



**WESTPHAL WATERSHED AND
STORMWATER STUDY -
FINAL REPORT**

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Prepared for:
Halifax Regional Municipality

Prepared by:
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WESTPHAL WATERSHED AND STORMWATER STUDY – FINAL REPORT

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1 Introduction

The 2006 Halifax Municipal Planning Strategy (Regional Plan) provides guiding principles on the development of future settlement in the Halifax Regional Municipality (HRM) until 2031. Land development within a watershed has the potential to negatively impact the biophysical environment; therefore, the Regional Plan requires that prior to undertaking secondary municipal planning or considering amendments to existing secondary plans, HRM must complete watershed studies to aid in municipal planning. The assessment of study areas and watershed studies are intended to provide solutions and recommendations to existing issues or potential impacts due to future development, identify measures to improve or maintain water quality of water bodies within the watershed, and to mitigate the potential impact that future development may exert on these natural environments.

The areas being studied as part of this project are the remaining Future Serviced Communities identified for development by the Regional Municipal Planning Strategy (Regional Plan) and the Road to Economic Prosperity for African Nova Scotian Communities. Three areas were remaining that had not yet undergone the comprehensive neighbourhood planning process. These were: Sandy Lake, Highway 102 West Corridor and Morris Lake. A fourth area, Westphal was added to the future serviced development through the African Nova Scotian Road to Economic Prosperity Action Plan. This report focuses on the Westphal Expansion in the communities of Westphal and Cole Harbour.

This study was prepared in conjunction with the Land Suitability Analysis (Stantec 2024a) of the Westphal Study Area (WSA). More information regarding existing conditions of the site with respect to topography, geology, wildlife, wetlands, watercourses, forest habitat, species at risk, and contaminated sites can be found within the Land Suitability Analysis Report. Additionally, further background conditions on the site can be found within the suite of studies prepared for the Westphal Future Serviced Community, which include:

- Development Scenarios Report – Westphal (Stantec 2023)
- Westphal Transportation Study (Stantec 2024b)
- Westphal Water Servicing Plan (Stantec 2024c)

1.1 Background

The Westphal Study Area (WSA) is located in the communities of Westphal and Cole Harbour between Forest Hills Parkway and Lawrencetown (**Figure 1.1**). The area is roughly bounded by John Stewart Drive to the west, Highway 7 (Main Street) to the north, Ross Road to the east, Cole Harbour Road to the south. The WSA covers approximately 414.4 hectares (ha). Much of the land within the WSA is undeveloped (forested) and is located primarily within the watersheds (Little Salmon River watershed and Shore Direct Watershed) which drain into Cole Harbour with a small proportion that drains into Cow Bay (Cow Bay River watershed) (**Figure 1.1**). The dark blue line which delineates the watershed boundary used in the modelling differs slightly from the provincial secondary watershed boundary due to the use of different elevation datasets and results in slightly different boundaries. The LiDAR derived Study Area



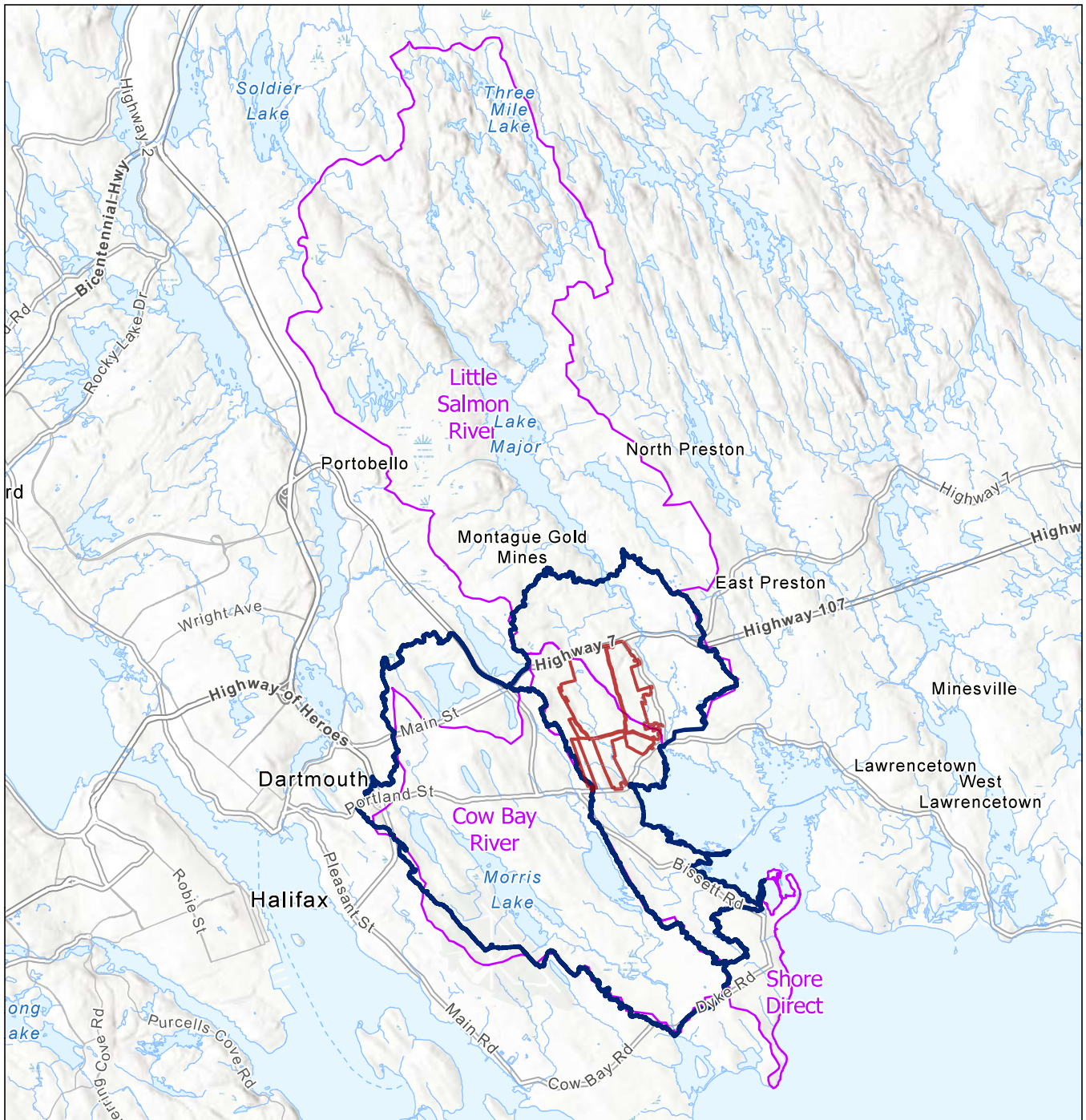
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watershed defined two catchment areas one overlapping a portion of the Cow Bay River Secondary Watershed and one overlapping the Little Salmon River and Shore Direct Watershed, as the Project is in the lower portion of the Little Salmon River Watershed the catchment delineation effectively identified a shore direct catchment draining into Cole Harbour via Little Salmon River amongst other tributaries.

