



ENGINEERING INC.

#6 - 1905 EVERGREEN COURT, KELOWNA, B.C. CANADA V1Y 9L4 · CELL: 250-899-7090 · E-MAIL: bclarke@exlengineering.com

Metis Minerals
752 Vernon St.
Nelson, BC V1L 4G2

October 23rd, 2024

Project No. 23-00000-342

Attention: Mr. Ted J. Nunn

**REFERENCE: PETROGRAPHIC EXAMINATION OF COARSE AND FINE AGGREGATES
T.P COMBINED**

As requested, petrographic examinations were completed on one sample of aggregate material supplied from Metis Minerals aggregate source, T.P Combined. The material supplied and tested is summarized in the table below. The petrographic examination was performed in accordance with CSA Test Method A23.2-19 15A, *Petrographic examination of aggregates*. The enclosed coarse and fine aggregate work sheets are derived from the CSA A23.2-19 15A test method. Upon receipt of samples, the material was washed, and then dried for analysis. The intended use of the material is summarized in the table below.

Table 1 Summary of Aggregate Quality Classifications				
Sample ID	Material Type	Source	Petrographic No or Grade	Intended Use
Coarse Aggregate	Screened Gravel	T.P. Combined	116, Good	Ready Mix Concrete
Fine Aggregate	Screened and Washed Gravel	T.P. Combined	Good	Ready Mix Concrete

METHOD

As noted above, the basis for the examination was CSA Test Method A23.2-15A-15. The coarse and fine aggregate samples were prepared according to the procedures as outlined in the test method. The coarse material was examined as per Section 6.1(b) of the test method, Method B.

The fine aggregate material was separated according to sieve sizes and those fractions making up greater than 5 % of the mass were analyzed for composition, and physical and mechanical properties.

ALKALI AGGREGATE REACTIVITY

The petrographic analysis is not related to the potential for alkali-aggregate reactivity (AAR) of this aggregate when used in Portland cement concrete. AAR potential must be separately assessed. Historical usage of the material, as well as past AAR evaluations or evaluations of similar material, should be taken into account when assessing the potential for expansive reactivity in Portland cement.

AAR is a reaction between the hydroxide ions associated with the dissolved salts of sodium and potassium and the silica molecules of certain imperfectly crystallized siliceous rocks and minerals, such as opal, chert, and cristobalite, or highly siliceous volcanic glasses or highly strained or granulated siliceous rocks (such as quartzite, siltstone and phyllite). The reaction produces a silica gel that will expand in the presence of moisture. The expanding gel causes cracks in the aggregate and paste. The cracks allow more moisture to enter and expansive gel to fill the cracks and cause more expansion.

