



Torbay Wetland Inventory

Watercourse and Waterbody Update

PREPARED BY

Feaver's Lane

PREPARED FOR

Fundamental | Town of Torbay

IN PARTNERSHIP WITH

Aquatic Conservation Initiative | College of the North Atlantic

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1. Project Overview

This project is a collaboration among Feaver's Lane (FL), Aquatic Conservation Initiative (ACI) and College of the North Atlantic's (CNA's) Reality Capture and Digitization Technology Access Centre, with support from Fundamental Inc. and the Town of Torbay.

In Newfoundland and Labrador, development activities within wetlands are regulated under the [Water Resources Act](#) through the [Policy for Development in Wetlands](#) (Government of Newfoundland and Labrador, 1997). Historically, only wetlands (saturated soils) depicted in the 1:50,000 Topographic Data of Canada – Canada Vector (CanVec) Series have been considered during regulatory review. However, this dataset is coarse in resolution and lacks the level of detail required to support informed planning and development decisions. This project seeks to produce a comprehensive wetland inventory for the Town of Torbay that can be adopted by both the provincial government and the Town to enhance the accuracy and consistency of development proposal reviews.

In addition to the wetland inventory, this project includes a secondary deliverable refining the delineation of watercourses and waterbodies within the Town of Torbay using high-resolution terrain metrics and imagery (Appendix A and B). While the wetland inventory represents original mapping derived from project-specific classification methods, the watercourse and waterbody component builds on existing hydrographic data by improving positional accuracy and detail using high-resolution DEM-derived terrain indices and current imagery. Together, these deliverables provide the Town of Torbay with a natural asset inventory of its wetlands, watercourses, and waterbodies, supporting more informed planning and development decisions.

This study was conducted within the municipal boundary of the Town of Torbay, located on the Avalon Peninsula in Newfoundland and Labrador (see Figure 1).

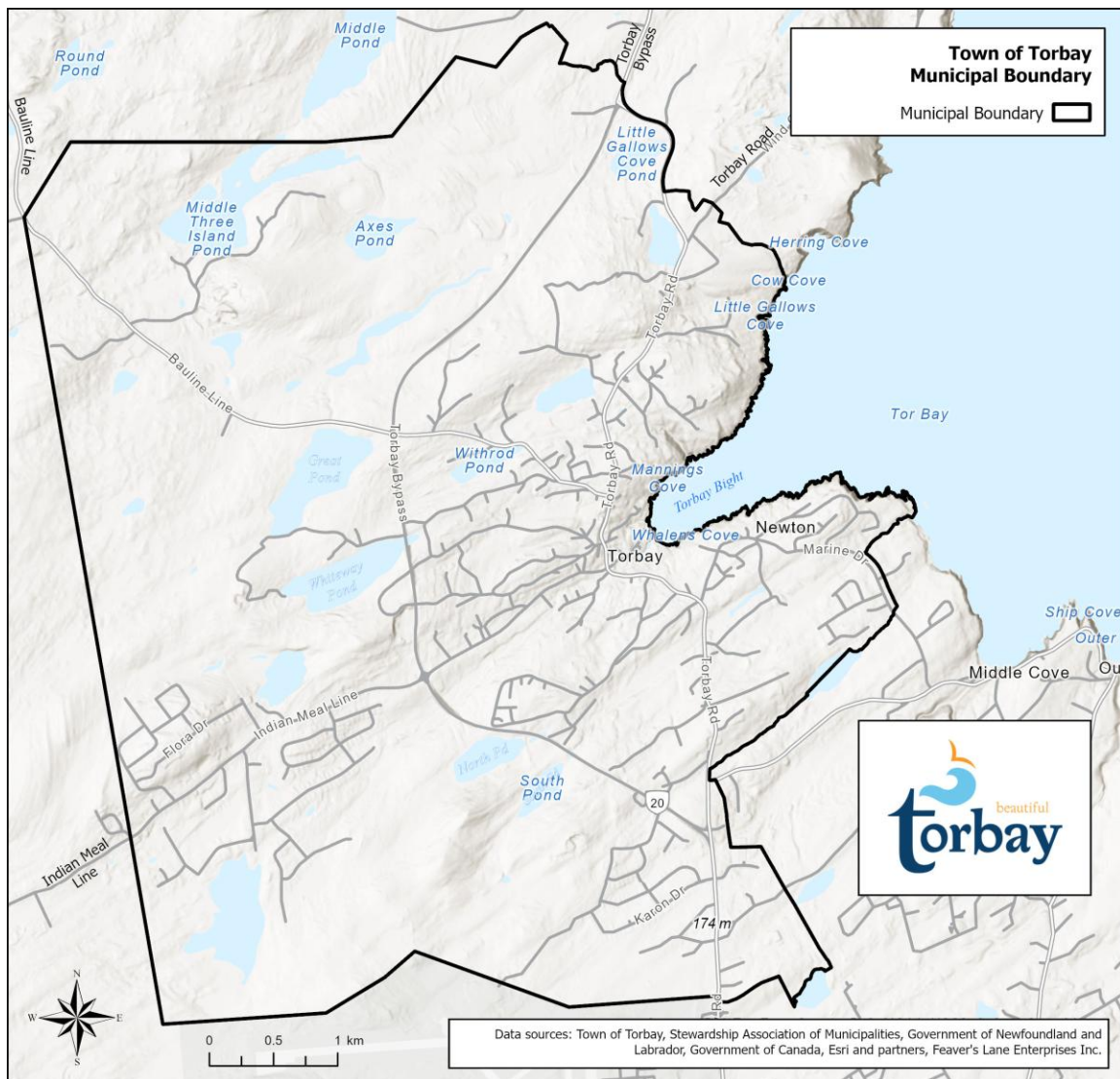


Figure 1: Study Area – Town of Torbay Municipal Boundary

Project Team

Paola Vincent, Feaver's Lane

Feaver's Lane Enterprises Inc. is a geographic information systems (GIS) consulting company incorporated in 2010 and focused on applying spatial decision-support technologies to help balance ecological, social, and economic perspectives. The company's work spans natural resource management, species and biodiversity mapping, conservation planning, municipal management, and impact assessment, with services including spatial analysis, cartography, data collection, and custom application development. In recent years, Feaver's Lane has expanded its client base to include municipalities across Newfoundland and Labrador, working closely with town staff and contracted planners to support planning, zoning, and related mapping needs.