Considering the small drainage area within the WSA that drains into the Cow Bay River watershed, the stormwater modeling assumes future development will be developed to route drainage north into the Little Salmon River watershed. As a result, the watershed model identifies drainage originating from Little Salmon River, Cow Bay River and Shore Direct Watersheds, while the stormwater modeling references only the Little Salmon River and Shore Direct watersheds.

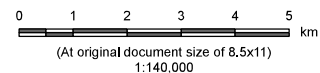
Broom Lake, located within the WSA, is within the Shore Direct Watershed, adjacent the Little Salmon River Watershed, near the north border of the WSA and has a lake surface area of 5,628 m². Bathymetry has not been mapped for Broom Lake, however there is a small stream (Broom Brook) that drains from Broom Lake south into Cole Harbour and into the Atlantic Ocean. There are no current established recreational uses of Broom Lake as it is only accessible via unmarked trails.





Legend

-  Study Area
-  Watershed Boundary
-  Secondary Watershed Boundary
-  Watercourse
-  Waterbody



Project Location
Halifax Regional Municipality,
Nova Scotia

Prepared by AC on 2024-04-17

Client/Project
Halifax Regional Municipality
Future Served Communities

160410459

Figure No.

1.1

Title

Project Location

Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Data Sources: Stantec; Halifax Regional Municipality, Government of Nova Scotia
3. Background: Esri

2 Watershed Study

The objective of this watershed study is to determine water quality impacts to sensitive or natural receptors within or downstream of the WSA. The focus of this study is on sourcing and quantifying contaminant loadings of phosphorus (P), fecal coliforms and sediment due to impacts of land-use change to the WSA and its contributing watershed area from proposed development scenarios. These specific contaminants were selected based on observed adverse effects to waterbodies around HRM from these contaminants. In this study, contaminant loading models for four land development scenarios (low-density, mid-density, developer requested, and areal land-use) were evaluated to understand the potential water quality effects resulting from each scenario. The outcome of the study is to provide a number of recommendations for the planning, design, and implementation of new developments that will help to maintain existing water quality.

2.1 Surface Water Quality Observations

Data collection on surface water quality for the WSA was completed by Stantec monthly from April to November 2023 at four locations across the WSA as shown in **Figure 2.1**. No previous or historical water quality has been collected from the study area. Water samples collected were intended to support the Westphal Watershed Study and the sampling program conducted may not be of sufficient duration or frequency to establish pre-development conditions. For areas where new or additional development could adversely impact watercourses, the Halifax Regional Municipal Planning Strategy mandates the completion of watershed or sub-watershed studies before undertaking secondary planning strategies. Developers must assess potential risks to water sources and establish monitoring programs to evaluate changes in water quality and quantity. This involves confirming parameters to be measured, determining sampling locations and frequency, and establishing baseline data prior to development.