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE CSA A23.2-2A

Metis Minerals
752 Vernon St.
Nelson, BC V1L 4G2

Project number: 24-00000-342
Project: 2024 Misc. Testing

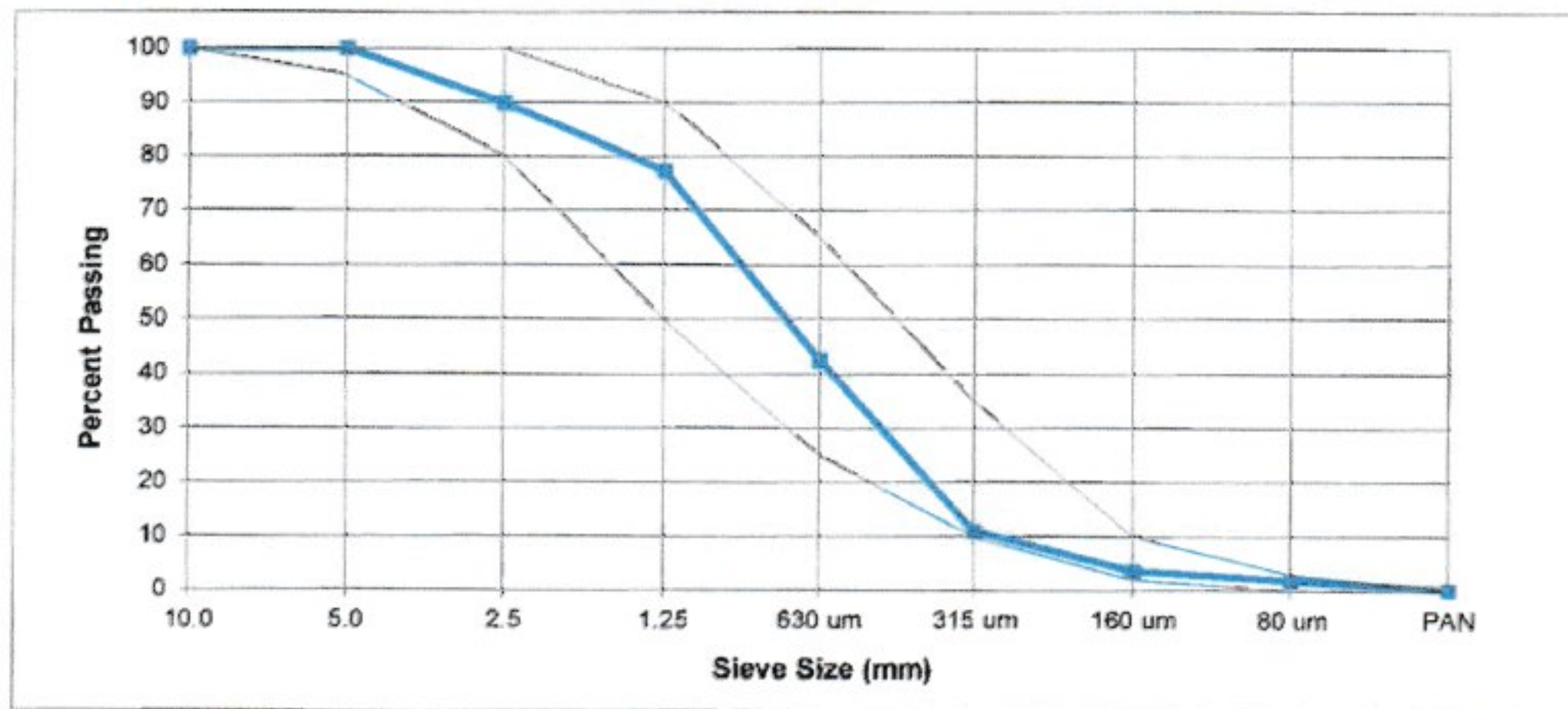
Attention: Ted J. Nunn

Sample:	T.P. Combined - Fine Portion
Source	Columbia River Dam Pit Investigation

DATE SAMPLED: June 18, 2024
DATE TESTED: June 25, 2024

SAMPLED BY: Client
TESTED BY: DM

SIEVE ANALYSIS					MATERIAL SPECIFICATION:	
CSA Sieve Size (mm)	ASTM Sieve Size (in.)	Weight Retained (g)	% Retained	% Passing	CSA Group FA1	
10.0	3/8	0.0	0.0	100.0	100	100
5.0	No. 4	0.0	0.0	100.0	95	100
2.5	No. 8	101.4	9.7	90.3	80	100
1.25	No. 16	144.5	13.8	76.4	50	90
630 um	No. 30	325.9	31.2	45.2	25	65
315 um	No. 50	301.4	28.9	16.3	10	35
160 um	No. 100	122.5	11.7	4.6	2	10
80 um	No. 200	25.8	2.5	2.1	0	3
PAN	PAN	22.1	2.1	0.0	0	0
Total	Total	1043.6	100.0	-		



Remarks: a) Fineness Modulus: 2.67
b) Grading of fine aggregate meets the requirements of Table 10 of CSA A23.1-19 for Group FA1

Reported by: HR

Reviewed by:


G. Lecuyer, P. Eng. - Materials Engineer

Notice: The test data given herein pertain to the sample provided, and may not be applicable to material from other zones/depths. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Petrographic Examination of Fine Aggregate (CSA – A23.2-15A)

Source Name:	Concrete Sand – T.P. Combined, Metis Minerals	Date Tested:	August
Sample Number:	C1546 (L24-0103AG)	Petrographer:	Robert

