West Bedford Holdings Limited

Master Stormwater Management Plan
Area 7 & 8

Report

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Master Stormwater Management Plan Areas 7 & 8

Project Number 15727

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TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

Appendices

Property and Confidentiality

REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And / Or Publication Details
00	2012-11-29	Client Draft Review
01	2013-02-22	Final Report

LIST OF ACRONYMS

ac	Acre
ASCE	American Society of Civil Engineers
BMP	Best Management Practice
BW	Bedford West
HRM	Halifax Regional Municipality
ICP-AES	Inductivity Coupled Plasma / Atomic Emission Spectroscopy
kg	Kilogram
LID	Low Impact Development
m	Metre
mm	Millimetre
MSWMP	Master Stormwater Management Plan
NSE	Nova Scotia Environment
NSPI	Nova Scotia Power Inc.
SWM	Stormwater Management
TP	Total Phosphorus
TSS	Total Suspended Solids
WBHL	West Bedford Holdings Limited

1 INTRODUCTION

This Master Stormwater Management Plan (MSWMP) has been prepared by LVM Maritime Testing in consultation with West Bedford Holdings Limited (WBHL) for consideration by Halifax Regional Municipality (HRM) staff and the Bedford Lakes Advisory Board. This plan presents a conceptual stormwater management system for the site, and explains how this system will meet the goals and objectives of the Bedford West Master Planning Study.

2 ISSUE

This stormwater management plan addresses the potential effects upon water quality and quantity from land development in the West Bedford Sub-Areas 7 and 8. In our opinion, the plan adheres to all relevant policies and objectives for development as set forth in the "Environmental Protection" policies of the Bedford West Master Planning Study and the Bedford West Planning Area Subwatershed Management Plan.

3 GOALS AND OBJECTIVES

The purpose of this Master Stormwater Management Plan is to address the potential effects upon water quality and quantity from land development in the West Bedford Sub-Areas 7 and 8. Both sub-areas are owned by WBHL and are located in Bedford, within the HRM. All development is governed by HRM planning documents. Policy BW-1 is summarized below, this policy and policies BW-2 through BW-13 are provided in Appendix 2.

3.1 Bedford West Master Planning Study

The goal of this MSWMP for the West Bedford Sub-Areas 7 and 8 is outlined by Policy BW-1 in the Bedford West Master Planning Study (HRM, 2006). In accordance with this policy, this MSWMP shall:

- Identify significant constraints and sensitivities with regard to flood potential, and environmental features and provide appropriate protection measures;
- Provide estimates of pre-development and post-development flow rates (where post-development flow rate means the expected flow rates upon full build out of an area as permitted by the development agreement) at critical locations within watercourses such as culverts and other road crossings and at downstream developments;
- Outline the type and location of stormwater management facilities and the approach to protecting receiving waters from contamination, excessive flow rates and loss of aquatic habitat and to protect the quantity and quality of groundwater flows; and

- Conform with the recommendations of Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford, 2004) unless otherwise acceptable to the Municipality and the Province.

3.2 Bedford West Planning Area Subwatershed Management Plan

The goals of this Master Stormwater Management Plan will also be realized through the pollution prevention and conservation practices outlined in the Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford, 2004). These practices are summarized below:

- Minimize erosion and sediment mobilization;
- Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces;
- Maximize the protection of natural drainage features and vegetation;
- Minimize land disturbance including clearing and grading;
- Minimize soil compaction;
- Provide low maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers and pesticides;
- Provide vegetated open-channel conveyance systems that discharge into and through stable, vegetated areas;
- Maximize the removal of phosphorus and sediments on site;
- Maximize water infiltration on site; and
- Monitor water quality to confirm the water quality goals are met.

These goals of the subwatershed management plan are in alignment with those already set forth in the HRM Master Planning Study (HRM, 2006); however, the subwatershed management plan also discusses phosphorus and sediment removal. As a result, this MSWMP focuses on natural corridor preservation and best management practices for stormwater quantity reduction as well as phosphorus and sediment removal in stormwater runoff.

4 ENVIRONMENTAL SETTING

4.1 Site Location

The 181 hectare (449 acre) site is bounded by Blue Mountain Road to the north, Belle Street/Colins Road to the south (Kearney Lake), Kearney Lake Road to the east and Black Duck Brook to the west. The two sub-areas are separated by the right-of-way for the proposed Highway 113, with Sub-Area 8 being the 90 ha (221 ac) to the north and Sub-Area 7 being 92 ha (228 ac) to the south. Figure A-1 in Appendix 1 identifies the boundary of the areas included in this study.

4.2 Geology and Soil

Geology and soils work was performed by Jacques Whitford (1989) and is compiled in the Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford, 2004). The geology and soils information from these documents are summarized here.

4.2.1 Topography

The topography of the site is a function of the glacial scour and deposition over the existing bedrock surface. Figure A-2 (Appendix 1) shows the slopes that are greater than 15% and 20%. Approximately nine percent of the Bedford West Planning area contains terrain between 15% and 20% slope. About fifteen percent of the terrain has slopes greater than 20%. Figure A-2 has been taken from the Bedford West Subwatershed Management Plan (Jacques Whitford, 2004).

4.2.2 Surficial Geology

The Bedford West Planning Area is overlain by five soil series: Halifax, Rockland, Aspotogan, Gibraltor and Wolfville (MacDougall et al., 1963; Figure A-3 in Appendix 1). The areas designated in this map are only used in this map, and are not referred to in the remainder of this report. Halifax soil groups dominate Sub-Area 8. Halifax soils are stony, shallow, and generally unsuitable for agriculture and account for about 44% of the soils in the Bedford West Planning Area. These soils are well, to excessively drained. The parent material is olive to yellowish-brown sandy loam to gravelly sandy loam glacial till derived primarily from quartzite. Rockland soils group dominates Sub-Area 7. Rockland soils are described as exposed bedrock on at least 48% of the land surface in the Bedford West Planning Area, or the till is extremely shallow or stony. This land type occurs over granite or quartzite rock formation.

Infiltration through coarse-grained surficial deposits, and into bedrock fissures, is a desirable process that, if maintained, will serve to reduce both stormwater volumes and sediment mass fluxes at the site. The field survey and grain size analysis undertaken for the Birch Cove Lakes Environmental Study indicate that the Halifax soil series is not highly susceptible to soil erosion (Porter Dillon et al., 1996). The highest risk of soil erosion will come from the type and amount of fill material imported into the Bedford West Planning Area.

4.2.3 Bedrock Geology

The contact between the Cambrian aged Goldenville Formation of the Meguma Group and the Devonian aged granodiorites runs east-west along the southern portion of the Bedford West Planning Area. The Goldenville Formation consists of massive quartzite with minor occurrences of quartz and calcite veining near the top of the unit. The quartzite showed moderate fracturing throughout, ranging from 4 to 20 fractures per 1.5-m intervals (Jacques Whitford, 1989).

The structural geology of the Goldenville Formation is characterized by complex folds that are jointed by the convergence of two anticlinal structures. The northeasterly-striking Waverley Anticline is truncated by a northwesterly-striking transverse anticline that forms the eastern boundary of Kearney Lake.

During the development of subdivisions within the Bedford West Planning Area, it is possible that blasting will be required. Any blasting will adhere to the HRM By-law (B-600) Respecting Blasting. This by-law includes testing of the drinking water from wells within a specified scaled distance in all directions from the blasting area before and after blasting.

4.2.4 Soil and Bedrock Chemistry

The granite and quartzite bedrock geology is not classified as acid generating. The acetic acid leach procedure (Ministry of Environment Regulation 309) was used to determine the degree to which metals are leached from the bedrock and soil under normal rainfall conditions. The leachability values for bedrock and soils were conducted for the Blue Mountain area (Jacques Whitford, 1989). By conventional interpretation, materials that generate leachate that is less than one hundred times the Canadian Drinking Water Quality Guidelines are acceptable for landfill disposal. For the purpose of this project, this guideline has been used to indicate the relative toxicity of soil and bedrock material. Construction controls on runoff and erosion are imperative and will be addressed during the site planning design phase.

Part of the Inductivity coupled plasma/atomic emission spectroscopy (ICP-AES) test was used for confirming the leachability analysis. The test confirmed that the major constituents of the samples were aluminum, iron, calcium and magnesium. Arsenic was not detected in the bedrock samples. The arsenic detected in one groundwater monitoring well in this area likely originates from localized mineralized zones.

4.3 Watercourse and drainage corridors

4.3.1 Watershed Drainage

West Bedford Sub-Areas 7 and 8 are located within the Paper Mill Lake Watershed. Figure A-4 (Appendix 1) shows the property boundaries and the watershed drainage areas within the Bedford West Planning Area.

4.3.2 Natural Wetlands

A field survey report for Sub-Areas 7 and 8 was conducted by Dillon Consulting Limited (2008). This report identifies and delineates existing natural wetlands within the development area and also provides a description of each wetland as well as an inventory or rare plants.

4.3.3 Role of Drainage Corridors and Natural Wetlands in Stromwater Management

Where possible, natural drainage corridors and wetlands on the site will be preserved. Figure A-5 (Appendix 1) shows the natural stormwater features, including the preserved existing wetlands, that are proposed to be preserved in Sub-Areas 7 and 8. The preservation of the connectivity of the natural system will provide stormwater quantity attenuation and quality buffering. Utilizing, and working, with the natural drainage system will help to maintain the natural hydrologic cycle of the site post-development.

Vegetation along Black Duck Brook and the wetlands that will not be disturbed, will reduce runoff quantities by minimizing stormwater velocities and promoting infiltration. The SWM features will also aid in the removal of pollutants such as total suspended solids and phosphorus from the stormwater runoff. In addition to this natural water conveyance system, wetlands may be one of the many site features that provide additional water quality improvements before discharge to Kearney Lake.

4.3.4 Watercourses

While there are numerous wetlands located throughout the project site (identified earlier) there is only one watercourse that has been identified which is Black Duck Brook that runs along the entire west side of the proposed developent area. There is no proposed alteration of Black Duck Brook. The development will incorporate to maintain the existing quality of the brook and the water being discharged into Kearney Lake through the stormwater management methods outlined in Section 5. Pre/Post conditions will be balanced through the use of Best Management Practices.

5 CONCEPTUAL STORMWATER MANAGEMENT PLAN FACILITIES

The strategy for this site, as recommended by the Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford, 2004), is to provide an integrated approach to stormwater management. This approach has been developed based on a hierarchy of stormwater management practices that begin at the source of runoff and pollution creation. This hierarchy of stormwater management practices includes:

- Preservation and integration of natural stormwater features and vegetation;
- Lot-level controls;
- Conveyance controls; and
- End-of-pipe controls.

This Master Stormwater Management Plan is organized into two primary components: BMP descriptions and modeling results. The impacts on both quantity and quality of each BMP

integrated into the site design will be discussed. Preservation of natural stormwater features and vegetation is discussed separately.

Strategies to control the rate and quality of runoff from Areas A, B, C, D, E, H, W and X of the West Bedford Sub-Areas 7 and 8 development are discussed in this MSWMP.

5.1 Preservation of Natural Stormwater Features

Preserving natural vegetation and soils in their undisturbed state is key to minimizing changes in the natural water balance. The preserved natural stormwater features at West Bedford Sub-Areas 7 & 8 have been integrated into the development to act as a natural resource for tree protection, ecological habitat protection and green space.

Treatment trains with the integration of selected wetlands based on types and treatment/stormwater capacity will convey, treat, reduce and enhance stormwater runoff from West Bedford Sub-Areas 7 & 8. Careful attention to the NSE approval requirements during the design development phase will be incorporated to ensure that the preserved stormwater features are capable of balancing the post developed stormwater management flows.

Benefits of integrating the natural stormwater features:

- Cleanse stormwater runoff;
- Promote evapotranspiration from trees and natural ground cover;
- Promote natural infiltration from undisturbed soils;
- Increase groundwater recharge;
- Preserve native site vegetation and plant communities;
- Provide natural buffers and green space as amenities, and
- Maintain the natural ecology for fish and waterfowl species.

During the master planning process, specific wetlands were identified as assets to the community to be preserved. These areas were reserved based on the existence of natural streams, existing wetlands, potential location of rare plants, and with regard to the Community Concept Plan for Bedford West as identified in the Bedford West Master Planning Study prepared by the Halifax Regional Municipality (HRM, 2006).

The preserved areas will be integrated into the Master Stormwater Management Plan for this development. Where possible, the residential building lots will be graded to direct stormwater runoff from natural vegetation and of suitable quality to these preserved streams, wetlands and vegetated corridors. Black Duck Brook will remain intact with significant vegetated buffers along both sides of the defined watercourses (minimum 30 meters). All

pre/post stormwater flows will be balanced at Black Duck Brook or other critical discharge points.

5.2 Proposed BMP Description

The primary goal of the stormwater management system is to reduce the post-development runoff rates and pollutant loads, where possible, through the use of various BMP strategies. In order to obtain the greatest reduction in stormwater runoff and the highest pollutant removal rates, BMPs should be implemented in series wherever possible. The BMP strategies are divided into three categories: source controls, conveyance controls, and end-of-pipe controls.

5.2.1 Stormwater Source Control

Stormwater source controls involve measures to store and treat stormwater before it reaches the conveyance system or downstream BMP. The lot controls for this development may include, where possible:

- homeowner lawn care best management practices;
- roof leaders that are directed to lawns and vegetated areas rather than the street
- roof storage for commercial sites; and
- pre/post balancing for all commercial, apartment and institutional sites.

Each homeowner in Sub-Areas 7 and 8 will be given a Lawn Care Best Management Practices Guide. This guide is located in Appendix 4 of this plan. It provides details and encourages the following best practices:

- the use of rain barrels
- elimination of toxic runoff and infiltration
  - fertilizer and pesticide reduction
  - pet waste removal
  - lawn and landscaping naturalization
  - use of native species
  - creation of rain gardens
- additional green practices
  - dethatching
  - management of downspouts
  - green bin composting

Wherever possible, roof leaders will be directed to lawns and vegetated areas to recharge groundwater and minimize the volume of water entering the conveyance system. This control measure is designed to infiltrate stormwater and to reduce runoff.

