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Nova Scotia Power Incorporated

Hydro Asset Study

December 21, 2018

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TABLE OF CONTENTS

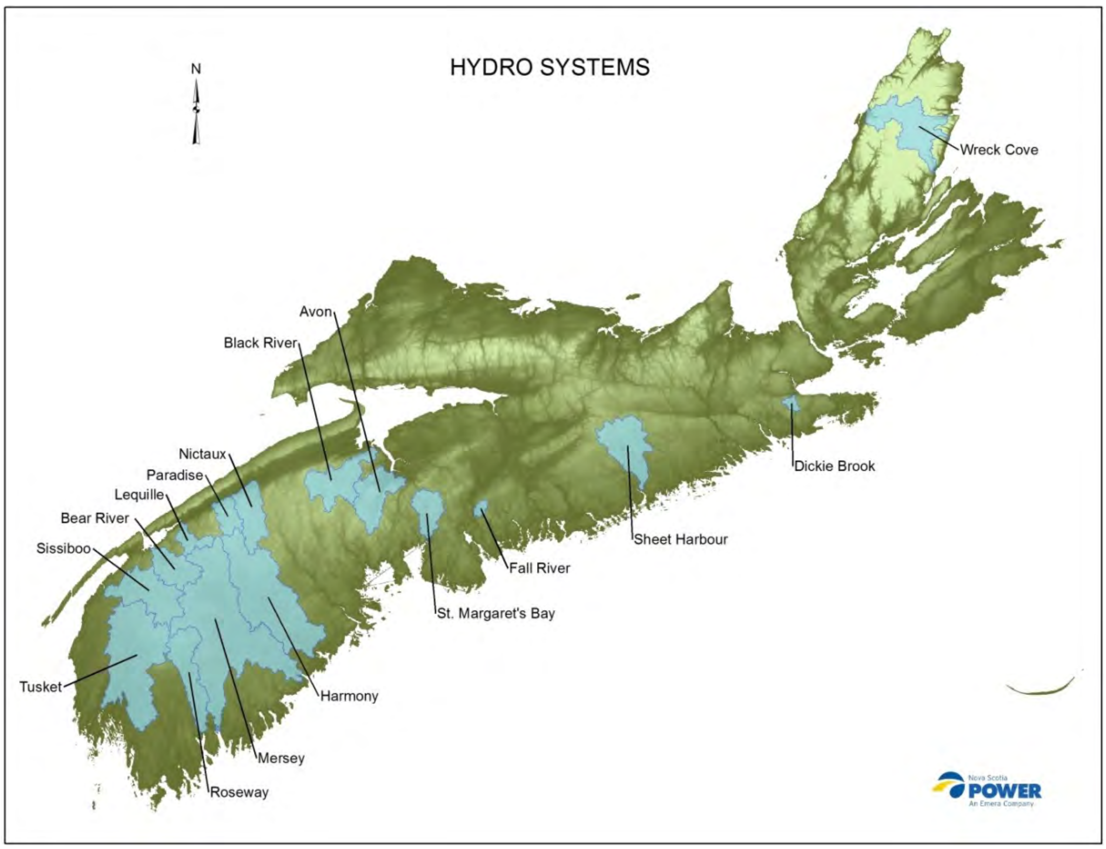
TABLE OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Nova Scotia Power (NS Power or the Company) generates electricity and the Company is required to maintain 40 percent renewable generation by 2020 pursuant to Nova Scotia's *Renewable Energy Standards* (RES). NS Power accomplishes this through a variety of resources, one of which is hydro power. NS Power hydro produces on average approximately one terawatt-hour of renewable electricity annually (net winter capacity totaling 377 MW). This is the product of sustained operations of 17 hydro systems and associated electricity generating assets. The extent of these systems' watersheds is outlined in Figure 1. These systems currently generate electricity from 31 active powerhouses containing 50 generating units.

Figure 1: Location of NS Power Hydro Systems



The Hydro Asset Study (Hydro Study) presents the inputs that are required for both the next Integrated Resource Plan (IRP) and Depreciation Study with regard to hydro assets.

The Hydro Study outlines the assumptions and methodology used to determine these values. The assumptions outline inclusions and exclusions pursued for the Hydro Study.

The Hydro Study, which includes Appendices A - F, provides the following:

- Methodology (Section 2) – Outlines NS Power's approach to establish the necessary inputs for an Integrated Resource Plan IRP and a Depreciation Study, which include the forecast costs of individual system investments and estimate of the total cost to decommission each asset;

- System Costs (Section 3) – Provides forecast sustaining costs and decommissioning costs of each of NS Power's hydro systems, represented by the net present value (NPV) of the option. The costs found below in Figure 2 represent the capital spending required to sustain or decomision NS Power's hydro systems. The costs do not reflect the total value of the hydro systems and do not include the cost of replacement energy and capacity nor do they reflect the value that NS Power's hydro systems provide to the overall system. That information will be examined in an IRP process.

Figure 2: Summary of forecast sustaining and decommissioning costs of NS Power hydro systems

System	Sustaining	Decommissioning	Annual Generation GWh
Annapolis	$34,490,000	$23,920,000	22
Avon	$10,190,000	$46,695,000	25
Bear River	$17,880,000	$124,550,000	34
Black River	$47,350,000	$194,690,000	94
Dickie Brook	$5,400,000	$33,020,000	8
Fall River	$3,910,000	$6,500,000	2
Harmony		$5,360,000	
Lequille	$8,330,000	$10,000,000	25
Mersey	$355,730,000	$213,560,000	231
Nictaux	$6,240,000	$28,190,000	40

System	Sustaining	Decommissioning	Annual Generation GWh
Paradise	$7,130,000	$64,190,000	21
Roseway		$4,566,000	
Sheet Harbour	$33,440,000	$55,460,000	44
Sissiboo	$16,290,000	$200,050,000	72
St. Margaret's Bay	$23,490,000	$68,060,000	24
Tusket	$23,630,000	$79,530,000	11
Wreck Cove	$160,120,000	$424,940,000	291

- Battery Storage (Section 4) – Pursuant to the Board's direction from the 2018 ACE Plan Decision[1], this section provides comments on NS Power's plan for evaluating storage technologies in the next IRP.

[1] NSPI 2018 ACE Plan, M08350, Board Order, page 2.

2.0 METHODOLOGY

This Hydro Study provides (1) a forecast of individual system investments required over the next 40 years. The methodology for sustaining costs is described in Section 2.2. (Given that the Harmony and Roseway Hydroelectric Systems are currently classified as not used and not useful for accounting purposes, NS Power has not identified sustaining costs for these systems) and (2) an estimate of the total cost to decommission each asset. The methodology for decommissioning costs is described in Section 2.3.

2.1 Hydro Asset Study Assumptions

2.1.1 Class 5 Cost Estimates

All cost estimates (sustaining and decommissioning) used in the Hydro Study are provided on a per system basis and were developed using a Class 5 estimate, as defined in the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System[2]. Class 5 estimates are the industry accepted level of cost detail for initial project definition and assumes that minimal project scoping has been completed and includes a broad range of accuracy, from -50 to +100 percent. As such, costs within this Hydro Study, whether sustaining or decommissioning, remain high-level estimates.

2.1.2 Cost Assumptions and Use of Net Present Value

Cost estimates to decommission existing assets, unless otherwise stated, are present valued to 2018 dollars. In addition, unless stated otherwise, decommissioning costs account for the entire removal of the hydro system where the watershed is able to resume a natural flow regime. This scenario presumes that assets have been removed and land has been stabilized to a degree such that NS Power is no longer responsible for maintenance and public safety around the watershed.

[2] https://web.aacei.org/.

Unless stated otherwise, all sustaining costs are estimated based on the requirement to keep hydro systems operating as they presently do in 2018 dollars. Annual spend estimates represent project costs allocated to the in-service year and not annual spend forecasts.

An estimate of Administrative Overheads (AO), and Allowance for Funds Used during Construction (AFUDC) are incorporated into final costs, unless otherwise stated in the description of each hydro system.

For the purpose of the Hydro Study, a 40-year time horizon was used. This was selected as it is consistent with the period for which NS Power has analyzed and submitted projects to date. However, this does not mean that NS Power anticipates removing its hydro systems from service in 40 years; rather, 40 years of costs were extracted, and the present value of their sum is provided for information purposes only.

2.1.3 Drawings

This Hydro Study contains drawings for 16 of the hydro systems. These drawings are intended to be informational and should not be used as technical support. The drawings are not completely illustrative of the structures that exist within each hydro system.

2.2 Sustaining Capital Costs

The forecasted sustaining costs for each hydro system are presented in two categories. The Hydro Study provides both sustaining capital costs and operating costs for each hydro system. In addition, there are several hydro systems that are the subject of an existing or contemplated regulatory filing. These systems include Annapolis, Gaspereau Lake on the Black River System, Mersey, and St. Margaret’s Bay. Individual forecasts for these systems are outlined below in Section 3.

2.2.1 Sustaining Capital

The sustaining capital cost estimates for each hydro system were compiled utilizing NS Power's asset management methodology. This method is consistent with industry best practice for forecasting medium to long-term investment timing and spending. The results inform a forecast long-term sustaining investment profile for each major asset class for each hydro unit, station and system. A standardized approach for project timing and cost estimates was used based on proportioned historic costs and baselined project scopes. The amount and timing of actual investments will be based on an understanding of asset risk (condition and criticality) based on the latest operational information, which could result in a change to NS Power's long-term forecast to optimize investment. The sustaining plan can be used to support capital forecasting, as it identifies project requirements and timing, but itself does not represent a capital forecast. When comparing single capital years from ACE plans to a long-term planning document it is important to take into consideration leveling of investment. It is expected that the timing of investments will change from the Hydro Interval Plan (HIP) as annual assessments based on the latest operational information is essential to optimizing investment.

The investment planning methodology was reviewed by METSCO Energy Solutions (METSCO) and confirmed to be aligned with asset management best practices. The METSCO Report is attached as **Appendix A** and their qualifications are summarized on page 21 of the report**.**

Its review states, "NS Power's management practices are comparable to other utilities of similar size and sophistication"[3]. In addition, the METSCO Report notes that appropriate labour and operations constraints were given in determining a maximum number of annual overhauls to be executed by the Company.[4]

[3] METSCO Energy Solutions Report, Appendix A, page, 14
[4] METSCO Energy Solutions Report, Appendix A, page, 14.

2.2.2 Operational Costs

It was assumed that the operations staffing, maintenance and support costs will remain constant with regard to the hydro fleet. Unless otherwise noted, the average of the past five years of available hydro operational data was used and projected out over the analysis period of the Hydro Study.

Based on the past five years of available data, NS Power currently incurs an average of approximately $3,380,000 of hydro operational spend that is not system specific. These costs are not included in the Hydro Study individual System Costs. These costs include the costs to run the Milton Machine Shop, previously the White Rock Machine Shop, and to employ Planners, Administrative Staff and compensate salaried employees working on fleet wide initiatives. Escalating at an annual rate of two percent inflation, out across the 40-year Hydro Study analysis period, the total present-day value of these costs is approximately $59,680,000.

2.2.3 Replacement Energy Cost

The Replacement Energy Cost (REC) is the $/MWh that NS Power will be required to pay to replace the energy lost if a Hydro System is not available to generate electricity. This value is incorporated when completing an IRP and is not included in this Hydro Study. Redevelopment or Life Extension & Modernization hydro capital projects would also be supported by an economic analysis taking into consideration the avoided costs of replacement energy. In this way, the cost benefit of generation is not included in any of the Hydro Study costs.

2.3 Decommissioning Costs

Decommissioning costs in the Hydro Study include all activities deemed necessary to remove a hydro system and return the watershed to a natural flow regime. The decommissioning costs are divided into the following primary streams: physical removal; environmental; sedimentation; and archaeology.

Physical Removal, Environmental and Sedimentation - The physical removal, environmental assessment and sediment management costs associated with decommissioning were developed by Hatch Ltd. (Hatch). Please refer to **Appendix B** for a copy of the report prepared by Hatch (Hatch Report). A summary of Hatch's qualifications can be found at page 13 of their report.

In addition to the Hatch Report, J.B. Yates Consulting Ltd. (Yates) was retained to provide an update to its 2010 report on the cost estimates for powerhouse removal on NS Power's hydro system. The cost estimates previously prepared by Yates were filed as Appendix C to NS Power's 2010 Depreciation Study[5]. Please refer to **Appendix C** of the Hydro Study for the updated report prepared by Yates (Yates Report). A summary of Yates's qualifications can be found at page 141 of the Yates report.

Yates was retained to develop a separate report for the removal of assets at the Annapolis tidal facility. This is due to the station's unique configuration and assets. Please refer to **Appendix D** for the Yates Annapolis Report.

Strum Consulting (Strum), also corroborated estimates in the Hatch Report. A copy of the report prepared by Strum is attached as **Appendix E** (Strum Report). The Strum Report corroborates the costs of wetland permitting, delineation, and monitoring alterations. A summary of Strum's qualifications can be found at page 160 of their report.

[5] NSPI 2010 Depreciation Study, P-891/M03655, October 29, 2010.

Archaeology - Archaeology costs were developed by Boreas Heritage Consulting Inc. (Boreas). Please refer to **Appendix F** for the report prepared by Boreas (Boreas Report). Archaeological sites in the province of Nova Scotia are protected by the *Special Places Protection Act* (SPPA). This Provincial legislation applies to all archaeological sites, either recorded or unknown. The purpose of the report, in accordance with the SPPA and Communities, Culture and Heritage (CCH) Heritage Research Permit Guidelines is to provide NS Power with a guide as to potential archaeological costs within NS Power's hydroelectric sites in the event such facilities were decommissioned. The costs contained within the Boreas Report are an estimate, and further archaeological reconnaissance would be required before final recommendations regarding archaeological potential within a defined study area can be made. NS Power would not fully understand the extent of costs associated with archaeology until such archaeological potential is more defined and fully scoped within a given site.

In addition, these high-level decommissioning cost estimates do not include potential wetland compensation costs, or the exclusions outlined in the Hatch Report.[6] Exclusions include, for example, unexpected site conditions, unidentified ground conditions, soil decontamination and disposal costs, lost or altered recreational uses, loss of revenue to local businesses, etc. Any costs required to alter the transmission system resulting from the decommissioning of a hydro system are not included in the Hydro Study. Determining these costs would require further site-specific analyses.

For the purposes of this Hydro Study, the estimated decommissioning costs assume the restoration of a system to natural free-flowing conditions, which avoids any further sustaining costs. This is complex, and the case histories (as outlined in the Hatch Report) show that mitigation measures to reduce the negative impacts of dam removal are not always successful, which can lead to long-term issues and remediation costs. While decommissioning estimates were made based on knowledge of the systems, precedent

[6]Hatch Report, Appendix B, page 62.

experience and engineering judgment, there remains uncertainty with respect to the overall requirements (and associated costs) for full environmental remediation.

As such, decommissioning estimates are high-level and currently exclude multiple variables that could only be determined upon a more detailed assessment of each system.

2.3.1 Removal of Assets

The Hatch Report outlines the total cost to decommission NS Power's hydro assets using two methods:

- Previous comprehensive estimates – Annapolis, Harmony, Mersey River, Roseway, St. Margaret's Bay, Tusket, and Black River;
- Empirical estimating tool –Avon, Bear River, Dickie Brook, Fall River, Lequille, Nictaux, Paradise, Sheet Harbour, Sissiboo, and Wreck Cove.

Previous estimates were completed by Hatch for various NS Power hydro projects. Hatch's decommissioning costs in those estimates were completed on an asset by asset basis, at the level of a Class 5 estimate, and incorporated into this Hydro Study.

For the 10 systems noted above, Hatch developed an empirical estimating tool that provides data via a statistical analysis exercise, without requiring an excess of time and resources. The Hatch Report compiles actual or estimated infrastructure removal costs for over 100 case projects. The Hatch Report relates these costs to each project's dam height. Using linear regression, a curve was fit to the data of removal cost versus dam height. NS Power hydro site removal costs were then derived from this curve's equation. The case examples predominantly included costs for removal of all of a site's assets. This includes dams, powerhouses, surge tanks, canals, gate structures and fish passages. Therefore, the estimates provided in the Hatch Report for NS Power systems are also assumed to include all system assets. NS Power has over 150 hydro dams, and associated surge tanks, canals, fish passages and other water control infrastructure. Dams are a variety of ages, sizes, and were built using a variety of construction methodologies and materials. At such a stage, the methodology in the Hatch Report provides a reasonable Class 5 estimate.

As noted above, Yates provided costs pertaining to hydro assets for the 2010 Depreciation Study[7]; accordingly, Yates was selected to provide updated cost estimates. Yates' scope of work pertained exclusively to the removal and stabilization of all of NS Power's hydro powerhouses. The scope included providing costs for: removing assets to create brownfield sites appropriate for future industrial use; stabilizing sites to prevent environmental risk; and securing sites to prevent potential public harm. The Yates Report develops individual costs for each of NS Power's current hydro powerhouses. There are a definitive number of powerhouses, with clearly defined footprints, and available existing configuration.

The estimated costs shown in the Yates Report were then related to those compiled in the Hatch Report. Hatch's removal costs from previous works included powerhouse removal costs as these scopes of work were also used independently of the Hydro Study. Hatch's costs that were determined through linear regression also include powerhouse removal costs, as the reviewed case studies were for entire hydro systems. Costs developed by Yates are not in addition to those presented in the Hatch Report.

2.3.2 Environmental Assessment

The Hatch Report completes costing for each of the 17 river systems to have an Environmental Assessment (EA) completed and sedimentation managed. These costs are based on a thorough literature review of over 300 dam decommissioning estimates and actual costs. These sites were put into a matrix based on environmental risk and cost. NS

[7] NSPI 2010 Depreciation Study, P-891/M03655, October 29, 2010.

Power sites were then fit into this matrix to generate site specific cost estimates for decommissioning EAs. The costs to pursue a full EA include the costs to engage with the Mi'kmaq and consult with stakeholders.

The Nova Scotia Wetland Conservation Policy requires strict management of impacts to wetland habitat as a result of construction projects.[8] As such, NS Power sought a supplemental opinion on the associated costs from a local consultant familiar with wetland permitting work to ensure costs are in line with Hatch's environmental costs. These costs were based on a literature review that including projects in other jurisdictions (Please refer to **Appendix E** for the Strum Report). The cost of wetland delineation, field work, reporting, permitting, and follow-up monitoring were estimated, as well as the cost to evaluate compensation needs and options for the various hydro systems. The cost of this work for each system aligns with the environmental costs determined by Hatch.

The Strum Report confirms that wetland permitting costs are not likely to be a significant cost driver in the decision-making process. However, these cost estimates do not include the potential cost of wetland compensation, which may arise if an Environmental Assessment predicts significant net loss of wetland habitat as a result of decommissioning. Net loss of wetland habitat and compensation requirements cannot be accurately predicted without undertaking a significant detailed modeling exercise that would need to consider bathymetry, topography, hydrology, soil stratigraphy, climatic conditions, vegetation and results of discussions with the provincial regulator.

2.3.3 Sediment management

Sedimentation management is a large work scope during hydro decommissioning. As many hydro sites are nearing their centenary as electricity generating facilities, there are generations of sediment that may have built up over time. Also, many systems have had

[8] https://novascotia.ca/nse/wetland/conservation.policy.asp

water retaining structures for longer than they have generated power. They may have previously operated sawmills or other functions. As stated in the Hatch Report, sediment can account for 48 percent of a project's infrastructure removal costs.[9] This percentage is largely impacted by historical and geological knowledge of a site. The Hatch Report confirms that there is a risk of significant sediment management costs upon removal of any of NS Power's hydro structure.

2.3.4 Archaeological Considerations

To determine the potential cost of archaeology related to decommissioning of hydro assets, NS Power selected Boreas (please refer to the Boreas Report attached as **Appendix F**). Boreas created a set of archaeological assumptions foundational upon archaeological and planning principles as a result of historical heritage guidelines, standards and best practices throughout Nova Scotia for completing archaeology work during hydro refurbishment or decommissioning activities. Boreas used these archaeological assumptions to determine high level cost estimates of archaeological activities required at each site, if decommissioning were to occur. Assumptions were developed without engagement with CCH or Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO). Future works, if undertaken, would involve project specific engagement with the regulator, local Mi'kmaq communities and the KMKNO to determine specific requirements and Mi'kmaq engagement costs.

To provide archaeology cost estimates, Boreas and NS Power analyzed individual sites to estimate areas of potential impact during hypothetical decommissioning construction works.

[9] Hatch Report, Appendix B, page 7.

3.0 SYSTEM COSTS

The following subsections provide both the forecast sustaining costs and decommissioning costs of each of NS Power's hydro systems represented by the Net Present Value (NPV) of the option over 40 years. The methodologies for determining these costs are defined above and site-specific assumptions are noted with their respective systems. The final column for each table denotes the source for each cost. A summary of the estimated costs is presented in Figure 3 below:

Figure 3: Summary of System Costs

System	Sustaining	Decommissioning	Annual Generation GWh
Annapolis	$34,490,000	$23,920,000	**22**
Avon	$10,190,000	$46,695,000	**25**
Bear River	$17,880,000	$124,550,000	**34**
Black River	$47,350,000	$194,690,000	**94**
Dickie Brook	$5,400,000	$33,020,000	**8**
Fall River	$3,910,000	$6,500,000	**2**
Harmony		$5,360,000	
Lequille	$8,330,000	$10,000,000	**25**
Mersey	$355,730,000	$213,560,000	**231**
Nictaux	$6,240,000	$28,190,000	**40**
Paradise	$7,130,000	$64,190,000	**21**
Roseway		$4,566,000	
Sheet Harbour	$33,440,000	$55,460,000	**44**
Sissiboo	$16,290,000	$200,050,000	**72**
St. Margaret's Bay	$23,490,000	$68,060,000	**24**
Tusket	$23,630,000	$79,530,000	**11**
Wreck Cove	$160,120,000	$424,940,000	**291**

3.1 Annapolis Tidal Power Facility

The Annapolis Tidal Power Facility was commissioned in 1984 in the town of Annapolis Royal, NS. It has a maximum rated capacity of 19.9 MW and generates electricity as the ebb tide flows out from St. Mary's Bay. The powerhouse contains one propeller style runner.

Annapolis was originally constructed as a research facility and is approaching its end of life. Although the facility was only committed to run for four years, NS Power has successfully maintained it for a much longer period. As such, it requires a capital investment in excess of what the sustaining capital would dictate. A detailed analysis on the feasibility of a Life Extension and Modernization (LEM) projects is being undertaken to determine if it is economically justifiable. The current scope of work being estimated below in Figure 4 is that of a P50 cost estimate. That is, there is a 50 percent chance costs will be higher.

The powerhouse is incorporated into an island and is accessed by a causeway that would not be removed during decommissioning.

Figure 4: Annapolis Tidal sustaining forecast

		Source
Sustaining capital	$3,070,000	NS Power
LEM	$19,530,000	NS Power
NS Power operating costs	$11,890,000	NS Power
Total	**$34,490,000**	

Figure 5: Annapolis Tidal decommissioning forecast

		Source
Removal	$12,000,000	Hatch Report Yates Report NS Power
Environmental	$2,270,000	Hatch Report
Sedimentation[10]	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Additional	$3,760,000	NS Power
AO/AFUDC	$1,670,000	
Total	**$23,920,000**	

[redacted]

3.1 Avon Hydro System

The Avon hydro system, outside of Martock, Nova Scotia, was built in the 1920s, and is shown below in Figure 8. The run of river system generates first through Avon 2, then Avon 1. The pair is rated for a total of 7.3 MW. The system includes five reservoirs, five dams and associated spillways, and two canals.

Figure 6: Avon sustaining forecast

Sustaining capital	$8,140,000	NS Power
NS Power operating costs	$2,050,000	NS Power
Total	**$10,190,000**	

Figure 7: Avon decommissioning forecast

		Source
Removal	$10,570,000	Hatch Report
Environmental	$5,335,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$46,695,000**	

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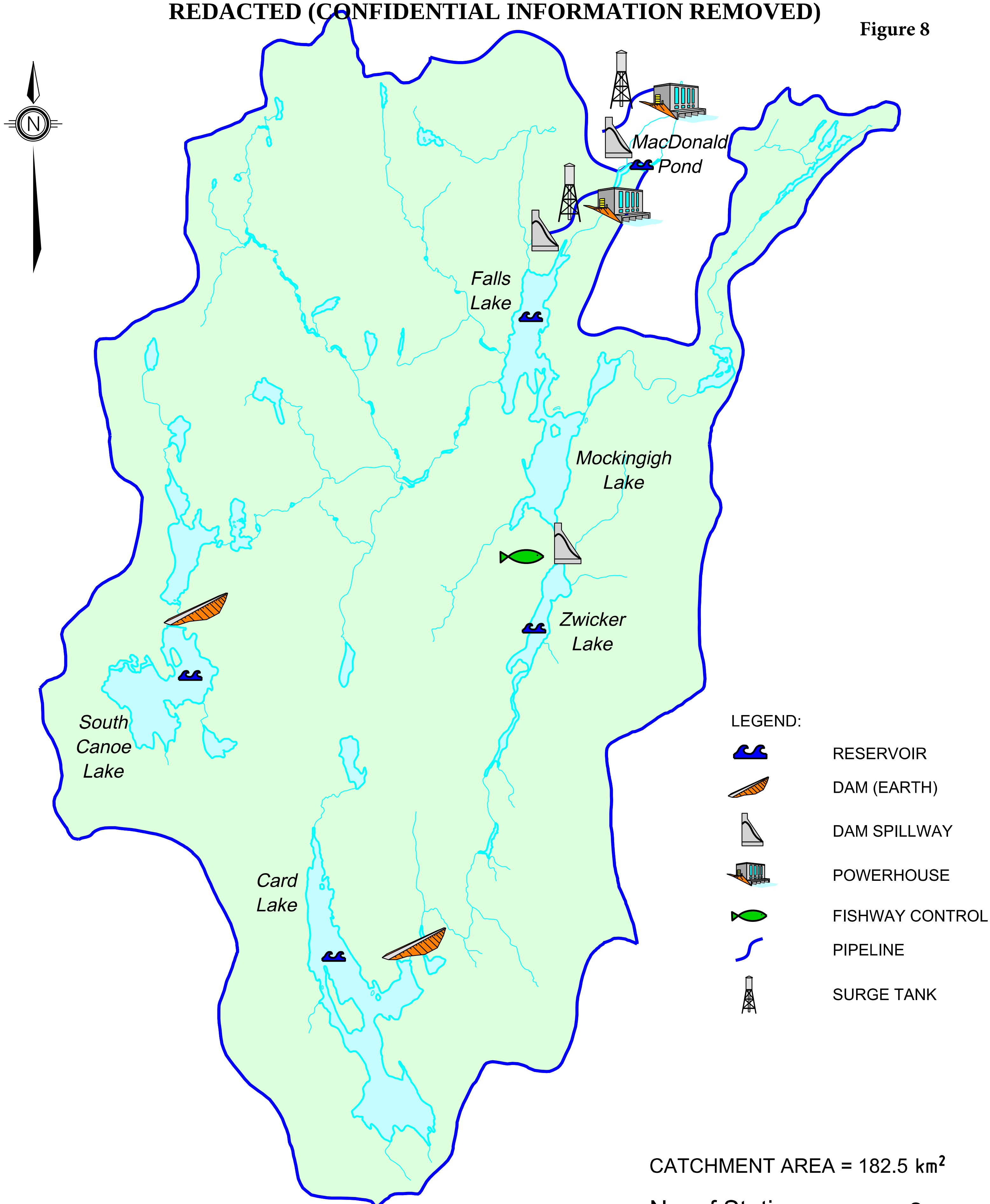
Figure 8



CATCHMENT AREA = 182.5 km^2

No. of Stations 2

Generating Units 2

Capacity .... 7.6 MW

Avon Hydro System

3.2 Bear River Hydro System

The Bear River hydro system is comprised of two powerhouses, Gulch and Ridge, rated for 11.5 MW total, both built in the 1950s, with one unit each. The system is shown below in Figure 11. The Bear River hydro system also includes one reservoir, two head ponds, three dams and associated wing dams and spillways, one canal and two penstocks.

Figure 9: Bear River sustaining forecast

		Source
Sustaining capital	$9,260,000	NS Power
NS Power operating costs	$8,620,000	NS Power
Total	**$17,880,000**	

Figure 10: Bear River decommissioning forecast

		Source
Removal	$20,780,000	Hatch Report
Sedimentation[11]	[redacted]	
Environmental	$12,010,000	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$124,550,000**	

[redacted].

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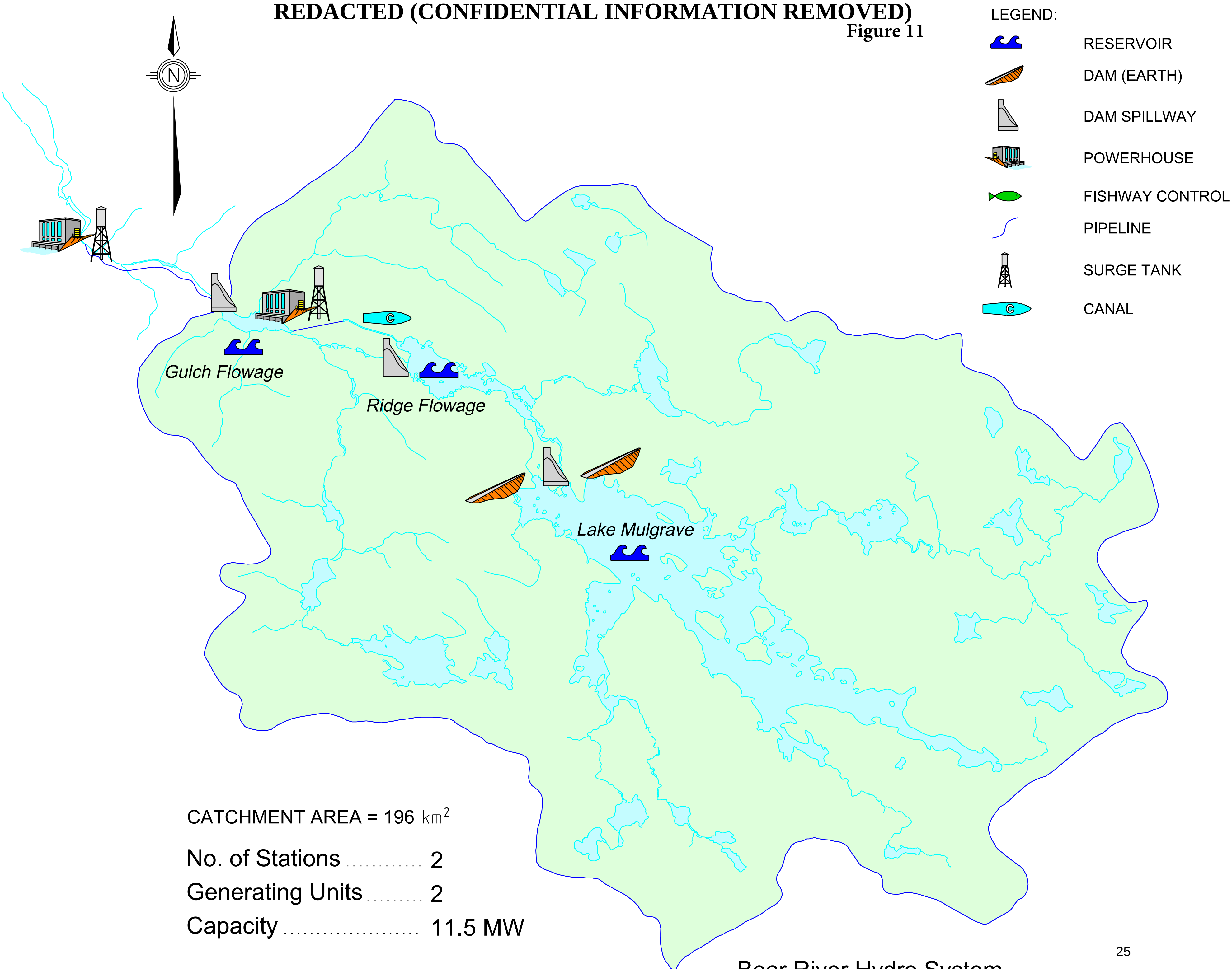
Figure 11



CATCHMENT AREA = 196 km^2

No. of Stations 2

Generating Units 2

Capacity .... 11.5 MW

Bear River Hydro System

3.3 Black River Hydro System

The Black River hydro system is outside Gaspereau, NS and capable of generating up to 21.6 MW. It is a run of river system, built in the 1940s, comprised of five powerhouses and six generating units. The furthest upstream powerhouse is at Methals Falls, which feeds water through Black River Lake to the Hollow Bridge Development, which in turn feeds water via Lumsden Pond to the Lumsden powerhouse. From there, water traverses to Hells Gate Development where two generating units are located. Downstream of Hells Gate, the flow of the Black River becomes part of the larger Gaspereau River. Downstream of the confluence of the Black and Gaspereau rivers is the White Rock Generating Station from where water is discharged into the lower reaches of the Gaspereau River and its marine estuary. The system is comprised of 12 reservoirs and associated spillways, 20 dams and associated wing dams, three canals that provide water to the powerhouses, and three fish passages. The system is shown below in Figure 14.

Figure 12: Black River sustaining forecast

		Source
Sustaining capital	$35,080,000	NS Power
NS Power operating costs	$12,270,000	NS Power
Total	**$47,350,000**	

Figure 13: Black River decommissioning forecast

		Source
Removal	$58,110,000	Hatch Report
Environmental	$28,880,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology		Boreas Report
AO/AFUDC	$12,090,000	
Total	**$194,690,000**	

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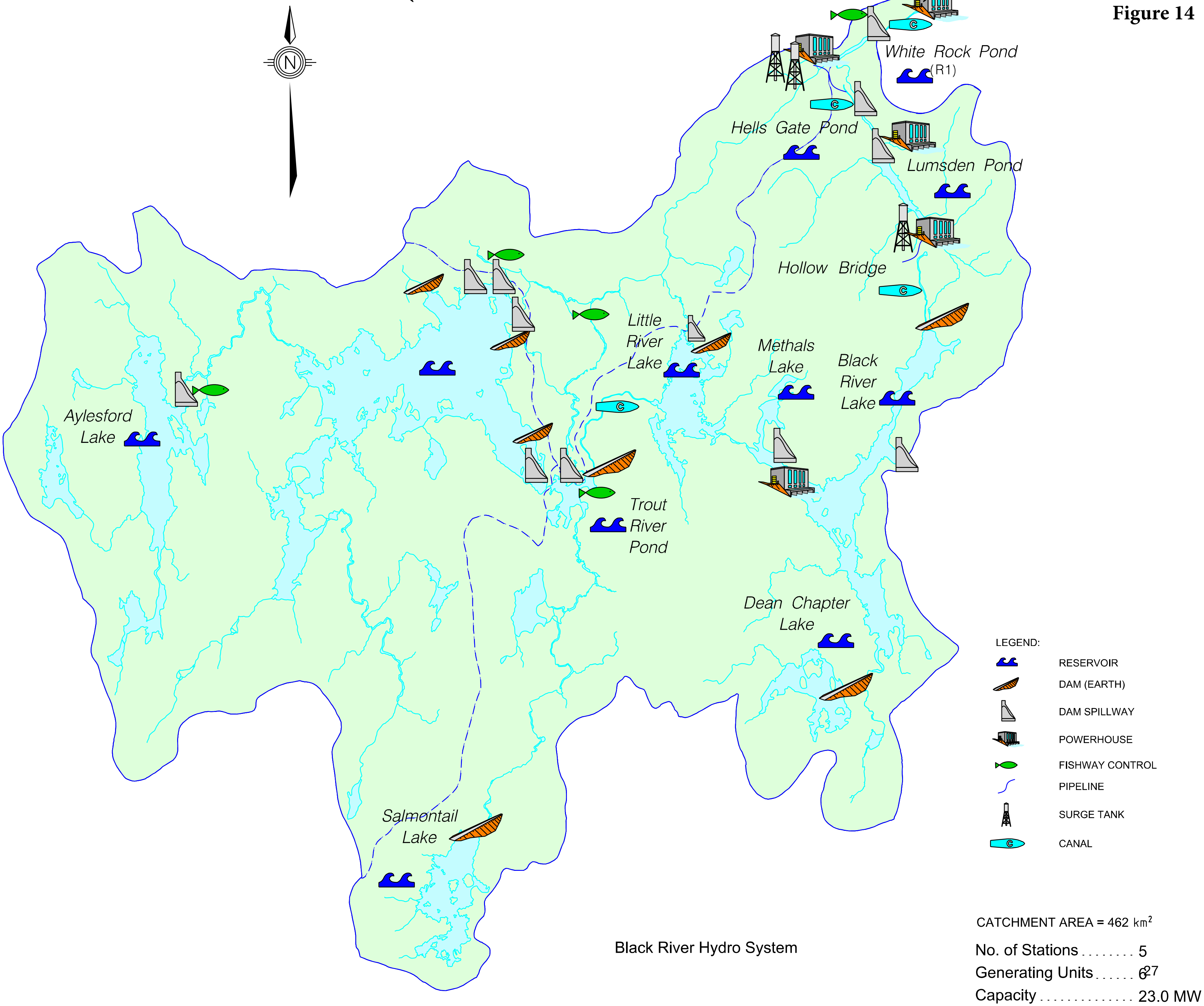
Figure 14



Black River Hydro System

3.4 Dickie Brook Hydroelectric System

The Dickie Brook hydro system, outside of Guysborough, NS, was built in the 1940s and is comprised of one powerhouse with two units, rated for a total of 3.1 MW, and is shown in Figure 17. The system includes two reservoirs, two main dams and associated wing dams, one power canal and a penstock.

Figure 15: Dickie Brook sustaining forecast

		Source
Sustaining capital	$4,680,000	NS Power
NS Power operating costs	$720,000	NS Power
Total	**$5,400,000**	

Figure 16: Dickie Brook decommissioning forecast

		Source
Removal	$7,550,000	Hatch Report
Environmental	$3,880,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$33,020,000**	

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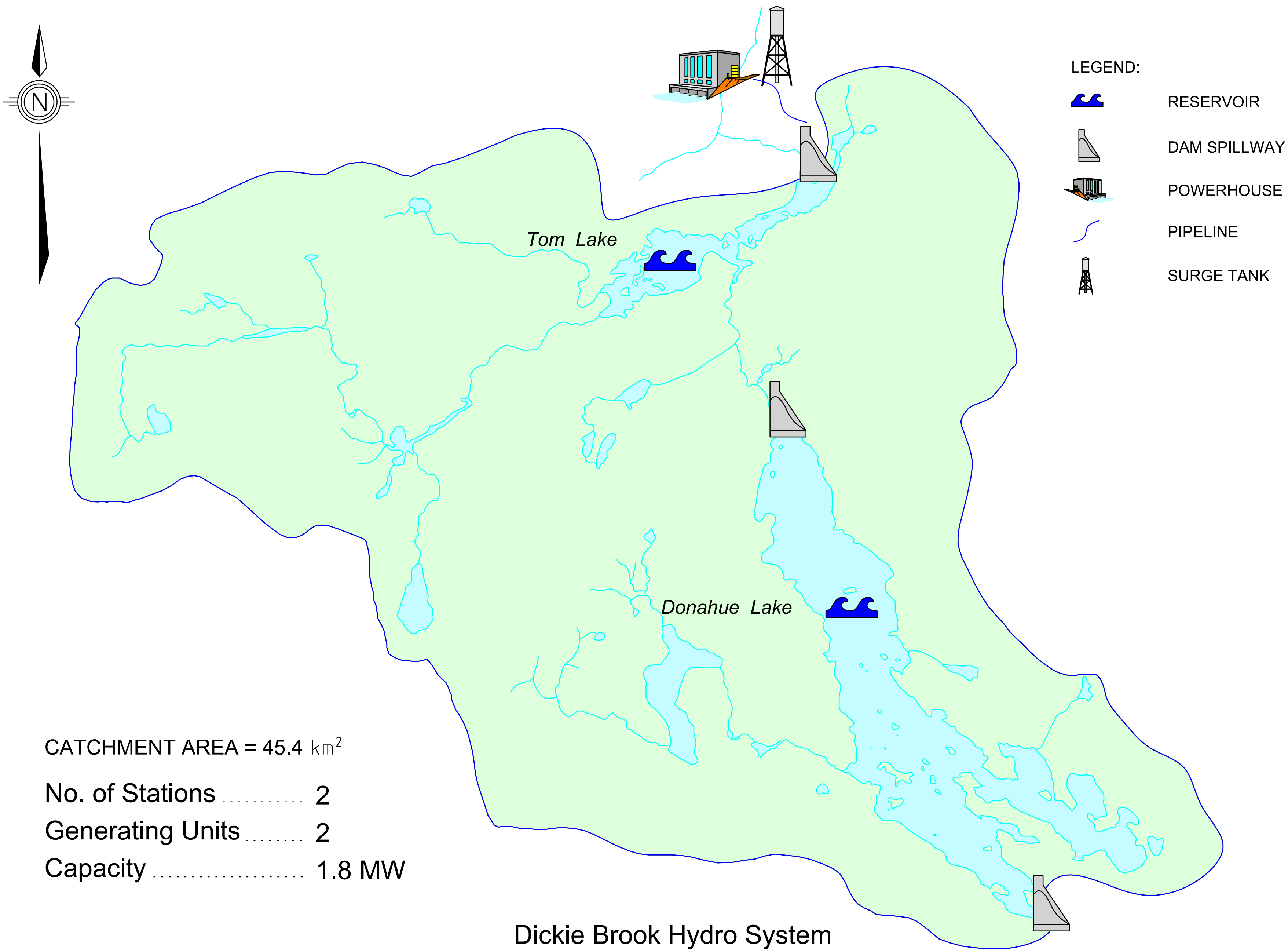
Figure 17



CATCHMENT AREA = 45.4 km^2

No. of Stations 2

Generating Units 2

Capacity .... 1.8 MW

Dickie Brook Hydro System

3.5 Fall River Hydro System

The Fall River hydro system, shown in Figure 20, was built in 1985, has one powerhouse with a single 500 kW rated unit. There are two reservoirs, two dams and wing dams, one canal and a penstock.

Figure 18: Fall River sustaining forecast

		Source
Sustaining capital	$2,470,000	NS Power
NS Power operating costs	$1,440,000	NS Power
Total	**$3,910,000**	

Figure 19: Fall River decommissioning forecast

		Source
Removal	$530,000	Hatch Report
Environmental	$1,090,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$ 6,500,000**	

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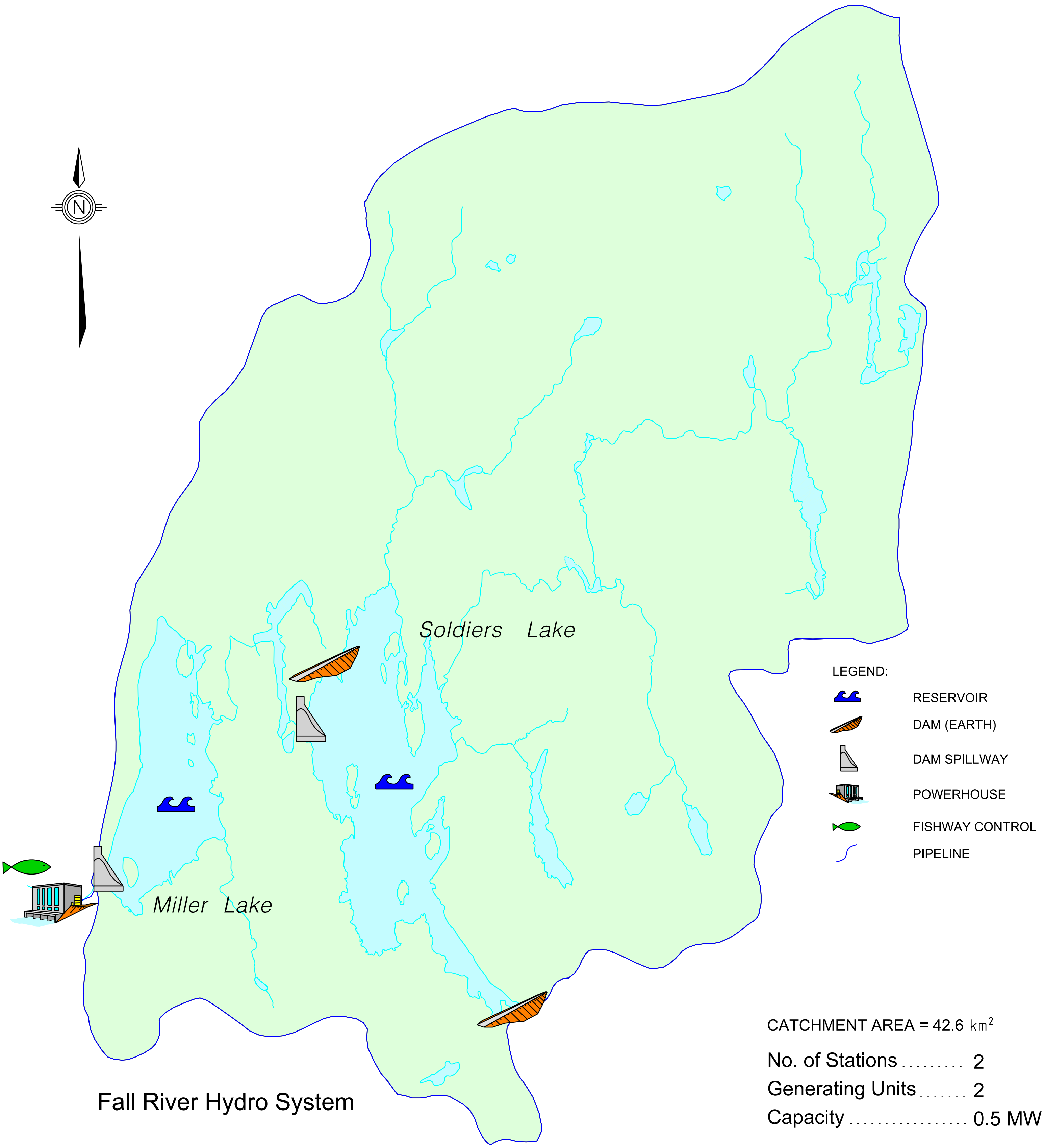
Figure 20



3.6 Harmony Hydroelectric System

The Harmony hydro system was partially decommissioned in 2017. At that time the original 700 kW powerhouse was removed. The reservoirs and associated infrastructure are currently maintained. There is one reservoir and an associated spillway, one dam and a fish passage. The system is shown in Figure 22.

As a result of previous works, Harmony's archaeology has largely been mitigated. That said, there are known petroglyphs that are currently below water level. As decommissioning would lead to lowered reservoirs, work would be required to determine next steps for the petroglyphs.

Figure 21: Harmony decommissioning forecast

		Source
Removal	$3,790,000	Hatch Report
Environmental	$730,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$ 5,360,000**	

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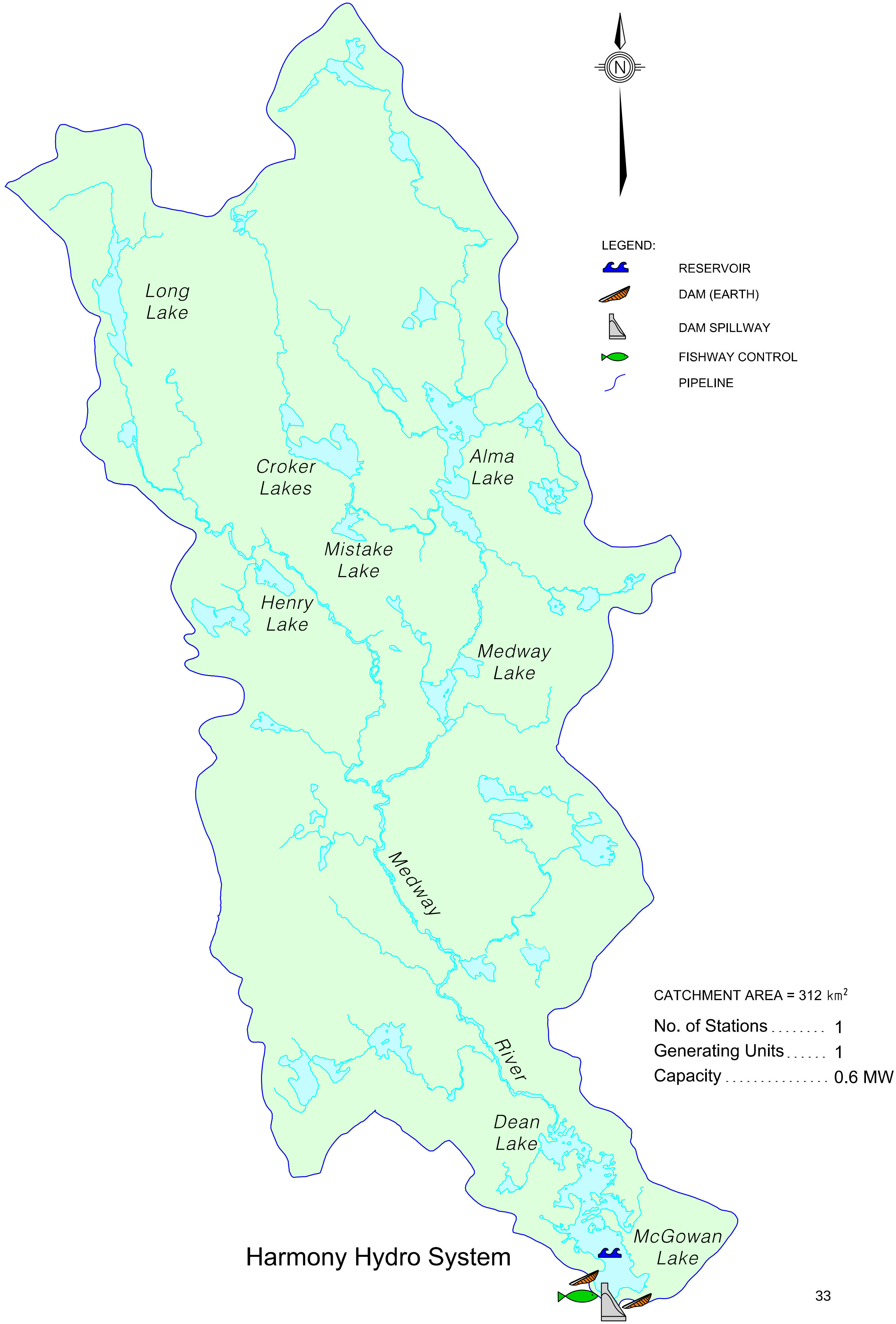
Figure 22



3.7 Lequille Hydroelectric System

The Lequille hydro system, built in 1968, has one powerhouse with a unit rated for 11 MW. The system is shown in Figure 25**Error! Reference source not found.**. The system has three reservoirs and associated spillways, two dams and associated wing dams and intake, and one canal.

Figure 23: Lequille sustaining forecast

		Source
Sustaining capital	$7,930,000	NS Power
NS Power operating costs	$400,000	NS Power
Total	**$8,330,000**	

Figure 24: Lequille decommissioning forecast

		Source
Removal	$5,530,000	Hatch Report
Sedimentation[12]	[redacted]	
Environmental	$3,880,000	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$10,000,000**	

[redacted]

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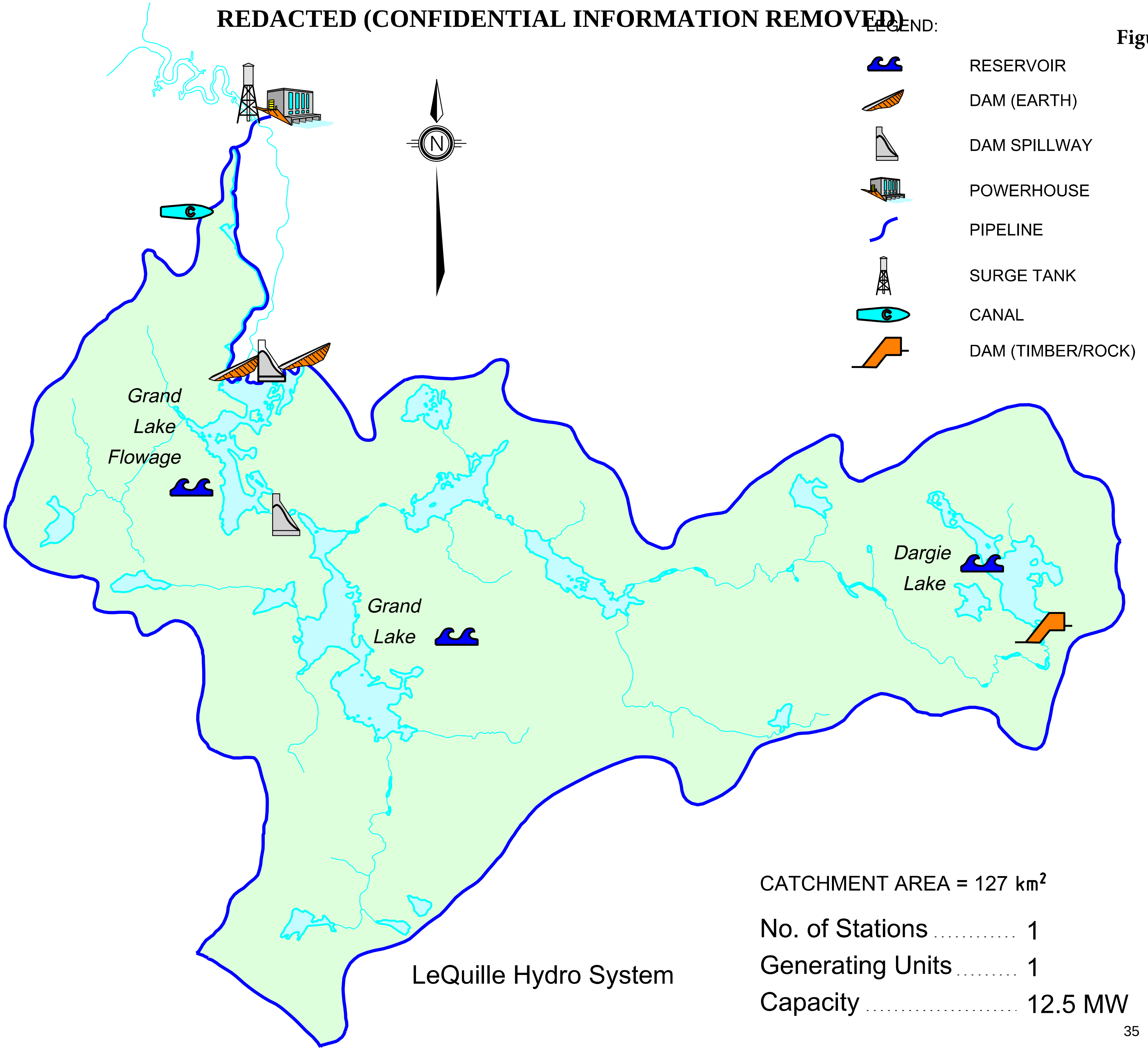
Figure 25



LeQuille Hydro System

CATCHMENT AREA = 127 km^2

No. of Stations 1

Generating Units 1

Capacity .... 12.5 MW

3.8 Mersey Hydroelectric System

The Mersey hydro system is a run of river system, with six powerhouses, 12 units and an installed capacity of 43.6 MW, as shown in Figure 28. Each powerhouse has an adjoining main dam, and several wingdams and spillways, to make up over 40 total structures. Water from the Lake Rossignol reservoir goes through Upper Lake Falls, Lower Lake Falls, Big Falls, Lower Great Brook, Deep Brook, and lastly Cowie Falls, before continuing along the Mersey River.

