MARITIME TESTING
Consulting Engineering & Environmental Services

- OVERVIEW -
SLATE MANAGEMENT PLAN
35 TOWNHOUSE UNIT DEVELOPMENT
BLOCK C, WASHMILL LAKE DRIVE

Prepared for

Mr. Yiani Paliliatsos
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September 27, 2011

MTL PROJECT NO. 13623

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EXECUTIVE SUMMARY

Development of 35 townhouse units and one clubhouse at Block C, Washmill Lake Drive will require excavation into the sulphide bearing bedrock to achieve design grades. This activity will be subject to Nova Scotia Environment's *Sulphide Bearing Material Disposal Regulations*.

Off-site disposal of all disturbed rockfill at the licensed marine infill sites will not be economically feasible for the development site and, therefore, managed re-use of slate rockfill on the site is being proposed for the proposed site development. Based on our experience on similar development projects in Halifax, this report provides details on how this activity will be managed.

In summary, the buildings and associated asphalt-paved areas will provide surface cover over slate rockfill. Sulphide bearing rockfill is not proposed for re-use in service trenches. Service trenches will be backfilled with imported (non-sulphide bearing) fill and not located within encapsulation zones.

As the building pads and parking lots are completed, the majority of the land area where bedrock disturbance has occurred becomes hard surfaced with asphalt and buildings. Any disturbed areas not covered by hard surfacing will covered by an impervious material consisting of a 750 mm layer of clay with a hydraulic conductivity less than $1x10^{-6}$ cm/sec, or the equivalent. Surface water will be prevented from infiltrating into the former bedrock excavations, as the hard surfaces and grading will direct it into the storm sewers or offsite as sheet flow. Drainage layers constructed of imported rockfill at the base of each encapsulation cell will allow groundwater to move through the sites without ponding in the encapsulation cells.

Monitoring will be conducted to ensure no worsening of surface water quality from background conditions. Surface water treatment such as with limestone will be conducted if necessary, based on the monitoring results.

1.0 INTRODUCTION

On behalf of Mr. Yiani Paliliatsos of Kivotos Developments, Maritime Testing (1985) Limited (Maritime) has reviewed the preliminary development plans for 35 townhouse unit and a clubhouse development project, as they relate to the excavation of sulphide bearing rock. The project is to be located to the north of the Washmill Lake Drive of the Halifax Regional Municipality.

The proposed development of "Block C" will include 35 townhouse units and one clubhouse with two associated access roadways from Washmill Lake Drive to the south, parking lots and underground services. Direct access to the property will be from Washmill Lake Drive to the south. The intent of this report is to detail how sulphide bearing material will be used as structural fill in select areas and how potential environmental impacts from earthworks activities that will disturb sulphide bearing slate bedrock will be mitigated. We also provide guidelines for re-use of sulphide bearing material as structural fill in select areas.

2.0 EXISTING SITE CONDITIONS

Maritime Testing is familiar with the geology of the area from work on adjacent properties including the extension of Washmill Lake Court. The development site is generally slopes downward from the north to the south towards Washmill Lake Drive. The ground surface is moderately steep and rolling, and bedrock controlled, with a combination of exposed bedrock outcrops and thin soil veneer over bedrock in most areas. The bedrock in this area is of the Meguma Supergroup of meta-sediments. Specifically, the site is underlain by bedrock of the Cunard Formation of the Halifax Group. This unit is described as black slate and metasiltstone. The Cunard Formation slates are typically sulphide bearing and, as such, any disturbance of the bedrock must be in accordance with the *Sulphide Bearing Material Disposal Regulations*.

3.0 DISTURBANCE OF SLATE BEDROCK

Regulations

The development of the building sites and installation of underground services will require excavation into the sulphide bearing bedrock to achieve design grades. This activity will be subject to the *Sulphide Bearing Material Disposal Regulations* pursuant to the Nova Scotia Environment Act. Section 9 of the *Regulations* outline the excavation requirements, which include (we summarize):

- limiting overburden removal and bedrock disturbance to satisfy the construction requirement,
- diverting run-off away from the bedrock exposure,

- removing and disposing of the excavated bedrock immediately in accordance with the regulations,
- minimizing bedrock exposure time,
- diverting run-off to a centralized point on the property where it can be monitored if required by NSE, and
- no storage of the sulphide bearing material without written approval from NSE.

Anticipated Disturbance

Servant, Dunbrack, Mckenzie and MacDonald Ltd. are currently studying the cut and fill requirements of the site and adjusting the design grades to minimize slate disturbance. The disturbance volume will be made available once the grades are finalized, and this information will be incorporated into the Application to NSE for the on-site re-use of the sulphide bearing material. The details of anticipated areal limits of site disturbance and the stormwater management plan for the proposed development are provided in Appendices A and B.