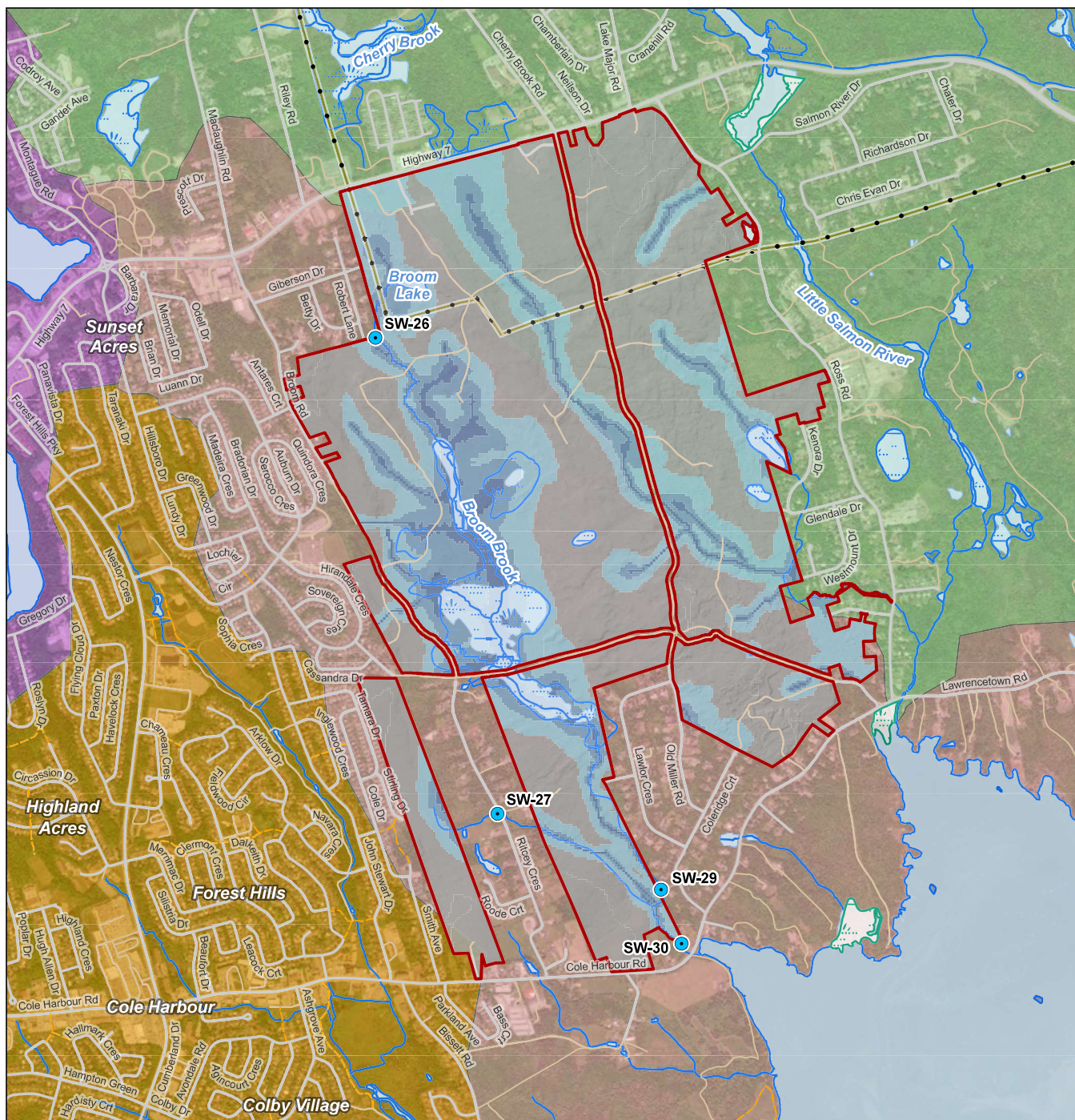
A description of local water quality and summary of the 2023 Stantec water quality results can be found in the *Westphal Land Suitability Analysis* (Stantec 2024) and results of the water quality monitoring can be found in **Table 2.1**. Water quality sampling began in April 2023 and the final round of sampling was completed in November 2023 at four locations (SW-26, SW-27, SW-29, and SW-30) across the WSA. Water quality stations SW-26, SW-29, and SW-30 are located on Broom Brook (**Figure 2.1**), whereas SW-27 is located on an unnamed watercourse that drains from wetland WLF on the western side of the WSA and runs beneath Ritcey Crescent before joining with the drainage from Broom Lake (SW-29). Water quality samples were submitted to Bureau Veritas Labs in Bedford, Nova Scotia (NS) for laboratory analysis of bacteria, total suspended solids (TSS), total phosphorus (TP), turbidity, colour, and chloride. Mean, median, maximum, and minimum water quality results were calculated for the four water quality stations, based on eight monthly datasets. Generally averages are used when describing water quality characteristics however in cases where water quality data does not follow a normal distribution (e.g., due to varying pollution sources, natural variation), the median provides a measure of the central tendency and reflects the typical water quality conditions providing an approximation of water quality within the watershed.



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Contaminant models were developed to assess key parameters that are particularly sensitive to changes in land use within a watershed, such as when forested land is developed to residential or commercial use. Probable causes of water quality impacts may be identified by examining changes to these key parameter concentrations. Total phosphorus, fecal coliform (represented by *E. coli*), and sediment were identified as key parameters that will be used to assess changes in trophic level/nutrients, water clarity, and anthropogenic inputs, respectively. A description of existing conditions of parameters that may affect the internal Total P loading of the lake including pH, dissolved oxygen (DO), temperature, and conductivity is provided in **Section 2.1.4**.





Notes
 1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
 2. Data Sources: Stantec; Government of Nova Scotia, Department of Service Nova Scotia and Internal Services
 3. Background: Government of Nova Scotia, Department of Service Nova Scotia and Internal Services

- Water Sampling Locations
- Water Table Depth (metres)**
 - 0 - 0.10 m
 - 0.11 - 0.50 m
 - 0.51 - 2 m
 - > 2m
- Watershed Context Lands**
 - Cow Bay River
 - Little Salmon River
 - Shore Direct
 - Shubenacadie River

- Utilities**
 - Transmission Line
- Transportation**
 - Highway
 - Road
 - Resource / Seasonal Road
 - Trail

- Other Features**
 - Waterway
 - Waterbody
 - Designated Wetland of Special Significance
 - Wetland (NSECC)
 - Study Area

0 250 500 Metres
 (At original document size of 8.5x11)
 1:24,000



Project Location
 Halifax Regional Municipality,
 Nova Scotia

Prepared by IProdrug on 2024-03-06
Revised by NWhite on 2024-03-14
Reviewed by MB on 2024-03-18

Client/Project
 Halifax Regional Municipality
 Future Serviced Communities
 Background Studies