The operating costs below are not those based on previous years. Operating costs for the Mersey River System are scoped to be reduced as redevelopment is pursued.

Figure 26: Mersey sustaining forecast

		Source
Sustaining capital	$24,090,000	NS Power
Redevelopment	$320,230,000	NS Power
NS Power operating costs	$11,410,000	NS Power
Total	**$355,730,000**	

Figure 27: Mersey decommissioning forecast

		Source
Removal	$82,540,000	Hatch Report
Environmental	$7,840,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology		Boreas Report
AO/AFUDC	$8,720,000	NS Power
Total	**$213,560,000**	

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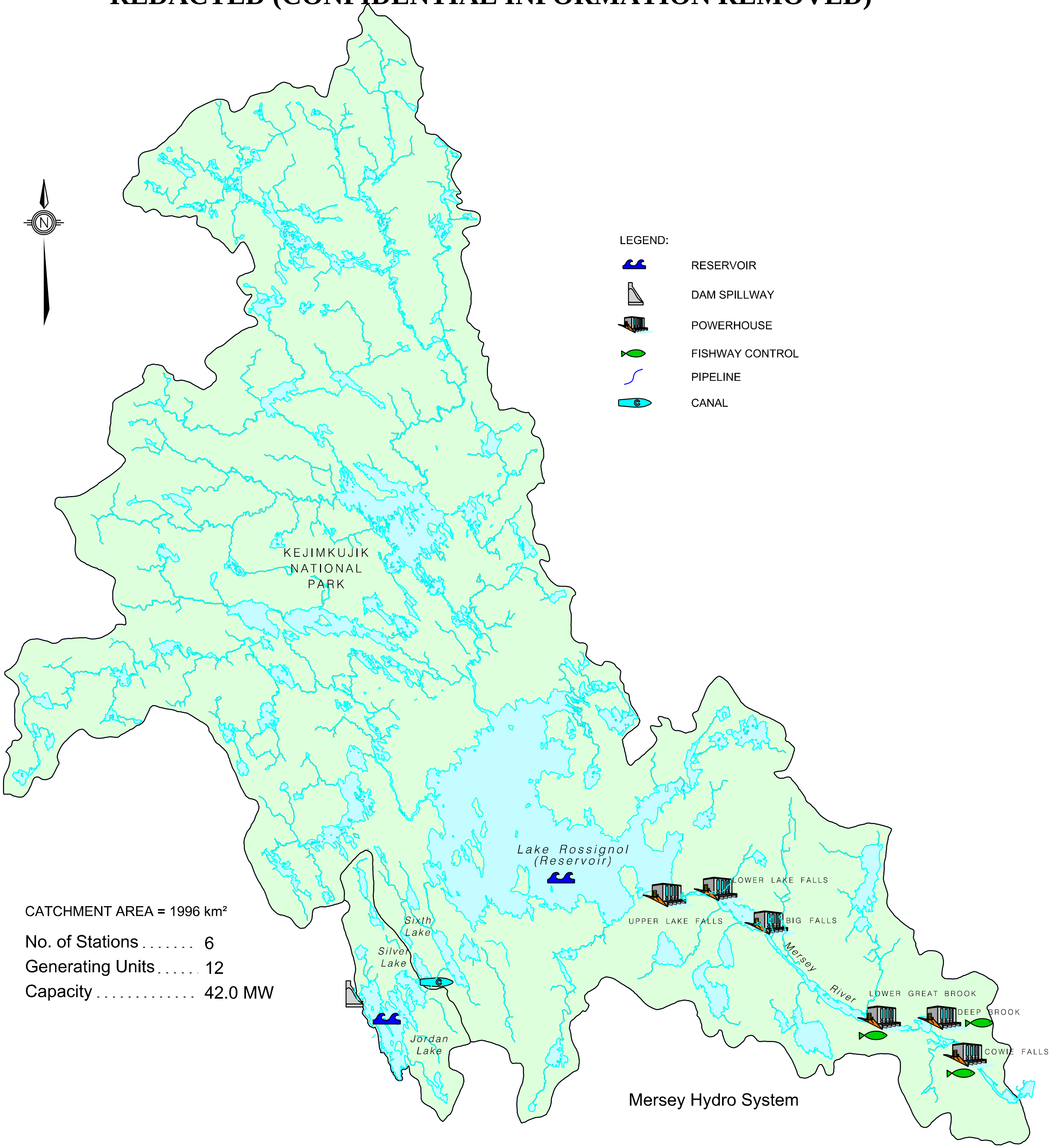
Figure 28



3.9 Nictaux Hydroelectric System

The Nictaux Hydro system has a rated capacity of 8.5 MW from one unit. Water from Big Molly Upsim Lake flows to McGill Lake, then down the Nictaux River, where it is joined by water from Scragg Lake. Water is directed to the powerhouse via a canal. Each reservoir has a main dam, and associated spillways, for a total of 11 structures. The system is shown below in Figure 31.

Figure 29: Nictaux sustaining forecast

		Source
Sustaining capital	$4,040,000	NS Power
NS Power operating costs	$2,200,000	NS Power
Total	**$6,240,000**	

Figure 30: Nictaux decommissioning forecast

		Source
Removal	$11,850,000	Hatch Report
Environmental	$7,690,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$28,190,000**	

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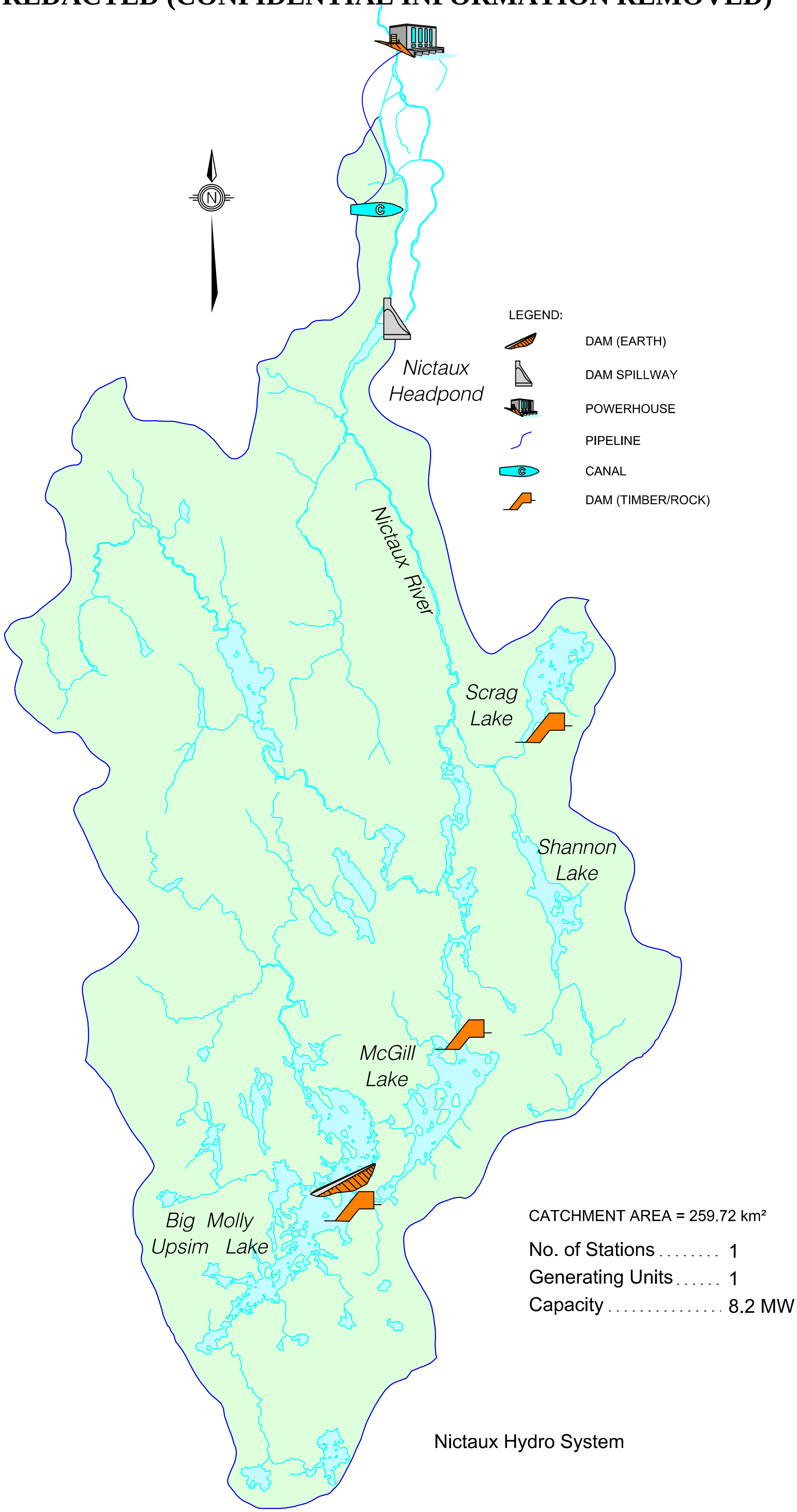
Figure 31



Nictaux Hydro System

3.10 Paradise Hydroelectric System

The Paradise Hydro system has a maximum capacity of 6.2 MW from a single unit, as shown in Figure 34. Water from Corbett Lake flows to Dalhousie Lake. It joins water from Paradise Lake in Saunders Pond. A pipeline and surgetank carry water to the powerhouse.

Figure 32: Paradise sustaining forecast

		Source
Sustaining capital	$6,660,000	NS Power
NS Power operating costs	$470,000	NS Power
Total	**$7,130,000**	

Figure 33: Paradise decommissioning forecast

		Source
Removal	$5,720,000	Hatch Report
Environmental	$2,540,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$64,190,000**	

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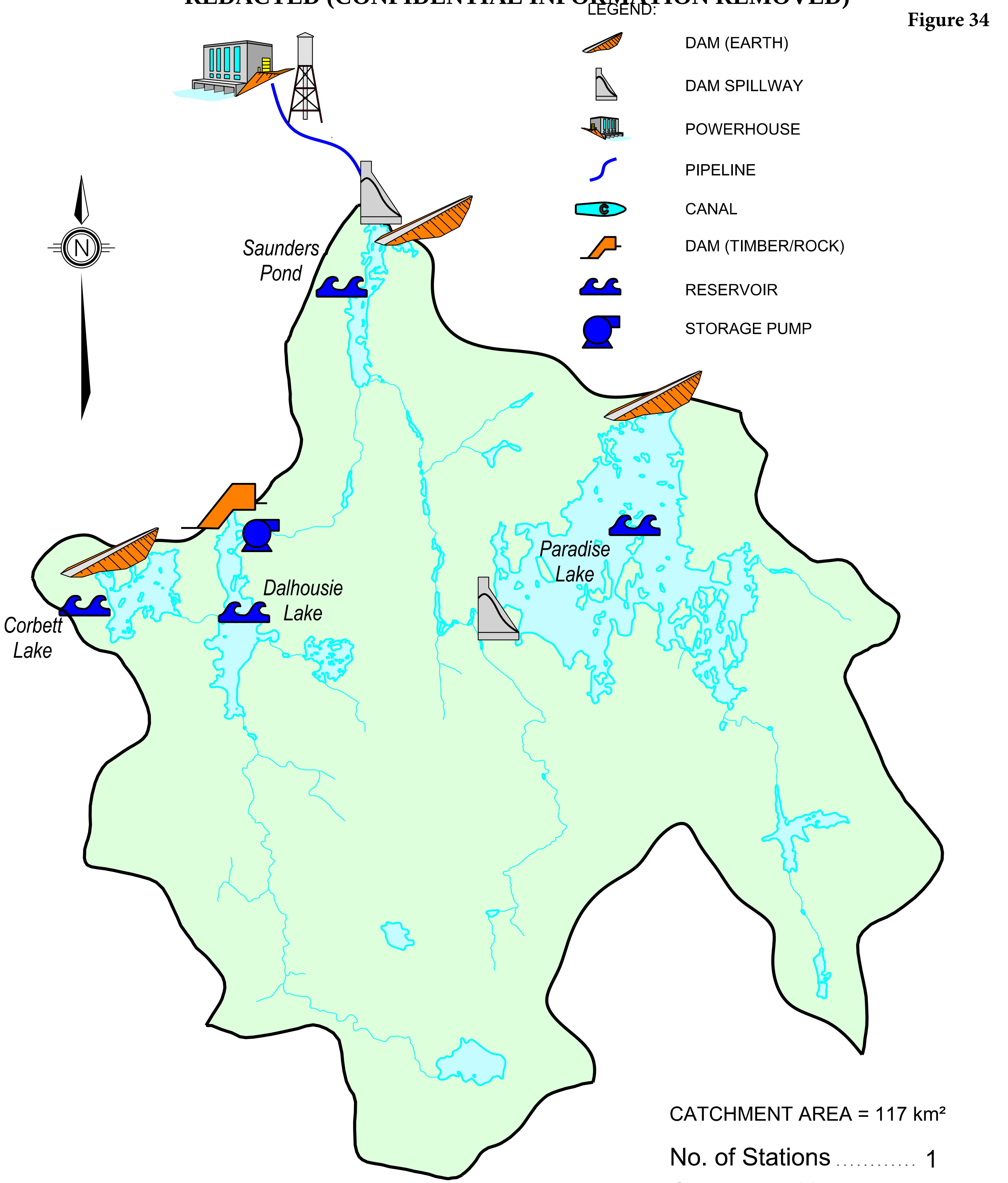
Figure 34



Paradise Hydro System

3.11 Roseway Hydroelectric System

The Roseway hydro system has not generated electricity since 2009 and is classified as not used not useful for accounting purposes. Its two units are rated for 1 MW total, shown in Figure 36. Water from many upstream lakes flows down the Roseway River, to the main dam and powerhouse.

Figure 35: Roseway decommissioning forecast

		Source
Removal	$3,830,000	Hatch Report
Environmental	$730,000	Hatch Report
Sedimentation[13]	[redacted]	
Archaeology	[redacted]	Boreas Report
Total	**$4,566,000**	

[redacted]

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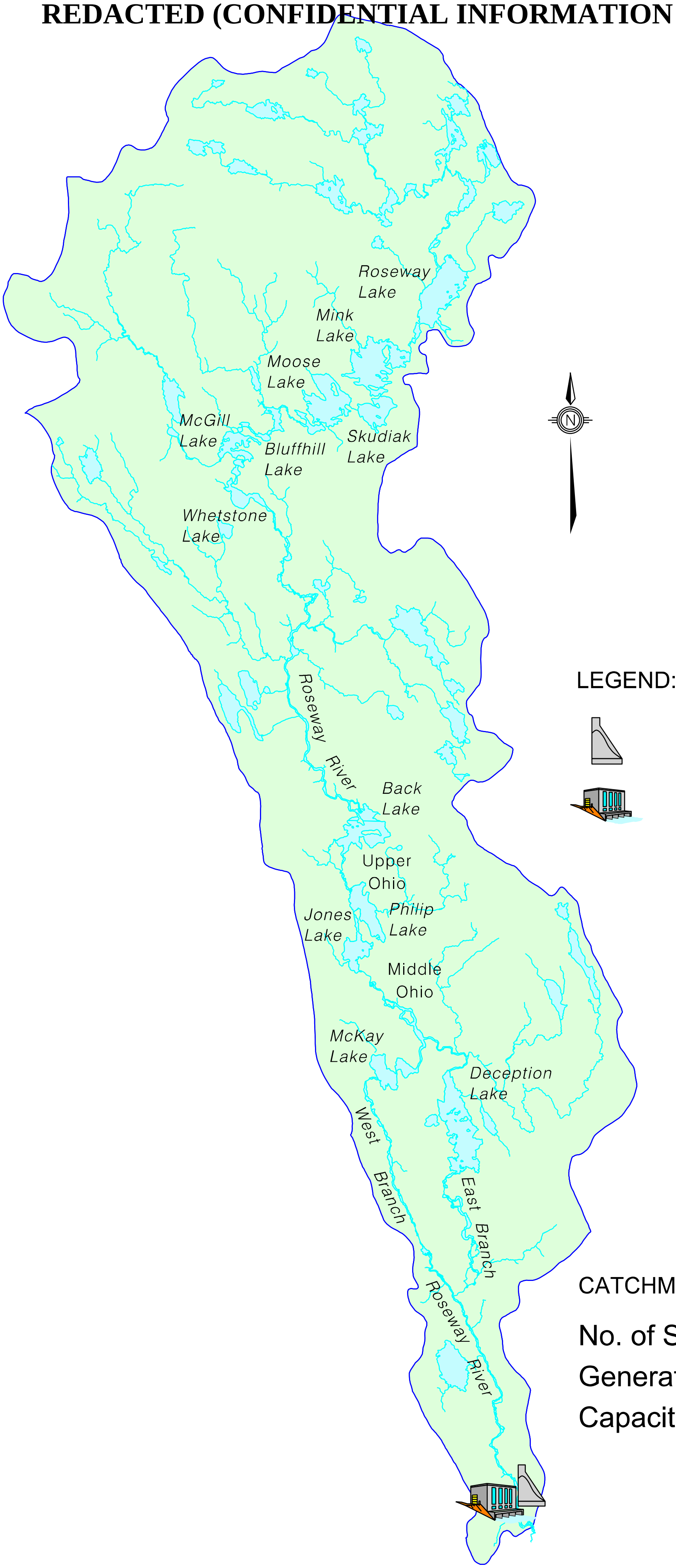
Figure 36



CATCHMENT AREA = 524 km^2

No. of Stations 1

Generating Units 2

Capacity .... 1.0 MW

Roseway Hydro System

3.12 Sheet Harbour Hydroelectric System

The Sheet Harbour hydro system, shown in Figure 39 has a rated capacity of 10.6 MW. This is generated by six units, three per powerhouse. Water is held at the Marshall Flowage and generates through Malay Falls. Water then meets with the Ruth Falls Flowage and generates through Ruth Falls.

Figure 37: Sheet Harbour sustaining forecast

		Source
Sustaining capital	$23,490,000	NS Power
NS Power operating costs	$9,950,000	NS Power
Total	**$33,440,000**	

Figure 38: Sheet Harbour decommissioning forecast

		Source
Removal	$12,410,000	Hatch Report
Environmental	$5,340,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$55,460,000**	

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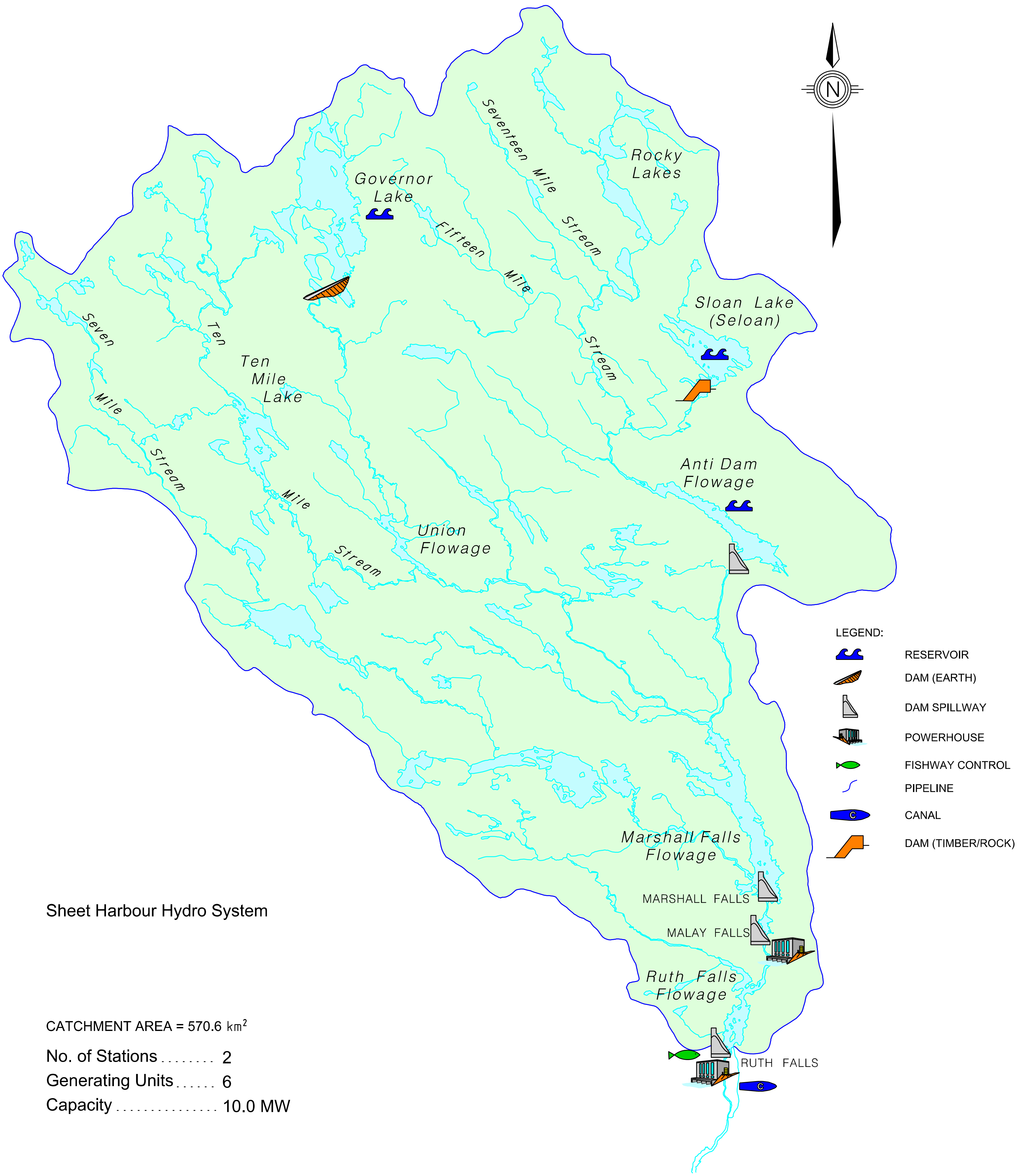
Figure 39



Sheet Harbour Hydro System

CATCHMENT AREA = 570.6 km^2

No. of Stations 2

Generating Units 6

Capacity .... 10.0 MW

3.13 Sissiboo Hydroelectric System

The Sissiboo hydro system has a maximum rated capacity of 28.2 MW and is shown in Figure 42. Water from Fifth Lake generates through Fourth Lake. Water flows through Sissiboo Grand Lake, and then joins water from Big Tom Wallace Lake. It generates through Sissiboo Falls and then Weymouth Falls. There are penstocks and surge tanks.

Figure 40: Sissiboo sustaining forecast

		Source
Sustaining capital	$14,170,000	NS Power
NS Power operating costs	$2,120,000	NS Power
Total	**$16,290,000**	

Figure 41: Sissiboo decommissioning forecast

		Source
Removal	$61,980,000	Hatch Report
Environmental	$33,800,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$200,050,000**	

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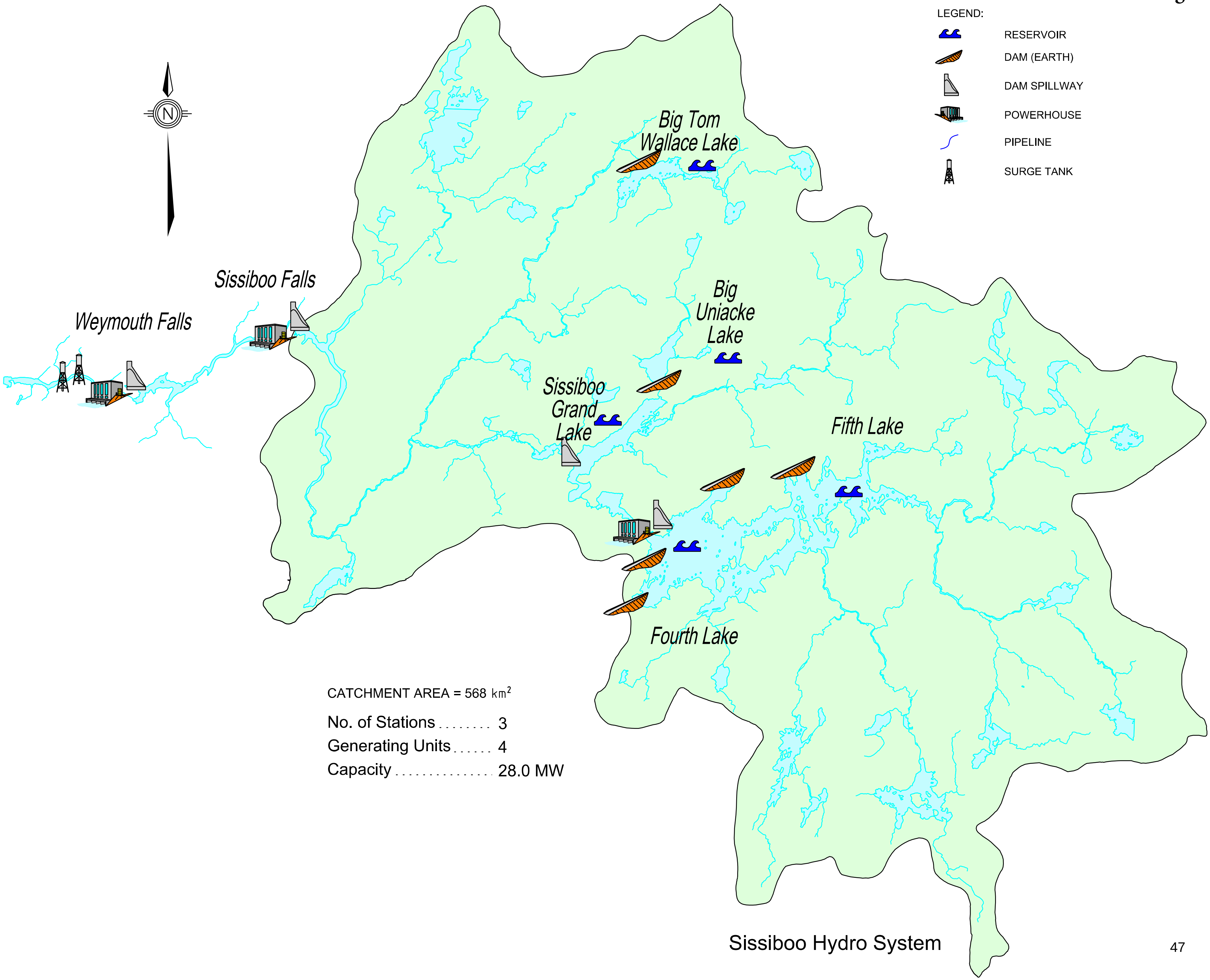
Figure 42



Sissiboo Hydro System

3.14 St. Margaret's Bay Hydroelectric System

The St. Margaret's Bay hydro system has a rated capacity of 8.9 MW. Water flows through the reservoirs, Five Mile Lake, Big Indian Lake and Sandy Lake, through a penstock and surge tank to two Sandy units. Water from Wright's Lake flows through Coon Pond, a penstock and a surge tank to the one Mill Lake unit. Water from the Sandy and Mill Lake units goes to Mill Lake, then through a penstock and surge tank, to the two Tidewater units. This can be seen in Figure 45.

Figure 43: St. Margaret's Bay sustaining forecast

		Source
Sustaining capital	$17,780,000	NS Power
NS Power operating costs	$5,710,000	NS Power
Total	**$23,490,000**	

Figure 44: St. Margaret's Bay decommissioning forecast

		Source
Removal	$25,470,000	Hatch Report
Environmental	$10,120,000 `	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
Total	**$68,060,000**	

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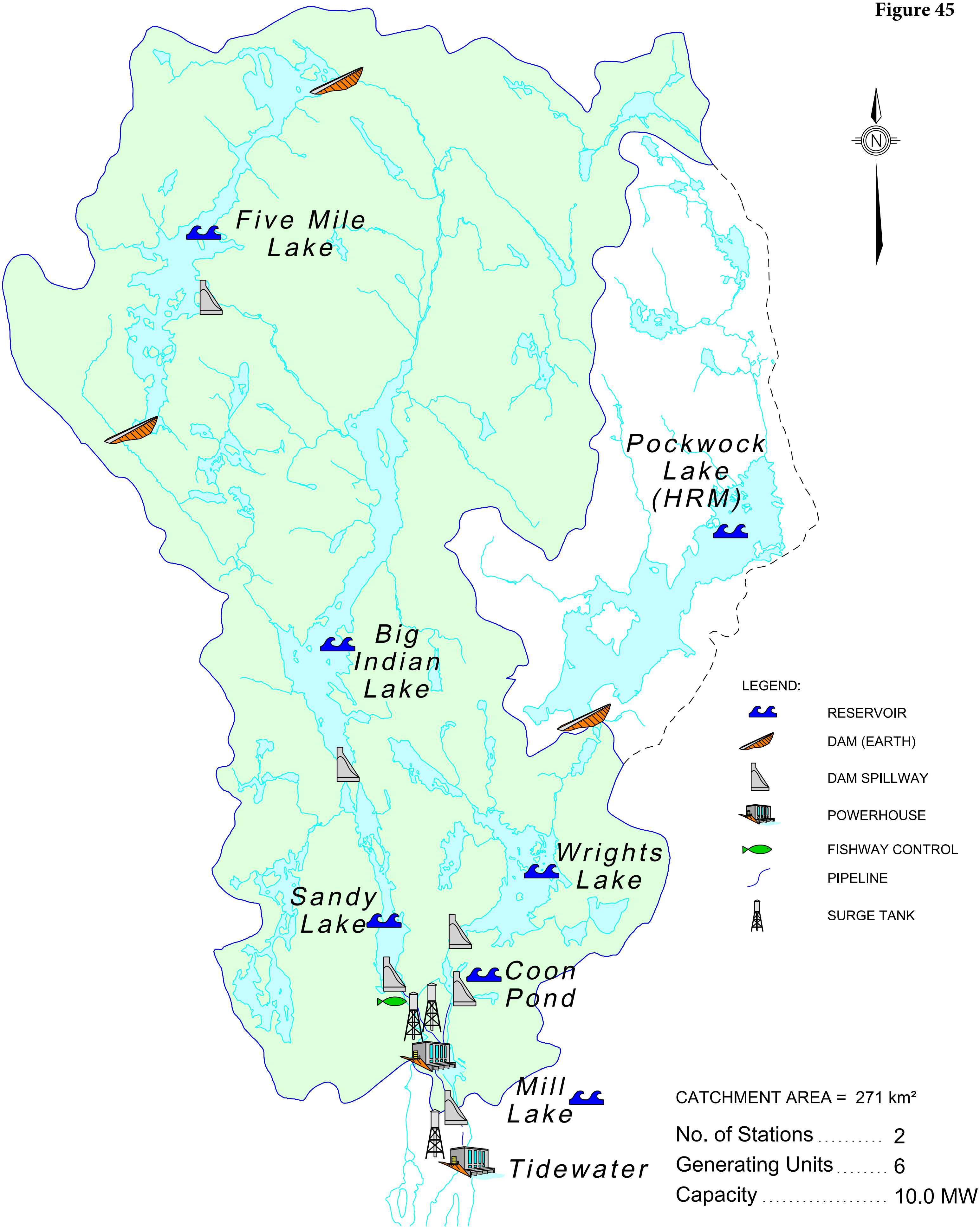
Figure 45



St. Margarets Bay Hydro System

3.15 Tusket Hydro System

The Tusket hydro system, shown in Figure 48 has a rated capacity of 2.4 MW, across three units in one powerhouse. Water is held at four reservoirs, Lake Vaughan, Raynards Lake, Mink Lake and Great Barren Lake. There are seven dams, and three fish passages.

The Tusket main dam is under consideration for reconstruction. Construction Costs that have been previously submitted to the UARB are shown below as sustaining and operating costs.

Figure 46: Tusket sustaining forecast

		Source
Sustaining capital	$20,550,000	NS Power
NS Power operating costs	$3,080,000	NS Power
Total	**$23,630,000**	

Figure 47: Tusket decommissioning forecast

		Source
Removal	$ 18,990,000	Hatch Report
Environmental	$10,580,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
AO/AFUDC	$2,010,000	NS Power
Total	**$79,530,000**	

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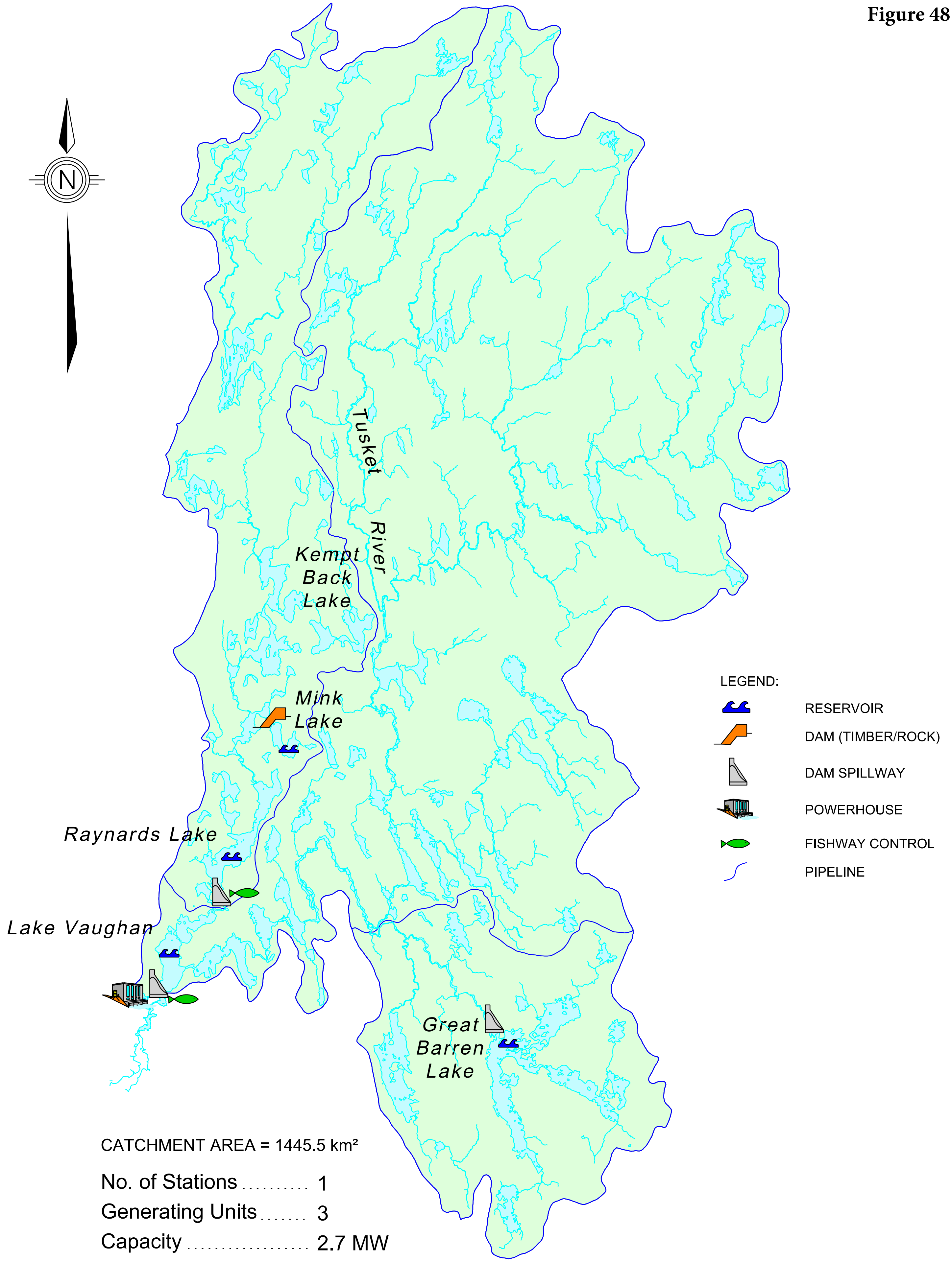
Figure 48



CATCHMENT AREA = 1445.5 km²

No. of Stations 1
Generating Units 3
Capacity .... 2.7 MW

Tusket Hydro System

3.16 Wreck Cove Hydroelectric System

The Wreck Cove hydro system, shown below in Figure 51 has a maximum capacity of 215.8 MW, across three units in two powerhouses. Water from the Cheticamp Flowage, Ingonish I, Ingonish II, Gisborne Flowage, and MacMillan Flowage generate through the Gisborne unit. This water enters the Wreck Cove Flowage Reservoir, and then travels via tunnel to the head pond, Surge Lake. A blasted penstock carries water down to two Wreck Cove units.

Figure 49: Wreck Cove sustaining forecast

		Source
Sustaining capital	$55,510,000	NS Power
LEM	$84,830,000	NS Power
NS Power operating costs	$19,780,000	NS Power
Total	**$160,120,000**	

Figure 50: Wreck Cove decommissioning forecast

		Source
Removal	$128,280,000	Hatch Report
Environmental	$46,980,000	Hatch Report
Sedimentation	[redacted]	Hatch Report
Archaeology	[redacted]	Boreas Report
AO/AFUDC	$13,560,000	NS Power
Total	**$424,940,000**	

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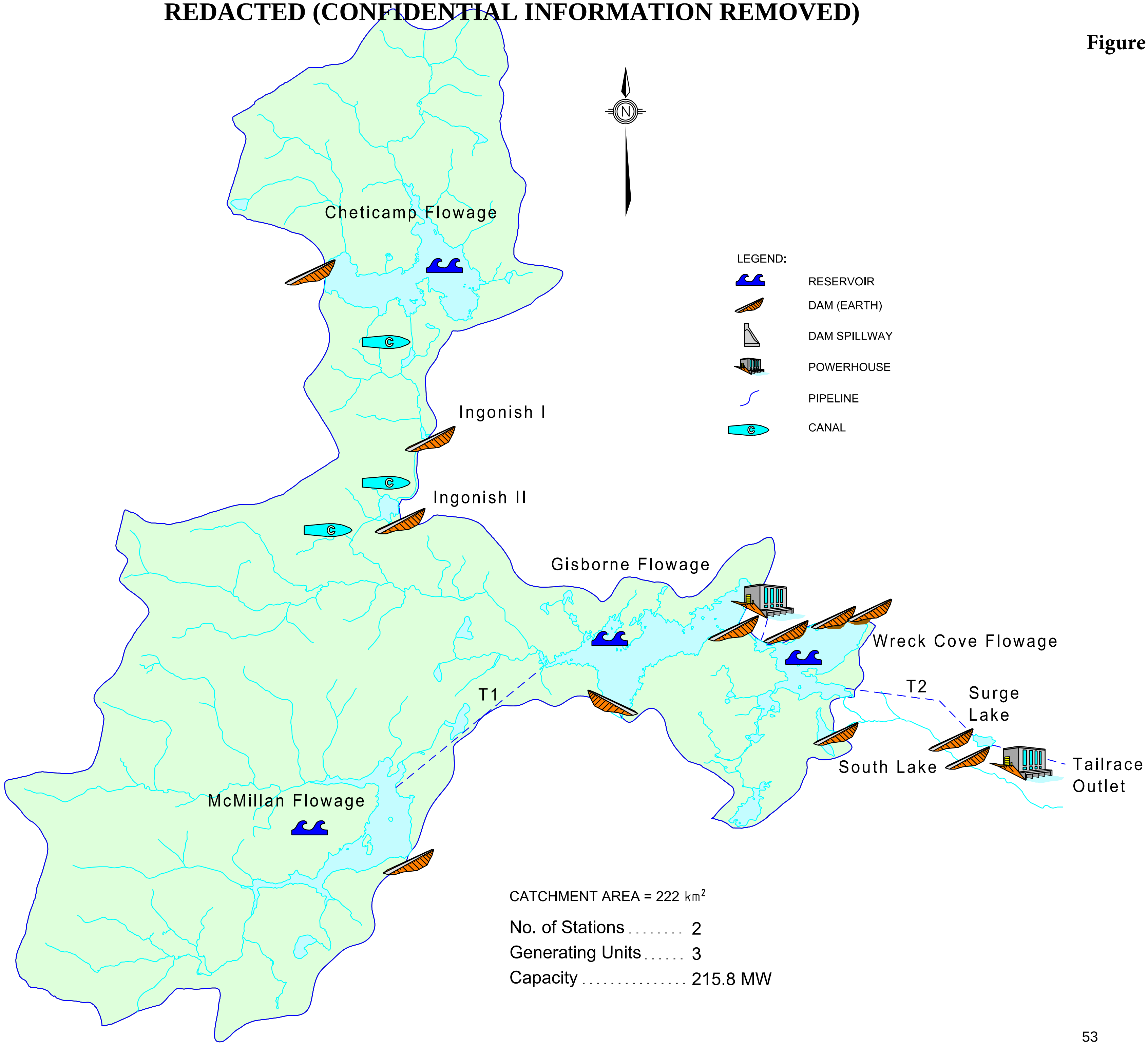
Figure 51



CATCHMENT AREA = 222 km^2

No. of Stations 2
Generating Units 3
Capacity .... 215.8 MW

Wreck Cove Hydro System

4.0 BATTERY STORAGE

In its Decision regarding the 2018 Annual Capital Expenditure plan, the UARB stated as follows:

> The Board appreciates the current limitation and challenges related to battery storage. Given potentially rapid technological innovations, the possibility that renewable energy (other than hydro), combined with battery storage, will become a cost-effective way of providing firm dispatchable RES compliant energy, must be considered when assessing NSPI's future generation mix. A more comprehensive assessment of this issue, as part of an overall assessment of hydro assets, would be of assistance to the Board.

In preparation for its next Integrated Resource Plan, NS Power is developing detailed assumptions regarding the projected costs and capabilities of new renewable energy and electricity storage (including battery) resource options. This information will include the potential advances in technology performance, the current capital and operating costs as well as the declining cost trajectories of these technologies, and analysis regarding the provision of capacity by battery storage.

A critical assumption regarding battery storage, beyond projected cost estimates, is the duration required to enable the provision of capacity to the electricity system. Unlike conventional generation assets, which theoretically can provide capacity for as long as required with the exception of unforeseen outages, a battery can only output its maximum capacity according to the amount of energy it can store (e.g. a 1 MW/1 MWh battery can output 1 MW for 1 hour while a 1 MW/4 MWh battery can output 1 MW for 4 hours). The storage duration required to ensure adequate capacity is unique to each utility, as it depends on the system's existing generation fleet characteristics and the load profile in the region; it can also increase as storage penetration increases. The duration of a storage resource directly impacts its cost as it dictates the size of the battery required. NS Power is assessing this specific assumption as part of the Loss of Load Expectation (LOLE) study being conducted to evaluate the capacity contribution of wind in preparation for the next IRP.

The information provided in the Hydro Asset Study, including the projected capital investment and estimated decommissioning costs of existing hydro assets, in combination with the IRP assumptions regarding alternative technology options, will allow comparison of these new resource combinations with the costs of maintaining and/or refurbishing existing hydro assets for the Board's consideration. Beyond just the production of renewable energy, the modeling conducted in an IRP also considers capacity, dispatchability, system economics, transmission constraints, emissions and renewables policy compliance, and other factors critical to overall reliable and economic system dispatch, and will allow for the appropriate comprehensive examination of this issue. The UARB has directed NS Power to undertake an IRP for completion by mid-2020 and to complete pre-IRP analyses, including the storage evaluation work discussed above, by July 31, 2019.[14]

[14] M08059, Letter from the UARB to Nova Scotia Power, October 5, 2018.

5.0 CONCLUSION

The Hydro Study provides forecast sustaining capital and operating costs and decommissioning costs of each of NS Power's hydro systems. NS Power has engaged expert consultants to assist with (i) estimating the physical removal, environmental assessment and sediment management costs associated with decommissioning; (ii) estimating archaeology costs to determine the potential cost of archaeology related to decommissioning of hydro assets, which analyzes individual sites to estimate areas of impact during hypothetical decommissioning construction works; and (iii) review NS Power's investment planning methodology with respect to its hydroelectric assets in the context of current industry practice.

All cost estimates used in the Hydro Study are provided on a per system basis and were developed using a Class 5 estimate, as defined in the Association for the Advancement of Cost Engineering (AACE)'s Cost Estimate Classification System.

In addition, and pursuant to the Board's direction from the 2018 ACE Plan Decision, NS Power provides comments on its plan for evaluating storage technologies in the next IRP. In preparation for its next IRP, NS Power is developing detailed assumptions regarding the projected costs and capabilities of new renewable energy and electricity storage (including battery) resource options.

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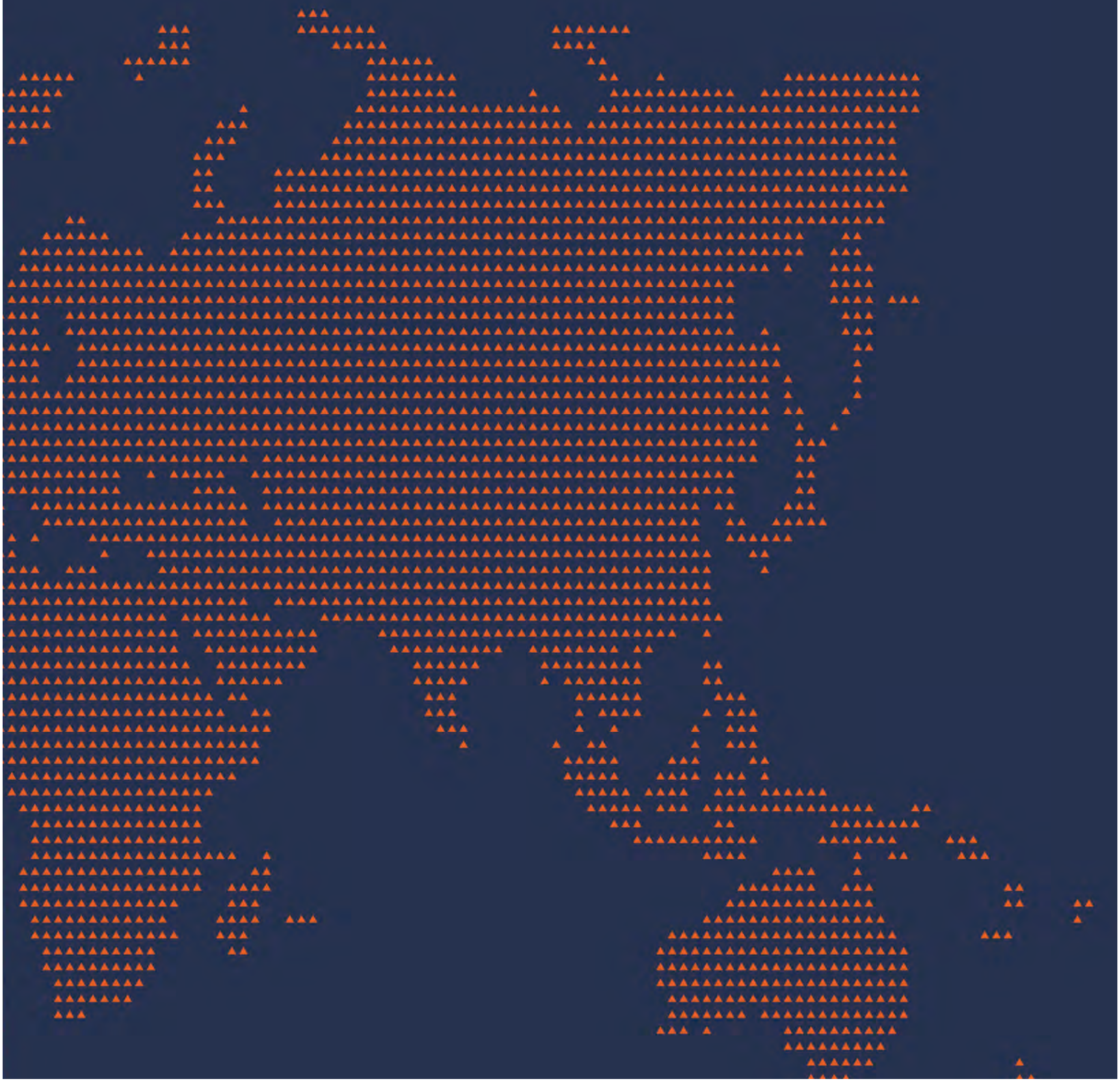

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Review of NS Power's Hydro Asset Management Spending Plan

December 2018

Prepared For:
Nova Scotia Power

Prepared By:
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Review of NS Power's Hydro Asset Management Spending Plan

METSCO Report # 18-94

Dec 2018

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Vice President, Strategy and Assets

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Approved By:

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Chief Executive Officer

Table of Contents

List of Tables

List of Figures

Executive Summary

Nova Scotia Power Inc. ("NS Power") retained METSCO Energy Solutions Inc. ("METSCO") to provide an independent assessment of the utility's Hydro Interval Plan ("HIP" or "Plan") – a recently developed long-term hydroelectric asset management plan. Among other corporate drivers, NS Power developed the HIP framework in response to the Nova Scotia Utility and Review Board's ("Board" or "UARB") mandate to produce 40% of energy from renewable sources by 2020. In reviewing the HIP plan, METSCO's role was to assess whether and to what extent its key tenets align with contemporary utility asset management practices.

METSCO's engagement consisted of multiple interviews with NS Power's management staff, independent review of supporting planning documentation, and other materials provided by NS Power. Among other factors, METSCO considered the completeness of asset registry, life-cycle cost estimates, and investment optimization and prioritization frameworks underlying the Plan.

The HIP covers NS Power's major hydroelectric assets, spanning 15 river systems. With the HIP horizon set to 40 years, assets undergo analysis over two "intervention intervals" defined on the basis of CEATI's HydroAMP planning solution. The first intervention interval represents consideration of replacement or major refurbishment activities in the near term, while the second considers the asset needs over the remaining plan period.

METSCO assessed the HIP against *Subject Specific Guidelines for Asset Management Policy, Strategy and Plant and for Life-Cycle Value Realization* framework issued by the Institute of Asset Management (IAM). We found NS Power's management practices to be comparable to other utilities of similar size. Overall, we found that NS Power deployed a proactive asset risk management approach when developing the HIP. The key outcome of this approach are shorter recommended intervals for asset interventions when compared to historical records, using robust assumptions for near-term capital enhancement work.

We observe that the proactive approach may initially lead to overly conservative assessments of the capital spending needs for the longer-term. However, METSCO is satisfied that NS Power's actual scope and timing of capital work over the longer-term will be determined by detailed asset condition assessments performed as individual assets approach their longer-term intervention intervals. These detailed assessments can be expected to yield more realistic spending profiles than may be suggested through a macro-level planning exercise that HIP represents.

While endorsing NS Power's overall approach to long-term planning of hydro fleet asset management work, METSCO recommended a subset of modest enhancements to the condition and criticality scoring methodologies that NS Power should consider integrating into the HIP framework as it matures. In our assessment, these modest enhancements should help advance NS Power asset management strategy further, make it easier to audit and refine, and integrate with other facets of the utility's asset management strategy.

1. Introduction

1.1 Background

Electrical generation in Nova Scotia finds itself amidst a transition towards a more diverse and greener portfolio of generation assets to improve reliability, efficiency and sustainability of its system. Among the objectives identified by NS Power for the purposes of this transition are:

- *Value of Renewable Energy* – hydropower has been identified as a key component of NS Power's Renewable Energy Strategy to meet government policy requirements reflecting the public's desire for cleaner and renewable electricity (40% renewable energy is mandated by 2020).
- *Reliability* – a number of existing hydro assets are beyond their planned retirement dates, and are in various states of condition. Incorporating modern instrumentation, monitoring, and control technology, along with self-regulating spillway structures, would allow for an increased degree of remote operation, and higher degree of reliability during significant flood events.
- *Flexibility* – Hydropower has the ability to support integration of variable generation sources, such as wind energy, into NS Power's generation portfolio. To accomplish this, the hydro generating assets must be sufficiently flexible to respond to the inherent variation these assets' output, and maintain the integrity of the overall supply mix. Due to their age and original design, the existing units are not capable of supporting maneuverability required for integration.
- *Increase in Generation Output* – reinvesting in the hydro generating assets is expected to increase the overall generation due to the expected increases in equipment efficiencies and modification to civil structures above current state.

NS Power's Asset Management (AM) team has already commenced its journey towards developing and implementing advanced asset management practices for the company's hydro fleet. One of the team's first steps was to define the scope of long-term capital needs in relation to the existing infrastructure, to inform its expectations of the financial and human resources underlying the modernization work.

NS Power's AM strategy entails pacing the volume of planned hydro asset investment levels in line with a long-term sustainable investment profile, reflective of short- and longer-term needs. This means that investments need to be affordable for customers, while addressing the necessary risks underlying the operation of hydro assets. To achieve the requisite investment profile, NS Power explored four options for re-investing in the hydro fleet as per definition by the Electrical Power Research Institute:

- ***Modernization*** of existing hydropower facilities to improve output, flexibility, cost effectiveness and reliability in support of legislated requirements and the integration of variable/intermittent generation resources in to NS Power's generation portfolio.
- ***Life Extension*** of identified assets to maintain sustainability, dependability or for reasons of public or environmental concern. Activities include, but are not limited to, maintenance, repair, and replacement.
- ***Redevelopment*** of the hydro fleet to add new units and/or new hydro facilities, where economic, and ensuring any redevelopment is aligned with modernization objectives.

- ***Decommissioning*** any aspects of the hydro fleet that is not economic or feasible to modernize or extend life (retirement).

The Hydro Interval Plan (HIP) is the product of NS Power's planning efforts in the area of long-term life extension and modernization of the existing hydro fleet. The purpose of the HIP is to provide a long-term view on NS Power's financial needs required to sustain all the major assets within the hydro fleet in an acceptable condition, along with the minimum investments required to perform the desired unit modernization work. The HIP document's planning horizon is set to 40 years.

1.2 Purpose and Scope of Work

METSCO Energy Solutions Inc. was retained by NS Power to conduct a review of the existing Hydro Asset Management Spending Plan, to ensure its alignment with modern asset management practices. The scope of METSCO's work included:

- Review of asset management documentation and models, including but not limited to the developed spending plan and supporting documentation on unit costs, asset criticality and condition assessments.
- Interviews with NS Power management staff, regarding the workflow and specific asset management documentation follow-up questions.
- Delivery of a report summarizing the findings and high-level opportunities for improvements.

The scope of this review document only applies to the Hydro Interval Plan. The HIP includes both sustainment and modernization activities. During the kick-off discussion, NS Power specified that the scope doesn't extend beyond the sustainment activities. Accordingly, the authors of this report reviewed only the capital planning documents in relation to the HIP. For clarity METSCO did not perform any assessments on the scope of maintenance work, or frequency of such activities, due to them being considered out of scope.