Sieve Size	5.0 – 2.5 mm	2.5 – 1.25 mm	1.25 – 0.630 mm	0.630 – 0.315 mm	0.315 – 0.160 mm
Percent Retained on Sieve	9.7	13.9	31.2	28.9	11.7
Rock/Mineral Type	Total Percentage per Sieve Fraction				
Granitic	28.0	26.3	15.3	6.0	1.7
Volcanic	0.0	1.3	1.0	0.7	0.3
Gneiss	55.7	28.0	10.7	12.3	8.3
Quartz	6.0	38.0	66.7	74.0	79.0
Feldspar	10.0	4.7	4.3	4.7	3.0
Hornblende	0.0	0.0	0.0	0.0	4.3
Mica	0.0	0.0	0.3	1.3	3.0
Friable	0.3	1.7	1.7	1.0	0.4
Totals	100.0	100.0	100.0	100.0	100.0

Tested in accordance with CSA Standard A23.2-15A
Sieve analysis test results were provided by EXL Engineering Inc.

**SIEVE ANALYSIS OF COARSE
AND FINE AGGREGATE
ASTM C 136**

Metis Minerals
752 Vernon St.
Nelson, BC V1L 4G2

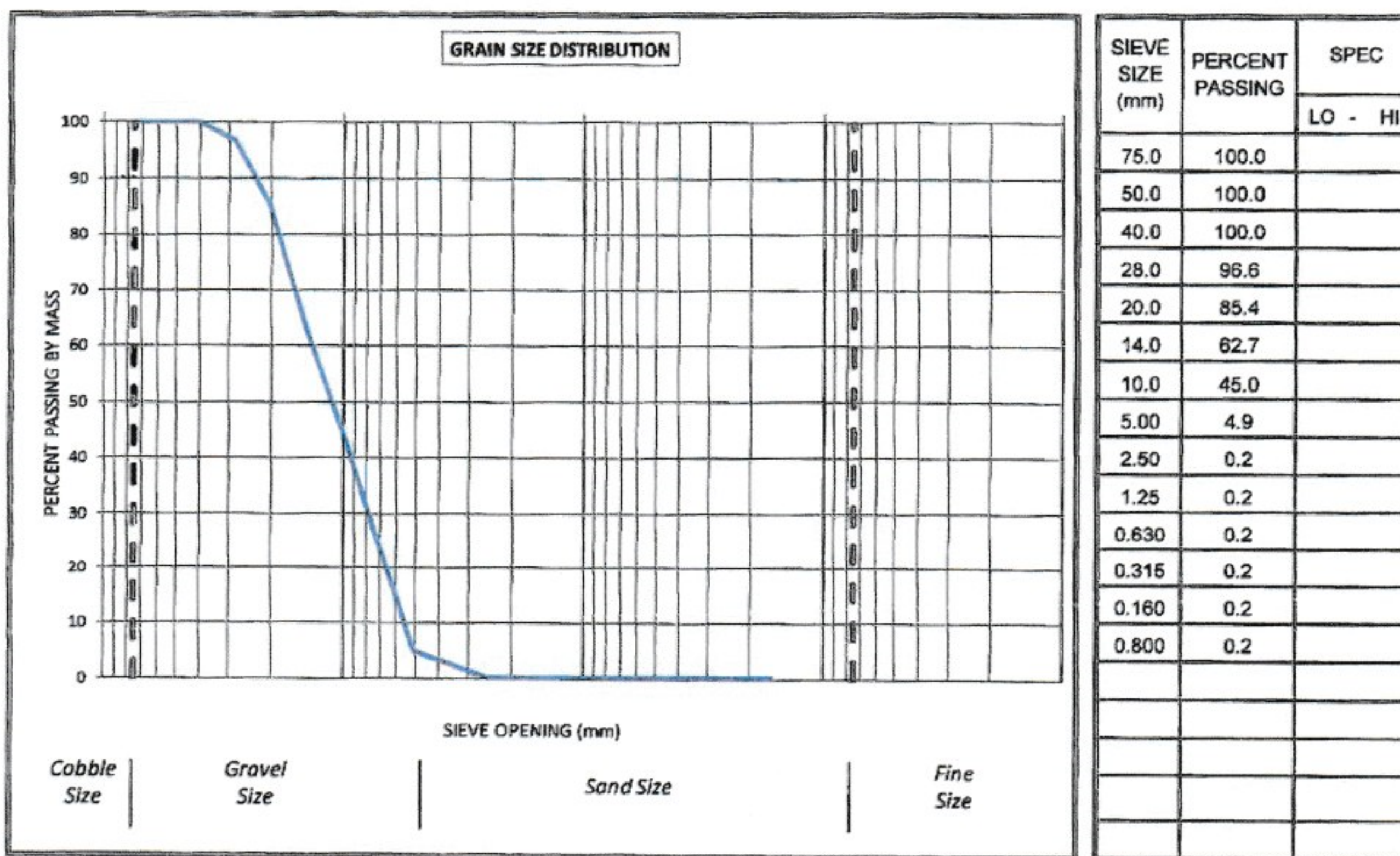
Date: August 29, 2024
Project No.: 24-00000-342