The advantages of incorporating roof leader strategies into stormwater management are:

- Reduced total volume of runoff
- Reduced peak stormwater flows
- Reduction of erosion
- Treatment/removal, and after soil saturation, filtration of stormwater pollutants

5.2.2 Stormwater Conveyance Controls

5.2.2.1 Storm Sewer (Throughout Development)

The stormwater conveyance system (underground piping) is designed to carry the 5-year/24-hour storm. The primary stormwater conveyance in the development will be a storm sewer system with both conveyance and BMPs built into the system. Flows that exceed the capacity of the stormwater conveyance system will be conveyed to the BMPs and outfalls via conveyance depressions along the edge of the road surface.

5.2.2.2 Vegetated Swales (Throughout Development)

Vegetated swales detain runoff, filter sediment and pollutants, and promote infiltration. This overland flow conveyance practice serves to reduce peak runoff rates, infiltrate water and filter pollutants. Figures 1 and 2 show the basic configuration of a vegetated swale.

Swales can be used along the edges of parking lots and in-between roadways to help control runoff from impervious areas. Check dams in the swale reduce water velocities and are necessary to prevent severe erosion on slopes greater than 4%. This type of stormwater management practice is proposed for use throughout the development where feasible.

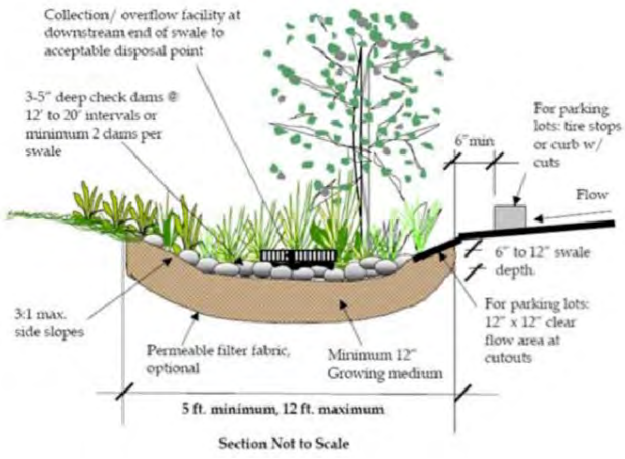

Figure 1. Schematic of a vegetated swale. (Source: City of Sandy Point, OR)

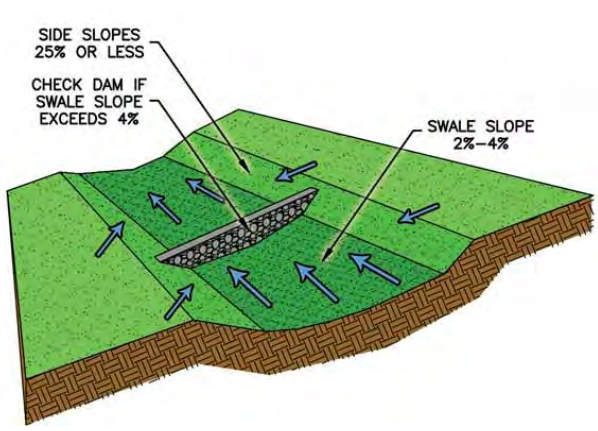

Figure 2. Vegetated swale bottom configuration.

5.2.2.3 *Infiltration Trenches*

Infiltration trenches are a stormwater management technology that can play an important role in Low Impact Development (LID) site design. Dispersed around the site, these infiltration structures can recharge groundwater and help maintain or restore the site's natural hydrology. Infiltration trenches store water in the void spaces between crushed stone or gravel ; the water is cleansed as it slowly percolates downward into the subsoil. This type of stormwater management quality facility will be constructed as a stormwater conveyance alternative throughout the development. Figure 3 is a cross section of a typical infiltration trench.

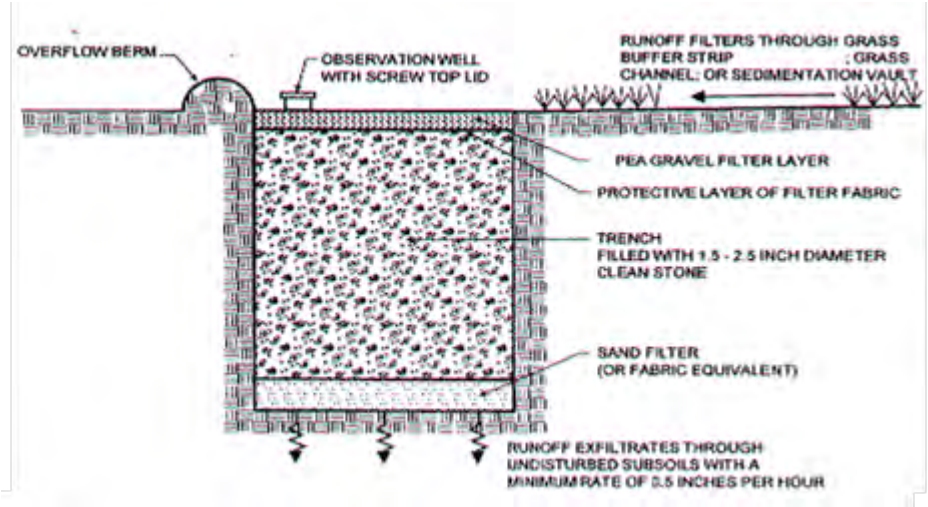

Figure 3. Section view of infiltration trench.

5.2.3 End-of-pipe Controls

5.2.3.1 Infiltration Basin (Drainage Area A)

An infiltration basin is a depression located in permeable soils that capture, store and infiltrate stormwater runoff. These basins are typically designed to infiltrate stormwater within 48 hours. Infiltration basins are designed with a flat bottom to allow for infiltration across the BMP, this bottom must be located a minimum of one metre (three feet) above seasonal high ground water and bedrock.

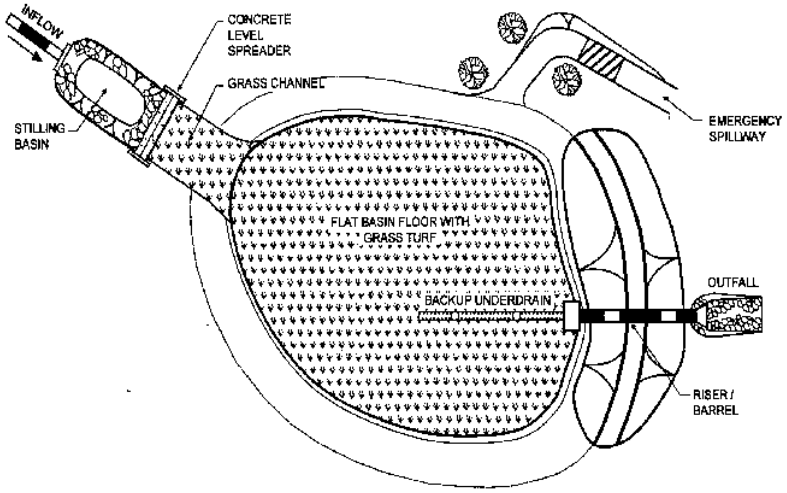

Figure 4. Plan view of Infiltration Basin.

Infiltration systems can be designed to address a variety of stormwater management goals including: water quality improvements, runoff reduction, flow attenuation, thermal impacts and groundwater recharge. An infiltration basin will manage runoff from Area A of the development. The primary goals of this BMP in Sub-Areas 7 and 8 are water quality improvement and runoff management. Figures 4 and 5 show the typical plan and profile of an infiltration basin.

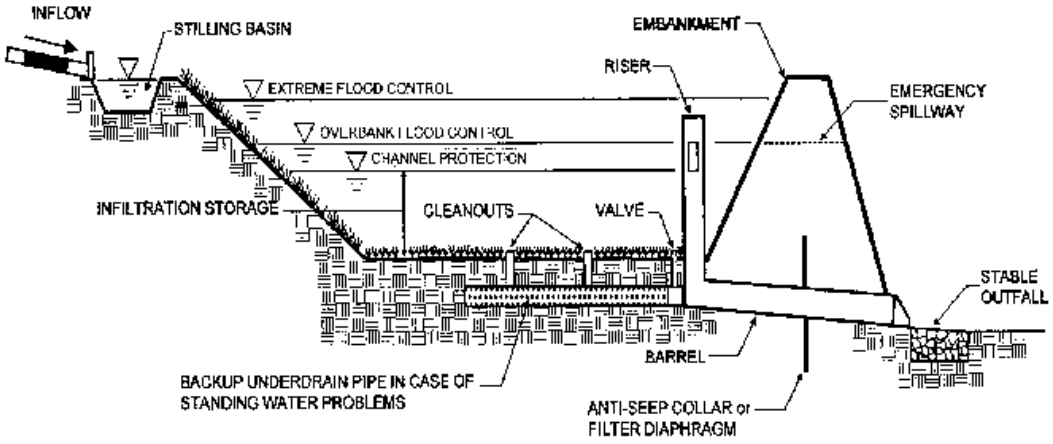

Figure 5. Profile of Infitration Basin.

5.2.3.2 *Extended Dry Detention Basin (Drainage Area W and X)*

The extended detention facilities will be designed to control the rate of runoff in Area W and X to match predevelopment conditions. The primary function of the detention pond is to control the rate of discharge in order to prevent erosion to downstream stream channels, and flooding. Detention ponds function primarily as a water quantity control measure and can also provide quality measures if drawdown times are lengthened and an extended storage is provided.

The stormwater detention ponds proposed to manage stormwater from Area W and X will have a 30-hour drawdown time. Extended detention dry detention ponds are designed to be drained, and are not intended to retain standing water. Detention basins may be designed with an influent forebay; forebays typically remain filled with water after the detention basin has drained. Figure 6 is a cross section of a typical extended detention dry basin.

Detention ponds can also provide water quality improvements if drawdown times are lengthened and extended detention are provided. The HRM Stormwater Management Guidelines list typical detention times for different types of dry ponds. The HRM Stormwater Management Guidelines (2006) provide removal estimates of 50% for TS, and 20%-40% for TP.

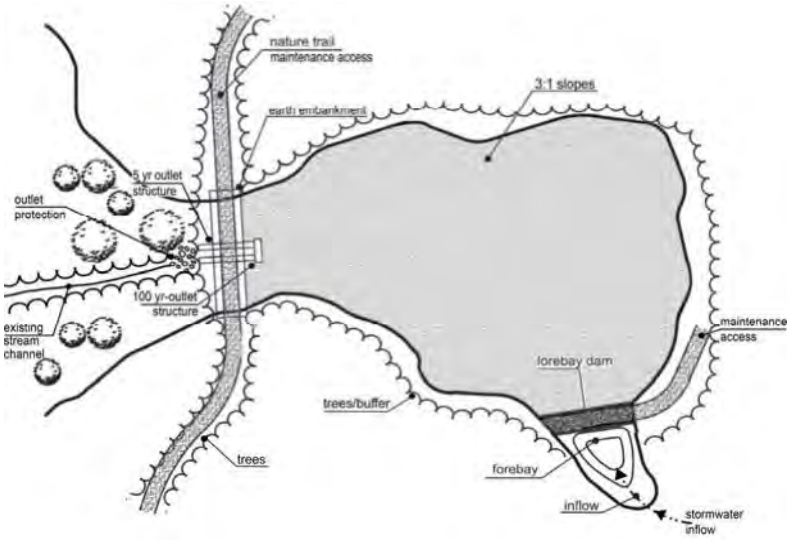

Figure 6. Plan of Extended Detention Basin with forebay.

5.3 Stormwater Modeling Results

The goal of the MSWMP is to match, as closely as possible, the pre-development hydrologic (quantity) and pollutant transport (quality) conditions to the post-development conditions on the entire development and subwatershed scales. The impacts of the proposed Best Management Practices (BMPs) described in Section 5.2 on water quantity and quality exiting the site are discussed separately in this section.

5.3.1 Strormwater Quantity Design Criteria

The proposed HRM Stormwater Guidelines generally recommend the control of post-development peak flows from the 2, 5, 10, 25, 50 and the 100-year 24-hour storm events. The storm event rainfall quantities as summarized in the proposed HRM Stormwater Guidelines (HRM, 2006) are presented in Table 5.1.

Table 5.1 Rainfall intensity-duration frequency values for Shearwater A weather station.

DURATION	RETURN PERIOD RAINFALL AMOUNTS (mm)					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5 min	5.8	7.8	9.2	10.9	12.2	13.4
10 min	8.7	11.3	13.1	15.3	17.0	18.6
15 min	10.7	13.6	15.6	18.0	19.8	21.6
30 min	14.6	18.6	21.2	24.5	26.9	29.4
1 hr	20.4	25.1	28.2	32.2	35.1	38.0
2 hr	29.4	38.1	44.0	51.3	56.7	62.1
6 hr	48.7	63.1	72.7	84.7	93.7	102.6
12 hr	58.3	74.5	85.2	98.8	108.8	118.8
24 hr	65.9	89.7	105.5	125.5	140.3	155.0

5.3.2 Pre and Post Development Quantity Modeling Results

Water quantity and flow rate modeling for the development was performed by MacWilliams Engineering. The site was modeled using HydroCAD. HydroCAD models stormwater runoff rates for specific design storm events based on the pre and post development scenarios.

The pre-development modeling results are summarized in Table 5.2 for the West Bedford Sub-Areas 7 and 8 development. The points referred to in this table are shown in Drawing D01 (Appendix 1). The Post-Development modeling results are summarized in Table 5.3 and the Post-Development subdrainage area map with critical modeling points for the 5-year and 100-year storm events are provided in Appendix 1 (Drawings D02 and D03, respectively).

The Post-Development runoff conditions presented here are based on the use of retention ponds. This is a conservative, preliminary approach. The specific proposed BMP designs will be further detailed at the Subdivision Agreement development stage.