The work was performed by our core team of engineers and economists, including Thorhallur Hjartarson, P.Eng., M.A.Sc., and Alexander Bakulev, PhD, IAM Certificate in Asset Management, who have extensive experience on similar assignments involving asset risk-based management and system plan developments. They are intimately familiar with the best-in-class asset management practices and have completed many assignments involving regulatory filings for electric utilities, including hydro generation, transmission and distribution. METSCO has leveraged its combined experience for this particular initiative. This team has assisted numerous utilities in Canada, USA, and around the world in developing and implementing asset management frameworks.

1.3 METSCO's Evaluation Framework

Considering the narrow focus of the review, METSCO's assessment of the HIP plan relied on the *Subject Specific Guidelines for Asset Management Policy, Strategy and Plant and for Life-Cycle Value Realization* framework issued by the Institute of Asset Management (IAM). The IAM documents provide the guidance as to how to implement the requirements of the two Asset Management standards – namely ISO 55001 and PAS 55. Among the elements of the chosen IAM framework, METSCO defined the following key elements as being most relevant to the scope of our review:

- *Asset Registry Completeness* – evaluation of the data supporting the Hydro Interval Plan in terms of comprehensiveness of asset information and asset lists.

- *Life-Cycle Cost Estimates* – review of assets lifecycle costs and associated activities.
- *Investment Prioritization and Optimization* – evaluation of the asset prioritization criteria utilizing asset condition and risk assessment and approach to pace the level of capital spending in the outer years, and review of consideration being given to analysis of alternatives and options, as well as cost-benefit analysis to maximize the value from utilizing the hydro assets.
- *Other considerations* – additional factors noted by METSCO in the process of reviewing the documents and interviews.

Other key elements such as asset management principles and objectives, supporting asset management tools and decision-making criteria, auditing practices with continual improvement actions, stakeholder engagement, current and future required performance, demand analysis and gap definitions, and compliance requirements were not benchmarked against asset management practices (i.e. not evaluated against ISO 55001 and PAS 55). However, considering that the Hydro Interval Plan is a document that is focused on forecasting NS Power's capital needs in sustaining the hydro fleet for the next 40 years, tools and other decision-making criteria were reviewed to gain an understanding of the analysis underlying the forecast.

2. Hydro Interval Plan Assessment

2.1 Asset Registry Completeness

In reviewing the HIP, a certain level of confidence in the data feeding into the construction of the plan was necessary to justify the underlying analysis for the plan. METSCO conducted a comprehensive review of NS Power's asset register, and interviewed NS Power asset management staff to verify that the hydro asset fleet is contained within the plan and in accordance with asset management best practices.

The Hydro Interval Plan covers NS Power's major hydroelectric assets, spanning 15 river systems. The plan contains the following asset classes: penstocks, dams, cranes, head-gates, balance of plants, control valves, generator rotors and stators, surge-tanks, tailraces, turbines, structures, governors, I&C, electrics, and their sub-classes including power transformers, circuit breakers, switchgears, bus, among others, were contained in the plan. Table 1 provides a summary of the hydro fleet included in HIP per river system.

Table 1: Hydro Fleet per River System Contained in the HIP.

River System	BOP	CN	DM	EL	GR	GS	GN	HG	I&C	PS	ST	TL	TR	SG	CV
Annapolis	x	x	x	x	x	x	x	x	x	x	x	x	x		
Avon River	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bear River	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Black River	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dickie Brook	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fall River	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Lequille	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Mersey	x	x	x	x	x	x	x	x	x	x	x	x	x		
Nictaux	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Paradise	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sheet Harbour	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Sissiboo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
St Margarets Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tusket	x	x	x	x	x	x	x	x	x		x	x	x		
Wreck Cove	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

BOP	Balance of Plants & Tools/Equipment	**PS**	Penstock
CN	Crane	**ST**	Structures (Separate from Dam)
EL	Electrics	**TL**	Tailrace
GR	Generator Rotor	**TR**	Turbine & Components
GS	Generator Stator	**SG**	Surge-tanks
GN	Governor	**CV**	Control Valve
HG	Headgate & Trash Rack	**DM**	Dams & Water Impounding

METSCO finds that the asset register contains all the hydro assets essential for consideration.

2.2 Life-Cycle Cost Estimates

Typically, long-term sustainment plans are developed based on the required frequency, as well as the associated costs, to replace the assets. NS Power's HIP plan is based on calculating the intervals at which assets are forecasted to be replaced/refurbished and the unit cost estimates. The plan includes most major capital-intensive activities such as refurbishment and replacements of the individual assets.

NS Power utilizes the intervals along with applied assumptions regarding activities covered in each interval, to assign the forecasted costs. The CEATI HydroAMP tool was utilized to estimate the appropriate intervals for each asset class. The future life-cycle intervals are based on the typical HydroAMP useful lives of the assets within the hydro fleet that were adjusted based on historical records of the assets coupled with engineering judgment.

METSCO expressed concerns in relation to the length of the intervals utilized to forecast the intervention timing. METSCO noted that some of the asset intervals appear to be somewhat shorter when compared to the past NS Power practices. Shortening the intervals may lead to overestimating the future capital needs due to more frequent interventions than necessary.

NS Power's asset management team advised that its current asset management philosophy is to be more proactive in asset interventions in order to align with the strategic objectives of proactively addressing potential worsening condition, and preventing the failure risk levels from becoming unacceptable to the stakeholders. This strategic choice made by the utility drives the shorter interval compared to the past asset intervention intervals.

Since the HIP time horizon covers 40 years, some asset classes may have two interventions planned for and budgeted in that timeline. Depending on the asset and initiative, interventions may entail a replacement of the asset, resulting in a significant capital spend, or a smaller sustainment/refurbishment activity with a more moderate budget.

The costs for the first interval represent replacement or major refurbishment in most cases. This includes modernization/upgrade programs such as replacement of all wood penstocks with steel or fiberglass, and steel surge tanks with glass as they are maintenance free and last a long time. The first interval dictates the timing of the second interval where the cost reflects sustainment activities.

METSCO understands that the costing assumptions underlying the first-interval scope of work for each project represent the costs of replacement / rewind activity, which are the most comprehensive means of renewing an asset. In discussing these assumptions with NS Power, METSCO was satisfied that prior to any actual work proceeding, NS Power would conduct more detailed asset condition and risk assessment studies to confirm the most economic means of addressing the needs in each individual case. On balance, METSCO confirms the reasonableness of this costing assumption, as conducting more detailed studies for all the assets at this juncture would result in incurring material study costs well in advance of the actual intervention work being required. METSCO notes that NS Power's estimation approach is reflective of industry practices for long-term spending estimation.

NS Power applies cost estimates based on similar refurbishment/replacement activities found in historical records for similar size assets. In some instances, where the historical records lack for a certain asset size, engineering assumptions for the cost estimate were made and documented. In other cases, where the boundaries cross between two units (e.g. generator rotor and stator) the cost was split between the two units such that overall project cost was the same. METSCO acknowledges the fact that each individual project when designed and executed may vary significantly in costs when compared to the estimated historical-based costs. However, it may still be the best possible way to provide high-level cost estimates for the purpose of long-term sustainment planning activities.

2.3 Investment Prioritization and Optimization

This section considers how the assets are being prioritized for interventions and how the timing and scope of the interventions are optimized.

The fundamental objective of investment prioritization is to give the highest priority in the replacement/refurbishment schedule to those assets that represent the highest risk to the utility based on their asset condition and criticality. One of the key aspects of optimization is consideration of alternatives to address each asset's deficiencies, whether the value extracted from the future assets is maximized considering its costs, load and utilization. Another aspect is to optimize the resources required for asset replacements/refurbishments by replacing the related assets at once.

The condition and ultimately the risk of a given unit governs the prioritization process for the hydro interval plan. The most critical assets (those found to be in the worst condition) impose the highest risk on the system and are considered for being addressed in the near term.

Risk-based analysis forms a crucial part of the NS Power's asset management process. The overall risk score, as well as its underlying components (i.e. condition and criticality scores), provide NS Power asset managers and planners with an initial means of prioritizing the assets. The sub-index components considered in our evaluation are:

- Asset Condition Assessment: a major component of risk and asset prioritization, and it considers the data on the physical state of the assets and their core components along the relevant degradation factors expected to compromise the overall condition of an asset.
- Asset Criticality: takes into consideration the impact of failure at the individual asset, asset class, and station levels respectively with regards to Health & Safety impacts, Environmental impacts and Business Sustainability impacts. Input information for the formulations of this index includes various factors as the assessment varies from one asset class to another.

Asset condition assessment practices are based on the HydroAMP Guide. METSCO is impressed with the fact that the asset condition is present for almost all asset classes and is being utilized to justify the individual projects as well as being utilized to prioritize the asset interventions in the long-term planning cycle. Additionally, the asset condition assessment process is being used to estimate the current and future probability of asset failure, which provides asset managers with a more granular, objective and consistent information on all the assets in the system. NS Power performs condition assessments on the following asset classes:

- Balance of Plants (BOP)

- Exciter
- Governor
- Headgates
- Penstocks
- Generator Rotor
- Generator Stator
- Turbine
- Dams and water impounding assets

On the other hand, asset criticality assessment practices are based on established internal standards. The approach for criticality assessment may not be consistent between the asset classes, however, it's being used by the asset managers to be able to focus on the most critical assets during the planning activities. Criticality scores were generated for the following asset classes:

- Balance of Plants (BOP)
- Exciter
- Governor
- Headgates
- Penstocks
- Generator Rotor
- Generator Stator
- Turbine
- Dams
- Electrics

NS Power is actively working on aligning the scoring methodology globally. Historically, asset prioritization systems in Hydro generation varied by asset. We should note that for reporting, NS Power translates all the scores to a 5x5 risk matrix to ensure consistency across all assets.

The HIP considered prioritization of all asset classes except for dams. Dams were considered as a special asset class, with the highest consequential costs of asset failure. As such, planned interventions into this asset class are timed exclusively on the basis of the Dam Safety program parameters. Within this program, dams are prioritized based on risk where dam safety is assessed according to Canadian Dam Association guidelines, including storm assessment, dam condition, design assessment, earthquakes, floods, and estimated loss of life.

METSCO suggests improvements to the risk-based analysis, such as further refining criticality evaluations, though conclude asset condition and risk assessment practices to be appropriately utilized for NS Power to prioritize the assets in the HIP by addressing the most critical assets in the worst condition first.

When reviewing historical expenditure trends (Figure 1), we see that the last ten years average historical costs is $23M/year, excluding the "Active" investments – which are projects that have started but not yet commissioned, as such the investments can be contributed to both pre- and post-2018 periods. On the other hand, NS Power's 10-year future outlook (Figure 2) of planned average sustainment costs is $22.9M/year. While the trend might resemble that of historical spends, we note that the investments in Figure 2 exclude the Mersey river system as it is considered a redevelopment site with redevelopment cost equating to approx. $17M/year. As such, excluding it makes direct comparison invalid, given that this river system was accounted for in the historical profile. The total future spending over the next 10-years, with the redevelopment costs included, is $40M/year, which is significantly higher than the trend seen in the historical profile. This due to NS Power's proactive approach as described in section 2.2. Therefore, METSCO could not utilize direct comparison between historical and future spending profiles to form a rational conclusion.

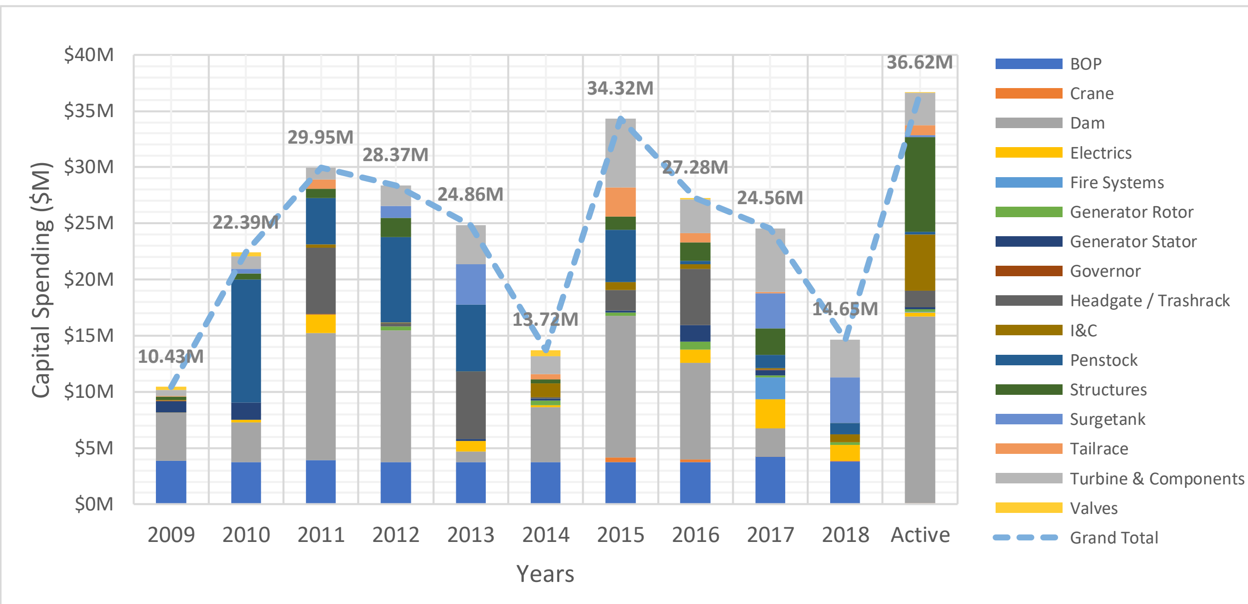

Figure 1: NS Power historical spending trend.

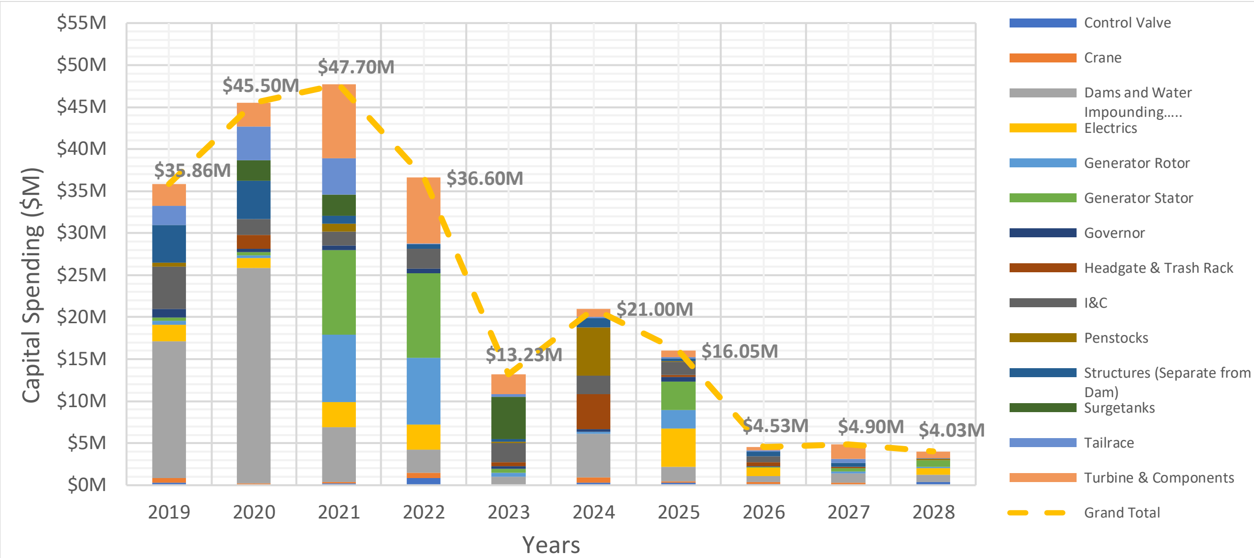

Figure 2: NS Power hydro interval plan 10-year outlook (in 2018 dollar value).

Another key observation in Figure 2 is the more capital expenditure required for the first five years versus the last five years. It was brought to METSCO's attention that heavy investments (e.g. Wreck Cove) are considered for the near term. METSCO notes that it may represent some opportunities to further level the spending to the outer years.

The analysis revealed that proper considerations were given to the resource constraints in the next 40 years in the HIP spending profile. The plan limits a number of specific replacements per year and considers the following utility's resource constraints: two-three overhauls per year, two switchgears and /or two I&C upgrades per year. Overhauls are spread across the years to keep the work consistent with the levels of available NS Power labour force. Where there is an overhaul planned, efforts are made to align the intervals of each of the Rotor, Stator, Crane, and Control Valve to minimize the outages the customers would experience. Additionally, the HIP determines the first interval upgrades for governors and I&C based on the work performed for electrics such as power transformer, circuit breaker and bus.

METSCO finds the labour resource and operational constraints considered in the Hydro Interval Plan appropriate.

Table 2 represents a summary of all capital expenditures planned for the next 10 years.

Table 2: NS Power HIP 10-year future outlook (in 2018 dollar value).

Asset	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Control Valve	$0.3M		$0.2M	$0.9M		$0.3M	$0.3M	$0.2M	$0.1M	$0.4M
Crane	$0.5M	$0.3M	$0.2M	$0.6M		$0.6M	$0.2M	$0.2M	$0.2M	$0.0M
Dams and Water Impounding	$16.3M	$25.6M	$6.5M	$2.8M	$1.0M	$5.2M	$1.8M	$0.8M	$1.2M	$0.9M
Electrics	$2.0M	$1.2M	$3.0M	$3.0M		$0.0M	$4.5M	$1.0M		$0.8M
Generator Rotor	$0.5M	$0.3M	$8.1M	$8.0M	$0.5M	$0.2M	$2.2M	$0.0M	$0.2M	$0.2M
Generator Stator	$0.5M	$0.5M	$10.1M	$10.0M	$0.5M	$0.0M	$3.4M	$0.1M	$0.4M	$0.8M
Governor	$1.0M	$0.4M	$0.5M	$0.6M	$0.3M	$0.3M	$0.6M	$0.1M		$0.0M
Headgate & Trash Rack		$1.6M		$0.0M	$0.5M	$4.2M	$0.2M	$0.5M	$0.2M	$0.0M
I&C	$5.1M	$2.0M	$1.7M	$2.4M	$2.3M	$2.3M	$1.6M	$0.7M		$0.0M
Penstocks	$0.4M		$0.9M	$0.0M	$0.2M	$5.7M	$0.1M	$0.0M		$0.2M
Structures	$4.5M	$4.5M	$1.0M	$0.5M	$0.4M	$1.1M	$0.3M	$0.5M	$0.5M	$0.1M
Surgetanks		$2.5M	$2.5M		$5.0M					
Tailrace	$2.3M	$4.0M	$4.3M	$0.2M	$0.3M	$0.2M	$0.2M	$0.2M	$0.4M	$0.0M
Turbine & Components	$2.6M	$2.8M	$8.8M	$7.8M	$2.4M	$1.0M	$0.8M	$0.4M	$1.8M	$0.8M
Total	$35.9M	$45.5M	$47.7M	$36.6M	$13.2M	$21.0M	$16.1M	$4.5M	$4.9M	$4.0M

3. Conclusion

In setting out to conduct this assessment, METSCO sought to provide a review of NS Power's Hydro Interval Plan framework across a number of dimensions. We accomplished this through multiple interviews with NS Power's management staff, individual review of supporting documentation, and other materials provided by NS Power. We dedicated a considerable amount of time to the evaluation of asset registry completeness, life-cycle cost estimates, and investment optimization and prioritization.

The Hydro Interval Plan combines NS Power's capital needs in sustainment and modernization of the existing hydro fleet strategy. The plan does not propose any decommissioning or redevelopment work as they are outside of the purpose of the HIP. However, it was brought to METSCO's attention that NS Power has been developing plan documents to address the redevelopment and decommissioning options.

METSCO finds that the HIP contains all major asset classes for the 15 river systems that are essential for consideration in developing the sustainment plan.

NS Power considered a more proactive asset risk management approach when developing the HIP. This approach resulted in shorter intervals for asset interventions when compared to the historical records, and in consideration of a more conservative capital-intensive intervention in the nearest interval for each asset. The proactive approach may lead to the overestimation of the capital spending needs in the future profile. However, NS Power's actual scope and timing of work will be determined by detailed asset condition assessment upon reaching the interval. As such, METSCO notes that the actual investments may be lower, and type of interventions may vary than those presently captured in the HIP.

Previous project costs and investments necessary to maintain assets in their current condition were applied on a present value basis. METSCO observes the expenditure plan to be front-loaded over the earlier years. This is due to heavier activities (i.e. replacement and major refurbishment) placed for the first interval as part of the NS Power's proactive asset management approach. METSCO notes that appropriate labour and operations constraints were given in determining a maximum number of upgrades to be executed by the company.

NS Power's management practices are comparable to other utilities of similar size. Slight enhancement in condition and criticality scaling methodologies, having a process to ensure that the plan is auditable, and the incorporation of the HIP in the broader asset management processes would advance NS Power asset management strategy and provide optimal management of hydroelectric assets.

Appendix A: Investigators Short Bio

Mr. Thor Hjartarson, MASc, PEng

Thor Hjartarson is Engineering leader with over 25 years of professional experience in electrical and power engineering. In former role at Toronto Hydro he led a large asset management division with responsibilities for planning, engineering, reliability analysis, system studies, record management, data quality, mobility and GIS improvements where he was recognized for transforming an existing older culture of engineering practice to a dynamic powerhouse of technical innovation and knowledge. He has strong technical background in transmission and distribution engineering with leadership in innovation of asset management principles. One of the founders of the Health Index Methodology in utility asset condition assessment and has led comprehensive implementations of a risk-based investment planning methodologies. In his previous consulting career, he has had experience with over 30 well known electrical power companies around the world. He graduated from the University of Iceland, Reykjavik, and received a M.A.Sc degree in Electrical Engineering from the University of British Columbia, Vancouver, B.C., Canada. He has authored several technical papers focusing on T&D asset management.

Mr. Alexander Bakulev, Ph.D., IAM Certificate

Alexander Bakulev is an experienced professional with over 15 years of experience in utility asset management, investment and budget planning, and strategic management. He has extensive experience in long-term economic asset planning, business case development, financial modelling, and risk-based investment planning for generation, transmission, and distribution companies in North America and Europe. Alexander has developed asset management plans and led regulatory filing procedures with detailed economic justification of the company’s operational and capital spending. He understands in detail regulatory filing requirements for DSP submission and has direct experience in preparing Distribution System Plans. Alexander also has an excellent project management experience and has led a variety of corporate strategic projects, including business case development, project initiation with detailed planning and budgeting, as well as managing team resources and third-party vendors for successful project delivery. Mr. Bakulev has had experience both within the utility sector and in management consulting environment. Alexander has been at senior management positions in a distribution company leading the emergency dispatch centre, productivity improvement group, and a group responsible for asset management long-term planning, economic risk-based project justification, asset risk management, and data quality. In management consulting Alexander led utility asset management planning, financial analysis, and business modelling practice in addition to managing a variety of projects in several industries, including utilities, telecommunications, and agriculture. Alexander holds Ph.D. in Economics in Saint-Petersburg Sate University, Russia and is certified in Asset Management by the Institute of Asset Management, UK.

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HATCH

Nova Scotia Power Inc.

Hydro System Decommissioning Cost Estimate

For

Nova Scotia Power Inc.'s Control Structures

H357345-00000-200-230-0001
Rev. 0
December 12, 2018

Nova Scotia Power Inc.

Hydro System Decommissioning Cost Estimate

For

Nova Scotia Power Inc.'s Control Structures

H357345-00000-200-230-0001
Rev. 0
December 12, 2018

NSPI's Hydro System Decommissioning Cost Estimate

H357345-00000-200-230-0001

IMPORTANT NOTICE TO READER

This report (and included estimate) was prepared by Hatch Ltd. (“**Hatch**”) for the sole and exclusive benefit of Nova Scotia Power Inc. (the “**Client**”) for the sole purpose of assisting the management of the Client in making decisions with respect to the future of NSPI’s Hydro Systems (the “**Project**”), and must not be provided to, relied upon or used by any other party.

This report is meant to be read as a whole, and sections should not be read or relied upon out of context. The report includes information provided by the Client and by certain other parties on behalf of the Client. Unless specifically stated otherwise, Hatch has not verified such information and does not accept any responsibility or liability in connection with such information.

This report contains the expression of the opinion of Hatch using its professional judgment and reasonable care, based upon information available at the time of preparation. The quality of the information, conclusions and estimates contained in this report is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

As this report includes high level Class 5 cost estimates, all estimates and projections contained in this report are based on limited and incomplete data. Accordingly, while the work, results, estimates and projections in this report may be considered to be generally indicative of the nature and quality of the Project, they are not definitive. No representations or predictions are intended as to become the results of future work, and Hatch does not promise that the estimates and projections in this report will be sustained in future work.

Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

Nova Scotia Power Incorporated (NSPI) owns and operates 33 hydroelectric plants on 17 hydro river systems, with a total installed capacity of about 400 MW. NSPI reuested that Hatch undertake a high level (Class 5 (1)) cost estimate for full decommissioning of all of NSPI's hydroelectric assets.

The cost estimates include infrastructure removal costs including powerhouse, substation and equipment removal costs, and the environmental costs associated with studies, engineering requirements, construction mitigation, environmental assessment/consultations and potential environmental monitoring requirements. In addition, an indication of potential sediment management costs based on contamination and the nature of the sediments in the various reservoir was developed based on precedent information for sediment management costs in dam decommissioning projects.

The estimates do not include

- potential costs associated with compensation to recreational users, as well as compensation to residents and businesses (effects to properties and revenues)
- potential costs associated with First Nation compensation, royalties or any other traditional-use reimbursements
- other typical Class 5 cost estimate exclusions as are detailed within the report.

The Assets

The NSPI hydroelectric system includes a large number of varied components as is listed in Table ES-1.

Table ES-1: Summary of NSPI Structures

Structures	Total
Reservoirs	67
Dams/Intakes/Wingwalls/intakes	90
Spillways/Sluiceways	70
Canals and Canal Dykes	18
Fishways	13
Powerhouses	33

Methodology

To undertake an assessment of the decommissioning costs for such a large number of structures. Where possible, Hatch relied on existing work for the systems listed in Table ES-2 to provide efficiencies and cost savings.

Table ES-2: Scope of Work Performed in Previous Class 5 Decommissioning Estimates

System	Scope of Estimate		
	Infastructure Removal	Environmental Costs	Sediment Management
Annapolis	yes	yes	yes
Gaspereau (Part of the Black)	yes	yes	yes
Harmony	yes	no	no
St. Margarets Bay	yes	yes	yes
Tusket	yes	yes	yes

For those systems that were not previously studied by Hatch, empirical approaches were developed, as is described within the report, to establish a high level estimate of the potential costs for full decommissioning of the hydroelectric assets.

Results

The total costs for decommissioning the entire NSPI hydroelectric system was determined to be in the order of $760 million (in 2018 $CDN) as is summarized in Table ES-3.

Table ES-3: Estimated Costs to fully Decommission NSPI's Hydroelectric System

System	Combined Installed Capacity (MW)	Estimated Infrastructure Removal Costs in $ 2018 CDN	Estimated Environmental Costs in $ 2018 CDN	Sediment Management Costs	Total
Annapolis	20.0	22,065,000	2,287,500	[redacted]	[redacted]
Avon	6.0	10,571,000	5,335,000	[redacted]	[redacted]
Bear River	9.9	20,780,000	12,012,000	[redacted]	[redacted]
Black River	20.4	58,108,000	28,883,000	[redacted]	[redacted]
Dickie Brook	2.4	7,550,000	3,883,000	[redacted]	[redacted]
Fall River	0.5	531,000	1,089,000	[redacted]	[redacted]
Harmony	0.0[1]	3,791,756	726,000	[redacted]	[redacted]
Lequille	13.1	5,532,000	3,883,000	[redacted]	[redacted]
Mersey	45.6	83,378,000	8,054,865	[redacted]	[redacted]
Nictaux	7.2	11,849,000	7,689,000	[redacted]	[redacted]
Paradise	4.8	5,715,000	2,541,000	[redacted]	[redacted]
Roseway	0.7	3,828,061	726,000	[redacted]	[redacted]

System	Combined Installed Capacity (MW)	Estimated Infrastructure Removal Costs in $ 2018 CDN	Estimated Environmental Costs in $ 2018 CDN	Sediment Management Costs	Total
Sheet Harbour	10.5	12,410,000	5,335,000	16,384,042	34,129,042
Sissiboo	25.0	61,978,000	33,803,000	10,575,717	106,356,717
St. Margaret's Bay	10.2	25,465,000	10,120,734	1,837,129	37,422,863
Tusket	2.7	18,990,000	10,583,882	27,295,383	56,869,265
Wreck Cove	223.5	124,192,000	45,485,000	8,913,745	178,590,745
Total	**402.5**	**476,733,817**	**182,436,981**	**103,440,222**	**762,611,020**

1. Introduction

Nova Scotia Power Inc. (NSPI) owns and operates 33 hydroelectric plants on 17 hydro river systems, with a total installed capacity of about 400 MW (Figure 1).

Figure 1: NSPI's Hydroelectric System

The number of dams, canals and control structures that make up the NSPI portfolio of hydroelectric assets system are listed in Table 1. Details of the structures are provided in Appendix A.

Table 1: Summary of NSPI Structures

Structures	Total
Reservoirs	67
Dams/Intakes/Wingwalls/intakes	150
Spillways/Sluiceways	78
Canals	17
Fishways	11
Powerhouses	30

The objective of the study is to provide NSPI with a high level (Class 5 (1)) cost estimate for full decommissioning of NSPI's waterpower assets. The cost estimates include infrastructure removal costs, the estimated environmental costs associated with studies, engineering requirements, construction mitigation, environmental assessment/consultations and potential environmental monitoring requirements. In addition, an indication of potential sediment management costs based on contamination potential and the nature of the sediments in the reservoir (if known) was developed based on precedent information for sediment management costs in dam decommissioning projects. Excluded from the estimates are

- potential costs associated with compensation to recreational users, as well as compensation to residents and businesses (effects to properties and revenues)
- potential costs associated with First Nation compensation, royalties or any other traditional-use reimbursements
- costs associated with Powerhouse and substation decommissioning.

1.1 Qualifications

Hatch is an employee-owned, multidisciplinary professional services firm that delivers a comprehensive array of technical and strategic services, including consulting, information technology, engineering, process development, and project and construction management to the Waterpower and Dam, Mining, Metallurgical, Energy, and Infrastructure sectors. Hatch has served clients for almost 100 years and has project experience in more than 150 countries around the world. With over 8,000 people in over 65 offices, the firm has more than $35 billion in projects currently under management.

The energy and dams sector of Hatch was formed In 2004, when Acres International was acquired by Hatch, Ltd an international consulting and planning organization with its corporate base in Ontario Canada. Hatch provides consulting engineering and management services to the energy, infrastructure and industrial sectors.

In the Energy sector Hatch has a complete compliment of staff that includes professionals in all the engineering disciplines needed to plan, design, construct and decommission hydroelectric facilities and dams. Currently Hatch is one of the world's largest consulting firms that specializes in hydroelectric facilities and dams with over 500 staff that are dedicated to the design and construction of dams and hydroelectric facilities. Our senior staff are world recognized for unrivaled skills highly skilled and experienced in the engineering, operations, maintenance, rehabilitation, expansion, design, onstruction and decommissioning of dams and waterpower developments.

Over the years Hatch has undertaken the planning, assessment and implementation of a number of dams and hydroelectric facilities including the first dam ever removed in Ontatio following a structureds process; the award wiunn ing Finlayson Dam Decommission ing project for the Ontario Ministry of Natural Resources and Forestry and the award winning Crooks Hollow dam removal project for Halton Conservation in Ontario. We have also undertaken numerous studies, enfvironmental assessments and extimates for projects such as the Mactequac generating station in New Brunswick, the Muskrat Falls Generating Station in Labnradore and several dams owned by Domtarf in Ontario.

Clients recognize Hatch for its ability to bridge the gaps between research and innovative technologies, and between engineering and reliable operations. We are particularly known for working with senior client management to develop business strategies; managing and optimizing production; executing projects. Hatch delivers unprecedented business results for our clients through a commitment to quality, lower operating costs, more efficient utilization of capital assets, higher standards for safety and risk management, faster startups and continuous performance improvements in all projects and programs.

2. Methodology

In preparing the estimates for each of the systems Hatch relied on data provided by NSPI regarding the components of each of the systems.

To undertake an assessment of the decommissioning costs for such a large number of structures, where possible, Hatch made use of existing work performed to estimate the infrastructure removal costs for the following ystems to provide efficiencies and cost savings:

- Roseway
- Harmony
- Mersey
- Tusket
- Annapolis
- St. Margaret's Bay Systems
- Gaspereau (part of the Black River System)

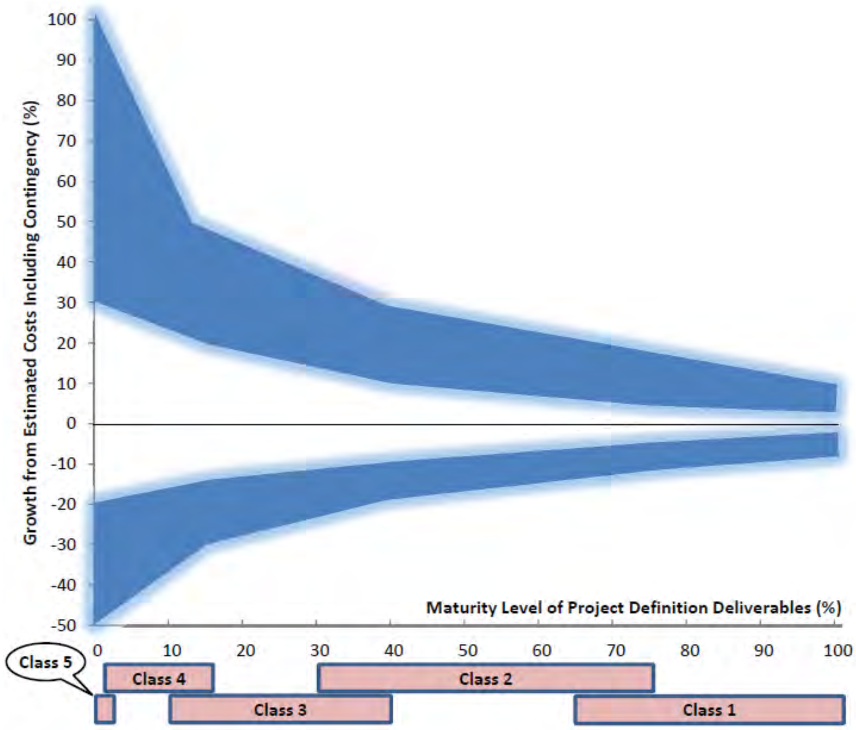
For four of these systems, Tusket, Annapolis, St. Margaret's Bay Systems and the Gaspereau Hydroelectric facility, Class 5 estimates of the environmental costs associated with decommissioning and a high level assessment of potential sediment management costs were also prepared. For those systems that were not previously studied by Hatch, empirical approaches were used to establish a high level estimate of the potential decommissioning costs.

As is detailed in the January 2013 AACE cost estimation guidelines, Class 5 estimates represent an estimate in which little or no engineering has been performed to define the scope of work. This concept is illustrated in Figure 2.

2.1 Estimating Infrastructure Removal Costs

As a first step, research was performed to compile a listing of infrastructure removal costs for a wide range of precedent dam removal projects. These then were used to establish costs. Using this precedent information on infrastructure removal costs a relationship between structure height and removal costs was developed. The NSPI structures were then scrutinized and adjusted as needed for any unusual aspects of the structure. For example, a particularly long dam might be considered to represent two average dams, canal revegetation was assessed separately and, in cases where access is limited, an additional allowance was added. This is further discussed in Section 3.2 – Infastructure removal Costs.

Figure 2: NSPI's Hydroelectric System



2.2 Estimating Environmental Decommissioning Costs

Environmental costs represent the second component of the total decommissioning cost. These costs were estimated based on a review of precedent environmental assessment/engineering costs. To the extent possible, the specific environmental characteristics of the sites for each of these case studies were noted and used as the bases for the development of an environmental cost estimating matrix, further detailed in Section 3.3.

2.3 Preparation of Conceptual Sediment Management Estimates

In any project where there is a need to implement sediment transport mitigation measures, it can be expected that the project costs will increase significantly. As an example, the costs associated with sediment management alone may be more than 50% greater than the costs of infrastructure removal. Pansic et al. (2) has indicated that, on average, 48% of the total dam decommissioning costs are related to sediment management. However, there are also cases where sediments are not a factor in the decommissioning process

For each of the reservoirs sediment management costs were estimated based on typical costs experienced in precedent projects as reported by Pansic et. al., 1995 and adjusted using knowledge of the nature of the reservoir, the reservoir use, historical use of the reservoir for industrial activities, known archeological issues and information available on the nature of the sediments contained in the reservoir. Systems

Decommissioning estimates were prepared for the entire NSPI portfolio of hydroelectric assets. Information on the reservoir areas and the methodology for developing the maps is provided in Section 4.5.

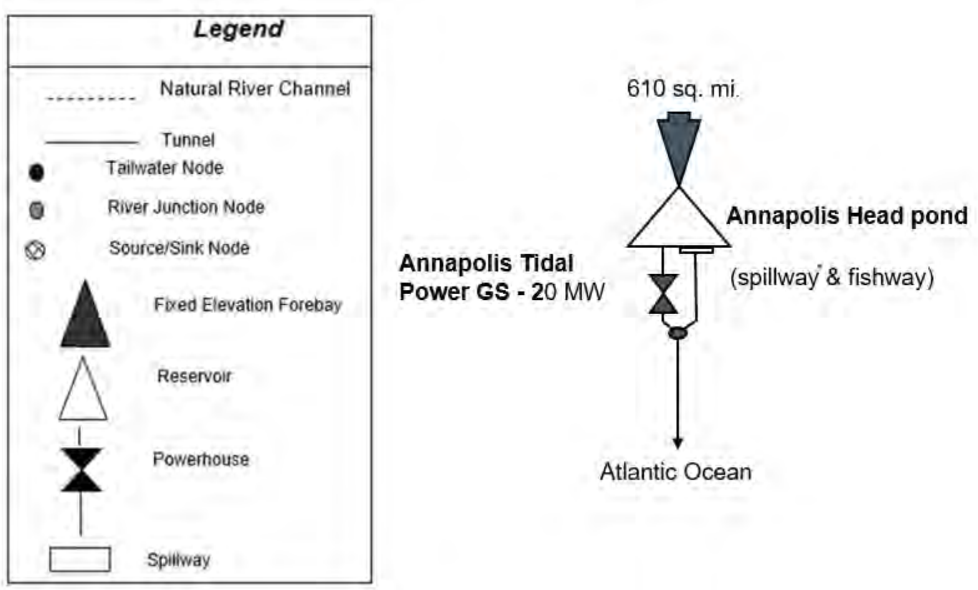
2.4 Annapolis Tidal Power Facility

The Annapolis Royal Generating Station is a 20 MW tidal power station that was constructed in 1984 on the Annapolis River immediately upstream from the town of Annapolis Royal, Nova Scotia (Figure 3).

Figure 3: The Annapolis Royal Tidal Project

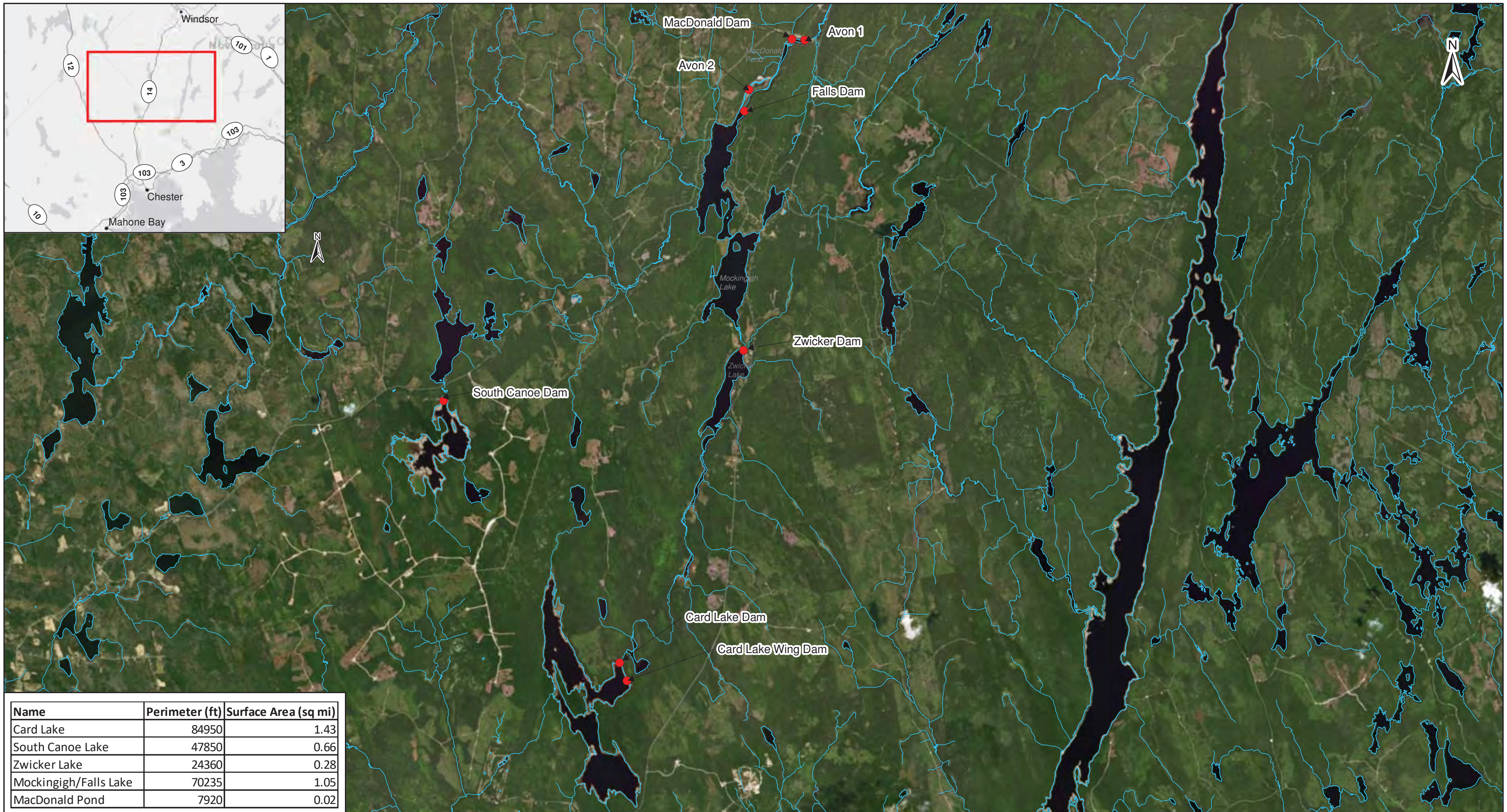
The generating station uses tidal differences in the Annapolis Basin, a sub-basin of the Bay of Fundy to generate electricity. A schematic of the system is provided in Figure 4. The structures at the site include a powerhouse, substation and fishway. There is also a gated control structure owned by the Government of Nova Scotia.

Figure 4: Schematic of the Annapolis Royal Tidal Power Plant



2.5 The Avon Hydroelectric System

The Avon Hydroelectric System was constructed in central Nova Scotia in 1928. The system consists of two power stations capable of producing up to 6.75 MW of electricity. As illustrated in Figure 5, five reservoirs, five dams with associated spillways and two canals provide water to the powerhouses.



Name	Perimeter (ft)	Surface Area (sq mi)
Card Lake	84950	1.43
South Canoe Lake	47850	0.66
Zwicker Lake	24360	0.28
Mockingigh/Falls Lake	70235	1.05
MacDonald Pond	7920	0.02

LEGEND

- Water Control Structures
- Watercourse
- Lake

0 0.75 1.5 3 Km

1:85,000

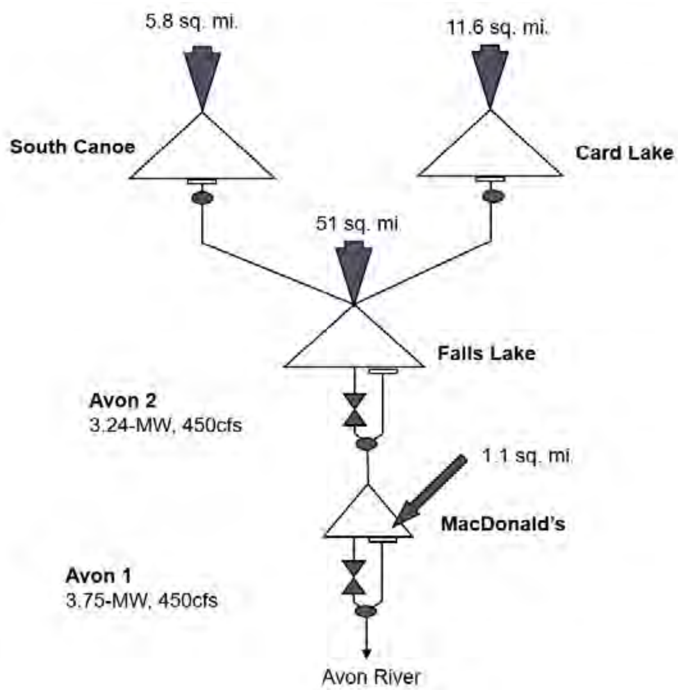
Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**		
Figure Title:	**Avon Hydro System**		
HATCH	Nova Scotia Power Inc.	**Date: August 21 2018**	
Version: 0	**Review:** TC	**Figure:** 3-3	**Page:**

Document Path: T:\Maps\GIS_Data\NSPI\Avon\MXD\AvonRiver.mxd

A schematic of the system is provided in Figure 6.

Figure 6: Schematic of the Avon Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

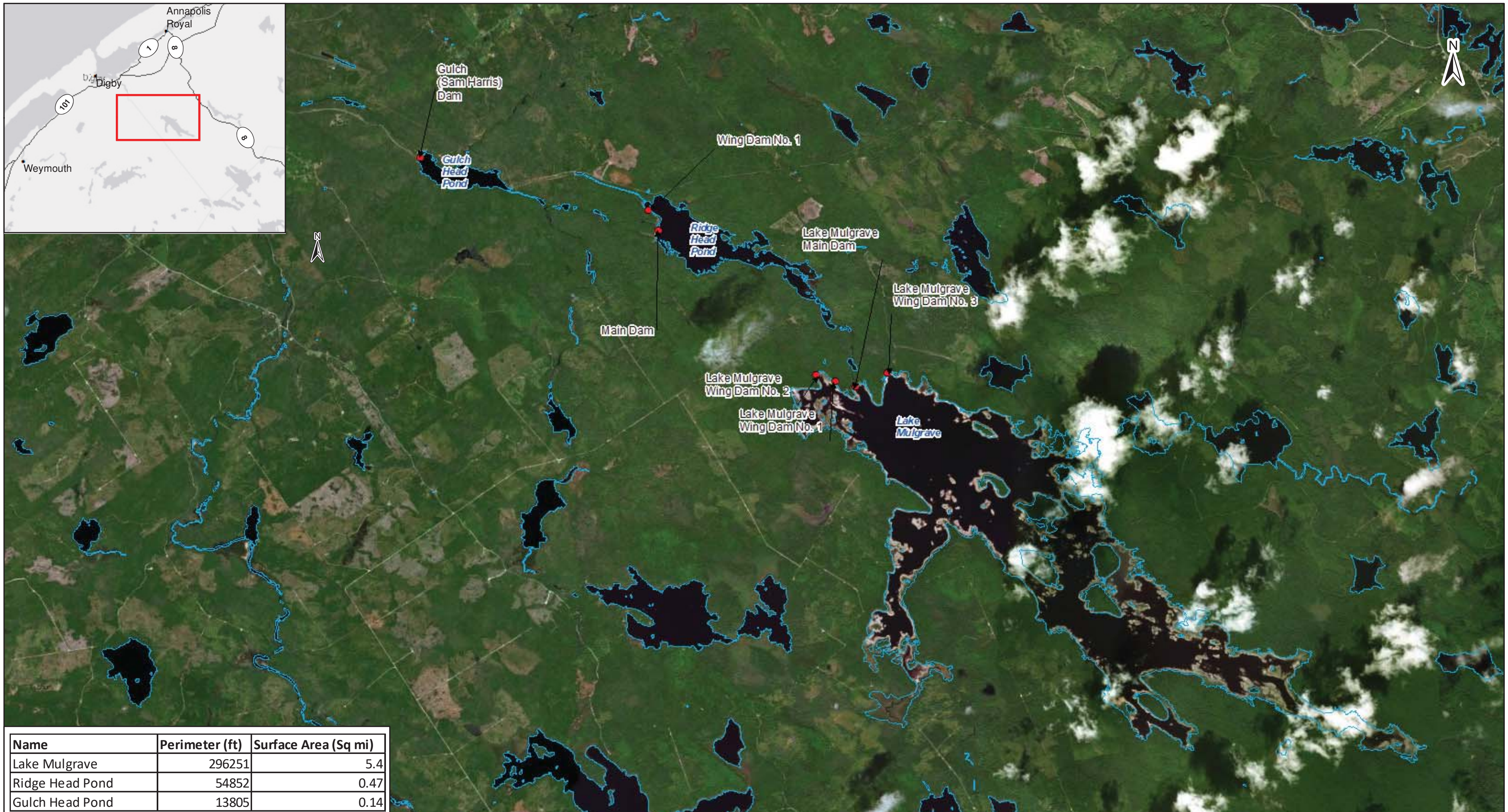
Details of the structures included in the assessments are listed in Table 2.

Table 2: Summary of Structures Assessed for the Avon Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Card Lake Main Dam and Spillway	26	570		1,561,787
Card Lake Wing Dam	13	420		780,893
Zwicker Lake Dam and Spillway	19	117		654,555
South Canoe Lake Dam and Spillway	28	1,200		1,894,763
Mockingigh/ Falls Lake Dam and Spillway	17	905		1,688,564
Mockingigh/ Falls Lake Canal		845	1,545	
MacDonald Pond Main Dam and Spillway	51.5	622		576,829
MacDonald Pond Power Canal	13.1	1,584	5,034	

2.6 The Bear River System

The Bear River Hydroelectric System was constructed in northwestern Nova Scotia in the 1950s. The system consists of two power stations capable of producing up to 10 MW of electricity. As illustrated in Figure 7, one reservoir and two head ponds, three dam and associated wing dams and spillways and one canal that provide water to the powerhouses.