Figure No.
 2.1

Title
**Watershed and Wet Area Mapping
 in the WSA**

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Table 2.1 Summarized Water Quality Results from the WSA Collected During Spring/Summer 2023

Location			CCME CWQG-FAL		Broom Brook			Unnamed Watercourse	
Parameter	Units	Value	Guideline Value	SW-26	SW-29	SW-30	SW-27		
Microbiological									
<i>Escherichia coli</i>	CFU/100mL	Mean* Median* Max* Min*	235 CFU/100mL ^A	327.8 390 >2500 9	258 290 600 <10	294 120 >2500 <10	374 245 >2500 <10		
Total Coliforms	CFU/100mL	Mean* Median* Max* Min*		1194 1300 >2500 370	800 760 1500 200	625 555 >2500 400	1217 46.5 >2500 28		
Inorganics									
Dissolved Chloride (Cl ⁻)	mg/L	Mean* Median* Max* Min*	maximum of 640 mg/L for short term exposures or 120 mg/L for long term exposures ^B	79.1 86.0 120 27	36.4 32.0 70.0 21.0	34.8 31 67 19	30.4 27.5 53 14		
Colour	TCU	Mean* Median* Max* Min*		23.5 12.0 54.0 7.9	130 122 230 55	113 112 190 49	71.1 46.5 170 28		
Total Phosphorus	mg/L	Mean* Median* Max* Min*	Trophic Status Ranges are provided in Table 2.2	0.040 0.034 0.066 0.021	0.022 0.021 0.029 0.017	0.024 0.022 0.032 0.018	0.041 0.030 0.090 0.022		
Total Suspended Solids	mg/L	Mean* Median* Max* Min*	maximum increase of 25 mg/L from background for short term exposures or 5 mg/L from background for long term exposures ^C	5.17 1.50 21.0 1.20	2.0 2.0 2.8 1.2	3.8 2.5 9.0 <1.0	35.6 4.1 250 1.8		
Turbidity	NTU	Mean* Median* Max* Min*		2.98 0.93 9.40 0.20	1.54 1.35 3.0 0.65	1.80 1.15 3.70 0.28	8.38 4.20 40.0 1.70		

* Mean, Median, Maximum, and Minimum were calculated from eight monthly results.

^A Health Canada 2024

^B CCME 2011

^C CCME 2009

* Mean, Median, Maximum, and Minimum were calculated from eight monthly results.

^A Health Canada 2024

^B CCME 2011

^C CCME 2009



2.1.1 TOTAL PHOSPHORUS

Phosphorus (P) is a common water quality parameter associated with the growth and proliferation of algae and aquatic vegetation in freshwater bodies. It is typically considered a limiting nutrient in natural freshwater systems, meaning it is not as readily available in comparison with other nutrients required for plant growth. The level of biological productivity within a lake is defined by the trophic level of the lake (**Table 2.2**). Lakes can naturally transition to a higher trophic level by accumulating nutrients (such as P) over thousands of years (Anderson 2002). In urbanized watersheds; however, the influence of human activities can cause an increase in P loading to waterbodies, contributing to an overabundance of vegetation and algae growth in a process called cultural eutrophication (Anderson 2002).

Table 2.2 Total Phosphorus Trigger Ranges for Canadian Lakes and Rivers (CCME 2004)

Trophic Status	Total Phosphorus (mg/L)
Ultra-oligotrophic	<0.004
Oligotrophic	0.004 to 0.010
Mesotrophic	0.010 to 0.020
Meso-eutrophic	0.020 to 0.035
Eutrophic	0.035 to 0.100
Hyper-eutrophic	>0.100

Levels of Total P in the WSA are presented in **Table 2.1**. Total P for the WSA ranged from 0.017 to 0.090 mg/L, with an average of 0.032 mg/L using data collected from eight samples during the Spring, Summer, and Fall of 2023 – which is classified as meso-eutrophic (**Table 2.2**). Similarly, the median Total P concentration in the WSA was 0.027 mg/L, is also classified as meso-eutrophic (**Table 2.2**).

Internal Loading

Internal P loading is the process by which P trapped in the sediment of a lake becomes resuspended in the water column (Sondergaard 2003). During periods of increased external loading of a lake system, organic and inorganic P can become trapped in the sediment. The increased loading of P within the lake during the internal loading process often leads to eutrophication and deterioration of the ecosystem health such as an increase in cyanobacterial blooms, dissolved oxygen depletion, turbid water, and poor aquatic habitat. Factors that can influence P solubility and release back into the water column include redox reactions (P sorbed into iron (III) compounds is released as iron (III) is reduced to iron (II)), resuspension of sediment, temperature, pH, chemical diffusion, microbial processes, and mineralization (Sondergaard 2003).

Anthropogenic watershed runoff is the primary source of external P loading into a lake (James 2016). Without the implementation of low-impact development (LID) or mitigation measures, runoff from the surrounding watershed can result in the deposition of P-rich sediment in lake basins.



2.1.2 FECAL COLIFORM

E. coli is a species of coliform bacteria of fecal origin, referred to as a fecal coliform bacteria. It is commonly used as a fecal indicator bacteria (FIB), denoting the potential presence of fecal matter containing pathogens and an associated risk to human health. Although there are other species of bacteria within the fecal coliform family, *E. coli* and fecal coliform are considered analogous in this report for the purposes of modelling. The presence of *E. coli* in recreational waters may come from wild or domestic animals in proximity to a waterbody. In urbanized watersheds, stormwater runoff and domestic wastewater discharge represent additional sources of *E. coli*.

