RIPRAP ASSESSMENT VARIOUS SITES HWY 40 NEAR GRANDE CACHE, AB

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Need for Riprap

- Increased traffic along Hwy 40 has generated a lot of construction projects to upgrade highway
- Lack of good quality heavy rock riprap in Grande Cache area
- Lack of fieldstone
- Alluvial rock typically small and rounded (more suitable for Class 1M and gabions)
- Bedrock is sedimentary rock of poor durability

AT Heavy Rock Riprap Specs

The heavy rock riprap supplied shall be hard, durable and angular in shape, resistant to weathering and water action, free from overburden, spoil, shale or shale seams and organic material, and shall meet the gradation requirements for the class specified. In general, no sandstone will be permitted for all classes, however if the proposed material meets or exceeds the minimum requirements, consideration may be given to accepting the material. For these occurrences, further testing shall be done to ensure acceptability. This would include testing of the material in accordance with CSA A23.2-15A "Petrographic Examination of Aggregates". The minimum dimension of any single rock shall be not less than one third of its maximum dimension. The minimum acceptable unit weight of the rock is 2.5

t/m3.

AT Heavy Rock Riprap Specs

Specific Gravity, Absorption and Durability Index Requirements (1)

TEST METHOD	REQUIREMENT
California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregates (California Test 206)	Minimum Specific Gravity = 2.60 Maximum Absorption = 2.0%
California Department of Transportation Method of Test for Durability Index (California Test 229)	Minimum Durability Index = 52 (1)

Notes: (1) Durability Index may be less than 52 if the durability absorption ratio (DAR) is greater than 23, where DAR = Durability Index / (Absorption % +1%)

Past Sources

- Limestone from quarries near Cadomin.
  - Good quality hard rock but quarries no longer open
- Igneous fieldstone imported from long distances
  - Very expensive to haul from long distances
- Local Sedimentary Rock blasted from pit operated by Rodar (previously known as the CN pit).
  - Typically used sandstone, conglomerate and shale. Issues with long term durability

Limestone spur at Lone Teepee Creek

Close up view of limestone rock in spur

Typical rocks in Rodar pit – shale, sandstone, conglomerate, greywacke

Conglomerate – Igneous coarse aggregate with sandstone matrix

Conglomerate deterioration – Ditch Grande Cache, 2016

Weathering of the sandstone matrix – (7 yrs old)

Shale

Splitting of sandstone (10 yrs old)

Greywacke - Good riprap

QA/QC for Greywacke Riprap

- Field Inspection
  - Visual inspection
  - Drop test
  - Hammer ping test
  - Physical measurement – weight and dimensions
- Laboratory Testing
  - Durability
  - Density
  - Spec gravity
  - Petrographic analysis

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

CT 206

Golder Associates

Client:	Heavy North	Project No:	1651750
Short Title:	Rock Testing	Phase No:	10000
Sample No.:	Rock (Lab Crushed Minus 19.0 mm)	Date Sampled:	August, 2017
Source:	Edco Pit (6-12-57-8 W6)	Date Tested:	August 30, 2017
Description:	Class 3M grey wacke material	Tested by:	DC

Trial No.	Mass (g)	Relative Density (Dry Basis)	Relative Density (SSD Basis)	Apparent Relative Density	Absorption (%)
1	2588.8	2.716	2.736	2.773	0.76
2	2584.9	2.719	2.737	2.770	0.68
AVERAGE		**2.717**	**2.737**	**2.772**	**0.72**

Reported by: S. John, AScT

Reviewed by: ______________________
L. Hu, M. Sc. E., P.Eng.

DURABILITY INDEX

CT 229

Golder Associates

Client:	Heavy North	Project No:	1651750
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Description:	Class 3M grey wacke material	Tested by:	DC

PROCEDURE	SEDIMENT HEIGHT (inch)		DURABILITY INDEX (D_c)
A (COARSE AGGREGATE)	Trial 1	0.9	76
	Trial 2	0.9	76
	Trial 3	0.9	76
	Average	**0.9**	**76**

Reported by: S. John, AScT

Reviewed by: ______________________
L. Hu, M. Sc. E., P.Eng.