Name	Perimeter (ft)	Surface Area (Sq mi)
Lake Mulgrave	296251	5.4
Ridge Head Pond	54852	0.47
Gulch Head Pond	13805	0.14

LEGEND

- Water Control Structures
- Waterbody

0 0.5 1 2 Km

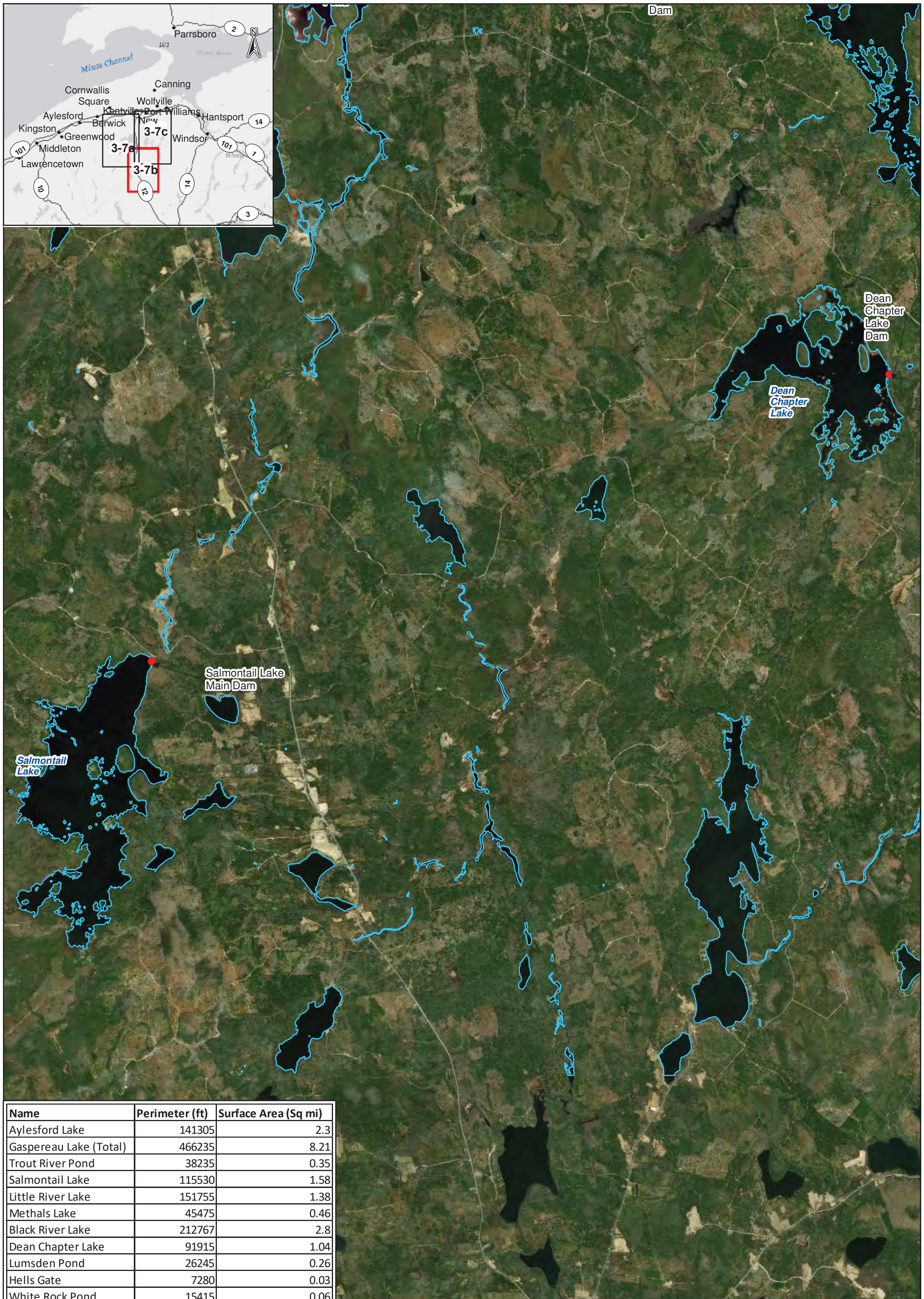
1:55,000

Data Sources:

1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Bear River Hydro System**
HATCH / Nova Scotia Power Inc.	**Date: August 10 2018**
Version: 0 **Review:** TC	**Figure:** 3-5 **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\Bear\MXD\Bear.mxd



Name	Perimeter (ft)	Surface Area (Sq mi)
Aylesford Lake	141305	2.3
Gaspereau Lake (Total)	466235	8.21
Trout River Pond	38235	0.35
Salmontail Lake	115530	1.58
Little River Lake	151755	1.38
Methals Lake	45475	0.46
Black River Lake	212767	2.8
Dean Chapter Lake	91915	1.04
Lumsden Pond	26245	0.26
Hells Gate	7280	0.03
White Rock Pond	15415	0.06

LEGEND

- Water Control Structures
- Waterbody

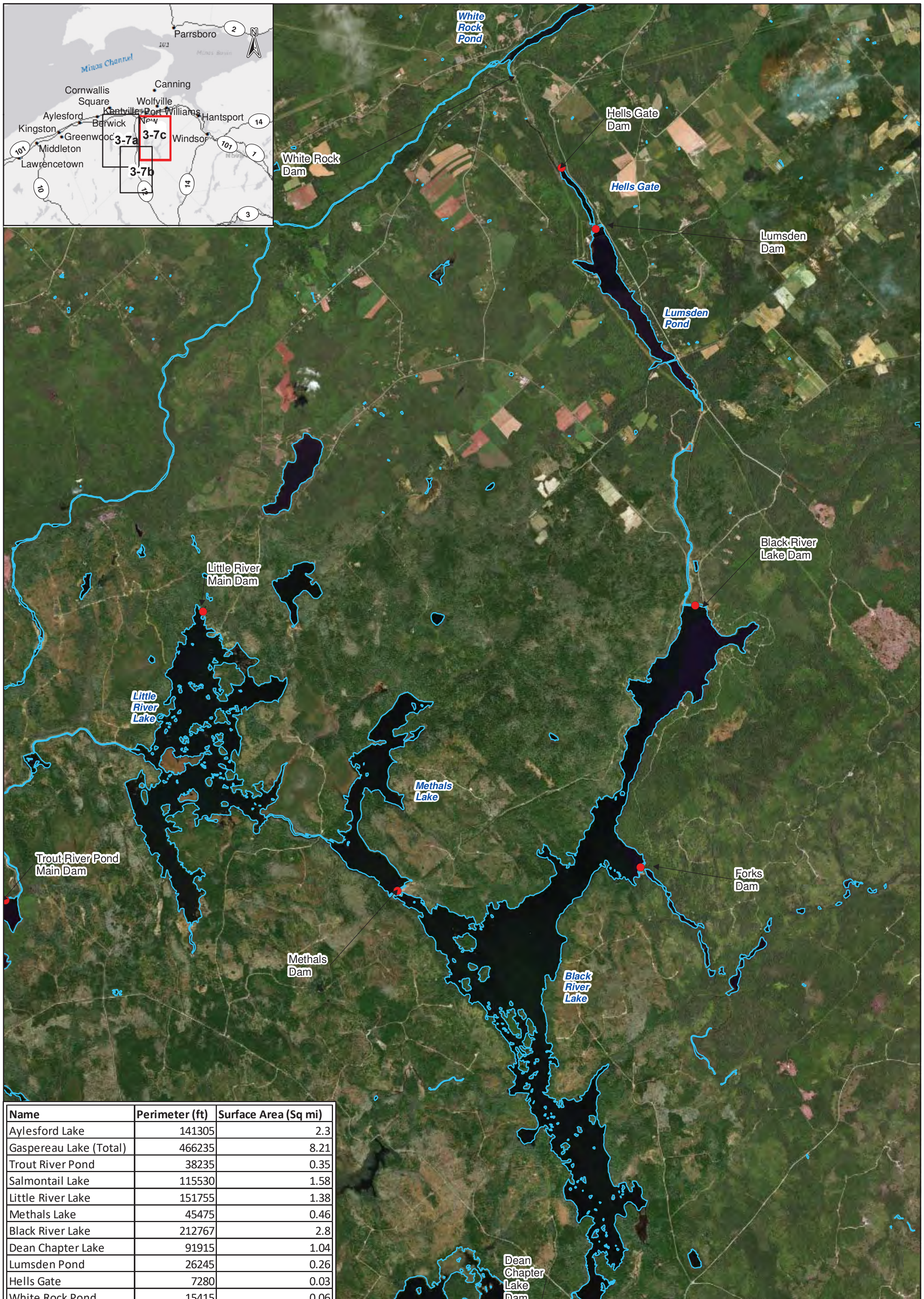
0 0.5 1 2 Km
1:50,000

Data Sources:

1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Black River Hydro System
HATCH / Nova Scotia Power Inc.	Date: July 24 2018
Version: 0	Review: TC
Figure: 7b	Page:

Document Path: T:\Maps\GIS_Data\NSPI\BlackRiver\MXD\BlackRiver_AllStructures.mxd



Name	Perimeter (ft)	Surface Area (Sq mi)
Aylesford Lake	141305	2.3
Gaspereau Lake (Total)	466235	8.21
Trout River Pond	38235	0.35
Salmontail Lake	115530	1.58
Little River Lake	151755	1.38
Methals Lake	45475	0.46
Black River Lake	212767	2.8
Dean Chapter Lake	91915	1.04
Lumsden Pond	26245	0.26
Hells Gate	7280	0.03
White Rock Pond	15415	0.06

LEGEND

- Water Control Structures
- Waterbody

0 0.5 1 2 Km

1:50,000

Data Sources:

1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project: Hydro System Decommissioning Cost Estimate

Figure Title: Black River Hydro System

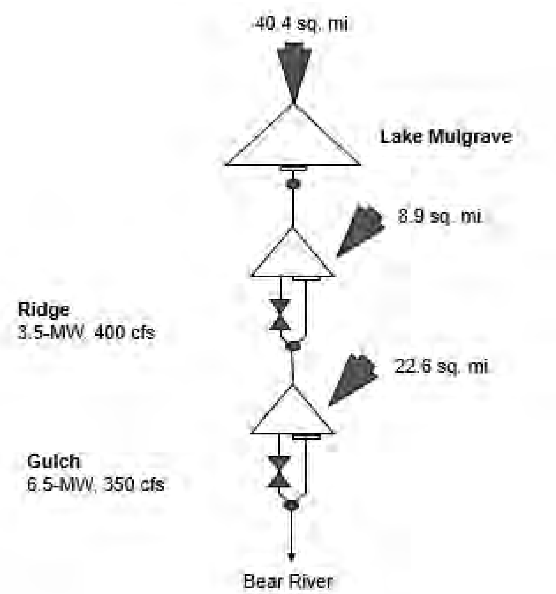
HATCH | Nova Scotia Power Inc. | **Date: July 24 2018**

Version: 0 | **Review:** TC | **Figure:** 7c | **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\BlackRiver\MXD\BlackRiver_AllStructures.mxd

A schematic of the system is provided in Figure 8.

Figure 8: Schematic of the Bear River Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

Details of the structures included in the assessments are listed in Table 3.

Table 3: Summary of Structures Assessed for the Bear River Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Lake Mulgrave Main Dam	34	600		3,561,179
Lake Mulgrave Wing Dam 1 and Spillway	20	245		2,094,811
Lake Mulgrave Wing Dam 2	22	2,100		2,304,292
Lake Mulgrave Wing Dam 3	17	755		1,780,589
Ridge Main Dam and Spillway	40	770		1,034,299
Ridge Wing Dam 1	25	1,080		646,437
Ridge Wing Dam 2	10	800		258,575
Ridge Canal Embankment	5	50	121	
Gulch Main Dam and Spillway	57	730		1,112,823

2.7 The Black River Hydroelectric System

The Black River Hydroelectric System was constructed in central Nova Scotia starting in 1919 and continued again in the 1940s. It is a system that consists of five power stations capable of producing up to 23.8 MW of electricity. As illustrated in Table 9, 12 reservoirs and associated spillways, 20 dam and associated wing dams and three canals provide water to the powerhouses. The system also includes three fishways.

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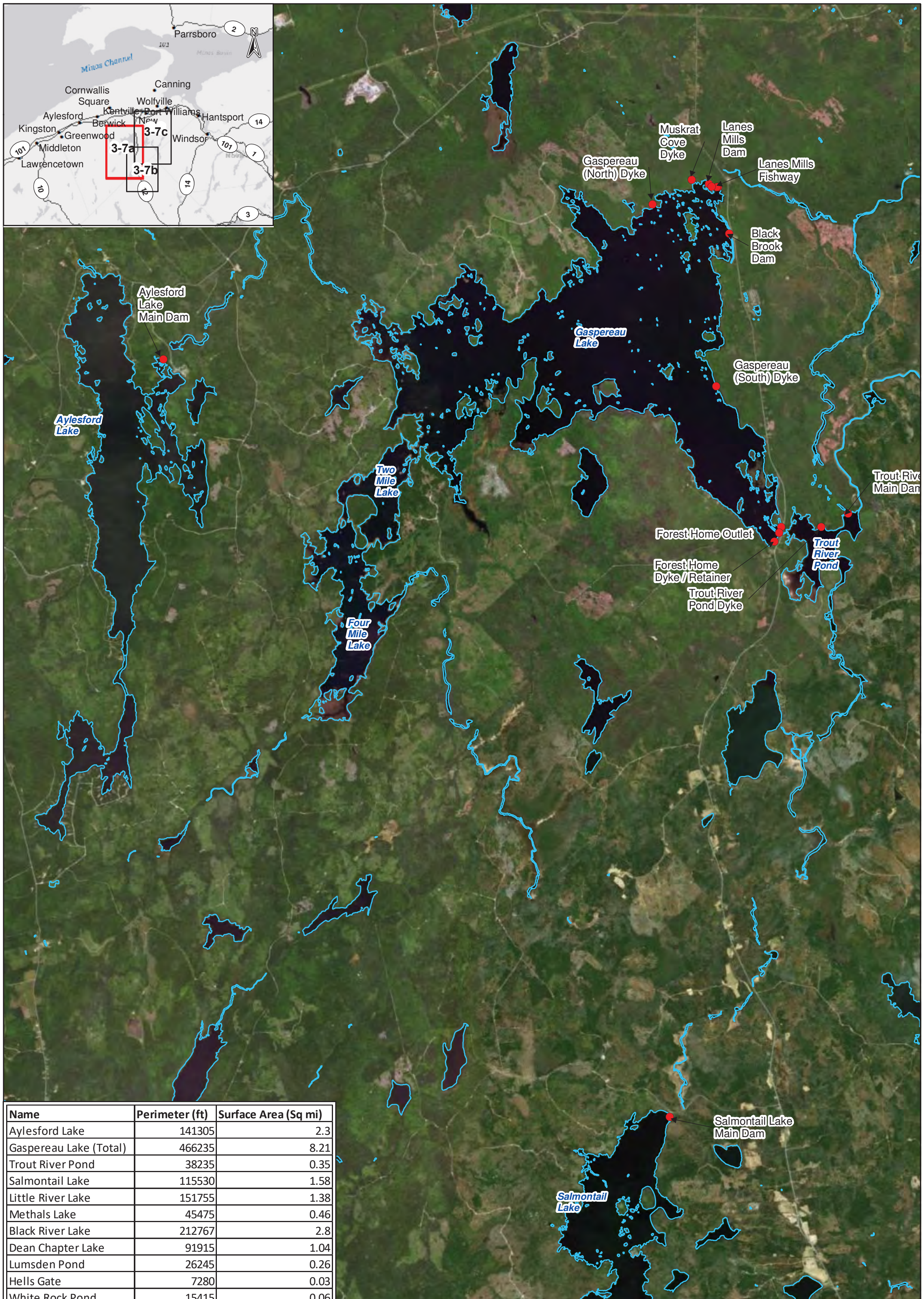


Name	Perimeter (ft)	Surface Area (Sq mi)
Aylesford Lake	141305	2.3
Gaspereau Lake (Total)	466235	8.21
Trout River Pond	38235	0.35
Salmontail Lake	115530	1.58
Little River Lake	151755	1.38
Methals Lake	45475	0.46
Black River Lake	212767	2.8
Dean Chapter Lake	91915	1.04
Lumsden Pond	26245	0.26
Hells Gate	7280	0.03
White Rock Pond	15415	0.06

LEGEND

- Water Control Structures
- Waterbody

0 0.5 1 2 Km
1:60,000

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimeters are larger than that shown in satellite imagery and may reflect full supply level.

Project: Hydro System Decommissioning Cost Estimate

Figure Title: Black River Hydro System

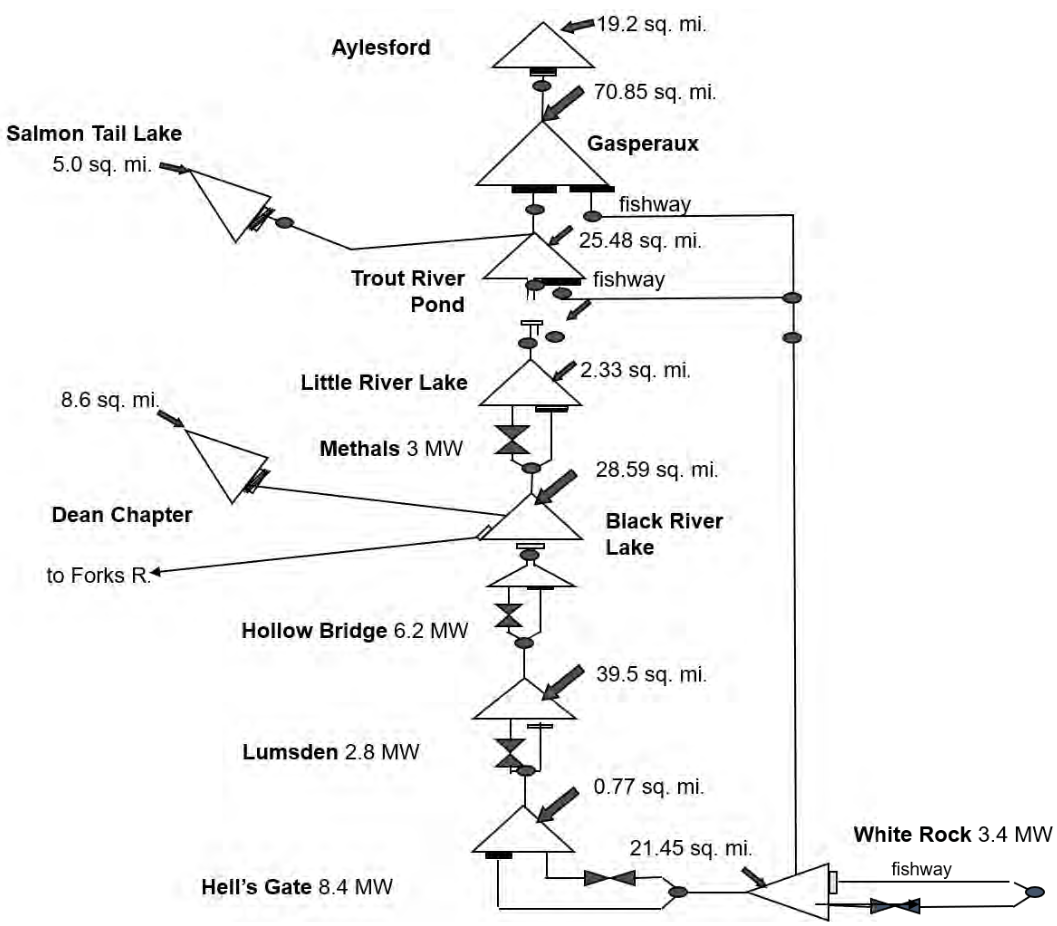
HATCH | Nova Scotia Power Inc. | **Date:** July 24 2018

Version: 0 | **Review:** TC | **Figure:** 3-7a | **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\BlackRiver\MXD\BlackRiver_AllStructures.mxd

A schematic of the system is provided in Figure 10.

Figure 10: Schematic of the Black River Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management. The costs reported herein are for full decommissioning of the facility.

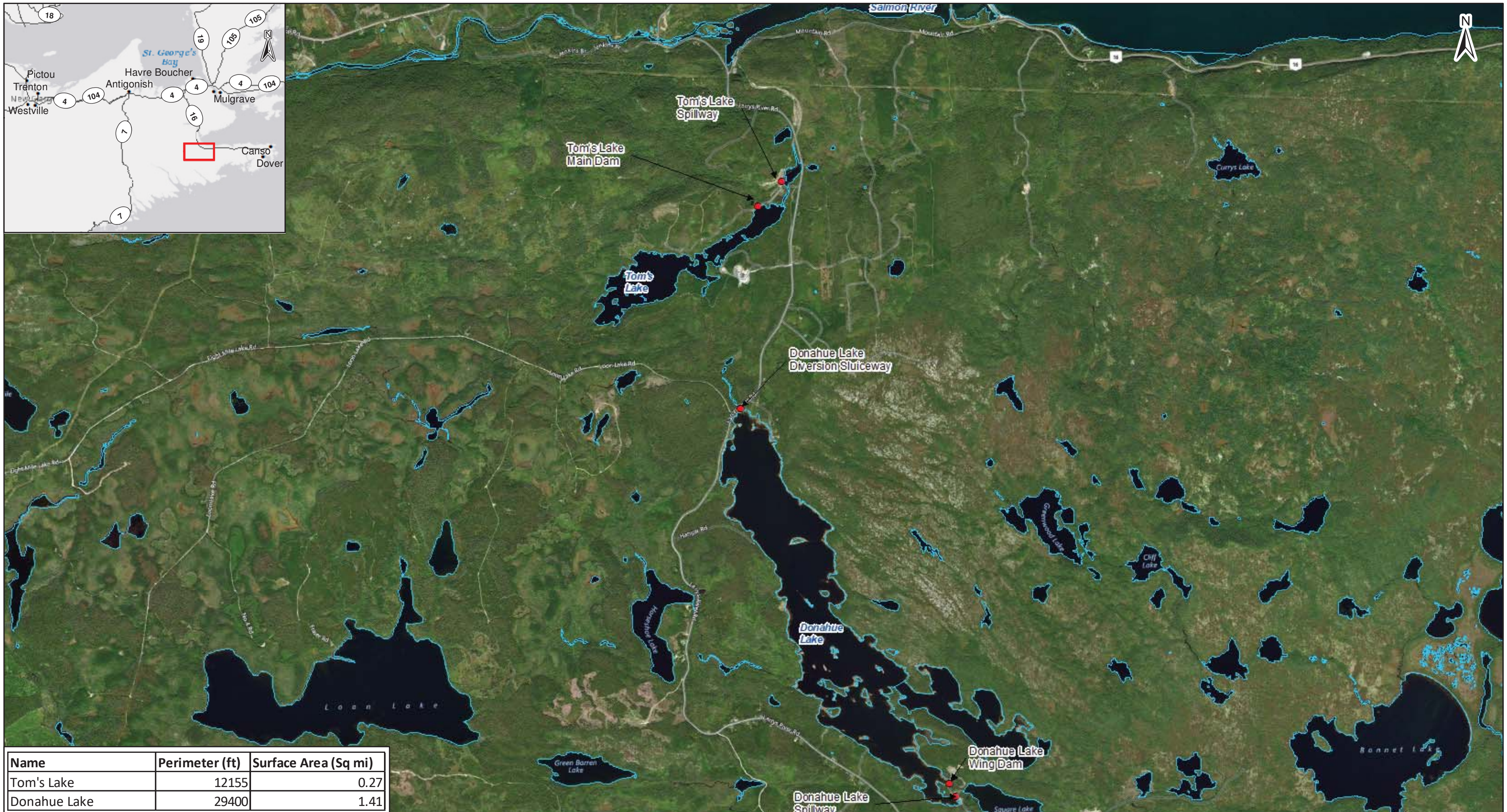
Details of the structures included in the assessments are listed in Table 4.

Table 4: Summary of Structures Assessed for the Black River Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Aylesford Lake Main Dam and Spillway	18	223		3,597,038
North and South Gaspereau Dyke	10	778		
Lanes Mills Spillway	11	349		
Black Brook Dyke	16	2,934		
Muskrat Cove Dyke and Spillway	10	796		
Forest Home Dyke	15	4,620		
Trout River Pond Diversion Dam	30	830		1,622,174
Trout River Pond Dykes LMN	11	660		
Trout River Pond Spillway / Dyke P	13	689		
Trout River Pond Gaspereau Canal Dyke	20	20,200	77,193	
Trout River Pond Mid-Pond Dyke and Spillway	8	100		
Salmontail Lake Main Dam and Spillway	22	615		3,594,450
Hatchard Lake Dam	8	470		
Little River Lake Main Dam and Spillway	15	775		1,609,605
Little River Lake Wing Dam	13	700		1,394,991
Methals Dam and Spillway	50	1,574		3,215,568
Black River Lake Dam	42	1,050		6,318,858
Forks Dam and Spillway	38	1,006		5,717,062
Hollow Bridge Canal	18.5	8500	31,294	
Lunn Dam	3	168		
Dean Chapter Lake	19	400		2,469,761
Lumsden Main Dam and Spillway	72	903		2,672,355
Hell's Gate Main Dam and Spillway	58	365		597,138
White Rock Main Dam and Spillway	39	274		850,204
White Rock Canal	30	5,000	23,760	3,597,038

2.8 The Dickie Brook Hydroelectric System

The Dickie Brook Hydroelectric System was constructed in southeastern Nova Scotia in the 1940s. It consists of a single powerhouse capable of producing up to 2.4 MW of electricity. As illustrated in Figure 11, two reservoirs and associated spillways, two dams and associated wing dams/Intakes and one canal provide water to the powerhouse.



Name	Perimeter (ft)	Surface Area (Sq mi)
Tom's Lake	12155	0.27
Donahue Lake	29400	1.41

LEGEND

- Water Control Structures
- Waterbody

0 0.4 0.8 1.6 Km

1:40,000

Data Sources:

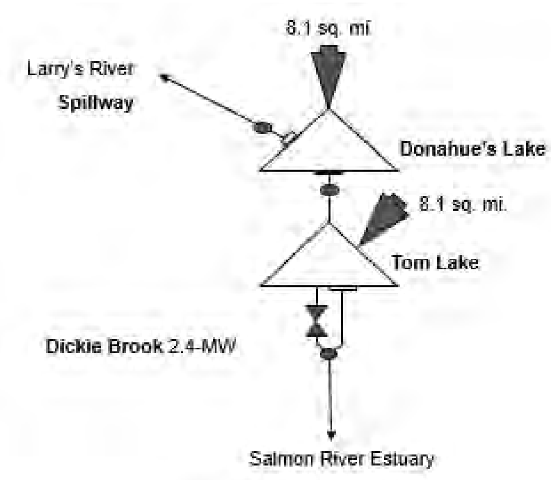
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimeters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Dickie Brook Hydro System**
HATCH / Nova Scotia Power Inc.	**Date:** July 25 2018
Version: 0 / **Review:** TC / **Figure:** 3-9	**Page:**

Document Path: T:\Maps\GIS_Data\NSPI\DickieBrook\MXD\DickieBrook.mxd

A schematic of the system is provided in Figure 12.

Figure 12: Schematic of the Dickie Brook Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generation facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

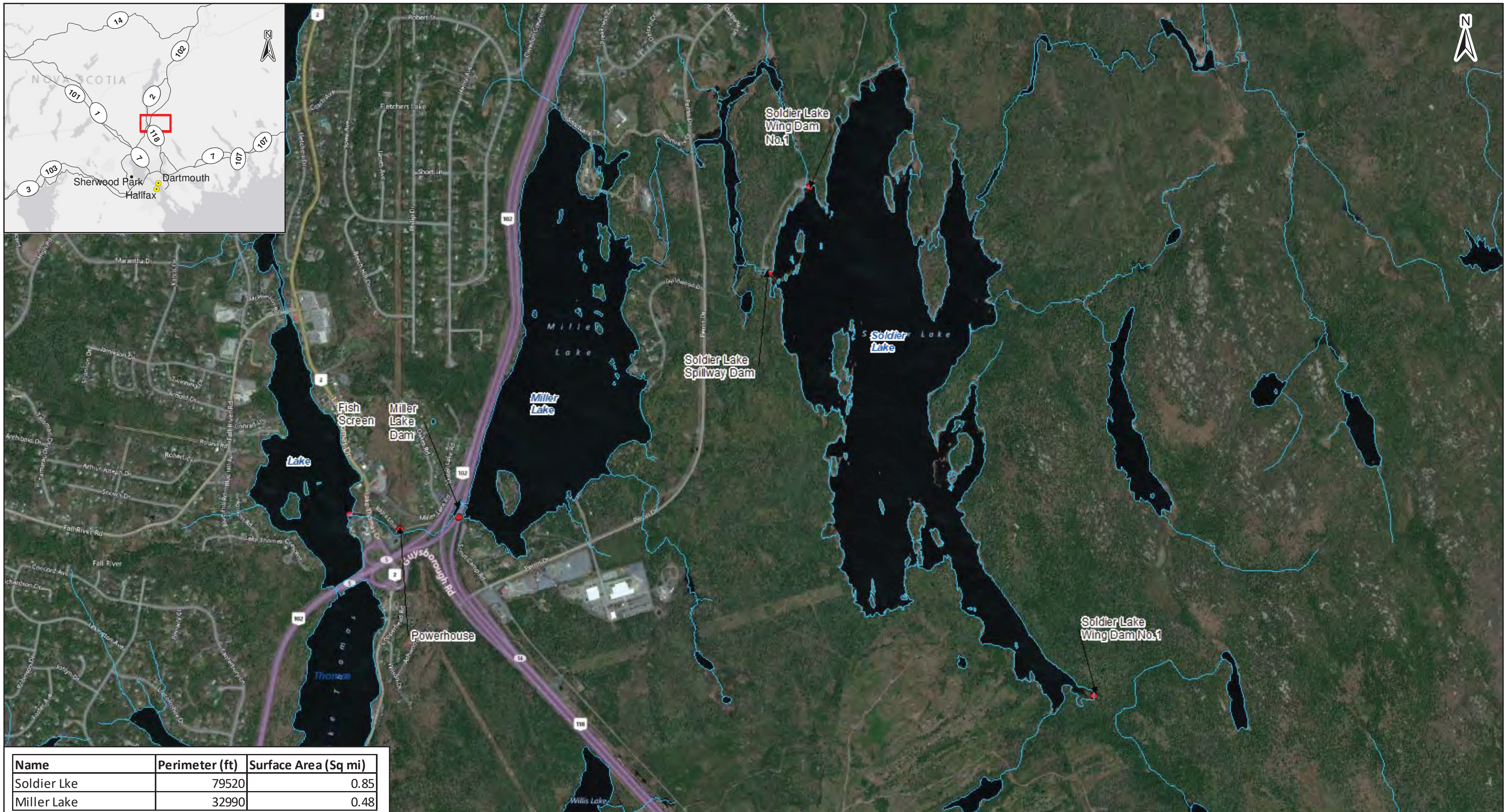
Details of the structures included in the assessments are listed in Table 5.

Table 5: Summary of Structures Assessed for the Dickie Brook Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Tom's Lake Main Dam	45	558		773,539
Tom's Lake Spillway	22	564		
Tom's Lake Wing Dam No. 1, No. 2 Freeboard Dyke	9	641		
Tom's Lake Wing Dam No. 3	10	226		
Tom's Lake Intake Structure	22	30		
Donahue Lake Main Dam	14	607		582,090
Donahue Lake Diversion Sluiceway/Canal	16	656		
Donahue Lake Wing Dam	9.5	475		

2.9 The Fall River Hydroelectric System

The Fall River Hydroelectric System's wing dams were constructed in central Nova Scotia in the 1920s. The remainder of the system was constructed in 1985. It consists of a single powerhouse capable of producing up to 500 kW of electricity. As illustrated in Figure 13, two reservoirs and associated spillways, two dams and associated wing dams and Intakes and one canal provide water to the powerhouse.



Name	Perimeter (ft)	Surface Area (Sq mi)
Soldier Lke	79520	0.85
Miller Lake	32990	0.48

LEGEND

- Water Control Structures
- Watercourse
- Waterbody

0 0.2 0.4 0.8 Km

1:20,000

Data Sources:

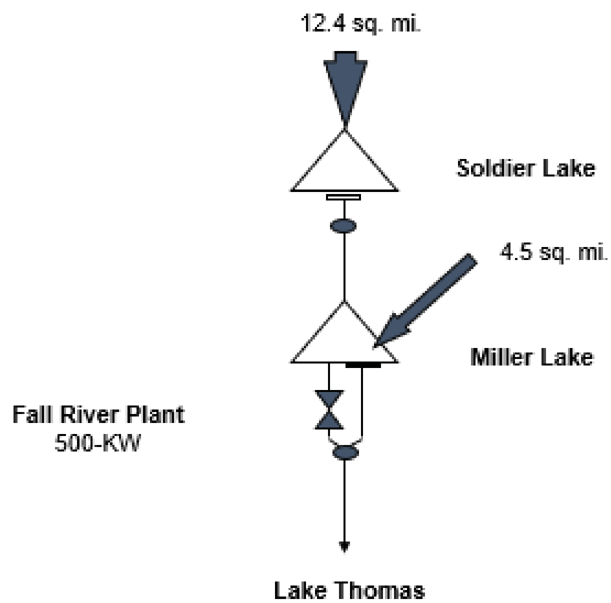
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Fall River Hydro System**
HATCH — Nova Scotia Power Inc.	**Date: July 25 2018**
Version: 0 **Review:** TC	**Figure:** 3-11 **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\FallRiver\MXD\FallRiver.mxd

A schematic of the system is provided in Figure 14.

Figure 14: Schematic of the Fall River Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

Details of the structures included in the assessments are listed in Table 6.

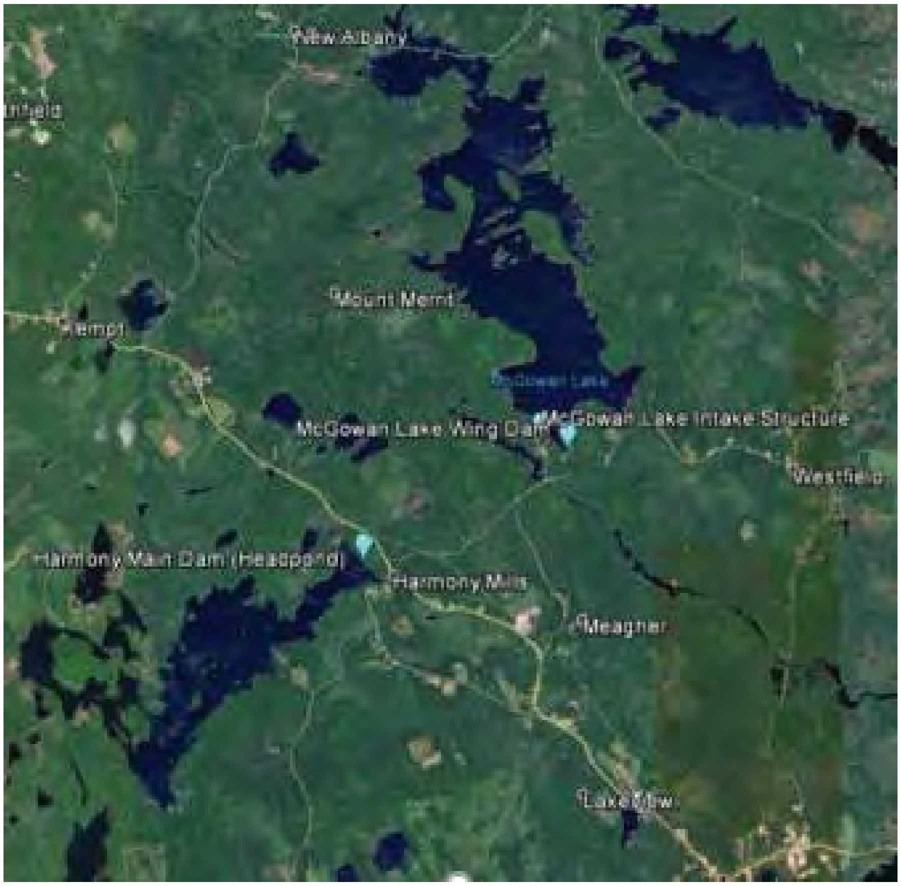
Table 6: Summary of Structures Assessed for the Fall River Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m²)	Exposed Reservoir Area (m²)
Soldiers Lake Spillway Dam	17	154		613,222
Soldier Lake Wing Dam No. 1	12	310		432,863
Soldier Lake Wing Dam No. 2	4	125		144,288
Miller Lake Dam and Spillway	15.7	268		732,482

2.10 The Harmony Hydroelectric System

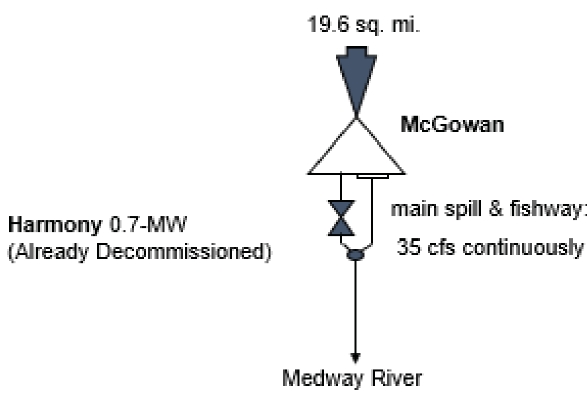
The Harmony Hydroelectric System was constructed in southeastern Nova Scotia in 1943. It consists of a single powerhouse capable of producing up to 700 kW of electricity. As illustrated in Figure 15, one reservoir and an associated spillway, one dam and an associated intake provide water to the powerhouse. The system also includes a fishway.

Figure 15: The Harmony Hydroelectric System



A schematic of the system is provided in Figure 16.

Figure 16: Schematic of the Harmony Generating System



Details of the structures associated with the Harmony system are listed in Table 7.

Table 7: Summary of Structures Associated with the Harmony Hydroelectric System

Structure	Height (ft.)	Length (ft.)
Harmony Main Dam and Spillway	20	856
McGowan Lake Wing Dam	10.5	460
McGowan Lake Intake Structure	14	107

2.11 The Lequille Hydroelectric System

The Lequille Hydroelectric System was constructed in northwestern Nova Scotia in 1968. The system consists of a single power station capable of producing up to 13.1 MW of electricity. As illustrated in Figure 17, three reservoirs and associated spillways, two dams and associated wing dams and intake and one canal that provide water to the powerhouses.

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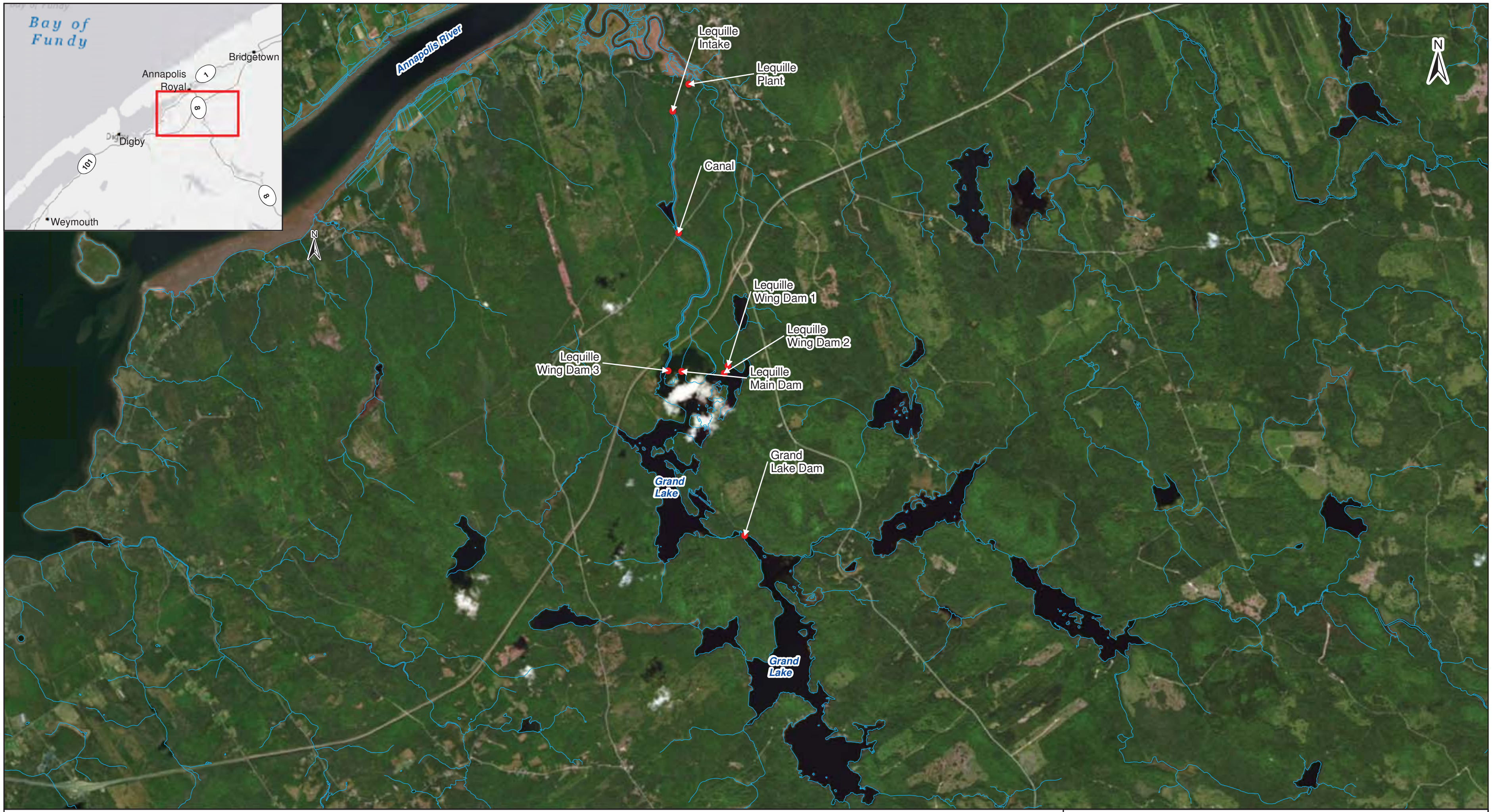

LEGEND

- Water Control Structures and Assets
- Watercourse
- Waterbody

0 0.5 1 2 Km
1:55,000

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Lequille Hydro System
HATCH / Nova Scotia Power Inc.	Date: August 21 2018
Version: 0 / Review: TC	Figure: 3-15 / Page:

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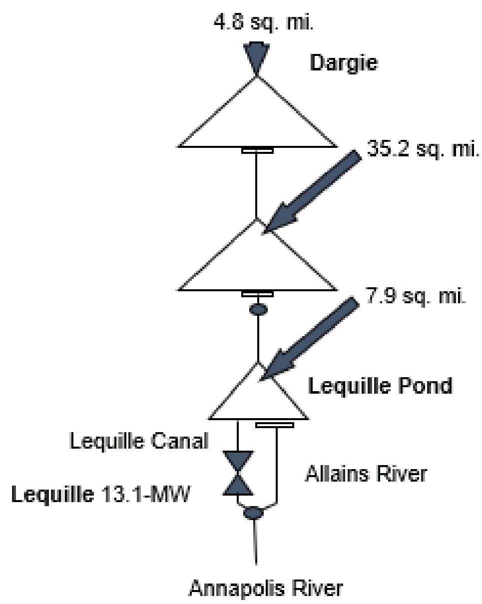
A schematic of the system is provided in Figure 18.

Figure 18: Schematic of the Lequille Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management

Details of the structures included in the assessments are listed in Table 8.

Table 8: Summary of Structures Assessed for the Lequille Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Grand Lake Dam and Spillway	15	320		1,696,102
Canal Intake and Wing Dam No. 1 and Spillway	30	410		574,418
Lequille Main Dam	40.5	440		775,465
Lequille Spillway Structure	20	96		382,945
Lequille Wing Dam No. 3	10	188		191,473
Lequille Wing Dam No. 4	14	240		268,062
Lequille Canal Embankment	29	13,555	63,153	
Lequille Intake Structure	31	15		593,565

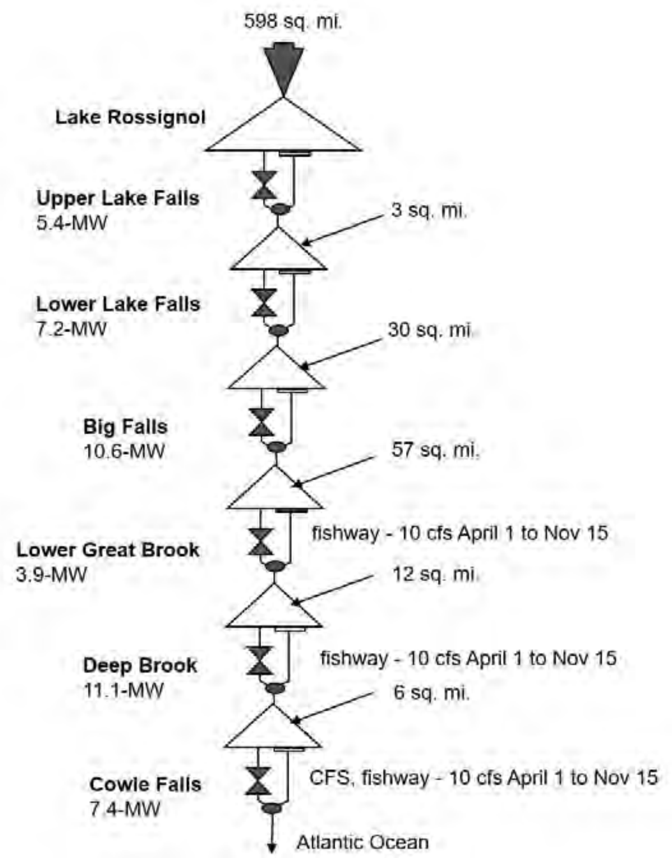
2.12 The Mersey Hydroelectric System

Most of the Mersey Hydroelectric System was constructed in southwestern Nova Scotia in 1928 and 1929, construction started again in 1938 and during the 1950s. It consists of six powerhouses capable of producing up to 45.6 MW of electricity. As illustrated in Figure 19, six reservoirs and associated spillways and sluiceways, nine dams and associated wing dams and intakes and two canals provide water to the powerhouses. The system also includes three fishways.

Figure 19: The Mersey Hydroelectric System

A schematic of the system is provided in Figure 20.

Figure 20: Schematic of the Mersey Generating System



Details of the structures associated with the Harmony system are listed in Table 9.

Table 9: Summary of Structures Associated with the Mersey Hydroelectric System

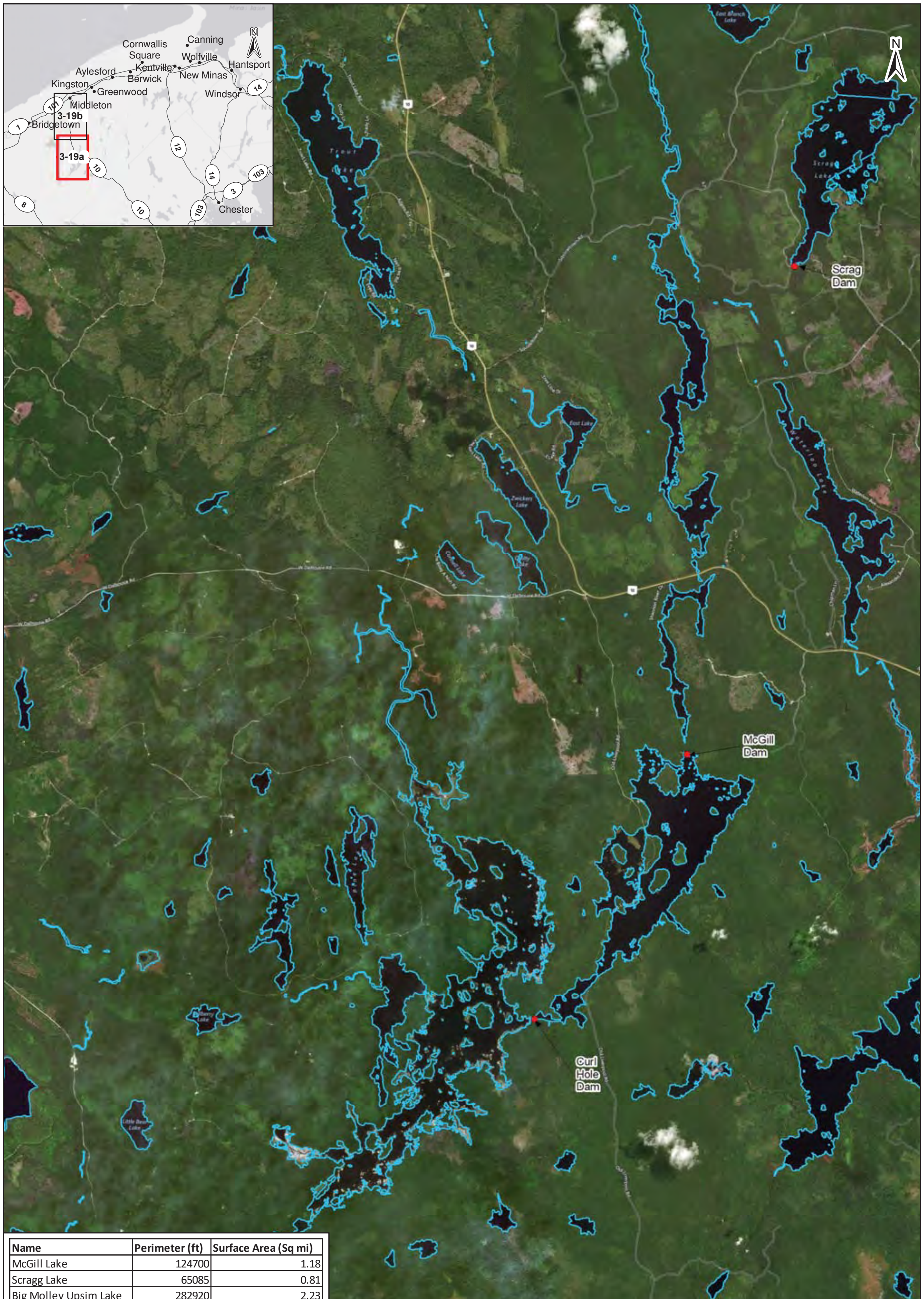
Structure	Height (ft.)	Length (ft.)
Upper Lake Falls Left Wing Dam	22	600
Upper Lake Falls Bulkhead	34	14
Upper Lake Falls Sluiceway	48	40
Upper Lake Falls Main Dam	52	454
Upper Lake Falls Right Wing Dam	14	200
Upper Lake Falls Spillway	15	252
Lower Lake Falls Right Wing Dam	15	804
Lower Lake Falls Left Wing Dam	5	480
Lower Lake Falls Canal Embankment	23	1,641

Structure	Height (ft.)	Length (ft.)
Lower Lake Falls Main Dam	21	469
Lower Lake Falls Sluiceway	22	96
Lower Lake Falls Spillway	10	1,400
Lower Lake Falls Powerhouse Bulkhead Dams	35	50
Lower Lake Falls Sluiceway Bulkhead Dam	22	106
Big Falls Embankment No. 1 (Left Wing Dam)	21	543
Big Falls Sluiceway	36	100
Big Falls Embankment No. 2 (Main Dam)	34	1,263
Big Falls Embankment No. 3	30	1,314
Big Falls Embankment No. 4 (Right Wing Dam)	23	458
Big Falls Bulkhead Dam	49.2	84
Big Falls Spillway	16	1,180
Lower Great Brook Spillway Left	4	582
Lower Great Brook Spillway Right	4	238
Lower Great Brook Sluiceway	25	170
Lower Great Brook Left Wing Dam	33	436
Lower Great Brook Main Dam	25	923
Lower Great Brook Right Wing Dam	11	365
Deep Brook Spillway	10	400
Deep Brook Sluiceway	19	400
Deep Brook Road Wing Dam	21	1,650
Deep Brook Canal Embankment Dam	8	2,570
Deep Brook Right Wing Dam	9	280
Deep Brook Main Dam	48	2,600
Cowie Falls Left Wing Dam	26	100
Cowie Falls Spillway	31	300
Cowie Falls Sluiceway	34	95
Cowie Falls Main Dam	33	750
Cowie Falls Wing Dam 1	13	750
Cowie Falls Wing Dam 2	4	75
Cowie Falls Wing Dam 3	4	100
Cowie Falls Wing Dam 4	5	70
Cowie Falls Wing Dam 5	3	30
Jordan Lake Main Outlet Weir	6	8
Jordan Lake Main Outlet Dykes (Dykes 3 and 4)	13.8	217
Jordan Lake Driving Canal Weir	4.9	50
Jordan Lake Driving Canal Dykes (Dykes 1 and 2)	8.9	249

Structure	Height (ft.)	Length (ft.)
Jordan Lake Main Dam (including Dykes 5, 6 and 7)	8.2	1,304
Sixth Lake Outlet Dykes	9.8	571
Sixth Lake Outlet Weir	4.6	66

2.13 The Nictaux Hydroelectric System

The Nictaux Hydroelectric System was constructed in northwestern Nova Scotia between 1954 and 1956. The system consists of a single power station capable of producing up to 7.2 MW of electricity. As illustrated in Figure 21 four reservoirs, five spillways, five dams and associated wing dams and intakes and one canal provide water to the powerhouses.



Name	Perimeter (ft)	Surface Area (Sq mi)
McGill Lake	124700	1.18
Scragg Lake	65085	0.81
Big Molley Upsim Lake	282920	2.23

LEGEND

- Water Control Structures
- Waterbody

0 0.5 1 2 Km

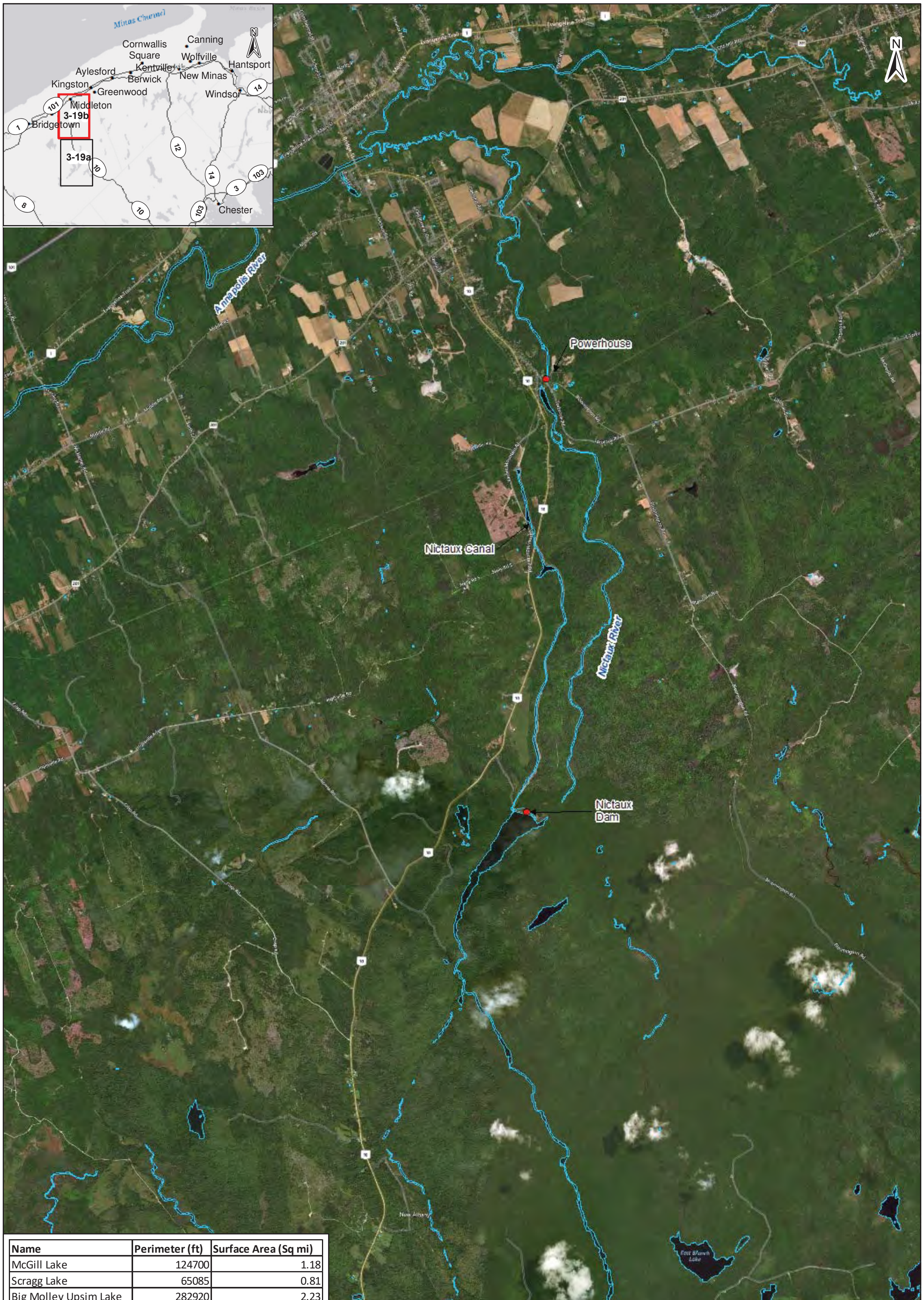
1:50,000

Data Sources:

1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing Maps
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Nictaux River Hydro System
HATCH Nova Scotia Power Inc.	Date: July 25 2018
Version: 0	Review: TC
Figure: 3-19a	Page:

Document Path: T:\Maps\GIS_Data\NSPI\Nictaux\MXD\Nictaux_AllStructures.mxd



Name	Perimeter (ft)	Surface Area (Sq mi)
McGill Lake	124700	1.18
Scragg Lake	65085	0.81
Big Molley Upsim Lake	282920	2.23

LEGEND

- Water Control Structures
- Waterbody

0 0.5 1 2 Km
1:50,000

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing Maps
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project: Hydro System Decommissioning Cost Estimate

Figure Title: Nictaux River Hydro System

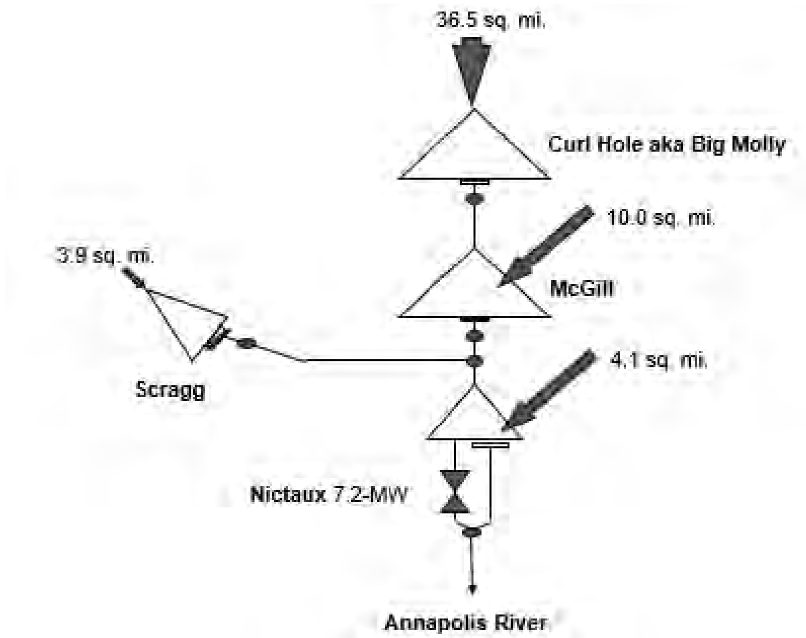
HATCH | Nova Scotia Power Inc. | Date: July 25 2018

Version: 0 | Review: TC | Figure: 21b | Page:

Document Path: T:\Maps\GIS_Data\NSPI\Nictaux\MXD\Nictaux_AllStructures.mxd

A schematic of the system is provided in Figure 22.