4.0 RE-USE OF SLATE ROCKFILL

Design grades of the various buildings being proposed for development are currently being fine-tuned to minimize the quantity of bedrock disturbance. Complete avoidance of bedrock disturbance will not be possible, yet off-site disposal of all disturbed rockfill at the licensed marine infill sites may not be economically feasible. Based on our experience on similar development projects in Halifax, we provide the following overview of how the managed re-use of sulphide bearing rockfill will be achieved.

Note that all of the excavation requirements summarized in Section 3.0 above must be met regardless of whether disturbed bedrock is maintained on the property or removed from the site. These principals will be incorporated into the erosion and sedimentation control plan for the site. In addition to these requirements, application will be made to Nova Scotia Environment for approval to re-use specific volumes of sulphide bearing material in specific locations. If granted, the Approval would stipulate the terms and conditions of the re-use. Maritime has been liasing with NSE about the requirements and is currently working on the detailed application, as the grades are being finalized.

4.1 General

Servant, Dunbrack, Mckenzie and MacDonald Ltd. has prepared *Limits of Disturbance Plan* (see Appendix A). In keeping with these plans and the principles outlined in the *Sulphide Bearing Material Disposal Regulations*, the removal of vegetation and overburden soils shall be limited to satisfy the construction requirement. To this end, the development of the building sites will be

staged. Surface run-off will be directed away from the sulphide bearing material disturbance sites where possible.

4.2 Underground Services

Installation of water and sewer services for this project will require excavation into sulphide bearing bedrock to achieve design grades. Loose rock, once broken or blasted from the service trench, will be immediately placed into the on-site encapsulations cells beneath the buildings or parking lots.

4.3 Building Sites

Based on our geotechnical work in the area, we expect only a very thin soil cover over bedrock. Outcrops are visible throughout the area.

The site will be prepared by removing the grubbing layer and exposing the bedrock surface. Once this is complete, the bedrock topography will be surveyed. The natural drainage routes will be identified and documented for future water monitoring purposes.

Most of the townhouses will require a combination of cut and fill to achieve the design grade and the clubhouse is expected to require an overall lowering of grades. Therefore there will be several sulphide bearing material fill area beneath the proposed buildings. The proposed mitigation details for the encapsulated sulphide bearing material are shown in a cross sectional drawing provided as Figure 1.

At the base of the encapsulation cell, a 300mm layer of imported quarried rockfill will be placed as a drainage layer. This will allow any groundwater that migrates beneath the buildings to flow through the 300mm of imported rockfill along the top of the bedrock, beneath rather than within the slate rockfill. Grading at the bottom of the excavation would be conducted to ensure no ponding of water within the slate rockfill during drainage. Grading requiring fill would be carried out utilizing imported non-sulphide bearing structural fill or approved site glacial soil at the base of excavation. Based on site topography, any groundwater migrating from the fill areas through the drainage layer is expected to surface at select locations along the perimeter of the development site, where it can be monitored.

Following placement of the drainage layer, the excavated Slate bedrock will be placed as engineered fill. In this case, rock will be cut and placed on the areas of townhouses that require fill.

Upon completion of the encapsulation cells at selected townhouses, the cast-in-place concrete foundations will be constructed followed immediately by cast-in-place concrete walls, and placement

of subfloor granular materials and vapour barrier. Once sufficient curing of the concrete foundations and walls has occurred, the cast-in-place concrete floor will be constructed. Around the perimeter of the encapsulation cells, the impervious layer will extend to the non-slate drainage layer (Figure 1). This will mitigate against lateral groundwater migration into the sulphide bearing material encapsulation cell.

4.4 Asphalt Paved Areas

Beneath asphalt paved areas, sulphide bearing material will be isolated from water exposure with surface capping measures, control of surface water, and subsurface drainage measures. The quarried rock (non-slate) drainage layer would be provided at the bottom of the encapsulation area with positive grading to an outlet to prevent groundwater build up and maintain a drained condition. The sulphide bearing site rockfill would be placed and compacted above the drainage layer. A protective cap of low permeable imported "clay" soil would be constructed above the rockfill and extend beyond the limits sufficiently to prevent water infiltration through the sulphide bearing rockfill. To achieve this, a 300mm thick layer of clay liner would be placed with a maximum permeability of 2.5 x 10^{-7} cm/s. This would provide the equivalent protection of a 1.2m thick layer of low permeable soil with a permeability of 1 x 10^{-6} cm/s, exceeding the 750mm requirement of the *Sulphide Bearing Materials Disposal Regulations*. Laboratory prequalification testing and confirmatory as-constructed testing of the liner would be conducted to confirm permeability characteristics.