Table 5.2 Pre-Development Quantity Modeling Results for the Design Storm Events

POINT	AREA	COEFF		TC	INTENSITY (MM/HR)		FLOW (M^3/SEC)	
	(HEACTAES)	5-YR	100-YR	(MIN.)	5-YR	100-YR	5-YR	100-YR
A	8.88	0.31	0.51	76.0	21.8	34.9	0.16	0.43
B	40.74	0.32	0.53	147.8	15.1	24.2	0.52	1.56
C	2.35	0.30	0.50	30.0	36.6	58.4	0.07	0.19
D	25.03	0.32	0.52	95.0	19.3	30.9	0.42	1.16
E	0.96	0.30	0.50	80.0	21.2	33.9	0.02	0.05
H	6.75	0.30	0.51	69.0	23.0	36.8	0.13	0.35
I	23.73	0.33	0.55	40.0	31.2	49.8	0.68	1.79
W	5.70	0.32	0.54	56.0	25.9	41.4	0.14	0.36
X	84.09	0.32	0.52	81.5	21.0	33.6	1.47	4.26
Y	87.96	0.32	0.53	85.3	20.5	32.8	1.52	4.40

Table 5.3 Post-Development Quantity Modeling Results for Design Storm Events (Retention Ponds)

DISCHARGE POINT	AREA (HECTARES)			COEFF.	TC (MIN)	INTENSITY (MM/HR)	FLOW (M^3/SEC)
	CONTROLLED	UNCONTROLLED	TOTAL				
A	22.13	1.75	23.88	0.39	45.0	29.2	0.17
B	3.55	4.39	7.94	0.33	78.0	21.5	0.20
C	3.55	-	3.55	0.30	77.4	21.6	0.07
D	7.59	6.85	14.44	0.37	29.0	37.3	0.43
E	-	0.90	0.90	0.31	77.0	21.7	0.02
H	6.01	2.54	8.65	0.42	60.0	24.9	0.12
I	-	21.13	21.13	0.35	40.0	31.2	0.66
W	13.06	4.96	18.02	0.36	62.7	24.5	0.12
X	86.01	15.09	101.10	0.37	98.8	18.9	1.49
Y	86.01	20.33	106.34	0.37	102.5	18.5	1.60

5.3.3 Stormwater Quality Design Criteria

The goal of the stormwater quality management system is to reduce the post-development runoff pollutant loads whenever possible through the use of various BMP strategies. The primary pollutants of concern, as identified in the Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford 2004), are Total Suspended Solids (TSS) and Total Phosphorus (TP). The site will contain a variety of land uses. Table 5.4 summarizes the pollutant runoff concentrations generated from a number of these land uses.

Table 5.4 Mean Pollutant Concentration Generated by Runoff from Various Land Uses

LAND USE	TSS (MG/L)	TP (MG/L)
Forested wetland	19.0	0.2
Cropland and Pasture	19.2	0.2
Upland Forest	19.7	0.2
Urban Open	20.0	0.2
Communication and Utility	20.7	0.2
Low-density residential	22.1	0.2
Medium-density	30.5	0.2
Institutional	41.9	0.3
High-density residential	47.7	0.3
Multifamily residential	47.7	0.3
Commercial	54.2	*
Highways	57.8	*
Industrial	57.8	*

Notes:

Source: HRM Stormwater Guidelines (2006)

* TP Concentration not provided for in the HRM Guidelines

The primary pollutant of concern identified with downstream modeling results as outlined in the West Bedford Subwatershed Management Plan (Jacques Whitford, 2004) is phosphorus. Table 5.5 summarizes estimated removal rates of both TSS and TP from a number of BMPs.

Table 5.5 Removal Rates of Selected Best Management Practices (BMPs)

BMP	REMOVAL RATES (%)	
	TSS	TP
Extended Dry Detention Pond[1]	50	30
Infiltration Basin and Trenches	90	70
Vegetated Filters	85	60
Grassed Swales	85	40

Source: HRM Stormwater Guidelines (2006)

[1] According to HRM Stormwater Guidelines (2006), performance data shows that the removal rates of a detention pond are applicable if an extended detention component is provided.

5.3.4 Pre and Post Development Quality Modeling Results

Stormwater quality modeling has been performed for the Pre and Post-Development conditions for TSS and TP mass transport in the first flush (12.5 mm) storm event. Table 5.6 summarizes the modeling results of Pre-Development conditions and Table 5.7 summarizes the Post-Development conditions both prior to and after BMP use. The concentration of TSS and TP in the stormwater runoff is dependent on the type of land use and the estimated concentration of pollutants in the stormwater runoff. The land use types are based on the pre-existing conditions and the development plan, Table 5.4 summizes the first flush runoff concentrations for a variety of land uses utilized in calculating the modelling results. The mass transport of pollutants for each area is determined using the following equation:

M = (V x C) / 1000

Where:

M = Mass (kg) of pollutants transported

C = Concentration of TSS or TP in the stormwater (mg/L) from Table 5.3.

V = Volume of stormwater runoff (m^3), determined by the following equation:

V = A x Coeff x Rainfall x 10

Where:

A = Drainage Area (hectare)

Coeff = runoff coefficient (dimensionless)

Rainfall = 12.5 mm (this is first flush event)

Table 5.6 Pre Development Water Quality Modeling Results

DISCHARGE POINT	.PRE-DEVELOPMENT	
	TSS (KG)	TP (KG)
Sub-Area 7[1]	29.77	0.30
Sub-Area 8[2]	30.61	0.31
TOTAL	60.38	0.61

Table 5.7 Post Development Water Quality Modeling Results without and with BMPs

DISCHARGE POINT	NO BMPS		WITH BMPS	
	TSS (KG)	TP (KG)	TSS (KG)	TP (KG)
A[1]	27.87	0.18	2.79	0.054
D	3.05	0.01	3.05	0.01
H	3.29	0.02	3.29	0.02
W[2]	0.86	0.01	0.43	0.007
X[2]	13.43	0.09	6.72	0.063
Y	9.08	0.06	4.54	0.042
Uncontrolled	35.69	0.36	36.21	0.37
TOTAL	95.6	0.75	59.35	0.596

Notes :

1 – Treatment with Infiltration Basin (TSS Removal = 90% and TP Removal = 70%)

2 - Treatment with Extended Dry-Detention (TSS Removal = 50% and TP Removal = 30%)

6 PROTECTION MEASURES DURING AND AFTER SITE DEVELOPMENT

Some degree of erosion and sedimentation can be expected from equipment activity and earth moving on the property. This temporary effect can be minimized by appropriate erosion and sedimentation prevention and control measures. All personnel will comply with applicable environmental laws, regulations, standards and practices, permits, approvals, and requirements of federal, provincial, and municipal authorities. Professional land development companies, such as West Bedford Holdings Limited, have established guidelines that are enforced through the tender/contract period. Appendix 3 of this report is a detailed erosion and sediment minimization plan that will be utilized during construction for West Bedford Sub-Areas 7 and 8. All developers within the plan are encouraged to adopt similar on-site procedures. Clear and concise guidelines and site specific erosion control plans must be provided to all contractors.

For construction projects, there are three categories of erosion and sediment control: runoff controls, erosion protection, and sediment interception. Runoff controls will limit or contain soil

movement from the construction site, minimize raindrop impact on the soil, and reduce runoff volume and runoff velocities.

Erosion protection measures are used to reduce or eliminate the detachment of soil particles by falling raindrops or to resist sheet or channel flow. These measures are placed on, or applied to, the soil surface and are often used in conjunction with runoff control and sediment interception measures.

Soil loss from slopes may occur even with erosion and runoff control measures. If this soil can enter a waterbody, mitigative measures will be required to intercept it. Methods used to trap sediment include vegetated buffer strips, silt fences, filter berms, and sediment traps.

6.1 Temporary Protection Measures

The geology of the site consists mainly of bedrock with some areas of glacial till. The area is considered to have low risk of soil erosion. Imported soil will be limited to topsoil needed for landscaping. Standard erosion and sedimentation control measures will be employed for all erodable soils.

The erosion and sedimentation control plan during construction will include:

- Silt fences, etc. installed before grubbing operation;
- Clean run-on water controlled/diverted by installation of channels, berms, and grading;
- Exposed soil minimized via rapid cover by mulch, gravel etc.;
- Soil exposure controlled relative to forecasted weather conditions;
- Site grading to low slopes complete with ponding depression areas and shallow ditches to retain stormwater; and
- Monitoring

6.2 Premanent Protection Measures

The erosion and sedimentation control plan for permanent stabilization should include:

- Stabilization of all disturbed surfaces
- Periodic inspection of erosion and sedimentation control measures to ensure continued effectiveness.

6.3 Ongoing Protection Measures

There are a variety of other “soft” protection measures that can be adopted by the community to further aid in stormwater quality and quantity management. The Halifax Regional Municipality Bedford West Master Planning Study (HRM, 2006) provides the following suggestions:

- Public education. Educate individuals in the development about the effects of poor stormwater management and the methods by which they can minimize their impact (e.g. the protection measures listed in the following bullets). Methods of education can include billing inserts, school and community programs, pamphlets, etc.
- Litter control and recycling programs. Litter control and recycling programs reduce the potential for clogging of stormwater management facilities, and can be implemented through the use of no-littering bylaws.
- Animal waste control. Clean-up and proper disposal of household pet waste through the use of bylaws reduces the release of nutrients and pathogenic bacteria to downstream receiving waters.
- Spill response plans. The implementation of emergency spill response plans can help limit pollutants and hazardous chemicals from entering downstream receiving waters.
- Proper storage and use of chemicals, fertilizers, and pesticides. The decreased use and proper application of fertilizers can greatly decrease the nutrient and chemical loading to downstream watercourses. Common control measures include applying fertilizers to minimize potential for runoff and hand-weeding as opposed to controlling weeds with chemicals.
- Vacant lot clean-up. Lot clean-up can prevent the accumulation of debris and other material which may pollute downstream watercourses.
- Identification and prohibition of illegal/illicit storm drain connections and discharges. This is another way to minimize pollutant load to receiving waters.
- Street sweeping and catch basin cleaning. Street sweeping and catch basin cleaning can reduce oil and grease runoff as well as decrease the potential for clogging of stormwater management facilities.
- Road salt management. Properly managed road salt application programs minimize the load of salt and sediment in stormwater runoff.
- Pollution prevention lawn care. Utilization of proper fertilizer and pesticide application will reduce the release of nutrients and chemicals that typically contribute to downstream receiving water impairments. Also, guidelines will require a minimum of 6” of topsoil on lawn areas prior to seeding and/or sodding.

To address the issues outlined in the HRM study, West Bedford Holdings Limited has prepared a Home Owner’s Guide to address Lawn Care Best Management Practices (Appendix 4). The document outlines the developer’s environmental commitment for the development as well as the management practices that the home owner can undertake to contribute to that commitment.

7 STORMWATER FACILITIES MAINTENANCE

The maintenance program to ensure the effectiveness of the erosion and sedimentation control plan includes:

- Daily (and during precipitation events) inspection of temporary erosion and sedimentation control measures to check for damage. Damaged structures will be repaired.
- Maintenance of environmental protection structures (including removal of silt material) until disturbed areas have been completely stabilized. Following stabilization of disturbance areas, environmental protection structures will be removed and the area will be re-graded and stabilized.

8 COMPLIANCE WITH THE HRM ENVIRONMENTAL PROTECTION POLICIES

The following section is intended to demonstrate compliance with the Environmental Protection policies of the Bedford West Master Planning study. Policies that are directly applicable to the stormwater management system are discussed here; additional Bedford West (BW) policies are listed in Appendix 2.

BW-1: Preparation of a Master Stormwater Management Plan

This document is intended to fulfill the requirement for an overall stormwater management plan. With respect to the specific directives of BW-1:

- Areas of significant environmental value have been identified for preservation and possible incorporation into the overall stormwater management plan. Flood prevention for the 1:5 year storms and 1:100 year events will be addressed through an overall stormwater management system. Additional management of the commercial properties will be addressed through site-specific development agreements or at the subdivision stage.
- Means for preventing adverse changes to water quality and quantity are documented throughout this strategy. The development will meet or exceed municipal and provincial guidelines.
- The types and design of proposed stormwater management facilities has been identified. As to the type, size and design of BMPS, specific measures will be identified in conjunction with the final design/location of the proposed interchange. These measures will be identified in future development agreements for the commercial areas abutting the Bicentennial Highway.
- Monitoring procedures have been included in the SWMP. Response procedures have also been identified for the purpose of minimizing the impacts during construction.

BW-2: Detailed Design Specifications

Subdivision plan submittals shall adhere to the objectives set forth and previously approved within the Master Stormwater Management Plan for West Bedford Sub-Areas 7 and 8.

BW-3: Water Quality Monitoring Program

West Bedford Sub-Areas 7 & 8 will participate in the water quality monitoring program, as created and required by the Bedford Watershed Advisory Board.

BW-4: Policy noted

BW-5: Policy noted

BW-6: Discharge to Watercourses

Various measures will be employed as directed by either the HRM or NSE. These measures will be stipulated at either the development agreement or subdivision approval stages. Balancing post-development flows to the pre-development flow rates will be achieved by the use of various Best Management Practices, as described in Section 5.2 of this document.

BW-7: Protection of Watercourses

Watercourses are protected throughout the development. HRM requires the retention of a 20 meter wide (minimum) riparian buffer along all designated watercourses; a 30 meter wide riprarian buffer will be placed on Black Duck Brook and Kearney Lake.

BW-8: Site Disturbance Prior to Development Approvals.

No disturbance of the plan area is contemplated prior to approval of neighbourhood development agreements. Survey work and geotechnical investigations will proceed with minimal disturbance.

BW-9: Watercourse Protection Setbacks

No development, grade alteration, excavation, fill, pavement or removal of natural vegetation within one hundred (100) feet of the high water mark shall take place, in adherence with this policy. A 30 meter wide riparian buffer will be observed on Black Duck Brook and Kearney Lake.

BW-10: Non-Disturbance Areas

The western side of Black Duck Brook as well as numerous wetlands and buffers throughout the site will remain as non-disturbance areas.

BW-11: Tree Planting Program

Native plants will be used due to their performance, site enhancement and life cycle costs.

BW-12: Steep Terrain

An effort has been made to protect areas of steep terrain and limit development or disturbance to these areas. Most of these areas have been included on the aforementioned green areas.

BW-13: Modifications to Servicing Specifications

Specific modifications will be identified in conjunction with neighborhood subdivision agreements.

9 STORMWATER MANAGEMENT SUMMARY

A series of stormwater management facilities are being considered for the site to manage stormwater runoff quantity and quality. This management train is three fold and includes: source controls, conveyance controls and "end-of-pipe" controls. A focus of the management system is control and minimization of stormwater runoff at the source, and the use of natural drainage corridors and vegetated swales for conveyance. These practices will promote groundwater recharge and preservation of the site's natural ecology, as well as minimize sediment and pollutant transport off the site.

Following the source controls, where possible, natural corridors and vegetated swales will be used for conveyance of stormwater runoff. Some of the residential property runoff, and commercial runoff, will be collected by the natural drainage corridors. These drainage corridors include buffer zones and adjacent minimal disturbance zones that will promote groundwater infiltration, filtration and aquifer recharge.