Figure 22: Schematic of the Nictaux Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

Details of the structures included in the assessments are listed in Table 10.

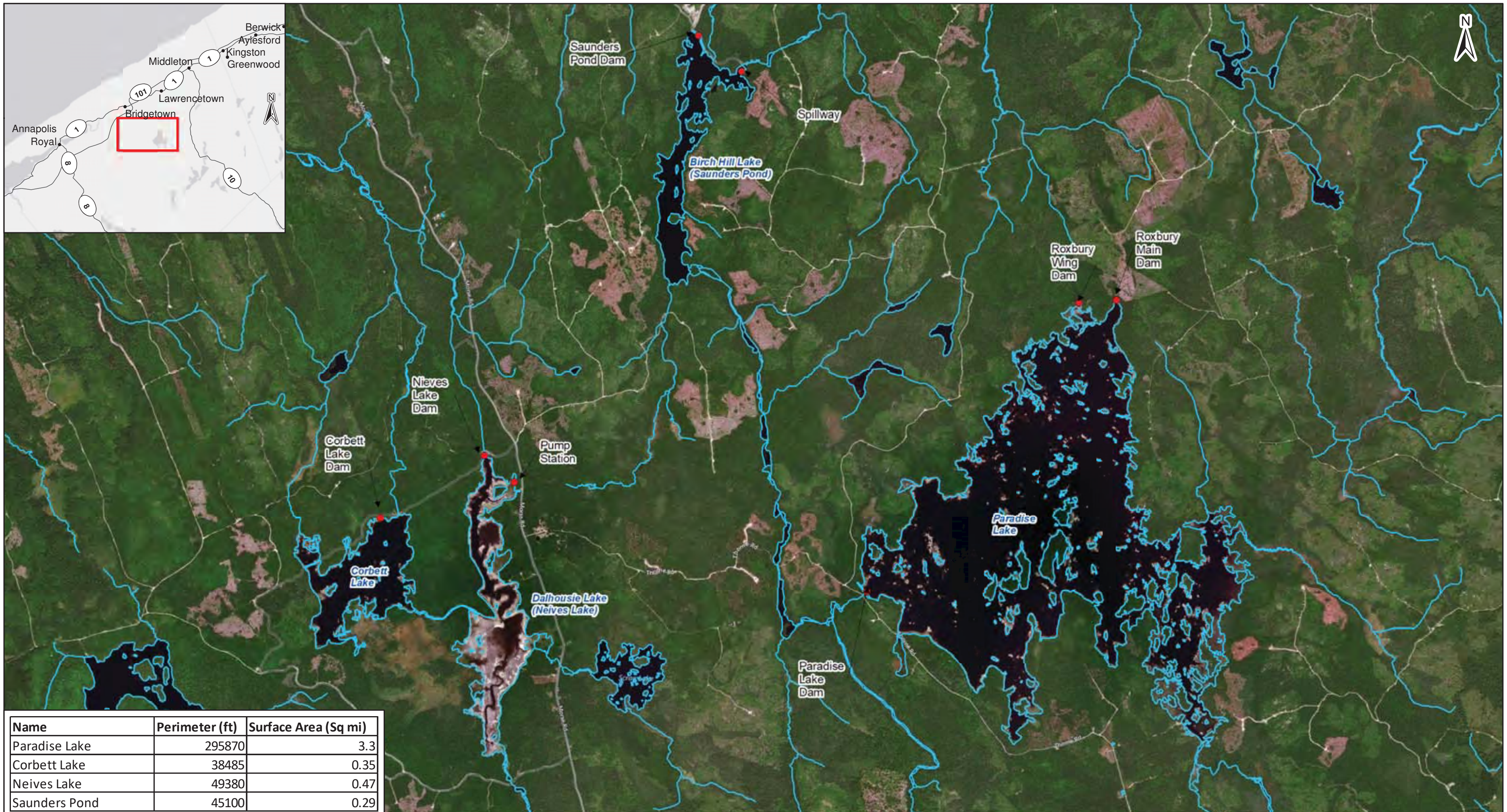
Table 10: Summary of Structures Assessed for the Nictaux Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Big Molly Upsim Curl Hole Dam	23	480		9,202,514
Earth/Rockfill Dykes	4	100		Included above
Earth/Rockfill Overflow	4	230		
Curl Hole Timber Spillway	6.5	168		
Curl Hole Concrete Spillways 1	9	192		
Curl Hole Concrete Spillway 2	9	282		
McGill Lake Dam and Spillway	26.5	485		4,673,339
Scragg Lake Dam and Spillway	13	1,050		1,196,573
Nictaux Main Dam and Spillway	96.5	2,000		Included

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Nictaux Canal Embankment	60	17,160	129,400	n/a

2.14 The Paradise Hydroelectric System

The Paradise Hydroelectric System was constructed in northwestern Nova Scotia in the 1980s. The system consists of a single power station capable of producing up to 4.8 MW of electricity. As illustrated in Figure 23, three reservoirs and associated spillways and three dams and associated wing dams and intakes provide water to the powerhouses.



Name	Perimeter (ft)	Surface Area (Sq mi)
Paradise Lake	295870	3.3
Corbett Lake	38485	0.35
Neives Lake	49380	0.47
Saunders Pond	45100	0.29

LEGEND

- Water Control Structure
- Watercourse
- Waterbody

0 0.4 0.8 1.6 Km
1:40,000

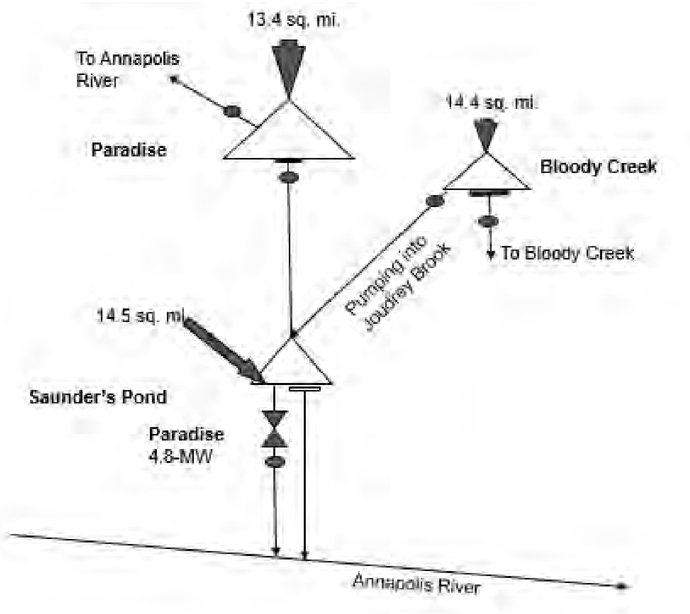
Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimeters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Paradise Hydro System**
HATCH Nova Scotia Power Inc.	**Date: July 26 2018**
Version: 0 **Review: TC**	**Figure: 3-21** **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\Paradise\MXD\Paradise.mxd

A schematic of the system is provided in Figure 24.

Figure 24: Schematic of the Paradise Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

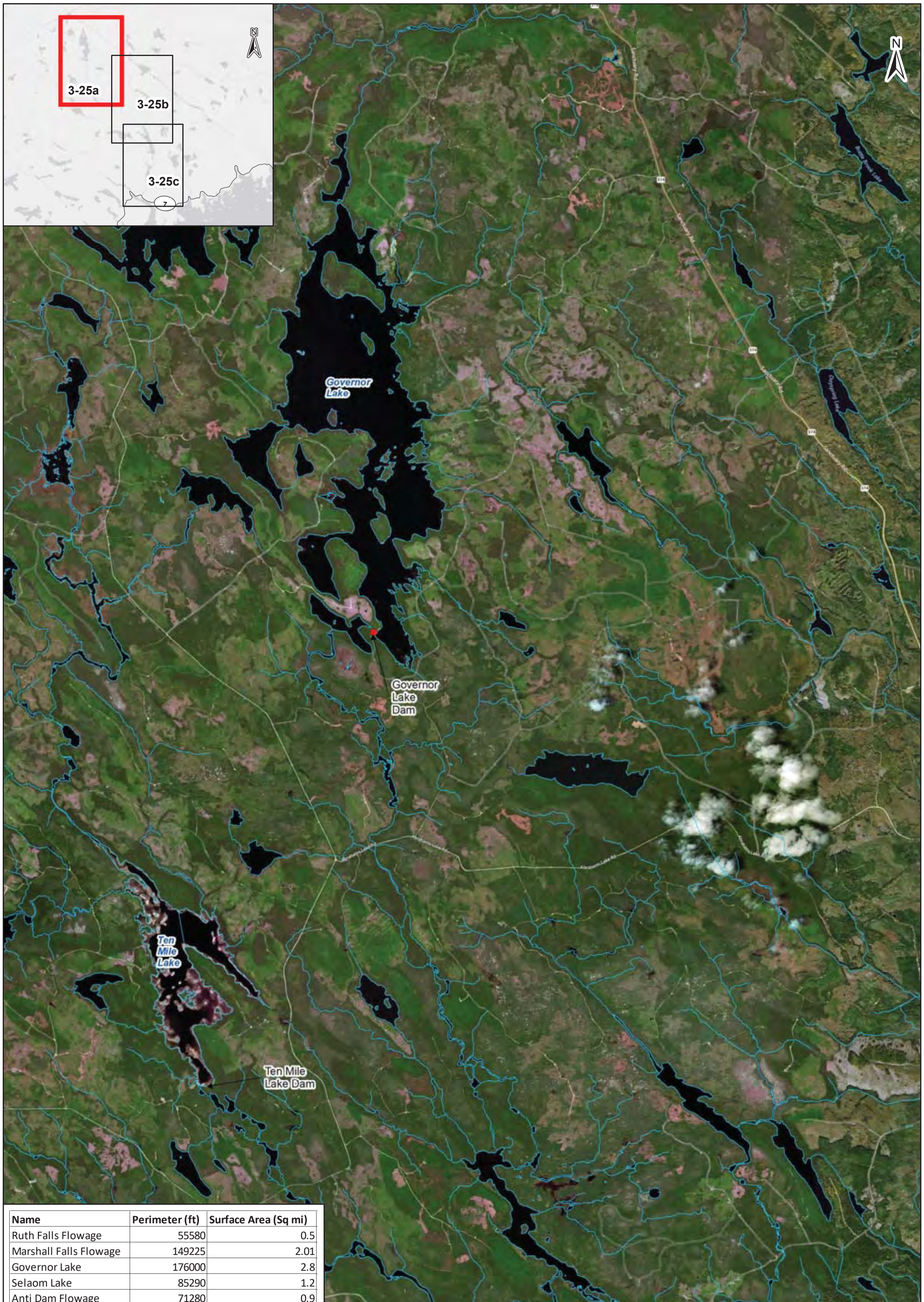
Details of the structures included in the assessments are listed in Table 11.

Table 11: Summary of Structures Assessed for the Paradise Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Spillway Dam	17.1	387		2,196,723
Power Canal Dykes	15.4	518	1,759	1,359,876
Saddle Dam	6.6	197		941,453
Spillway Embankment Dam	13.8	89		1,150,664
Intake Structure	14.8	25		1,142,946
Neives Lake Dam and Spillway	8	408		558,671
Saunders Pond Dam and Spillway	12	2,012		765,372

2.15 The Sheet Harbour Hydroelectric System

The Sheet Harbour Hydroelectric System was constructed in southeastern Nova Scotia in the 1920s. It is a system consisting of two power stations capable of producing up to 10.5 MW of electricity. As illustrated in Figure 25, seven reservoirs and associated spillways, six dams and associated wing dams and intakes, and two canals provide water to the powerhouses. There are also two fishways associated with this system.



Name	Perimeter (ft)	Surface Area (Sq mi)
Ruth Falls Flowage	55580	0.5
Marshall Falls Flowage	149225	2.01
Governor Lake	176000	2.8
Selaom Lake	85290	1.2
Anti Dam Flowage	71280	0.9

Water Control Structures and Assets
Waterbody
Watercourse

0 0.5 1 2 Km
1:50,000

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing Maps
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Sheet Harbour Hydro System
HATCH / Nova Scotia Power Inc.	Date: August 21 2018
Version: 0 / Review: TC / Figure: 3-25a	Page:

Document Path: \\IDCdata01\Reference\Maps\GIS_Data\NSPI\SheetHarbour\MXD\SheetHarbour_AllStructures.mxd

Name	Perimeter (ft)	Surface Area (Sq mi)
Ruth Falls Flowage	55580	0.5
Marshall Falls Flowage	149225	2.01
Governor Lake	176000	2.8
Selaom Lake	85290	1.2
Anti Dam Flowage	71280	0.9

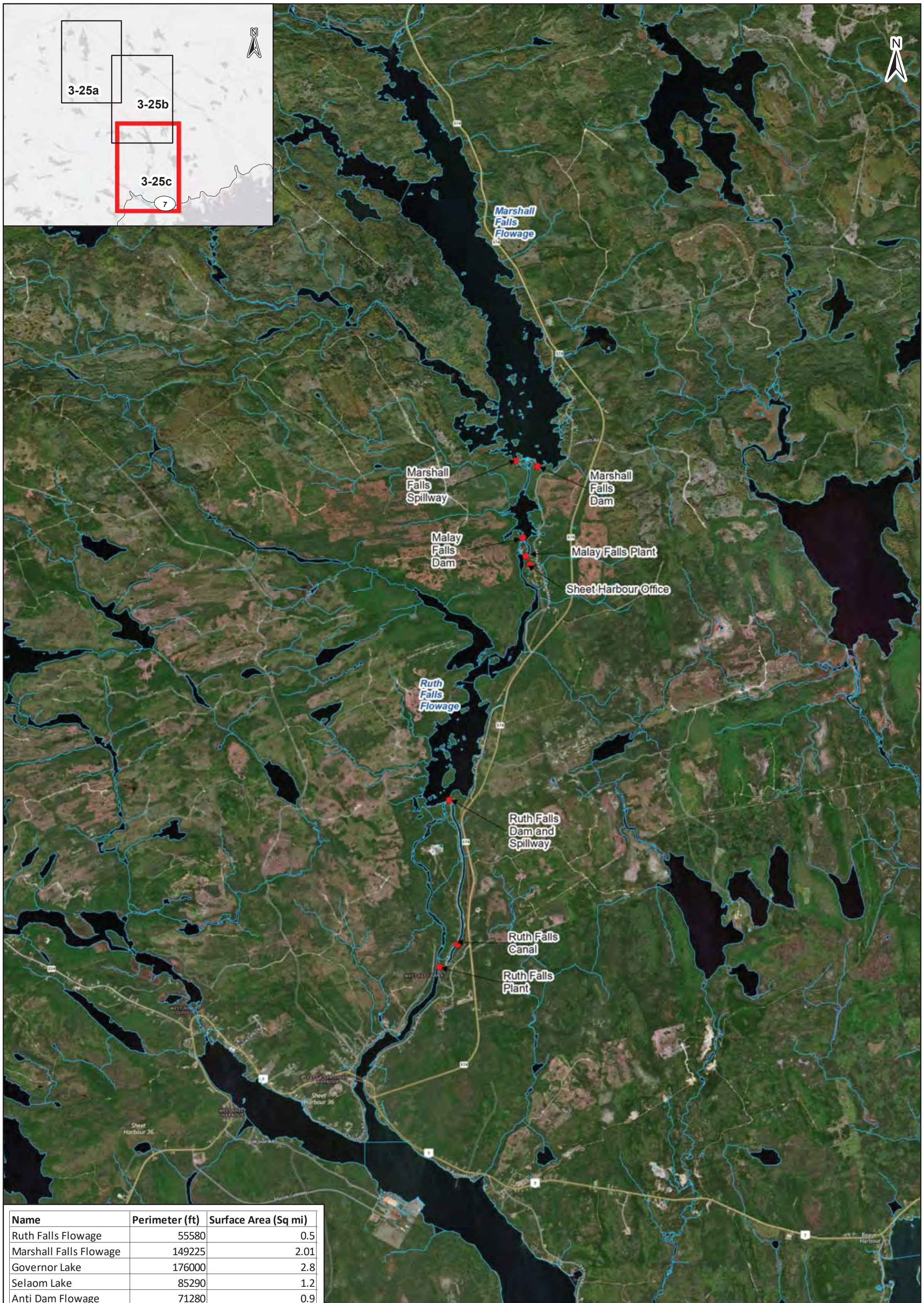
Water Control Structures and Assets
Waterbody
Watercourse

0 0.5 1 2 Km
1:50,000

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing Maps
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Sheet Harbour Hydro System**
HATCH / Nova Scotia Power Inc.	**Date: August 21 2018**
Version: 0 **Review:** TC	**Figure:** 3-25b **Page:**

Document Path: \\IDCdata01\Reference\Maps\GIS_Data\NSPI\SheetHarbour\MXD\SheetHarbour_AllStructures.mxd



Name	Perimeter (ft)	Surface Area (Sq mi)
Ruth Falls Flowage	55580	0.5
Marshall Falls Flowage	149225	2.01
Governor Lake	176000	2.8
Selaom Lake	85290	1.2
Anti Dam Flowage	71280	0.9

● Water Control Structures and Assets

Waterbody

Watercourse

0 0.5 1 2 Km

1:50,000

Data Sources:

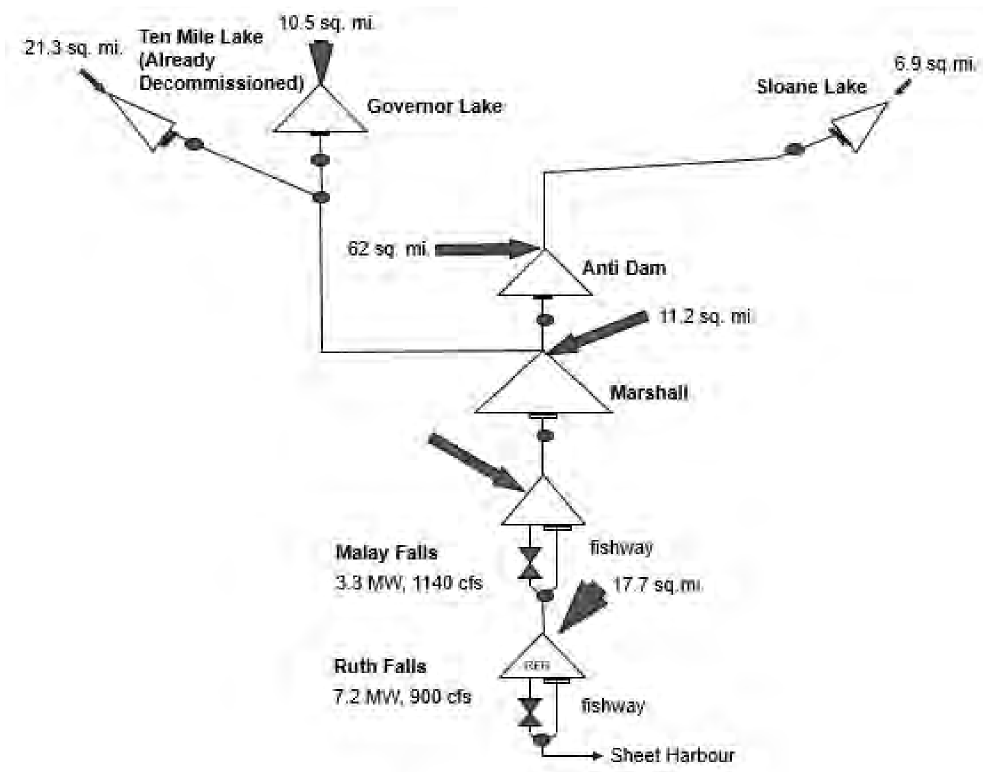
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri WMS, Bing Maps
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Sheet Harbour Hydro System
HATCH Nova Scotia Power Inc.	Date: August 21 2018
Version: 0 Review: TC	Figure: 3-25c Page:

Document Path: \\IDCdata01\Reference\Maps\GIS_Data\NSPI\SheetHarbour\MXD\SheetHarbour_AllStructures.mxd

A schematic of the system is provided in Figure 26.

Figure 26: Schematic of the Sheet Harbour Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

Details of the structures included in the assessments are listed in Table 13.

Table 12: Summary of Structures Assessed for the Sheet Harbour Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m²)	Exposed Reservoir Area (m²)
Malay Falls Main Dam and Spillway	20	578		Included
Malay Falls left and right Canal Dykes	28	1,100	5,023	n/a
Ruth Falls Main/wing dams and Spillway	32.8	1,190		2,578,145
Ruth Falls Spillway and Sluice	32.8	445		Included above
Ruth Falls Power Canal	20.3	8,000	30,795	n/a

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Marshall Falls Main Dam and Spillway	28	1,390		5,909,009
Governor Lake Dam and Spillway	10	945		2,489,016
Sloane Lake Dam and Spillway	10	2,178		1,206,183
Anti-Dam and Spillway	35	613		3,528,180

2.16 The Sissiboo Hydroelectric System

The Sissiboo Hydroelectric System was constructed in northwestern Nova Scotia from 1958 to 1961. The system consists of three power stations capable of producing up to 27.2 MW of electricity. As illustrated in Figure 27, five reservoirs and associated spillways and five dams and associated wing dams and intakes provide water to the powerhouses.

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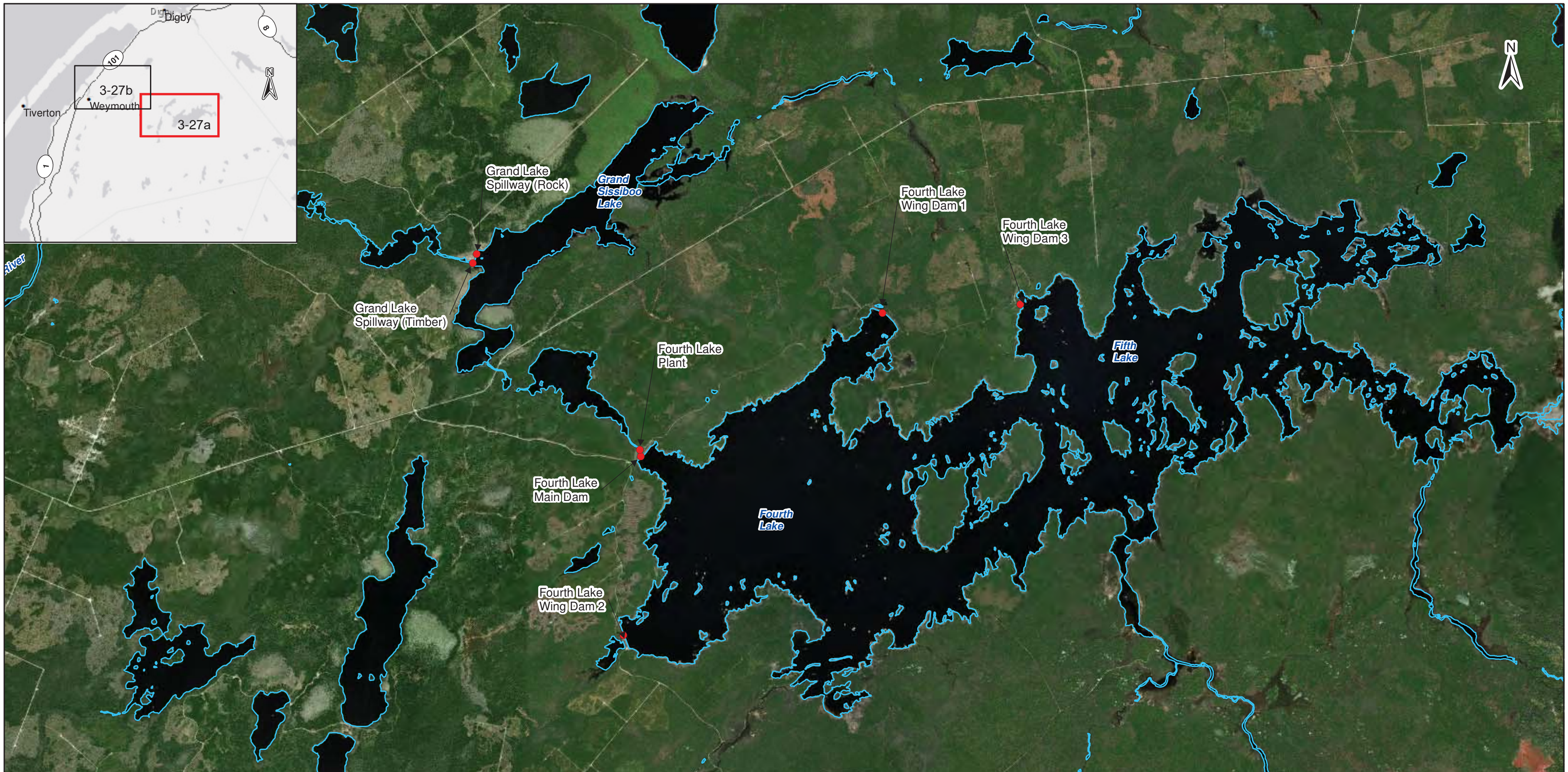


Name	Perimeter (ft)	Surface Area (Sq mi)
Fourth Lake/Fifth Lake	552720	0.5
Sissiboo Grand Lake	68290	0.97
Sissiboo Dam Headpond	58490	9.8

LEGEND

- Water Control Structures and Assets
- Waterbody

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Sissiboo Hydro System**
HATCH / Nova Scotia Power Inc.	**Date: August 09 2018**
Version: 0 / **Review:** TC	**Figure:** 3-27a / **Page:**

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Name	Perimeter (ft)	Surface Area (Sq mi)
Fourth Lake/Fifth Lake	552720	0.5
Sissiboo Grand Lake	68290	0.97
Sissiboo Dam Headpond	58490	9.8

LEGEND

- Water Control Structures and Assets
- Waterbody

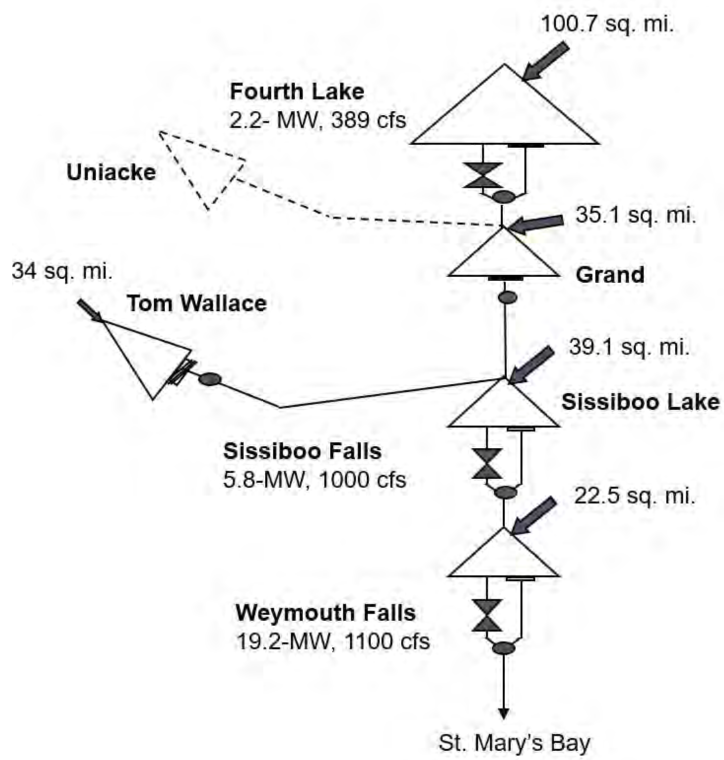
Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Sissiboo Hydro System**
HATCH Nova Scotia Power Inc.	**Date: August 09 2018**
Version: 0	**Review:** TC
Figure: 27b	**Page:**

Document Path: T:\Maps\GIS_Data\NSPI\Sissiboo\Sissiboo_AllStructures.mxd

A schematic of the system is provided in Figure 28.

Figure 28: Schematic of the Sissiboo Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management.

Details of the structures included in the assessments are listed in Table 13.

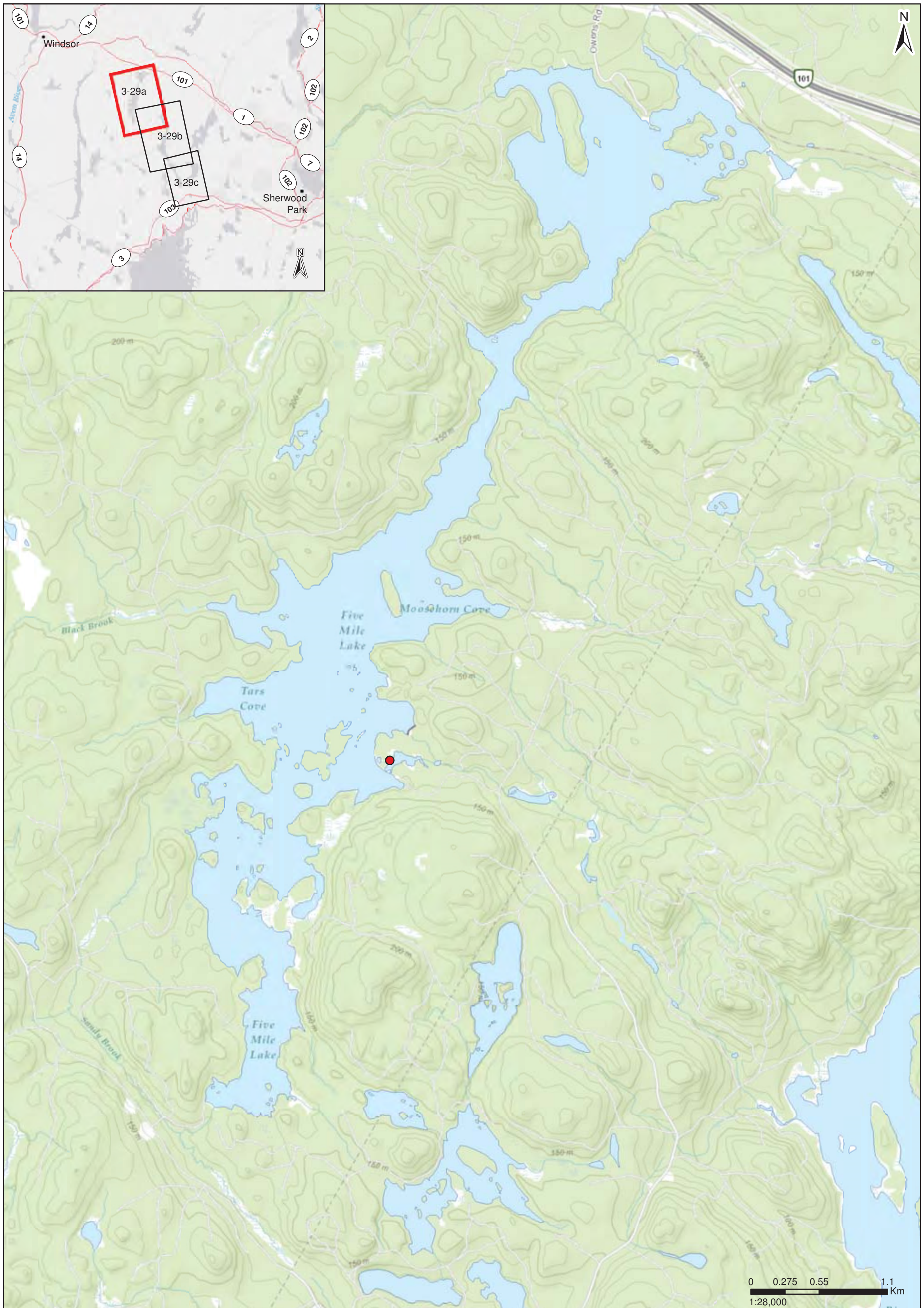
Table 13: Summary of Structures Assessed for the Sissiboo Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Fourth Lake Main Dam	75	1,450		11,724,962
Fourth Lake Wing Dam 1	37	2,000		5,784,314
Fourth Lake Wing Dam 2	60	1,680		9,386,125
Fourth Lake Wing Dam 3 and Spillway	20	865		3,128,708
Fourth Lake Musquash Dam	8	350		1,250,663
Sissiboo Grand Lake Spillway (Rockfill)	9	380		Included

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
Sissiboo Grand Lake Spillway (Timber)	15	426		
Sissiboo Grand Lake Wing Dykes	6	436		579,460
Sissiboo Falls Concrete Dam and Spillway	70	790		5,790,215
Sissiboo Falls Embankment Dam	35	1,100		Included
Weymouth Falls Main Dam	105	700		Included
Weymouth Falls Wing Dam and Spillway	105	1,026		Included
Weymouth Falls Intake Structure	30	152		Included
Tom Wallace Dam	6	173		Included

2.17 The St. Margaret's Bay Hydroelectric System

The Mersey Hydroelectric System was constructed in south-central Nova Scotia from 1917 continuing into the 1920s. It consists of three generating facilities housed in two powerhouses capable of producing up to 10.2 MW of electricity. As illustrated in Figure 29, five reservoirs and associated spillways, nine dams and associated wing dams and a cross-over structure provide water to the powerhouses.



LEGEND

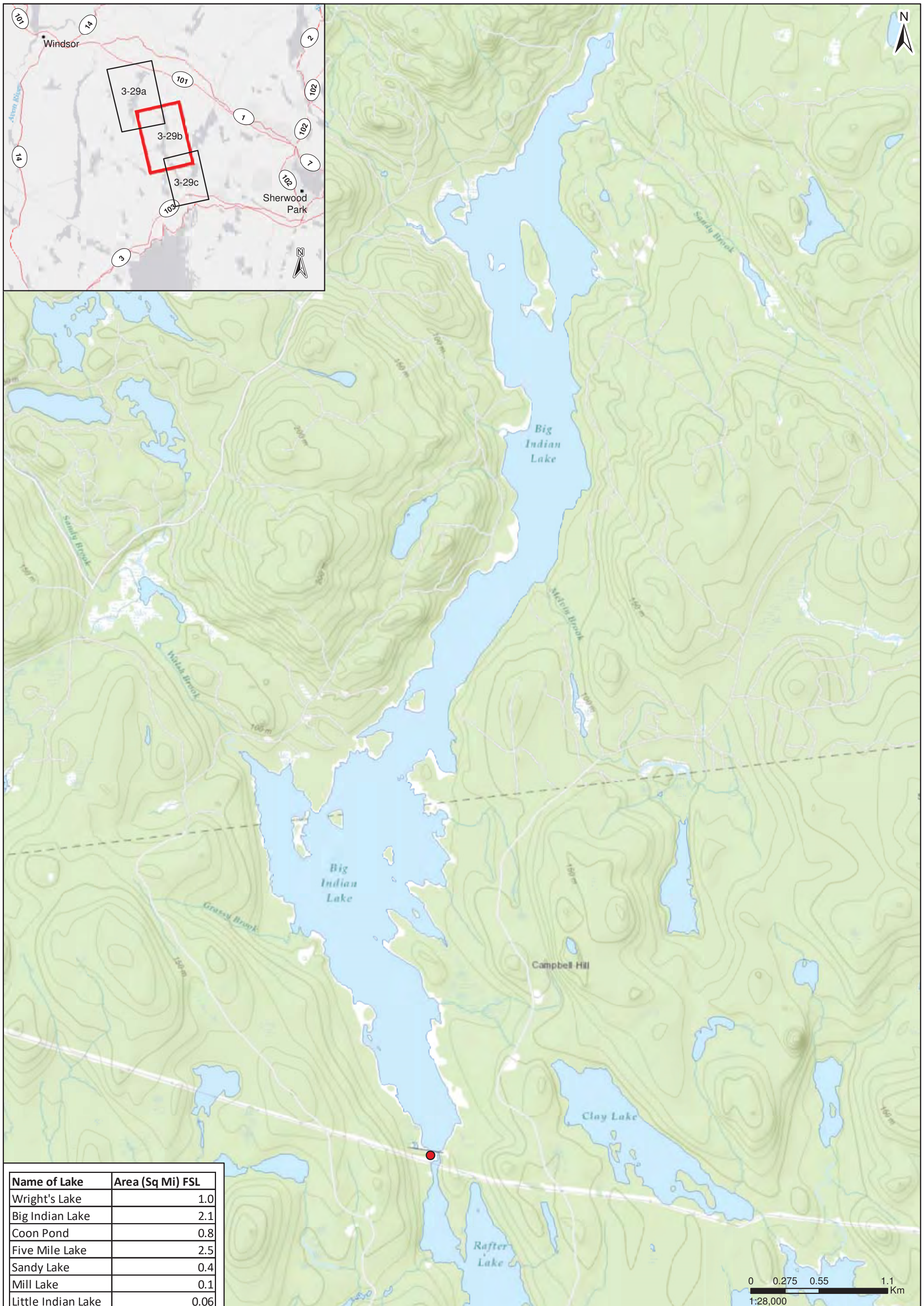
Dam Location

Waterbody

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme

Project:	Hydro System Decommissioning Cost Estimate Nova Scotia Power Inc.
Figure Title:	St. Margarets Bay Hydro System
Prepared By: HATCH	Date: August 21 2018
Version: 0 Review: MM	Figure: 3-29a Page:

Document Path: T:\Maps\GIS_Data\NSPI\StMargaretBay\MXD\St.Margarets Bay_Overall_project.mxd



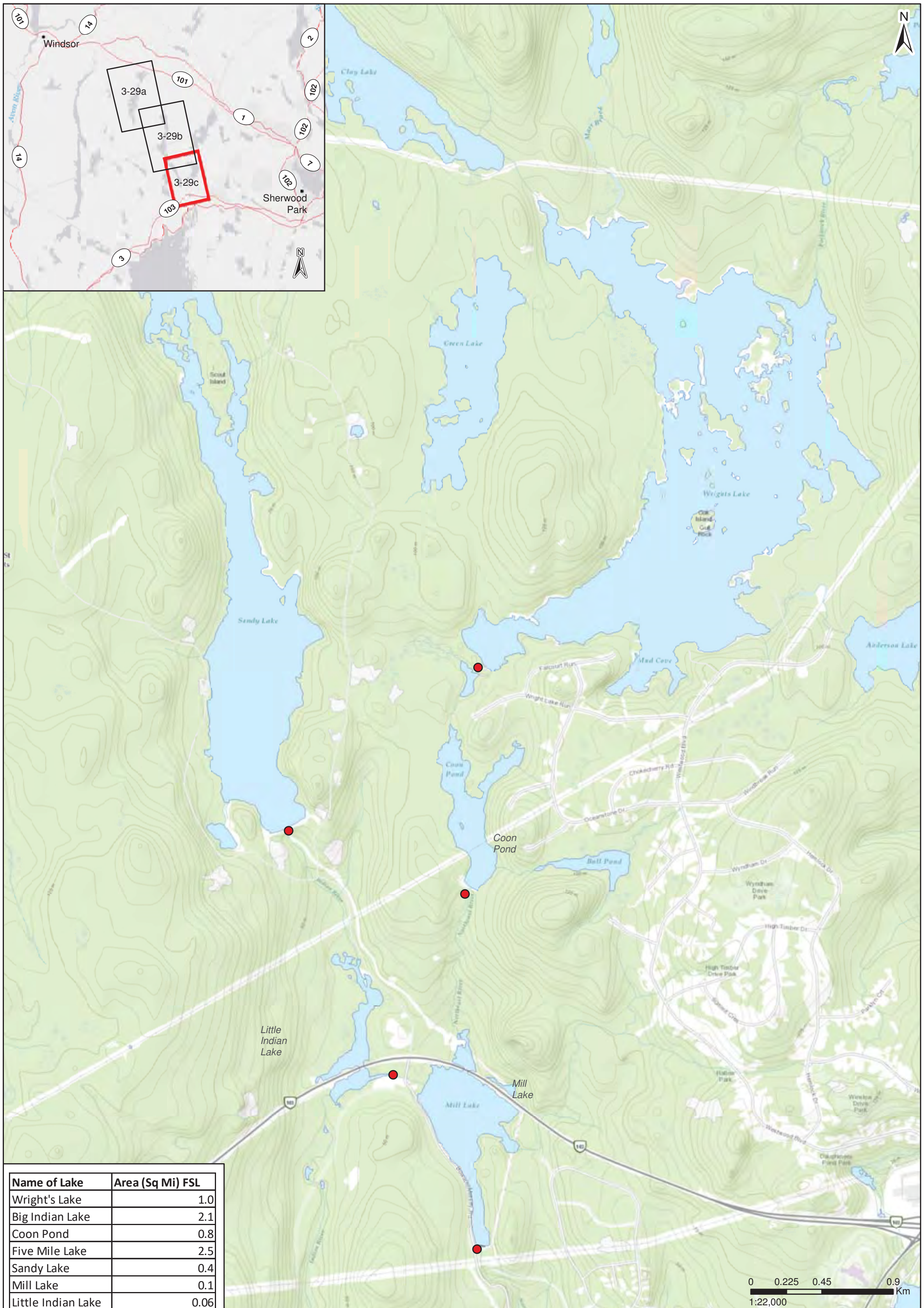
Name of Lake	Area (Sq Mi) FSL
Wright's Lake	1.0
Big Indian Lake	2.1
Coon Pond	0.8
Five Mile Lake	2.5
Sandy Lake	0.4
Mill Lake	0.1
Little Indian Lake	0.06

LEGEND

- Dam Location
- Waterbody

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme

Project:	Hydro System Decommissioning Cost Estimate Nova Scotia Power Inc.		
Figure Title:	St. Margarets Bay Hydro System		
Prepared By:	HATCH	Date:	August 21 2018
Version: 0	Review: MM	Figure: 29b	Page:



Name of Lake	Area (Sq Mi) FSL
Wright's Lake	1.0
Big Indian Lake	2.1
Coon Pond	0.8
Five Mile Lake	2.5
Sandy Lake	0.4
Mill Lake	0.1
Little Indian Lake	0.06

LEGEND

- Dam Location
- Waterbody

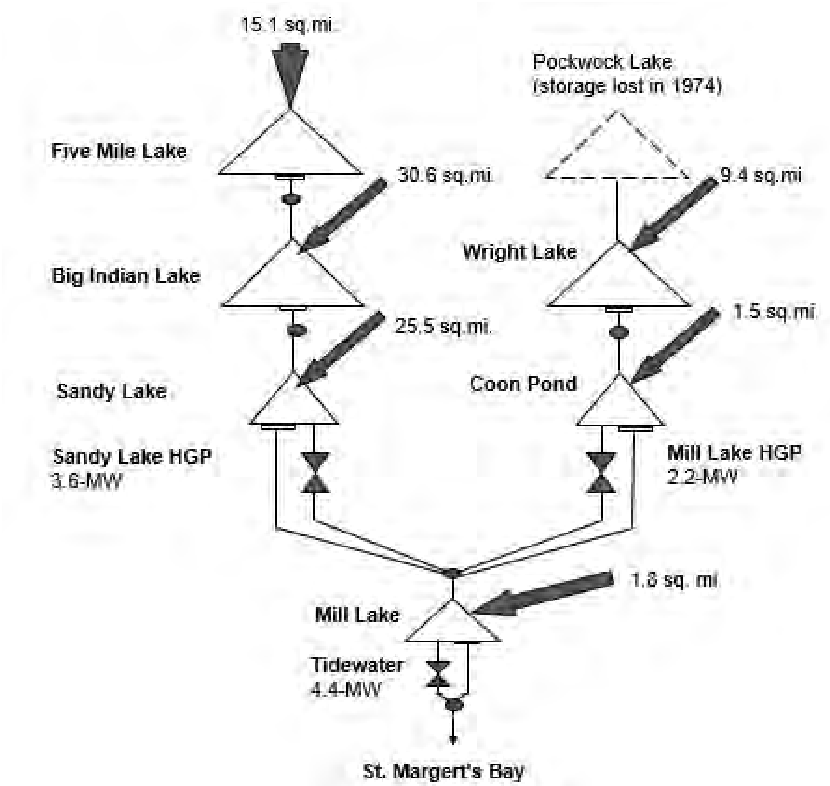
Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme

Project:	Hydro System Decommissioning Cost Estimate Nova Scotia Power Inc.
Figure Title:	St. Margarets Bay Hydro System
Prepared By:	HATCH
Date:	August 21 2018
Version:	0
Review:	MM
Figure:	29c
Page:	

Document Path: T:\Maps\GIS_Data\NSPI\StMargaretBay\MXD\St.Margarets Bay_Overall_project.mxd

A schematic of the system is provided in Figure 30.

Figure 30: Schematic of the St. Margaret's Bay Generating System



Details of the structures associated with the St. Margarets Bay system are listed in Table 14.

Table 14: Summary of Structures Associated with the St. Margaret's Bay Hydroelectric System

Structure	Height (ft.)	Length (ft.)
Coon Pond Dam and Spillway	32	408
Sandy Lake Dam and Spillway	50.5	1,021
Big Indian Spillway	25.1	430
Big Indian Main Dam (Concrete)	37.9	470
Big Indian Main Dam (Earthfill)	33.3	120
Big Indian Wing Dam No. 1	4	75
Big Indian Wing Dam No. 2	2.5	85
Five Mile Lake Main Dam	14.5	695
Mack Lake Dam	20	410
Five Mile Lake Wing Dam No. 1	6	200

Structure	Height (ft.)	Length (ft.)
Five Mile Lake Wing Dam No. 2	4	165
Five Mile Lake Wing Dam No. 3	4	105
Five Mile Lake Wing Dam No. 4	10	500
Beeswanger Dam	8	460
Wrights Lake Dam and spillway	17	326
Wrights Lake Wing Dam No. 1	4	20
Wrights Lake Wing Dam No. 2	3.5	20
Wrights Lake Wing Dam No. 3	5	35
Little Indian Lake Cross-over Control Structure	4	170
Mill Lake Dam (Tidewater)	20	830

2.18 The Tusket Hydroelectric System

The Tusket Hydroelectric System was constructed at the south-eastern tip of Nova Scotia from 1929 to 1930. It consists of a single generating station capable of producing up to 2.7 MW of electricity. As illustrated in Figure 31, four reservoirs and associated spillways, five dams and associated wing dams, and a canal provide water to the powerhouse. There are also two fishways associated with this system.

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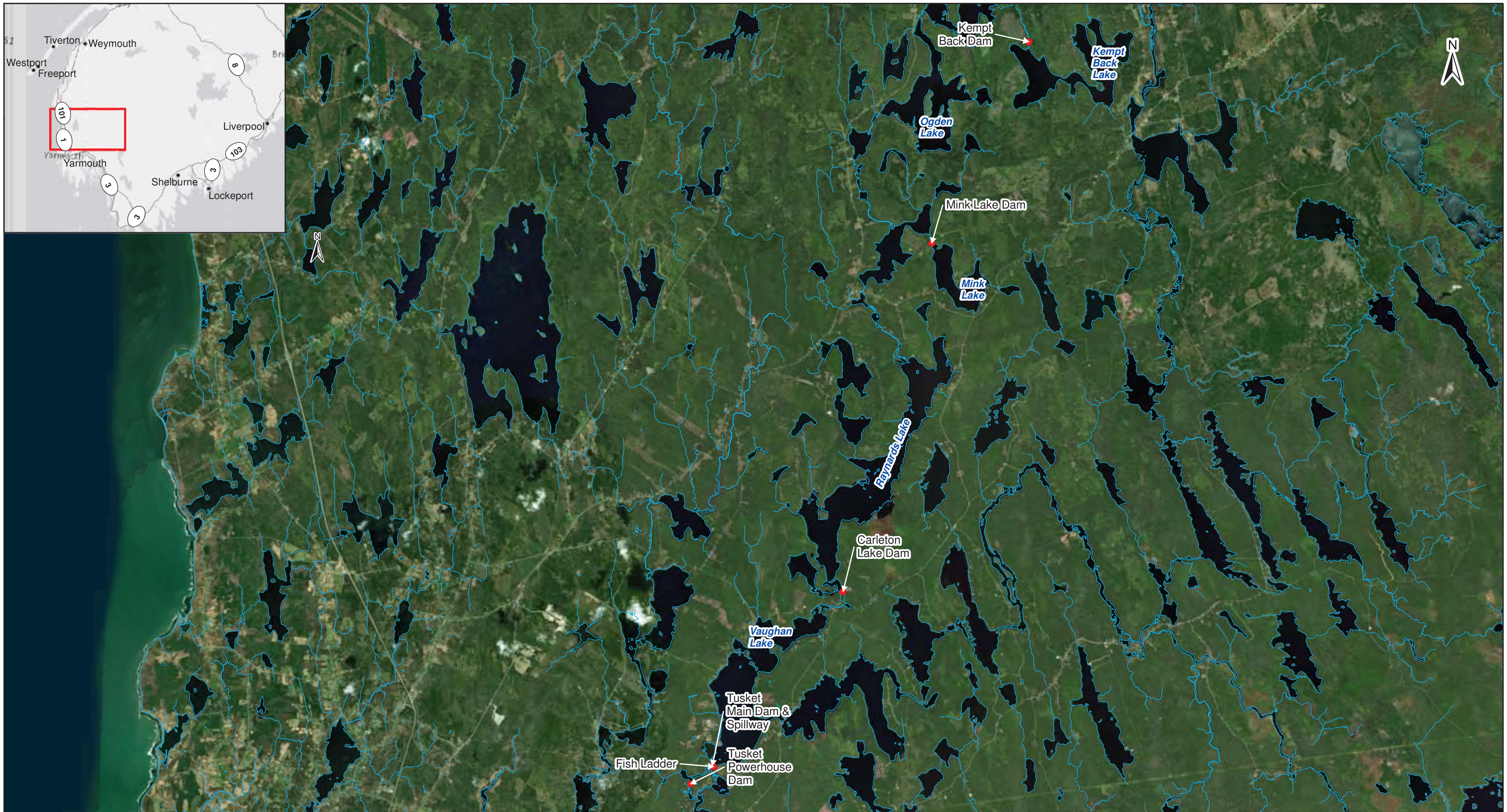


LEGEND

- Water Control Structures and Assets
- Watercourse
- Waterbody

0 1 2 4 Km
1:100,000

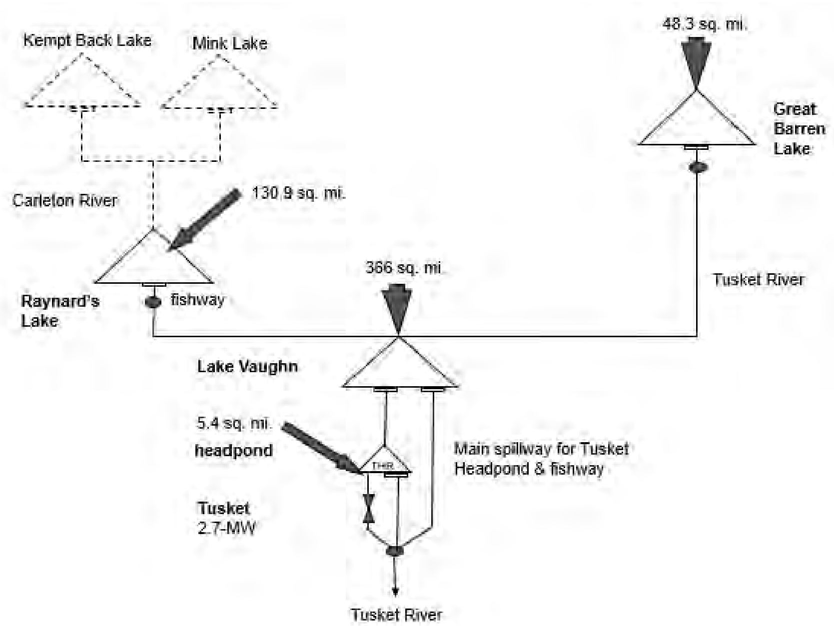
Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Tusket Hydro System**
HATCH Nova Scotia Power Inc.	**Date: August 21 2018**
Version: 0 **Review:** TC	**Figure:** 3-31 **Page:**

Document Path: T:\Maps\GIS_Data\NSPI\Tusket\MXD\Tusket.mxd

A schematic of the system is provided in Figure 32.

Figure 32: Schematic of the Tusket Generating System



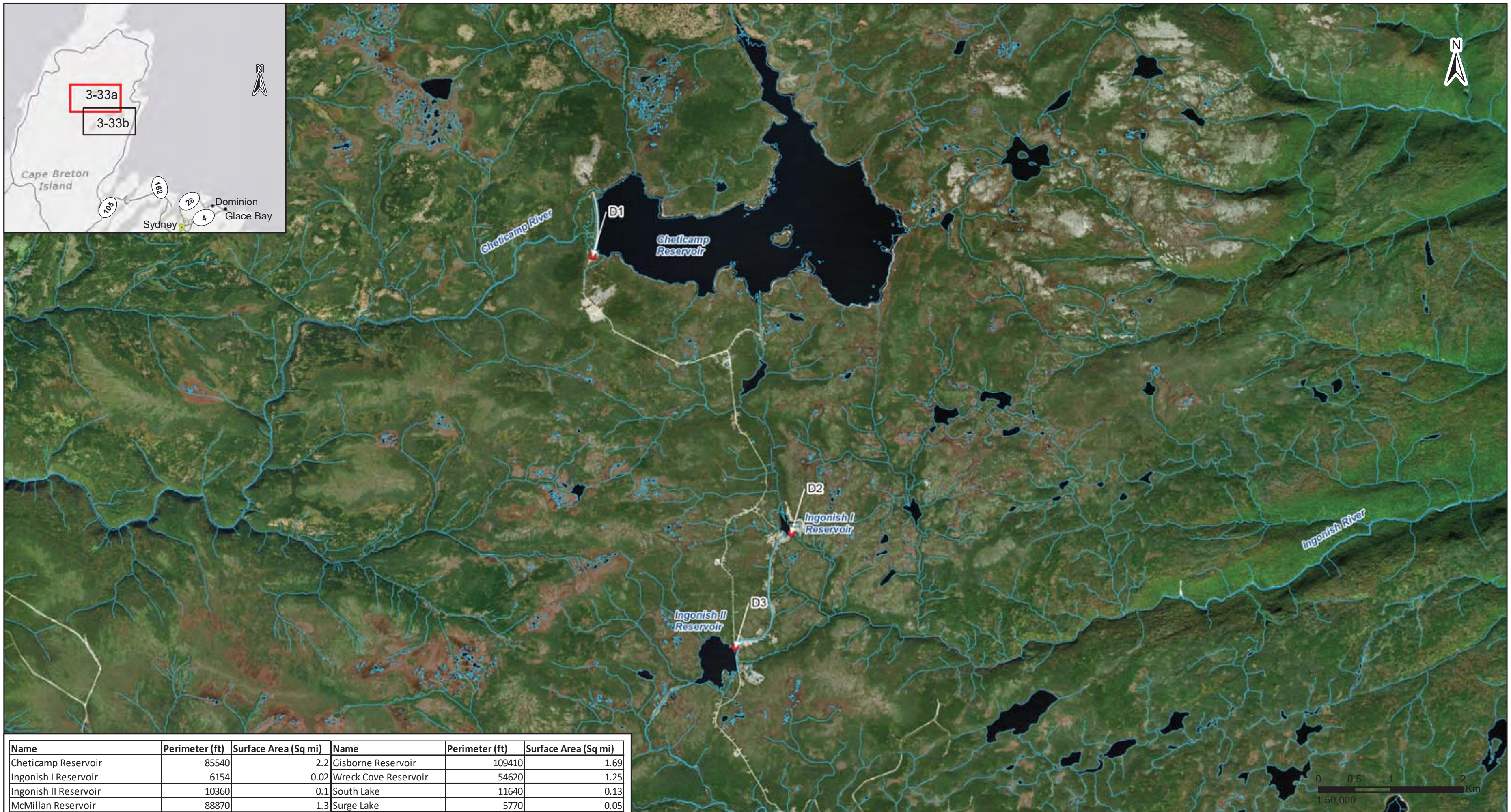
Details of the structures associated with the Tusket system are listed in Table 15.