Pavement structure gravels would be placed and compacted above the clay cap. A low permeable pavement would be constructed at the top of the encapsulation area to direct surface water to stormwater infrastructure. Details are as follows, and as shown in Figure 2.

The pavement structure will include a 75 mm thickness of a dense graded asphalt concrete mixture with a more closed gradation characteristic (i.e. lower permeability). This HRM Special C Mix will be compacted to a minimum of 92.5 percent of the material's theoretical maximum density. It has a low design air voids relative to conventional mixes and results in a higher bitumen content. Laboratory triaxial permeability testing performed on a prepared sample of the mixture indicates a permeability of 1 x 10^{-8} cm/s. For construction purposes, the maximum in-place permeability would be 5 x 10^{-8} cm/s. During construction all joints with structures (e.g. manholes, catchbasins, concrete curbs, etc.) would be treated with a tack compound to promote a good bond with the asphalt and create low permeability characteristics at these joints.

5.0 MONITORING PLAN

Regulations

The development of the building sites and installation of underground services will require excavation into the sulphide bearing bedrock to achieve design grades. This activity will be subject to the *Sulphide Bearing Material Disposal Regulations*. Section 11 of the *Regulations* outline the disposal site operational requirements with respect to surface water monitoring (paraphrased):

a) effluent or run-off from a disposal site must be directed to a centralized collection point and monitored for pH, aluminum, conductivity and other items detailed in the approval;
b) effluent from the centralized collection point must meet the following criteria:
   i) pH ≥ 4.0
   ii) aluminum ≤ 0.8 mg/l
   iii) conductivity ≤ 500 micromhos/cm

In addition, Halifax Water has a stormwater by-law that stipulates a pH of not less than 6.0.

Monitoring Plan

From water monitoring in the adjacent upgradient area (i.e. Block B) we understand that baseline stormwater pH generally does not satisfy HRM's stormwater quality guideline range of 6.0 to 9.5. The pH of stormwater in the area was lower than the acceptable range prior to commencement of the Washmill Court Extension project.

A background surface water quality monitoring event was conducted in the adjacent area and subject site by Maritime on April 12, 2011. One surface water sample in the adjacent upgradient area (i.e. Block B), which we has identified as SW8 and located with GPS, was collected and submitted for metals, general inorganic chemistry and pH analysis. The water samples represent the background condition of the subject site prior to proposed disturbance of sulphide bearing rock, and reflect the chemistry of rain water runoff over the site. The water sample at SW8 was reported to be low in pH (4.32 on the sampling date) and elevated in aluminum (422µg/L), iron (1320µg/L) and lead (1.32µg/L) concentrations.

During the background monitoring event, Maritime Testing identified two proposed monitoring stations (SW6, SW7) within proximity of the building sites (Figure3) where baseline and construction phase water quality monitoring will be conducted to safeguard against worsening of the water quality. Based on review of the topographic mapping for the site and the design grades of the buildings, any drainage from the encapsulation cells would come to the surface at the southern limits of site disturbance, and therefore would be picked up at these locations. Additional monitoring stations may be established once drainage routes from the cells are groundtruthed.

During construction, water samples will be collected weekly, timed if possible during precipitation events, and tested for field parameters (temperature, pH and conductivity) and total aluminum. Once the cells are completed, the monitoring program will be conducted monthly and will continue for one year post construction.

The purpose of the monitoring program will be to ensure no worsening of water quality below background conditions and no pH readings of less than 4.0. If there is any evidence of acid generation from the project based on the water quality findings, the developer will treat the surface water, such as with limestone addition.

6.0 CONTINGENCY PLAN

The site grades are being designed such that fill requirements exceed cut requirements. Therefore, a surplus of sulphide bearing material is not anticipated. However, the following contingency options have been identified for any surplus sulphide bearing material that may be encountered:

1) raise the founding elevation of proposed buildings to accommodate more sulphide bearing material,
2) place the material in an alternate on-site encapsulation cell that is approved by NSE , or
3) transport the material off-site for appropriate disposal at one of the two local, licensed marine disposal sites.

In addition, surface water quality will be monitored during and for one year after the construction project, with surface water quality compared to baseline conditions. If acidified waters are realized, treatment such as with limestone will be carried out.

7.0 CONCLUSION

A development of 35 townhouse units and one clubhouse with associated parking lots and driveways at "Block C", to the north of Washmill Lake Drive, will require excavation into the sulphide bearing bedrock to achieve design grades. This activity will be subject to Nova Scotia Environment's *Sulphide Bearing Material Disposal Regulations.*

Off-site disposal of all disturbed rockfill at the licensed marine infill sites may not be economically feasible and therefore managed re-use of slate rockfill on the site is being proposed. Based on our experience on similar development projects in Halifax, this report has provided an overview of how this activity will be managed. Detailed application to NSE for Approval of the re-use, including the location and capacity of the various cells, is being made as design grades are being finalized.