Attention: Ted J. Nunn

C1545

PROJECT: 2024 Misc. Testing

SAMPLE I.D.:	24-278	Sampled By	Client	Tested By	DM
DATE SAMPLED:	18-Jun-24	DATE RECEIVED :	19-Jun-24	DATE TESTED :	24-Jun-24
MATERIAL:	Surface Test #1 Sand and Gravel				
SOURCE:	On Site				



Specification: No specification provided by client.

Comments:

Reported by: HR

Reviewed by:

G. Lecuyer
G. Lecuyer, P. Eng. - Materials Engineer

Notice: The test data given herein pertain to the sample provided, and may not be applicable to material from other zones/depths. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.

Detailed Petrographic Examination of Coarse Aggregates (CSA – A23.2-15A)

Material Name / Source:	20-5 mm T.P. Combined Coarse Aggregate - Columbia River Dam Pit Investigation, Metis Minerals	Project Number:	L24-0103AG
Sample Number:	C1545	Sieve Fraction:	5 to 10 mm
Petrographer:	R. Ji	Date Tested:	Aug. 01, 2024

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Granite	59.5	24.0	24.0
Gneiss	170.3	68.8	68.8
Volcanic	2.7	1.1	1.1
Quartz	5.9	2.4	2.4
Fair (PN Multiplier = 3)			
Gneiss	8.5	3.4	10.2
Poor (PN Multiplier = 6)			
Gneiss	0.8	0.3	1.8
Deleterious (PN Multiplier = 10)			
Total	247.7	100	108.3

Note:

- (1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.
- (2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.



**Detailed Petrographic Examination of Coarse Aggregates
(CSA – A23.2-15A)**

Material Name / Source:	20-5 mm T.P. Combined Coarse Aggregate - Columbia River Dam Pit Investigation, Metis Minerals	Project Number:	L24-0103AG
Sample Number:	C1545	Sieve Fraction:	10 to 14 mm
Petrographer:	R. Ji	Date Tested:	Aug. 01, 2024

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Granite	118.2	15.4	15.4
Gneiss	567.1	73.8	73.8
Volcanic	12.5	1.6	1.6
Quartz	7.5	1.0	1.0
Fair (PN Multiplier = 3)			
Gneiss	59.9	7.8	23.4
Poor (PN Multiplier = 6)			
Deleterious (PN Multiplier = 10)			
Friable	2.8	0.4	4.0
Total	768.0	100	119.2

Note:

- (1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.
- (2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.



**Detailed Petrographic Examination of Coarse Aggregates
(CSA – A23.2-15A)**

Material Name / Source:	20-5 mm T.P. Combined Coarse Aggregate - Columbia River Dam Pit Investigation, Metis Minerals	Project Number:	L24-0103AG
Sample Number:	C1545	Sieve Fraction:	14 to 20 mm
Petrographer:	R. Ji	Date Tested:	Aug. 01, 2024

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Granite	151.0	8.3	8.3
Gneiss	1480.6	81.4	81.4
Volcanic	6.6	0.4	0.4
Quartz	3.8	0.2	0.2
Fair (PN Multiplier = 3)			
Granite	8.2	0.5	1.5
Gneiss	156.2	8.6	25.8
Poor (PN Multiplier = 6)			
Volcanic	5.1	0.3	1.8
Deleterious (PN Multiplier = 10)			
Friable	5.8	0.3	3.0
Total	1817.3	100	122.4

Note:

- (1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.
- (2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.

We trust this information meets your requirements at this time. Please do not hesitate to contact us should you require any further services or information.
Sincerely,

Prepared by:

EXL Engineering Inc.



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Lab Manager
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bclarke@exlengineering.com

Reviewed By:

EXL Engineering Inc.



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