As GIS Consultant with Feaver's Lane, Paola holds a Bachelor of Science in Geography with a minor in Biology, with special interests in GIS, physical geography, biogeography, and conservation biology. Her technical experience includes municipal planning and management mapping, habitat protection, restoration and enhancement, species mapping, multi-criteria screening and site selection, and imagery processing. On the Torbay Natural Asset Inventory project, Paola led the GIS analysis and mapping components, including wetland identification using high resolution imagery and terrain-derived indicators, watercourse and waterbody delineation, and preparation of project deliverables and reporting.

Heather Ward, College of the North Atlantic (CNA)

The Reality Capture and Digitization Technology Access Centre (RCD-TAC) at College of the North Atlantic is a specialized applied research centre that supports industry, government, healthcare, and community partners in adopting and advancing innovative reality capture and digitization technologies. Through expertise in remote sensing, photogrammetry, LiDAR, GIS, laser scanning, and multispectral and hyperspectral imaging, RCD-TAC collects, processes, analyzes, and visualizes spatial data to address real-world challenges and accelerate innovation across multiple sectors. The Centre works closely with a multidisciplinary network of partners to improve technological literacy, operational efficiency, and evidence-based decision-making through applied research and technology adoption initiatives.

As Director of RCD-TAC, Heather brings more than 12 years of experience in environmental consulting, GIS, and remote sensing, with extensive expertise in spatial analysis and environmental monitoring. Her work has focused on the application of satellite, aerial, drone, LiDAR, radar, and other geospatial technologies, with particular strengths in land cover classification, remote sensing analytics, and geospatial data interpretation. Heather provides technical leadership on projects involving environmental assessment, change detection, and spatial modelling, helping translate complex geospatial data into actionable insights for partners and stakeholders.

Gabby Riefesel, Aquatic Conservation Initiative (ACI)

Founded in 1992 under the name St. John's Harbour ACAP, Aquatic Conservation Initiative is an environmental non-profit that conserves aquatic and coastal ecosystems through research, collaboration, and education. ACI has worked on wetland classifications, restoration, conservation, and assessing the ecosystem services wetlands provide to communities and the broader ecosystem for over 30 years. On the Torbay Natural Asset Inventory project, in partnership with the Town of Torbay, Fundamental Inc. and Feavers Lane, Project Director Gabby Riefesel led the field verification component of the project. Gabby has a background in spatial ecology, plant identification, and has worked in the environmental sector for over 10 years.

2. Data Sources

The data sources included aerial imagery, LiDAR, previous wetland inventories, and other supplemental datasets, as described below.

Aerial Imagery

Aerial Imagery of the Town was collected by Eagleview Technologies in 2025. The spatial resolution of the imagery is 0.075m (7.5cm) per pixel and the imagery contains three spectral bands (blue, green and red).

Eagleview orthophotography served as the primary dataset for wetland identification and delineation. The high spatial resolution allowed detailed interpretation of vegetation communities, surface moisture indicators, drainage features, and wetland boundaries. Because the imagery does not contain a near-infrared (NIR) band, vegetation indices such as NDVI could not be calculated directly.

LiDAR

LiDAR-derived terrain products generated from the Government of Canada 1-metre High Resolution Digital Elevation Model (HRDEM; Natural Resources Canada, 2020) were used to identify low-lying areas, drainage pathways, hydrologic connectivity, and subtle depressions that may support wetland conditions. Terrain metrics derived from the HRDEM included slope, flow accumulation, Topographic Wetness Index (TWI), Height Above Nearest Drainage (HAND), and local relief models. These products provided valuable information on landscape position, water movement, and potential areas of saturation, supporting both wetland delineation and field verification efforts.

Previous Wetland Inventories

Ducks Unlimited field delineated, wetlands

- Ducks Unlimited Canada field-delineated wetlands were collected in 2023. A total of 40 wetlands were delineated and characterized.
- Includes a report, the Ducks Unlimited Canada WESP-AC Assessment of 40 Torbay Wetlands, which scored wetland functions and benefits (e.g., water storage, habitat support, ecological condition) to provide the Town with baseline data to inform development and conservation decisions (Ducks Unlimited Canada,2023).

Fisheries, Agriculture and Lands, Land Cover

- This layer is administered by the Forest Ecosystem Management Division, Department of Forestry, Agriculture and Lands and represents the most current information available (Government of Newfoundland and Labrador, n.d.). The dataset is created for forest inventory, but also includes Non-Forest attribute information, including three wetland types as identified below in Table 1.

Table 1: Wetland Type identified in Forest Inventory GIS file

Class	Description
Bog	Wet areas of bog or marsh that may include patches of open water. Wetness may be seasonal or close to the surface to prohibiting tree growth.
Web Bog	Wet areas of bog or marsh with a large number of open water patches.
Treed Bog	Wet areas of bog or marsh with $\leq 10\%$ tree cover.

Other Supplemental datasets

[CanVec 1:50 000 topographic](#) dataset saturated soils layer

- Represents areas that may exhibit wet or poorly drained soil conditions but is not a wetland inventory or delineation dataset (Natural Resources Canada, n.d.-b).
- Due to its coarse scale and generalized mapping, the layer was used for contextual information only and was not relied upon for wetland boundary delineation.

Hydrology datasets

- Included [CanVec rivers and waterbodies](#) (Natural Resources Canada, n.d.-a)
- [National Hydrographic Network \(NHN\)](#) (Natural Resources Canada, 2024) and flow direction layers
- Department of Fisheries, Forestry and Agriculture (FAL) Landcover (streams and waterbodies)
- Used to identify drainage networks, hydrologic connectivity, and potential water movement across the landscape.
- Supported interpretation of wetland extent and helped refine wetland boundaries in areas influenced by surface water.

Project-Supported Field Investigations

FL/ACI field delineated wetlands

- Field verification was completed in November 2025 following an initial desktop screening and wetland interpretation process.
- Additional field work was conducted in June 2026 in partnership with CNA.
 - Drone imagery was collected for selected wetlands that were difficult to access on foot or where field verification was not practical.
 - The work focused on obtaining visual confirmation of wetland characteristics, hydrologic features, and landscape context.

3. Methodology

Mixed Interpretation Approach

A mixed-method approach was used to identify and delineate wetlands. Wetland boundaries were interpreted using a combination of aerial imagery, Object Based Image Analysis, terrain metrics, existing wetland inventories, and field verification. This approach is particularly suitable for a municipal-scale study area such as Torbay where high-resolution imagery, LiDAR, and field verification can be combined to improve mapping accuracy.