It is our opinion that with careful planning, construction methodology, monitoring and diligence, the environmental risks of building site development in the area to the south of Washmill Lake Drive can be managed.

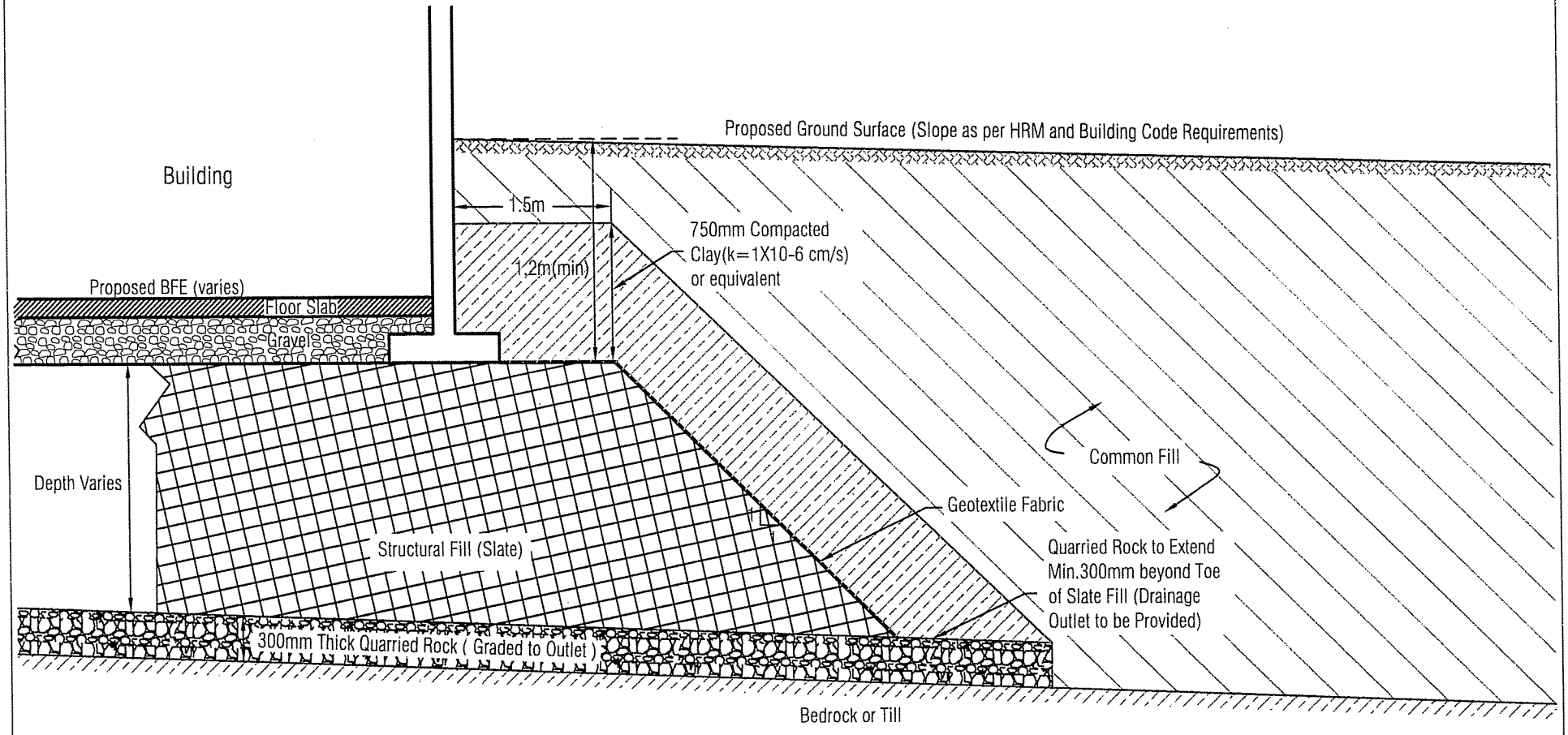
We trust that this meets with the application requirements. Please feel free to contact the undersigned if you have any questions.