The end-of-pipe best management practices proposed for the site include an infiltration basin (Area A), and extended dry detention basins (Areas W and X). End-of-pipe BMPs will provide the necessary controls to match pre- and post-development stormwater runoff rates and will also provide additional water quality improvements.

This stormwater management strategy will serve to both minimize pollutant transport, and the volume of stormwater runoff created. These practices meet the following objectives highlighted in the Bedford West Master Planning Study:

- To adequately convey stormwater flow from upstream sources;
- To mitigate the adverse effects of stormwater flows, such as flooding and erosion, onto downstream areas;
- To preserve natural watercourses;
- To accommodate stormwater management practices that are compatible with recreational functions and minimize environmental degradation and flooding of downstream developments;

- To undertake stormwater management planning on a watershed basis with community design based on natural drainage patterns;
- To prevent flooding of properties and safeguard flood plains;
- To preserve the water quality of lakes and rivers; and
- To preserve groundwater flows.

10 REFERENCES

HRM (Halifax Regional Municipality). 2006. Halifax Regional Council Memorandum. Project 00382 – Bedford West Master Planning Study. April 27, 2006.

Dillon Consulting Limited. 2006. Halifax Regional Municipality Stormwater Management Guidelines. Report 05-4808-0400. Prepared for the Halifax Regional Municipality. Halifax, Nova Scotia.

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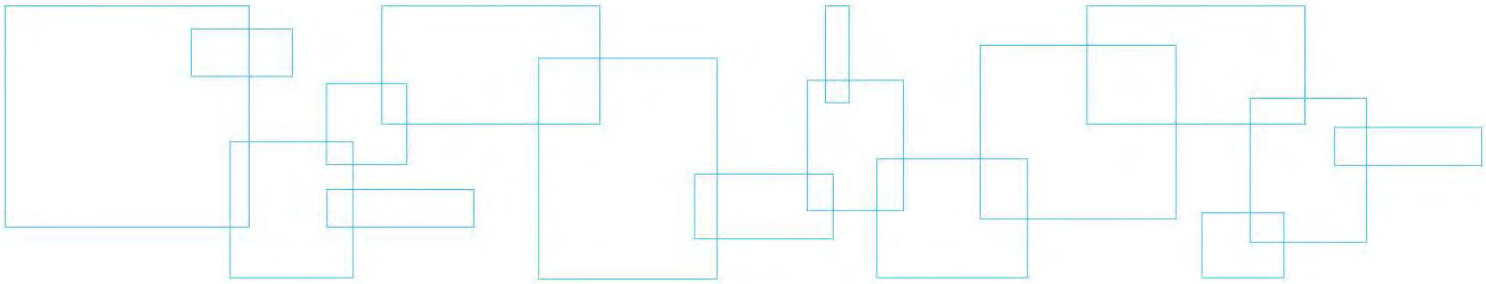
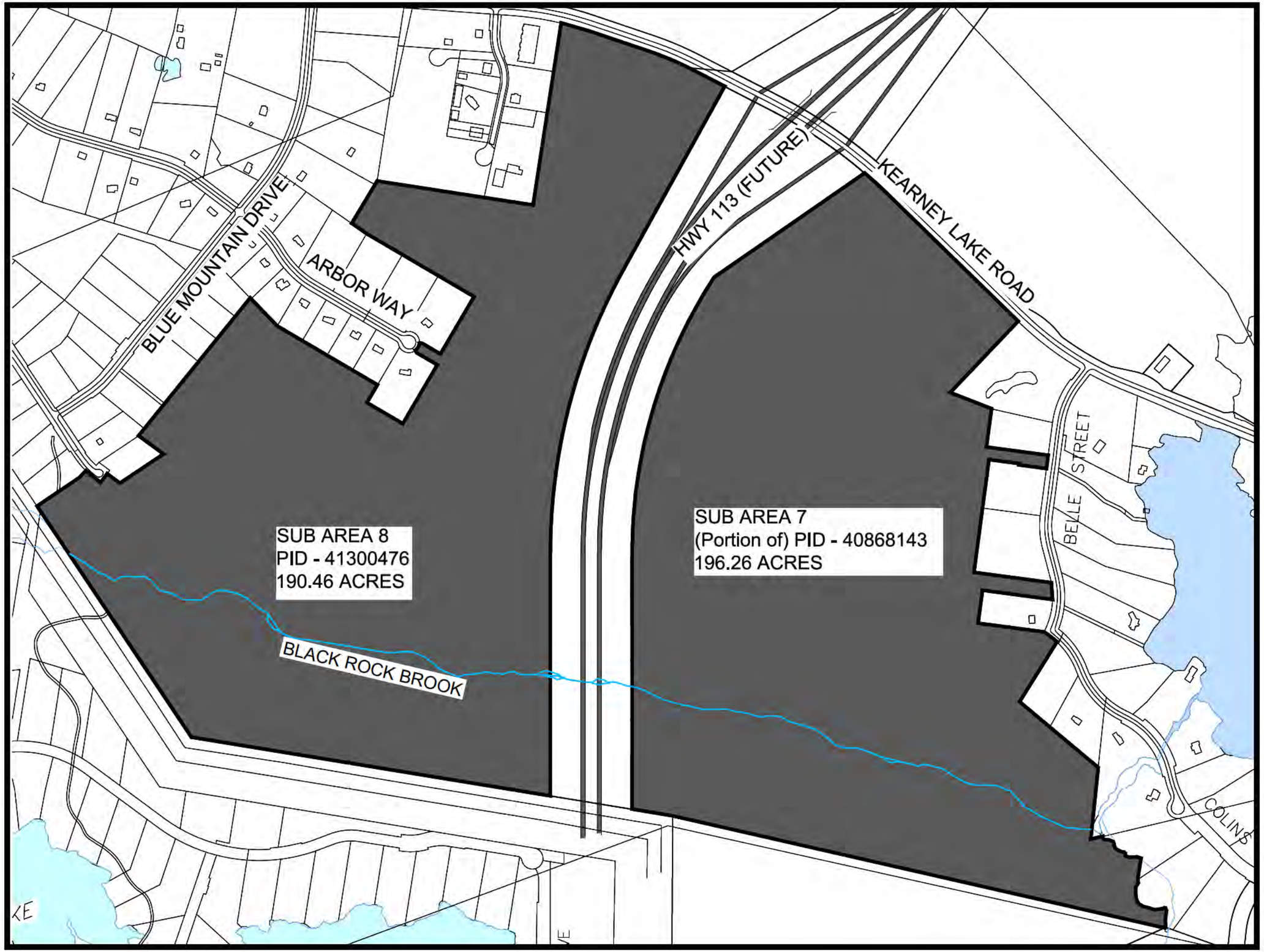
Appendix 1 Site Map Figures





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MASTER STORMWATER MANAGEMENT PLAN AREAS 7&8

FIGURE A. 1 THE PARKS OF WEST BEDFORD SUB-AREAS 7&8

FIGURE A. 2 THE PARKS OF WEST BEDFORD SUB-AREAS 7&8

FIGURE A.3: SOILS MAP FOR THE BEDFORD WEST PLANNING AREA

NOTES: SUB AREAS 7 & 8 ARE IN THE AREA 2B BOUNDARY

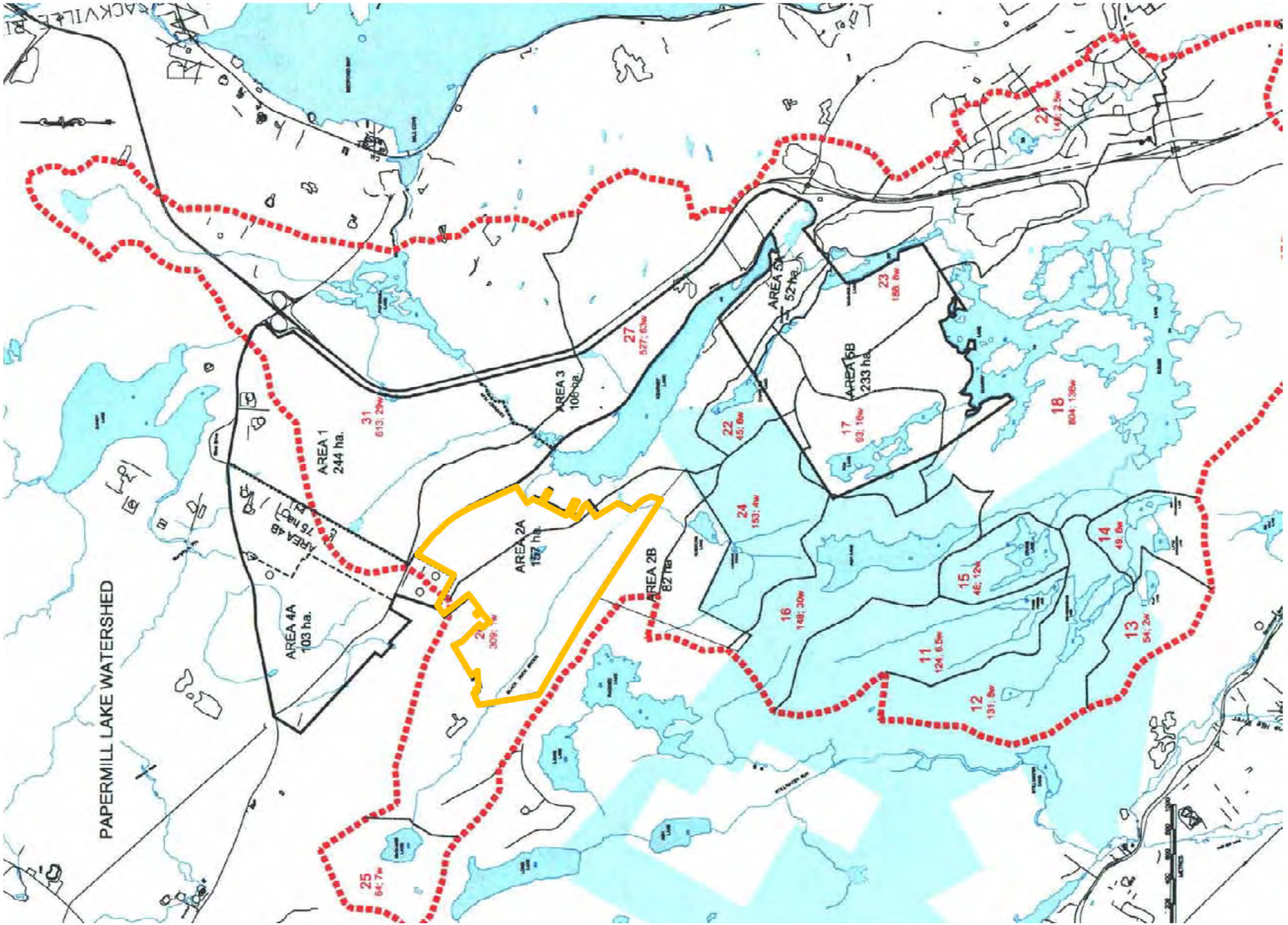
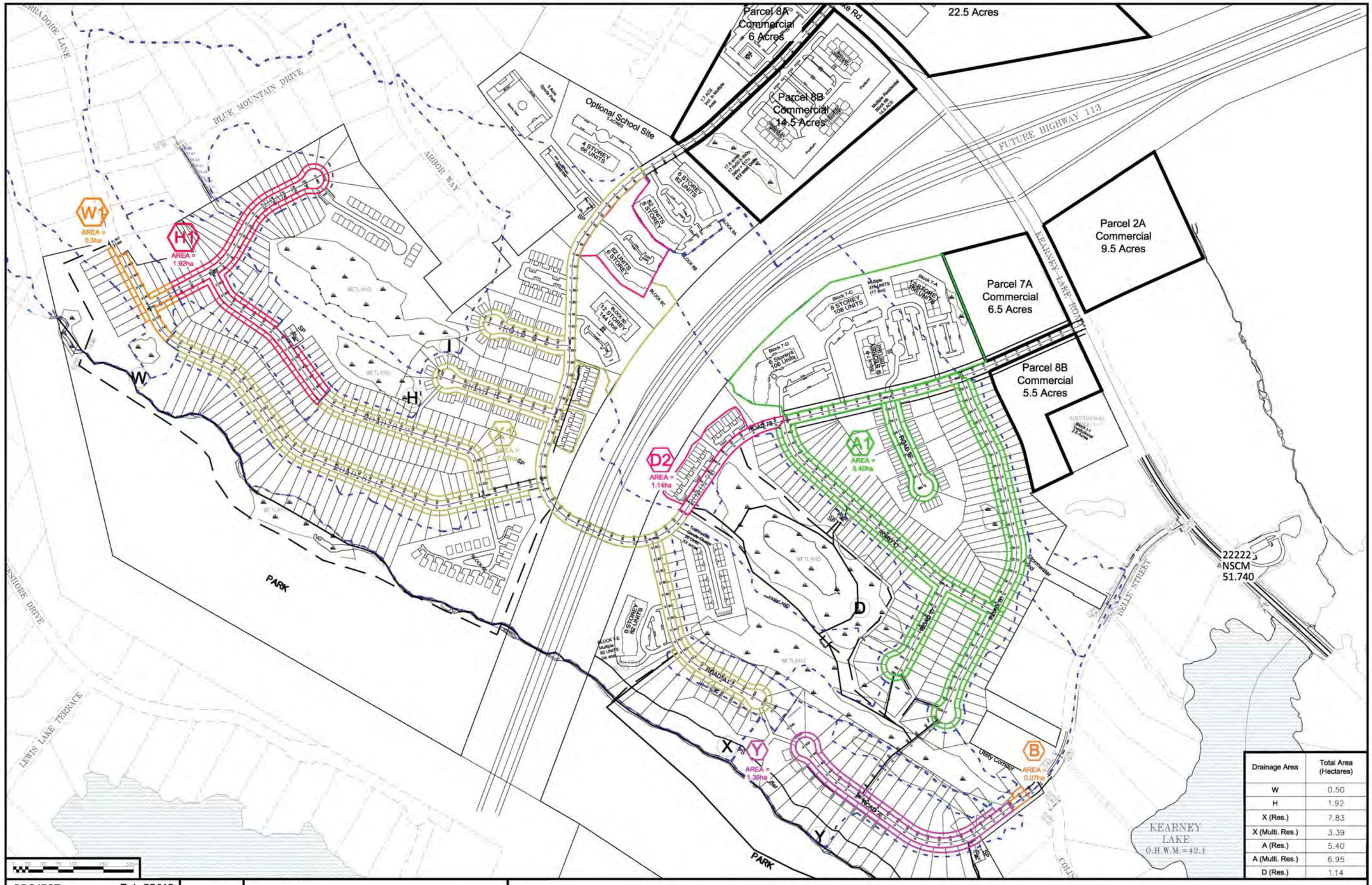