Object Based Image Analysis

An object-based image segmentation was completed on the aerial imagery. This process groups similar pixels into objects based on their spectral, spatial, and geometrical properties. It mimics human visual perception by identifying distinct features like rivers, buildings, trees, or in this case, wetlands (Blaschke, 2010). The segmentation output was used as a visual interpretation aid rather than an automated classification tool. Spectrally homogeneous segments were reviewed by the analyst against the aerial imagery to assess whether individual objects represented wetland or non-wetland conditions. This approach allowed the structure of the segmentation to guide interpretation without relying on the classification alone to determine wetland boundaries.

A fully automated classification was not used as the sole method for wetland delineation. The RGB-only imagery lacked the spectral information needed to reliably distinguish wetland vegetation from spectrally similar surfaces such as dark open water and new pavement. See Section 5 – Imagery Spectral Constraints and Classification Limitations for a full discussion.

3D Visual Interpretation based on landform and drainage features

A 3D visual interpretation approach uses elevation-based datasets, such as LiDAR-derived digital elevation models, topographic wetness index, and surface models, to reveal landform and drainage characteristics that are often difficult to detect in traditional 2D imagery.

Terrain metrics were used as both an initial screening tool for the FL and ACI field work and a supporting dataset for wetland delineation. Potential wetland areas generally exhibited low height above nearest drainage (HAND), low slope, high topographic wetness, and low local relief. Areas meeting multiple criteria were considered more likely to support wetland conditions and were prioritized for visual interpretation and field verification. Terrain datasets were also viewed in 3D to help identify low-lying areas, subtle depressions, drainage pathways, and hydrologic connections. This information, combined with aerial imagery, was used to refine wetland boundaries and improve delineation accuracy (Rapinel et al., 2015).

Topographic Wetness Index

The Topographic Wetness Index (TWI) is a hydrological model that quantifies the influence of topography on water accumulation in a landscape, helping to identify areas likely to be wetter due to their position in the terrain (Beven & Kirkby, 1979). The TWI is calculated by using two variables calculated from the LiDAR digital terrain model: Catchment area and slope

Higher TWI values indicate areas where water is more likely to accumulate and remain on the landscape, creating conditions favorable for wetland formation.

The TWI can be calculated using the following formula:

$$TWI = \ln\left(\frac{A}{\tan(\beta)}\right)$$

Where:

- A is the area contributing flow to a point in square meters (i.e. the catchment area)
- [\$\beta\$ is the slope in radians.](#)

When these datasets are rendered in three dimensions, subtle depressions, shallow basins, low-gradient slopes, and microtopographic breaks become more apparent, allowing analysts to identify areas where water is likely to accumulate or move slowly across the landscape. Drainage pathways, flow channels, and contributing catchments can also be visualized more clearly in 3D, helping to confirm hydrologic connectivity between features. By examining these landform and hydrologic patterns from multiple viewing angles and elevations, interpreters can more accurately distinguish wetland-forming terrain from adjacent uplands, refine boundary placement, and assess the spatial extent of wetland hydrology. This method strengthens delineation accuracy by combining geomorphic context with surface-water behaviour, providing a defensible basis for mapping wetlands in complex or subtle terrain.

Rather than applying a single fixed TWI threshold, several cutoffs were reviewed during wetland delineation. Because wetland-forming conditions vary across the landscape, testing a range of thresholds helped reveal areas of potential saturation under different environmental situations.

Height Above Nearest Drainage (HAND) and Local Relief

HAND measures the vertical distance between a location and the nearest downslope drainage feature and is effective for identifying riparian and floodplain wetlands (Rennó et al., 2008; Nobre et al., 2011). Local Relief measures the relative elevation of a location compared to the surrounding landscape and is effective for identifying depressional wetlands (Gallant & Wilson, 2000). Both metrics were used because they identify different wetland-forming processes and improve detection of both hydrologically connected and isolated wetland systems.

Delineation Procedure

Wetland boundaries were delineated through the integrated analysis of high-resolution aerial imagery, object-based image segmentation, and LiDAR-derived terrain datasets within a GIS environment. Aerial imagery was examined for visual indicators of wetland conditions, including distinct vegetation patterns, surface moisture signatures, and evidence of persistent or seasonal inundation. The object-based segmentation layer was used alongside the imagery to identify spectrally homogeneous areas and help structure the interpretation, allowing analysts to systematically review potential wetland objects against multiple datasets rather than interpreting raw imagery alone.

LiDAR-derived elevation products, including digital elevation models and slope surfaces, were used to identify subtle depressions, drainage pathways, and microtopographic features that influence wetland hydrology. These datasets were systematically overlaid and interpreted to confirm hydrologic connectivity, assess landscape position, and refine boundary placement. The combined use of imagery, segmentation, and LiDAR allowed for a more accurate and defensible delineation, particularly in areas where vegetation structure or terrain complexity required additional spatial context (Rapinel et al., 2015).

4. Results

This section presents the results of the Torbay wetland inventory (Figure 2), including the structure of the wetland data layer, the attributes assigned to each wetland polygon, and summary statistics describing the inventory. The wetland data layer is the primary deliverable of this project. Updated watercourse and waterbody delineations, developed as secondary deliverables, are presented separately in Appendix A and Appendix B.