Sincerely Yours,
Maritime Testing (1985) Limited

Xiaojing Jiang, MES., P.Eng.
Environmental Engineer

Doreen Chenard, B.Sc. in Agr.
Manager, Environmental Assessments

Attachments

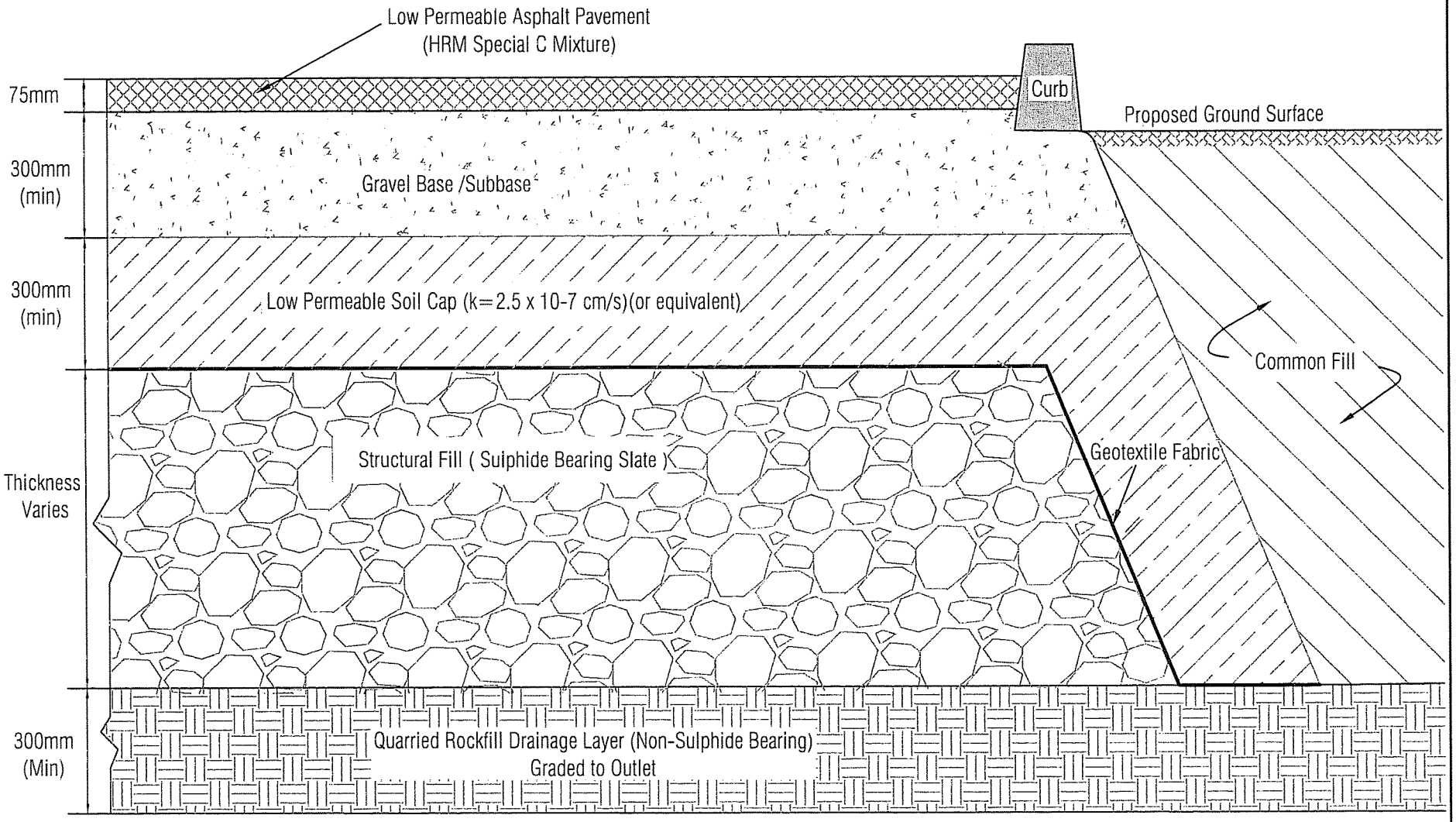


REGISTERED PROFESSIONAL ENGINEER
DATE 09/26/2011
XJ.JIANG
8144
PROVINCE OF NOVA SCOTIA

MARITIME TESTING
Consulting Engineering & Environmental Services

Slate Encapsulation under Building
35 Townhouse Units Development
Block C, Washmill Lake Drive, Halifax, NS