FIGURE A.4: WATERSHEDS IN THE BEDFORD WEST PLANNING AREA



Drainage Area	Total Area (Hectares)
W	0.50
H	1.92
X (Res.)	7.83
X (Multi. Res.)	3.39
A (Res.)	5.40
A (Multi. Res.)	6.95
D (Res.)	1.14

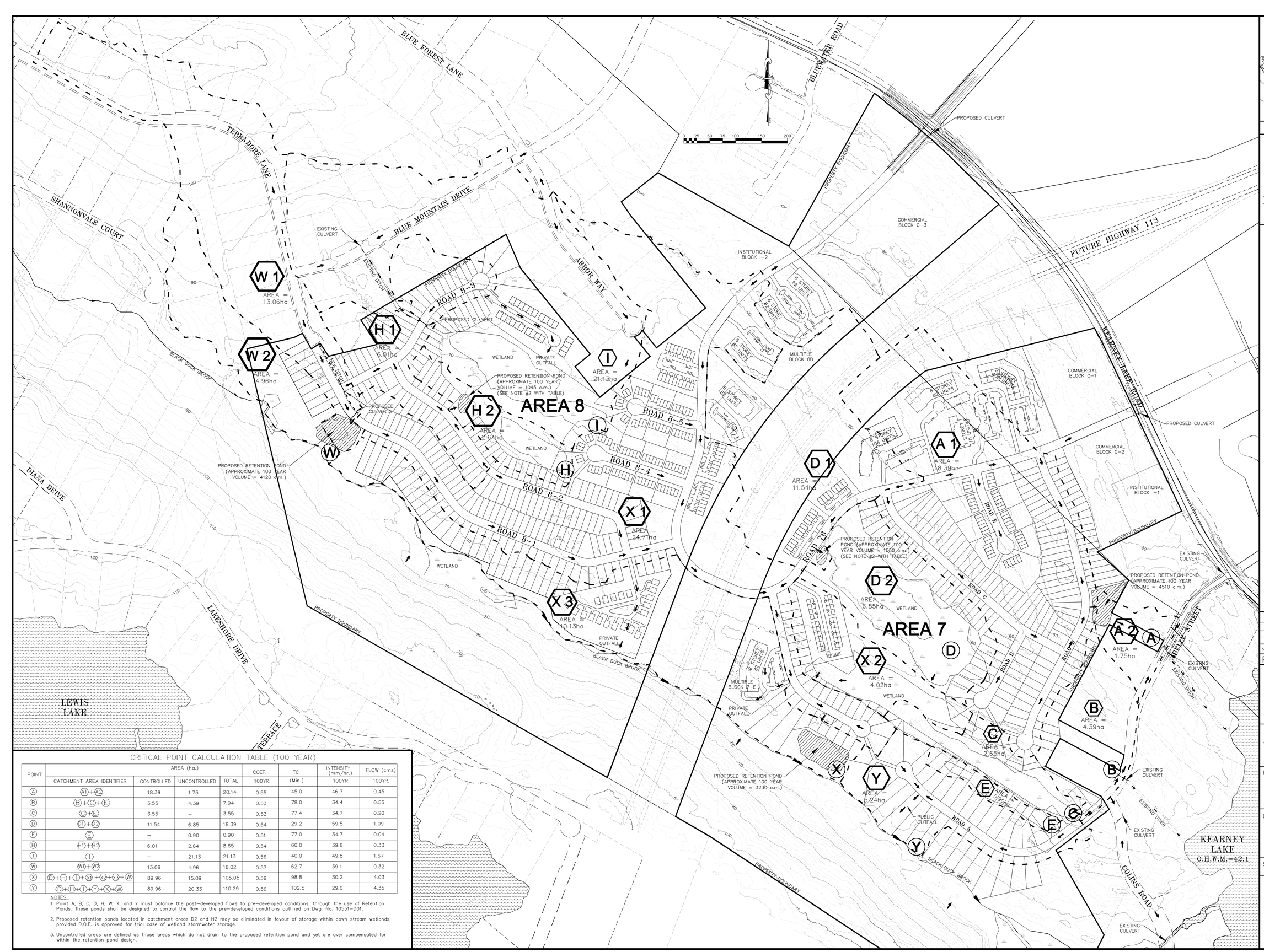
PROJECT Feb.22/'13
West Bedford

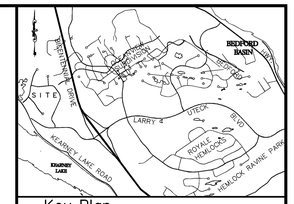
DRAWING
Sub Areas 7&8

N

General Notes:

All commercial & institutional sites are responsible for their own Water Quality & Quantity Balancing.





Key Plan
N.T.S.

LEGEND

(A)	CRITICAL CALCULATION POINT
(A)	DRAINAGE AREA IDENTIFIER
→	FLOW DIRECTION
HP	HIGH POINT IN ROADWAY
LP	LOW POINT IN ROADWAY
– – – –	EXISTING LOTS
– — – —	EXISTING ROW

NOTES:

1. Contour interval is 2.0m, based on LRIS mapping blended with actual field data provided by Servant Dunbrack Limited.
2. For storm drainage calculations refer to Mac Williams Eng. Ltd. storm drainage calculation sheets.
3. For predeveloped conditions refer to Mac Williams Eng. Ltd drawing #10551-D01.
4. All proposed roads that connect to existing roadways with existing ditch systems have the potential to require sections of new ditch systems constructed in order to transition between the two types of drainage systems.
5. All Multi-Residential, Commercial & Institutional properties within this development shall be required to pre-post balance their own stormwater flows within their own property.
6. The term "Retention Pond" used throughout this drawing is used in an equivalent nature as the term "Attenuation Pond."

CRITICAL POINT CALCULATION TABLE (100 YEAR)

POINT	AREA (ha.)				COEF.	TC	INTENSITY (mm/hr.)	FLOW (cms)
	CATCHMENT AREA IDENTIFIER	CONTROLLED	UNCONTROLLED	TOTAL	100YR.	(Min.)	100YR.	100YR.
(A)	(A1)+(A2)	18.39	1.75	20.14	0.55	45.0	46.7	0.45
(B)	(B)+(C)+(E)	3.55	4.39	7.94	0.53	78.0	34.4	0.55
(C)	(C)+(E)	3.55	–	3.55	0.53	77.4	34.7	0.20
(D)	(D1)+(D2)	11.54	6.85	18.39	0.54	29.2	59.5	1.09
(E)	(E)	–	0.90	0.90	0.51	77.0	34.7	0.04
(H)	(H1)+(H2)	6.01	2.64	8.65	0.54	60.0	39.8	0.33
(I)	(I)	–	21.13	21.13	0.56	40.0	49.8	1.67
(W)	(W1)+(W2)	13.06	4.96	18.02	0.57	62.7	39.1	0.32
(X)	(D)+(H)+(I)+(X1)+(X2)+(X3)+(W)	89.96	15.09	105.05	0.56	98.8	30.2	4.03
(Y)	(D)+(H)+(I)+(Y)+(X)+(W)	89.96	20.33	110.29	0.56	102.5	29.6	4.35

NOTES:
1. Point A, B, C, D, H, W, X, and Y must balance the post-developed flows to pre-developed conditions, through the use of Retention Ponds. These ponds shall be designed to control the flow to the pre-developed conditions outlined on Dwg. No. 10551-D01.
2. Proposed retention ponds located in catchment areas D2 and H2 may be eliminated in favour of storage within down stream wetlands, provided D.O.E. is approved for trial case of wetland stormwater storage.
3. Uncontrolled areas are defined as those areas which do not drain to the proposed retention pond and yet are over compensated for within the retention pond design.

No.	Description	Date	By
	Revision or Issue		

THE SHAW GROUP

MAC WILLIAMS ENGINEERING LIMITED

Project
WEST BEDFORD
CONCEPT DESIGN
BEDFORD, N.S.

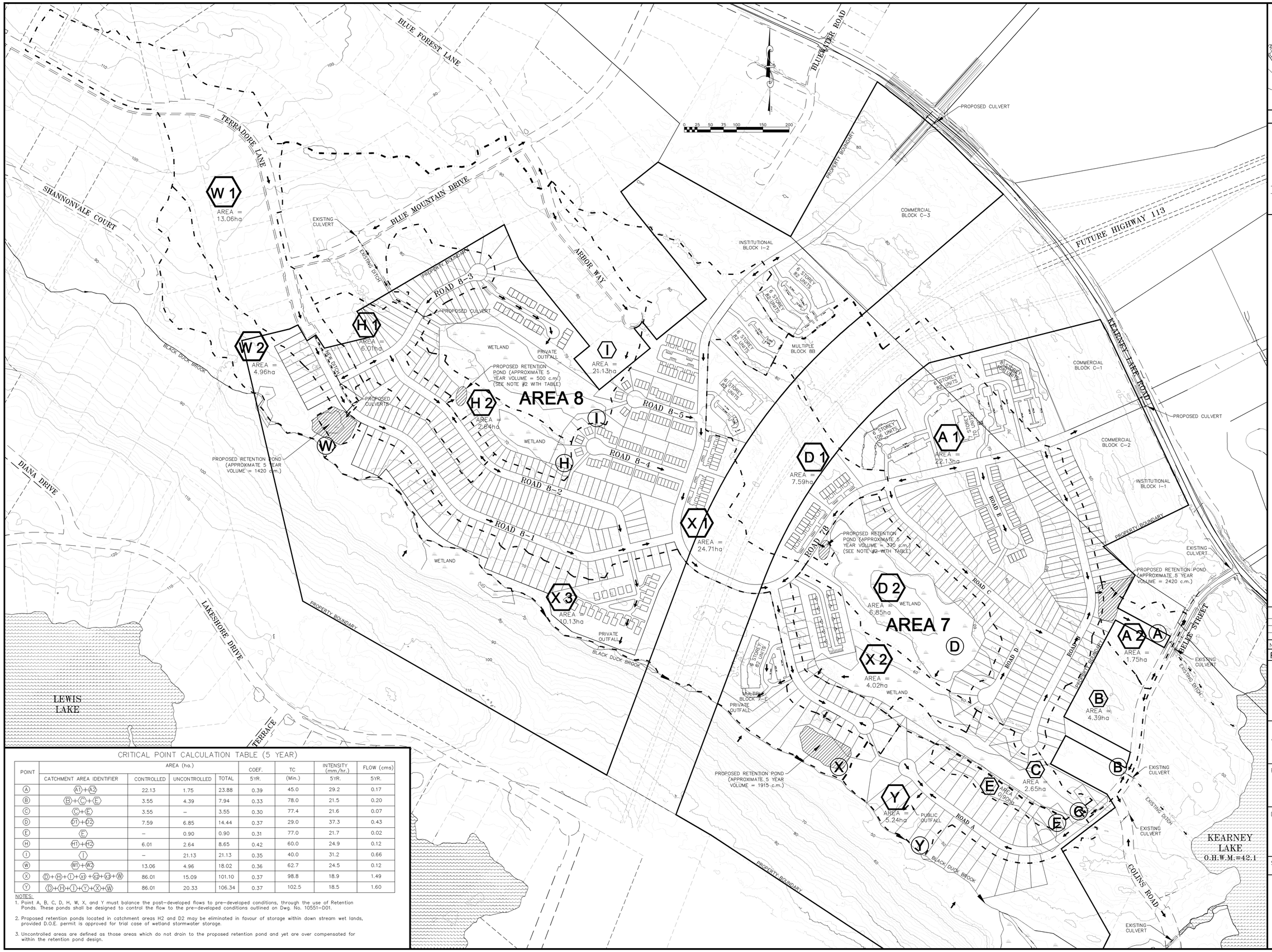
Drawing
POST-DEVELOPMENT (100 YEAR)
DRAINAGE PLAN
(SUB-AREAS)

Scale 1: 3000

DRAFT NOT FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER PROVINCE OF NOVA SCOTIA xxx DATE D. M. WILLIAMS 5711

Date	Drawn
August xx, 2012	ACD
Design: DMW	Check: DMW	Approv: DMW
Project No. 09540	Sheet No. 3 Of 3
Drawing No. 10551-D03	Rev. 0

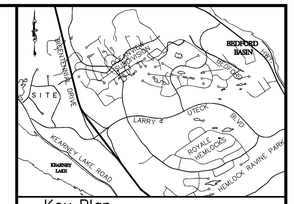


CRITICAL POINT CALCULATION TABLE (5 YEAR)

POINT	AREA (ha.)				COEF.	TC	INTENSITY (mm/hr.)	FLOW (cms)
	CATCHMENT AREA IDENTIFIER	CONTROLLED	UNCONTROLLED	TOTAL	5YR.	(Min.)	5YR.	5YR.
(A)	(A1)+(A2)	22.13	1.75	23.88	0.39	45.0	29.2	0.17
(B)	(B)+(C)+(E)	3.55	4.39	7.94	0.33	78.0	21.5	0.20
(C)	(C)+(E)	3.55	–	3.55	0.30	77.4	21.6	0.07
(D)	(D1)+(D2)	7.59	6.85	14.44	0.37	29.0	37.3	0.43
(E)	(E)	–	0.90	0.90	0.31	77.0	21.7	0.02
(H)	(H1)+(H2)	6.01	2.64	8.65	0.42	60.0	24.9	0.12
(I)	(I)	–	21.13	21.13	0.35	40.0	31.2	0.66
(W)	(W1)+(W2)	13.06	4.96	18.02	0.36	62.7	24.5	0.12
(X)	(D)+(H)+(I)+(X1)+(X2)+(X3)+(W)	86.01	15.09	101.10	0.37	98.8	18.9	1.49
(Y)	(D)+(H)+(I)+(Y)+(X)+(W)	86.01	20.33	106.34	0.37	102.5	18.5	1.60

NOTES:

1. Point A, B, C, D, H, W, X, and Y must balance the post-developed flows to pre-developed conditions, through the use of Retention Ponds. These ponds shall be designed to control the flow to the pre-developed conditions outlined on Dwg. No. 10551-D01.
2. Proposed retention ponds located in catchment areas H2 and D2 may be eliminated in favour of storage within down stream wet lands, provided D.O.E. permit is approved for trial case of wetland stormwater storage.
3. Uncontrolled areas are defined as those areas which do not drain to the proposed retention pond and yet are over compensated for within the retention pond design.