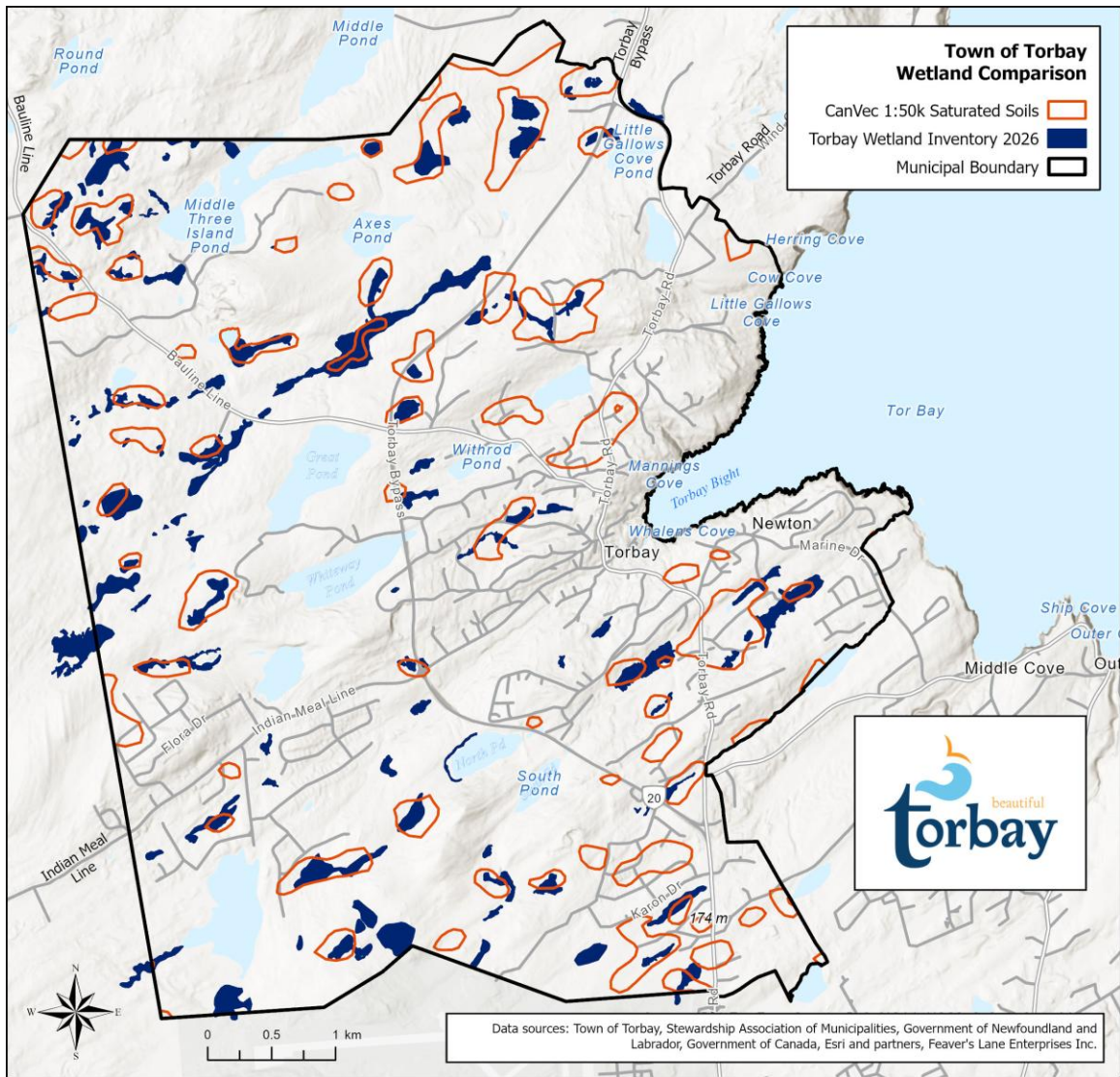


Figure 2: Wetland Comparison, CanVec 1:50,000 Saturated Soils and the 2026 Torbay Wetland Inventory

Wetland Data Layer Attributes

Field	Description	Values
Wetland_ID	Unique identifier for each wetland polygon	WL_TB_01, FL_1, DU_TB02_ext, etc.
Source	Origin of the wetland boundary	Ducks Unlimited 2023; CNA/FL Desktop Delineation; ACI/FL Desktop Delineation; ACI/FL 2025 Field Work
Pred_Class	Predicted wetland class, either field-designated or derived from the FAL land cover dataset. FAL-sourced classes were not field verified.	Bog (FAL), Bog (Field), Fen (Field), Treed Bog (FAL), Bog and Treed Bog (FAL), Marsh, Shallow Water

Verification	Whether the wetland was verified in person or by drone. Blank indicates desktop interpretation only.	Field Verified; Drone Verified; blank
Connected	Estimated hydrologic connectivity to other wetlands or water bodies	Yes; No; Possible
Deg_Con	Overall confidence in the delineation, reflecting the quantity and quality of supporting evidence	High; Medium; Low

Connected

Assessing hydrologic connectivity is important because connected wetlands carry greater ecological and regulatory weight, impacts to one can affect others (Leibowitz & Nadeau, 2003). It also:

- Helps determine whether wetlands function as isolated units or as part of a larger connected network.
- Supports cumulative impact assessment for development proposals.
- Helps determine whether features are separate wetlands or a single wetland complex.
- Informs municipal stormwater and flood risk planning.

Connectivity was assessed using aerial imagery, hydrology data, and LiDAR-derived terrain metrics (flow depressions, drainage pathways) and assigned a confidence rating of **Yes**, **No**, or **Possible** for each wetland (Figure 3). These assessments are estimations based on remote sensing and terrain analysis only and should be used with caution.

