

**Peats Point Subdivision  
Source Protection Study  
WHPA-E Zone Delineation  
and Vulnerability Analysis**

*Final Report*

*May 14, 2009*

*Quinte Conservation*

09-1460

*Submitted by*

**Dillon Consulting  
Limited**

May 14, 2009

Quinte Conservation  
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Attention: Mr. Mark Boone, P.Geo.

**Peats Point Subdivision Source Protection Study WHPA-E Zone  
Delineation and Vulnerability Analysis  
Final Report**

Dear Mr. Boone:

We are pleased to provide three copies of the final report Peats Point Subdivision Source Protection Study WHPA-E Zone Delineation and Vulnerability Analysis. The report addresses the technical requirements of the MOE Technical Rules – Assessment Report for mapping surface water related vulnerability zones for GUID wells.

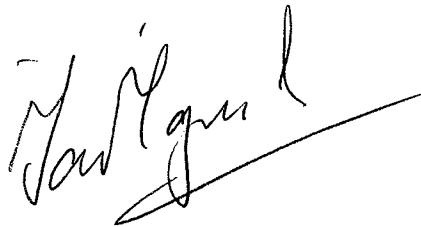
We look forward to assisting you with further Water Budget and Source Protection initiatives in the Quinte Region.

If you have any questions, please contact the undersigned.

Yours sincerely,

**DILLON CONSULTING LIMITED**

Igor Iskra, Ph.D., P.Eng.  
Project Manager



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## 1. INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Quinte Conservation to undertake the vulnerability assessment of the Peats Point Subdivision municipal potable water system. This information will be used as input into the Quinte Source Protection Region (SPR) Assessment Report, that will be submitted to the Ontario Ministry of the Environment (MOE) as part of the requirements under the *Clean Water Act*.

The study was completed in accordance with the MOE Technical Rules: Assessment Report, issued in December 2008. As a requirement under the Technical Rules, well head vulnerability zones are to be delineated for the Peats Point Subdivision municipal water system. In March 2008, Dillon issued an interim report that identified well head protection area (WHPA) zones A, B, C and D, which correspond to groundwater-based vulnerability areas. The MOE Technical Rules require that additional vulnerability zone be mapped for municipal wells that have been identified as Groundwater under the Direct Influence of Surface Water (GUDI) by O.Reg 170/03 under the *Safe Drinking Water Act*. The Peats Point Subdivision municipal well, which is a GUDI well, requires this additional study to assess its vulnerability to surface water contamination. According to the Technical Rules (Rule 5, Section 4) the vulnerable area delineation for a GUDI well should be completed according to the surface intake delineation rules (Rules 55-78). The new vulnerability zone is WHPA-E which is to be delineated according to the IPZ-2 rules.

## 2. WELL CHARACTERIZATION

The Peats Point Water Treatment Plant (WTP) is located at 49 Howard Crescent in the Peats Point Subdivision. It was built in 2005 and it provides drinking water for 19 dwellings. The WTP design flow is 80.4 m<sup>3</sup>/day. The average flow rate in 2007 was 14 m<sup>3</sup>/day. The Peats Point WTP has a two-stage water treatment process: filtration and disinfection (ultra-violet and chlorination with Sodium hypochlorite).

The well is considered to be under the influence of surface water from the Bay of Quinte.

The UTM NAD 1983 intake coordinates for the Peats Point Subdivision well were obtained from the GIS layer provided by Quinte Conservation as being 312416E and 4890207N.

### **3. WELL CLASSIFICATION**

For the purpose of the WHPA-E delineations, the Peats Point GUDI well was classified as Type D surface water intake (inland lake and others intakes) and was delineated according to the Part VI of the Technical Rules.

### **4. IDENTIFICATION OF SURFACE WATER BODIES**

Delineation of the WHPA-E zone is based on the location of the nearest surface water body to the pumping well. Rule 56 of the Technical Rules specifies that the Water Virtual Flow – Seamless Provincial Data Set (watercourses) and the Water Poly Segment GIS data layers (lakes, ponds, wetlands and wide rivers) are to be used to delineate surface water bodies. These data were obtained from Quinte Conservation. Based on this mapping, the well is located approximately 40 m north-west from the Bay of Quinte.

