when statistically verified through rank correlation

Of the two trends, the poor sieve results of the soil samples are known to be indicative to road quality, especially the high levels of silt contained in all road sections including the "better" road sections used for control samples in the investigation. The high amount of silt in the granular base will lead to poor drainage of the gravel, and thereby retain water for longer periods of time leaving the roads in a muddy weaker condition.

The poor drainage in the granular not only prevents water from draining, but will also prevent salt from dissipating through the granular while dissolved in the melt water. Under normal conditions, salt accumulation from the winter will enter solution during the rain events of spring, summer, and fall. The salt in solution will either drain off the surface of the road or pass through the granular eventually dispersing into the ditches on either side of the road. As previously mention the salt bonds with the fines and can make compacting the gravel during regrading more difficult since the gravel behaves like a gap graded product. Thus the claim that the road becomes disturbed more quickly after regrading can more likely be attributed to the salt.

This investigation has confirmed the correlation between road condition and presence of salt, but there is not enough conclusive evidence that the poor condition of the roads was caused by the presence of the salt if there was not already a high content of silt in the granular. It is important to note some other details regarding the investigation and the laboratory testing performed:

1. Sample locations were not limited to the areas of muddy conditions, but also included areas of pitting and rippling. These multiple types of negative conditions can all be linked to the quality of the granular gradation.

2. The sieve analysis includes wash-sieving the fine aggregate which would have removed the salt from the sample. The material passing the 0.075mm sieve (the silt) includes some amount of salt inflating the values recorded.

3. The road crossfalls and measurements recorded noted a few items of concern. Table 2.3 has highlighted road sections with crossfalls less than 2.5%, which would have significantly reduced surface drainage. Some sections of the road noted shallow ditching which also slows the drainage of water away from the road.

4. Sample depths were taken in the upper 50-75mm of the road base. Aggregate segregation from vehicular traffic will cause finer material to rise and remain at the surface of the road. The samples collected only represent the condition of the surface of the road and not the granular base as a whole. This was done to focus the investigation on the poor conditions of the surface itself, and to provide more usable data from the SAR testing to identify the presence of salts (which was specifically requested in the investigation).

5. Remedial Recommendations

Any remedial plan to improve these roads should include enhancing the drainage characteristics of the road. This would include the use of OPS specified granular material, increasing crossfall where required, deepening and regrading ditches, or raising the profile of the road to increase elevation above watercourses and wetlands. Granular roads, by their design, require constant maintenance and regrading. Often mud from tires or wind blown dust is on the road, and the continuous cycle of grading can reduce the quality of the granular material. One strategy is to remove the surface inch in the spring with a grader directing it to a windrow, that is removed and replaced with fresh granular. Also the use of a water truck during regrading and the compacting of the granular with a vibratory roller will improve the ability of the granular to not become disturbed. For long-term quality, it would be worth considering the addition of surface treatment that would require less maintenance during its life-cycle. As the initial cost of surface treatment may seem expensive for roads with very few residents, if it is weighed against a continuous maintenance plan it may become more cost effective.

The following remedial recommendations are provided for the consideration of the township, including recommendations that are strongly advised and optional remediation plans to maintain road integrity over longer life spans.

5.1 Required Recommendations

- **Full Granular Replacement:** Although no AADT data (present traffic volumes) are known for these roads, the expected traffic level and interpreted subgrade characteristics require a Granular Base Equivalency (GBE) of 200 as per Structural Design Guidelines for Flexible Pavements for Secondary Roads. This will require either the removal of 200mm of existing material for full replacement with Granular ‘A’, or the addition of 200mm of Granular ‘A’ on the existing grade. Alternatively, the required GBE would also be met with the accommodation of 100mm of Granular ‘A’ and 150mm of Granular ‘B’, or as a third option the retention of 100 mm of existing granular ‘A’

the placement of a TX140 geogrid and 75 mm of fresh Granular 'A'. Please note that increasing the grade of the road will require widening the profile of the road to accommodate the higher slope at the edge of the shoulder/road.

- Grade the crossfall of each lane to create an ideal minimum grade of 3% for all roads and allow greater surface drainage.
- Where positive drainage of surface water allows, cleanout surface vegetation and grade ditches to transport water away from the roads faster without stagnation.
- Utilize a water truck during regrading along with smooth drum vibratory compactor.

5.2 Optional Recommendations

- **Double Surface Treatment or Single Surface Treatment with Prime:** For roads with an AADT between 200 and 1000, a surface treatment road design is recommended by provincial standards. For the township, this option is provided as a long term design recommendation that would significantly reduce the need for annual maintenance. It will require the full removal of the existing granular base (as noted above) to allow either 250mm of Granular 'A', or the placement of 150mm of Granular 'A' base over 150mm Granular 'B' subbase or the retention of 100 mm of existing granular 'A' the placement of a TX140 geogrid and 75 mm of fresh Granular 'A'. The surface treatment would then be applied over the prepared granular base. Crossfall and ditching improvements are still recommended where required.
- **Hot Mix Asphalt Design:** The current traffic loads for these county roads do not warrant the requirement for asphalt pavement, but the application of a single lift of hot mix asphalt will provide the best long-term road surface. Should traffic loads be forecast to increase, the minimum requirements for a hot mix asphalt design with AADT of 200 to 1000 will require a GBE of 410 usually made up of 50 mm HL3 or 4 asphalt, 150 mm Granular 'A' and 250 mm Granular 'B'. This would require the full removal of the existing granular base (as noted above) to allow the placement of this pavement profile, or a grade raise or 200 mm 150mm of new Granular 'A' base over the existing 250 mm Granulars as an equivalent Granular 'B' subbase. Where the granular was found to be deficient of the 250 mm thickness, the addition of a TX140 geogrid would be necessary. A single lift of 50mm of hot mix asphalt would then be paved over the prepared granular base. Suitable surficial HL mixes would include HL-3 or HL-4.

Please note that for all recommendations, GHD recommends that all granular material is compacted to 100% standard Proctor density. Due to the limitations of this investigation, it is also recommended that a proof-roll subgrade inspection be conducted for each road during construction to identify possible areas of subgrade instability that would reduce the integrity of the granular base. These areas, should they be identified, would require further excavation and replacement with approved granular material or crushed limestone if water is encountered in the excavation.

5.3 Design Review

Due to the preliminary nature of the design details at the time of this report, it is recommended that GHD's geotechnical group be allowed to review the roadway design, including utility profiles and final grading,

prior to its finalization. In addition, we strongly recommend that our firm be retained to review the grading proposals when they are available.

Geotechnical inspection and review of excavations and compaction procedures must be carried out to ensure compliance with our recommendations.

6. Statement of Limitations

The attached Statement of Limitations is an integral part of this report. Should questions arise regarding any aspect of this report, please contact our office.

Sincerely,

GHD

Adam MacKenzie Bonner, HBSc

Andy Fawcett, P.Eng.