Key Plan
N.T.S.

LEGEND

(A)	CRITICAL CALCULATION POINT
A	DRAINAGE AREA IDENTIFIER
→	FLOW DIRECTION
HP	HIGH POINT IN ROADWAY
LP	LOW POINT IN ROADWAY
– – –	EXISTING LOTS
– — –	EXISTING ROW

NOTES:

1. Contour interval is 2.0m, based on LRIS mapping blended with actual field data provided by Servant Dunbrack Limited.
2. For storm drainage calculations refer to Mac Williams Eng. Ltd. storm drainage calculation sheets.
3. For predeveloped conditions refer to Mac Williams Eng. Ltd drawing #10551-D01.
4. All proposed roads that connect to existing roadways with existing ditch systems have the potential to require sections of new ditch systems constructed in order to transition between the two types of drainage systems.
5. All Multi-Residential, Commercial & Institutional properties within this development shall be required to pre-post balance their own stormwater flows within their own property.
6. The term "Retention Pond" used throughout this drawing is used in an equivalent nature as the term "Attenuation Pond."

No.	Description	Date	By

Revision or Issue

THE SHAW GROUP

MAC WILLIAMS ENGINEERING LIMITED

Project
WEST BEDFORD
CONCEPT DESIGN
BEDFORD, N.S.

Drawing
POST-DEVELOPMENT (5 YEAR)
DRAINAGE PLAN
(SUB-AREAS)

Scale 1: 3000

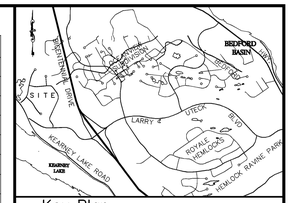
NOT FOR CONSTRUCTION
DRAFT

REGISTERED PROFESSIONAL ENGINEER PROVINCE OF NOVA SCOTIA D. M. WILLIAMS 5711 XXX DATE

Date	Drawn
August xx, 2012	ACD
Design / Check / Approv.	
DMW / DMW / DMW	
Project No. 09540	Sheet No. Of 3 2
Drawing No. 10551-D02	Rev. 0

CRITICAL POINTS CALCULATION TABLE (PRE DEVELOPED)

POINT	AREA		COEF.		TC	INTENSITY (mm/hr.)		FLOW (cms)	
	IDENTIFIER	HECTARES	5YR.	100YR.	(Min.)	5YR.	100YR.	5YR.	100YR.
Ⓐ	Ⓐ	8.88	0.31	0.51	76.0	21.8	34.9	0.16	0.43
Ⓑ	Ⓑ+Ⓓ	40.74	0.32	0.53	147.8	15.1	24.2	0.52	1.56
Ⓒ	Ⓒ	2.35	0.30	0.50	30.0	36.6	58.4	0.07	0.19
Ⓓ	Ⓓ	25.03	0.32	0.52	95.0	19.3	30.9	0.42	1.16
Ⓔ	Ⓔ	0.96	0.30	0.50	80.0	21.2	33.9	0.02	0.05
Ⓗ	Ⓗ	6.75	0.30	0.51	69.0	23.0	36.8	0.13	0.35
Ⓘ	Ⓘ	23.73	0.33	0.55	40.0	31.2	49.8	0.68	1.79
Ⓦ	Ⓦ	5.70	0.32	0.54	56.0	25.9	41.4	0.14	0.36
Ⓧ	Ⓦ+Ⓧ+Ⓗ+Ⓘ	84.09	0.32	0.53	81.5	21.0	33.6	1.47	4.26
Ⓨ	Ⓦ+Ⓧ+Ⓗ+Ⓘ+Ⓨ	87.96	0.32	0.53	85.3	20.5	32.8	1.52	4.40



Key Plan
N.T.S.

LEGEND

- Ⓐ — CRITICAL CALCULATION POINT
- (A) — DRAINAGE AREA IDENTIFIER
- → — FLOW DIRECTION
- HP — HIGH POINT IN ROADWAY
- LP — LOW POINT IN ROADWAY
- EXISTING LOTS
- EXISTING ROW

NOTES:

1. Contour interval is 2.0 Metre, based on LRIS mapping blended with actual field data provided by Servant Dunbrack Limited.
2. For storm drainage calculations refer to Mac Williams Eng. Ltd. storm drainage calculation sheets.

No.	Description	Date	By
	Revision or Issue		

THE SHAW GROUP

MAC WILLIAMS ENGINEERING LIMITED

Project
WEST BEDFORD
CONCEPT DESIGN
BEDFORD, N.S.

Drawing
PRE-DEVELOPMENT
DRAINAGE PLAN
(SUB-AREAS)

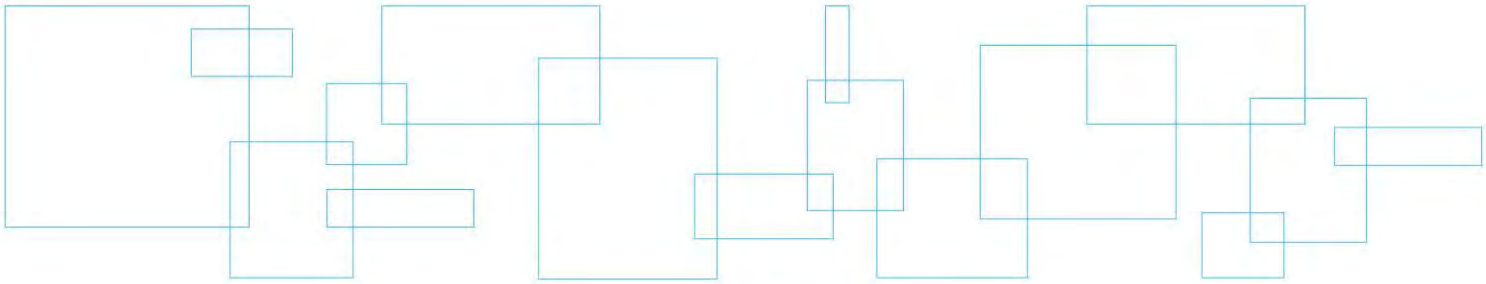
Scale 1:3000

DRAFT NOT FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER — D. M. WILLIAMS — 5111 — PROVINCE OF NOVA SCOTIA — XXX DATE

Date	Drawn
August xx, 2012	ACD
Design / Check / Approv.	
DMW / DMW / DMW	
Project No. 09540	Sheet No. Of 1 3
Drawing No. 10551-D01	Rev. 0

Appendix 2 Halifax Regional Municipality Bedford West Planning Study BW1-13 Policies



LVM | MARITIME TESTING

ENVIRONMENTAL PROTECTION

Objectives:

- to undertake stormwater management planning on a watershed basis with community design based on natural drainage patterns
- to prevent flooding of properties and safeguard flood plains
- to preserve the water quality of lakes and rivers
- to preserve groundwater flows
- to preserve and maintain significant environmental features
- to restore trees over area which have been disturbed by development activities
- to support regional initiatives in solid waste recovery, Halifax Harbour cleanup and watershed management

Policy BW-1:

No development agreement shall be approved unless a master stormwater management plan has been prepared, reviewed by the Bedford Waters Advisory Board and accepted by the Municipality. The management plan shall:

a) identify significant constraints and sensitivities with regard to flood potential, and environmental features and provide appropriate protection measures;

b) provide estimates of pre-development and post development flow rates (where post development flow rate means the expected flow rates upon full build out of an area as permitted by the development agreement) at critical locations within watercourses such as at culverts and other road crossings and at downstream developments;

c) outline the type and location of stormwater management facilities and the approach to protecting receiving waters from contamination, excessive flow rates and loss of aquatic habitat to protect the quantity and quality of groundwater flows; and

d) conform with the recommendations of the Bedford West Planning Area Subwatershed Management Plan (Jacques Whitford: May 2004) unless otherwise acceptable to the Municipality and the Province. Policy BW-2: No subdivision approvals shall be granted unless the detailed design specifications conform with the master stormwater management plan approved under policy BW-1.

Policy BW-3:

A water quality monitoring program shall be undertaken for the Paper Mill Lake watershed, illustrated on Schedule BW-2 to track the eutrophication process. The program is to be designed in accordance with national guidelines established by the Canadian Council for Ministers of the Environment (the CCME

guidelines) and undertaken by a qualified persons retained by the Municipality and financed in whole or in part by developers within the watershed area. Specifics of the program are to be negotiated under the terms of a development agreement in consultation with the Bedford Watershed Advisory Board. The monitoring program shall:

a) specify the duration of monitoring for the pre-construction, construction and post-construction phases of development. Pre-construction phase means a period of time before construction activity starts. Post-construction phase means a period of time that commences at full build out of the area permitted by a development agreement. Construction phase means the full time period between the pre-construction and post-construction phase;

b) specify the physical and chemical water quality indicators to be measured, the location and frequency of testing and the format of submissions to the Municipality in each phase referenced under clause (a);

c) establish physical and chemical water quality indicator threshold levels for the recreational uses of the lakes which would be used as a basis for re-evaluating watershed management controls and future development potential within the area. The threshold indicators are to be established prior to any development approvals being granted;

d) conform with all water quality policies, specifications, protocols and review and approval procedures approved by Regional Council.

Policy BW-4:

Where the Community Council is satisfied that a development agreement application has been made for a development proposal which could not be reasonably expected to impact the quality of water within the Paper Mill Lake watershed, the requirements of policy BW-3 may be waived.

The Community Council shall seek the advice of the Bedford Watershed Advisory Board before granting any waiver.

Policy BW-5:

In the event that water quality threshold levels, as specified under clause (c) of policy BW-3, for Paper Mill Lake or Kearney Lake are reached, the Municipality shall undertake an assessment and determine an appropriate course of action respecting watershed management and future land use development in the area. An assessment shall consider the CCME guidelines. Water quality thresholds and any assessment reports shall be made available to the public.

Policy BW-6:

No stormwater shall be discharged directly into any natural watercourse without the use of mitigative measures as stipulated in under the stormwater management plan and in accordance with municipal and provincial guidelines.

Policy BW-7:

No development, grade alteration, excavation, fill, pavement or removal of natural vegetation shall be permitted within one hundred (100) feet of the high water mark, or within the limits of any 1 in 20 year

flood plain of Kearney Lake, Kearney Lake Run or Black Duck Brook or within sixty-six (66) feet of the high water mark of any other watercourse, or within the limits of any 1 in 20 year flood plain of any watercourse, except as provided for by development agreement in accordance with an approved water management plan approved pursuant to the provisions of policy BW-9 or as provided to allow for trail systems, transportation crossings or utilities.

Preservation of Trees and Environmentally Significant Features

Objectives:

- To identify, preserve and maintain significant environmental features;
- To protect riparian buffer areas around lakes and watercourses;
- To minimize site disturbance, maximize tree retention and to restore trees over area which have been disturbed by development activities

Policy BW-8:

No development agreement shall be entered into over lands on which trees have been removed except:

a) as may be required for a bonafide land survey;

b) to satisfy any provincial or federal requirements; or

c) where, in the opinion of Council, the extent of such cutting would not preclude achieving the three objectives stated above.

Policy BW-9:

Within any watercourse protection setback established under policy BW-7, no vegetation or soil shall be removed or altered unless a management plan has been approved to provide for restoration of vegetation, shoreline access paths, habitat management, safety and welfare or shoreline recreation where such provisions may be made without adversely affecting the primary purpose of preserving water quality in the lake. Any study or management plan submitted pursuant to this clause shall be prepared by a person qualified to make the required determinations and an approval procedure shall be established under the terms of a development agreement

Policy BW-10:

Wetlands, lakes, watercourses, endangered species habitat and any other features of environmental significance shall be delineated as non-disturbance areas under development agreements. Non-disturbance areas shall be located to allow for continuity of non-disturbance areas on abutting lots, municipal parkland and open space dedications, and natural areas adjacent to watercourses.

Policy BW-11:

A tree replanting program shall be incorporated into development agreements. The program shall specify the locations, number, type and diameter of trees to be planted. The type of trees shall be indigenous to Nova Scotia.

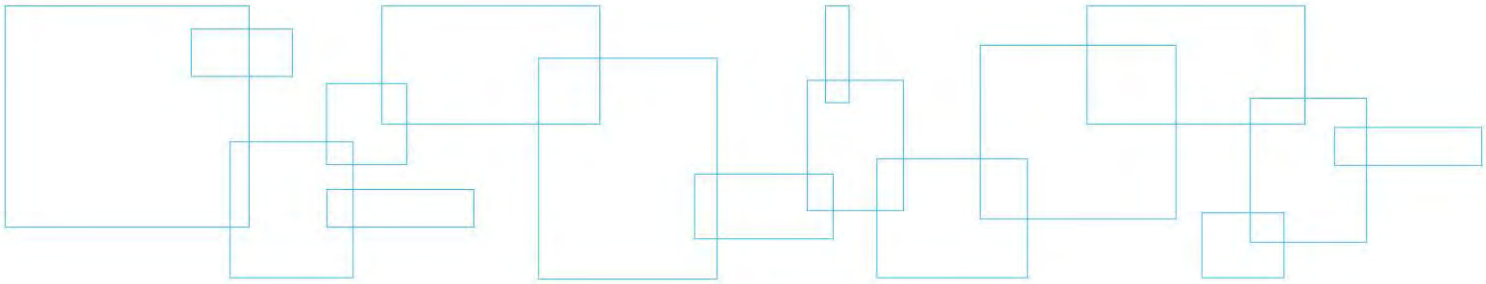
Policy BW-12:

Development of major land areas on slopes in excess of twenty-five percent (25%) shall be prohibited under any development agreement except where it can be demonstrated that such development would not create any hazard and could better preserve open spaces or areas of environmental value.

Policy BW-13:

The Municipality may allow for modifications to the service system specifications adopted under subdivision regulations where such modifications would enhance the ability to preserve the natural environment without compromising the intended objectives of the service systems.