### **5. DELINEATION OF WHPA-E ZONE**

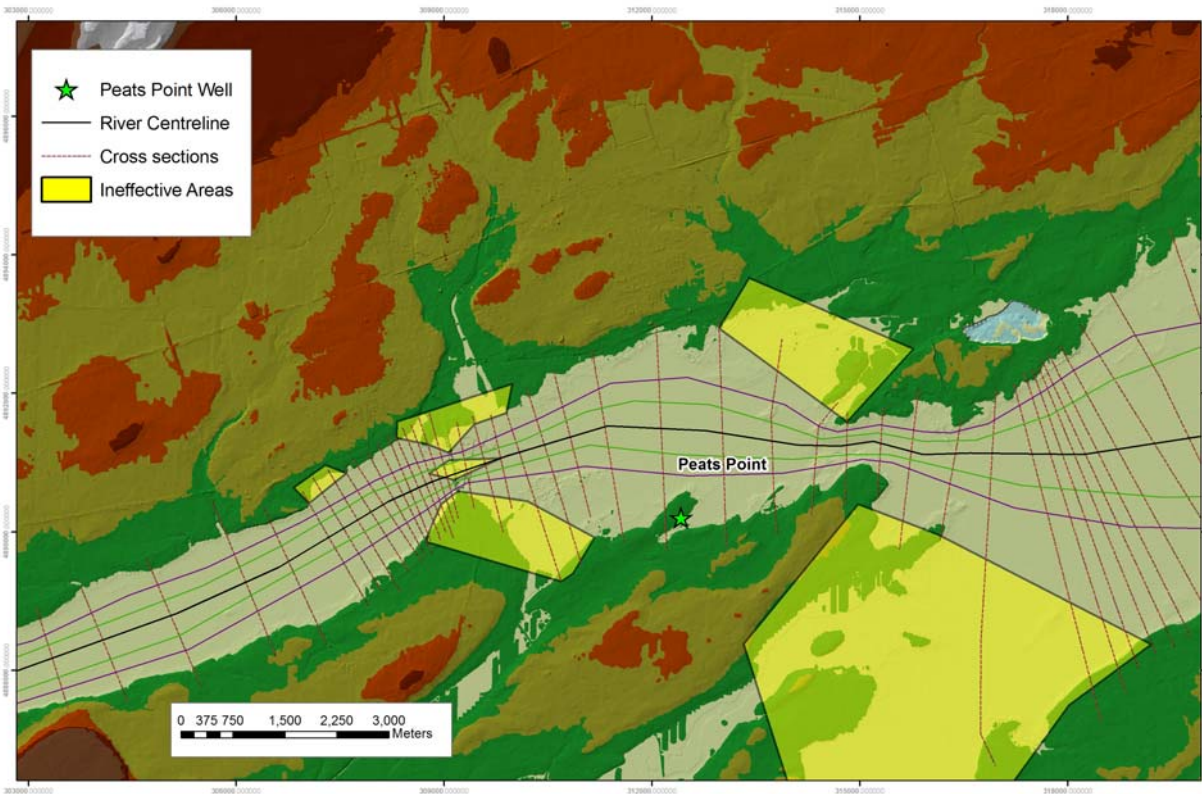
The zone known as WHPA-E (or IPZ-2 in the surface water terminology) was delineated according to Part VI.4 and VI.6 of the Technical Rules. Zone WHPA-E is composed of the following areas:

- the area within the surface water body that may contribute water to the well (or to its closest in-stream point) within 2 hours. It includes the instream portion representing the Bay of Quinte and the up-tributary portion representing small watercourses and drainage features that discharge into the Bay;
- a setback of not more than 120 m inland along the abutted land measured from the high water mark of the surface water body. The 120 m setback encompasses the area where overland flow drains into the WHPA-E.
- the area that contributes water to WHPA-E through transport pathways (i.e., tile drainage, stormwater drainage system, ditches along the roads, etc.)