AM/af/1

Encl. Appendix A – Sieve Analysis Test Results
Appendix B – Sodium Absorption Ration (SAR) Test Results

cc:

STATEMENT OF LIMITATIONS

This report is intended solely for the Township of Douro-Dummer and other parties explicitly identified in the report and is prohibited for use by others without GHD's prior written consent. This report is considered GHD's professional work product and shall remain the sole property of GHD. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to GHD. Client shall defend, indemnify and hold GHD harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, GHD will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, GHD is the geotechnical engineer of record. It is recommended that GHD be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the eleven (11) test hole locations only. The subsurface conditions confirmed at the 11 test hole locations may vary at other locations. The subsurface conditions can also be significantly modified by construction activities on site (eg. excavation, dewatering and drainage, blasting, pile driving, etc.). These conditions can also be modified by exposure of soils or bedrock to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by GHD is completed.

Enclosures

Appendix A
Sieve Analysis Test Results

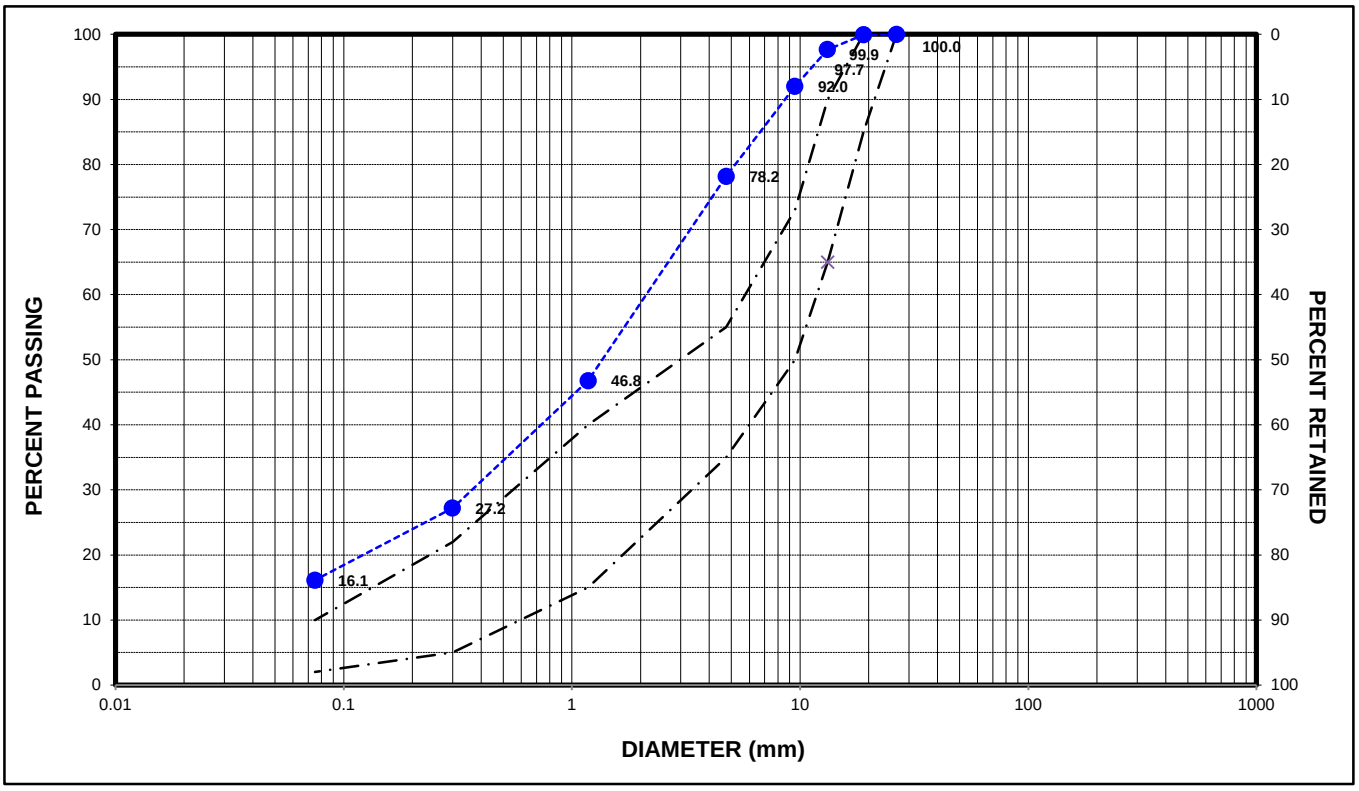
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-410
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-1

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	**100.0**	100		
19.0	**99.9**	85	-	100
13.2	* **97.7**	65	-	90
9.50	* **92.0**	50	-	73
4.75	* **78.2**	35	-	55
1.18	* **46.8**	15	-	40
0.300	* **27.2**	5	-	22
0.075	* **16.1**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

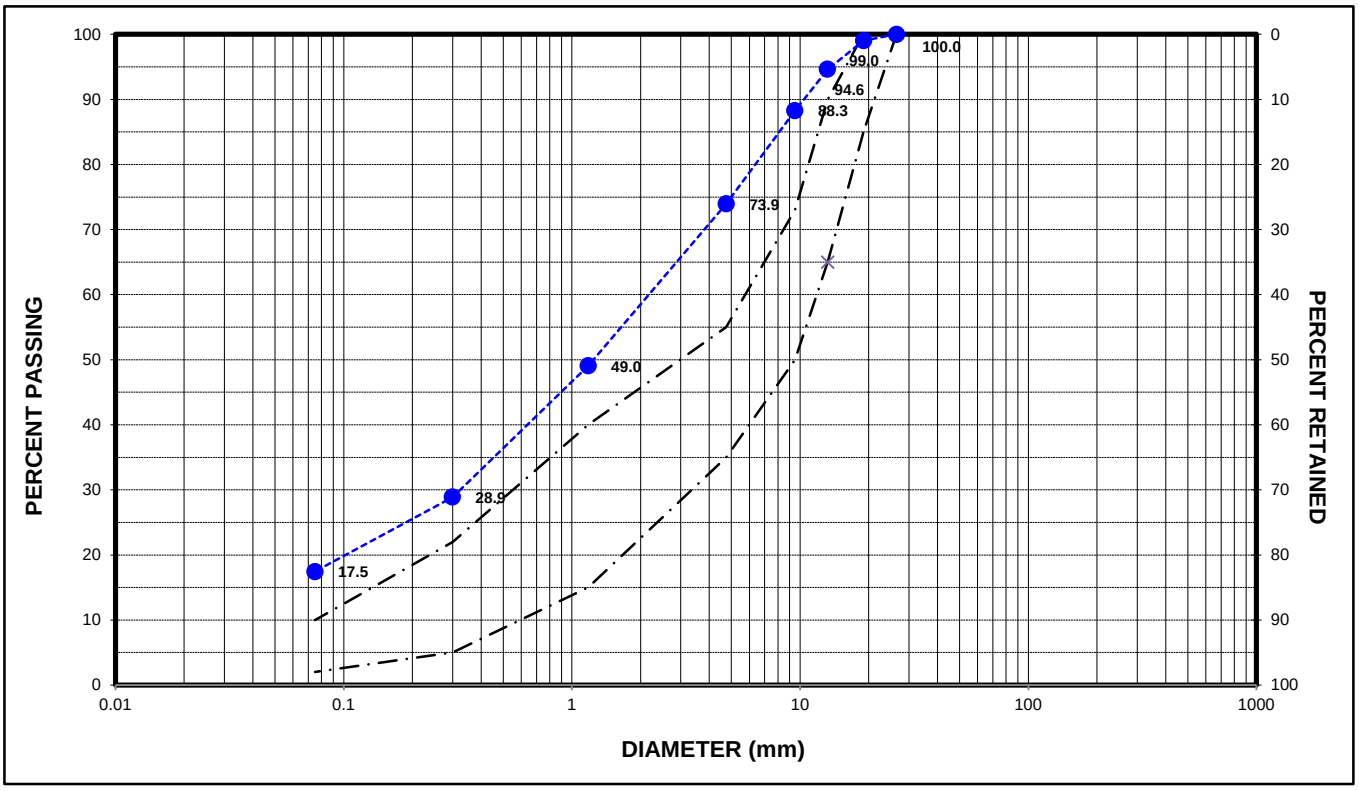
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-411
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-2