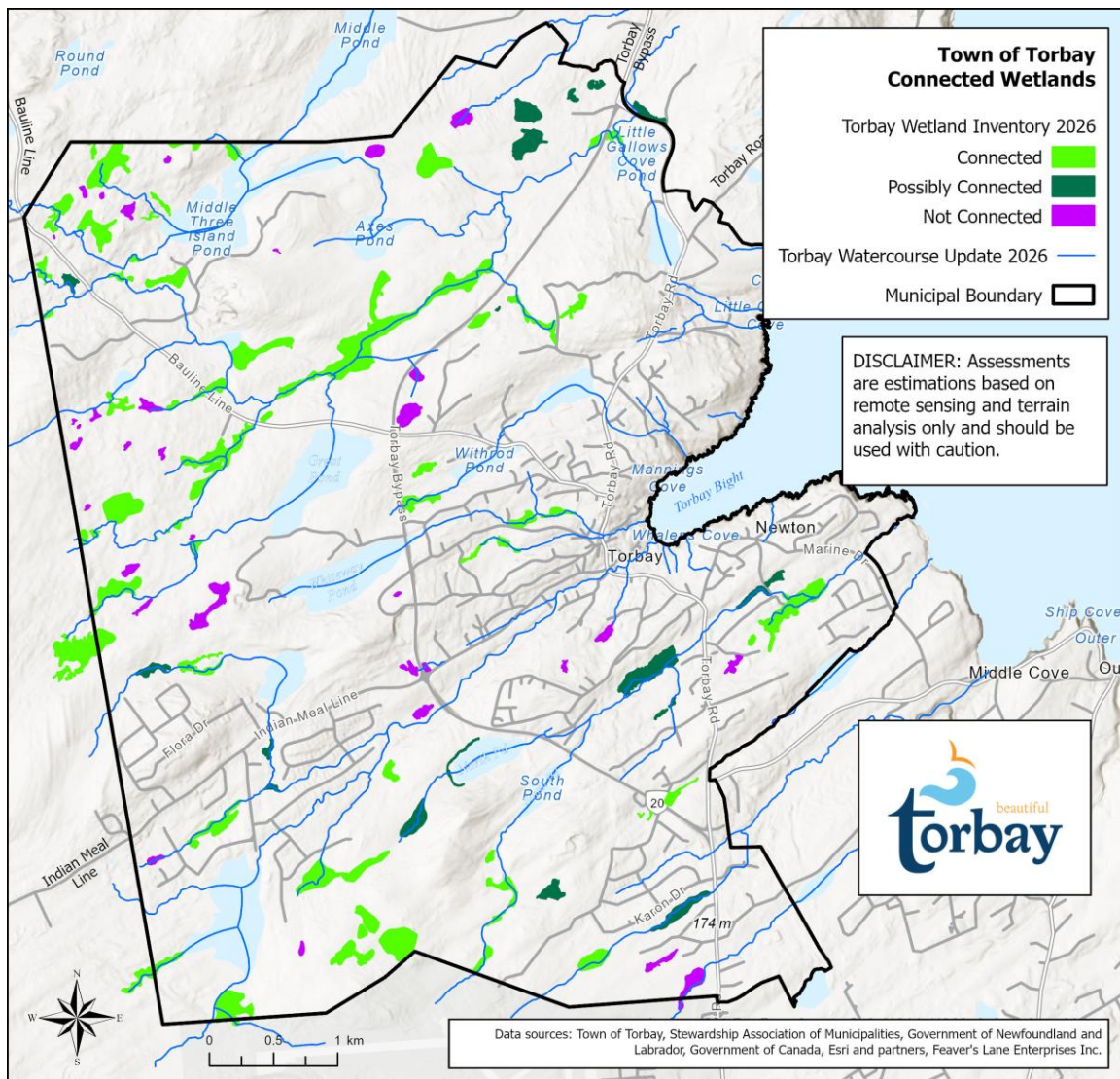


Figure 3: Connected Wetlands, Hydrologic Connectivity of the 2026 Torbay Wetland Inventory (See Appendix A for watercourse Update workflow)

Predicted Wetland Class (Pred_Class)

The predicted wetland class, assigned either through field identification (DUC or FL) or derived from the FAL (Fisheries, Agriculture and Lands) provincial land cover dataset. FAL-sourced classifications were not field verified and should be considered preliminary. Classes identified in the field supersede FAL designations where both exist. Wetland class was not assigned for 96 polygons (130.5 ha) where insufficient evidence was available to confidently determine wetland type through desktop interpretation alone or wetland data came from DUCs field work and no class attribute was found in data. Field verification is required to classify these areas. Wetland classes follow the Canadian Wetland Classification System (National Wetlands Working Group, 1997).

Degree of Confidence (Deg_Con)

A confidence rating of High, Medium, or Low was assigned to each wetland polygon based on the quantity and quality of supporting evidence available during delineation. Confidence ratings considered factors such as field verification, agreement between aerial imagery and terrain-derived datasets, clarity of wetland indicators, and the certainty of boundary placement.

High-confidence wetlands were supported by field observations and/or multiple lines of consistent evidence from imagery, terrain metrics, and existing wetland inventories.

Medium-confidence wetlands exhibited several wetland characteristics but lacked direct field verification or contained minor uncertainty regarding wetland extent or classification.

Low-confidence wetlands were identified primarily through desktop interpretation where evidence was limited, conflicting, or where site access constraints prevented field verification. These areas may benefit from additional investigation in the future.

Note: we used the confidence level to help with the June 2026 field verification.

Wetland ID

Each wetland polygon is assigned a unique identifier. The prefix indicates the source or surveyor:

- WL_TB denotes wetlands that were desktop delineated as part of this inventory.
- FL denotes wetlands identified during Feaver's Lane field work.
- TB denotes wetlands originally mapped by Ducks Unlimited.
- _ext suffix denotes extensions to existing Ducks Unlimited wetlands added during this study.

Source

Indicates the origin of the wetland boundary. Sources are represented in the inventory as:

- Ducks Unlimited (2023) boundaries were incorporated from an existing wetland survey.
- CNA/FL and ACI/FL desktop delineations were completed by College of the North Atlantic, Aquatic Conservation Initiative and Feaver's Lane staff using aerial imagery and terrain analysis.
- Feaver's Lane 2025 Field Work boundaries that were delineated or refined based on ground-truthing conducted in November 2025 (with additional verification field work done in June 2026).

Verification

Indicates whether a wetland was verified beyond desktop interpretation. Field Verified wetlands were visited on the ground; Drone Verified wetlands were confirmed using aerial drone imagery but not visited on foot. A blank value indicates the wetland was identified

through desktop interpretation only and has not been independently verified. Confidence ratings reflect this where applicable.

Wetland Statistics

The Torbay wetland inventory contains 133 wetland polygons covering a total area of approximately 181.7 hectares. Summary statistics by verification status, delineation confidence, and hydrologic connectivity are provided in the tables below.

Verification Status	Count	Area (ha)
Field Verified	59	78.0
Drone Verified	9	4.5
Desktop Only	65	99.2
Total	133	181.7

Delineation Confidence	Count	Area (ha)
High	103	157.7
Medium	23	21.6
Low	7	2.4

Hydrologic Connectivity	Count	Area (ha)
Yes	81	132.0
Possible	19	27.8
No	33	21.9

Wetland Class	Polygons	Area (ha)	% of Total Area
Bog	24	40.9	22.6%
Fen	21	24.9	13.8%
Marsh	2	0.8	0.4%
Shallow Open Water	1	0.5	0.3%
Unclassified	85	114.1	63.0%
Total	133	181.2	100.0%

5. Discussion

The wetland inventory developed for the Town of Torbay represents a combination of high-resolution aerial imagery, LiDAR-derived terrain analysis, existing wetland information, and field verification. While this approach provided a detailed and defensible wetland inventory, several factors influenced the interpretation and delineation process. The following sections discuss the strengths, limitations, and considerations associated with the mapping methodology and resulting wetland inventory.

Imagery Spectral Constraints and Classification Limitations

The aerial imagery used in this study was collected with three spectral bands (red, green, blue) and does not include a near-infrared (NIR) band. This is a meaningful constraint for wetland mapping. NIR reflectance is fundamental to calculating vegetation indices such as NDVI (Tucker, 1979), which are commonly used to distinguish vegetated land cover types in automated image classification. Without NIR, wetland vegetation, open water, and other dark or low-reflectance surfaces, including new pavement, can appear spectrally similar in RGB imagery, making it difficult for automated classifiers to reliably separate them.

For this reason, a fully automated pixel-based or object-based classification was not used as the primary method for wetland identification. Even where multispectral imagery is available, automated classification alone is generally not sufficient for wetland delineation. Wetland boundaries are influenced by hydrology, terrain position, soil conditions, and vegetation communities that require contextual interpretation to map accurately. The mixed approach used in this study, combining segmentation-guided visual interpretation, LiDAR-derived terrain analysis, and field verification, addresses these limitations and produces a more accurate and defensible wetland inventory than classification alone would provide for a relatively small study area such as the Town of Torbay.