#### **5.1 Instream Delineation**

In order to define the WHPA-E travel time limits based on average flow conditions within the Bay of Quinte, a one-dimensional HEC-RAS model for the Bay was used. The model was built for the Belleville and Point Anne Intake Protection Zone Study in 2007. The model coverage

area, centerlines, cross-sections and ineffective areas are shown on **Figure 1**. Variation in colours on the Figure represent differences in ground elevation.



**Figure 1:** Extent of HEC-GeorAS model.

The HEC-RAS flow and boundary conditions were used from the *Intake Protection Zone Studies, Belleville and Point Anne Surface Water Vulnerability Analysis* (Dillon, 2007). A steady flow analysis was considered to be adequate, which requires constant flow values at the upstream and at flow change locations; and for a sub-critical flow analysis, a boundary condition (or starting water elevation) at the downstream end of the river system. The flows entered in the model were obtained by examining Water Survey of Canada hydrometric data. The 2-year flow in the Bay of Quinte downstream of Trenton was estimated as 508 m<sup>3</sup>/s, while the flow in the Big Bay was 669 m<sup>3</sup>/s. Combined flow of the Moira River, Blessington River and Sawguin River between these locations was estimated as 161 m<sup>3</sup>/s. The downstream water level was selected as 74.2 m based on a low water datum. This will ensure lower flows and, as a result, more conservative travel times.

Once the parameters were entered into the HEC-RAS model, it was checked for correctness in mimicking the Bay's physical and hydraulic conditions, as well as for any errors related to data entry. Following this, the HEC-RAS model was run, and the hydraulics results were tabulated.

The results of HEC-RAS runs show that the flow velocities around Peats Point Subdivision are relatively low (0.09 – 0.18 m/s) and travel times between cross-sections are long, as could be expected for this wide bay. The 2-hour travel limits based on flow alone for three Peats Point well projections are shown on **Map 1**.

## **5.2 Wind-Driven Transport**

Wind-driven surface transport velocities have been determined based on historical wind records obtained for the Trenton meteorological station. Typically these transport velocities representing contaminant movement are estimated as 3% to 5% of the wind velocity measured 10 m above ground. One-hour time series of wind speed and direction obtained from MSC were processed to create a 2-hour time series that formed the basis of this analysis. The statistical distribution of wind velocities at each bearing was determined and was summarized to reveal mean, median and upper quartile values. Upper quartile values were used to predict travel velocities at each bearing since median or average values would predict transport in only the prevailing wind directions and would ignore the possibility of low frequency winds from non-prevailing directions. These values range from 1.81 km/hr from the east to 11.21 km/hr from the south-west. The resulting 2-hour travel distances for wind transport are shown on **Map 1**.

## **5.3 WHPA-E Zone 120 meter Set-Back**

As required by the Technical Rules, all streams and the Bay of Quinte were buffered with a 120 m set-back inland along the abutted land. The edge of the Bay of Quinte polygon was used to represent the high water mark required in the Technical Rules.

## **5.4 Transport Pathways**

There were no transport pathways identified in the WHPA-E zone.

## **5.5 Consolidated WHPA-E limits**

The Peat Point Subdivision well may interact with the surface water of the Bay of Quinte at least in three locations identified on **Map 2**. The WHPA-Ea, WHPA-Eb and WHPA-Ec zones were delineated based on these three interaction points. Each of these zones is the result of wind/flow transport and a 120 m setback as required by the Rules.

However, MOE Technical Rules do not envisage having several WHPA-E zones for one well. Therefore a decision was made to combine WHPA-Ea, WHPA-Eb and WHPA-Ec zones into one combined WHPA-E (**Map 3**).

## 6. VULNERABILITY SCORES

A vulnerability score was assigned to the WHPA-E zones in accordance with Part VIII, Rule 87 of the Technical Rules. The score is a product of the area vulnerability factor and the source vulnerability factor. Details on the calculation of the score are presented in the following subsections.