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)		Sample % Passing	OPSS Gradation Specification Minimum %	-	Maximum %
26.5		**100.0**	100		
19.0		**99.0**	85	-	100
13.2	*	**94.6**	65	-	90
9.50	*	**88.3**	50	-	73
4.75	*	**73.9**	35	-	55
1.18	*	**49.0**	15	-	40
0.300	*	**28.9**	5	-	22
0.075	*	**17.5**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

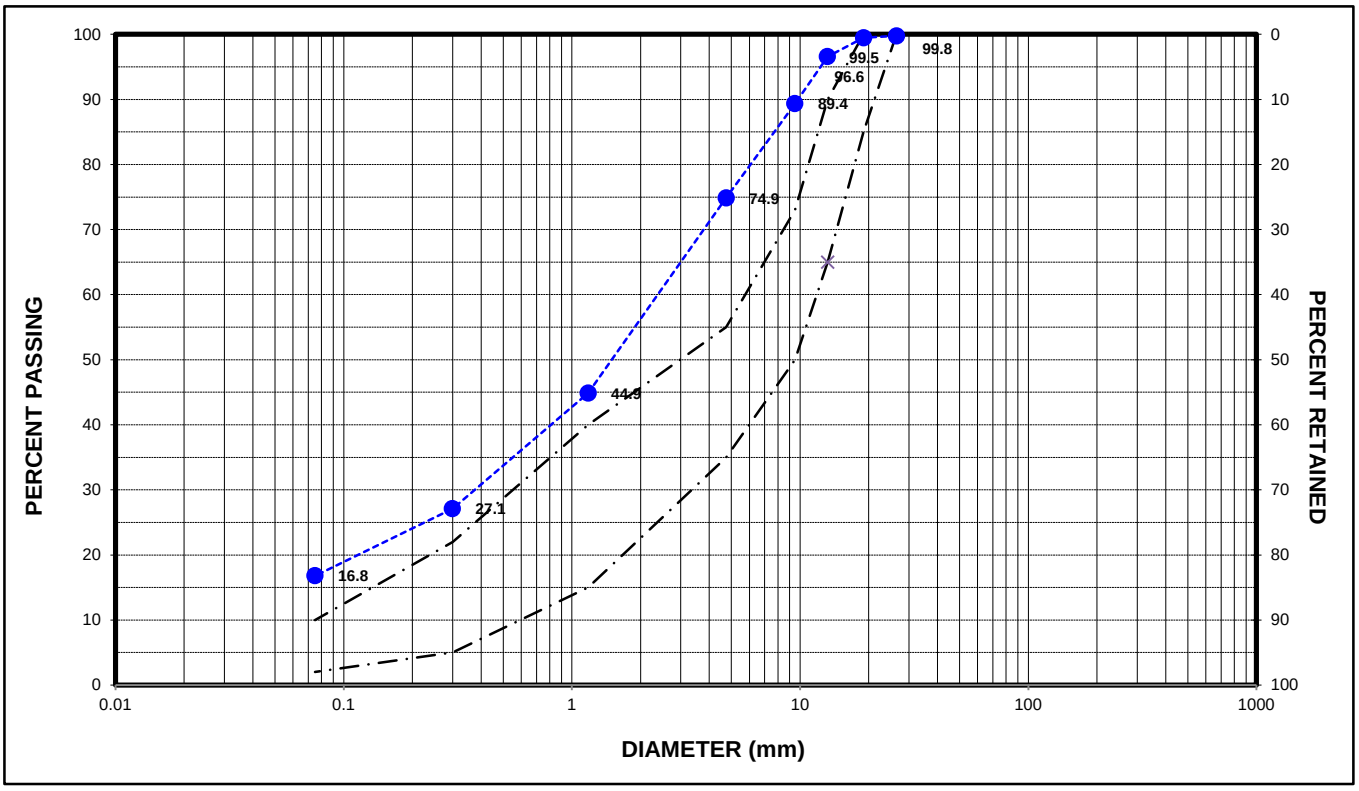
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-412
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-3

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	* **99.8**	100		
19.0	**99.5**	85	-	100
13.2	* **96.6**	65	-	90
9.50	* **89.4**	50	-	73
4.75	* **74.9**	35	-	55
1.18	* **44.9**	15	-	40
0.300	* **27.1**	5	-	22
0.075	* **16.8**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