DATE: September 2011	SCALE: NTS	DRAWN BY: JJ	CKD BY: DC	JOB No. 13623	FIGURE 1



REGISTERED PROFESSIONAL ENGINEER
DATE 09/26/2011
XJ.JIANG
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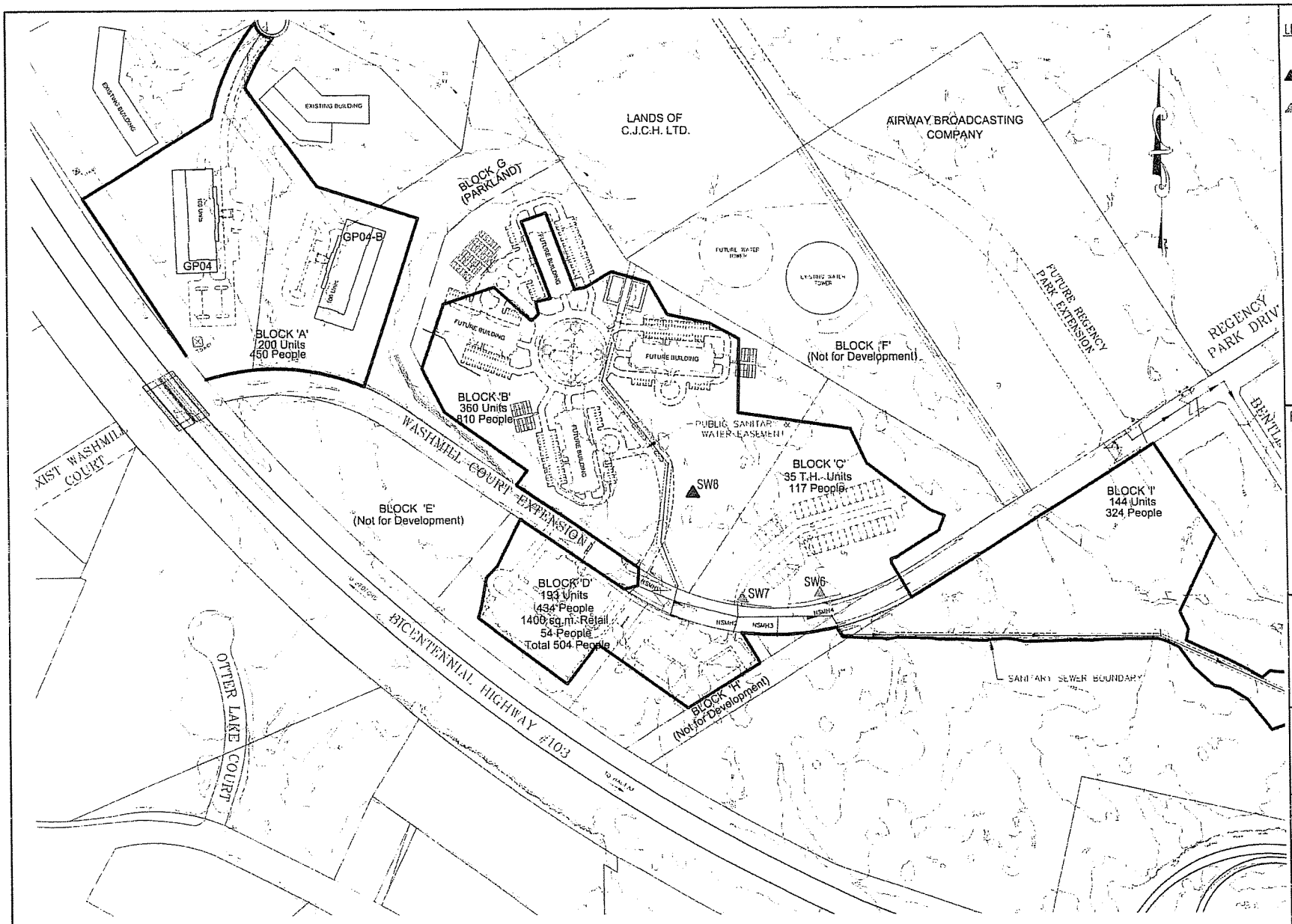
PROVINCE OF NOVA SCOTIA

MARITIME TESTING Consulting Engineering & Environmental Services			Slate Encapsulation under Parking Lots 35 Townhouse Units Development Block C, Washmill Lake Drive, Halifax, NS		
DATE: September 2011	SCALE: NTS	DRAWN BY: JJ	CKD BY: DC	JOB No. 13623	FIGURE 2



LEGEND:

▲ SW3 - Surface Water Sample Location

▲ SW1 - Proposed Surface Water Sample Location During Construction

Ref:

Plan of Sanitary Boundaries, Clayton Park West, Washmill Court Extension, Halifax, NS, DWG No. 09512-F08, Dated Jan. 14, 2011, Produced by Mac Williams Engineering Limited

PROJECT:

Monitoring Program
Slate Management Plan

TITLE:

Surface Water Sampling Locations
Block C, Washmill Lake Drive
Halifax, NS

DRAWN: JJ	CHECKED: DC
DATE: September 2011	APPROVED: DC
SCALE: NTS	DWG: FIGURE 3
PROJECT: 13623	

MARITIME TESTING
Consulting Engineering & Environmental Services

Appendix A

Preliminary Site Grading/ Limit of Disturbance Schematic, Block C, August 3, 2011, Provided by Servant, Dunbrack, Mckenzie and MacDonald Limited