### 6.1 Area Vulnerability Factor

Area vulnerability factors were assigned to the WHPA-E zone as per Part VIII.2, Rules 88 to 93. For the WHPA-E zone, Rule 89 specifies a value that is not less than 7 and not more than 9. This value was derived based on the following criteria as required in Rule 92:

- The percentage of the area that is composed of land.
- The land cover, soil type, permeability and slope.
- Hydrological and hydrogeological conditions that contribute water to the area through transport pathways.

Some criteria for defining Area Vulnerability Factors are shown on **Table 1**. Soils in the WHPA zones are predominantly gravelly loam and sand with moderate slopes. The soils around the well consist of silty sand/sandy silt with moderate natural drainage characteristics. Significant percentage of the WHPA area is composed of water.

The overburden geology has been mapped by Leyland (1982) as being comprised of shallow drift over limestone bedrock. Generally, the overburden material in the vicinity of Peats Point Subdivision is less than 1 m thick, such that the above-mentioned soils do not provide significant protection to the aquifer from surface contaminants. The bedrock geology consists of limestone and shale of the Verulum Formation. The upper portion of the limestone aquifer can be considered an unconfined fractured bedrock aquifer. Both vertical and horizontal fractures are common in the top 30 to 50 m of the bedrock. The presence of vertical fractures results in the aquifer being susceptible to surface contamination. The lack of a protective low permeability



overburden layer results in the aquifer most likely being recharged quickly after precipitation events and being vulnerable to contamination from the surface (Dillon 2008).

Therefore, out of 3 possible numbers, the highest Area Vulnerability Factor of 9 was assigned to the Peats Point WHPA-E zone. The decision was mainly based on hydrogeology.

**Table 1.** Criteria for defining Area Vulnerability Factors for Well Head Protection Areas

	Soil Type	Average Slope	Land Use
WHPA-Ea	Predominantly gravelly loam with some areas of sand	2.6 %	Water - 7 %, Urban - 0%, Crop - 39%, Swamp/Marsh - 7%, Forest - 11%, Bog/Fen - 0%, Pasture - 33%, Other - 2%
WHPA-Eb	Mostly gravelly loam and gravelly sand	3.8 %	Water - 85%, Urban - 0%, Crop - 5%, Swamp/Marsh - 1%, Forest - 0.6%, Bog/Fen - 0% Pasture - 6%, Other - 3%
WHPA-Ec	Predominantly gravelly sand	6.1 %	Water - 91%, Urban - 0%, Crop - 0.2%, Swamp/Marsh - 0%, Forest - 0%, Bog/Fen - 0%, Pasture - 7%, Other - 2%
WHPA-E combined	A mixed of gravelly loam, gravelly sandy and sandy	3.0 %	Water - 61%, Urban - 0%, Crop - 15% , Swamp/Marsh - 3%, Forest - 4% , Bog/Fen - 0% Pasture - 15%, Other - 2%

## 6.2 Source Vulnerability Factor

A source vulnerability factor was assigned to the WHPA-E zone as prescribed in Part VIII, Rules 94 through 96 of the Technical Rules. The source vulnerability factor for a Type D intake can be 0.8 or 1.0 based on the following criteria as required in Rule 95:

- Depth of the intake from the top of the water surface.
- Distance of the intake from land.
- Number of recorded drinking water issues related to the intake (if any).

The well depth is 36.9 m and it intercepts a moderate-yield fracture at a depth of 32.8 m. The Peats Point Subdivision well is located about 40 m from the Bay of Quinte. Since the well was opened in 2005, there were no drinking water issues related to the intake. However, it should be noted, that disposal of sewage within the Peats Point subdivision and adjacent properties is though on-site septic systems which may recharge the groundwater.

The Peats Point Subdivision well has been identified as being GUDI, and therefore they may receive some water from the Bay of Quinte. Overall, the major source of water to the well is attributed to groundwater, however, a small, and unknown portion of water may potentially

originate from a surface water source. Raw water in the well may be prone to contamination from bacteria from the septic tanks.

Considering the potential impacts of the well from surface water, a value of 0.9 was assigned to WHPA-E. The score, which is at the middle portion of the recommended range for a Type D intake, reflects the condition that the well does not pump directly from surface water, however in close proximity of potential bacteria contamination.