PETROGRAPHIC EXAMINATION OF COARSE AGGREGATE

CSA A23.2-15A / ASTM C295

Heavy North
625 Parsons Road SW
Edmonton, Alberta
T6X 0N9

Project: 1651-750.10000
September 6, 2017

ATTENTION: Mr. Fuad Salad, CET

Source, Sample:	Edco Pit (6-12-57-8 W6), Class 3M rock

Date received: August 2017

Sampled by: Client

	PETROGRAPHIC DESCRIPTION/ PHYSICAL QUALITY	PERCENT BY MASS	MULTI-PLIER	PN CONTRI-BUTION
GOOD	**Greywacke** – fine-grained (0.05 – 0.12 mm), some matrix (15 – 20%); quartz, feldspar, biotite/muscovite, minor calcite. Carbonaceous material present in the matrix, locally concentrated. Sericitized mica and feldspar. Minor (trace) of fine-grained framboidal pyrite. Grains are subangular to subrounded. Well defined thin bedding, with some cross-bedding. Very dense, strong. Dark grey, with rust-brown weathered surfaces.	94.7	1	**94.7**
	Subtotal	***94.7***		***94.7***
FAIR	**Greywacke** – as above, but weathered, medium strength, often with iron-oxides imparting a weathered rusty brown halo on surfaces.	5.3	3	**15.9**
	Subtotal	***5.3***		***15.9***
	TOTALS	**100.0**	**PN**	**110.6**

Note: The PN is not related to potential for Alkali-Aggregate Reaction or other chemical reactions, which must be assessed by appropriate means.

PETROGRAPHER: 

F. Shrimer, P. Geo.

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

Edco Pit Class 3M rock

General

The sample consisted of crushed rock material taken from a large, approximately 0.65 m boulder. In preparation for the examination, the sample was split, quartered and reduced to a mass appropriate for the examination. Then, it was washed to remove surficial dust.

The particle geometry was variable, with particle shapes ranging from flaky and scooped to generally equidimensional/cubical. The flat/flaky pieces are likely due to the crushing process via a laboratory jaw crusher. The surface texture of particles was generally moderately rough.

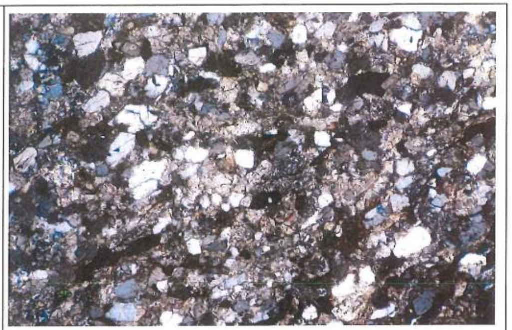
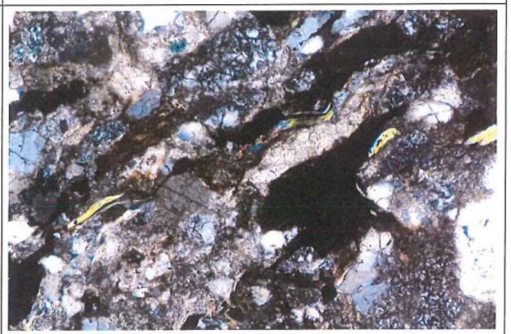
Lithologic Composition

Identification of rock type and mineralogy was done using a stereomicroscope with magnifications from 10x to 70x, supplemented by basic geologic diagnostic methods. Thin section specimens were prepared to assist in identification of the rock.

The sample consists of a fine-grained matrix-rich greywacke sandstone that is finely-bedded. In thin-section, the rock is observed to consist of quartz, feldspar, lithic fragments, biotite, muscovite and minor calcite. It exhibits rusty brown weathering on surfaces, and calcite is concentrated on some surfaces as well. Grain size is variable and ranged from about 0.05 to 0.12 mm, on average. Grain size and composition varies between layers. Matrix is estimated to represent about 20% of the rock.