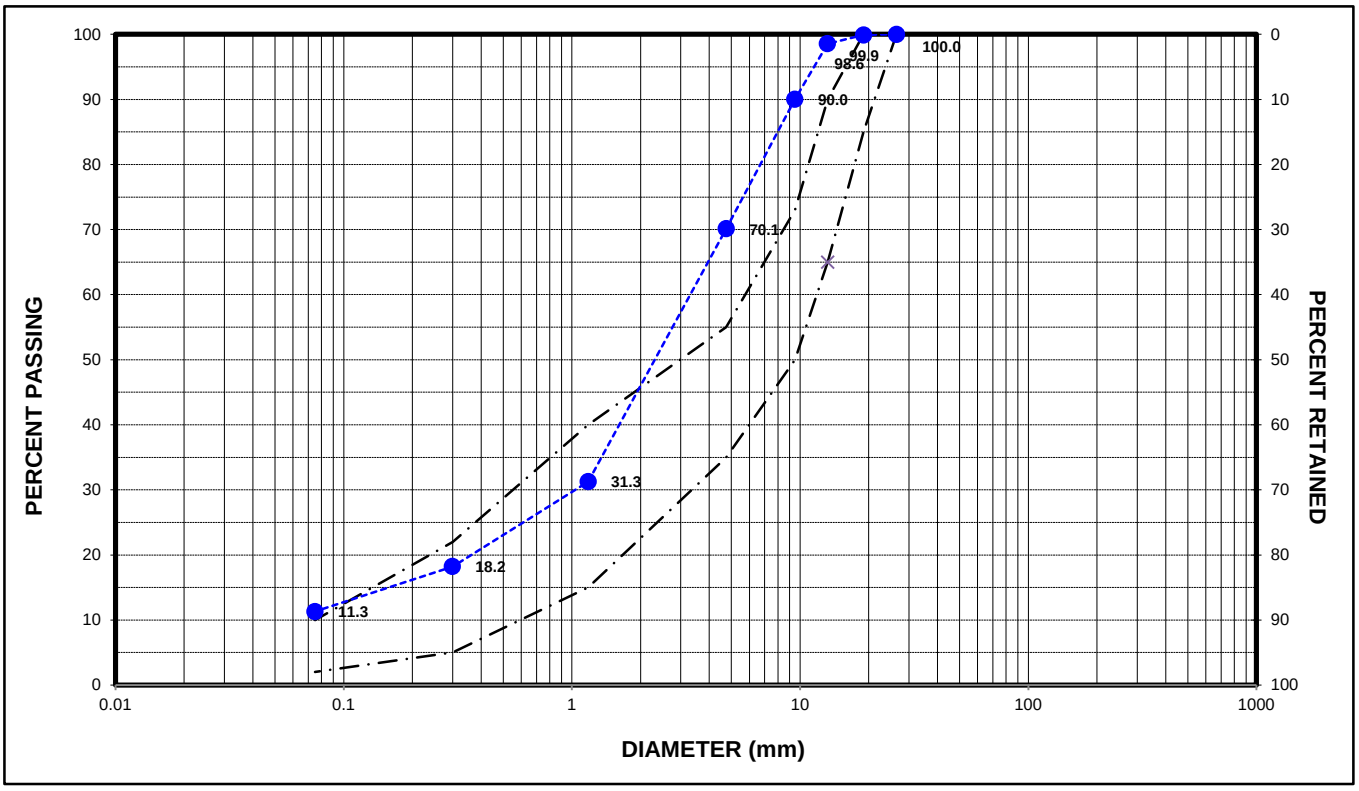
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-413
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-4

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)		Sample % Passing	OPSS Gradation Specification		
			Minimum %	-	Maximum %
26.5		**100.0**	100		
19.0		**99.9**	85	-	100
13.2	*	**98.6**	65	-	90
9.50	*	**90.0**	50	-	73
4.75	*	**70.1**	35	-	55
1.18		**31.3**	15	-	40
0.300		**18.2**	5	-	22
0.075	*	**11.3**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by:		**Date:**	December 12, 2015
Verified by:		**Date:**	December 12, 2015

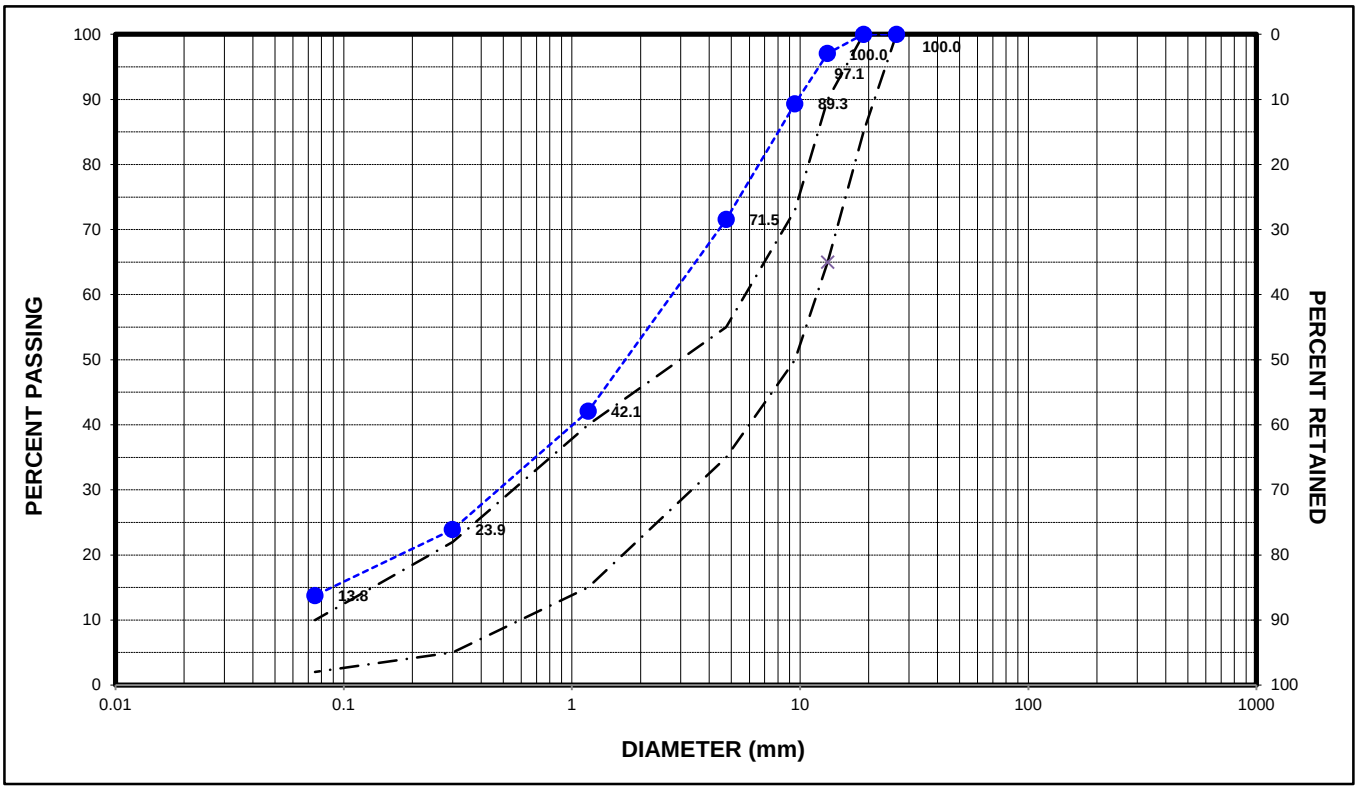
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-414
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-5

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	**100.0**	100		
19.0	**100.0**	85	-	100
13.2	* **97.1**	65	-	90
9.50	* **89.3**	50	-	73
4.75	* **71.5**	35	-	55
1.18	* **42.1**	15	-	40
0.300	* **23.9**	5	-	22
0.075	* **13.8**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