### 6.3 Summary of Vulnerability Scores

The product of the WHPA-Ea zone vulnerability factor and source vulnerability factor is a vulnerability score of 8.1 suggesting a high vulnerability. The WHPA-Ea score is comparable with the IPZ-2 score for surface water intakes in similar settings in Ontario.

Similarly, the WHPA-Eb vulnerability score is 7.2 and WHPA-Ec score is 6.3 indicating a relatively lower vulnerability. Lower values of the WHPA-Eb and WHPAc Area Vulnerability Factors reflect the increased travel time to the intake.

These scores will ultimately be used as part of the water quality risk assessment within the zones. **Table 2** summarizes the source vulnerability factors and scores assigned for each WHPA zone. The combined WHPA-E vulnerability factor was conservatively assigned the same value as for WHPA-Ea.

**Table 2.** WHPA Vulnerability Factors and Scores

Intake Protection Zone	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
WHPA-Ea	9.0	0.9	8.1
WHPA-Eb	8.0	0.9	7.2
WHPA-Ec	7.0	0.9	6.3
Combined WHPA-E	9.0	0.9	8.1

## 8. REFERENCES

1. Dillon, 2007, Intake Protection Zone Studies, Belleville and Point Anne Surface Water Vulnerability Analysis, November 2007.
2. Dillon, 2008, Peats Point Subdivision Municipality of Prince Edward County Wellhead Protection Area Delineation Update, Draft Report, March 31, 2008.
3. Leyland J.G., and Mihychuk M., 1982, Quaternary Geology of the Belleville Area, Southern Ontario: Ontario Geological Survey, Map P.2540. Geological Series-Preliminary Map. Scale 1:50,000, Geology 1981.
4. Ontario Ministry of the Environment, 2008, Technical Rules: Assessment Report. *Clean Water Act*, 2006. Released December 12, 2008, 56 p.
5. Prince Edward County website:  
[http://www.pecounty.on.ca/government/public\\_works/water\\_wastewater/water/peats.php](http://www.pecounty.on.ca/government/public_works/water_wastewater/water/peats.php)

## 9. LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon Consulting Limited ("Dillon") as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Although a reasonable investigation was conducted by Dillon, Dillon's investigation was by no means exhaustive and can not be construed as a certification of the absence of any contaminants from the site(s). Rather, Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. It is therefore possible that currently unrecognized contamination or potentially hazardous materials may exist at the site(s), and that the levels of contamination or hazardous materials may vary across the site(s). Further review and updating of the report may be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are