A small amount of metallic minerals, consisting of ilmenite and pyrite, were observed in the rock.

Photograph 1: Selection of crushed particles of the Edco Pit Class 3M rock, illustrating angular nature of the particles. A brown weathering halo is observed on the large fragment at lower right.

Photograph 2: View of thin-section sample in cross-polarized light, 100x magnification, field of view 1.3 mm.	
Photograph 3: View of thin-section sample in cross-polarized light, 200x magnification, field of view 0.7 mm.	

Interstitial material in the rock is composed of a mixture of finely-divided sediments, carbonaceous material and clay.

Lithic fragments included a variety of rock types: volcanic rock, fine-grained sedimentary rock, phyllite, and chert were observed.

Engineering Characteristics

In addition to the geologic classification of the sample, it was also examined for characteristics relevant to the engineering uses for which it might be considered. Aspects such as porosity, strength, presence or absence of vugs, voids, fissures, cracks, coatings and impurities in the particles were considered in the assignment of individual particles into various quality classifications.

On the basis of this sorting of the sample, the relative amounts of "Good" and "Fair" quality material were determined. This enabled the calculation of a Petrographic Number (or "PN"), which is an index of a coarse aggregate's overall physical-mechanical quality. The PN for this sample was "111".

Chemical Reaction Potential

If used in the production of concrete, the rock comprising this sample may have potential a deleterious expansive reaction in concrete known as *"Alkali-Aggregate Reaction"* (AAR). This is considered possible due to the presence of strained quartz.

Additionally, the presence of small amount of metallic minerals, including sulphides, should be evaluated due to the potential for such materials to become altered and weathered under ambient exposure conditions, thereby producing sulphatic runoff that can harm the environment, or sulphate minerals that can attack concrete.

Summary

The Edco Pit Class M3 rock sample had a PN of 111, and was composed of greywacke. The physical-mechanical characteristics of the rock are judged to be good on the basis of the PN.

Additional assessment of the rock may be warranted, if necessary/applicable, for evaluation of potentially harmful effects due to chemical alteration of minerals present in the rock.

Reviewed by:

F. Shrimer, P. Geo.

B. Hudson, P. Geo.

Rock rejected due to presence of conglomerate

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Drop Testing in Pit

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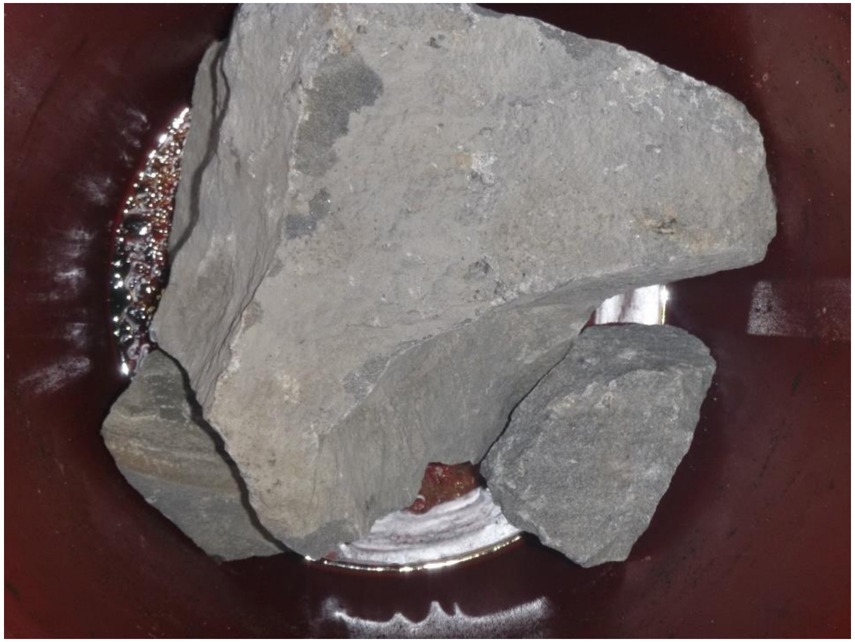
Weighing Rocks in the Pit