Fecal coliform levels for the WSA are presented in **Table 2.1**, and individual sample water quality results are presented in **Appendix A**. *E. coli* levels for Broom Brook ranged from below the laboratory detection limit (<10 CFU/100 mL) to >2500 CFU/100mL (SW-26 and SW-30), with an average of 293 CFU/100mL and a median of 294 CFU/100mL using data collected from three surface water stations during the Spring and Summer of 2023. Total coliforms for Broom Brook ranged from 200 CFU/100 mL (SW-29) to >2,500 CFU/100mL (SW-26 and SW-30), with an average of 873 CFU/100mL and a median of 871 CFU/100mL using data collected from five surface water stations during the Spring and Summer of 2023. According to *Health Canada's Guidelines for Canadian Recreational Water Quality* (2024), the maximum acceptable single event *E. coli* concentration is 235 CFU/100mL. The *E. coli* levels reported for Broom Brook exceeded this guideline at surface water stations SW-26 (June, July, August, September, November 2023), SW-29 (June, August, September 2023), and SW-30 (August, September 2023).

Fecal coliform levels for the unnamed brook are presented in **Table 2.1**, and all water quality results are presented in **Appendix A**. *E. coli* levels for the unnamed brook (SW-27) ranged from less than the laboratory detection limit (10 CFU/100mL) to >2500 CFU/100mL, with an average of 374 CFU/100mL and a median of 245 CFU/100mL using data collected during the Spring and Summer of 2023. Total coliforms ranged from 28 CFU/100mL to >2500 CFU/100mL, with an average of 1217 CFU/100mL and a median of 46.5 CFU/100mL using data collected during the Spring and Summer of 2023. The *E. coli* levels reported for the unnamed brook exceeded this guideline at surface water stations SW-27 in June, August, and September.

Potential sources of fecal coliform bacteria within the WSA include runoff from wildlife and avian sources, as well as potential runoff from nearby anthropogenic sources such as the commercial area along Highway 7 (Main Street) (**Figure 2.1**). The lack of precipitation and dry conditions earlier in the summer mixed with the wet conditions in July could have caused increased concentrations in streams.

2.1.3 TOTAL SUSPENDED SOLIDS

Sediment carried in water has a variety of effects on water quality and is commonly measured as Total Suspended Solids (TSS) (mg/L) (Environment Canada n.d.). Sediment is associated with clarity of water and can decrease the penetration of light into the water which has the potential to impact the survival of fish and other aquatic life. Additionally, sediment plays a role in the transport and fate of pollutants in water as contaminants can attach to sediment particles and be transported and deposited in other areas. The CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME CWQG-FAL) for



suspended sediments is a maximum increase of 25 mg/L from background levels for short term exposures (e.g., 24 hours), and a maximum average increase of 5 mg/L from background levels for long term exposures (e.g., between 24 hours and 30 days) (CCME 1999).

Construction and land development projects accelerate the transport of sediment by exposing large areas of soil to rain and runoff within a watershed. Without implementation of erosion and sediment control measures, there is a risk of the degradation or destruction of fish habitat and impact to users of the lake or waterbody for recreational use.

TSS for Broom Brook ranged from less than the laboratory detection limit (1.0 mg/L; SW-30) to 21.0 mg/L (SW-26), with an average of 3.6 mg/L and a median concentration of 2.0 mg/L using data collected from three surface water stations during the Spring, Summer, and Fall of 2023. TSS for the unnamed brook ranged from 1.8 mg/L to 250 mg/L (SW-27), with an average of 35.6 mg/L and a median concentration of 4.1 mg/L using data collected from SW-27 during the Spring, Summer and Fall of 2023. Summary statistics for TSS concentrations in Broom Brook are presented in **Table 2.1**, and all water quality results are presented in **Appendix A**.

2.1.4 BASELINE GENERAL WATER QUALITY

Baseline water quality profiles of the WSA were collected between April and November 2023. The results from the monitoring are presented in **Appendix A**, and a comprehensive description of water quality for the WSA is presented in the Land Suitability Analysis (Stantec 2024). The following section describes the results of the *in-situ* water quality of the WSA for parameters that may affect the nutrient loading, including pH, dissolved oxygen (DO), temperature, and conductivity.

Water quality across the WSA is quite variable with pH values ranging from a minimum of 6.21 observed at SW-27 to a maximum of 8.10 at SW-29. The average pH value across the WSA was determined to be 7.13 which is within the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CWQG-FAL) (6.5 to 9.0). Dissolved oxygen values range from 4.68 mg/L (SW-27) to 14.62 mg/L (SW-30), with an average of 9.22 mg/L across the WSA. The CCME CWQG-FAL for DO is 6.0 mg/L for early life stage aquatic life and 5.5 mg/L for other life stages. The lowest average DO concentrations were observed in July 2023, and the average DO concentrations across all sites were 6.02 mg/L. Temperature measurements range from 0.1°C (SW-29 in November 2023) to 20.2°C (SW-29 in July 2023). Conductivity across the WSA range from 171.3 µS/cm (SW-30) to 512.97 µS/cm (SW-26), with an average of 297.2 µS/cm. Higher surface water conductivity typically indicates higher concentrations of dissolved ions in the water which can be from a variety of natural and anthropogenic factors including: urban runoff, natural geology, evaporation, saltwater intrusion, and stormwater/wastewater discharges.



3 Water Quality Assessment

3.1 Watershed Delineation

Watershed delineation was completed using LiDAR (HRM 2019), aerial imagery, and flow accumulation mapping (also known as wet areas mapping) (Stantec 2024). The wet areas mapping indicates depth to water table and can also be used to predict what areas may accumulate surface water in watercourses and wetlands (**Figure 2.1**).