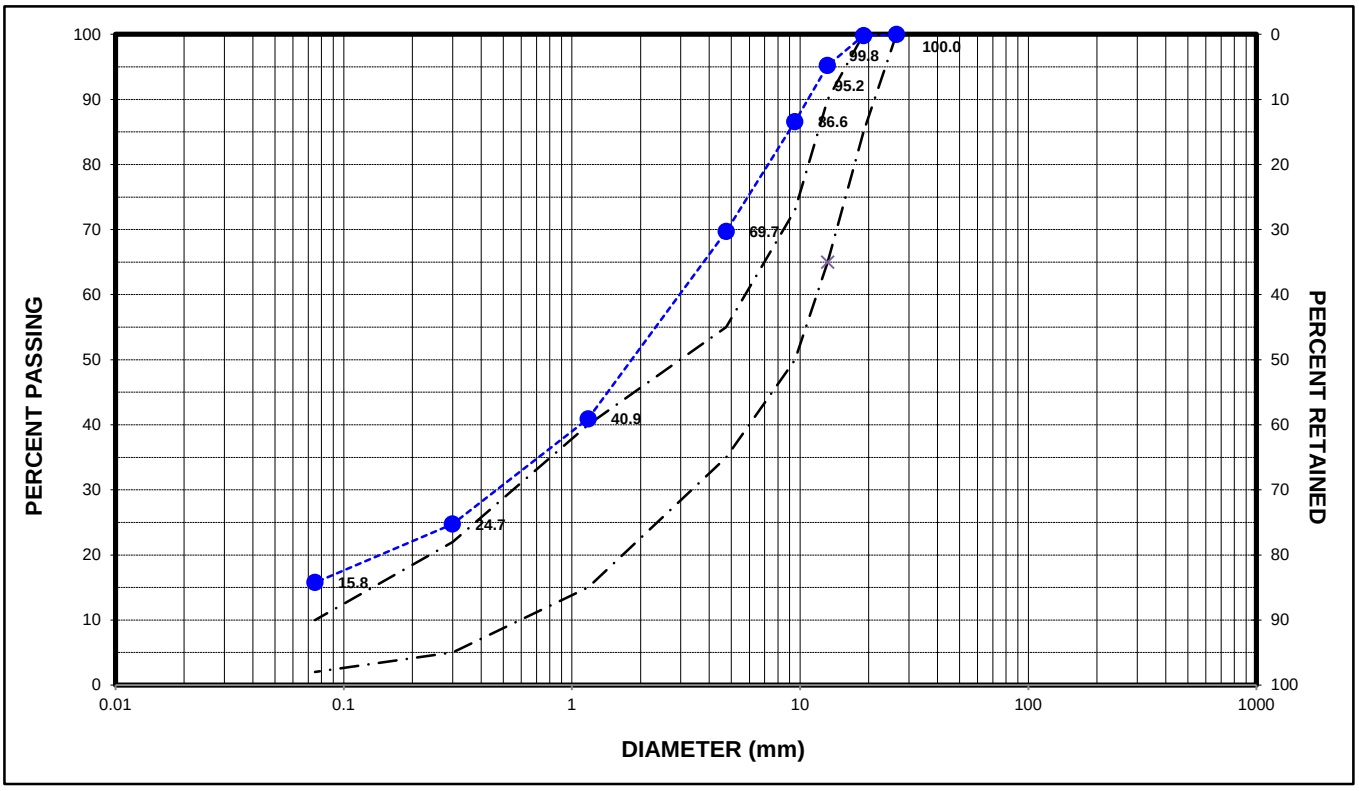
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-415
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-6

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)		Sample % Passing	OPSS Gradation Specification		
			Minimum %	-	Maximum %
26.5		**100.0**	100		
19.0		**99.8**	85	-	100
13.2	*	**95.2**	65	-	90
9.50	*	**86.6**	50	-	73
4.75	*	**69.7**	35	-	55
1.18	*	**40.9**	15	-	40
0.300	*	**24.7**	5	-	22
0.075	*	**15.8**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by:		**Date:**	December 12, 2015
Verified by:		**Date:**	December 12, 2015

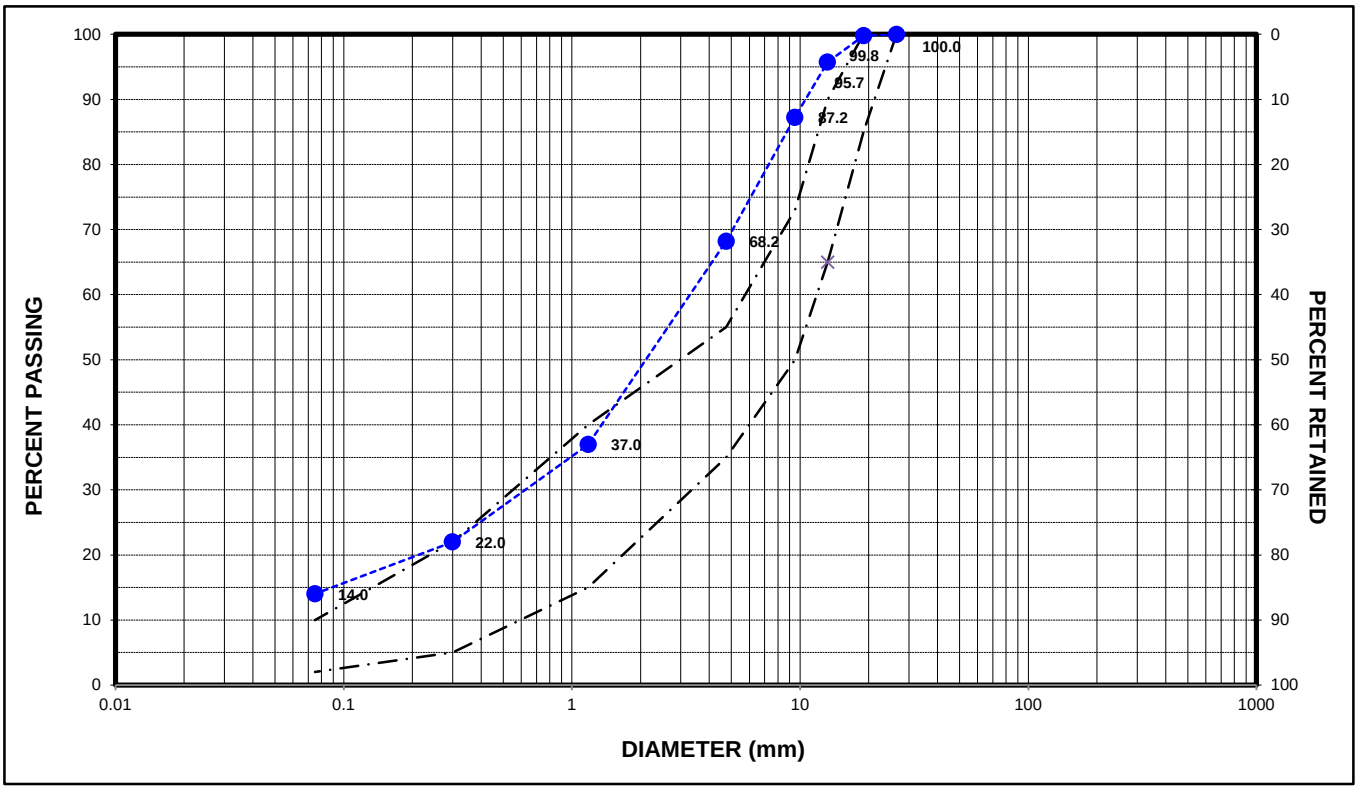
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-416
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-7