Sample being tested
Feb., 2018

Case History – S Curves

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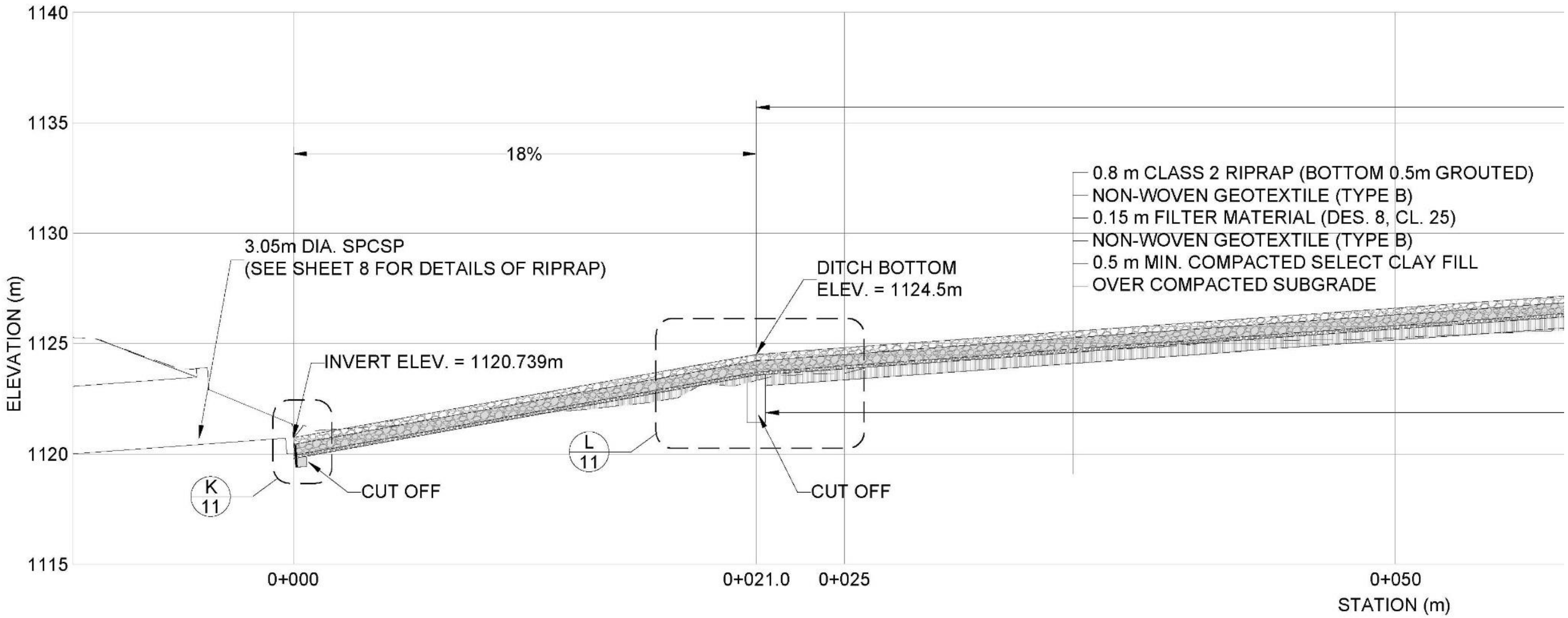
Case History – S Curves

- Highway re-aligned and new Centreline Culvert constructed
- Creek eroded upstream channel destroying riprap and A jacks lining
- Repairs completed as part of high water mitigation program.
- Grouted riprap selected as preferred option
- Despite warnings of poor local riprap quality, contractor bid based on using rock from Rodar pit
- After significant review greywacke was approved for use

Case History – S Curves

- Channel gradient varied from 7% to 18%
- Design flow was 100 year return of 20 m3 to match capacity of new centreline culvert
- Grouted riprap consisted of 800 mm thickness of Class 2 Heavy rock riprap with bottom 500mm grouted with cement based grout
- Underlain by compacted clay layer
- Underlain by free draining gravel layer with vertical vent pipes to relieve groundwater pressure