Appendix 3 Erosion and Minimization Plan



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1. CONSTRUCTION SCHEDULE

Environmental Concern

The probability for erosion and sedimentation on construction sites is highest during precipitation events. According to 30 year records at Shearwater Airport, the greatest amounts of precipitation occur during winter and spring months. The maintenance and inspection of the Erosion and Sedimentation controls is critical during this period

This area is predominantly a bedrock site of greywacke bedrock of the Goldenville Formation Meguma Group. Areas of overburden consist of native surficial soils consisting of glacial till deposits comprising gravel, sand and silt. The characteristic permeability of these soils is considered moderate. Though these soils are only moderately erodable the construction on the site must proceed with caution to ensure that the environmental protection measures are adhered to and enforced.

2. CLEARING AND GRUBBING

Environmental Concern

Clearing activities in the vicinity of a watercourse will cause disturbance of the protective vegetative buffer or riparian zone adjacent to the watercourse and could subsequently lead to erosion of the approach slopes and sedimentation into and the obstruction of the watercourse. For construction projects, there are three categories of erosion and sediment control: runoff controls, erosion protection, and sediment interception.

Runoff controls limit or contain soil movement from the construction site, minimizing raindrop impact on the soil and reducing runoff volume and runoff velocities. Generic controls considered for this Project are discussed below.

Erosion protection measures are used to reduce or eliminate the detachment of soil particles by falling raindrops or to resist sheet or channel flow. These measures are placed on, or applied to, the soil surface and are often used in conjunction with runoff control and sediment interception measures. Erosion protection measures to be used as appropriate in pipeline construction include:

- gravel sheeting;
- mulches;
- tackifiers;
- erosion control blankets; and
- revegetation.

Re-vegetation is generally used only for permanent protection and often requires another form of temporary protection measure to be successfully established.

The key to managing runoff and stormwater flows is to minimize erosion and sedimentation. Methods for managing stormwater flows include:

- sediment traps
- sediment basins
- diversion swales and ditches

Best Management Practice

- Before any clearing or grubbing commences. clearing limits, easements, setbacks, sensitive/critical areas and their buffers, trees and drainage courses will be delineated with flagging tape. This practice ensures workers can clearly recognize areas to be protected.
- No clearing or construction will occur within the protective green/belts/protected sensitive areas as identified on the development plans.
- To reduce the velocity of runoff, crop residues, plants, and rough soil surfaces are applied to help spread the flow of water over a greater area and into a thin layer.
- Diversion berms are commonly used on slopes to intercept sheet flow on exposed surfaces and to reroute flow into undisturbed areas. Erosion protection is required at the berm outlets.
- Check dams are a temporary measure constructed in ditches, swales, or chutes to reduce hydraulic gradient and flow velocity, thus minimizing the potential for erosion of the channel.
- Sediment traps and swales or dikes (diversion channels) will be installed around each lot before construction begins to control excavation water and where required to intercept runoff \from sheet flow from entering the disturbed house pad area. Necessary erosion control measures such as interception ditches will be completed prior to clearing of each work site.
- The work site will not be cleared nor will topsoil be removed prior to commencement of construction
- Cleared and graded areas will be limited to minimize the area of exposed soil
- Minimal amount of natural vegetation and topsoil will be removed at each construction site
- Home sites will be cleared and grubbed and will be stabilized immediately following the completed excavation.
- Mulches consisting of wood chips, stone or commercial anti-erosion mats will be used to limit erosion on land, which is cleared of vegetation.
- All non-mercantile timber will be chipped on site and used as temporary protective cover over exposed and disturbed areas.
- Grubbed material, which is not used for fill, will be disposed offsite in accordance with Nova Scotia Environment’s legislation and Halifax Regional Municipal Bylaws.

- The contractor and developer will maintain a stockpile of erosion control material onsite.

3. GRADING

Environmental Concern

Grading requirements near watercourses can be extensive in housing developments to accommodate lot and street development. Accordingly, slopes may be contoured to allow for the site development. Disturbance of the slopes may cause instability, which could result in erosion and subsequent sedimentation of watercourse.

Soil loss from slopes may occur even with erosion and runoff control measures. If this soil can enter a waterbody, mitigative measures will be required to intercept it. Methods used to trap sediment include vegetated buffer strips, silt fences, filter berms, and sediment traps.

Best Management Practices

- Construction along the access roads will be sequenced such that each section is to be completed and stabilized before proceeding to the next section unless overlapping work is approved by the project engineer.
- Work along the streets will not exceed 500 metres. The contractor will work continuously until the streets are completed. If work is halted for 5 days, temporary stabilization structures and material will be installed.
- A crushed rock construction entrance will be established to prevent tracking of mud offsite and through the new and adjacent subdivisions.
- Lot grading will entail completion of each lot driveway first and vehicular travel on the lot will be restricted to the driveway. Access to each lot will be restricted to one driveway.
- The driveway will consist of clear stone or gravel to a thickness of three to six inches. If necessary, filter fabric will be laid under the stone if fines are encountered. This surface will be maintained during construction.
- Once the house pad is graded, the exposed pad unless prepared from rock fill will be graveled with clear stone. All exposed soil or unworked home sites will be stabilized no more than 5 days upon completion of the construction.
- No mud, debris or other excavation material will be placed on the street. Fill material will not be stored next to the curb. Fill will be piled within the perimeter of the cleared lot (no more than 3 metres around the house pad) until needed for cut lots or landscaping.
- Imported fill material will be assessed to ensure that material is not composed of high percentage of fines.
- All stockpiled fill material will be covered with tarps or other material, which are secured, to protect it from rainfall.

- Diversions will be constructed at the top of each fill slope at the end of each work day, as needed. Diversions will be located at least 0.6 m uphill from the top edge of each fill. The outlet of diversions, if free of sediment, will be located on undisturbed or stabilized areas when possible. Otherwise, sediment laden runoff must be diverted to a sediment retention structure.
- Sediment traps, smaller than sediment basins, are more easily installed and moved as grading progresses, will be incorporated into the drainage pattern around each house lot. Sediment traps will serve areas less than 2 ha (5 acres). These structures will be placed downslope of the home lots to intercept runoff on relatively level areas or natural depressions.
- Sediment barriers will be used to treat small areas and include enviro-fencing, straw bales, filter fabric, gravel and earth berms. Barriers will be placed below disturbed areas subject to erosion including along the contour of exposed slopes; at the base of a slope; along a street or sidewalk; and at storm drain inlets. Barriers will not be placed in a drainage way with high volume or high velocity.
- All water pumped from ditches, swales or sumps should be discharged away from the watercourse and filtered through a sediment trap, 2 m^3 (3 yd^3) of class B gravel, filter bag, or undisturbed vegetation to filter out solid material before the water enters the watercourse.
- Silt accumulation along silt fences and swales will be removed regularly.
- Long and steep slopes on the construction site will be minimized to prevent erosional velocities from developing. If long slopes are present, they will be benched to interrupt the flow of water and minimize erosion.

4. CULVERT INSTALLATION

- A buffer zone will be established along the watercourse by placing geotextile silt fences on both sides of the channel. Work must be completed in the dry, therefore water will be diverted around the construction site.
- Diversion channels can consist of a ditch lined with polyethylene liners that are properly placed and secured. Sandbags or an impermeable dam will be installed at the inlet to divert the flow. Inlet and outlet protection to prevent erosion and scouring at the ends will be installed.
- Unlimited fording of watercourses by construction equipment will not be permitted.
- Culverts will be properly designed to handle the increased flows as a result of development and comply with NSE regulations with respect to the Watercourse Alteration Permit.
- Side banks of the channel will be stabilized and revegetated subsequent to completion of the culvert installation.

5. INSPECTION AND ENFORCEMENT

Environmental Concern

Thorough maintenance of all temporary and permanent erosion and sediment control measures will ensure the integrity of the aquatic resources they protect. Monitoring of the site following major rainstorms will determine that runoff control devices are effective and allow for the removal of accumulated sediment.

Best Management Practices

- With respect to sediment control, all work is to be completed to the satisfaction of the project engineer and HRM.
- On-site inspection will be an active part of any development and management program. The effectiveness of control measures will be inspected and monitored during rain events and maintained and upgraded as necessary or as directed by the Project Engineer or Environmental Inspectors.
- The Contractor and Project Engineer will incorporate a routine end-of-day check to ensure the integrity of the protection measures.
- Monitoring of meteorological conditions and forecasts as a proactive means will be conducted to minimize the potential for erosion.

6. RESTORATION AND PERMANENT PROTECTION MEASURES

The final restoration phase is critical for mitigation long-term impacts to watercourses. West Bedford Holdings Limited will incorporate all appropriate mitigative measures to ensure proper restoration of the sites adjacent to watercourses and channel of each watercourse.

Environmental Concern

Proper restoration of the watercourses and adjacent areas will minimize post-construction impacts to these areas. Implementation of permanent protection measures such as a stormwater management plan will minimize the volume of stormwater constituents into water courses.

Best Management Practices

- The sites will be reclaimed immediately to limit sustained erosion.
- Wood chips, vegetative growth or rock facing (riprap) on steep slopes will be restored in all denuded areas.
- Prompt re-establishment of vegetation will reduce the need for costly remedial measures caused by erosion damage to slopes.
- The targets to minimize and reduce contaminant input into the Kearney Lake / Papermill Lake system will be met through implementation of control devices that have proven to reduce contaminant inputs. The strategy recommended for this site is to provide an integrated approach to

stormwater management that is premised on controlling surface runoff and pollution at the source. Therefore, a hierarchy, or train, of stormwater management practices may include:

- stormwater lot level controls, which will be achieved using an overflow catchbasin piping arrangement, storage upon the roof and parking lot, CDS Stormwater oil/water separation units; and
- end-of-pipe stormwater management facilities which will consist of CDS Stormwater units (or approved equal), and velocity breaks prior to stormwater entering the natural water courses.
- Stormwater lot level controls involve measures to store and treat stormwater before it reaches the street conveyance system.
- End-of-pipe stormwater management facilities found to be most suitable for the proposed commercial development for treatment of the stormwater is the CDS Stormwater Unit (or approved equal) system for the following reasons:
    - performance does not depend upon soil characteristics;
    - no additional disturbance to the natural areas to create retention ponds or artificial wetlands;
    - the performance is definable and measurable; and
    - maintenance is simple and the HRM has the equipment required.

7. HAZARDOUS MATERIAL STORAGE AND HANDLING OF FUELS AND HAZARDOUS MATERIALS

Environmental Concern

Accidental spills of fuels, lubricants or other chemicals may enter watercourse and eventually reach the Kearney Lake / Papermill Lake Watershed. Proper storage and handling of these materials should prevent the probability of accidents.

Best Management Practice

- Machinery maintenance will not be performed in or near a watercourse, ditch or storm sewer. Some examples of maintenance include washing out cement mixers, changing oil, greasing, spray painting, cleaning of spraying equipment or painting equipment, etc.
- Any hazardous liquid including fuel and lubricants will be stored in a designated area surrounded by an impervious berm, which would contain a spill of the volume of all stored liquid.
- Solid hazardous materials including cement, lime and sulphur should not be stored within 25 m of a watercourse.
- Any spillage of a hazardous material into any watercourse will be reported to the Nova Scotia Environment’s Environmental Emergencies 24 Hour Service (424-5620).

8. CONTINGENCY PLANNING

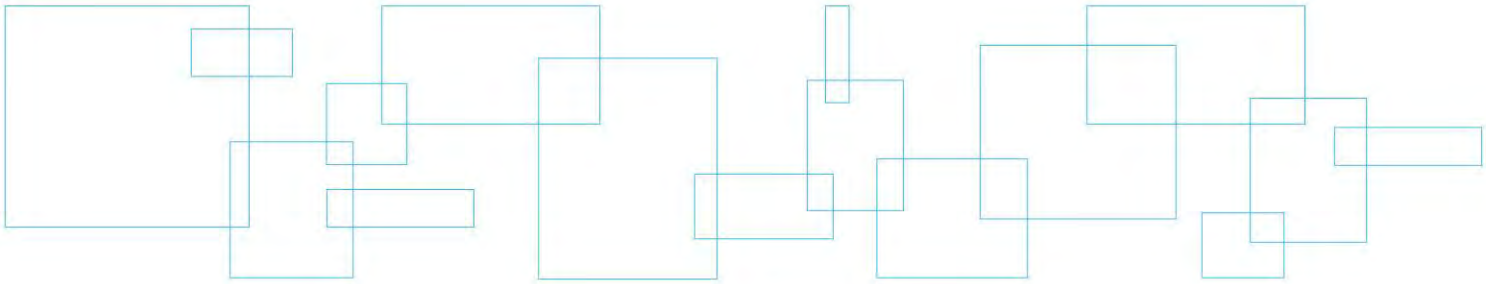
Extreme Storm Events

Extreme storm events (usually subtropical storms) can result in extensive erosion due to heavy rainfall impact and the associated stormwater runoff. Erosion of approach slopes adjacent to watercourses is to be expected during these events. Watercourse flows can be expected to increase suddenly, possibly exceeding the capacity of ditches, swales and sediment traps. Throughout the course of construction, the Environmental Inspectors must be aware of current meteorological predictions and the potential ramifications. Subject to a review of the construction activities planned for the day and the locations of these activities, the prediction of storm events will result in the suspension in the vicinity of watercourses and wetlands.

Excessive runoff can be mitigated or controlled by the use of additional diversion berms, straw bale check dams, sediment fences and/or sandbag barriers. Additional sediment interception measures such as sediment traps can also be constructed quickly. The CONTRACTOR will ensure that equipment, personnel and required materials will be available for application as required.

Following extreme storm events, Environmental Inspectors, will conduct environmental monitoring in those areas deemed at risk. Recommendations regarding erosion control will be made by the Environmental Inspectors as required.

Appendix 4 The Parks of West Bedford Best Management Practices Home Owners' Guide



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The Parks of West Bedford

Lawn Care Best Management Practices

Home Owners' Guide

THE PARKS
OF WEST BEDFORD
EMBRACING NATURE... ENJOYING LIFE.

West Bedford Holdings Limited

THE PARKS
OF WEST BEDFORD
EMBRACING NATURE... ENJOYING LIFE

West Bedford Holdings Limited Commitment

West Bedford Holdings Limited is dedicated to developing residential communities that are sensitive to low impact and sustainable development. Our goal is to not only plan and design residential communities that are responsible, sustainable and functional, but to inspire our Homeowners in the Community to learn from their decisions and to develop a greater appreciation for the environment and its resources. For this reason we challenge you the Homeowner to better understand your environmental responsibility within the Papermill Lake watershed.