Table 15: Summary of Structures Associated with the Tusket Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)
Tusket Main Dam and Spillway	29	226	
Tusket Powerhouse Dam	25	580	
Tusket Canal Embankment	12	2,300	7,073
Tusket Western Wing Dam	10	150	
Carleton Lake Dam and Spillway	25	1,175	
Great Barren Lake Dam and Spillway	18.8	1,196	
Mink Lake Dam/Spillway	7.8	112	

2.19 The Wreck Cove Hydroelectric System

The Wreck Cove Hydroelectric System was constructed near the north-western tip of Nova Scotia between 1975 and 1980. The system consists of two power stations capable of producing up to 223.5 MW of electricity. As illustrated in Figure 33 five reservoirs, seven spillways, eleven dams and associated wing dams and intakes, and two canals provide water to the powerhouse.



Name	Perimeter (ft)	Surface Area (Sq mi)	Name	Perimeter (ft)	Surface Area (Sq mi)
Cheticamp Reservoir	85540	2.2	Gisborne Reservoir	109410	1.69
Ingonish I Reservoir	6154	0.02	Wreck Cove Reservoir	54620	1.25
Ingonish II Reservoir	10360	0.1	South Lake	11640	0.13
McMillan Reservoir	88870	1.3	Surge Lake	5770	0.05

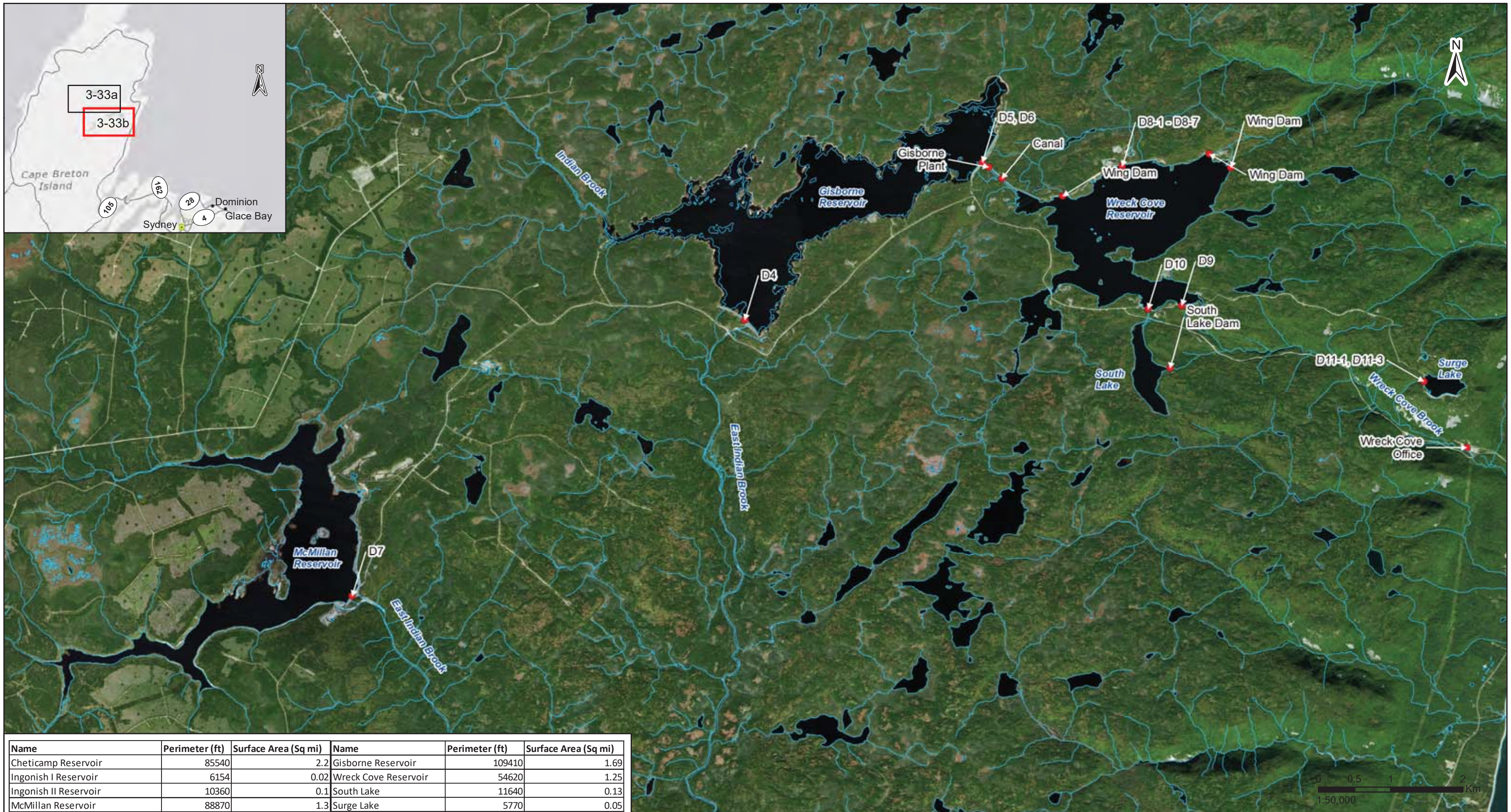
LEGEND

- Water Control Structures and Assets
- Waterbody
- Watercourse

Data Sources:
1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	Hydro System Decommissioning Cost Estimate
Figure Title:	Wreck Cove Hydro System
HATCH / Nova Scotia Power Inc.	Date: August 21 2018
Version: 0	Review: TC
Figure: 3-33a	Page:

Document Path: T:\Maps\GIS_Data\NSPI\WreckHarbour\Wreck_AllStructures.mxd



Name	Perimeter (ft)	Surface Area (Sq mi)	Name	Perimeter (ft)	Surface Area (Sq mi)
Cheticamp Reservoir	85540	2.2	Gisborne Reservoir	109410	1.69
Ingonish I Reservoir	6154	0.02	Wreck Cove Reservoir	54620	1.25
Ingonish II Reservoir	10360	0.1	South Lake	11640	0.13
McMillan Reservoir	88870	1.3	Surge Lake	5770	0.05

LEGEND

- Water Control Structures and Assets
- Waterbody
- Watercourse

Data Sources:

1. Spatial referencing UTM NAD 83 Zone 20
2. Image Sources: Esri Topo WMS, Delorme
3. Perimeter and Surface Area based on water polygons, Nova Scotia open data. Overall these perimters are larger than that shown in satellite imagery and may reflect full supply level.

Project:	**Hydro System Decommissioning Cost Estimate**
Figure Title:	**Wreck Cove Hydro System**
HATCH / Nova Scotia Power Inc.	**Date: August 21 2018**
Version: 0	**Review:** TC
Figure: 33b	**Page:**

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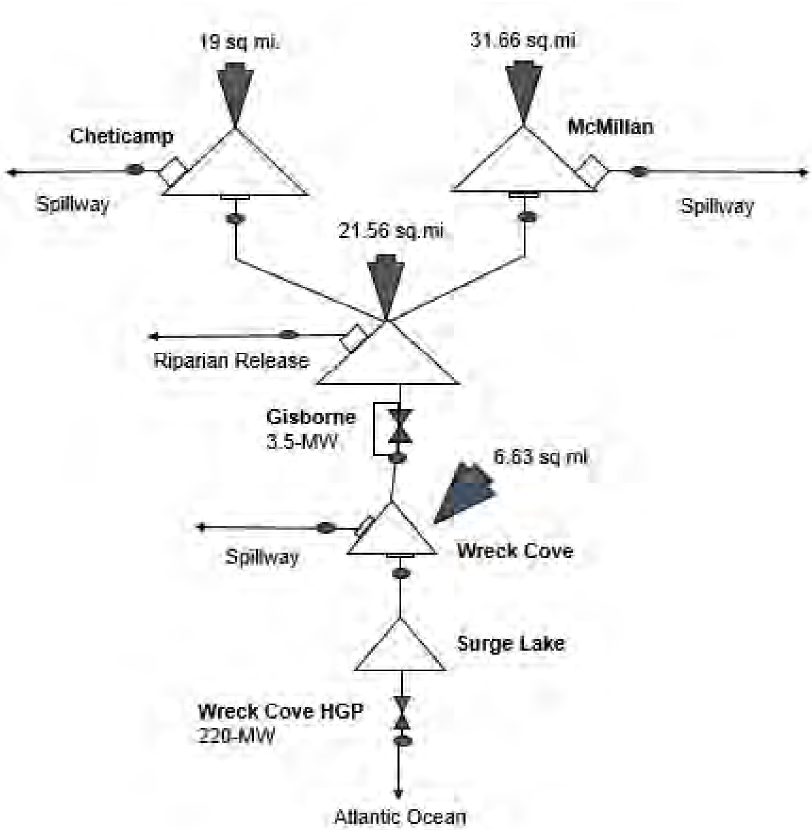
A schematic of the system is provided in Figure 34.

Figure 34: Schematic of the Wreck Cove Generating System



Decommissioning estimates for this system consisted of high level estimates of removal and environmental costs associated with the removal of the generating facilities, water retaining structures, estimates of the potential environmental assessment and remediation costs and an allowance for sediment management

Details of the structures included in the assessments are listed in Table 16.

Table 16: Summary of Structures Assessed for the Wreck Cove Hydroelectric System

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
D-1 Cheticamp Flowage and Spillway	49	3,525	22,978	
D-2 Ingonish I and Spillway	34	1,090		295,904
D-3 Ingonish II and Spillway	47	1,973		688,609
D-4 South Gisborne and Spillway	92.5	2,810		3,578,111

Structure	Height (ft.)	Length (ft.)	Exposed Canal Area (m^2)	Exposed Reservoir Area (m^2)
D-5 East Gisborne	43	1,395		1,663,338
D-6-1 McLeod Brook	72	1,609		2,785,124
D-6-2	10	1,200		386,823
D-7 McMillian Flowage and Spillway	170	1,995	35,434	NA
D-8-1 Wreck Cove Lakes	30	2,412		257,481
D-8-2	11.2	857		96,126
D-8-3	9.8	983		84,111
D-8-4	20	1,166		171,654
D-8-5	30.8	1,536		264,347
D-8-6	22	620		188,820
D-8-7	9.8	341		84,111
D-9 Wreck Cove Brook and Spillway	51.8	861		444,584
D-10 Long Lake	33.1	1,170		284,088
D-11-1 Surge Lake	76.1	611		206,992
D-11-2	44	1,594		119,680
D-11-3	17.1	145		46,512
South Lake Dam and Spillway	12.1	292		199,183

2.20 Decommissioned Reservoir and Canal Areas

The estimates of the area of newly exposed reservoirs that would occur in the event that the systems were decommissioned were estimated using GIS based web map service imagery that provided a high-level indication of the amount of exposure based on the height of the dam impounding the reservoir.

Canal exposure following decommissioning was based on the height of canal and a high level assumption for the purposes of the Class 5 cost estimate of 3H:1V slopes and a 20-foot wide base.

3. Cost Estimates

3.1 Dam Decommissioning Risks

Any dam decommissioning that involves the restoration of the systems to natural free-flowing conditions that existed prior to the development of the hydro system is a complex and expensive undertaking. Consideration needs to be taken not only of the required construction activities but also a wide range of environmental considerations. Failure to account for these important factors can lead to significant adverse downstream effects that can persist for many years after construction.

The estimates performed as part of this assignment are based on precedent experience or more comprehensive assessments that Hatch has performed previously. In either case, the estimates account for infrastructure removal and environmental costs. However, as is discussed in Section 4, any decommissioning project also carries with it sediment management risks that can amount to significant additional costs.

A review of various dam removal case histories indicates that the mitigation measures used to reduce the effects of dam removal may include: sequencing the reservoir drawdown over several months or years; complete or partial removal of the sediment behind the dam by dredging and/or excavation; placing and stabilizing the sediment on the dewatered floodplain followed grading and compaction; and, seeding and planting of shrubs and trees. If these types of measures are not implemented, or impacts not properly assessed, there can be significant long-term adverse downstream effects, for many years after the dam is removed. Table 17 provides a summary of reported long term adverse effects following dam decommissioning that was compiled (3) (4).

Table 17: Mitigation Measures and Reported Post Removal Problems for Some Precedent Dam Decommissioning Projects

Dam	Date Removed	Height (ft)	Mitigation Techniques Attempted, Problems Reported
Willow Falls, Wisconsin	1992	18	Significant post removal sediment transport degraded fishery Additional dredging planned.
Mounds, Wisconsin	1998	18	Seeding, Channel stabilization. Post removal sediment transport degraded fishery. Additional dredging planned.
Woolen Mills, Wisconsin	1988	5.5	Slow drawdown to allow low flow channel to form and seeding. Habitat improved 5 years after removal.
Fort Edward, New York	1973	9.4	2600 m^3 (approx..) sediment dredged during removal. By 1976, over 470,000 m^3 of sediments dredged to maintain navigation, including 140 000 m^3 of sediments dredged to maintain navigation, including 140 000 m^3 of PCB contaminated materials.
Sweasey, California	1970	16,8	Reservoir lowered slowly to allow low flow channel to develop. Sediment transport problems for 2 years after removal.

Dam	Date Removed	Height (ft)	Mitigation Techniques Attempted, Problems Reported
Nolichucky, Tennessee	1973	29	Dam partially left in place to retain sediments. Significant sediment transport problems occurred over 2-yr period.
Newaggo, Michigan	1969	20	Removal produced a wave of sediment extending five miles downstream. 500 000 m^3 of sediment expected to move down river for 50 to 80 years.
Sandstone, Minnesota	1995	6.1	Sediments could wash downstream causing problems.
Welch, Minnesota	1994	2.7	Significant non-toxic sediment in reservoir allowed to wash downstream.
Mussels, Pennsylvania	1992	9.4	760 000 m^3 of non-hazardous silt in the reservoir. Sediment mitigation involved staged drawdown and stilt trap construction. 57000 m^3 (est.) silt discharged after removal.
Fulton, Wisconsin	1993	NR	Sediment mitigation involved silt trap construction, dredging riverbank stabilization. Post removal sediment problems affected fish habitat for 5-km d/s. Expected to abate in 5 years.
Prairie Dells, Wisconsin	1991	18.3	Sediment mitigation measures involved sediment trap construction and controlled drawdown over two years. Two years after removal, 30 000 m^3 of sediment excavated from trap. Ongoing turbid events have had negative impact on fisher. Expected to continue for five years.

These case histories indicate that the most common mitigation measures used to reduce the impacts of dam removal (silt trap construction, dredging, shore line stabilization, channel design and staged removal) were not always successful, leading to significant long-term issues and remediation costs. It is therefore necessary and prudent to factor these costs into any decommissioning scenario to obtain an estimation of the total decommissioning costs.

With these limitations in mind, estimated infrastructure removal and environmental costs have been developed based on Hatch's understanding of the conditions at these sites. However, to account for the level of engineering performed to date, a contingency of 50% forms part of the total estimated costs in addition to the uncertainties associated with a Class 5 cost estimate. Sediment management costs have also been estimated based on precedent experience and the characteristics of the reservoirs (where known).

3.2 Infrastructure Removal Costs

3.2.1 General Description

Removal of the dams and the power generating facilities involve dismantling, demolition, and disposal of water impoundment structures to an extent that the sites are returned to an acceptable and practicable level of naturalization to approximate preconstruction conditions. In general, this entailed revoval of the infrastructure, planting grasses and shrubs to re-vegetate newly exposed reservoir/river banks and allowances for slope stabilization. The actual requirements can only be established following detailed studies. However, adequate allowance are considered to be available in the project contingencies to cover this work.

3.2.2 Estimate Methodology

eThe cost estimates provided herein are considered Class 5 – Concept screening. Class 5 estimates generally use stochastic estimating methods such as cost/capacity curves and factors, historical data and other parametric and modelling techniques. Class 5 estimates are prepared for business planning purposes and high-level budgeting.

Typical accuracy range for a Class 5 estimate is -50% and +100%.

For the current study, the cost estimates have been prepared without the benefit of a dam removal plan (i.e. construction methodology), and other detailed data during this preliminary stage of project evaluation. In many cases the costs have been derived on the basis of precedent experience adjusted for any peculiarities of the system such as ling canals, multiple reservoirs and long dams or other items that may impact cost.

3.2.3 Direct Costs – Comprehensive Estimates

The methodology for the Class 5 estimates that was performed for the facilities listed in Section 2 is described in the reports prepared for each of these systems as listed in the reference section of this report. For these sites, the direct cost was defined as the cost for the dismantle/removal/disposal of equipment, demolition/removal of structures, as well as the provision for site access improvements and site reinstatement.

The methodology used (as applicable) was as follows:

- Access Roads

  Costs were developed based on preliminary road lengths that were scaled out of Google earth. These costs are assumed to cover any clearing required as well as road maintenance for the duration of construction.

- Cofferdams and Dewatering

  In general, it was assumed all dams, spillways and overflows would be removed in the wet. Therefore, for most facilities, no costs were assumed for cofferdams and dewatering. In the precedent estimates, some allowances for control of water would have been included in the reported costs. In the previous Class 5 estimates performed by Hatch, cofferdams and dewatering costs were included as was considered to be required.

- Demolition of Embankment Dams

  Material take-offs were developed for fill quantities based on drawings provided by NSPI or drawings in-house from previous NSPI projects. No offsite disposal was assumed for fill material.

- Demolition of Concrete Overflows/Spillways and Dams

  Material take-offs were developed for concrete quantities based on drawings provided by NSPI or drawings in-house from previous NSPI projects. Any gate houses were scaled out of google earth and demolition was assumed on a square foot basis. No offsite disposal was assumed for concrete.

- Pipeline Demolition

  Pipeline and penstock lengths were derived from drawings if they were available. If drawings were not available, lengths were scaled out of Google earth. Demolition costs were based on historical NSPI projects.

- Surge Tank Demolition

  Surge tank demolition was based as a lump sum item and costs were developed based on historical NSPI surge tank demolition projects.

- Powerhouse Demolition

  The subsurface concrete quantities for powerhouse demolition were factored based on similar subsurface powerhouses from in-house Hatch data. Little powerhouse data was available. Therefore, square footage was scaled out of Google earth and demolition was based on a square foot basis. No salvage values were applied for mechanical and electrical equipment.

- Engineering and Owners Costs

  These were estimated on the basis of a percentage of the total construction cost based on Hatch’s experience with typical construction and decommissioning projects. This includes costs for the owners management staff and the costs to yndertake the engineering needed to tender the project as well as to oversee implementation.

- Site Restoration

  After dam demolition, exposed shoreline is anticipated to require shaping, grading and hydroseeding in various locations. Quantities were developed using GIS and data available from provincial government datasets that include lake polygons and high-resolution elevation data. A surface was developed from the elevation data and contours created. The water level elevation after dam removal was estimated and plotted and the area and perimeter of exposed shoreline calculated. Costs were based on an average length for the overall perimeter of each site.

- Indirect Costs

  Construction indirect costs for all sites are factored as a percentage of the total direct costs and are intended to cover items such as supervisory/site staff and expenses, mobilization/demobilization, temporary site facilities, and site services expenses. It was assumed labor is local; therefore, no provisions for meals and accommodations for workers was accounted for in the estimate.

- Contingencies

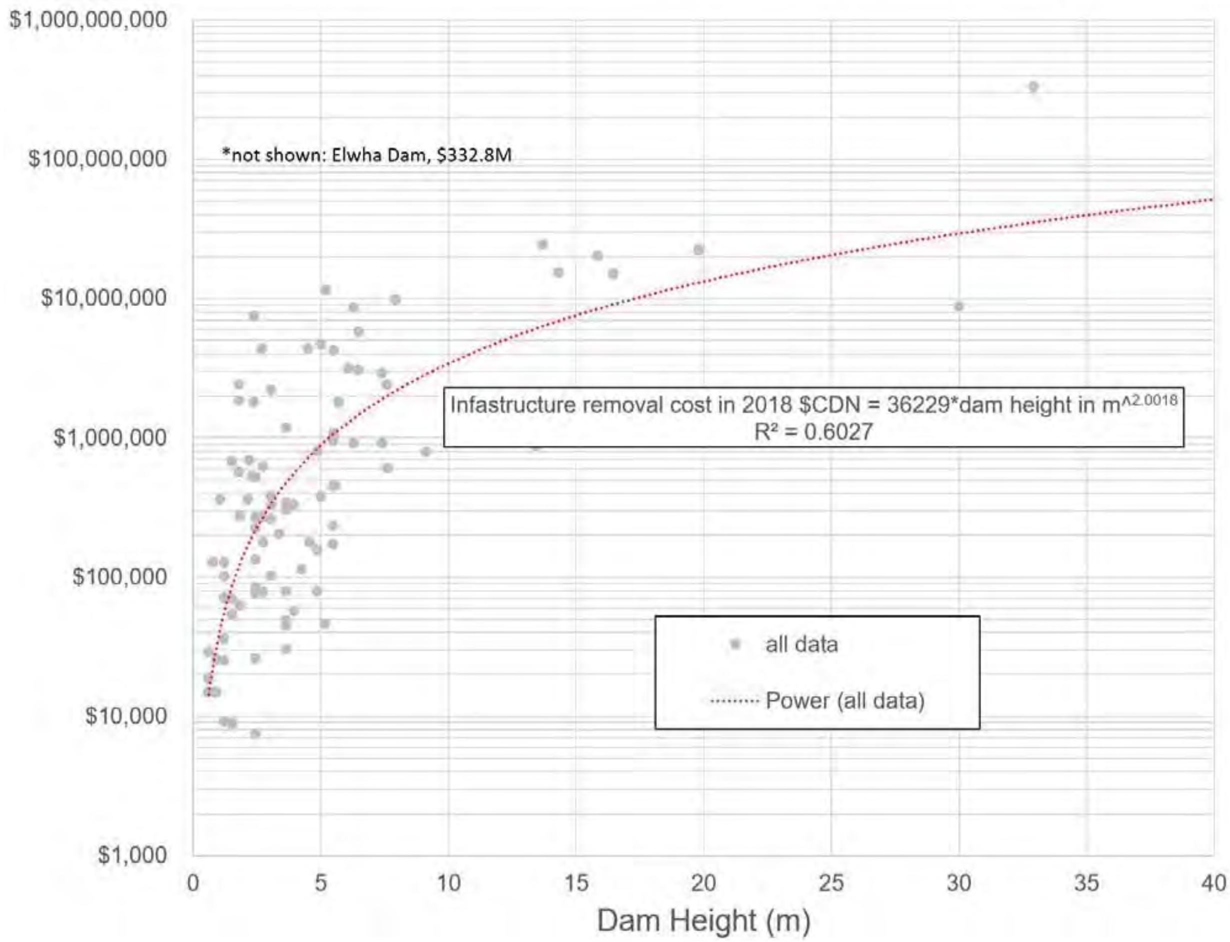
  Contingencies are included in the estimates to provide for costs which cannot be specifically identified at the time of estimate preparation, but which can be foreseen with varying degrees of probability throughout the life of the project – i.e., contingencies are costs that are expected to be incurred. They are an assessment of risk exposure due to factors such as quantity growth, weather constraints, and uncertainties in labour and productivity. Due to the high level of uncertainty associated with lack of project definition and the limited engineering that has been performed to date a contingency of 50% has been included in the total cost estimate in accordance with AACE rguidelines with the exception of the St. Margarets Systems were the level of engineering performed permitted the selection of a 30% contingency.

3.2.4 Direct Costs Based on Precedent Experience

For the remaining systems, infrastructure removal costs were estimated based on actual or estimated infrastructure removal costs for over 100 case examples, escalated as appropriate to 2018 $CDN (5). Details of these precedent infrastructure removal costs are shown in Figure 35 which shows a reasonable relationship between the cost of dam or dam/powerhouse removal net of environmental and sediment management costs and the height of the structure. Typically, the maximum height of the structure was typically used. However, for longer dams in excess of 750 m, the mean height was selected as being more representative of the benchmark data. It was also assumed that, for longer dams, the increased volume of fill would result in reduced unit prices. Based on an assumed average length in the order of 300 m for the benchmark case examples, infrastructure removal costs were adjusted downwards in accordance with the following criteria:

- Dams up to 300m long : zero reduction.
- Dams 300 to 600 long : 20% volume discount.
- Dams 600 to 1000m long : 30% volume discount.
- Dams in excess of 1000 m long : 30% volume discount:

Figure 35: Relationship of Infrastructure Removal Costs with Structure Height



The estimates were then adjusted to include engineering and owner's costs based on a percentage of the construction costs. In the case of facilities with canals, an additional cost was included for remediation of the exposed canal slopes based on a high level estimate of the area that would be exposed following decommissioning. It was assumed that the canals would not be backfilled but rather re-vegetated[2].

In the case of dams that were associated with powerhouses, the precedent costs include the cost of powerhouse removal, and associated structures such as switchyards and powerhouse equipment (including allowances for salvage) were assumed to be already included in the

[2] Re-vegetation means planting grasses and native shrubs as necessary to stabilize and return newly exposed shorelines to a state approximateing natural pre-construction conditions.

precedent costs for infrastructure removal. In the case where facilities had surge tanks or long penstocks, a separate allowance was added to the precedent costs.

The adjusted precedent costs were assumed to include adequate allowances for the following items:

- Access Roads
- Demolition and Disposal
- Indirect Costs
- Contingencies

3.2.5 *Summary of Estimated Infrastructure Removal Costs*

The infrastructure removal costs for each of the structures in NSPI's hydroelectric portfolio are summarized in Table 18. Details of the estimates by structure are provided in Appendix A. These estimates exclude environmental costs, archaeological costs, and socio-economic costs, which are described in Section 3.3. Exclusions are noted below the table. All costs presented in this report are in 2018 Canadian dollars.

Table 18: Estimated Infrastructure Removal Costs

Item						
System	Number					Cost ($2018 CDN)
	Dams	Spillway/Intakes	Canals	Powerhouse	Fishways	
Annapolis	0	1	0	1	1	22,065,000
Avon	8	4	2	2	0	10,571,000
Bear River	9	3	1	2	0	20,780,000
Black River	22	10	3	4	2	58,108,000
Dickie Brook	5	3	1	1	0	7,550,000
Fall River	4	2	0	1	0	531,000
Harmony	2	2	0	1	1	3,791,756
Lequille	6	3	2	1	0	5,532,000
Mersey	33	17	3	6	3	83,378,000
Nictaux	8	5	1	1	0	11,849,000
Paradise	7	3	0	1	0	5,715,000
Roseway	4	3	1	1	1	3,828,061
Sheet Harbour	6	6	2	2	2	12,410,000
Sissiboo	10	5	0	2	0	61,978,000
St. Margaret's Bay	19	8	0	3	0	25,465,000

Item						
System	Number					Cost ($2018 CDN)
	Dams	Spillway/Intakes	Canals	Powerhouse	Fishways	
Tusket	7	3	1	1	1	18,990,000
Wreck Cove	21	5	0	2	0	124,192,000
Total	**150**	**78**	**17**	**30**	**11**	**476,733,817**

Exclusions

The following costs are not included in the capital cost estimate:

- Taxes and duties.
- Unexpected site conditions.
- Unidentified ground conditions.
- Development fees and approval costs of Statutory Authorities.
- Working capital.
- Permits.
- Event risk.
- Financing costs.
- Costs driven by revisions/changes to laws and regulations Soil decontamination and disposal costs.
- Land Ownership - compensation to land owners related to depreciated land values and altered uses.
- Lost or altered recreational uses.
- Loss of revenue to local businesses.
- Protection and/or moving cultural heritage sites.
- Removal/reinstatement of transmission lines or any work needed on the grid from the switchyard poles.
- Escalation.

3.3 Environmental Considerations and Costs

Environmental costs were based on an assessment of the various studies and consultations that would be needed to quantify the various environmental considerations associated with a dam decommissioning project.

Environmental considerations that would need to be studied were similar for each of the structures/systems. However, the relative contribution of each consideration and threrfore the scope of the required studies varied among sites. The main considerations that were used to derive environmental sensitivity/importance for the development of the environmental cost matrix included

- dam size
- associated fisheries
- indigenous community/stakeholder interest
- recreational use
- sediment management
- flood reduction.

These considerations impact the level of study and consultation that would be needed to undertake the environmental assessment portion of the decommissioning project. The actual costs to implement the considerations are not included in the costs estimates.

3.3.1 Dam Size

Dam height and resulting reservoir volume and surface area were considered as key factors in developing the costs. For each of the reservoirs involved, a series of field studies would be required to obtain baseline information as part of the environmental assessment process. The effort (with associated costs) required to conduct field assessments such as water and sediment sampling, fish community and habitat studies increases with the size of the reservoir. Reservoirs formed by dams slow the flow of water and trap sediment behind the dam. Larger volume reservoirs may be considered as having a higher potential for accumulated sediments (dependent on type of geology in area). Larger surface areas may also lead to a higher number of different types of habitat which may require more detailed habitat and impact assessments, thus increasing cost.

The removal of each of the dams will result in a lowering of the corresponding lake by the approximate dam height. The results of this will vary. Some reservoirs will remain a lake, with a reduction in surface area and volume. Others may have a more significant change in the morphology of the water courses, with the creation of ponds and larger stretches of river in the area presently occupied by the lakes. The lowering of the water levels would lead to a reduction in wetted area and subsequent loss of wetland areas. The lowered storage capacity and retention capability is expected to reduce the lake storage attenuation effect to inflows, resulting in some degree of increase in peak flood flows. Exposed substrate may be prone to erosion, depending on its composition.

3.3.1.1 Effects on Flow Velocities

It is anticipated that there will be a general increase in velocities along certain portions of the rivers. The anticipated increase in velocities would be the result of the increased peak flows, combined with the reduced cross-sectional flow area due to the lower water levels following removal of the dams. Such velocity increases would be expected to result in increased potential for erosion and transport of previously deposited sediments from within the former head ponds as well as potential channel and bank erosion in other susceptible areas until the river's sediment transport regime reaches equilibrium.

3.3.2 Associated Fisheries

The potential impacts on the fish species and any fisheries on the reservoir and/or associated rivers will need to be considered in the removal of the water retentions structures.

The lowering of water levels and altered flow regimes will result in physical alteration to the aquatic environment, which is turn could affect fish and aquatic habitat areas (e.g., benthic invertebrate production, feeding, breeding, spawning and fry-rearing) important for sustaining critical lifecycle processes. In addition, increases in suspended sediment in the water column can degrade water quality (e.g., increased turbidity, decreased oxygen, reduce light penetration) that can result in fish mortality or injury (due to gill clogging and abrasion), physiological effects (e.g., reduced fish growth) and altered behavioral patterns (e.g., movement and migration). The lowered water level of each of the lakes will result in a reduction in lake habitat and fish which prefer lake habitat as the waterbodies are transformed back to their pre-dam condition.

The presence of commercial, recreational or Aboriginal fisheries on the reservoirs or associated river(s) would lead to the involvement of the Department of Fisheries and Oceans Canada (DFO) and the need for Fisheries Act Authorizations. Consultation with DFO to determine the required level of investigation would be required. The possible need for localized habitat restoration/offsetting measures (e.g., substrate placement, riparian planting, erosion protection) would also impact associated costs. To develop a complete understanding of the potential effects on the natural environment and ecological processes, and to identify required mitigation measures and restoration works necessary to prepare accurate cost estimates, the completion of various studies would be required. Such studies would include multi-season/multi-year field programs to collect baseline data on aquatic species (e.g., fish and benthic invertebrates), aquatic habitat mapping (e.g., spawning), water quality.

Along the river reaches, the lowered water levels will result in a potential decrease of fish and aquatic habitat. The restoration of the natural flow regime in the river, including biochemical, sediment and nutrient transport processes, and the removal of barriers to fish movement, is expected to be beneficial to the ecosystem health of the river. However, it is assumed that some localized enhancement/restoration works would be implemented at various locations along the downstream river reaches. Such measures could include: the placement of rock and other in-water structures (where appropriate) to provide fish habitat (e.g., spawning and rearing areas); water quality enhancement (e.g., aeration) through creation of pools and riffles; and installation of live crib walls, large woody debris and brush layers to provide additional habitat diversity.

The presence of listed fish species in the system could potentially impact the decommissioning costs as well as schedule. Typically, listed species require more detailed assessments than unlisted ones and compensation negotiations and implementation tend to lengthier and more expensive.

3.3.3 Indigenous Community/Stakeholder Interest

The degree of stakeholder or Indigenous Community interest in the dam decommissioning can have a considerable impact on the associated costs. The archaeological importance or built heritage that may be associated with any of the structures may lead to protracted consultation during the environmental assessment process and longer and/or more detailed post-removal monitoring. In the instances where stakeholders and/or indigenous communities have established associations (fishing, residences etc) with the reservoir or river close to the dam, there may be significant resistance to proposed changes. Facilities may also have unique features which have led to different groups developing an interest in them. This may impact consultation efforts during EA and construction phases of decommissioning, thus affecting cost.

Many of the reservoirs have considerable potential archaeological value. Decommissioning of the dams would be expected to attract considerable archaeological interest. Monitoring by an archaeologist of the exposed shorelines during the drawdown process in order to study and document any recovery of exposed artifacts would be expected to be required. Costs associated with archaeological assessments and activities are not included in this cost estimate, as these are being developed on behalf of NSPI by other parties.

Cost estimates developed during this exercise include stakeholder and indigenous community engagement and consultation activities that would typically be included in an EA process. There are additional potential costs such as treaty-related compensation or stakeholder remunerations. These are not considered as typical costs and are not included in the estimates derived and noted in this report.

3.3.4 Recreational Usage

Recreational use varies in intensity across the systems and there is some degree of recreational use at all except the most remote of the reservoirs. Impacts to fishing, boating and camping, as well as seasonal residence all would need to be considered during decommissioning EAs. removal of the structures and consequent lowering of water levels would either reduce or eliminate the area’s capacity to accommodate some or all of these activities. The degree of impact would need to be assessed through site-specific studies. Studies may include additional socio-economic and additional cost (beyond typical EA costs) could include compensation to neighbouring property owners and/commercial interests. These compensatory costs are not included in the estimates derived for this report.

3.3.5 *Sediment Management*

As noted previously, dams have the potential to cause deposition of sediment in the associated reservoirs. The types of substrate in the reservoirs vary across locations, with a number of the sites having coarse gravel or rocky substrate, indicating that sediment accumulation has been minimal since the erection of the dam. However, there are some locations which have sediment deposition which may be significant. The quantity as well as the quality of sediment is of interest and can have major impacts on decommissioning costs.

The erosion, transport and deposition of sediment following dam removal could result in negative effects on the environment since the rate of sediment transport controls the process of channel evolution which has important consequences for water quality, nutrients, food supply and biochemical process that affect aquatic and wildlife habitat availability and suitability, wildlife and habitats, vegetation and wetlands.

Dam removal would represent a large and rapid (i.e., within months or years) change in river morphology at the dam location compared to natural rates and scales of normal river change (i.e., millennia). The reservoir, and the upstream channel and tributaries, will typically respond to the lowering of the water level through incision (i.e., erosion and down cutting) into the sediment forming new channels. This channel evolution may not necessarily return the impoundment area to its pre-dam condition since the channel changes could lead to a new equilibrium different from the pre-damming channel form.

This process of establishing a new equilibrium channel with a new floodplain is likely to create changes in hydraulic and sediment conditions that can lead to water quality changes (i.e., turbidity, acidity and temperature) and fluvial geomorphologic changes such as braided channels, meanders and cutbacks as the new equilibrium channel and floodplain are established (6). In addition, geomorphic processes upstream from the removed dam may lead to bank failures (sloughing) as the channel forms, if the water level is lowered too rapidly.

There is no known requirement for reservoir levels to be lowered in yearly intervals. Typically, dams within the size ranges of the NSPI facilities are lowered over the course of weeks or months. It is not expected that lowering the NSPI reservoirs at similar rates would present any unique erosion issues. Controlled lowering to the final water level as soon as possible actually allows for stabilization works and revegetation to begin earlier.

In order to develop a complete understanding of the potential sediment related effects of dam removal and to prepare accurate estimates of the potential costs to manage any previously deposited sediments in the river upstream of each dam the completion of various studies would be required.

Hydraulic (i.e., sediment transport) modeling would be required to assess the sediment's susceptibility to erosion and transport following the removal of the dams. Where deemed necessary, sediment samples would have to be analyzed for a range of chemical parameters to assess the quality of the sediment to determine if special sediment management measures may be required. Coupled with this, would be the need to develop an understanding of the fluvial geomorphological regime of the rivers (pre- and post-dam removal) and the associated ecological features and human uses of the rivers that could be subject to potential impacts.

These factors will undoubtedly affect the sediment management approach (e.g., active or passive sediment management) and the timelines for the reservoir lowering and removal of the dams. Only through the completion of this work, can the appropriate sediment management measures (e.g., dredging, excavation, disposal) as well as riverbank stabilization and fish habitat restoration measures be properly identified, and the true costs established.

3.3.6 Flood Reduction

Removal of the dams would result in changes to the water levels of each of the associated lakes, and to flows and water levels along the impacted branches of the rivers. Such changes would result in both direct and indirect effects to ecological features, processes and functions that support a variety of aquatic and terrestrial species along the impacted portion of the water system.

The lowering of the water levels will result in dewatering of some of the areas which are currently under water. Over time, much of the formerly flooded terrestrial and aquatic habitats would be expected to return to near pre-dam conditions. The restoration of the natural flow regime in the river, including biochemical, sediment and nutrient transport processes, and the removal of barriers to fish and wildlife movement, among other aspects, is expected to provide long-term environmental benefits to the ecosystem health of the river.

The lowering of the lakes to their pre-dam condition would reduce the surface area of each of the lakes quite noticeably. This would expose what is currently flooded shoreline, which could be susceptible to surficial soil erosion until vegetation becomes adequately re-established. Natural regeneration of vegetation is expected to occur rapidly in the majority of areas where soils are present. However, hydroseeding with a native grass mixture, combined with strategic vegetative plantings would likely be required for any erosion susceptible areas identified during the lake drawdown process. Over time, the exposed shorelines would result in the creation of additional habitat for wildlife including mammals, birds, amphibians and reptiles. Stabilization and revegetation efforts would add to the cost associated with decommissioning.

3.4 Conceptual Level Environmental Cost Estimates

3.4.1 Conceptual Level Environmental Costs – Comprehensive Studies

Comprehensive environmental cost estimates were previously completed by Hatch for the following systems:

- Annapolis
- Black River (Gaspereau Lake)
- St. Margaret's Bay
- Tusket

In preparing these estimates, both direct and indirect costs were assessed to address the various environmental effects. The costs included studies to identify and assess potential effects including: design and construct mitigation measures (e.g., erosion protection works); install channel and flood plain restoration works (e.g., aquatic and terrestrial habitats); conduct long-term environmental monitoring (with adaptive management); and relocate or rebuild affected infrastructure (e.g., water intakes, docks, shorelines, roads, bridges) as well as to address other currently unknown factors.

3.4.2 Conceptual Level Environmental Costs – Precedent Experience

For the remainder of the systems, a cost matrix was used to categorize the environmental costs associated with decommissioning of each site based on their complexity. This allowed each of the systems to be grouped within an environmental cost category for estimating purposes based on an assessment of precedent case examples. This environmental precedent method was developed for use on the NSPI systems and is separate from the infrastructure removal precedent method. The steps involved in the development of the precedent costs are detailed in the following sections.

3.5 Step 1: Dam Decommissioning Cost Literature/Case Study Review

Approximately 300 academic and technical documents, including online sources, were reviewed prior to establishing the database which would eventually be used to generate the environmental estimation matrix. Several decommissioning studies and cost estimates undertaken by Hatch were also included in the review. All previous Hatch-generated estimates that involved NSPI assets were also included. For the cases where there were defined separate decommissioning costs for environmental components, these costs were recorded. In other cases, only the total decommissioning/removal costs were available. In these instances, the portion attributable to environmental costs was estimated. In the absence of any additional information, 22 % of the total decommissioning costs was attributed to environmental engineering costs. This is based on the relative contribution values derived by Pansic et al. (2).

3.6 Step 2: Compilation of Database and Generation of Scoring Criteria

Upon completion of the literature review, the relevant information was compiled in a spreadsheet database. New information was used to augment an existing Hatch listing of projects with decommissioning costs or cost estimates. The result was a database listing approximately 140 dam structures along with the known or estimated environmental decommissioning cost.

Size

Within the database, all the listed structures were first categorized by size. Three dam sizes - Small, Medium and Large – were used. The size was determined based on

a) height of the dam

b) volume of the associated reservoir

c) surface area of the associated reservoir.

The height of the dam, where available, was used as the main size determinant, but since the volume and surface area of the associated reservoir have direct impacts on effort and cost of assessments, these were also considered. There were also instances where the size of the dam was not available, but one (or both) of either the reservoir volume or area was available. In such cases, the surface area and/or volume were used as the size determinants.

To the extent possible, based on the information available from the research findings, the following physical, environmental and social components were used to develop categories:

a) Associated fisheries.

b) Stakeholder interest and/or recreational usage.

c) Contaminated sediments and/or industrial use.

d) Inundation (flood) reduction.

Associated Fisheries

The importance of associated fisheries was determined by whether there was a known significant fishery impacted by the presence of the structure or if there was a known fishery-related issue such as fish passage associated with the decommissioned structure. Associated fisheries were considered to be either present or absent and thus accorded entries of 'Yes' or 'No', respectively. If there was no available information, then it was accorded an 'Unknown' designation. Numerical values of two (for a Yes) and one (for No) were accorded to the 'Associated Fisheries' category. Unknowns were also accorded a value of one. The maximum score that could be obtained from the 'Associated Fisheries' was therefore two (fisheries present).

Stakeholder Interest/Recreational Use

Stakeholder interest and/or recreational use was determined by whether the decommissioning was known to have generated significant stakeholder interest, including to what extent the dam and/or the associated reservoir may have been used recreationally. Based on the information the structures were then classified as having High, Medium, Low or Unknown degree of stakeholder interest. The numerical scores accorded for High, Medium and Low were three, two and one respectively. A value of one was also accorded to the Unknowns.

Contaminated Sediment

Contaminated sediment and/or industrial use was determined by whether there was information indicating or confirming that the sediment in or around the reservoir or decommissioning site was contaminated. The known existence of industrial activity that may have contributed to sediment contamination was considered an indicator of contaminated sediment. The category was classified as either Yes, No or Unknown, and values of two for Contaminated and one for Uncontaminated or Unknown were accorded.

Inundation (Flood) Reduction

Inundation (flood) reduction was determined based on a number of factors. The main factor was the height to the dam along with the topography of the location. The purpose of the dam was also considered. Three categories were developed. These were Major, Average, Minimal. Scores of three, two and one, respectively were used for the classifications. Unknown sites were also accorded a value of one.

Figure 36 displays a screenshot of a portion of the database after the dam size and environmental component compilation. Table 19 summarizes the scoring criteria that were employed.

Figure 36: Spreadsheet showing Dam Sizes and Identified Environmental Components

Dam Decommissioning - North America

Dam Name	Location	Hydropower	Hatch Involved	Estimate	Type	Volume (m3)	Surface Area (km2)	Height(ft)	Height(m)	Dam Size	Date Removed or Estimate Date	Removal Cost (USD)	Removal Cost (USD2018)	Removal Cost (CAD2018)	Environmental Engineering Cost (CAD) *assume environmental cost is 22% of the total cost (Pansic et al., 1995)	Reason for Removal	Associated Fisheries	Stakeholder interest/recreational use	Contaminated Sediment/Industrial use	Inundation reduction	Environmental Division Score
Behrend Capped Waterfall Dam	Pennsylvania	No	No	No	Concrete	-	-	2.5	0.8	Small	2007	$10,000	$12,130	$15,163	$3,336	Disrepair	No	Unknown	Unknown	Minimal	4
Benbow Dam	California	No	No	No	Concrete	-	-	20	6.1	Medium	2016	$2,430,000	$2,546,640	$3,183,300	$700,326	Fish passage	Yes	High	Unknown	Minimal	6
Big Spring	Wisconsin	No	No	Yes	Gravity and earthfill	-	-	18	5.5	Small	2007	$300,000	$363,900	$454,875	$100,073	Safety concerns	No	Medium	Unknown	Minimal	5
Cedar Run	Pennsylvania	No	No	Yes	Concrete	-	-	3	0.9	Small	2007	$17,200	$20,864	$26,080	$5,737	Fish passage	Yes	Medium	Unknown	Minimal	6
Charlotte City Dam	Michigan	No	No	No	Earthfill	-	-	8	2.4	Small	2003	$160,710	$219,691	$274,613	$60,415	Improve water quality and habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5

Table 19: Scoring Criteria for the Environmental and Social Components Identified

Environmental Component	Associated Fisheries	Stakeholder Interest / Recreational Use	Contaminated Sediment / Industrial Use	Inundation Reduction
Score	Yes (2)	High (3)	Yes (2)	Major (3)
	No / Unknown (1)	Medium (2)	No / Unknown (1)	Average (2)
		Low / Unknown (1)		Minimal / Unknown (1)

3.7 Step 3: Generation of Environmental Division Score

To generate the environmental division score, the scores from each of the four environmental and social components were summed. The environmental division score is out of a maximum 10 and is a benchmark which was then used in estimating the environmental costs associated with varying dam sizes for future dam decommissioning projects.

An overall environmental division score was classified as High if it had a Score of 8 to 10, Medium if had a Score of 5 to 7 and Low if it had a Score of 4 or below. The dams were then categorized into one of nine categories depending on various dam sizes and different levels of environmental and social concerns at the project locations. Table 20 shows the nine different categories and their corresponding environmental division score.

Table 20: Environmental Division Score with Corresponding Categories

Dam Size	Environmental Concerns	Environmental Division Score
Small	Low	4 and below
	Medium	5 – 7
	High	8 – 10
Medium	Low	4 and below
	Medium	5 – 7
	High	8 – 10
Large	Low	4 and below
	Medium	5 – 7
	High	8 – 10

3.8 Step 4: Cost Estimate Range Generation

Dam structures from the Database spreadsheet were then categorized into one of the nine categories (e.g., Small size dam with Low environmental concerns, Medium size dam with High environmental concerns, etc.) in correspondence to the size of dam and different levels of environmental concerns. The median value for each category was calculated using the range of values and used to generate the Estimated Environmental Cost. These values are shown below in Table 21. The corresponding Total Decommissioning Costs are also displayed for reference.

Table 21: Cost Estimates for Varying Dam Sizes & Relevant Environmental Concerns

Dam Size	Environmental Concerns	Estimated Environmental Cost	Estimated Total Decommissioning Cost
Small	Low	$121,000	$550,000
	Medium	$363,000	$1,650,000
	High	$1,100,000	$5,000,000
Medium	Low	$3,080,000	$14,000,000
	Medium	$3,520,000	$16,000,000
	High	$4,400,000	$20,000,000
Large	Low	$4,840,000	$22,000,000
	Medium	$6,600,000	$30,000,000
	High	$66,000,000	$300,000,000

3.9 Step 5: Application to NSPI Systems

After generating the matrix of estimating the environmental costs, a new database with only NSPI Hydro Systems was developed based on the information provided by NSPI. Using the provided information, the described methodology was applied to each primary structure in each system. As shown in the screenshot in Figure 37, these NSPI dam structures were all categorized by dam size given an individual environmental division score. Environmental and total decommissioning costs were estimated based on which category of the nine categories that specific structure fell into.

Figure 37: NSPI Hydro Systems Database

NSPI Hydro System																
Hydro System	Reservoir	Dam Name	Type	Volume (million m3)	Surface Area (km2)	Height (m)	Dam Size	Associated Fisheries	Stakeholder Interest / Recreational Use	Contaminated Sediment / Industial Use	Inundation Reduction	Environmental Division Score	Infrastructure Removal Cost	Environmental Cost	Total Decommissioning Cost	Estimated Total Decommissioning Cost
Avon	South Canoe Reservoir	South Canoe Dam	Earthfill	8.88	-	7.6	Small	No	Medium	Yes	Minimal	6	$2,100,240	$363,000	$4,073,789	$1,650,000
Avon	Falls Lake Headpond	Falls Dam	Earthfill	109.7	-	10.7	Small	No	Medium	Yes	Average	7	$4,165,593	$363,000	$5,963,872	$1,650,000
Avon	MacDonald Headpond	MacDonald Dam	Earthfill dyke and concrete gravity	194.2	-	15.8	Medium	No	Medium	Yes	Average	7	$9,089,251	$3,520,000	$13,099,556	$16,000,000
Black River	Aylesford Reservoir	Aylesford Dam	Earth / Rockfill	17.98	49.7	5.5	Small	Yes	High	No	Minimal	7	$1,099,295	$363,000	$4,519,778	$1,650,000
Black River	Gaspereau reservoir	Lanes Mills Dam	Earthfill / Concrete	58.9	177.4	5.5	Small	Yes	High	No	Minimal	7	$951,000	$837,600	$1,239,600	$1,650,000
Black River	Gaspereau reservoir	Muskrat Cove Dam	Earthfill / Concrete			3.7	Small	Un-known	High	No	Minimal	6	$348,000	$837,600	$1,185,600	$1,650,000

The precedent environmental costs developed on the basis of this matrix are summarized in Table 22. The Dam Decommissioning Database Methodology: Environmental Costs is provided in Appendix B, along with the estimated environmental costs for each of the structures.

Table 22: Estimated Environmental Costs

System	Basis of Estimate	Estimated Environmental Costs in $ 2018 CDN
Annapolis	Comprehensive	2,287,500
Avon	Precedent	5,335,000
Bear River	Precedent	12,012,000
Black River	Precedent/Comprehensive	28,883,000[3]
Dickie Brook	Precedent	3,883,000
Fall River	Precedent	1,089,000
Harmony	Precedent	726,000
Lequille	Precedent	3,883,000
Mersey	Comprehensive	8,054,865
Nictaux	Precedent	7,689,000
Paradise	Precedent	2,541,000
Roseway	Precedent	726,000
Sheet Harbour	Precedent	5,335,000
Sissiboo	Precedent	33,803,000
St. Margaret's Bay	Comprehensive	10,120,734
Tusket	Comprehensive	10,583,882
Wreck Cove	Precedent	45,485,000

Comprehensive for Gaspereau System only.

4. Sediment Management and Cost Allowances

4.1 Uncertainties and Exclutions

Shuman (7) concluded that successful restoration through dam removal requires an assessment of the effects induced by dam removal on river stability, hydrology, floodplain restoration, sediment pollutants, sediment transport, surface erosion, and water quality. From a geomorphic point of view, the questions that need to be answered included

1. What is Stored behind the dam?
2. How fast and under what conditions will the channel recover its previous form and transport regime?
3. What will happen to any sediments that are released, how far will they travel, where will they be redeposited, and will sediment re-deposition change the river channel or the floodplain?
4. What are the ecological consequences of removal the dam on both resident and anadromous populations of aquatic species (8) stated that the most obvious detrimental effect caused by dam removal is sediment transport that occurs because of channel reformation in the former impoundment. Therefore, prevention measures must be planned to control and limit the potential adverse consequences. Impacts depends on whether sediments are suspended in water or are deposited on stream channel bed. Research revealed that released sediments may fill pools and interrupt mussel reproduction, as well as kill adult fish, mussel and other aquatic wildlife directly by clogging gills and causing suffocation. Rare and threatened fish specifies are vulnerable of even a relatively minor increase in stream turbidity. Kundell and Rasmussen (9) pointed out that when occasional turbid events occur in a river system, up to three quarters of some fish specifies can be eliminated.

Sediments deposited downstream following a dam removal can destroy spawning areas and reduce survival rate of eggs that are laid. It can also increase the oxygen demand on deplete dissolved Oxygen (“DO”) in streams. From a flood control point of view, sediment deposition on the stream bed can reduce channel capacity, exacerbating downstream bank erosion and flooding, as well as reduce flood transport capacity under bridges and through culverts.

Given the seriousness of these potential impacts, any dam removal requires careful study and planning to ensure that practical and effective methods are used to mitigate future problems. Unfortunately, only limited data exists on actual pre- and post-removal conditions. For this reason, widely accepted methodologies for impact evaluation are not available since the complicated processes are not fully understood. In addition, sediment problems are usually site specific. They therefore require evaluation and treatment in accordance with the characteristics of basin conditions, sediment properties, channel and floodplain forms.

There is, therefore, significant uncertainties with respect to the determination of the extent of environmental effects to quantify any of the related costs at this stage. The following potential cost items were excluded from the estimate as a result of the current level of engineering that has been performed in accordance with AACE guidelines.

- Investigation, management and removal of reservoir sediments (quantity and quality of sediments is unknown).
- Hazardous material abatement (lead, asbestos).
- Large scale re-vegetation measures of the newly exposed reservoir slopes or exposed canal slopes beyond seeding the exposed areas.
- Extensive re-creation, stabilization and/or channelization of new river sections.
- New fish passage structures (if required).
- Fish habitat reconstruction or compensation measures (if required).
- Channel and floodplain stabilization works (if required).
- Archaeological consulting services (investigations, assessment, stakeholder engagement).
- Archaeological protection and recovery measures.
- Financial compensation to recreational users.
- Financial compensation to residents/businesses.
- Infrastructure relocation and reconstruction work or new transportation infrastructure.

4.2 Sediment Management Allowances

If there is a need to implement measures to mitigate the impacts of erodible sediments, it can be expected that the project costs will increase significantly. As an example, the costs associated with sediment management alone may be more than 50% greater than the costs of infrastructure removal. Pansic et al. (2) suggests the following cost breakdown for a typical decommissioning project:

- Infrastructure Removal costs 30%
- Environmental Engineering 22%
- Sediment Management 48%.

For a detailed assessment of these costs for each of NSPI's reservoirs, a reliable estimate of costs would require extensive research. For this assessment, a preliminary estimate was based on information obtained from NSPI on the known nature of each of the reservoirs. This then allowed a high-level cost allowance to be developed on the basis of the criteria outlined in Table 23.

Table 23: Determination of Sediment Management Cost Allowances

Sediment Management Cost Classification	Description of Reservoir Sediments	Sediment Management Allowance
1	Bedrock or no material sediment management costs.	zero allowance.
2	Generally granular materials with no significant industry.	10% of the Pansic average.
3	Generally transportable sediments - no significant industry.	20% of the Pansic average.
4	Generally granular sediments with industry.	50% of the Pansic average.
5	Generally transportable sediments with industry.	100% of the Pansic average.
6	Generally transportable sediments with significant industry.	120% of the Pansic average.