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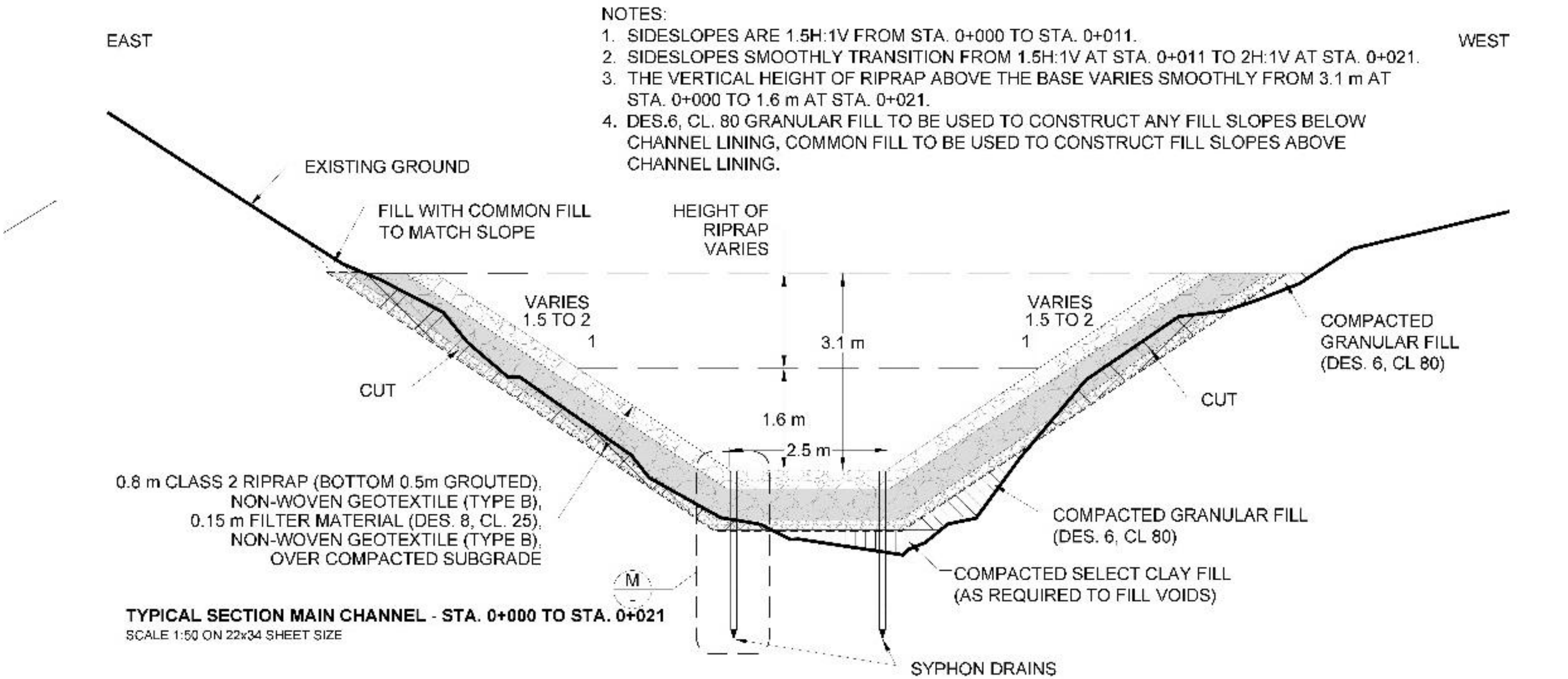

TYPICAL SECTION MAIN CHANNEL - STA. 0+000 TO STA. 0+021

SCALE 1:50 ON 22x34 SHEET SIZE

S-Curves: Good riprap in channel

S-CURVES
Washing Riprap
in main channel
before grouting

S-CURVES
Grouting Riprap in main channel – Nov., 2016

S-CURVES Grouting Riprap in main channel

S-CURVES Grouting Riprap in main channel/Measuring grout thickness

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S-CURVES Measuring Thickness of Grout

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