Field and Drone access constraints

Several wetlands in more remote areas of the study area were difficult or impractical to reach on foot. Trail conditions prevented vehicle access, distances made walking alone time-prohibitive for some sites, and no-trespassing signage on private land further restricted access in certain areas. Where field verification was not possible, wetland confidence ratings reflect this uncertainty. Future surveys could benefit from the use of ATVs to improve access along rough trails.

Flight restrictions in the Town of Torbay, largely due to the proximity of St. John's International Airport, limited where a larger drone could be deployed. A smaller mini drone was used where restrictions permitted; however, mini drones are more susceptible to wind interference and have more limited camera sensors than larger platforms, which affected image quality and the conditions under which flights could be conducted. As a result, drone coverage was more selective than originally anticipated, and some inaccessible wetlands could not be documented aerially at the level of detail that would have supported more confident delineation.

6. Conclusions

The Torbay wetland inventory identified 133 wetland polygons covering approximately 181.7 hectares across the full municipal area. Wetlands were delineated using a mixed approach combining high-resolution aerial imagery, object-based image segmentation, LiDAR-derived terrain analysis, and field verification. This approach was necessary given the spectral limitations of the available RGB imagery and the complexity of the landscape across the town.

Wetland Types

Where classification was possible, bogs were the dominant wetland type identified through the FAL (Fisheries, Agriculture and Lands) provincial land cover dataset, consistent with the bog-dominated landscape typical of the Avalon Peninsula (Wells, 1981); however, FAL-sourced classifications were not field verified and should be considered preliminary. FL field verification further identified fens as a significant wetland type within the study area, with field-identified classes superseding FAL designations where both exist. Wetland class was not assigned for 85 polygons (114.1 ha), either because insufficient evidence was available to confidently determine wetland type through desktop interpretation alone, or because the wetland data originated from DUC field work that did not include a class attribute. Field verification is required to classify these areas. Wetland classes follow the Canadian Wetland Classification System (National Wetlands Working Group, 1997).

Note that the Ducks Unlimited Canada (2023) WESP-AC assessment did not assign a wetland class to most of the 40 sites it scored. Classification was only provided narratively for a subset of wetlands discussed in detail within the report (TB_02, TB_08, TB_14, TB_15, TB_28, TB_34, TB_37, and TB_38), each identified as bog, fen, marsh, or shallow open water.

Ecological and Hydrologic Observations

Many wetlands in the inventory (81 of 133, covering 132.0 ha) showed evidence of hydrologic connectivity to other wetlands or water bodies, suggesting that much of the wetland area in Torbay functions as part of a larger interconnected network rather than as isolated features. This has implications for land use planning, impacts to one wetland in a connected system may affect others upstream or downstream. Connectivity assessments are based on remote sensing and terrain analysis and should be treated as estimates pending field confirmation.

Recommendations

- Field surveys should be prioritized for the 65 wetlands (99.2 ha) currently identified through desktop interpretation only, particularly those in or near areas subject to development pressure.
- Wetland classification should be completed for the 85 unclassified polygons through targeted field visits during the growing season.
- Connectivity assessments flagged as “Possible” (19 wetlands, 27.8 ha) warrant follow-up to confirm or rule out hydrologic linkages before these areas are considered in planning decisions.
- Regulatory consultation with the province regarding wetland alteration requirements is recommended prior to any development within or adjacent to mapped wetland boundaries.
- A Wetland Evaluation Significance Protocol (WESP) assessment is recommended for wetlands in areas facing development pressure. WESP is a standardized provincial tool used to evaluate the ecological, hydrologic, and social significance of individual

- wetlands, and provides a defensible basis for decision-making regarding wetland alteration or protection (Adamus, 2018). Results from this inventory can be used to prioritize which wetlands warrant a WESP assessment.
- Future surveys would benefit from imagery collected with a near-infrared band to support more robust vegetation classification, and from improved site access with ATVs and a larger drone platform where airspace restrictions permit.

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Appendix A: Use of Topographic Wetness Index to Support Watercourse Delineation

The Topographic Wetness Index (TWI) layer originally developed for the wetland delineation component of this project was reused to support an updated watercourse network delineation for the Town of Torbay.

TWI Top 15 Layer

The TWI is a continuous raster surface derived from the LiDAR digital terrain model, where higher values indicate areas more likely to accumulate and retain water based on their position in the landscape. To identify the areas of highest hydrological relevance, the TWI raster was reclassified to retain only the highest 15 percent of values (above the 85th percentile), referred to here as the TWI_top15 layer. These high-value areas correspond to terrain positions with large contributing catchment areas and relatively low slopes, conditions that are strongly associated with surface water accumulation, including watercourse channels and riparian corridors (Tarboton et al. 1992).

Application to Watercourse Delineation

The TWI_top15 layer was used as a spatial reference to guide the review and updating of watercourse delineations within the study area. Candidate watercourse features were assessed against three existing hydrological datasets: the [National Hydrographic Network \(NHN\)](#), the [FAL Land Cover – Waterbody dataset](#) (Department of Fisheries, Forestry and Agriculture), and the [1:50,000 CanVec Hydrographic Features](#). Where TWI_top15 values aligned with features present in one or more of these reference datasets, confidence in watercourse placement was increased. In addition, Eagleview imagery (2025) was used as a desktop validation source to visually confirm the presence of surface water or channel features and was treated as the most current and authoritative source for resolving positional discrepancies between datasets. Not all areas of elevated TWI were mapped as watercourses; the TWI_top15 layer was used as a guide rather than a direct mapping input. The TWI was particularly valuable for identifying smaller watercourses in treed areas where canopy cover obscured channel features in imagery, allowing visible watercourse segments to be connected where surface evidence alone was insufficient. Watercourses were digitized in MTM Zone 1 projection, and a minimal generalization was applied to smooth the resulting lines while preserving hydrological accuracy.

Retained CanVec 1:50,000 Watercourse Segments

At the request of the Town of Torbay, watercourse segments from the 1:50,000 CanVec Hydrographic Features dataset that could not be validated through TWI analysis, Eagleview imagery review, or the NHN dataset were retained in the updated watercourse layer. These segments were copied directly from the CanVec linework without modification and are

identified in the Notes attribute field as: "Copied from CanVec 1:50k, not present in NHN or identified by Feaver's Lane analysis. May need to be retired."