Details of the sediment management classification for each of the systems are summarized in Table 24.

Table 24: Sediment Management Classification by Structure

System	Sediment Management Selection Criteria			
	Characteristics		Sediment Removal Class	% of Pasic allowance for sediment management
	Sediments	Industry		
Annapolis	Silty Sands	No significant activity.	1	0%
Avon	Silty Sands	No significant activity.	3	20%
Bear River	Rocky with minor silt.	No significant activity.	1	0%
Black River	Rocky, some areas of silty sand.	Some	4	50%
Dickie Brook	Rocky, some areas of silty sand.	No significant activity.	3	20%
Fall River	Granular and rock.	No significant activity.	2	10%
Harmony	Rocky, some areas of silty sand.	No significant activity.	3	20%
Lequille	Very Rocky	No significant activity.	1	0%
Mersey	Rocky	No significant activity.	2	10%
Nictaux	Rocky	No significant activity.	3	20%
Paradise	Rocky	No significant activity.	2	10%
Roseway	Very Rocky	No significant activity.	1	0%
Sheet Harbour	Silty fine sands.	significant	5	100%
Sissiboo	Rocky	No significant activity.	3	20%
St. Margaret's Bay	Granular and rock.	No significant activity.	2	10%
Tusket	Silty fine sands.	Significant	5	100%
Wreck Cove	Rocky with some granular.	No significant activity.	1	10%

The total estimated decommissioning costs, inclusive of an allowance for sediment management for each system are listed in Table 25.

Table 25: Total Estimated Decommissioning Costs (including Sediment Management)

System	Total Estimated Removal Costs (net of Sediment Management)	Estimated Sediment Management Costs	Costs as a Percentage of the Total Decommissioning Cost			Total
			Infastructure Removal	Environ	Sediment Management	
Annapolis	24,352,500	[redacted]				
Avon	15,906,000					
Bear River	32,792,000					
Black River	86,991,000					
Dickie Brook	11,433,000					
Fall River	1,620,000					
Harmony	4,517,756					
Lequille	9,415,000					
Mersey	91,432,865					
Nictaux	19,538,000					
Paradise	8,256,000					
Roseway	4,554,061					
Sheet Harbour	17,745,000					
Sissiboo	95,781,000					
St. Margaret's Bay	35,585,734					
Tusket	29,573,882					
Wreck Cove	169,677,000					
Total	**659,170,798**	**103,440,222**	**63%**	**24%**	**14%**	**762,611,020**

5. References

1. AACE International Recommended Practice No. 69R-12. Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Hydropower Industry TCM Framework: 7.3 - Cost Estimating and Budgeting . January 25, 2013.

2. Pansic, N., Austin, R.J. and Finis, M. Sediment Management for Dam Decommissioning. United States Committee on Large Dams. Sediment Management and Erosion Control on Water Resources Projects. San Francisco, California : 15th Annual USCOLD Lecture Series - p29-46, May 15 - 19, 1995.

3. Donnelly, C. R., et al. The Process of Decommissioning Dams in Ontario. Regina, Saskatchewan, Canada : Proceedings of the Canadian Dam Association 2000 Conference, 2000.

4. Donnelly, C. R., et al. Issues and Controversies Associated with Dam Removals. Salt Lake City, Utah : Waterpower XII Conference, July 2001.

5. Inflation Calculator. [Online] Bank of Canada. https://www.bankofcanada.ca/rates/related/inflation-calculator/ .

6. Zhou, R. and Donnelly, C. R. The Impact of Dam Removal on Instream Sediments. Victoria, British Columbia, Canada : Proceedings of the Canadian Dam Association 2002 Conference, 2002.

7. Shuman. Environmental Considerations for Assessing Dam Removal Alternatives for River restoration. s.l. : River Research and Applications, Vo. 11, 249-261, 1995.

8. Doyle, Martin D., Stanley, Emily H. and Harbor, Jon M. Channel Adjustments following two Dam Removals in Wisconsin. s.l. : Water Resources Research Vol. 39, 2003.

9. Kundell, James E. and Rasmussen, Todd C. Evaluatingthe Erosion Measurement Standard Defined by the Georgia Erosion and Sedimentatin Act. s.l. : Recommendations of the Georgia Board of Regents' Scientific Panel, Georgia Water Resources Conference , 1995.

10. Robertson, M. J., et al. Effect of Suspended Sediment on Freshwater Fish and Fish Habitat. St. John's Newfoundland : Canadian Technical Report of Fisheries and Aquatic Sciences 2644. Science Branch, Fisheries and Oceans Canada, 2006.

11. (CCME), Canadian Council of Ministers of the Environment. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter. Winnipeg, Manitoba : Canadian Environmental Quality Guidelines, 2002.

12. Government of Nova Scotia. Nova Scotia Geomatics Centre. 2010.

13. Birtwell, I.K. The Effects of Sediment on Fish and Fish Habitat - Canadian Stock Assessment Section Secretariat, Research Document 99/139. s.l. : Fisheries and Oceans Canada, 1999.

14. Hatch Ltd. . Mersey Hydro System - Cost Estimate for Dam Removal Final Report. December 2015.

15. Hatch Ltd. St. Margret's Bay Hydro System 2012 Flood Study, Final Report. May 2013.

16. —. St. Margaret's Bay Decommissiong Cost Estimate Report No. H356941-00000-200-230-0001. July 25, 2018.

Appendix A
Detailed Infrastructure Removal Cost Estimates

Date Updated: Friday, August 24, 2018

NSPI Dam Register

				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
ANNAPOLIS	Right Causeway	n/a		65.6	1,150	23.6	n/a				1,150	20.0	-42	1	NA	NA	NA	NA	NA	NA	NA	
ANNAPOLIS	Left Causeway	n/a		58.1	1,706	24.7	n/a				1,706	17.7	-33	1	NA	NA	NA	NA	NA	NA	NA	
ANNAPOLIS	Downstream	n/a		41	3,120	23.6	n/a				3,120	12.5	-17	1	NA	NA	NA	NA	NA	NA	NA	
ANNAPOLIS	Powerhouse	n/a	Headpond	47	200	23	n/a				200	14.3	7	1	28,214,063	NA	NA	NA	NA	2,287,500	30,501,563	
															28214063.0				0.0	2,287,500	30,501,563	
AVON	Card Lake Main Dam	Impervious Fill	Storage	26	500	481	479.5	70		475	570	7.0	455	1	1,781,450		42,475	37	1,327,519	363,000	3,471,969	
AVON	Card Lake Wing Dam	Impervious Fill	Storage	13	420	481.7	478.7			n/a	420	4.0	469	1	570,243		42,475	18	663,759	363,000	1,597,002	
AVON	Zwicker Lake Dam	n/a	Storage	19	37	357	354	80		348.6	117	1.2	338	1	52,187		24,360	27	556,371	363,000	971,558	
AVON	South Canoe Lake Dam	Impervious Fill	Storage	28	1,150	682.5	679.5	50		673.5	1,200	7.6	655	1	2,100,240		47,850	40	1,610,549	363,000	4,073,789	
AVON	Mockingigh/ Falls Lake Dam	Low Permeability Fill	Headpond	17	562	342.5	339.5	342.5		335.2	905	10.7	326	1	4,165,593		70,235	24	1,435,279	363,000	5,963,872	
AVON	Mockingigh/ Falls Lake Canal		Headpond		845	340.7	na			n/a	845		341	1	assume left in place and revegetated	1,545			6,181	included above	6,181	
AVON	MacDonald Pond Main Dam	n/a	Headpond	51.5	400	193	n/a	222.1		184.4	622	15.8	142	1	9,089,251		7,920	73	490,305	3,520,000	13,099,556	
AVON	MacDonald Pond Power Canal	Impervious Fill	Headpond	13.1	1,584	193	192			n/a	1,584	4.0	180	1	assume left in place and revegetated	5,034		19	20,136	included above	20,136	assume 20 foot wide base and 3:1 slopes
															17,759,000				6,110,100	5,335,000	29,204,000	
BEAR RIVER	Lake Mulgrave Main Dam	Concrete	Storage	34	600	487	486				600	10.4	453	1	3,935,081		74,063	48	3,027,002	3,520,000	10,482,083	
BEAR RIVER	Lake Mulgrave Wing Dam 1	Timber	Storage	20	170	489.5	487.5	75		480	245	6.1	470	1	1,352,476		74,063	28	1,780,589	363,000	3,496,065	
BEAR RIVER	Lake Mulgrave Wing Dam 2	Timber	Storage	22	2,100	486	484				2,100	6.7	464	2	1,631,898		74,063	31	1,958,648	363,000	3,953,546	
BEAR RIVER	Lake Mulgrave Wing Dam 3	Timber	Storage	17	755	487	486.5				755	5.2	470	1	982,544		74,063	24	1,513,501	363,000	2,859,045	
BEAR RIVER	Ridge Main Dam and Spillway	Concrete	Headpond	40	770	415.5	413			410	770	12.2	376	1	5,416,658		18,284	57	879,154	3,520,000	9,815,813	
BEAR RIVER	Ridge Wing Dam 1	Concrete	Headpond	25	1,080	415.5	413				1,080	7.6	391	1	2,100,240		18,284	35	549,471	363,000	3,012,712	
BEAR RIVER	Ridge Wing Dam 2	Concrete	Headpond	10	800	415.5	413				800	3.1	406	1	348,870		18,284	14	219,789	363,000	931,659	
BEAR RIVER	Ridge Canal Embankment	Till	Headpond			415.5	413							1	assume left in place and revegetated					included above		assume 20 foot wide base and 3:1 sliopes
BEAR RIVER	Gulch Main Dam	Concrete	Headpond	57	530	271	269.5	200		262	730	17.4	214	1	11,025,234		13,805	81	945,900	3,520,000	15,491,134	
															26,793,000				10,874,054	12,375,000	50,042,000	
BLACK RIVER	Aylesford Lake Main Dam	Impervious Soil	Storage	18	180	671	671	43			223	5.5	653	1	1,099,295		141,305	25	3,057,482	363,000	4,519,778	
BLACK RIVER	North Gaspereau Dyke	Impervious Till	Storage	10	778	634	631				778	3.0	624	1	402,000				Included in Environmental Costs	837,600	1,239,600	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Date Updated: Friday, August 24, 2018

NSPI Dam Register

System	Development	Core Material	Purpose	Structure Data (ft)				Spillway Data (ft)			Total Length (ft)	ANALYSIS										
				Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation		Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
BLACK RIVER	Lanes Mills Spillway	n/a	Storage	11	200	628.1	n/a	148.7			349	5.5	617	1	951,000				Included in Environmental Costs	837,600	1,788,600	
BLACK RIVER	Black Brook Dyke	Impervious Till	Storage	16	2,934	635	632				2,934	4.9	619	3	2,915,000				Included in Environmental Costs	837,600	3,752,600	
BLACK RIVER	Muskrat Cove Dyke	Impervious Till	Storage	10	762	631	631	34			796	3.7	621	1	348,000				Included in Environmental Costs	837,600	1,185,600	
BLACK RIVER	Forest Home Dyke	Impervious Till	Storage	15	4,620	635	632				4,620	4.6	620	5	4,336,000				Included in Environmental Costs	837,600	5,173,600	
BLACK RIVER	Trout River Pond Diversion Dam (Main Dam)	Glacial Till	Storage	30	830	624.5	624.5				830	9.1	595	1	3,012,072		38,235	42	1,378,848	363,000	4,753,920	
BLACK RIVER	Trout River Pond Dykes LMN	Impervious Soil	Storage	11	660	621.5	620.8				660	3.4	611	1	419,731					N/A	419,731	
BLACK RIVER	Trout River Pond Spillway/ Dyke P	Impervious Soil	Storage	13	578	621.4	618.4	111			689	4.0	608	1	581,112					N/A	581,112	
BLACK RIVER	Trout River Pond Gaspereau Canal Dyke	Impervious Soil	Storage	20	20,200	622.5	622				20,200	6.1	603	1	assume left in place and revegetated	77,193			308,771	N/A	308,771	assume 20 foot wide base and 3:1 sliopes
BLACK RIVER	Trout River Pond Mid-Pond Dyke & Spillway	Impervious Soil	Storage	8	100	620.5	620.5				100	2.4	613	1	209,008					N/A	209,008	
BLACK RIVER	Salmontail Lake Main Dam	Impervious Soil	Storage	22	570	768.5	768	45			615	6.7	747	1	1,631,898		115,530	31	3,055,283	363,000	5,050,180	
BLACK RIVER	Hatchard Lake Dam	Impervious Soil	Storage	8	470	767.5	767				470	2.4	760	1	209,008					N/A	209,008	
BLACK RIVER	Little River Lake Main Dam	Impervious Soil	Headpond	15	700	620.4	621.5	75			775	4.3	605	1	671,635		75,878	21	1,368,164	363,000	2,402,799	
BLACK RIVER	Little River Lake Wing Dam	Impervious Soil	Headpond	13	700	620.7	620.7				700	4.0	608	1	581,112		75,878	18	1,185,742	N/A	1,766,854	
BLACK RIVER	Methals Dam	Impervious Soil	Storage	50	1,476	622	619	98			1,574	15.2	572	2	8,411,449		45,475	71	2,733,233	3,520,000	14,664,682	
BLACK RIVER	Black River Lake Dam	Impervious Soil	Headpond	42	1,050	581	580.5				1,050	12.8	539	1	5,963,061		106,384	59	5,371,029	3,520,000	14,854,090	
BLACK RIVER	Forks Dam	Impervious Soil	Headpond	38	820	579.5	579	186			1,006	11.6	542	1	4,896,529		106,384	54	4,859,502	3,520,000	13,276,032	
BLACK RIVER	Hollow Bridge Canal	Impervious Soil	Storage		6,336	567					6,336			1	assume left in place and revegetated	11,587			46,350	N/A	46,350	assume 20 foot wide base and 3:1 sliopes
BLACK RIVER	Lunn Dam	Impervious Soil	Storage	3	168	576.1	576.1				168	0.9	573	1	29,340					N/A	29,340	
BLACK RIVER	Dean Chapter Lake	Impervious Soil	Storage	19	400	620	620				400	5.8	601	1	1,222,606		91,915	27	2,099,297	363,000	3,684,903	
BLACK RIVER	Lumsden Main Dam	Impervious Soil	Storage	72	700	412.5	409.5	203			903	21.9	341	1	17,472,594		26,245	102	2,271,501	4,400,000	24,144,095	
BLACK RIVER	Hell's Gate Main Dam	n/a	Headpond	58	248	341.2	n/a	117			365	17.7	283	1	11,409,043		7,280	82	507,567	3,520,000	15,436,610	
BLACK RIVER	White Rock Main Dam	n/a	Headpond	39	200	140	n/a	74			274	11.9	101	1	5,153,310		15,415	55	722,673	4,400,000	10,275,983	
BLACK RIVER	White Rock Canal	Impervious Soil	Headpond	30	5,000	142	141.5				5,000	9.1	112	1	assume left in place and revegetated	23,760			95,040	N/A	95,040	assume 20 foot wide base and 3:1 sliopes
															71,925,000				29,060,482	28,883,000	129,868,000	
DICKIE BROOK	Tom's Lake Main Dam	Impervious Till	Headpond	45	558	309	309			n/a	558	12.5	264	1	5,686,576		12,155	64	657,509	3,520,000	9,864,084	
DICKIE BROOK	Tom's Lake Spillway	n/a	Headpond		282	302	n/a	282		302	564	0.0	302	1	0					included above	0	
DICKIE BROOK	Tom's Lake Wing Dam #1, #2 Freeboard Dyke	Impervious Till	Headpond	9	641	309	309			n/a	641	2.7	300	1	273,131					included above	273,131	

Date Updated: Friday, August 24, 2018

NSPI Dam Register																						
				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
DICKIE BROOK	Tom's Lake Wing Dam #3	Impervious Till	Headpond	10	226	307	307			n/a	226	3.0	297	1	337,263					included above	337,263	
DICKIE BROOK	Tom's Lake Intake Structure	n/a	Headpond	22	30	309	n/a			n/a	30	6.7	287	1	1,634,669					included above	1,634,669	
DICKIE BROOK	Donahue Lake Main Dam	Impervious Till	Storage	14	457	353	352	150		348.5	607	4.0	339	1	581,112		29,400	20	494,777	363,000	1,438,889	
DICKIE BROOK	Donahue Lake Diverson Sluiceway/Canal	Impervious Till	Storage		656	355	n/a			n/a	656			1	0			0	0	included above	0	
DICKIE BROOK	Donahue Lake Wing Dam	Impervious Till	Storage	9.5	475	354.5	352			n/a	475	2.9	345	1	304,351			13	0	included above	304,351	
															8,817,000				1,152,285	3,883,000	13,852,000	
FALL RIVER	Soldiers Lake Spillway Dam	n/a	Storage	17	114	219	n/a	40		214	154	4.6	202	1	768,714		25,507	24	521,239	363,000	1,652,953	
FALL RIVER	Soldier Lake Wing Dam No. 1	Impervious Fill	Storage	12	310	221	218.5			n/a	310	3.7	209	1	485,817		25,507	17	367,933	363,000	1,216,751	
FALL RIVER	Soldier Lake Wing Dam No. 2	Impervious Fill (none)	Storage	4	125	220	218.5			n/a	125	1.2	216	1	53,873		25,507	6	122,644	363,000	539,517	
FALL RIVER	Miller Lake Dam	n/a	Headpond	15.7	209	161.1	n/a	59		158.6	268	4.8	145	1	837,076		32,990	22	622,610	363,000	1,822,686	
															2,145,000				1,634,426	1,452,000	5,232,000	
HARMONY	Harmony Main Dam	Impervious Till	Headpond	20	615	109.5	107	240.75			856	6.1	90	1	1,350,734					363,000	1,713,734	Harmony we only did estimate for Partial Decommissioning at Powerhouse, no mention on
HARMONY	McGowan Lake Wing Dam	Impervious Till	Permiter Dyke	10.5	460	109.5	107				460	3.2	99	1	371,865					363,000	734,865	
HARMONY	McGowan Lake Intake Structure	n/a	Intake		107	110	n/a				107	0.0	110	1						included above		Intake remained in place in 2016 decommissioning report
															1,723,000				0	726,000	2,449,000	
LEQUILLE	Grand Lake Dam	Impervious Fill	Storage	15	195	415	414.5	125		408	320	4.6	400	1	768,714		79,955	21	1,441,686	363,000	2,573,401	
LEQUILLE	Canal Intake & Wing Dam No. 1	Impervious Fill	Headpond	30	370	406.5	404	40		402	410	9.1	377	1	3,041,371		13,539	42	488,255	included above	3,529,626	
LEQUILLE	Lequille Main Dam	Impervious Fill	Headpond	40.5	440	406.5	404				440	12.6	366	1	5,778,008		13,539	57	659,145	3,520,000	9,957,152	
LEQUILLE	Lequille Spillway Structure	n/a	Headpond	20	48	405	403	48		400	96	6.1	385	1	1,350,734		13,539	28	325,504	included above	1,676,238	
LEQUILLE	Lequille Wing Dam No. 3	Impervious Fill	Headpond	10	188	405	403				188	3.0	395	1	337,263		13,539	14	162,752	included above	500,014	
LEQUILLE	Lequille Wing Dam No. 4	Impervious Fill	Headpond	14	240	405	403				240	4.3	391	1	661,435		13,539	20	227,853	included above	889,288	
LEQUILLE	Lequille Canal Embankment	Impervious Fill	Headpond	29	13,555	404	402				13,555	8.8	375	1	assume left in place and revegetated	63,153			252,611	included above	252,611	assume 20 foot wide base and 3:1 sliopes
LEQUILLE	Lequille Intake Structure	n/a	Headpond	31	15	406	n/a				15	9.4	375	1	3,247,700		13,539	44	504,531	included above	3,752,231	
															15,185,000				4,062,337	3,883,000	23,131,000	
MERSEY	Upper Lake Falls Left Wing Dam	Earth	Headpond	22	600	285	285				600	6.7	263	1	23,498,300				Included in Infrastructure Removal Costs	3,525,000	27,023,300	
MERSEY	Upper Lake Falls Bulkhead	n/a	Headpond	34		281	n/a					10.4	247	1	included above					included above		
MERSEY	Upper Lake Falls Sluiceway	n/a	Headpond			235	n/a						235	1	included above					included above		

Date Updated: Friday, August 24, 2018

NSPI Dam Register

				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infrastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
MERSEY	Upper Lake Falls Main Dam	Earth	Headpond	52	454	285	285				454	15.8	233	1	included above					included above		
MERSEY	Upper Lake Falls Right Wing Dam	Earth	Headpond	14	200	285	285				200	4.3	271	1	included above					included above		
MERSEY	Upper Lake Falls Spillway	n/a	Headpond	15		270	n/a					4.6	255	1	included above					included above		
MERSEY	Lower Lake Falls Right Wing Dam	Earth	Headpond	15	804	237	235				804	4.6	222	1	14,420,300				Included in Infrastructure Removal Costs	2,163,000	16,583,300	
MERSEY	Lower Lake Falls Left Wing Dam	Till	Headpond	5	480	237	237				480	1.5	232	1	included above					included above		
MERSEY	Lower Lake Falls Canal Embankment	Concrete/Till	Headpond	23	1,641	237	235				1,641	7.0	214	1	included above	6,729			26,917	included above	26,917	assume 20 foot wide base and 3:1 sliopes
MERSEY	Lower Lake Falls Main Dam	Earth	Headpond	21	469	237	235				469	6.4	216	1	included above					included above		
MERSEY	Lower Lake Falls Sluiceway	n/a	Headpond	22	48	234	n/a	48			96	6.7	212	1	included above					included above		
MERSEY	Lower Lake Falls Spillway	n/a	Headpond	10	700	232	n/a	700			1,400	3.0	222	1	included above					included above		
MERSEY	Lower Lake Falls Powerhouse Bulkhead Dams	n/a	Headpond	35	50	237	n/a				50	10.7	202	1	included above					included above		
MERSEY	Lower Lake Falls Sluiceway Bulkhead Dam	n/a	Headpond	22	106	237	n/a				106	6.7	215	1	included above					included above		
MERSEY	Big Falls Embankment No. 1 (Left Wing Dam)	Earth	Headpond	21	543	188	186				543	6.4	167	1	21,521,000				Included in Infrastructure Removal Costs	3,228,000	24,749,000	
MERSEY	Big Falls Sluiceway	n/a	Headpond	36	52	166	n/a	48			100	11.0	130	1	included above					included above		
MERSEY	Big Falls Embankment No. 2 (Main Dam)	Earth	Headpond	34	1,263	188	186				1,263	10.4	154	1	included above					included above		
MERSEY	Big Falls Embankment No. 3	Earth	Headpond	30	1,314	188	186				1,314	9.1	158	1	included above					included above		
MERSEY	Big Falls Embankment No. 4 (Right Wing Dam)	Earth	Headpond	23	458	188	186				458	7.0	165	1	included above					included above		
MERSEY	Big Falls Bulkhead Dam	n/a	Headpond	49.2	84	188	n/a				84	15.0	139	1	included above					included above		
MERSEY	Big Falls Spillway	n/a	Headpond	16	590	181	n/a	590			1,180	4.9	165		included above					included above		
MERSEY	Lower Great Brook Spillway Left	n/a	Headpond	4	291	125.92	n/a	291			582	1.2	122	1	9,485,970				Included in Infrastructure Removal Costs	1,423,000	10,908,970	
MERSEY	Lower Great Brook Spillway Right	n/a	Headpond	4	119	125.1	n/a	119			238	1.2	121	1	included above					included above		
MERSEY	Lower Great Brook Sluiceway	n/a	Headpond	25	98	106	n/a	72			170	7.6	81	1	included above					included above		
MERSEY	Lower Great Brook Left Wing Dam	Concrete	Headpond	33	436	130	128				436	10.1	97	1	included above					included above		
MERSEY	Lower Great Brook Main Dam	Concrete	Headpond	25	923	131	128				923	7.6	106		included above					included above		
MERSEY	Lower Great Brook Right Wing Dam	Concrete	Headpond	11	365	131	128				365	3.4	120	1	included above					included above		
MERSEY	Deep Brook Spillway	n/a	Headpond	10	200	102	n/a	200			400	3.0	92	1	14,867,100				Included in Infrastructure Removal Costs	2,230,000	17,097,100	
MERSEY	Deep Brook Sluiceway	n/a	Headpond	19	200	106	n/a	200			400	5.8	87	1	included above					included above		
MERSEY	Deep Brook Road Wing Dam	Impervious Fill	Headpond	21	1,650	108	108				1,650	6.4	87	2	included above					included above		

Date Updated: Friday, August 24, 2018

NSPI Dam Register

				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
MERSEY	Deep Brook Canal Embankment Dam	Impervious Fill	Headpond	8	2,570	108	108				2,570	2.4	100	1	included above	6,940			27,760	included above	27,760	assume 20 foot wide base and 3:1 sliopes
MERSEY	Deep Brook Right Wing Dam	Clay	Headpond	9	280	108	108				280	2.7	99	1	included above					included above		
MERSEY	Deep Brook Main Dam	Impervious Fill	Headpond	48	2,600	108	104				2,600	14.6	60	3	included above					included above		
MERSEY	Cowie Falls Left Wing Dam	Earth	Headpond	26	100	62	58.5				100	7.9	36	1	19,537,400				Included in Infrastructure Removal Costs	2,931,000	22,468,400	
MERSEY	Cowie Falls Spillway	n/a	Headpond	31	159	49	n/a	141			300	9.4	18	1	included above					included above		
MERSEY	Cowie Falls Sluiceway	n/a	Headpond	34	61	49	n/a	34.5			95	10.4	15	1	included above					included above		
MERSEY	Cowie Falls Main Dam	Concrete	Headpond	33	750	62	58				750	10.1	29	1	included above					included above		
MERSEY	Cowie Falls Wing Dam 1	Timber	Headpond	13	750	62	58				750	4.0	49	1	included above					included above		
MERSEY	Cowie Falls Wing Dam 2	Impervious Fill	Headpond	4	75	62	62				75	1.2	58	1	included above					included above		
MERSEY	Cowie Falls Wing Dam 3	Impervious Fill	Headpond	4	100	62	62				100	1.2	58	1	included above					included above		
MERSEY	Cowie Falls Wing Dam 4	Impervious Fill	Headpond	5	70	62	62				70	1.5	57	1	included above					included above		
MERSEY	Cowie Falls Wing Dam 5	Impervious Fill	Headpond	3	30	62	62				30	0.9	59	1	included above					included above		
MERSEY	Jordan Lake Main Outlet Weir	n/a	Storage	6	8	295.3	n/a				8	1.8	289	1	121,303					included above	121,303	
MERSEY	Jordan Lake Main Outlet Dykes (Dykes 3 & 4)	Impervious Fill	Storage	13.8	217	299.9	300.85				217	4.2	286	1	642,655					included above	642,655	
MERSEY	Jordan Lake Driving Canal Weir	n/a	Storage	4.9	50	295.7	n/a				50	1.5	291	1	80,873					included above	80,873	
MERSEY	Jordan Lake Driving Canal Dykes (Dykes 1 & 2)	Impervious Fill	Storage	8.9	249	299.8	299.8				249	2.7	291	1	267,090					included above	267,090	
MERSEY	Jordan Lake Main Dam (including Dykes 5, 6 & 7)	Impervious Fill	Storage	8.2	1,304	300.85	300.2				1,304	2.5	293	1	226,694					included above	226,694	
MERSEY	Sixth Lake Outlet Dykes	Impervious Fill	Storage	9.8	571	286.9	286.7				571	3.0	277	1	323,895					included above	323,895	
MERSEY	Sixth Lake Outlet Weir	n/a	Storage	4.6	33	281.5	n/a	32.8			66	1.4	277	1	71,265					included above	71,265	
															$ 105,064,000						$ 120,619,000	
NICTAUX	Big Molly Upsim Curl Hole Dam	Impervious Fill	Storage	23	480	616	614			N/A	480	7.0	593	1	1,786,796		282,920	33	7,822,137	363,000	9,971,932	
NICTAUX	Earth/Rockfill Dykes	Earthfill	Storage	4		612	612			n/a		1.2	608	1	53,873					included above	53,873	
NICTAUX	Earth/Rockfill Overflow	Clay and Timber	Storage	4	115	610.8	n/a	115			230	1.2	607	1	53,873					included above	53,873	
NICTAUX	Curl Hole Timber Spillway	n/a	Storage	6.5	84	611	n/a	84			168	2.0	605	1	142,383					included above	142,383	
NICTAUX	Curl Hole Concrete Spillway 1	n/a	Storage	9	96	611	n/a	96			192	2.7	602	1	273,131					included above	273,131	
NICTAUX	Curl Hole Concrete Spillway 2	n/a	Storage	9	141	611	n/a	141			282	2.7	602	1	273,131					included above	273,131	
NICTAUX	McGill Lake Dam	Impervious Fill	Storage	26.5	355	601.5	600	130			485	8.1	575	1	2,372,584		124,700	37	3,972,339	363,000	6,707,923	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Date Updated: Friday, August 24, 2018

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				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infrastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
NICTAUX	Scragg Lake Dam	Impervious Fill	Storage	13	1,000	626	625	50			1,050	4.0	613	1	570,243		65,085	18	1,017,087	363,000	1,950,330	
NICTAUX	Nictaux Main Dam	Impervious Fill	Headpond	96.5	1,200	497	494	800			2,000	29.4	401	2	31,535,146					6,600,000	38,135,146	
NICTAUX	Nictaux Canal Embankment	Impervious Fill	Canal	60	17,160	493.5	493.5				17,160	18.3	434	1	assume left in place and revegetated	129,400			517,600	included above	517,600	assume 20 foot wide base and 3:1 sliopes
NICTAUX	Powerhouse Dam	n/a	Storage	19	176	117.5	n/a	176			352	5.8	99	1	1,218,925					included above	1,218,925	
															38,280,000				13,329,163	7,689,000	59,298,000	
PARADISE	Paradise Lake Dam	Impervious Fill	Storage	21	830	718	715			n/a	830	6.4	697		1,488,906		73,968	30	1,867,214	363,000	3,719,121	
PARADISE	Roxbury Main Dam	Impervious Fill	Storage	13	520	717	715	162		712	682	4.6	704	1	768,714		73,968	18	1,155,895	363,000	2,287,609	
PARADISE	Roxbury Wing Dam No. 1	Impervious Fill	Storage	9	288	717	719			n/a	288	3.0	708	1	326,706		73,968	13	800,235	363,000	1,489,941	
PARADISE	Roxbury Wing Dam No. 2	Impervious Fill	Storage	11	185	717	719			n/a	185	4.0	706	1	581,112		73,968	16	978,065	363,000	1,922,177	
PARADISE	Corbett Lake Dam	Impervious Fill	Storage	21	350	683.1	682			n/a	350	6.7	662	1	1,631,898		38,485	30	971,504	363,000	2,966,402	
PARADISE	Neives Lake Dam	Impervious Fill	Storage	8	336	682	682	72		676.2	408	5.8	674	1	1,222,606		49,380	11	474,870	363,000	2,060,476	
PARADISE	Saunders Pond Dam	Impervious Fill	Headpond	12	1,800	621	620	212		616	2,012	4.6	609	2	768,714		45,100	17	650,567	363,000	1,782,281	
															6,789,000				6,898,349	2,541,000	16,228,000	
ROSEWAY	Spillway Dam	n/a	Stroage	17.1	216	67.1	n/a	171		63.22	387	5.2	50	1	3,158,692				Included in Infrastructure Removal Costs	Included in Infrastructure Removal Costs	3,158,692	Report Done in 2013 Costs were escalated to 2018, unclear whether this includes environmental costs
ROSEWAY	Power Canal Dykes	Impervious Fill	Stroage	15.4	518	65.4	62.5			n/a	518	4.7	50	1	included above	1,759				included above		assume 20 foot wide base and 3:1 sliopes
ROSEWAY	Saddle Dam	Impervious Fill	Stroage	6.6	197	65.9	n/a			n/a	197	2.0	59	1	included above					included above		
ROSEWAY	Spillway Embankment Dam	Impervious Fill	Stroage	13.8	89	66.0	n/a			n/a	89	4.2	52	1	included above					included above		
ROSEWAY	Intake Structure	n/a	Headpond	14.8	25	65.9	n/a			n/a	25	4.5	51	1	included above					included above		
															3,159,000						3,159,000	
SHEET HARBOUR	Malay Falls Main Dam	Impervious Fill w/Blanket	Headpond	20	98	155.5	154.5	480		148	578	7.6	136	1	2,100,240					363,000	2,463,240	
SHEET HARBOUR	Malay Falls left and right Canal Dykes	Impervious Fill w/Blanket	Headpond	28	1,100	157	316.5			n/a	1,100	8.5	129	1	assume left in place and revegetated	5,023			20,090	included above	20,090	assume 20 foot wide base and 3:1 sliopes
SHEET HARBOUR	Ruth Falls Main and wing dams	Concrete	Headpond	32.8	775	116	111	415		104	1,190	6.1	83	1	1,352,476		55,580	46	2,191,423	363,000	3,906,900	
SHEET HARBOUR	Ruth Falls Spillway and sluiceAspillway and Sluce	Concrete	Headpond	32.8	445	116					445	10.0	83	1	3,636,171					included above	3,636,171	
SHEET HARBOUR	Ruth Falls Power Canal	HDPE Liner	Headpond	20.3	8,000	114.5	112			n/a	8,000	6.2	94	1	assume left in place and revegetated	30,795			123,179	included above	123,179	assume 20 foot wide base and 3:1 sliopes
SHEET HARBOUR	Marshall Falls Main Dam	Concrete	Storage	28	1,200	199.4	198.4	190		184	1,390	9.8	171	1	3,493,757		149,225	40	5,022,657	363,000	8,879,414	
SHEET HARBOUR	Governor Lake Dam	None	Storage	10	910	571.1	570.1	35		567.6	945	3.1	561	1	348,870		176,000	14	2,115,663	363,000	2,827,534	

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NSPI Dam Register

System	Development	Core Material	Purpose	Structure Data (ft)				Spillway Data (ft)			Total Length (ft)	ANALYSIS										
				Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation		Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
SHEET HARBOUR	Sloane Lake Dam	Timber	Storage	10	1,757	425.1	423.1	421.1		42	2,178	3.1	415	2	348,870		85,290	14	1,025,255	363,000	1,737,126	
SHEET HARBOUR	Anti Dam	Impervious Fill w/Blanket	Storage	35	370	318.5	317.5	243.25		311.5	613	10.4	284	1	3,935,081		71,280	49	2,998,953	3,520,000	10,454,034	
															15,215,000				13,497,222	5,335,000	34,048,000	
SISSIBOO	Fourth Lake Main Dam	Impervious Fill	Headpond	75	1,450	490	490			n/a	1,450	22.9	415	1	19,039,946		110,544	106	9,966,218	6,600,000	35,606,163	
SISSIBOO	Fourth Lake Wing Dam 1	Earthfill	Headpond	37	2,000	490	487.5			n/a	2,000	11.3	453	2	4,628,010		110,544	52	4,916,667	3,520,000	13,064,677	
SISSIBOO	Fourth Lake Wing Dam 2	Impervious Fill	Headpond	60	1,680	490	487.5			n/a	1,680	18.3	430	2	12,196,677		110,544	85	7,978,206	3,520,000	23,694,883	
SISSIBOO	Fourth Lake Wing Dam 3	Earthfill	Headpond	20	790	490	487.5	75		478	865	6.1	470	1	1,352,509		110,544	28	2,659,402	363,000	4,374,911	
SISSIBOO	Fourth Lake Musquash Dam	Earthfill	Headpond	8	350	488	488			n/a	350	2.4	480	1	215,761		110,544	11	1,063,063	363,000	1,641,825	
SISSIBOO	Sissiboo Grand Lake Spillway (Rockfill)	Timber Corewall	Storage	9	380	380.4	384			n/a	380	2.7	371	1	273,131					included above	273,131	
SISSIBOO	Sissiboo Grand Lake Spillway (Timber)	n/a	Storage	15	213	379.4	n/a	213		379.4	426	4.6	364	1	758,730					included above	758,730	
SISSIBOO	Sissiboo Grand Lake Wing Dykes	Earthfill	Storage	6	436	384.4	384.4			n/a	436	1.8	378	1	121,303		68,290	8	492,541	363,000	976,844	
SISSIBOO	Sissiboo Falls Concrete Dam	n/a	Headpond	70	510	223.5	n/a	280		208	790	21.3	154	1	16,583,849		58,490	99	4,921,682	6,600,000	28,105,531	
SISSIBOO	Sissiboo Falls Embankment Dam	Concrete Corewall	Headpond	35	1,100	223.5	219.45				1,100	10.7	189	1	4,140,793					included above	4,140,793	
SISSIBOO	Weymouth Falls Main Dam	Impervious Fill	Headpond	105	700	139.5	139				700	32.0	35	1	37,331,563					6,600,000	43,931,563	
SISSIBOO	Weymouth Falls Wing Dam	Earthfill	Headpond	105	700	139.5	139	325.5		128	1,026	21.3	35	1	16,527,480					6,600,000	23,127,480	
SISSIBOO	Weymouth Falls Intake Structure	n/a	Headpond	30	152	139.5	n/a			n/a	152	9.1	110	1	3,041,371					included above	3,041,371	
SISSIBOO	Tom Wallace Dam	Earthfill	Storage	6	173	473.7	473.7			n/a	173	3.7	468	1	497,144					363,000	860,144	
															116,708,000				31,997,779	34,892,000	183,598,000	
St. MARGARETS	Coon Pond Dam	n/a	Headpond	32	258	260.0	n/a	150	24	254.9	408	9.1	228	1	2,061,000				Included in Infrastructure Removal Costs	1,000,000	3,061,000	
St. MARGARETS	Sandy Lake Dam	Concrete/Earthfill	Headpond	50.5	798	223.5	221.5	223	54.5	216.5	1,021	15.4	173	1	6,880,000				Included in Infrastructure Removal Costs	1,700,000	8,580,000	
St. MARGARETS	Big Indian Spillway	n/a	Storage	25.1	430	240.0	n/a				430	7.7	215	1	2,898,000				Included in Infrastructure Removal Costs	1,450,000	4,348,000	
St. MARGARETS	Big Indian Main Dam (Concrete)	n/a	Storage	37.9	470	244.6	n/a				470	11.6	207	1	included above					included above		
St. MARGARETS	Big Indian Main Dam (Earthfill)	Concrete	Storage	33.3	120	244.6	244.6				120	10.1	211	1	included above					included above		
St. MARGARETS	Big Indian Wing Dam No. 1	Earthfill (None)	Storage	4	75	244.6	243.6				75	1.2	241	1	included above					included above		
St. MARGARETS	Big Indian Wing Dam No. 2	Earthfill (None)	Storage	2.5	85	244.6	243.6				85	0.8	242	1	included above					included above		
St. MARGARETS	Five Mile Lake Main Dam	n/a	Storage	14.5	695	444.5	n/a				695	4.9	430	1	4,580,000				Included in Infrastructure Removal Costs	1,200,000	5,780,000	
St. MARGARETS	Mack Lake Dam	Timber	Storage	20	410	446	446				410	6.1	426	1	1,350,734					1,350,734	2,701,469	

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NSPI Dam Register

System	Development	Core Material	Purpose	Structure Data (ft)				Spillway Data (ft)			Total Length (ft)	ANALYSIS										
				Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation		Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
St. MARGARETS	Five Mile Lake Wing Dam No. 1	Timber	Storage	6	200	445.3	445				200	1.8	439	1	included above					included above		
St. MARGARETS	Five Mile Lake Wing Dam No. 2	Timber	Storage	4	165	445.3	445				165	1.2	441	1	included above					included above		
St. MARGARETS	Five Mile Lake Wing Dam No. 3	Timber	Storage	4	105	446.0	446				105	1.2	442	1	included above					included above		
St. MARGARETS	Five Mile Lake Wing Dam No. 4	Timber	Storage	10	500	448.5	445				500	3.0	439	1	included above					included above		
St. MARGARETS	Beeswanger Dam	Timber	Storage	8	460	447.5	447				460	2.4	440	1	215,761					215,761	431,523	
St. MARGARETS	Wrights Lake Dam	Concrete	Storage	17	31	276	n/a	295	15	271.6	326	3.4	259	1	2,887,000				Included in Infrastructure Removal Costs	1,800,000	4,687,000	
St. MARGARETS	Wrights Lake Wing Dam No. 1	n/a	Storage	4	20	276.0	n/a				20	1.2	272	1	included above					included above		
St. MARGARETS	Wrights Lake Wing Dam No. 2	n/a	Storage	3.5	20	276.0	n/a				20	1.1	273	1	included above					included above		
St. MARGARETS	Wrights Lake Wing Dam No. 3	n/a	Storage	5	35	276.0	n/a				35	1.5	271	1	included above					included above		
St. MARGARETS	Little Indian Lake Cross-over Control Structure	Concrete	Storage	4	170	104.8	104.8				170	2.1	101	1	368,000				Included in Infrastructure Removal Costs	160,000	528,000	
St. MARGARETS	Mill Lake Dam (Tidewater)	Concrete	Headpond	20	830	93.5	93.5				830	3.0	74	1	1,823,000				Included in Infrastructure Removal Costs	1,100,000	2,923,000	
															23,063,000					9,976,496	33,040,000	
TUSKET	Tusket Main Dam	None (Earthfill)	Headpond	29	226	30	29				226	8.8	1	1	3,435,691					2,035,362	5,471,053	
TUSKET	Tusket Powerhouse Dam	Timber	Headpond	25	580	30	29				580	7.6	5	1	4,747,500					2,812,500	7,560,000	Includes Powerhouse
TUSKET	Tusket Canal Embankment	None (Earthfill)	Headpond	12	2,300	32	31				2,300	1.8	20	2	1,124,408					666,118	1,790,526	
TUSKET	Tusket Western Wing Dam	Timber	Headpond	10	150	30	29				150	3.1	20	1	included above					included above		
TUSKET	Carleton Lake Dam and spillway	Earthfill	Stroage	25	995	54.5	51.5	180	24	46	1,175	7.6	30	1	3,560,625					2,109,375	5,670,000	
TUSKET	Great Barren Lake Dam and spillway	None (Earthfill)	Stroage	18.8	1,056	138	134	140		130.2	1,196	4.6	119	1	4,747,500					2,812,500	7,560,000	
TUSKET	Mink Lake Dam/Spillway	Steel Sheet Pile	Stroage	7.8	112	83.3	n/a				112	2.4	76	1	1,374,276					814,145	2,188,421	
															18,990,000					11,250,000	30,240,000	
WRECK COVE	D-1 Cheticamp Flowage	Glacial Till	Storage	49	3,275	1,532.5	1,527	250	3	1,522	3,525	14.9	1,484	4	assume left in place and revegetated	22,978			91,910	N/A	91,910	assume 20 foot wide base and 3:1 sliopes
WRECK COVE	D-2 Ingonish I	Glacial Till	Storage	34	950	1,446.5	1,445	140	5.5	1,442	1,090	10.4	1,413	1	3,907,352		6,154	48	251,519	3,520,000	7,678,871	
WRECK COVE	D-3 Ingonish II	Earthfill (None)	Storage	47	1,875	1,440	1,439	98.4		1,434	1,973	14.3	1,393	2	7,470,911		10,360	66	585,318	3,520,000	11,576,229	
WRECK COVE	D-4 South Gisborne	Glacial Till	Storage	92.5	2,550	1,289.5	1,288	260	6	1,280	2,810	27.4	1,197	3	27,361,848		27,353	131	3,041,394	6,600,000	37,003,242	
WRECK COVE	D-5 East Gisborne	Glacial Till	Storage	43	1,395	1,287	1,286			n/a	1,395	13.1	1,244	1	6,252,378		27,353	61	1,413,837	3,520,000	11,186,215	
WRECK COVE	D-6-1 McLeod Brook	Earthfill (None)	Storage	72	1,609	1,287	1,286			n/a	1,609	21.7	1,215	2	17,154,633		27,353	102	2,367,355	3,520,000	23,041,989	
WRECK COVE	D-6-2	Glacial Till	Storage	10	1,200	1,287	1,286			n/a	1,200	3.0	1,277	1	337,263		27,353	14	328,799	included above	666,062	

Date Updated: Friday, August 24, 2018

NSPI Dam Register

				Structure Data (ft)				Spillway Data (ft)				ANALYSIS										
System	Development	Core Material	Purpose	Height (ft)	Length (ft)	Crest Elevation (ft)	Top of Core	Length	Height	Crest Elevation	Total Length (ft)	Ht. (m)	Foundation el. (ft)	Equivlent number of structures (benchmarking) - assume Normal benchmark up to 820 ft	Infastructure Removal Cost ($2018)	Exposed area Canals (m2)	Perimeter (ft)	Exposed Shoreline Length (ft)	Site Restoration Costs	Environmental Costs	Total Decommissioning Cost	Environmental mitigation assumptions
WRECK COVE	D-7 McMillian Flowage	Glacial Till	Storage	170	1,620	1,337	1,333	375	3.33	1,326	1,995	51.8	1,167	2	assume left in place and revegetated	35,434			141,737	N/A	141,737	assume 20 foot wide base and 3:1 sliopes
WRECK COVE	D-8-1 Wreck Cove Lakes	Glacial Till	Storage	30	2,412	1,206	1,205				2,412	9.1	1,176	3	3,041,371		6,069	42	218,859	363,000	3,623,230	
WRECK COVE	D-8-2	Glacial Till	Storage	11.2	857	1,206	1,205				857	3.4	1,195	1	423,148		6,069	16	81,707	included above	504,856	
WRECK COVE	D-8-3	Glacial Till	Storage	9.8	983	1,206	1,205				983	3.0	1,196	1	323,895		6,069	14	71,494	included above	395,389	
WRECK COVE	D-8-4	Glacial Till	Storage	20	1,166	1,206	1,205				1,166	6.1	1,186	1	1,350,734		6,069	28	145,906	included above	1,496,640	
WRECK COVE	D-8-5	Glacial Till	Storage	30.8	1,536	1,206	1,205				1,536	9.4	1,175	2	3,205,892		6,069	44	224,695	included above	3,430,587	
WRECK COVE	D-8-6	Glacial Till	Storage	22	620	1,206	1,205				620	6.7	1,184	1	1,634,669		6,069	31	160,497	included above	1,795,165	
WRECK COVE	D-8-7	Glacial Till	Storage	9.8	341	1,206	1,205				341	3.0	1,196	1	323,895		6,069	14	71,494	included above	395,389	
WRECK COVE	D-9 Wreck Cove Brook	Glacial Till	Storage	51.8	747	1,206	1,205	114	11	1,200	861	15.8	1,154	1	9,076,395		6,069	73	377,897	3,520,000	12,974,291	
WRECK COVE	D-10 Long Lake	Glacial Till	Storage	33.1	1,170	1,206	1,205				1,170	10.1	1,173	1	3,703,051		6,069	47	241,474	3,520,000	7,464,526	
WRECK COVE	D-11-1 Surge Lake	Glacial Till	Headpond	76.1	611	1,206	1,204				611	23.2	1,130	1	19,603,060		1,923	108	175,943	3,520,000	23,299,003	
WRECK COVE	D-11-2	Glacial Till	Headpond	44	1,594	1,206	1,204				1,594	13.4	1,162	2	6,546,839		1,923	62	101,728	3,520,000	10,168,567	
WRECK COVE	D-11-3	Glacial Till	Headpond	17.1	145	1,206	1,204				145	5.2	1,189	1	987,142		1,923	24	39,535	121,000	1,147,677	
WRECK COVE	South Lake Dam	Glacial Till	Storage	12.1	268	1,169	1,168	23.5	5.83	1,163	292	3.7	1,157	1	493,955		11,640	17	169,306	121,000	784,261	
															113,198,000				10,302,405	35,365,000	158,866,000	

DAMS

Notes:
Ten Mile Lake Dam in the Sheet Harbour Hydro System was removed from the prioritization spreadsheet because it was decommissioned in 2013
Uniacke Lake Dam in the Sissiboo Hydro System was decommissioned in 2011.
Kempt Back Lake Dam in the Tusket Hydro System was decommissioned in 2009.

Appendix B
Dam Decommissioning Database Methodology – Environmental Costs

B.1 Introduction

An existing Hatch excel file with dam decommissioning costs was utilized as the basis of the dam decommissioning database. This database compiled 140-150 dam decommissioning projects in North America and the dam characteristics (e.g. size, height, type, volume, surface area, reason for removal and engineering costs etc.) In addition, academic literature and external sources (roughly 250- 300 sources) were reviewed to determine which environmental and social components should be considered when estimating the environmental costs of decommissioning. Also, several Hatch projects were assessed to determine the percentage of total costs from previous projects which was allocated to environmental components. For non-Hatch projects, it was determined that 22 % of the total costs was the standard percentage allocated to environmental engineering costs (Pansic et al., 1995 (1)). This document will review environmental components, the scoring criteria, environmental division score and cost estimates from the Dam Decommissioning Cost Database.

B.2 Environmental Components and Scoring Criteria

The dams were categorized into three sizes based on height, volume and surface area (small, medium and large). Based off the research conducted, environmental and social components such as associated fisheries, stakeholder interest, recreational usage, contaminated sediments, industrial use at the project location and inundation reduction were taken into consideration when examining environmental costs (Figure, D-1).

Dam Decommissioning - North America

	A	Dam Name	Location	Hydropower?	Hatch Involved?	Estimate?	Type	Volume (m3)	Surface Area (km2)	Height (ft)	Height (m)	Dam Size	Date Removed or Estimate Date	Removal Cost (USD)	Removal Cost (USD_{2018})	Removal Cost (CAD2018)	Environmental Engineering Cost (CAD) *assume environmental cost is 22% of the total cost (Pandic et al 1995)	Reason for Removal	Associated Fisheries	Stakeholder interest/recreational use	Contaminated Sediment/Industrial use	Inundation reduction
4	1	Alameda Park	Pennsylvania	No	No	Yes	-	-	-	9	2.7	Small	2007	$ 52,500	$ 63,683	$ 79,603	$ 17,513	Partially failed	No	High	Unknown	Minimal
5	2	Alphonso	Oregon	No	No	Yes	-	-	-	10	3.0	Small	1999	$ 55,000	$ 83,050	$ 103,813	$ 22,839	Fish passage	Yes	Unknown	Unknown	Minimal
7	4	Ball Park Dam	Wisconsin	Unknown	No	Yes	-	-	-	11	3.4	Small	2004	$ 125,000	$ 166,500	$ 208,125	$ 45,788	Public safety	No	Unknown	Unknown	Minimal
9	6	Behrend Capped Waterfall Dam	Pennsylvania	No	No	No	Concrete	-	-	2.5	0.8	Small	2007	$ 10,000	$ 12,130	$ 15,163	$ 3,336	Disrepair	No	Unknown	Unknown	Minimal
10	7	Benbow Dam	California	No	No	No	Concrete	-	-	20	6.1	Intermediate	2016	$ 2,430,000	$ 2,546,640	$ 3,183,300	$ 700,326	Fish passage	Yes	High	Unknown	Minimal
11	8	Big Spring	Wisconsin	No	No	Yes	Gravity and earthfill	-	-	18	5.5	Small	2007	$ 300,000	$ 363,900	$ 454,875	$ 100,073	Safety concerns	No	Medium	Unknown	Minimal
12	9	Cedar Run	Pennsylvania	No	No	Yes	Concrete	-	-	3	0.9	Small	2007	$ 17,200	$ 20,864	$ 26,080	$ 5,737	Fish passage	Yes	Medium	Unknown	Minimal
16	12	Charlotte City Dam	Michigan	No	No	No	Earthfill	-	-	8	2.4	Small	2003	$ 160,710	$ 219,691	$ 274,613	$ 60,415	Improve water quality and habitat for aquatic life	Yes	Unknown	Unknown	Minimal
17	13	Cheltenham	Pennsylvania	No	No	No	Concrete/ masonry	-	-	9	2.7	Small	2008	$ 187,000	$ 218,603	$ 273,254	$ 60,116	Public safety hazard	No	Unknown	Unknown	Minimal
18	14	City of Charlotte	Michigan	No	No	No	Concrete	-	-	6	1.8	Small	2006	$ 180,000	$ 224,640	$ 280,800	$ 61,776	Fish passage	Yes	Unknown	Unknown	Minimal
19	15	Copemish	Michigan	No	No	No	Earthfill	-	-	8	2.4	Small	2003	$ 50,000	$ 68,350	$ 85,438	$ 18,796	Fish passage	Yes	High	Unknown	Minimal
22	16	Crocker Creek	California	No	No	No	Concrete	-	-	30	9.1	Small	2002	$ 460,000	$ 643,080	$ 803,850	$ 176,847	Abandoned	No	Unknown	Unknown	Minimal
23	17	Crooks' Hollow (H337415)	Ontario	No	Yes	No	Concrete	-	-	-	5.5	Small	2013	-	-	$ 1,084,600	$ 238,612	Improve habitat for aquatic life	Yes	High	Yes	Minimal
25	18	Dayton	Pennsylvania	No	No	No	Rock and earthfill	-	-	6	1.8	Small	2010	$ 44,000	$ 50,776	$ 63,470	$ 13,963	Lack of use (previously for water supply)	No	Unknown	Unknown	Minimal
27	19	Dennison	Ohio	Yes	No	No	Concrete	-	-	2	0.6	Small	2002	$ 17,000	$ 23,766	$ 29,708	$ 6,536	Improve water quality and habitat for aquatic life	Yes	High	Unknown	Minimal
28	20	Dimondale	Michigan	No	No	Yes	Earthfill	-	-	5	1.5	Small	2006	$ 442,400	$ 552,115	$ 690,144	$ 151,832	Substantially	No	Unknown	Unknown	Minimal
31	21	Elwha	Washington State	Yes	No	Yes	Concrete	-	-	108	32.9	Large	2012	$ 308,000,000	$ 337,568,000	$ 346,344,768	$ 76,195,849	Sediment management	No	High	Unknown	Major
32	22	Finlayson dam	Ontario	No	Yes	No	Gravity sluiceway	1,170,000	-	16.4	5.0	Small	1999	-	-	$ 387,118	$ 85,166	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal
33	23	Four Hill Flowage	Wisconsin	Unknown	No	Yes		-	-	13	4.0	Small	2008	$ 40,000	$ 46,760	$ 58,450	$ 12,859	Environmental concerns	No	Unknown	Unknown	Minimal
34	24	Franklin	Wisconsin	No	No	No	Concrete	-	-	13	4.0	Small	2001	$ 190,000	$ 269,990	$ 337,488	$ 74,247	Improve water quality and habitat for aquatic life	Yes	Unknown	Unknown	Minimal
35	26	Franklin Mill Dam	Pennsylvania	Unknown	No	No	Concrete	-	-	4	1.2	Small	2000	$ 14,000	$ 20,454	$ 25,568	$ 5,625	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal
37	28	Fulton	Wisconsin	Yes	No			-	-	16	4.9	Small	1993	$ 375,784	$ 654,240	$ 817,800	$ 179,916		Unknown	Unknown	Unknown	Minimal
40	30	Glade Run	Pennsylvania	Unknown	No	Yes	Concrete/ masonry	-	19.80	3	0.9	Small	2007	$ 10,000	$ 12,130	$ 15,163	$ 3,336	Enhance fisheries	Yes	Unknown	Unknown	Minimal
41	31	Goldsboro	Pennsylvania	No	No	No	Timber	1,233	-	4	1.2	Small	2005	$ 45,000	$ 57,960	$ 72,450	$ 15,939	Fish passage	Yes	High	Unknown	Minimal
42	32	Good Hope	Pennsylvania	No	No	Yes	Concrete	-	-	8	2.4	Small	2001	$ 300,000	$ 426,300	$ 532,875	$ 117,233	Fish passage	Yes	Unknown	Unknown	Minimal
43	33	Graceland	Pennsylvania	No	No	Yes	Concrete and earthfill	-	-	17	5.2	Small	2006	$ 30,000	$ 37,440	$ 46,800	$ 10,296	Public safety hazard	No	Unknown	Unknown	Minimal
45	34	Grayling Dam	Michigan	Unknown	No	No		-	-	9	2.7	Small	2005	$ 391,925	$ 504,799	$ 630,999	$ 138,820	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal
46	35	Gruendyke Mill	New Jersey	No	No	Yes	Concrete/ masonry	-	-	7	2.1	Small	2000	$ 200,000	$ 292,200	$ 365,250	$ 80,355	Flood damage and fish passage	Yes	High	Unknown	Minimal
47	36	Hackenberg	Pennsylvania	Unknown	No	No	Concrete	-	-	4	1.2	Small	2006	$ 6,000	$ 7,488	$ 9,360	$ 2,059	Fish passage	Yes	Unknown	Unknown	Minimal
49	37	Heilman	Pennsylvania	Unknown	No	Yes		144,317	-	15	4.6	Small	2007	$ 120,000	$ 145,560	$ 181,950	$ 40,029	Public safety	No	Unknown	Unknown	Minimal
50	38	Icicle Creek Dams	Washington	No	No	No	Concrete	-	551	10	3.0	Small	2003	$ 228,000	$ 311,676	$ 389,595	$ 85,711	Fish passage	Yes	Unknown	Unknown	Minimal
51	39	Intake Dam	Pennsylvania	No	No	No		-	-	8	2.4	Small	2001	$ 15,000	$ 21,315	$ 26,644	$ 5,862	Public safety	Yes	Unknown	Unknown	Minimal
52	40	Iron Stone Mine Dam	Pennsylvania	Unknown	No	No	Concrete	-	-	4	1.2	Small	2006	$ 83,000	$ 103,584	$ 129,480	$ 28,486	Fish passage	Yes	Unknown	Unknown	Minimal
53	41	James Ford's Dam	Pennsylvania	Unknown	No	No	Masonry/ timber	200,000,000	-	5	1.5	Small	2006	$ 46,000	$ 57,408	$ 71,760	$ 15,787	Fish passage	Yes	Unknown	Unknown	Minimal
57	42	Lower Saucon	Pennsylvania	No	No	No	Concrete	-	-	2	0.6	Small	2010	$ 13,200	$ 15,233	$ 19,041	$ 4,189	Safety concerns	No	Unknown	Unknown	Minimal
59	43	Main Street Dam	Pennsylvania	Yes	No	No	Concrete	-	-	12	3.7	Small	2004	$ 30,000	$ 39,960	$ 49,950	$ 10,989	Improve habitat for aquatic life; public safety hazard	Yes	Unknown	Unknown	Minimal
60	44	Manchester	Wisconsin	Unknown	No	Yes	Concrete and earthfill	-	-	16	4.9	Small	2005	$ 50,000	$ 64,400	$ 80,500	$ 17,710	Public safety hazard	No	High	Unknown	Minimal
61	45	Manchester Mill Dam	Wisconsin	No	No	No	Concrete and earthfill	-	-	12	3.7	Small	2006	$ 20,000	$ 24,960	$ 31,200	$ 6,864	Public safety hazard	No	Unknown	Unknown	Minimal
62	46	Mann Dams	Pennsylvania	Unknown	No	Yes		-	-	4	1.2	Small	2008	$ 70,000	$ 81,830	$ 102,288	$ 22,503	Enhance water quality and fisheries	Yes	Unknown	Unknown	Minimal
63	47	Marquette City Dam	Michigan	Yes	No	Yes	Concrete	-	-	10	3.0	Small	2004	$ 200,000	$ 266,400	$ 333,000	$ 73,260	Fish passage	Yes	Unknown	Unknown	Minimal
64	48	Martins Dam	Pennsylvania	No	No	No	Masonry	-	-	4	1.2	Small	2000	$ 20,000	$ 29,220	$ 36,525	$ 8,036	Public safety	No	Medium	Unknown	Minimal
65	49	McCoy-Linn	Pennsylvania	Unknown	No	Yes	Concrete	-	0.02	12	3.7	Small	2007	$ 406,600	$ 493,206	$ 616,507	$ 135,632	Partially failed	Yes	High	Unknown	Minimal
66	50	Meisers Mill Dam	Pennsylvania	Unknown	No	No		-	-	5	1.5	Small	2001	$ 5,000	$ 7,105	$ 8,881	$ 1,954	Partially failed	No	Unknown	Unknown	Minimal

Figure B-1: Environmental and Social Components Identified During Dam Decommissioning Projects

Table D-1 below highlights the scoring criteria which was developed to rank the level of concern with the environmental components identified.