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)		Sample % Passing	OPSS Gradation Specification Minimum %	-	Maximum %
26.5		**100.0**	100		
19.0		**99.8**	85	-	100
13.2	*	**95.7**	65	-	90
9.50	*	**87.2**	50	-	73
4.75	*	**68.2**	35	-	55
1.18		**37.0**	15	-	40
0.300		**22.0**	5	-	22
0.075	*	**14.0**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

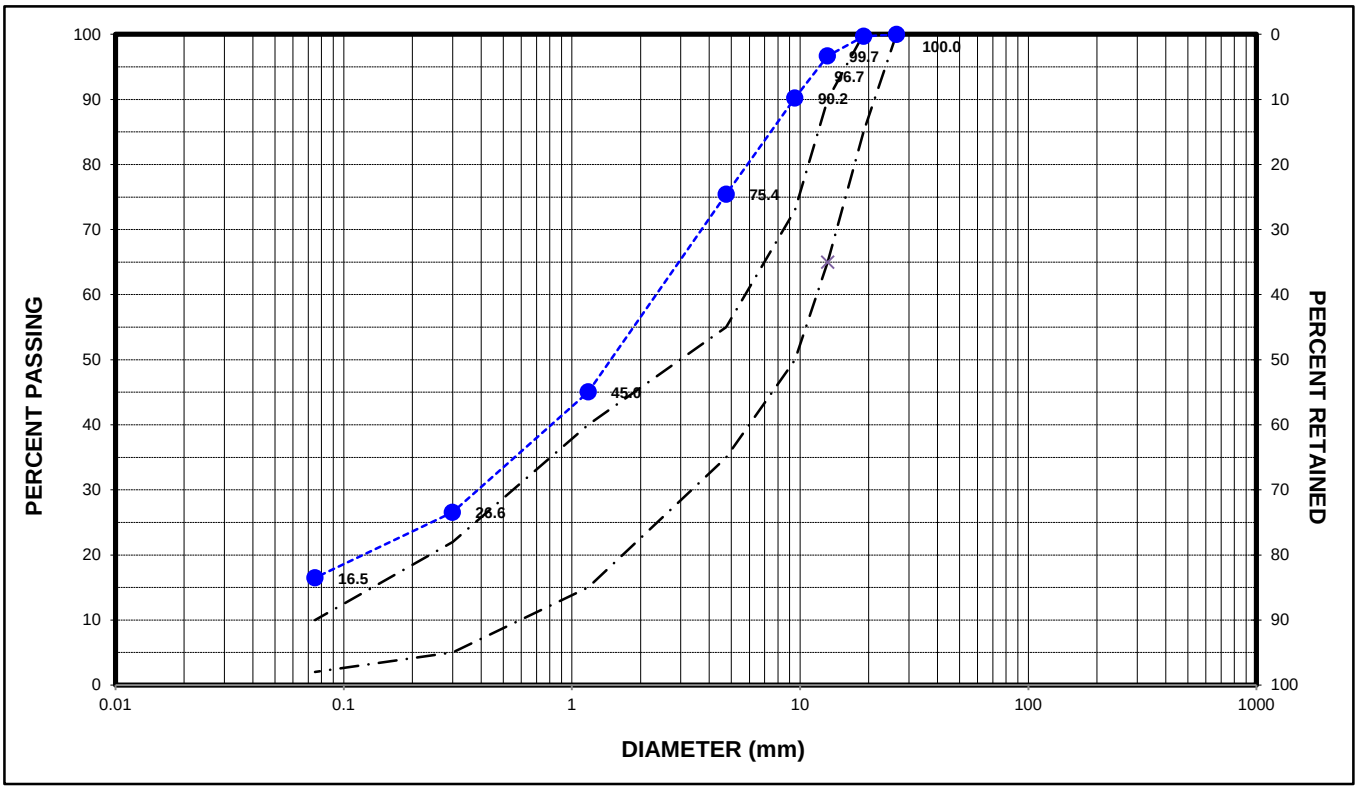
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-417
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-8

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	**100.0**	100		
19.0	**99.7**	85	-	100
13.2	* **96.7**	65	-	90
9.50	* **90.2**	50	-	73
4.75	* **75.4**	35	-	55
1.18	* **45.0**	15	-	40
0.300	* **26.6**	5	-	22
0.075	* **16.5**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

