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	PSPC		Stantec Consulting Ltd.
File:	121623104	Date:	November 5, 2019

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**Reference: Centreville (Trout Cove) Wharf Bedrock Assessment, Centreville, NS**

We are pleased to provide you with this memo that summarizes the findings of a bedrock assessment that was carried out in support of proposed improvements to the Centreville (Trout Cove) Small Craft Harbour in Centreville, Digby Neck, NS. This work was carried out in accordance with our proposal dated October 21, 2019, which included a site visit to collect non-intrusive geotechnical data from exposed bedrock, a summary of the findings, and comments on the anticipated rippability of the rock mass.

**BACKGROUND**

The Centreville (Trout Cove) Small Craft Harbour is scheduled to undergo improvements that would require dredging of the seafloor in the intertidal zone up to approximately 3.5 m below current elevations. A low bedrock outcrop is present within the proposed area of dredging. The bedrock is almost completely exposed and accessible during low tide, but fully submerged from mid to high tide periods.

**SITE VISIT**

Our site visit was carried out on October 23<sup>rd</sup>, 2019 and consisted of a walk-over and visual assessment by an engineering geologist. The visit was carried out at low tide to provide maximum exposure of the bedrock outcrop. The bedrock outcrop was fully covered in a thick layer of seaweed, which prohibited an overview of the outcrop surface in its entirety. Select areas across the outcrop were manually skimmed of seaweed for observation during the site visit.

Data collection consisted of photographs, geological assessment (rock type, strength, degree of fracture, rock mass classification), and general spatial measurements. A photo log of the site visit, with annotations is provided for reference in the attachment. A summary of the conditions encountered is provided below.

**BEDROCK CONDITION**

The bedrock outcrop consists of basalt, a mafic volcanic rock, of the North Mountain Formation. The formation extends along the southern shore of the Bay of Fundy from Cape Split, in the northeast, to the southern extent of Digby Neck in the southwest. The basalt is a fine-grained rock that, as observed in the natural rock faces of the bluffs immediately east and west of the wharf, occurs in thickly bedded flows that dip gently towards the northwest in this area.

Locally, some cobble and small boulder size blocks (typically <30 cm in maximum dimension) are scattered throughout the outcrop; otherwise, the outcrop is largely intact. Despite continual exposure to the wave action of the intertidal zone, the bedrock exposed in the outcrop consisted of slightly weathered to fresh, hard, very strong basalt. In the areas examined, a thin layer (less than 5 mm thick) of softened rock or mineral coating was common. Beneath this thin layer of weathering or mineralization, the rock was generally fresh. Field estimate of rock strength in accordance with the International Society of Rock Mechanics (ISRM) yields an unconfined compressive strength (UCS) estimate of 100 – 250 MPa equivalent to a rating of very strong (R5). Stantec's experience on geotechnical projects within the North Mountain basalt supports this potential strength range, with previously reported UCS values up to 250 MPa in this rock type.

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In the areas examined, the rock mass was moderately fractured with fracture spacing on the order of 10 – 30 cm. Fractures were generally clean and tight, with apertures less than 1 mm and limited visible mineral coatings. Geological Strength Index (GSI) is a value that represents the overall strength of a rock mass, taking into account the degree of fracture and condition of fracturing. GSI values range from 0 to 100; where a value of 0 represents very poor, heavily fractured or disintegrated rock mass and 100 represents intact or massive rock with very good joint surface conditions (i.e. clean, rough, interlocked). A GSI index of 70 – 80 is estimated for the bedrock examined at Trout Cove.

## DISCUSSION

The strength, hardness, and tightly interlocking structure of the bedrock observed at the Centreville (Trout Cove) wharf will limit its excavatability. Literature suggests that for  $GSI > 60$  in strong rocks, blasting is generally required for excavation (Tsiambaos & Saroglou, 2010). For reference, a chart that illustrates the relationship of GSI to excavatability in strong rocks has been developed and is provided on Page 5 of the attachments. Our experience with similar rock types supports this relationship and we anticipate blasting will be required during the dredging operations to achieve the proposed design grades.

## CLOSURE

We trust this report meets your present requirements and we thank you for the opportunity to support the advancement of this project. If you have any questions or comments on the information provided, please do not hesitate to contact the undersigned at your convenience.