LEGEND

EXISTING		PROPOSED
	CONTOURS	
	WATER SHUT-OFF/GATE/HYDRANT VALVE	
	FIRE HYDRANT	
	CATCH BASIN/MH	CB/CO
	ELEVATION	
	ROCK WALL	
	POWER POLE/LIGHT POLE	
	TREE	
	STREET SIGN	
	ELEVATION/GRADE	123.01 / 123.0
	DRAINAGE/SWALE FLOW DIRECTION	
	WATER MAIN/SERVICE	
	SANITARY MANHOLE & PIPE	SAN
	STORM MANHOLE & PIPE	STM
	FENCE MAIN	
	ROCK CUT	
	UNDERGROUND UTILITY	
	OVERHEAD WIRES	
	PROPERTY LINE/BOUNDARY	
	CHAINLINK FENCE	
	BUILDING	
	TOP OF SLOPE	
	TOE OF SLOPE	
	WET AREA	
	CURB/GAR	
	LIMIT OF DISTURBANCE	
	FIRST FLOOR ELEVATION	FFE=XXX.XX
	BASEMENT FLOOR ELEVATION	BASE=XXX.XX
	GARAGE FLOOR ELEVATION	GAR=XXX.XX

NOTES:

1. ALL ELEVATIONS ARE GEODETIC AND IN FEET UNLESS NOTED OTHERWISE
2. EXISTING CONTOURS FROM MAPPING DATA AND ARE APPROXIMATE ONLY
3. PROPERTY BOUNDARIES PREPARED BY TOWN PLAN OF SURVEY OF BLOCKS B, C, D & E AND PARCEL WLP-1, WASHMILL LAKE DRIVE & BACKSTRETCH DRIVE - SUBDIVISION NO. 102 PLAN NO. 24-491-D, DATED JANUARY 18, 2011

No.	Date	Revision Description	Apprv'd
	AUG 03/11	ISSUED FOR REVIEW	

SDMM
Servant, Dunbrack, McKenzie & MacDonald Ltd.
NOVA SCOTIA LAND SURVEYORS & CONSULTING ENGINEERS