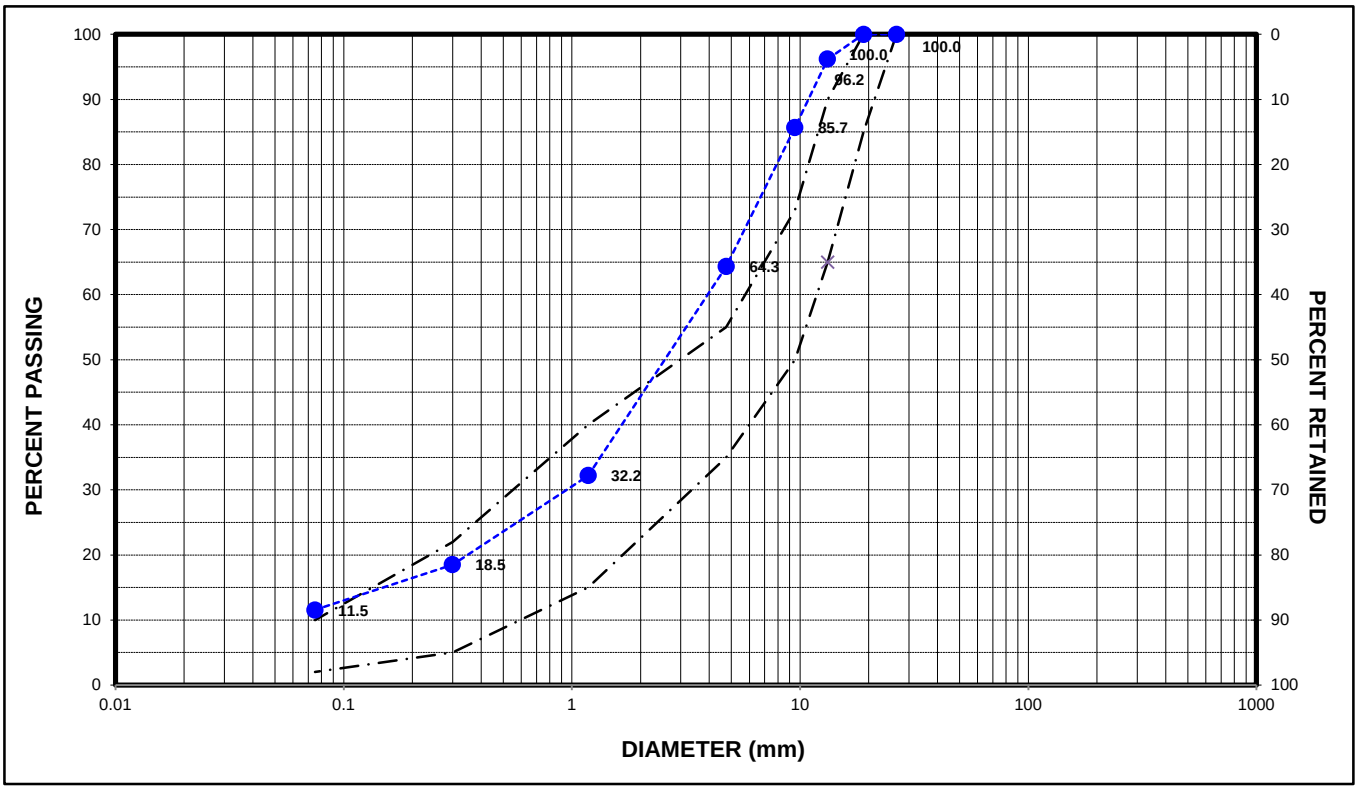
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-418
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-9

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	**100.0**	100		
19.0	**100.0**	85	-	100
13.2	* **96.2**	65	-	90
9.50	* **85.7**	50	-	73
4.75	* **64.3**	35	-	55
1.18	**32.2**	15	-	40
0.300	**18.5**	5	-	22
0.075	* **11.5**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

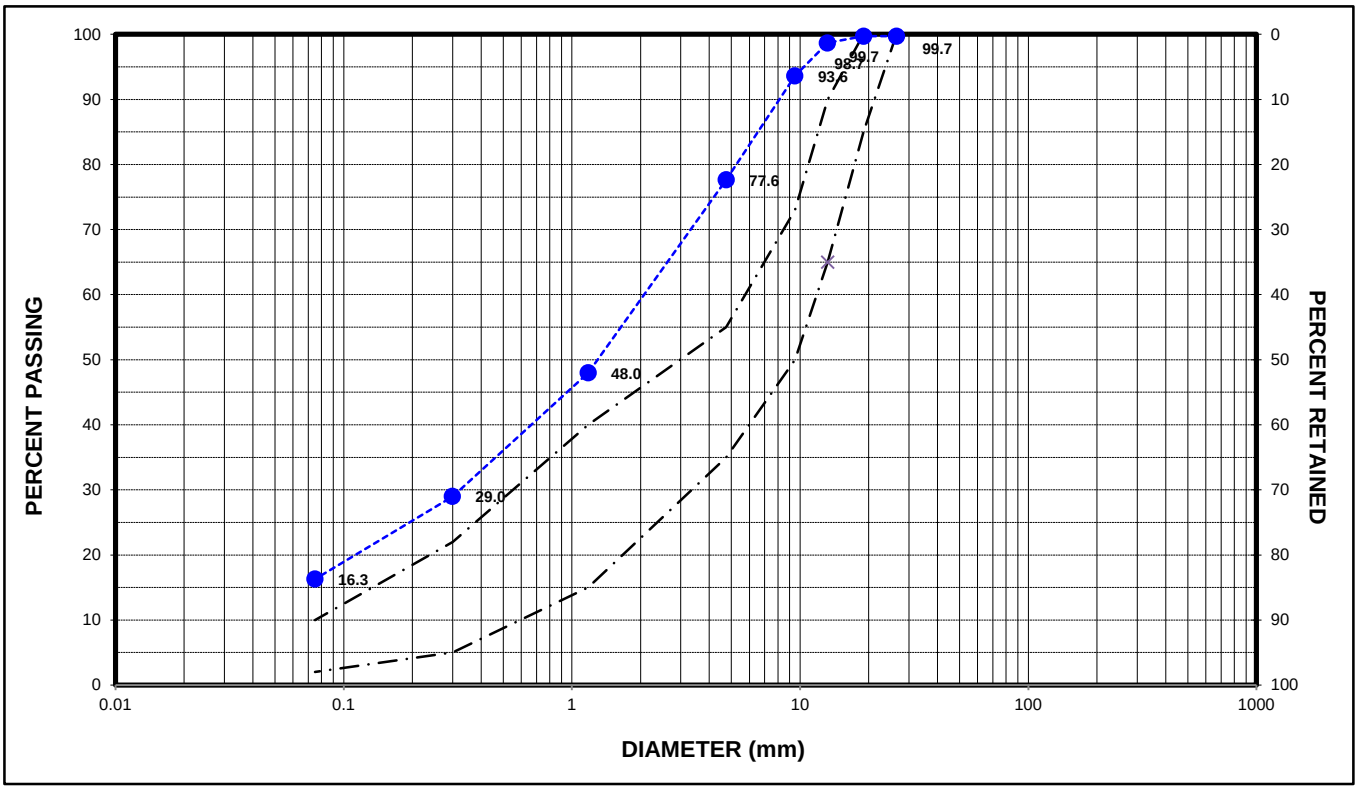
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-419
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-10

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	* **99.7**	100		
19.0	**99.7**	85	-	100
13.2	* **98.7**	65	-	90
9.50	* **93.6**	50	-	73
4.75	* **77.6**	35	-	55
1.18	* **48.0**	15	-	40
0.300	* **29.0**	5	-	22
0.075	* **16.3**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