**Stantec Consulting Ltd.**



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Attachment: Photo Log (Page 1 – 4)  
GSI vs. Excavatability (Page 5)

**Photo Log – Centreville (Trout Cove) Small Craft Harbour Bedrock Assessment (Page 1 / 4)**



**Photo 1** – Overview of seaweed-covered bedrock outcrop in area of proposed dredging



**Photo 2** – View west of the small craft harbour showing typical thickly bedded basalt flows (background)



**Photo Log – Centreville (Trout Cove) Small Craft Harbour Bedrock Assessment (Page 2 / 4)**



**Photo 3** – Bedrock condition at test location (western area of outcrop)



**Photo 4** – Bedrock condition at test location (center of outcrop)



**Photo Log – Centreville (Trout Cove) Small Craft Harbour Bedrock Assessment (Page 3 / 4)**



**Photo 5** – Bedrock condition at test location (northern area of outcrop)



**Photo 6** – Bedrock condition at test location (eastern of outcrop)



**Photo Log – Centreville (Trout Cove) Small Craft Harbour Bedrock Assessment (Page 4 / 4)**



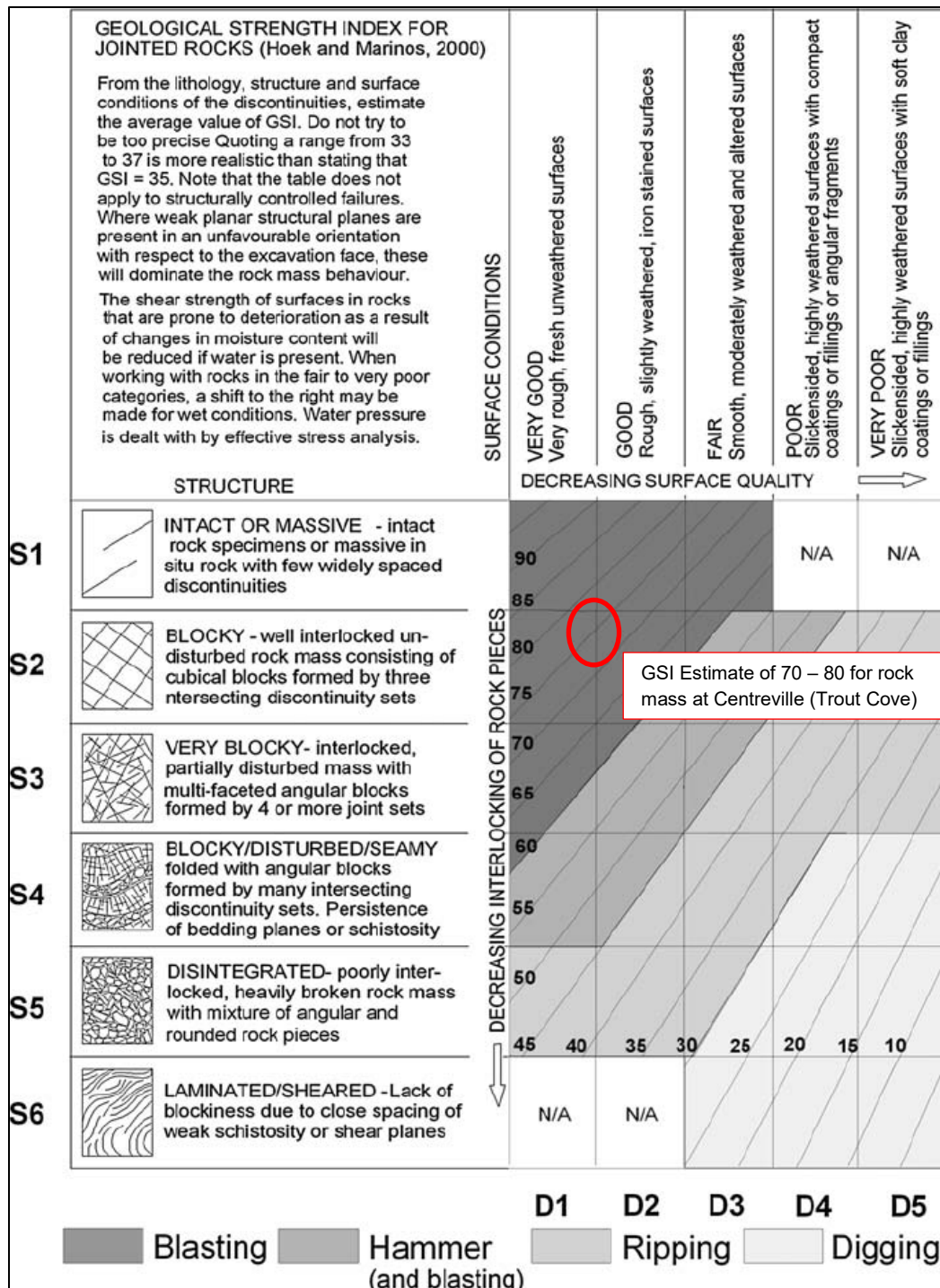
**Photo 7** – Bedrock condition at test location (western/central area of outcrop)



**Photo 8** – Overview of seaweed-covered outcrop at beach level (low tide)



Proposed Geological Strength Index (GSI) Chart for the Excavatability of Strong Rock Masses



Tsiambaos, G., Saroglou, H. 2010. Excavatability assessment of rock masses using the Geological Strength Index (GSI). Bulletin of Engineering Geology and the Environment, 69:13-27.