35 TOWNHOUSE UNIT DEVELOPMENT

HALIFAX, NOVA SCOTIA

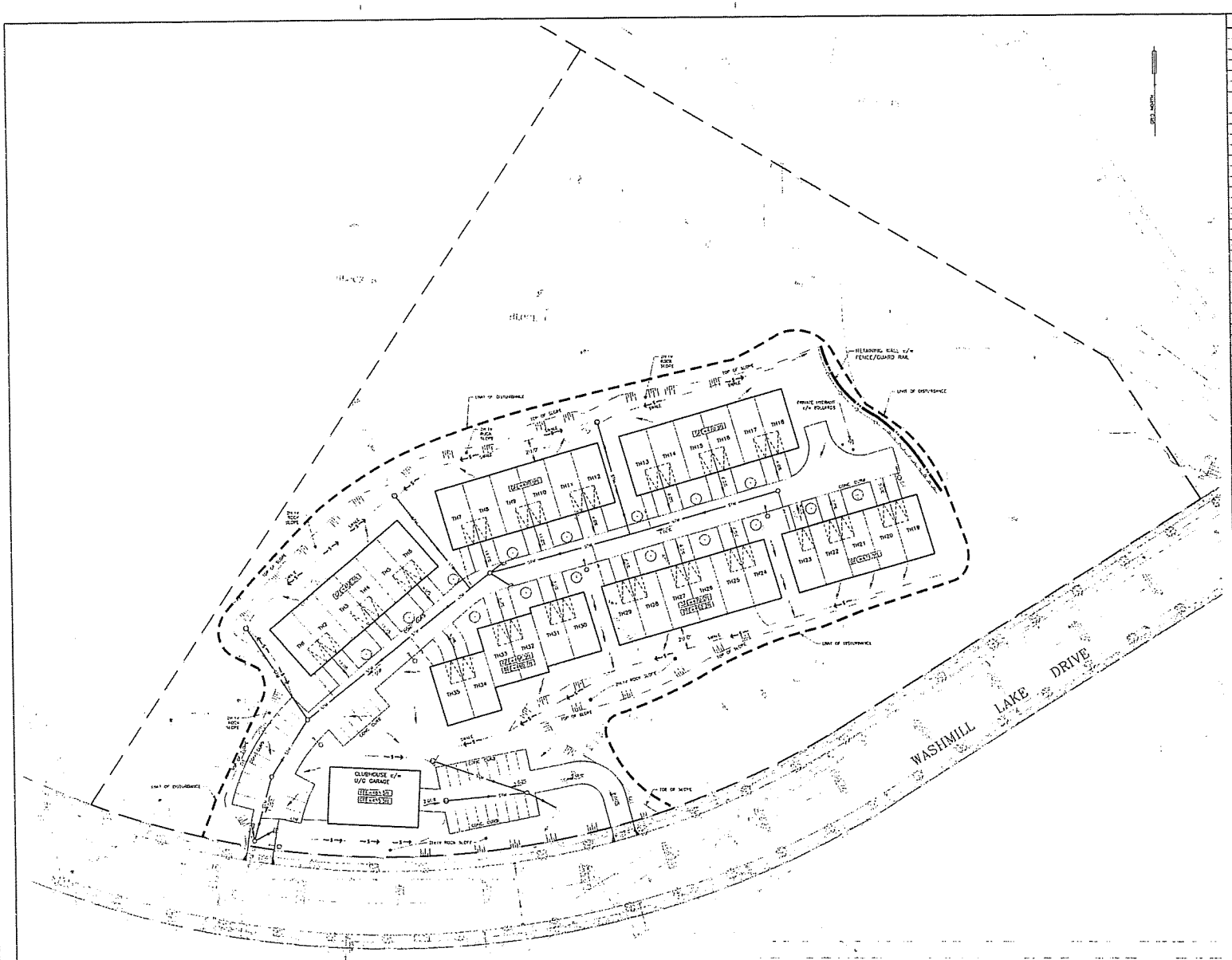
PRELIMINARY SITE GRADING & LIMITS OF DISTURBANCE SCHEMATIC

BLOCK C, WASHMILL LAKE DRIVE

Date: AUGUST 3, 2011	Drawn: M.WARE	Project No: FILE No. 1-4-60 (28551)
Scale: 1"=40'	Engineer: G. VACLEAR	Plan No: 16-962-0
Reference:	Approved:	
Surveyed: SDMM	Sheet: 2 OF 4	

Appendix B

Preliminary Stormwater Management Schematic, Block C, August 3, 2011, Provided by Servant, Dunbrack, Mckenzie and MacDonald Limited



LEGEND

EXISTING		PROPOSED
	CONTOURS	
	CURB STOP/GATE/BUTTERFLY VALVE	
	FIRE HYDRANT	
	THRUST BLOCK	
	SIAMESE SPRINKLER CONNECTION	
	CATCH BASIN(S)	
	VALLEY	
	ROCK EXPOSURE	
	RETAINING WALL	
	POWER POLE/LIGHT POLE	
	TREE	
	STREET SIGN	
	ELEVATION/GRADE	
	DRAINAGE/SWALE FLOW DIRECTION	
	WATER MAIN/SERVICE	
	SANITARY MANHOLE & PIPE	
	STORM MANHOLE & PIPE	
	FORCE MAIN	
	ROOF LINE	
	100 YR FLOOD LIMIT	
	SILT FENCE	
	UNDERGROUND CABLE	
	OVERHEAD WIRES	
	PROPERTY LINE/BOUNDARY	
	CHAIN LINK FENCE	
	BUILDING	
	TOP OF SLOPE	
	TOE OF SLOPE	
	WET AREA	
	GUARDRAIL	
	LIMIT OF DISTURBANCE	
	FIRST FLOOR ELEVATION	
	BASEMENT FLOOR ELEVATION	
	GARAGE FLOOR ELEVATION	

NOTES:

1. POST DEVELOPMENT FLOW IS CONTROLLED TO PRE DEVELOPMENT FLOW SO THAT THE 5 YR POST DEVELOPMENT AND PRE-DEVELOPMENT FLOWS ARE BALANCED AS PER SECTION 7.3.3 OF THE HRM MUNICIPAL DESIGN GUIDELINES (2006).
2. 100 YR POST DEVELOPMENT FLOWS ARE REDUCED BY STORMWATER MANAGEMENT SYSTEMS INCLUDING INLET CONTROL DEVICES, DISPERSION TRENCHES AND ROOF FLOW CONTROLS

No.	Date	Revision Description	Appr'd
	AUG 03/11	ISSUED FOR REVIEW	

SDMM
Sarrazin, Daubrack, McKenzie & MacDonald Ltd.
NOVA SCOTIA LAND SURVEYORS & CONSULTING ENGINEERS

35 TOWNHOUSE UNIT DEVELOPMENT

HALIFAX, NOVA SCOTIA

PRELIMINARY STORMWATER MANAGEMENT SCHEMATIC

BLOCK C, WASHMILL LAKE DRIVE

Date: AUGUST 3, 2011	Drawn: S. SCO	Project No: FILE No. 41-4-82 (2005-11)
Scale: 1" = 40'	Engineer: C. MACLEAN	Plan No: 16-964-D
Reference:	Approved:	
Surveyed: SCO/M	Sheet: 4 OF 4	