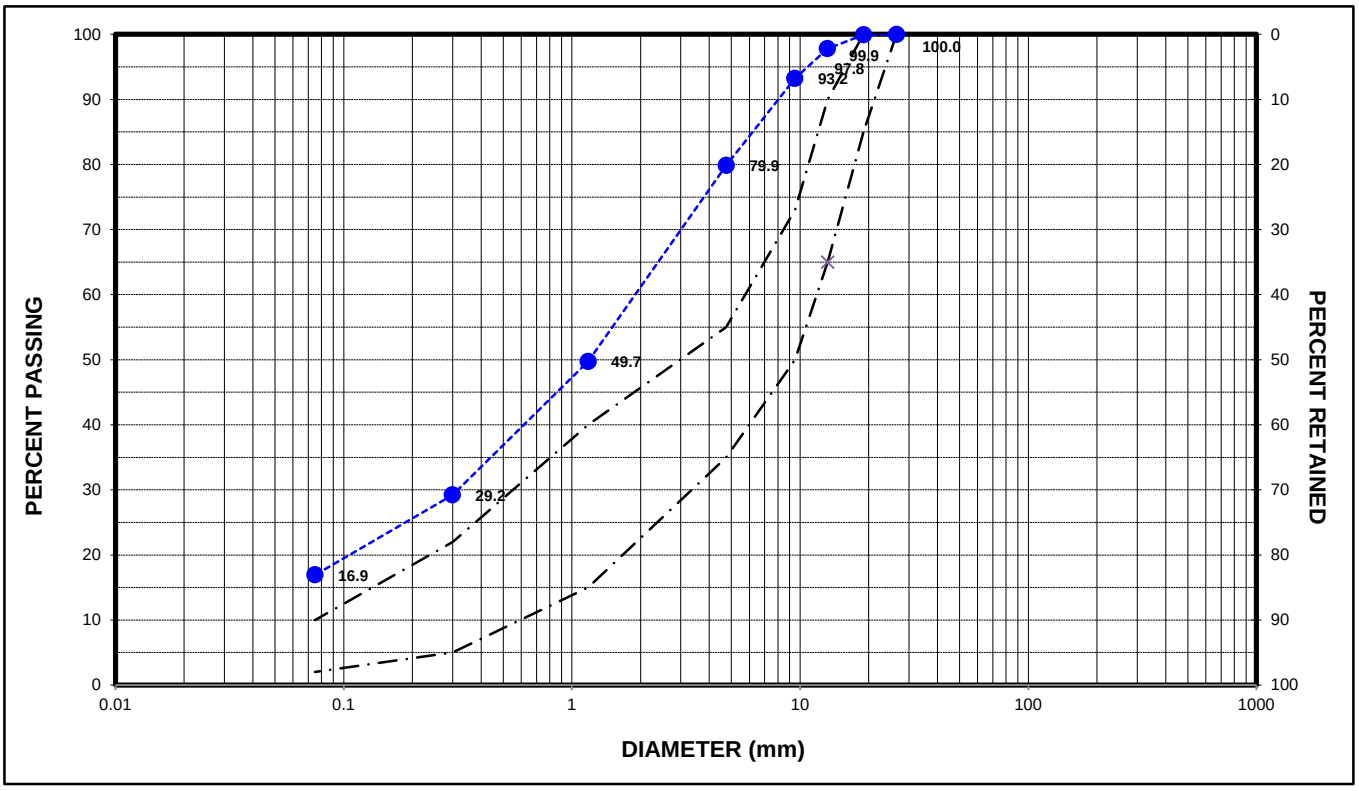
GRANULAR A - SIEVE ANALYSIS (QUARRY)
(LS-602)

Client:	Township of Douro - Dummer	**Lab no.:**	AG-15-420
Project/Site:	2015 Road Investigation	**Project no.:**	1114440-01

Source: TP-11

Sampled by: A.Bonner Date sampled: December 9, 2015

Sieve Size (mm)	Sample % Passing	OPSS Gradation Specification		
		Minimum %	-	Maximum %
26.5	**100.0**	100		
19.0	**99.9**	85	-	100
13.2	* **97.8**	65	-	90
9.50	* **93.2**	50	-	73
4.75	* **79.9**	35	-	55
1.18	* **49.7**	15	-	40
0.300	* **29.2**	5	-	22
0.075	* **16.9**	2		10



Remarks:

* Sieve result does not meet the OPSS Specification for: GRANULAR A - SIEVE ANALYSIS (QUARRY)

Performed by: _____ **Date:** December 12, 2015

Verified by: _____ **Date:** December 12, 2015

Appendix B
Sodium Adsorption Ratio (SAR) Test Results

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

17-December-2015

GHD
Attn : Adam Bonner

347 Pido Rd., Unit #29
Peterborough, ON
K9J 6Z8,

Phone: 705-749-3317
Fax:

Date Rec. : 14 December 2015
LR Report: **CA14205-DEC15**
Reference: 11114440-01
Douro-Dummer
PO#73501948

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Sample ID	Sample Date & Time	Sodium Adsorption Ratio ---	SAR Calcium mg/L	SAR Magnesium mg/L	SAR Sodium mg/L
1: Date Extracted / Digested		16-Dec-15	16-Dec-15	16-Dec-15	16-Dec-15
2: Date Analyzed		16-Dec-15	16-Dec-15	16-Dec-15	16-Dec-15
3: Analysis Approval Date		17-Dec-15	16-Dec-15	16-Dec-15	16-Dec-15
4: Analysis Approval Time		13:34	16:16	16:16	16:16
5: Table 1 Agricultural or other Property Use		1	---	---	---
6: Table 1 Res / Park / Ins / Ind / Com/ Comm Property Use		2.4	---	---	---
7: RDL		0.01	0.02	0.003	0.01
8: TP-1	07-Dec-15	1.64	55.0	0.978	44.9
9: TP-2	07-Dec-15	1.23	29.2	0.686	24.6
10: TP-3	07-Dec-15	0.89	23.3	0.494	15.9
11: TP-4	07-Dec-15	0.20	31.7	1.76	4.27
12: TP-5	07-Dec-15	3.33	12.1	0.807	44.2
13: TP-6	07-Dec-15	0.72	25.6	2.60	14.3
14: TP-7	07-Dec-15	1.83	30.3	1.31	37.8
15: TP-8	07-Dec-15	0.93	19.7	1.08	15.6
16: TP-9	07-Dec-15	0.96	17.5	1.04	15.3
17: TP-10	07-Dec-15	1.08	96.3	2.68	39.3
18: TP-11	07-Dec-15	1.11	49.4	1.28	28.9

Brian Graham B.Sc.
Project Specialist
Environmental Services, Analytical

OnLine LIMS

0000575772

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA14205-DEC15**

Method Descriptions

Parameter	SGS Method Code	Reference Method Code
Metals in aqueous samples - ICP-OES	ME-CA-[ENV]SPE-LAK-AN-003	MOE 4696e01/EPA 6010
Sodium adsorption ratio (SAR)	ME-CA-[ENV]ARD-LAK-AN-021	MOE 4696e01/EPA 6010

OnLine LIMS

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0000575772

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA14205-DEC15**

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank		RPD	Acceptance Criteria	LCS / Spike Blank			Matrix Spike / Reference Material		
							Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Metals in aqueous samples - ICP-OES - QCBatchID: ESG0055-DEC15												
SAR Calcium	0.02	mg/L	<0.02		0	20	100	80	120	72	70	130
SAR Magnesium	0.003	mg/L	<0.003		0	20	98	80	120	87	70	130
SAR Sodium	0.01	mg/L	<0.01		0	20	98	80	120	NV	70	130

OnLine LIMS

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Test method information available upon request. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.