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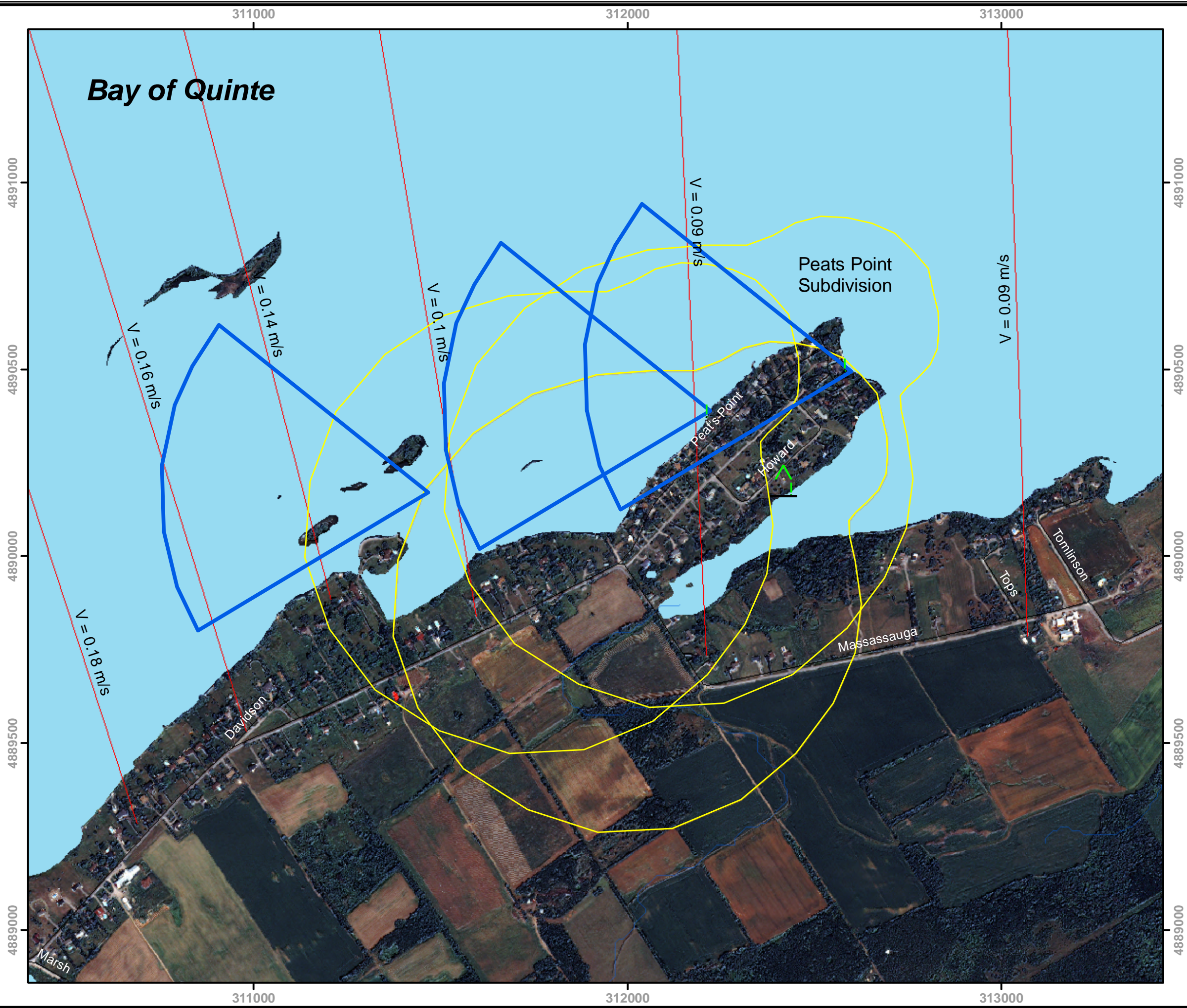
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# MAPS

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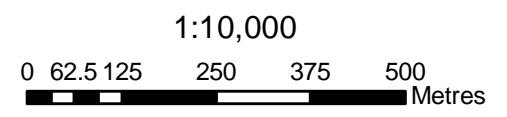


**Peats Point Subdivision  
Source Protection Study**

**Map 1  
2 h Wind and Flow Zones**

- Peats Point Well
- Well Projections
- 2h Flow Zone
- 2 h Wind Zone
- HEC-RAS Cross sections
- Roads

N  
2



North American Datum 1983, Zone 18 N

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Date Produced: April 20, 2009  
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Revision date:

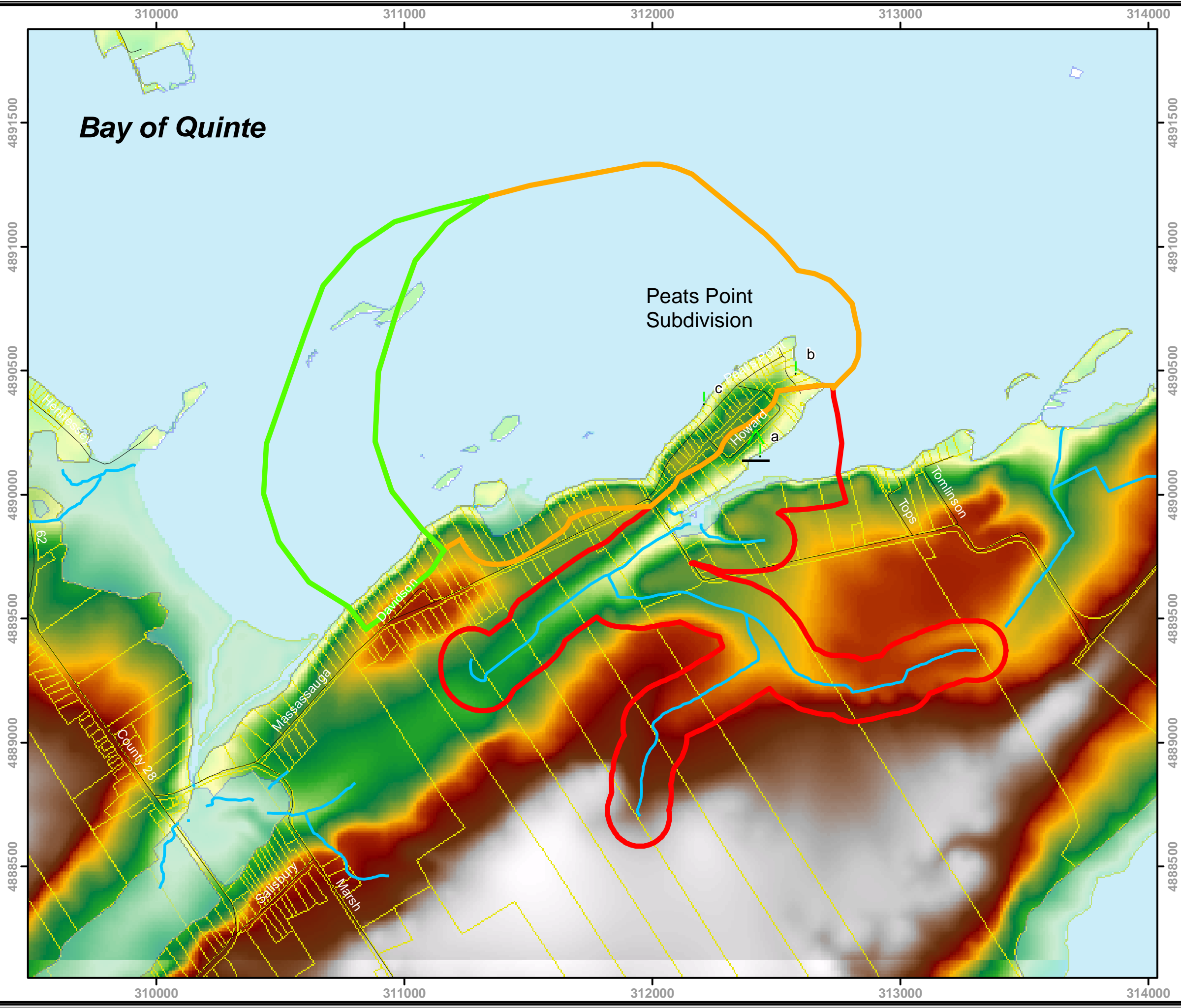
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Water Treatment Plant coordinates provided by Quinte Conservation.

Produced by Dillon Consulting Limited for Quinte Conservation.





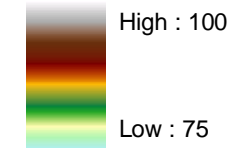
**Peats Point Subdivision  
Source Protection Study**

**Map 2**

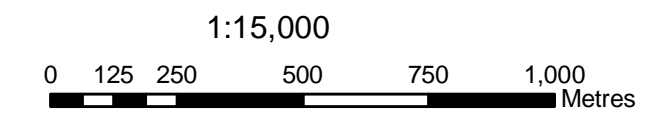
**Peats Point WHPA-Ea, Eb and Ec**

- Peats Point Well
- Intake Projections
- WHPA-Ec
- WHPA-Eb
- WHPA-Ea
- Streams
- Roads
- Assessment Parcels