The watercourses in this study were verified during field surveys conducted concurrently with the 2024 water sampling program. At each location where a watercourse was sampled for the water quality sampling program, the following information was collected:

- Channel and wetted width
- Water depth
- Substrate composition
- Bank description
- Functional in-water and riparian vegetation cover

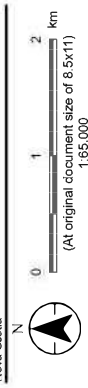
Land uses for the watershed were derived from Nova Scotia Department of Natural Resources and Renewables Forestry Layer as well as the zoning boundary layer from HRM. The results of the land use assessment are presented in **Figure 3.1** and **Figure 3.2**.



Nova Scotia Department of Natural Resources Land Use - Westphal Watersheds

Client/Project: Halifax Regional Municipality, Future Services Communities 160410459

Project Location: Prepared by AC on 2024-06-24
Halifax Regional Municipality, Nova Scotia



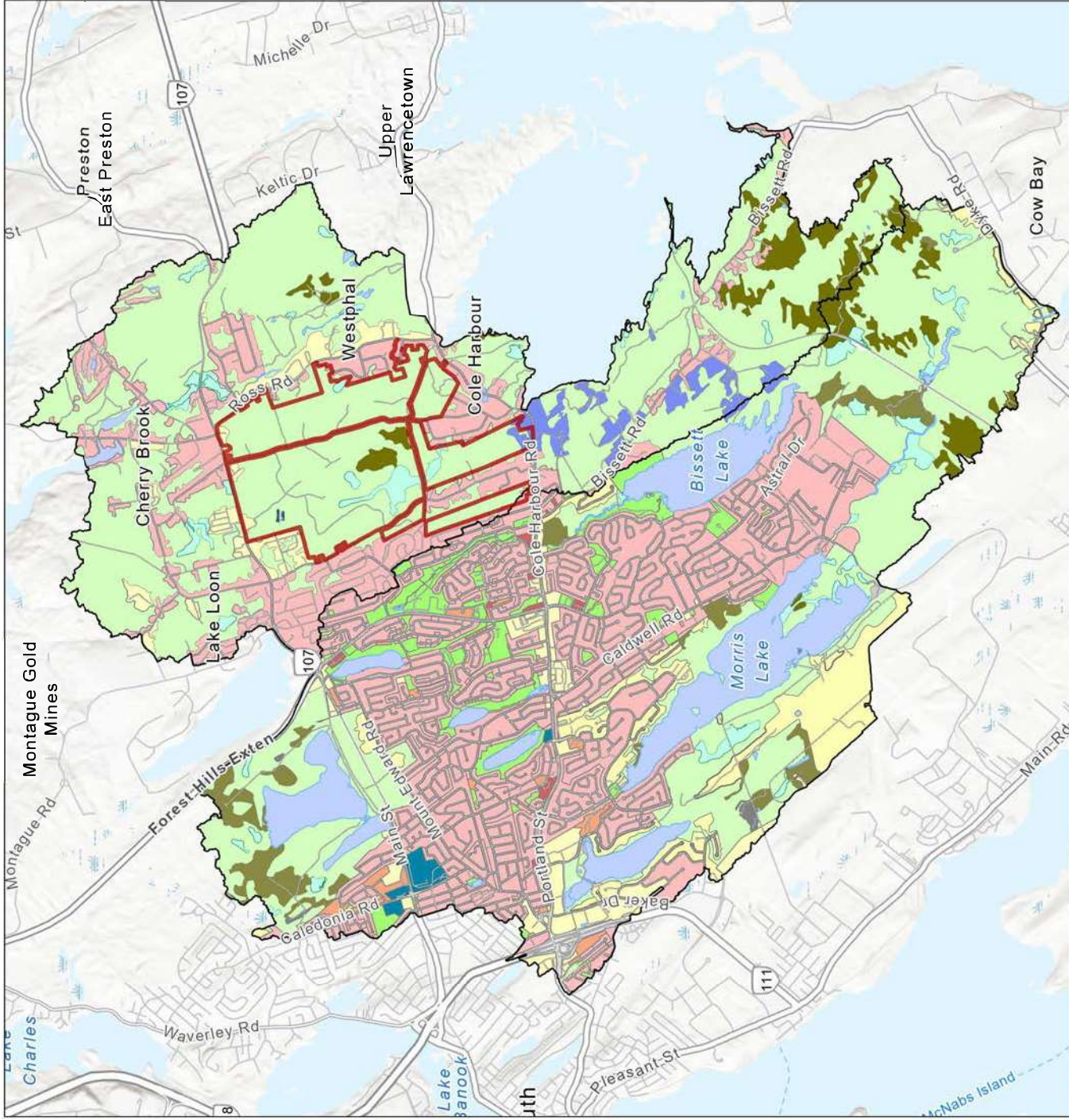
Legend

- Study Area
- Watershed Boundary
- Road
- Land Use**
 - High Density Residential
 - Medium Density Residential
 - Low Density Residential
 - Commercial
 - Institutional
 - Park
 - Forest
 - Agriculture
 - Gravel Pit
 - Non-Forest Misc
 - Rock/Dune/Barren
 - Other
 - Waterbody
 - Wetlands



Notes

1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Data Sources: Stantec; Halifax Regional Municipality, Government of Nova Scotia (DNR)
3. Background: Esri