These features are included for historical continuity, as they were represented as watercourses in previous mapping and the areas they occupy may still exhibit wet conditions. However, Feaver's Lane's analysis did not identify evidence supporting their classification as watercourses. These segments should be interpreted with a lower level of confidence than validated features, and we suggest symbolizing them distinctly in map products so this difference is visually apparent to users. Where the dataset is used to support hydrological analysis or modelling, users may wish to consider excluding these segments, as their inclusion could affect results.

Limitations

The TWI is derived from terrain data and does not incorporate real-time or seasonal hydrological conditions. It represents a modelled estimate of relative wetness potential rather than observed water presence. Watercourses within the study area vary in size and character, ranging from larger perennial channels to smaller intermittent or seasonal features; smaller watercourses may only be visible in imagery or reflected in TWI values during or shortly after wet periods, and their delineation should be interpreted with this variability in mind. As a result, some high-TWI areas may correspond to wet terrain features that do not function as defined watercourse channels (such as wet depressions), and field verification is recommended where watercourse presence is uncertain. Additionally, the TWI_top15 threshold is a relative classification based on the distribution of TWI values within the study area and should be interpreted in that local context rather than as an absolute hydrological standard.

Comparison to Existing Mapping and Implications for Use

Compared to the 1:50,000 CanVec Hydrographic Features, one of the datasets currently used by the Town in the absence of a single official or authoritative water features dataset, this watercourse delineation is substantially more accurate and represents a considerably more comprehensive mapping of watercourses within the study area, capturing many smaller channels and tributaries not present in the CanVec dataset (see Figure 4). This increased level of detail should be considered when applying this dataset to regulatory or policy contexts, such as the application of a 15-metre watercourse buffer. Not all mapped watercourses, particularly small or seasonal tributaries that flow only during wet periods, may warrant the same level of policy application as larger, perennial channels. Users of this dataset should apply professional judgment in determining which mapped features are appropriate for specific regulatory purposes, rather than assuming uniform policy treatment across all watercourses identified.

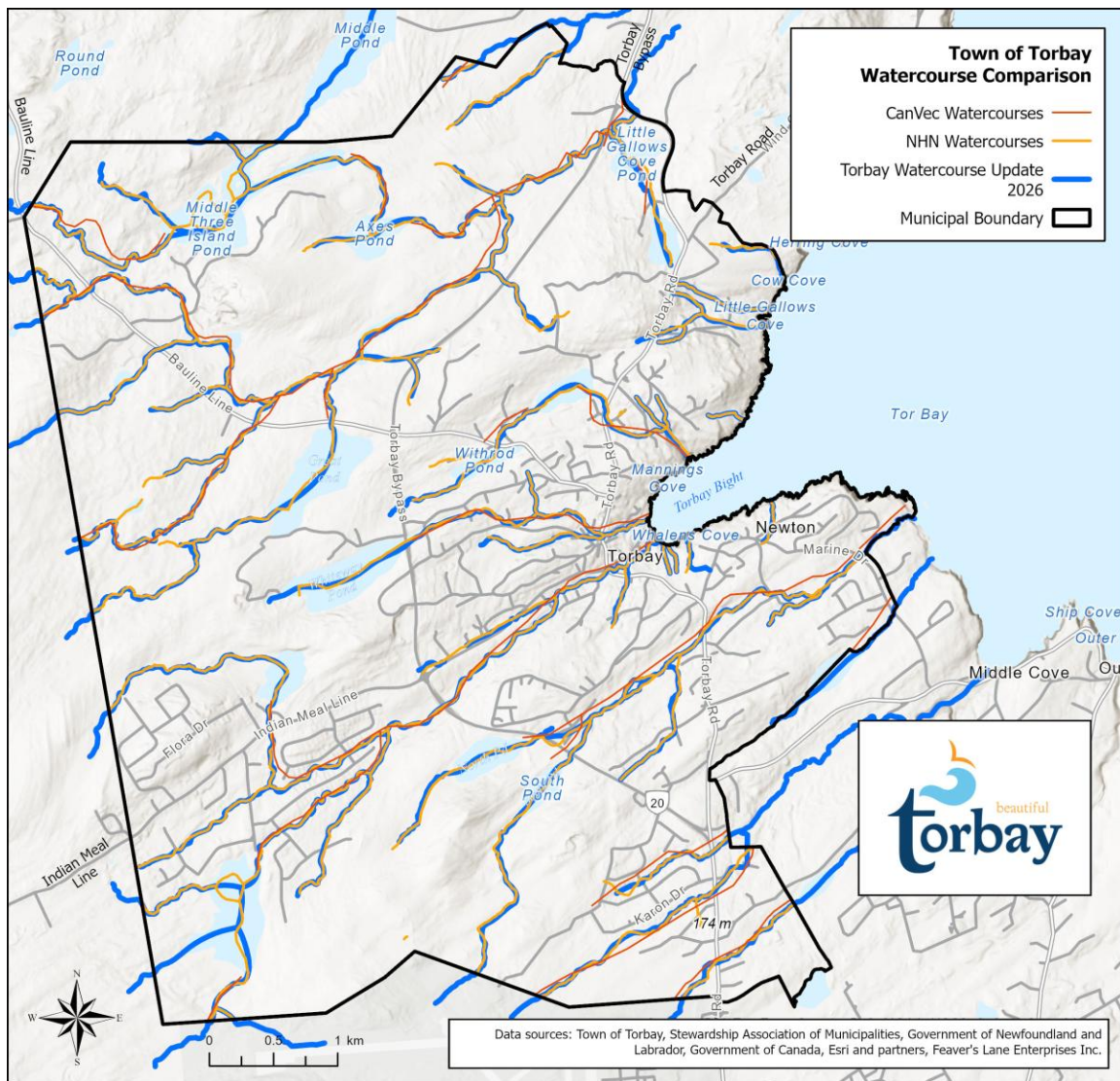


Figure 4: Watercourse Comparison, CanVec and NHN Watercourses versus the 2026 Torbay Watercourse Update

Appendix B: Validation of FAL Waterbody Delineations

Waterbody delineations in this study are based on the provincial [FAL Land Cover – Waterbody dataset](#) (Department of Forestry, Agriculture and Lands), among the most reliable waterbody datasets currently available for the Town of Torbay, with high-resolution imagery and the TWI layer used to support a review of boundary accuracy. The FAL dataset delineations aligned more closely with current imagery than the NHN, particularly along irregular shorelines (see Figure 5). Unlike the watercourse network described in Appendix A, this component is more accurately characterized as a validation exercise than a refinement.