**Topographic Elevation**



N  
2



North American Datum 1983, Zone 18 N

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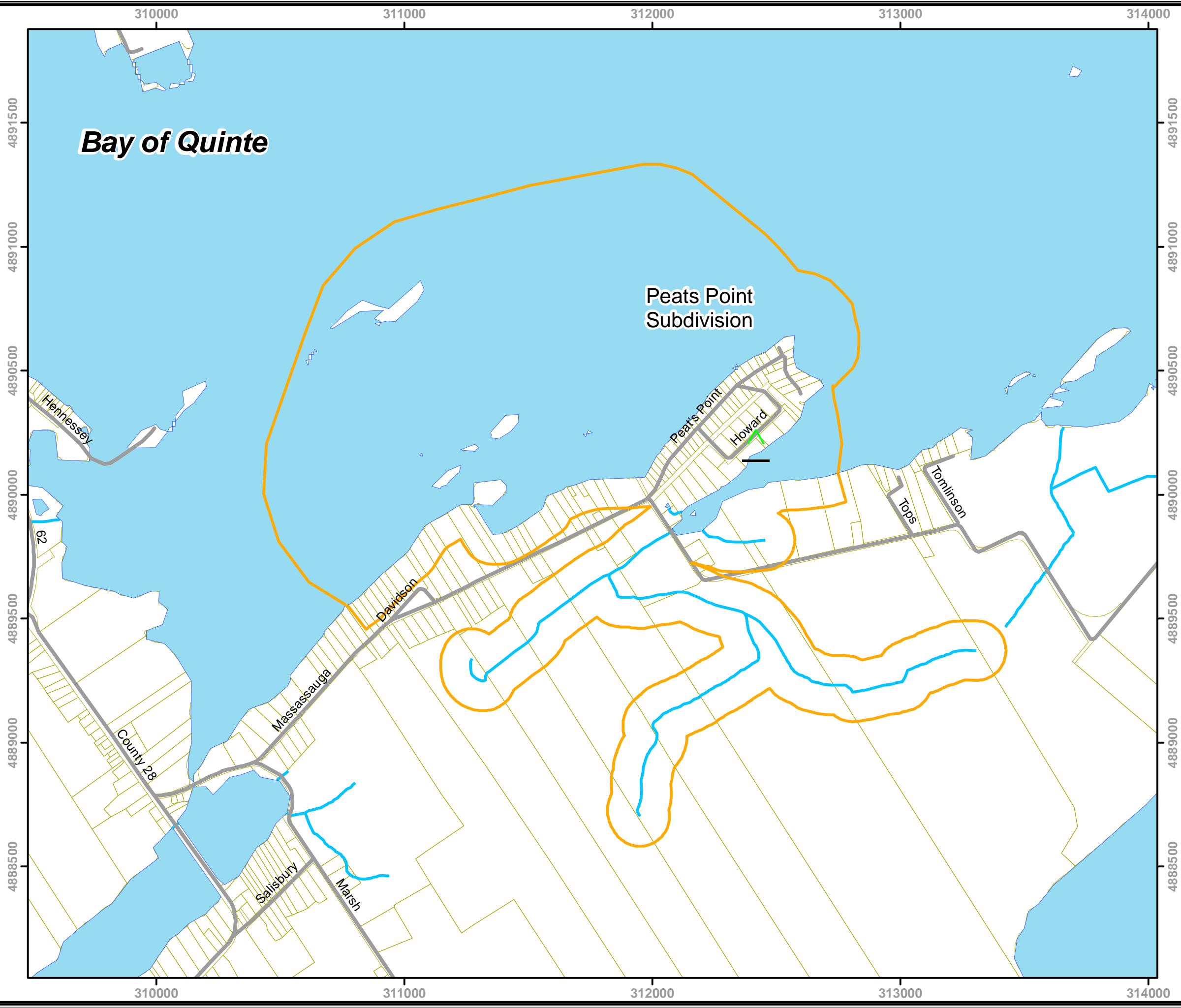
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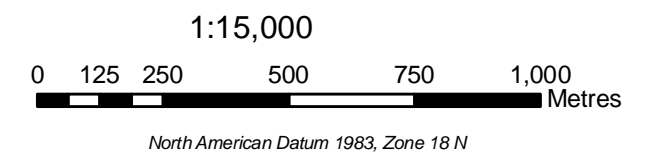


**Peats Point Subdivision  
Source Protection Study**

**Map 3  
Peats Point WHPA-E**

-  Peats Point Well
-  WHPA-E
-  Roads
-  Streams
-  Assessment Parcels

N  
**2**



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