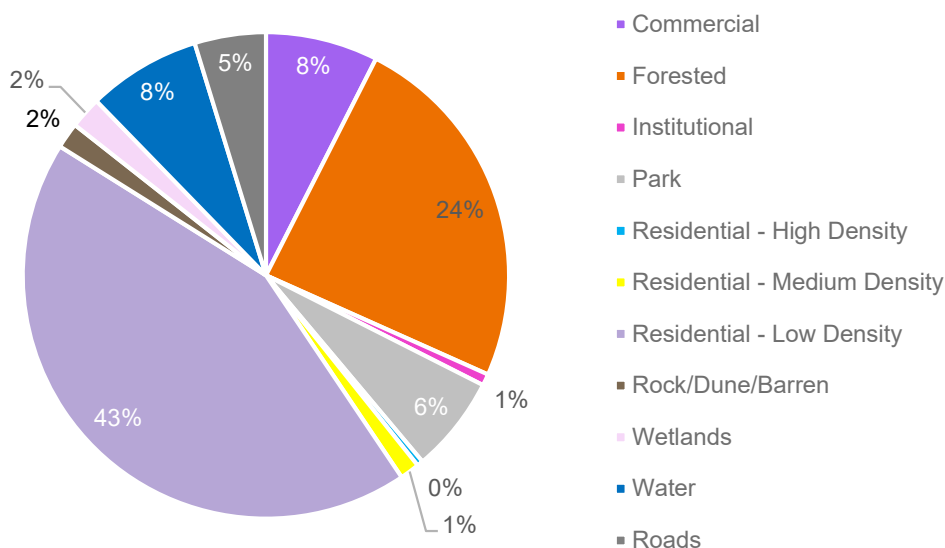


Figure 3.2 Westphal Study Area Land Use Breakdown

3.2 Climate

Climate normal data were used for an estimate of the annual rainfall in the study area. The Environment Canada Shearwater Climate Station (Composite Climate IDs: 8205090, 8205091, and 8205092) data from 1991 to 2020 were used. This station is located approximately 2 km from the WSA and is the closest climate station to the study area with a 1991-2020 climate normal dataset. For the thirty-year data period, the average annual precipitation is 1,414.2 mm per year (ECCC 2024). There are instances in Table 3.1 where the rainfall values exceed the total precipitation. The discrepancy arises because the total precipitation dataset covers a shorter period of records than the rainfall dataset at this location.

Table 3.1 Climate Normals Data – Shearwater Airport (Composite IDs: 8205091, 8205092, 8205090)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
R	87.5	69.9	107.0	94.7	122.5	102.0	101.0	81.8	109.8	141.4	123.0	110	1250.6
P	123.8	114	119.5	107.6	114.8	107.3	95.3	94.1	106.5	141	134.6	155.8	1,414.2
T	-4.1	-3.7	-0.3	4.5	9.5	14.4	18.5	19.1	15.8	10.2	5	-0.2	7.4
Notes: R = Rainfall (mm) P = Precipitation (mm) T = Temperature (°C)													

Annual precipitation amounts for 2023 at the Halifax Stanfield International Airport Climate Station were higher than the climate normal (1,396.2 mm) with a total annual precipitation of 1,575.2 mm – data for the



Shearwater A Climate Station for 2023 was not available. Large precipitation events during the months of June and July caused flooding events within the Sackville River Watershed.

As historical data is the input for calculating climate normals for a particular site, there is limited applicability of climate normals data to assess the future climate conditions. The Climate Atlas of Canada's online tool (Prairie Climate Center 2019) was used to generate projected climate change precipitation and temperature data for the Municipality of Halifax. This online data portal provides downscaled data projections of temperature and precipitation from an ensemble of 24 different climate models. Projected climate changes in temperature and precipitation associated with the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway 8.5 (RCP8.5) scenario over a 30-year time horizon were selected. The RCP8.5 scenario was chosen as it represents greenhouse gas emissions continuing to be released at current rates, i.e., a High Carbon climate future. The RCP8.5 scenario reflects an intermediate stabilization scenario for the emission of greenhouse gases, in which radiative forcing is stabilized at approximately 8.5 Watts per metre squared (IPCC 2020). Results of the climate change projections are found in **Table 3.2**.

Quantity and timing of precipitation on a watershed have the capacity to influence runoff volumes within the watershed. As precipitation trends increase, as shown in **Table 3.2**, greater runoff volumes are expected within the watershed; timing of these precipitation events have the potential to cause increased flooding events, changes to lake turnover rates, or sedimentation events within watersheds (Qiu et.al. 2021).

Table 3.2 Climate Change Projections – Halifax (RCP8.5)

Parameter	Averaging Period	1976-2005	2021-2050			2051-2080		
		Mean	Low	Mean	High	Low	Mean	High
Precipitation (mm)	annual	1,440	1,280	1,519	1,781	1,324	1,571	1,849
Temperature (°C)	annual	6.8	7.5	8.6	9.9	9.2	10.6	12.1

3.3 Development Scenarios

The WSA is being studied for future residential and commercial development. Four major owners —Kiel Development, Akoma Holdings, Annada Properties, and Jim Morash Construction—have declared their intentions to develop their landholdings. Kiel Development has the largest landholding within the WSA. Four development scenarios were assessed for changes in annual contaminant loads in this study and the details of each development scenario are provided in the *Development Scenarios – Westphal Study Area* (Stantec 2023) report. **Table 3.3** provides a breakdown of the land use changes to the total watershed area of the WSA for each development scenario. **Sections 3.3.1, 3.3.2, 3.3.3 and 3.3.4** provide short descriptions of each development scenario.