Waterbody Boundary Adjustments and Removals

Each FAL waterbody polygon was reviewed against Eagleview imagery (2025) and the TWI layer to identify discrepancies between the mapped boundary and current ground conditions. Five types of edits were applied:

- Waterbodies with a “River” code were removed if they were represented in the watercourse update from Appendix A.
- Boundaries were slightly shifted, where needed, to better align with current imagery and to correct minor positional offsets associated with reprojection to the Town's working coordinate system (MTM Zone 1).
- Boundaries were expanded where additional waterbody area was clearly visible in imagery or supported by the TWI layer (see Figure 6) beyond the existing FAL boundary (e.g., Soldiers Brook Pond). Boundaries were not reduced on this basis, since a smaller visible extent in a single image may reflect seasonal low-water conditions rather than an inaccuracy in the original FAL boundary.
- Waterbody polygons under 0.2 ha were removed entirely, where the original waterbody no longer exists as a discrete feature. In each case, this reflects development activity (e.g., golf course construction, road construction, paving) that has channelized the waterbody into the watercourse network, incorporated it into an adjacent wetland, or eliminated it from the landscape. An example is a small waterbody along the route of the Torbay Bypass, which has been channelized into a culvert and narrowed such that it is now better represented as a watercourse than a standalone waterbody. In each case, the underlying water feature was not lost from the dataset; rather, its representation was updated to match its current hydrological form, consistent with the watercourse and wetland delineations developed elsewhere in this study.
- A small number of features under 0.04 ha were identified through imagery and TWI review as potential waterbodies but, on closer inspection, were determined to be

small muddy depressions resulting from vehicle or ATV use rather than natural waterbodies. These features were not added to the delineation.

Limitations

Because the FAL dataset was retained as the base layer with only minor, clearly justified adjustments, this waterbody delineation should be considered a validation of existing data rather than an independently derived dataset. Boundary accuracy for any individual waterbody is therefore constrained by the original accuracy of the FAL polygon and is not equivalent to a delineation produced entirely from high-resolution imagery and terrain data. Waterbody extent is also inherently sensitive to seasonal and short-term hydrological conditions; the Eagleview imagery (2025) used for this review represents a single point in time, and boundaries visible in that imagery may not reflect conditions at other times of year. As with the watercourse network in Appendix A, any proposed alteration, infilling, or development near a mapped waterbody boundary should not rely on this dataset alone and should be confirmed through field verification, given the regulatory and ecological sensitivity associated with altering waterbody boundaries.

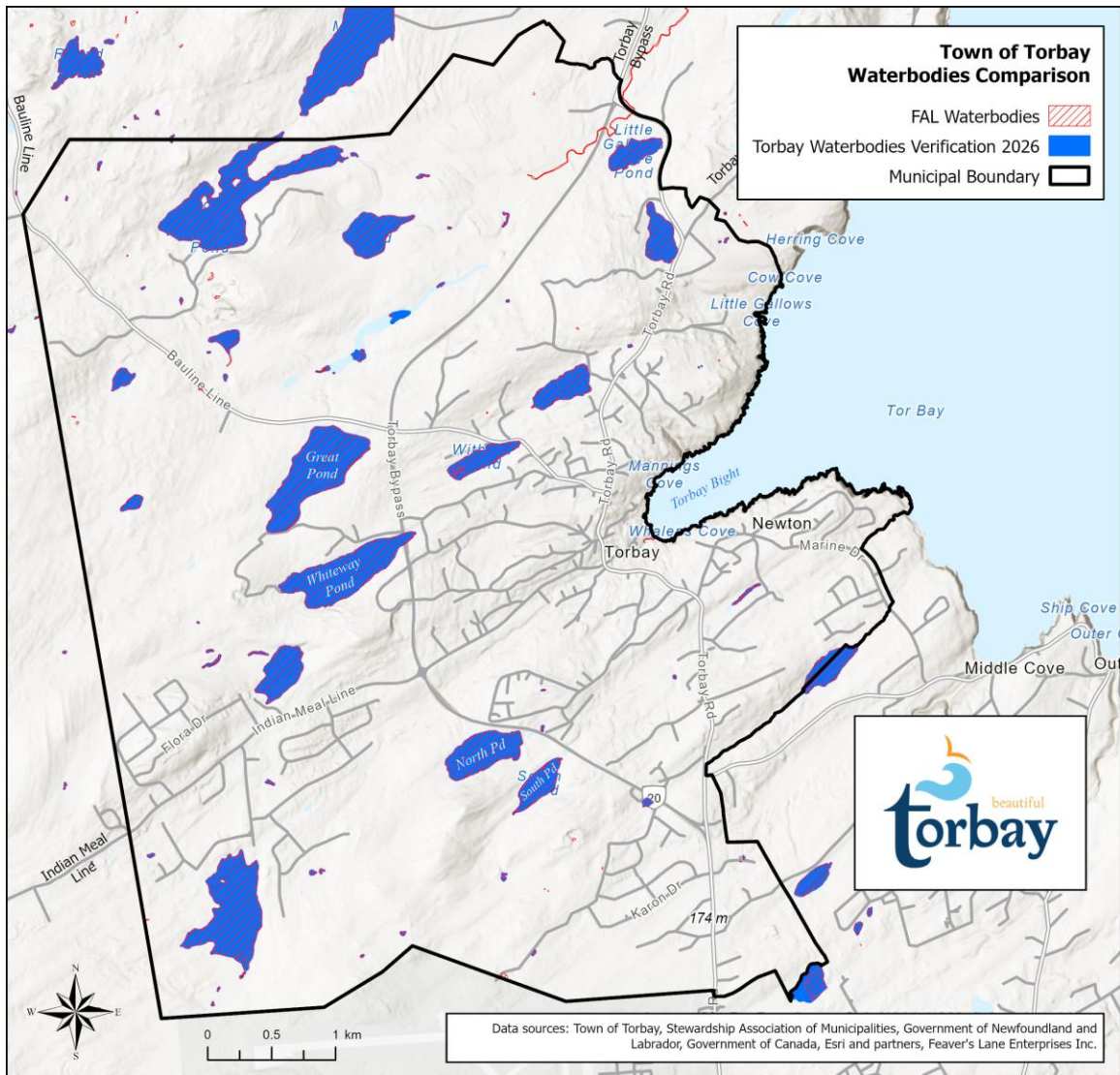


Figure 5: Waterbody Comparison, FAL Waterbodies and the 2026 Torbay Waterbody Verification
(Boundary differences may be hard to see in the map image. Please refer to GIS deliverables for better details)