The following Homeowner's Best Management Guideline will serve as a critical educational tool that each family should review and understand in order to preserve and enhance our most precious natural resource….*Water!*

Stop Runoff

Use a Rain Barrel -

Rain barrel usage is critical to the overall success of the stormwater management system. The benefits of using a rain barrel include:

- Stormwater that washes off rooftops and into downspouts is caught and retained.
- Homeowners use the water in the rain barrel as needed during the growing season.
- Water can be reused as needed in the garden or lawn landscape.
- Reduces stormwater runoff and pollution by providing treatment to the "first flush" of contaminants.
- Easy Installation suitable for all property types.
- Reduces water bills by not using potable water for irrigation.
- Water generated is very soft (low in minerals), which is good for plant growth.

The proper design, siting and maintenance practices are necessary to ensure that the rain barrel is functioning appropriately and not becoming a nuisance or mosquito breeding ground in the development. The following guidance is intended to provide the proper siting, mosquito control and maintenance practices for your rain barrel.

Finding the best location for your rain barrel -

To find the best location for your rain barrel, the following techniques are recommended:

- Place rain barrel on a hard, level, and pervious surface. Concrete blocks, bricks, decorative blocks, or flagstones work well as a base.
- Locate rain barrel at downspout nearest to the garden you want to irrigate.
- Rain barrels work using gravity to drain The garden to be irrigated should be lower in elevation that the rain barrel.
- Ensure that the rain barrel overflow location directs water towards your yard and not your neighbors.

What about those pesky mosquitoes?

Many homeowners worry that rain barrels will create a breeding ground for mosquitoes. The following is a list of tried and trusted techniques that can be employed to control mosquitoes:

- Ensure that the mosquito proof screen on the rain barrel is installed and functioning correctly.
- Ensure that the base is pervious, so overflow does not collect and leave standing water for mosquito breeding.
- Inspect rain barrel weekly ensure that the lid is securely closed and the water is free of organic material.
- Mosquito larvae require 6-9 days to hatch. Completely drain the barrel once per week and clean if necessary to prevent the formation of stagnant water.

When properly encased with a mosquito proof screen, rainbarrels will keep out any mosquitoes from breeding

How do I take care of my rain barrel?

To properly care for your rain barrel, the following techniques are recommended:

- Keep spigot closed when not using water
- Routinely inspect gutters, downspouts, rain barrel intake and mosquito screens for debris.
- Keep lid secured and screens clear of debris. Make sure the overflow tube and hose are functioning correctly.
- If odours develop, drain the rain barrel and spray with a hose until clean.
- Completely drain rain barrel before winter leave spigot open during the cold months so water does not accumulate and freeze.
- Ensure that the overflow is draining properly and not causing erosion of the rain barrel base. An example overflow is shown in the figure to the left.
- Rain barrel water is NOT potable *do not drink the water.*

Go-Toxic Free

Lawn Fertilizer

There are many natural ways to fertilize a lawn before reaching for a store-bought fertilizer. Compost and grass clippings are a cost-effective and environmentally friendly way to provide your lawn with nutrients. If you feel the need to purchase a fertilizer to care for your lawn, use organic fertilizers or slow release fertilizers.

- Clean Nova Scotia indicates that generally a 4:1:2 (the ratio of nitrogen to phosphorous to potassium) fertilizer applied at rate of 1 kilogram nitrogen per 100 square metres (2 pounds per 1000 square feet) provides the proper balance of nutrients.
- Combine the fertilizer with organic material (a mixture of good-quality soil, sand and a source of humus) and add this to your lawn's surface.
- Use a slow release or organic fertilizer before a rain (follow labels). If rain is not expected, water the lawn prior to fertilizing.
- Know your nutrient needs by understanding your soil and lawn conditions (most people apply too much fertilizer and this impacts water quality and well as lawn health).
- Go natural! Forget chemical fertilizers and replace your lawn with native plantings. There are over 1,500 to choose from for our region!

Organic fertilizers are often overlooked as an effective method for lawn care and maintenance

Pet Clean-Up

Pet waste is a health hazard and a pollutant as it contains excess phosphorus and harmful bacteria which can harm lake water quality. The following guidelines will provide for the proper cleanup pet waste and the elimination of any health concerns due to contact concerns.

- Clean up all animal waste whether on your lot or on trails or other places in the community.
- During walks, bring a bag and dispose of the waste in the toilet, garbage, or a designate pet compost area.
- In your yard, encourage pets to use one location. This will make clean-up easier and this area can be isolated from the rest of yard, which can prevent accidental contact with the pet waste.
- Do not feed Geese - It encourages them to frequent your yard and generate waste in your yard, driveway, or sidewalks.
- Pick up after pets before cleaning patios, sidewalks or driveways. Do not spray waste onto streets or into gutters.

Pesticide Use

Pesticides should be applied only as a last resort, or not at all. The major source of pesticides in urban streams is home applications to kill insects and weeds in the lawn and garden. If you need pesticides, only certain pesticides are permitted in HRM. Learn what pesticides are acceptable for trees, shrubs, plants, flowers and lawns in the HRM. Call Clean Nova Scotia (902) 420-6593 or visit the HRM website http://www.halifax.ca/pesticides/rules.html

Naturalize

Use Native Species

Many native species are suited to growing in a wide range of ecological conditions and they are usually best suited to the Nova Scotia climate. Because of this, once they are established they usually require less care and are a key element in creating a low maintenance and sustainable landscape. The species listed below are considered to be the types of species that would most usually found in the Parks of West Bedford area, however, use of other native species may also be appropriate. Final planting decisions should be made based on specific site conditions, species availability, and advice from landscape specialists.

Native Trees best suited for certain site conditions -

- Dry/Poor Sites: black spruce, balsam fir, white pine, red pine, white birch, grey birch, red oak, trembling aspen, and largetooth aspen.
- Moist/Poor Sites: black spruce, red maple, eastern Larch, and balsam fir.
- Average Sites: red spruce, white spruce, eastern hemlock, white pine, white birch, yellow birch, red oak, red maple, and sugar maple.
  Moist/Rich Sites: red spruce, white spruce, eastern hemlock, yellow birch, red maple, sugar maple, white ash, and ironwood.
- Native Shrubs: Wild raisin, serviceberry, false holly, Canada holly, velvet-leaf blueberry, lowbush blueberry, lambkill, bush honeysuckle, huckleberry, witch hazel, speckled alder, Labrador tea, rhodora, mountain ash, teaberry, spirea, striped maple, mountain maple, and beaked hazelnut.

Create Rain Gardens

A rain garden is a landscaping feature you can build to manage runoff. A rain garden will collect rain water and slowly filter water into the ground. They are usually a constructed depression (10-20 cm deep) that is designed to look like a natural area, but it will accept, infiltrate and clean stormwater. The rain garden will typically fill up with a few inches of water after a storm and within 1-2 days, the water will slowly filter into the ground. It is planted with wet and dry tolerant plants to absorb rain water. This technique encourages the recharge of the groundwater aquifer and uses the soil filters out any pollutants before the infiltrating water reaches the local groundwater table. When combined with a disconnected roof leader (downspout), the stormwater can be conveyed into the rain garden via a vegetated swale creating a high value natural landscape.

Rain gardens serve both a practical and aesthetic purpose; to clean and manage water run off, while creating a more beautiful landscape

Keep it Green

Lawn Irrigation

One of the key ways you can help to keep lawn care more sustainable is by thinking about how you keep your lawn irrigated. Turf grasses and other plants in a native landscape need water for growth and development. By implementing proper irrigation practices, lawn quality and aesthetics will be improved, while at the same time, lowering water bills. By watering infrequently and deeply you can help improve the health of your lawn. The following techniques will put you on the path to proper lawn irrigation practices and prevent over watering:

- A typical turfgrass requires 2.5 cm of water per week (through rainfall or irrigation), which will soak the upper 10 cm of soil.
- Monitor your irrigation by placing a can in path of sprinkler flow and stop irrigation once 2.5 cm of water has accumulated in the can.
- Ideal irrigation times are when temperatures are cooler in the early morning or early evening and when wind speeds are low.
- Let lawn completely dry out between irrigation intervals. The soil should be difficult to penetrate before irrigation.
- Lawns require water when the grass turns light-green to brown in color and the stalks remain bent over after being walked on.
- Stop irrigation when puddling or runoff occurs. Excessive moisture can potentially cause fungal disease in grasses and also prevents grasses from extending deep roots.
- Where possible, reuse collected stormwater from rain barrels for irrigation of gardens or smaller areas.
- Use sprinkles with uniform water application patterns. Do NOT aim sprinklers in a pattern that will water sidewalks, driveways, or the sides of homes.
- Without watering, most lawn grasses will go dormant over the hot summer months. This should not be a concern and the grasses will begin growing again during the cool season months.

Lawn Mowing

The frequency, height, pattern and condition of a lawn mower can impact the quality and sustainability of a lawn landscape. The following items provide a recommendation for maintaining your lawn through proper lawn mowing practices:

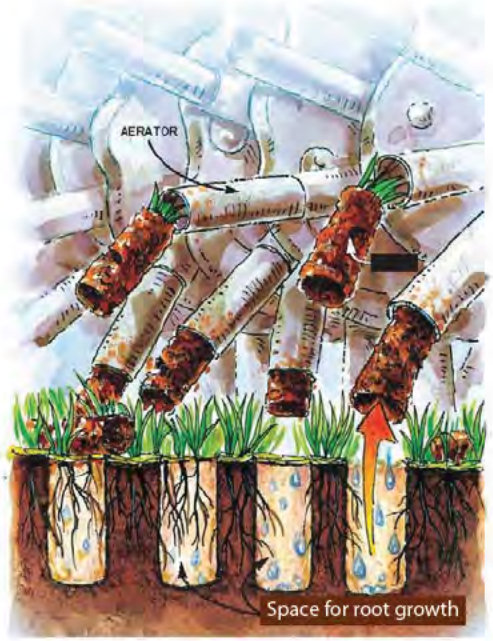
- Always use a sharp blade A dull blade will damage the remaining grass blades, potentially stunting future growth.
- Always mow when the grass is dry
- Mow at regular intervals (every 5-7 days).
- Cut grasses to a height of 6-8 cm. Higher cut grass will shade out weeds and encourages deep root growth.
- Never mow more than 1/3 of the grass blade This puts additional stress on the grass, potentially stunting growth.
- Use a mulching lawn mower and leave grass clippings on yard. The cut grass will contribute nitrogen to the soil and reduce fertilizer use on the yard.
- Avoid mowing when turf is under heat and drought stress.
  Alter the pattern with each mowing event to reduce wear on the grass surface.
- Wear appropriate safety gear, which includes long pants and shirt and eye/ear protection.
- Use a low emission lawn mower. According to Canada's Clean Air Foundation, a standard gas mower will emit the same amount of air pollutants in one hour as driving a new car for over 550 kilometers.

Keep it Green

Dethatching

Thatch is a layer of living and dead organic material that lies on top of the soil that can be a home to insects and fungus spores as well as prevent water, fertilizer and air from reaching the soil. The information below provides information how to avoid thatch formation and the removal of thatch should it become a problem:

- Avoid over fertilization and excess pesticide application. Thatch buildup is typically due to excess nitrogen and pesticide in the growing zone.
- Mulching lawnmowers do NOT cause thatch buildup.
  If thatch buildup becomes a problem, maintenance will be required on a yearly basis. The following options are available for thatch removal/control:
- Aeration - Mechanical aeration equipment will break up the thatch, allowing air to penetrate the soil and enhance thatch decomposition.
- Heavy Raking- A manual removal method for thin thatch layers.



Regular ground aeration is vital for a long lasting and healthy lawn

Manage your downspouts -

Roof leaders (downspouts) at the Parks of West Bedford where ever possible are directed to lawns and vegetated areas to recharge groundwater. The installation of a downspout diverter can help you to direct water to certain areas on your lot. Benefits of this technique include:

- Low cost alternative that directly reduces stormwater runoff.
- Allow management/use of stormwater on the property.
- Reduce water bills by using stormwater to irrigate lawns and gardens.
- Reduce the volume of stormwater runoff to end of pipe facilities.

Downspouts should drain the water away from any impervious areas, such as the foundation or driveway, and into vegetated zones

Get with the Program

Get to know your site

Getting to know your site is critical in helping you to create a more sustainable landscape. Consider the following options in caring for your land:

- Be sure you are not removing desirable native plants that are already well adapted to your site.
- Consider how much sunlight your site gets over the course of a day.
- Know your soil type! Does your soil hold moisture? How quickly does it drain? This can help you in choosing the right species and stormwa -ter management techniques.
- Plant a diverse mix of native species and understand how your chosen plants might 'creep' into adjacent areas.
- Over time, the cost of using native plants for landscaping is less than non-native plants. Think of our plants as long-term investments that can be phased in as your budget allow
- Make sure plants are not dug from the wild. This depletes the resource and many species do not thrive after transplanting.
- Consider interseeding (no till) or plugging plants into existing vegeta tion in places such as thin lawns, or sparsely vegetated old fields. This can result in fewer new weeds.
- Consider using shade trees screen your home from the sun they help keep you comfortable, and save money on air conditioning.

Green Bin Composting

We are lucky in HRM to have an advanced recycling program than can help us in managing our waste. Significant accumulations of grass clippings, leaves, pruned branches, and other vegetative material are typically produced during the growing season. The following guidelines outline the proper handling of these materials to help sustain a low maintenance landscape:

- Use your Green Bin for leaves & brush, and house & garden plant waste.
- Excess leaf & yard material can be placed alongside the cart using orange or clear plastic bags or heavy paper bags - 20 bag limit, 25 kg (55 lb) maximum weight per bag.
- Branches should be tied in armload - sized bundles - maximum 5 bundles. Each bundle not exceeding 34 kg (75 lb) and no individual piece in the bundle more than 4 feet long (1.2 m) or larger than 8 inches (0.2m) in diameter.
- Create your own compost for your landscape needs. Learn more from HRM at http://www.halifax.ca/wrms/backyardcompost.html or the Resource Recovery Fund Board at http://www.rrfb.com/pages/compost/Compost.html
- Leave grass clippings on the grass. If possible, use a mulching mower, which will spread the grass clipping through the grass and put nutrients back into the soil.
- If a mulching mower is not available, dispose of grass clippings in your green bin or compost, or spread clippings in a vegetable or flower garden, as a mulch under bushes or add to the soil.
- Rake leaves, seeds, and grass clippings out of the street and gutter.
- Do not dispose of organic debris by dumping it in or near water bodies