Table 3.3 WSA Development Scenarios Land Use Changes within Total Watershed Area

Land Use Type	Existing Land Uses (ha)	Low-Density Scenario (ha)	Medum-Density Scenario (ha)	Developer Requested Scenario (ha)	Areal Land Use Scenario (ha)
Commercial*	441.3	441.5	442.5	444.2	443.6
Institutional*	39.7	39.7	39.7	39.7	39.7
Forested**	2532.9	2271.9	2270.9	2269.2	2318.7
Parks**	331.6	331.6	331.6	331.6	331.6
High Density Residential (HDR)*	21.1	21.1	167.7	207.2	170.0
Medium Density Residential (MDR)*	66.6	66.6	104.4	114.9	105.2
Low-Density Residential (LDR)*	2515.3	2760.1	2575.6	2525.7	2523.6
Rock/Dune/Barren**	171.3	171.3	171.3	171.3	171.3
Road*	324.4	340.4	340.4	340.4	340.4
Water**	403.4	403.4	403.4	403.4	403.4
Wetland**	123.6	123.6	123.6	123.6	123.6
Totals					
Developed Land	3408.4	3669.4	3670.4	3672.1	3622.5
Undeveloped Land	3562.8	3301.8	3300.8	3299.1	3348.6
All Land	6971.2				
Notes: *indicates land use types used in sum for Developed Land. ** indicates land use types used in sum for Undeveloped Land.					

3.3.1 LOW-DENSITY SCENARIO

A Low-Density scenario will consider low-density housing and land cover approach to development proposing to reduce the density proposed by developers to understand the contrast between low- and high-development impacts on the watershed. This approach will utilize the current low density housing typologies, such as single detached dwellings. The total estimated population for the low-density scenario is 1,565 persons housed within 602 single family dwelling units in the WSA (Stantec 2023). This scenario has the family dwelling units using on-site wastewater treatment (i.e. septic systems) for household wastewater treatment. The other scenarios have the new family dwelling units using centralized wastewater treatment for household wastewater.

3.3.2 MEDIUM-DENSITY SCENARIO

A Medium-Density scenario attempts to optimize on the opportunity to create a moderate density while also balancing unit types between single family dwellings and multi-unit apartments (Stantec 2023). This approach accommodates low, medium-low, and medium-high density housing typologies such as single detached, duplex, townhouse, low-rise residential, multi-family medium density buildings, as well as



mixed-use buildings adding up to an 800% density increase compared to the Low-Density scenario. The Medium-Density Scenario results in a total of 7,156 residential units with a projected population of 14,934 residents in the WSA (Stantec 2023).

3.3.3 DEVELOPER REQUESTED SCENARIO

The developer requested density reflects the intentions of Kiel Developments Limited, Akoma Holdings Incorporated, Annada Properties Limited and Jim Morash Construction Limited and the corresponding estimated population for each development based on **Table 3.4**.

Figure 3.3 summarizes the total projected density for the WSA and shows the locations where current owners expect to develop their property. Lands shown in grey identify private homeowners, and institutional and commercial landowners who do not expect to develop or change the use of their property.

The proposed residential developments within the WSA will total 19,861 dwelling units with an estimated population of 35,149. A summary of all developer proposals can be found in **Table 3.4**. It should be noted that the developer requested scenario has the largest proposed population and is thus considered to also be the high-density scenario.

Kiel Developments Limited has devoted 152,900 square feet of space to commercial retail use. Akoma Holdings has proposed 90,664 square feet of commercial retail space while Annada Properties does not propose any commercial space for their concept (Stantec 2023). No commercial space is assumed for the vacant land to the south of the developer concepts. The total commercial space within the Study Area will therefore be 243,564 square feet of gross leasable area or 6.8 square feet per resident (Stantec 2023).

Table 3.4 Summary of WSA Developer Proposals and Common Elements

Developer	Proposed Development	Unit Breakdown	Total Estimated Population
Kiel Development Area – 247 acres	Development includes ground-based dwellings (singles, stacked townhomes), multi-unit apartment buildings, commercial and retail uses.	Singles – 153 Stacked Townhomes – 760 Multi-Unit Apartment – 4,122 Total – 5,035	9,794
Akoma Holdings Incorporated Area – 320 acres	Development includes ground-based dwellings (singles, stacked townhomes), multi-unit apartment buildings, commercial and retail uses.	Singles – 202 Stacked Townhomes – 740 Multi-Unit Apartment – 3,791 Total – 4,733	9,273
Annada Properties Limited Area – 228 acres	Development includes ground-based dwellings (singles, stacked	Singles – 56 Stacked Townhomes – 1,390	9,232



Developer	Proposed Development	Unit Breakdown	Total Estimated Population
	townhomes), multi-unit apartment buildings.	Multi-Unit Apartment – 3,040 Total – 4,486	
Jim Morash Construction Limited – 14.27 acres	Development includes single-family lots	Total – 5	13
Private Landowner – 215 acres Private Landowner - 127 acres	Development includes single-family lots	Total - 2,972 Total - 2,630	6,837
TOTAL		19,861	35,149
Commercial Space	GLA/Resident	Residents	Approximate Total GLA
Study Area Total	6.8	35,149	239,013

3.3.4 AREAL LAND USE SCENARIO

Following consultation with HRM, an additional development scenario was added to this study to evaluate areal land use change on contaminant loads within the WSA. This scenario (Areal-Land Use Scenario) consists of the Developer-Requested Scenario population; however, the development would be covering a 20% smaller land area. For example, the 264 ha of developed area in the Developer-proposed scenario was reduced by approximately 20% to 214 ha in the Areal scenario. However, considering the developer requested scenario represents 4% of the total watershed area this results in less than a 1% decline in developed area across the entire watershed, as shown in **Table 3.3**. The Areal-Land Use scenario is used to assess the value of maintaining naturally forested areas within the watershed and reducing developed land, while still maintaining the capacity to house a larger population. The land use breakdown for this scenario is presented in **Table 3.3**.