Table D-1: Scoring Criteria for the Environmental and Social Components Identified

Environmental Component	Associated Fisheries	Stakeholder Interest/ Recreational use	Contaminated Sediment/ Industrial use	Inundation Reduction
Score	Yes (2)	High (3)	Yes (2)	Major (3)
	No/Unknown (1)	Medium (2)	No/Unknown (1)	Average (2)
		Low/Unknown (1)		Minimal/Unknown (1)

B.3 Environmental Division Score and Environmental Cost Estimates

To calculate the environmental division score, each environmental component score was added. The environmental division score is out of ten and is a benchmark which will help in estimating the environmental costs associated with varying dam sizes for future dam decommissioning projects. An environmental division score is classified as high interest if it has a Score of 8-10, medium interest if has a Score of 6-7, low interest if it has a Score 4. The dams were categorized into nine categories depending on the varying levels of environmental concerns in the project locations. These categories and the environmental cost estimates can be seen in Table D-2 below (*see Dam Decommissioning Costs Excel File for the below environmental cost ranges*).

Table D-1: Environmental Cost Estimates for Varying Dam Sizes and Relevant Environmental Concerns

Dam Size	Environmental Concerns	Environmental Cost Estimate
Small	Low	$1,700 - $1,700, 000
	Medium	$5,700 - $2, 500,000
	High	$170,000 - $3,000,000
Medium	Low	$1,100, 000 - $3,000,000
	Medium	$700,000 - $4,000,000
	High	$1,000,000 -$4, 500,000
Large	Low	$80,000 - $3,300,000
	Medium	$200,000 - $3,500,000
	High	<$76,000,000

To assess the dam size and the relevant environmental categories, select the dam size (Column L2) with the arrow feature and proceed to the environmental division score (Column W2) to select the score. This can be seen in Figure D-2 below.

Dam Decommissioning - North America																						
	Dam Name	Location	Hydropower?	Hatch Involved?	Estimate?	Type	Volume (m3)	Surface Area (km2)	Height (ft)	Height (m)	Dam Size	Date Removed or Estimate Date	Removal Cost (USD)	Removal Cost (USD2018)	Removal Cost (CAD2018)	Environmental Engineering Cost (CAD) *assume environmental cost is 22% of the to cost (Pansic et	Reason for Removal	Associated Fisheries	Stakeholder interest/recreational use	Contaminated Sediment/Industrial use	Inundation reduction	Environmental Division Score
1	Alameda Park	Pennsylvania	No	No	Yes	-	-	-	9	2.7	[illegible]	2007	$ 52,500	$ 63,683	$ 79,603	$ 17,513	Partially failed	No	High	Unknown	Minimal	[illegible]
2	Alphonso	Oregon	No	No	Yes	-	-	-	10	3.0	Small	1999	$ 55,000	$ 83,050	$ 103,813	$ 22,839	Fish passage	Yes	Unknown	Unknown	Minimal	5
4	Ball Park Dam	Wisconsin	Unknown	No	Yes	-	-	-	11	3.4	Small	2004	$ 125,000	$ 166,500	$ 208,125	$ 45,788	Public safety	No	Unknown	Unknown	Minimal	4
6	Behrend Capped Waterfall Dam	Pennsylvania	No	No	No	Concrete	-	-	2.5	0.8	Small	2007	$ 10,000	$ 12,130	$ 15,163	$ 3,336	Disrepair	No	Unknown	Unknown	Minimal	4
7	Benbow Dam	California	No	No	No	Concrete	-	-	20	6.1	Intermediate	2016	$ 2,430,000	$ 2,546,640	$ 3,183,300	$ 700,326	Fish passage	Yes	High	Unknown	Minimal	6
8	Big Spring	Wisconsin	No	No	Yes	Gravity and earthfill	-	-	18	5.5	Small	2007	$ 300,000	$ 363,900	$ 454,875	$ 100,073	Safety concerns	No	Medium	Unknown	Minimal	5
9	Cedar Run	Pennsylvania	No	No	Yes	Concrete	-	-	3	0.9	Small	2007	$ 17,200	$ 20,864	$ 26,080	$ 5,737	Fish passage	Yes	Medium	Unknown	Minimal	6
12	Charlotte City Dam	Michigan	No	No	No	Earthfill	-	-	8	2.4	Small	2003	$ 160,710	$ 219,691	$ 274,613	$ 60,415	Improve water quality and habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5
13	Cheltenham	Pennsylvania	No	No	No	Concrete/ masonry	-	-	9	2.7	Small	2008	$ 187,000	$ 218,603	$ 273,254	$ 60,116	Public safety hazard	No	Unknown	Unknown	Minimal	4
14	City of Charlotte	Michigan	No	No	No	Concrete	-	-	6	1.8	Small	2006	$ 180,000	$ 224,640	$ 280,800	$ 61,776	Fish passage	Yes	Unknown	Unknown	Minimal	5
15	Copemish	Michigan	No	No	No	Earthfill	-	-	8	2.4	Small	2003	$ 50,000	$ 68,350	$ 85,438	$ 18,796	Fish passage	Yes	High	Unknown	Minimal	7
16	Crocker Creek	California	No	No	No	Concrete	-	-	30	9.1	Small	2002	$ 460,000	$ 643,080	$ 803,850	$ 176,847	Abandoned	No	Unknown	Unknown	Minimal	8
17	Crooks' Hollow (H337415)	Ontario	No	Yes	No	Concrete	-	-	-	5.5	Small	2013	-	-	$ 1,084,600	$ 238,612	Improve habitat for aquatic life	Yes	High	Yes	Minimal	6
18	Dayton	Pennsylvania	No	No	No	Rock and earthfill	-	-	6	1.8	Small	2010	$ 44,000	$ 50,776	$ 63,470	$ 13,963	Lack of use (previously for water supply)	No	Unknown	Unknown	Minimal	4
19	Dennison	Ohio	Yes	No	No	Concrete	-	-	2	0.6	Small	2002	$ 17,000	$ 23,766	$ 29,708	$ 6,536	Improve water quality and habitat for aquatic life	Yes	High	Unknown	Minimal	7
20	Dimondale	Michigan	No	No	Yes	Earthfill	-	-	5	1.5	Small	2006	$ 442,400	$ 552,115	$ 690,144	$ 151,832	Substantially failed	No	Unknown	Unknown	Minimal	4
21	Elwha	Washington State	Yes	No	Yes	Concrete	-	-	108	32.9	Large	2012	$ 308,000,000	$ 337,568,000	$ 346,344,768	$ 76,195,849	Sediment management	No	High	Unknown	Major	8
22	Finlayson dam	Ontario	No	Yes	No	Gravity sluiceway	1,170,000	-	16.4	5.0	Small	1999	-	-	$ 387,118	$ 85,166	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5
23	Four Hill Flowage	Wisconsin	Unknown	No	Yes		-	-	13	4.0	Small	2008	$ 40,000	$ 46,760	$ 58,450	$ 12,859	Environmental concerns	No	Unknown	Unknown	Minimal	4
24	Franklin	Wisconsin	No	No	No	Concrete	-	-	13	4.0	Small	2001	$ 190,000	$ 269,990	$ 337,488	$ 74,247	Improve water quality and habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5
26	Franklin Mill Dam	Pennsylvania	Unknown	No	No	Concrete	-	-	4	1.2	Small	2000	$ 14,000	$ 20,454	$ 25,568	$ 5,625	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5
28	Fulton	Wisconsin	Yes	No			-	-	16	4.9	Small	1993	$ 375,784	$ 654,240	$ 817,800	$ 179,916		Unknown	Unknown	Unknown	Minimal	4
30	Glade Run	Pennsylvania	Unknown	No	Yes	Concrete/ masonry	-	19.80	3	0.9	Small	2007	$ 10,000	$ 12,130	$ 15,163	$ 3,336	Enhance fisheries	Yes	Unknown	Unknown	Minimal	5
31	Goldsboro	Pennsylvania	No	No	No	Timber crib	1,233	-	4	1.2	Small	2005	$ 45,000	$ 57,960	$ 72,450	$ 15,939	Fish passage	Yes	High	Unknown	Minimal	7
32	Good Hope	Pennsylvania	No	No	Yes	Concrete	-	-	8	2.4	Small	2001	$ 300,000	$ 426,300	$ 532,875	$ 117,233	Fish passage	Yes	Unknown	Unknown	Minimal	5
33	Graceland	Pennsylvania	No	No	Yes	Concrete and	-	-	17	5.2	Small	2006	$ 30,000	$ 37,440	$ 46,800	$ 10,296	Public safety hazard	No	Unknown	Unknown	Minimal	4
34	Grayling Dam	Michigan	Unknown	No	No		-	-	9	2.7	Small	2005	$ 391,925	$ 504,799	$ 630,999	$ 138,820	Improve habitat for aquatic life	Yes	Unknown	Unknown	Minimal	5
35	Gruendyke Mill	New Jersey	No	No	Yes	Concrete/ masonry	-	-	7	2.1	Small	2000	$ 200,000	$ 292,200	$ 365,250	$ 80,355	Flood damage and fish passage	Yes	High	Unknown	Minimal	7
36	Hackenberg	Pennsylvania	Unknown	No	No	Concrete	-	-	4	1.2	Small	2006	$ 6,000	$ 7,488	$ 9,360	$ 2,059	Fish passage	Yes	Unknown	Unknown	Minimal	5
37	Heilman	Pennsylvania	Unknown	No	Yes		144,317	-	15	4.6	Small	2007	$ 120,000	$ 145,560	$ 181,950	$ 40,029	Public safety	No	Unknown	Unknown	Minimal	4

Figure D-2: Selection of Dam Size and Environmental Division Score on Excel

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Partially Confidential

NOVA SCOTIA POWER INC.
HYDRO PRODUCTION

SITE DECOMMISSIONING ESTIMATE SUMMARY
FOR ASSET RETIREMENT OBLIGATIONS (ARO) STUDY
(BY SYSTEM)

PREPARED BY:

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I. CONTENTS

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2.) The report is: Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study (By System) (the "Project").
3.) Data required to support detailed engineering assessments have not always been available and in such cases engineering judgments have been made which may subsequently turn out to not be accurate. Therefore, there are risks inherent with this sort of project. The Consultant accepts no liability beyond using reasonable diligence, professional skill and care in preparing the report in accordance with the standard of care, skill and diligence expected of professional engineering firms performing substantially similar work at the time such work is performed. This is based on the circumstances the Consultant knew or ought to have known given the information it had at the date the report was written and after due inquiry based on that information.
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II. EXECUTIVE SUMMARY

Examinations and derivations of conceptual plans and related cost estimates for demolitions at 31 hydro generation sites have been carried out and are presented herein.

Planning has focused on conceptualization of logical demolition and decommissioning methodology and costs derivations for structural demolition of powerhouses at each site including removals of related generating equipment such turbo-generators, governors, wicket gates and associated components, head covers, scroll cases, main line valves and control mechanisms and portions of pipelines found within the confines of each powerhouse.

Although much of the written site demolition planning descriptions presented herein may appear similar from site to site at first glance, please note that each river hydro-electric generating system and each hydro-electric development located therein is markedly different. Therefore it has been necessary to develop demolition remediation plans that are tailor-made for each location.

In order to streamline the planning derivation and cost estimating process, where possible, similar components and arrangements at various sites have been identified and categorized so that they can be addressed similarly during this work.

The aggregate estimated demolition costs for the 31 NSPI Hydro Production sites involved in this study is approximately $34,385,000.

(Note: site cost estimates are in $CDN and do not include applicable taxes.)

Please refer to the following individual hydro-electric generation system descriptions, powerhouse demolition plan descriptions and associated spreadsheets elsewhere in this report for more detailed information.

III. POWERHOUSE DEMOLITIONS STUDY OVERVIEW

1. Introduction

The following pages and attachments represent an estimate of demolition costs associated with conceptual powerhouse decommissioning plans for each of NSPI's 31 identified hydro sites (except the Harmony Development, which has already been removed, and the Annapolis Tidal Development, which is being addressed elsewhere.).

This estimate is intended to provide a reasonable approximation of expected costs per site for conceptual demolition plans, including consideration for site security (public safety) during demolition works; worker safety; environmental protection for the site; removal from site of features and equipment associated with the powerhouse structures and their operation; removal and disposal off-site of generated demolition debris not suitable for buried disposal at site; and site environmental remediation, as appropriate. Note that demolition methodology has been derived to reflect basic safety and environmental requirements (by law and/or policy of the regulatory authority having jurisdiction and NSPI).

In-stream powerhouses will be completely removed, including concrete substructure, but where practical existing structures will be demolished to a few feet below finished grade and infilled with suitable construction debris and least costly imported granular and/or common fill. At "in-stream" locations, only clean granular fill will be utilized as backfill.

Estimated costs are compiled and presented in accordance with AACE International Recommended Practices for a Class 5 estimate and are arranged to be in conformance with Canadian Council of Ministers of the Environment (CCME) National Guidelines for the Decommissioning of Industrial Sites. The primary characteristic for a typical Class 5 estimate is that the maturity level of project definition and deliverables is at about 0 percent to 2 percent. Secondary characteristics include: the purpose for the estimate is normally for concept screening; and, methodology for derivation of the estimate includes approximations based on judgement, analogy and limited mathematical determinations. The published expected accuracy range for such an estimate shows a typical variation in low and high ranges as follows: Low is considered minus 20 percent to minus 50 percent; while High range is considered to be +30 percent to +100 percent.

According to AACE, estimate accuracy is generally driven by the following:

- Level of non-familiar technology on each project;
- Complexity of the project;
- Quality of reference cost estimating data;
- Experience and skill level of the estimator;
- Estimating techniques employed;
- Time and level of effort budgeted to prepare the estimate;
- Unique or remote nature of project locations;

- The accuracy of the composition of the input and output streams.

For this project we are addressing 31 individual powerhouse sites and therefore 31 individual projects which display their own unique characteristics, conditions and work-plan requirements. The estimate total for the 31 sites is included in the Summary and Conclusions section of this report.

Demolition methodology requirements are unique for each powerhouse site and have therefore been individually derived for each site in consideration of specific site conditions, powerhouse configuration and construction arrangement, as well as location and access condition for each powerhouse and proximity to required resources and potential disposal sites and their associated tariffs (tipping fees).

Although most powerhouses share a very general common configuration, each hydro powerhouse development is unique and will present its own set of circumstances during any planned decommissioning or demolition activities. As a result, demolition cost estimates cannot be directly extrapolated from one site to another. For example: some powerhouses (such as those found on the Mersey River) form an integral part of the gravity dam and head-works structure, while others (such as Paradise) can be located more than two miles from the main dam and intake head-works. Some sites utilize independent intake structures, gates and penstocks, while others have gated intakes incorporated into the powerhouse structure. The main powerhouse at Wreck Cove is located within a granite mountain in the Cape Breton Highlands. In various powerhouses some turbo-generators are large, others like that found at Fall River are relatively small. Some turbo-generator units are horizontal while most are vertical in orientation. For each arrangement then, a demolition plan must be formulated that adequately addresses the conditions encountered at that site.

To streamline the estimating process, we have compartmentalized the planning to take into account specific similarities in several powerhouse configurations rather than just carry out a completely independent estimate for each of the 31 sites addressed by this study. To assist with the streamlining process specific demolition categorizations are included in this study and are described in detail elsewhere in this section of the report.

Conceptual demolition plans represented by this study consider current man-hour rates, as well as current machine/equipment rates, and estimated time to complete designated demolition and/or other required tasks for each site, as per site specific conceptualized decommissioning requirements.

The costs detailed in this report are representative of demolition of assets directly associated with existing powerhouses and existing machinery and mechanical and electrical cabinets, controls and related equipment used in the generation of electricity. Demolition of equipment used in the transmission and distribution of that electricity is not included. Costs for removals of dams and/or other similar or associated structures and/or facilities including, but not limited to, intake structures and related operating equipment (except where noted otherwise), pipelines and penstocks, head-ponds, storage reservoirs, canals, spillways and other water control facilities/devices and other infrastructure not directly associated with a powerhouse structure and its generating equipment, are not included in this study.

Note that one of the parameters of this report is to minimize possible costs associated with on-going maintenance and operations of facilities expected to remain in place. Therefore, all constructed features associated with the powerhouse and its operation will be removed and the site will be remediated to reflect pre-construction or near to pre-construction condition where possible. Note that in some cases there may be cause to review and consider implementation of features and facilities that may enhance public safety at these sites. However, such examination and consideration will be best employed at a more detailed planning stage.

Please also note that the decommissioning cost estimates herein do not include broad environmental assessments or costs for unforeseen environmental clean-ups (buried dump sites, etc.). Some specific habitat restorations and related work will be required and is included as noted or described in the plan for each powerhouse site.

Costs which may be associated with obtaining demolition permits, licenses, environmental assessments and permits or for possible costs associated with land or other similar acquisitions necessary for site decommissioning work to be carried out are not included in the estimates in this study.

Removal of fish ladders or other fish passage infrastructure, unless specifically noted otherwise is not included as part of this study.

Sites subjected to demolition will be considered to be left in their natural or near natural remediated and rehabilitated state. This will necessitate the complete removal of existing structural components, including the entire powerhouse substructure.

However, in order to reduce some of the demolition costs, construction debris, such as plain and clean concrete and masonry materials, will be buried at a suitable site location where possible. Other materials, such as steel rebar, structural steel and other building materials will be removed from site and disposed of off-site at appropriately licensed disposal and recycling facilities. Sites will be left in “brown-field” condition.

A hazardous materials assessment is not included in this exercise.

Asbestos has been identified in various locations in various plant sites over the years and efforts have been undertaken to have that material removed or rendered inert when discovered. It is expected that this material will occasionally be encountered during demolition work and that special precautions will be necessary when it is encountered to ensure safe removal from site. However, there is no allowance for that work in the estimates contained herein, those costs would be additional.

Costs associated with the removal of polychlorinated biphenyls (PCB’s) and oil-filled cable are not included in this study. As well, costs associated with clean-up of PCB contaminations outside the vessels or normal containments are not included.

Finally, derivation of costs associated with archaeological assessments and specific investigations at sites of archaeological significance are not included in this study. Similarly, engagement of local Mi’kmaq communities is not included in this study, but will be carried out by others.

Specific methodology for demolition exercises at each site will vary depending upon how each contractor would plan to carry out the work and what equipment might be at the contractors’ disposal. It is the intent of this report to provide reasonable median demolition cost estimates for each site based on location, known conditions, characteristics and requirements which might affect costs.

Construction of conventional earth-fill cofferdams at each site forms a large part of costs identified in this study. These cofferdams will be required for debris containment during the demolition process and more importantly, would be required for dewatering the area of work during sub-structure removals. Silt-booms, silt fences and oil spill containment booms and provision of oil-spill clean-up tools and equipment will be required during planned demolitions. However, no costs have been included in the individual site estimates to cover any environmental clean-up activities that may be collateral to undertaken demolition work.

The demolition process would involve the procurement of services of experienced contractors and related site supervision.

Demolition contractor(s) would probably be engaged through a procurement process to ensure that only appropriately experienced contractors would be engaged. Work carried out by those crews at each site would include removal of in-plant mechanical operating equipment and related components, removal of turbo-generators and related parts, and demolition and removal of powerhouse superstructure and substructure, as required. Removal of all electrical and controls equipment directly related to transmission is not included.

Credit for limited material salvage values is included in stated pricing. This issue is discussed in more detail in this section.

The demolition contractor would be responsible for all off-site material disposals.

Site access obstructions such as fencing, ditches, or strategically located fill or boulders may be required at some sites. No permanent site road gates are considered at this time.

A general decommissioning/demolition procedure for each hydro powerhouse site will consist of the following:

1. Develop/Engineer a Demolition, Material Removal and Disposal, Site Remediation and Public Safety Plan for each site. This may involve preparation of drawings, specifications and tender documents.
2. Prepare, apply for and obtain various site specific environmental and related approvals (and permitting under the Navigable Waters Protection Act, where applicable) in order to proceed with the Planned Decommissioning Works. (Note: Costs for these activities are not included in this estimate.)
3. Tender and Award of Planned Decommissioning Works
4. Contractor General Mobilization, Removals and installation of temporary facilities as required.
5. Demolition
6. Site Remediations and Access Removals and Site Access Obstruction installation, as required.
7. Clean-up, implementation of long term site security plan as deemed necessary.

A detailed breakdown of the basic required demolition steps for the site is listed in each site descriptions in this document.

Demolition cost estimates herein also include interest and other overhead costs expected to be incurred during the demolition process. Related engineering and planning costs, as well as site supervision during demolition, are also included in each site cost estimate.

NOVA SCOTIA POWER INC. - HYDRO PRODUCTION
SITE DECOMMISSIONING ESTIMATE SUMMARY FOR ASSET RETIREMENT OBLIGATIONS (ARO) STUDY (By System)

Please note that these cost and infrastructure estimates are intended for the sole purpose of determining appropriate asset retirement obligations for system components described herein. Any use of the information contained herein for other purposes or by parties other than those for whom this work was carried out is not permitted. (Please refer to Disclaimer.)

2. Demolition Categories

Powerhouses and related structures in the Nova Scotia Power Inc. Hydro Production currently in service were erected and commissioned between the late 1920's and the 1980's. Since then building technology and related codes and guidelines have evolved and as a result the appearances and structural arrangements of the powerhouses vary greatly from system to system across the Nova Scotia Power Inc. (NSPI) Hydro Production powerhouse inventory.

Adding to that the requirement for tailor-made engineering for each powerhouse structure to specifically suit each site's topography, geology, hydrology and production requirements, mean that it is a rare occurrence when any two powerhouse designs are similar. Therefore estimates for demolition and rehabilitation for each site must be completed on a generally individual basis.

However, many powerhouses on various systems do share some basic configurations which will enable some limited streamlining of the demolition cost estimate process. For instance, some of the powerhouse structures on the Mersey River Hydro System, constructed between the 1920's and 1950's share some basic architecture and mechanical arrangements, as do some of the structures on the Black River and Avon River systems which were constructed in the 1930's to 1950's. Therefore, the planning approach for basic demolition techniques for some structural components at similar facilities may be somewhat similar.

Where powerhouse superstructures are constructed of brick and mortar or where reinforced concrete is of lighter construction or the concrete is subjected to alkali aggregate reactivity demolition, may be easier and faster than at structures where the superstructure is constructed of much heavier and much higher strength solid reinforced concrete.

Many powerhouses utilize a combination of reinforced concrete and structural steel in order to reduce the quantity of concrete utilized during original construction. Many of the powerhouse substructures will be constructed exclusively of reinforced concrete.

Some powerhouses have been constructed with multiple similar turbo-generators and related equipment, while others have non similar multiple units and others feature single stand-alone generating units.

As well, the plant intake and outlet arrangements vary from powerhouse site to site. Some powerhouses are fed water via canals and penstock pipelines, while others are fed directly through an intake or gated head works that is integrated into the dam and powerhouse structure. Where penstock pipes are above ground, foundations will generally be relatively shallow, while buried penstock pipes will suggest that a powerhouse will have a more extensive and deeper concrete substructure arrangement. Some demolition planning will be similar where inlet configurations are similar.

Powerhouse outlet/tailrace conditions will vary from site to site but where the general outflow arrangements are similar, demolition and site remediation planning will be somewhat similar. However, note that in some locations, the powerhouse draft-tube and tailrace outlet is at or near the original river bed. In other locations original rivers have been diverted to enable construction of power stations. In such circumstances, the tailrace channel can extend a considerable distance to rejoin the original river alignment. Long tailrace arrangements will therefore involve considerable (but similar) downstream remediation efforts upon powerhouse retirement.

Therefore, to assist in conceptual demolition planning efforts and site restoration estimating, we will consider three main powerhouse arrangement categorizations for each site. These categorizations will consider inlet/intake configuration and conditions, general building architecture and construction as well as outlet/draft-tube and tailrace arrangements:

I. Intake Arrangement Demolition Categories:

- Category A – Powerhouses with penstock pipeline above ground, normally at the rear of the powerhouse. This arrangement normally suggests that the powerhouse will have a shallower concrete substructure.
- Category B – Powerhouses with penstock pipeline below ground, normally at the rear of the powerhouse. This arrangement normally suggests that the powerhouse will have a deeper and more substantial concrete substructure.
- Category C – Powerhouses with concrete headworks intake structure constructed integral with dam and powerhouse. This arrangement is usually characteristic of a substantial and multi-level concrete substructure.

II. Architectural Demolition Categories:

- Category A – Above ground brick and mortar, Reinforced Concrete and structural steel superstructure with Reinforced Concrete Substructure. This arrangement is normally lightest and easiest to dismantle. With some exceptions, many of these structures were constructed prior to World War II.
- Category B – Above ground reinforced concrete superstructure and reinforced concrete Substructure. This arrangement, unless subjected to alkali aggregate reactivity is normally the strongest and most durable structural arrangement. As a result it is expected that disassembly for this arrangement will be the most difficult and time-consuming. Many of these structures were constructed after World War 2 as post-disaster structures, although some of these structures were constructed in the 1920's and 1930's.
- Category C – Other. This covers powerhouse structural arrangements that are not covered by categories A and B above.

III. Outlet, Draft-Tube and Tailrace Arrangement Categories:

- Category A – Reinforced concrete and/or steel draft tube and direct (or near direct) outflow of tailrace into the original water course. This arrangement will require the least downstream remediation work as a result of powerhouse removal.
- Category B – Reinforced Concrete and/or Steel Draft Tube and outflow to a constructed tailrace diversion channel. This arrangement will require the most downstream remedial work as a result of powerhouse removal. It will be necessary to restore the tailrace channel to pre-construction or near original conditions.

The following is a listing of how each of the powerhouse structures will be categorized under these headings:

I. Intake Arrangement Demolition Categories:

- Category A – Penstock pipe above ground at rear of powerhouse. The following powerhouses reflect this arrangement:
    - i. Avon No.1 Development
    - ii. Avon No. 2 Development
    - iii. Methals Development

iv. Hollow Bridge Development
v. Hells Gate Nos. 1 and 2 Developments
vi. White Rock Development
vii. Bear River Gulch Development
viii. Sissiboo Falls Development
ix. Weymouth, Nos. 1 and 2 Developments
x. Roseway Nos. 1 and 2 Developments
xi. Sandy Lake Nos. 1 and 2, and Coon Pond Nos. 1 and 2 (shared powerhouse structure) Developments
xii. Tidewater Nos. 1 and 2 Developments
xiii. Dickie Brook Nos. 1 and 2 Developments

- Category B – Penstock pipe below ground at rear of powerhouse. The following powerhouses reflect this arrangement:

i. Lumsden Development
ii. Nictaux Development
iii. Paradise Development
iv. Lequille Development
v. Bear River Ridge Development
vi. Fourth Lake Development
vii. Deep Brook, Nos. 1 and 2 Development
viii. Fall River Development (shallow bury)
ix. Ruth Falls, Nos 1, 2 and 3 Developments
x. Gisborne Development
xi. Wreck Cove Nos. 1 and 2 Development

- Category C – Concrete Headworks Intake Structure Integral with Dam and Powerhouse. The following powerhouses reflect this arrangement:

i. Tusket Nos. 1, 2 and 3 Development
ii. Upper Lake Falls No. 1 and 2 Development
iii. Lower Lake Falls No. 1 and 2 Development
iv. Big Falls No. 1 and 2 Development
v. Lower Great Brook No. 1 and 2 Development
vi. Cowie Falls No. 1 and 2 Development
vii. Malay Falls Nos. 1, 2 and 3 Developments

II. <u>Architectural Demolition Categories:</u>

- Category A – Above ground brick and mortar, reinforced concrete and structural steel superstructure with reinforced concrete substructure. The following powerhouses reflect this arrangement:

i. Avon No. 1 Development

ii. Avon No. 2 Development
iii. Hollow Bridge Development
iv. Lumsden Development
v. Hells Gate, Nos. 1 and 2 Developments
vi. Nictaux Development
vii. Roseway, Nos. 1 and 2 Developments
viii. Dickie Brook, Nos. 1 and 2Development

- Category B – Above Ground Reinforced Concrete Superstructure (Heavy Construction) and Reinforced Concrete Substructure. The following powerhouses reflect this arrangement:

i. Methals Development
ii. White Rock Development
iii. Paradise Development
iv. Lequille Development
v. Bear River Ridge Development
vi. Bear River Gulch Development
vii. Fourth Lake Development
viii. Sissiboo Falls Development
ix. Weymouth Falls Nos. 1 and 2 Developments
x. Tusket Nos. 1, 2 and 3 Development
xi. Upper Lake Falls, Nos. 1 and 2 Development
xii. Lower Lake Falls, Nos. 1 and 2 Development
xiii. Big Falls, Nos. 1 and 2 Development
xiv. Lower Great Brook, Nos. 1 and 2 Development
xv. Deep Brook, Nos. 1 and 2 Development
xvi. Cowie Falls, Nos. 1 and 2 Development
xvii. Sandy Lake, Nos. 1 and 2 and Coon Pond, Nos. 1 and 2 (Mill Lake) Development
xviii. Tidewater , Nos. 1 and 2Development
xix. Malay Falls, Nos. 1, 2 and 3 Developments
xx. Ruth Falls, Nos. 1, 2 and 3 Developments
xxi. Gisborne Development

- Category C – Other

i. Fall River Development
ii. Wreck Cove, Nos. 1 and 2 Development

III. Outlet, Draft-Tube and Tailrace Arrangement Categories:

- Category A – Reinforced concrete and/or steel draft tube and direct or near direct outflow to original water course. The following powerhouses reflect this arrangement:

i. Avon No.2 Development

ii. Methals Development
iii. Lumsden Development
iv. Hells Gate Nos. 1 and 2 Developments
v. Bear River Gulch Development
vi. Nictaux Development
vii. Fourth Lake Development
viii. Sissiboo Development
ix. Upper Lake Falls, Nos. 1 and 2 Development
x. Lower Great Brook, Nos. 1 and 2 Development
xi. Cowie Falls, Nos. 1 and 2 Development
xii. Tidewater, Nos. 1 and 2 Development
xiii. Ruth Falls, Nos. 1, 2 and 3 Developments
xiv. Malay Falls, Nos. 1, 2 and 3 Developments
xv. Dickie Brook, Nos. 1 and 2 Development

- Category B – Reinforced Concrete and/or Steel Draft Tube and outflow to constructed tailrace diversion. The following powerhouses reflect this arrangement:

i. Avon No. 1 Development
ii. Hollow Bridge Development
iii. White Rock Development
iv. Paradise Development
v. Lequille Development
vi. Bear River Ridge Development
vii. Weymouth, Nos. 1 and 2 Developments
viii. Tusket, Nos. 1, 2 and 3 Development
ix. Roseway, Nos. 1 and 2 Developments
x. Lower Lake Falls, Nos. 1 and 2 Development
xi. Big Falls, Nos. 1 and 2 Development
xii. Deep Brook, Nos. 1 and 2 Development
xiii. Sandy Lake, Nos. 1 and 2 and Coon Pond , Nos. 1 and 2 Developments
xiv. Fall River Development
xv. Gisborne Development
xvi. Wreck Cove, Nos. 1 and 2 Development

3. Planned Demolition Methodology

General overall demolition methodology will involve various steps in establishing site security, worker safety and environmental protection during the dismantling, demolition and restoration process.

Demolition planning will consider that the dam, reservoir and any intake penstock pipeline infrastructure will be removed by others prior to commencement of powerhouse disassembly. All electrical and communications equipment directly related to transmission will be removed by others. As well, it is assumed that no outstanding asbestos abatement or other hazardous materials or site environmental issues will exist which would adversely affect demolition planning. All fisheries related infrastructure at each site will be removed by others except where specifically noted otherwise.

Although specific planning for demolition and restoration works will be tailored to each powerhouse site, each plan will encompass the following general considerations:

- Installation of site temporary security arrangements and contractor site temporary infrastructure to support planned activities, to protect public safety during the course of the work and to protect the environment. This may include the installation and maintenance of environmental protection features such as containment berms, silt curtains and fences, and oil booms during the course of the work at each site. Water control cofferdam structures such as dikes and berms will also be constructed at this time to encapsulate the building demolition foot-print. Cofferdams, dikes and berms may become permanent features or parts of other permanent features at demolition sites. Capacity for dewatering, sedimentation control and oil spill containment during demolition work will be provided at each site.
- Contaminated cooling water and lubricating and hydraulic oils and related fluids remaining in the powerhouse will be removed for recycling.
- Various machinery and control mechanisms will be dismantled and removed from each powerhouse, including turbo-generator parts and overhead cranes. Note that it has been assumed that existing overhead lifting devices such as bridge cranes and powered chain-falls will be utilized for disassembly efforts as possible. This may require management of electrical removals in such a manner that electrical power remains supplied to lifting devices for a period during disassembly works, or may necessitate that some sort of temporary power is supplied to that equipment prior to its removal from the building.
- Depending on site and powerhouse structural arrangements, some turbo-generator equipment can be removed from the powerhouse structure during machinery disassembly, while it may be expedient to remove other components once the roof of the powerhouse structure is removed. Exact removals methodology will depend on powerhouse configuration and site arrangement and how a chosen demolition contractor may wish to manage materials at site. For the purposes of this exercise, it will be expected that larger items such as generator stators will be removed from the building when the roof is removed. Other turbo-generator components can be removed as is most expedient.
- Windows, doors and miscellaneous components will be removed as practical prior to general structural demolition.
- Note that some temporary shoring and other support structures may have to be constructed or employed during the disassembly and demolition efforts to ensure structural stability and worker safety during building removal efforts.
- Roof removal will be carried out in a carefully planned disassembly exercise that may involve cutting-out and removing parts of reinforced concrete slabs and beams with engineered lifts at several locations. Trusses, where present, may be removed one at a time but without disassembly into smaller parts.
- Walls and main floors will be removed with conventional heavy demolition equipment including excavators and large percussion hammers. Demolition material will be separated (as practical) and stockpiled as it is knocked down, in preparation for disposal.
- Considerable excavation will be necessary where significant substructure removals are required, depending on the depth of foundations. Once the substructure is removed, excavations will be backfilled with excavated and demolished concrete and masonry material as appropriate and with least costly

imported fill as necessary. Along with significant excavations will be a requirement for water management as surface and groundwater will infiltrate excavations and will have to be removed.

- Plain concrete and masonry materials separated from reinforcing steel and embedded metal parts can be disposed of by burying at site. Rebar and embedded metal parts will have to be disposed of off-site. Note that unless the powerhouse is located "in-stream" the entire building substructure may not require removal from the powerhouse location. Concrete debris suitable for disposal at site will be buried in an appropriate site location.
- Rebar, other metal components and demolition materials will be trucked away from site to the nearest facility which is licensed by the Province of Nova Scotia to accept construction and building demolition debris. Note that tipping fees at such facilities have become significant in recent years.
- If practical, selected metals and other materials may be separated and harvested for salvage value. Note though that such activities may be prohibitively costly, precluding the practicality of such endeavours.
- At some locations the existing powerhouse will be located in-stream and/or in the original riverbed. Where that condition exists it may be necessary or appropriate to maintain or construct a diversion channel for river flow. Significant erosion protection around the infilled demolition excavation may be necessary. At such sites the entire powerhouse structure and substructure will be removed.
- The powerhouse site will be restored to pre-construction "brown-field" site condition.
- Where necessary, tailrace diversion channels will be restored to original or near original pre-construction condition.
- Powerhouse site access driveways will be removed and restored to original condition or near original condition where appropriate. In some cases it will be more practical to leave access roadways in place to facilitate search and rescue and firefighting activities. Stream crossing bridge structures (except culverts) will be removed where such a feature could present a hazard to the general public or where such a structure could represent an on-going maintenance liability.
- Significant efforts in multi-disciplinary engineering and other related technical support will be required during demolition and restoration planning and site works for each powerhouse.

4. Demolition Costs

Since of the work as described herein would be carried out by contractors, costs for demolition work throughout this study are based on standard current contractor pricing and contractor unit rates, although some of those rates may be averaged or optimized to better reflect actual market conditions.

This study has utilized the following sources for provision of costs for construction/demolition rates for men and equipment, including overhead costs and profit (plus HST):

Elliot Excavators Ltd.

- Bobcat E85 Mini-Excavator [redacted] plus transport to site
- Hitachi 35 Mini-Excavator with hydraulic hammer [redacted] plus transport to site
- Volvo 210 Excavator [redacted] plus transport to site
- John Deere 350 Excavator [redacted] plus transport to site
- John Deere 350 Excavator with hydraulic hammer [redacted] plus transport to site

- Komatsu D39 Dozer [redacted] plus transport to site
- Pick-up truck [redacted]

A.W. Leil Cranes

- 18 ton boom truck [redacted] including travel to and from site
- 28 ton boom truck [redacted] including travel to and from site
- 200 ton mobile crane [redacted] plus mobilization and demobilization costs and travel to and from site.

J. Mason Contracting Limited

- Un-skilled labour [redacted]
- Skilled trades rate [redacted]
- Foreman Rate [redacted] including truck

Dale Fabrication Inc.

- Dump truck and Driver [redacted]

<u>Disposal Site Tipping Fees</u>:

Costs for tipping fees at Halifax C&D Recycling Ltd. in Goodwood, and at Torbrook C&D Disposal and Recovery near the Town of Annapolis Royal have been utilized in costs estimation. Published rates for those tipping fees are as follows:

Halifax C&D Recycling

1. Concrete with Rebar (no metal projections) [redacted]
2. Concrete with Rebar(with metal projections) [redacted]
3. Mixed loads [redacted]

Torbrook C&D Disposal and Recovery

1. Construction and sorted demolition debris [redacted]
    - Brick, block, concrete
    - Asphalt
    - Asphalt shingles
    - Drywall
    - Wood Brush
2. Construction and Demolition Debris (Mixed)
3. Scrap Metals (This is a disposal fee, not a salvage value)

Estimated disposal costs derived in this study per site consider estimated demolition material volumes and weights generated at each site for disposal, and include trucking at hourly rates including driver, and estimated disposal site tipping fees.

5. Salvage Values

Salvage Values:

Pertinent posted material salvage values for Mississauga Ontario on July 16, 2018 are as follows:

Copper (bare)	[redacted]
Iron	
Steel	
Stainless steel	
Yellow brass	
Mixed aluminum	
Electric motors and generators	
Insulated wire no. 1	
Insulated wire no. 2	
Aluminum wire	

Note that nickel and other metal materials will be available in small quantities but will in all likelihood not be worth efforts required to salvage.

Copper windings on turbo-generator rotor poles may take considerable effort to remove and separate from the base metal stubs, and may not be worth efforts required for such material separation and sorting.

In accordance with the above rates, a 500 pound stainless steel Francis runner (turbine) will be worth approximately [redacted] in salvage value. Although many runners have been replaced over the years with stainless steel units, several less valuable cast iron or carbon steel Francis and Kaplan (or similar) turbines remain in service. A similar cast iron turbine would have a salvage value of about $40. Costs for removing and transporting such a turbine will exceed salvage value.

A moderately large 10 ton vertical rotor assembly may be worth about [redacted] in salvage, and a matching cast iron stator and its steel stack may be worth about [redacted] Other miscellaneous parts including stainless steel cladded carbon steel shafts and iron wicket gates and related parts may fetch as much as [redacted] salvage value. Therefore, rotor, stator, shafts and other miscellaneous parts on such a unit may have a total salvage value of about [redacted]

A 200 ton mobile crane may be needed to handle a moderately large unit rotor and stator. Costs for that equipment may be in the range of about [redacted] including travel and mobilization. Some assembly at site may be required (counter-weight and jib installation). (Cost starts when mobile crane unit leaves its yard and runs until it returns.) Trucking of the rotor will be about [redacted] Therefore, cost for salvaging those larger parts could be [redacted] Cost for salvage appears to exceed the salvage value for those parts.

Therefore, it appears that salvage value for larger components at single-unit developments may be marginal or negative. However, these parts must be removed from each powerhouse as part of the decommissioning process. If they are removed and stockpiled in a manner which is supportive of salvage intent, there may be some nominal salvage values which can be realized.

Although there will be potential for harvesting smaller components for salvage value, the benefits will probably be relatively small and not worthy of further detailed consideration in a Class 5 estimate. However, it is worth noting that at sites with multiple units, crane mobilization and some transportation costs can be shared between units, yielding higher incremental or nominal salvage values. Where there is reasonable potential for such credits, a negative value has been provided on the pertinent spreadsheet estimate.

Please note though that where salvage credits are applied, there will probably be proportionately increased demolition costs.

IV. SYSTEM DEMOLITIONS

1. Avon Hydro Electric System

The Avon Hydro Generating System, located on the Avon River, upstream of Martock, outside Windsor in Hants County of Nova Scotia, is comprised of two Hydro-electric generating developments namely Avon No. 1 and Avon No 2.

The “run-of-the-river” facilities are arranged in series on the Avon River, with Avon No. 1 located downstream of Avon No. 2. This nomenclature arrangement is unique to the NSPI hydro production inventory and are named in order from upstream plants to downstream plants.

Both powerhouses were originally constructed in about the 1920’s by the Avon River Power Company, a precursor to the Nova Scotia Power Commission and Nova Scotia Power Inc. (NSPI). In the late 1950’s the Avon No. 1 plant was replaced with a more modern facility.

a) Avon No. 1 Development

In about 1958 the old original Avon No. 1 powerhouse and pipeline were removed and replaced with a more modern brick masonry and peaked roof building. The original surge tank was removed as part of this work and most of the original pipeline was replaced with a new canal and gated concrete intake structure. The former wood stave penstock was replaced with a new wood stave pipe which was extended from the new intake structure to the powerhouse. This newer arrangement has maintained a production capacity of about 4.2 MW from a single vertical generating unit with about 117 feet of head since the 1958 reconstruction.

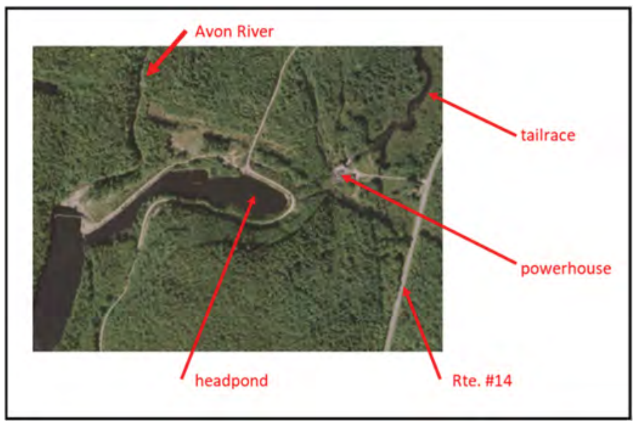

Photo 1: Avon No. 1 Development

The powerhouse can be accessed via a 500 foot-long (+/-) gravel driveway directly off Trunk Highway Rte. 14 in Upper Vaughan.

Avon No. 1 utilizes tailrace flow and/or spill from Avon No. 2 as its source for generation. Water that spills at the Avon No. 1 diversion dam (MacDonald Dam) bypasses Avon No. 1 and flows directly into the Avon River. Outflow from Avon No. 2 traverses a meandering path in a constructed tailrace channel for more than 3000 linear feet before flow once again joins up with the Avon River.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, that all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous material or environmental issues at this site that would adversely affect demolition planning. Note that there is some material laydown area at site.

Although the masonry superstructure of the building may be demolished with relative ease, the reinforced concrete substructure removal will require significant work with heavy equipment and will include substantial excavations.

Following demolition planning categorizations apply to the Avon No. 1 facility:

- Intake Classification – Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category A, reinforced concrete, steel and masonry'
- Outlet (Draft-tube) Classification – Category B, a lengthy tailrace channel will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables, and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as the Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, and support Trusses and related miscellaneous parts and components. Set aside and stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Dismantle exterior walls and related components. Stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab at generator level. Stockpile demolition material for disposal.

- Remove exposed interior steel penstock and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris for disposal.
- Remove auxiliary storage buildings and buried services including the on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected material to a designated construction debris disposal facility, while suitable other material such as pulverized concrete and masonry materials may be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected appropriate demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the lengthy tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Remove gravel access driveway from Highway No. 14.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Avon No. 2 Development

Completed in about 1929, Avon No. 2 is fed via a diversion dam (Falls Dam) at Falls Lake, a power canal and a steel penstock, and has a single vertically oriented generating unit with a capacity of about 3.0 MW, sourced from approximately 142 feet of head. This structure includes a combination of reinforced concrete and clay tile blocks while its substructure is comprised of reinforced concrete and mass concrete cast directly into the blasted or otherwise excavated hill-side bedrock.

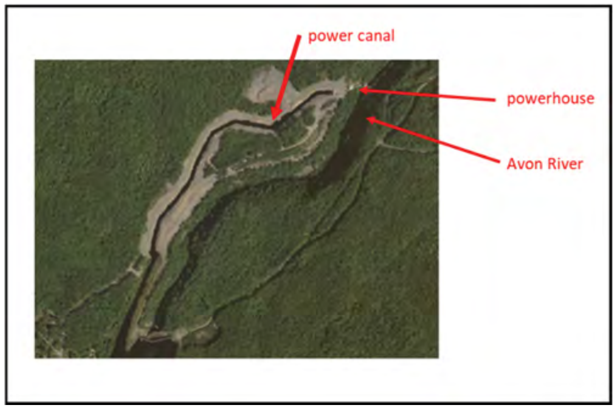

Photo 2: Avon No. 2 Development

The powerhouse can be accessed via gravel topped backroads which begin about a half-mile north of the Avon No. 1 access driveway at trunk highway No. 14. Gravel roads following parts of the Avon No. 1 head pond and power canal lead to the top of the hill and Falls Lake. Near the top of the slope is a dedicated powerhouse access side road which is hewn out of the east side rock face of the spillway gorge leading from Falls Lake Dam. The side road follows the east side of the gorge in the up-stream direction for about 1200 feet, and down slope to powerhouse grade. The powerhouse is on the west side of the river and is accessed from the gravel access via a steel and timber bridge which crosses the river.

Considerable work will be required to demolish and remove materials to the east side of the river. Due to bedrock proximity, there is limited opportunity to bury materials at this site, although there may be some potential burial sites at the upper end of the access road. The access roadway and bridge to the powerhouse are to be removed.

Outflow from the Avon No. 2 draft-tube enters directly into the Falls Dam spillway channel and original Avon River stream bed, where it is eventually diverted to the Avon No. 1 generator.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous material or environmental issues at this site that would adversely affect demolition planning. There is very limited available material lay-down area at this site.

Following demolition planning categorizations apply to the Avon No. 2 facility:

- Intake Classification – Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category A, reinforced concrete, steel and masonry;
- Outlet (Draft-tube) Classification – Category A, the draft tube discharges flow almost directly to Falls Dam spillway channel, the Avon River and the MacDonald Dam head pond.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace. This will necessitate the movement of granular and other materials from the east side of the Avon River to the west side. Some erosion protection will be necessary.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support Trusses and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Dismantle exterior walls and related components, stockpile demolition material for disposal. If there is limited room at site a large crane may have to be brought to site for early removals activities as there is limited laydown room on the powerhouse side of the river.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal. If there is limited room at site a large crane may have to be brought to site for early removals activities as there is limited laydown room on the powerhouse side of the river.
- Remove exposed interior steel penstock, main penstock butterfly valve and related parts; scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure. This structure is in close proximity to the Avon River and its draft-tube can be considered to be “in-stream”. Remove directly or stockpile as where possible for disposal.
- Disposal of construction and demolition debris – a large 200-ton or similar capacity mobile crane will be required to move construction debris and related components across the river to a location on the access road where excavators and similar equipment can move that material to trucks for transport to a designated disposal facility.

- Deliver or sell stockpiled salvage material. A large crane will be required to move this material to the east side of the river so that it can be transported to market.
- Infill foundation substructure excavation with compacted clean granular material to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site. Provide finish erosion protection. Material will have to be moved from the east side of the river to the west side to accomplish this task.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Remove and dismantle structural steel and timber river crossing which provides access to the powerhouse from the east side of the river. Once the bridge is removed from site the access side road shall be removed. Other gravel roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Avon River Hydro Electric Generation System

Avon No. 1 Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$410,500.00	Remediate 3000 ft. log tailrace channel.
Site Access Removals	$15,000.00	Includes re-grading at site access roads.
Site Services Removals	$10,000.00	Includes removal of buried water and waste-water buried.
BUILDINGS & STRUCTURES	.	
Powerhouse & Related Auxiliary Structures Removals	$175,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$5,000.00	Removal of miscellaneous auxilliary structures.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes dissembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$81,317.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$87,126.00	
Site Decommissioning Estimate Subtotal Avon No. 1 Development	**$890,993.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 1

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Avon River Hydro Electric Generation System

Avon No. 2 Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$276,825.00	
Site Access Removals	$90,000.00	Remediate 1200 ft. long access road and Avon River crossing structure.
Site Services Removals	$0.00	No sewage disposal at this site.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$222,250.00	Includes roof structure removal, removal of superstructure walls, removal of sub-structure; infilling of the powerhosue and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary buildings at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$39,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes dissembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$78,716.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$84,339.00	
Site Decommissioning Estimate Subtotal Avon No. 2 Development	**$862,380.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 2

2. Bear River Hydro Electric System

In Bear River there are two hydro-electric developments that comprise the Bear River Hydro-Electric Generation System and discharge water into the Bear River and the Annapolis Basin. The Ridge Development is fed by Ridge Head Pond, which is located on South Mountain above the Town of Bear River. Ridge powerhouse discharges to Sam Harris Pond which serves as the forebay for the downstream Gulch Development. Gulch plant discharges flow directly to the Bear River just above tidewater level in the Town of Bear River.

Both Bear River developments incorporate diversions to the original Bear River alignment. Both Bear River powerhouses are fed via pipelines which incorporate surge tanks and above ground penstock pipes.

These developments were originally constructed in the 1950's by the Nova Scotia Power Commission, a precursor to NSPI.

a) Ridge Development

Completed in 1957, the Ridge Development plant harnesses approximately 140 feet of head and provides 3.0 MW of electrical generation capacity from a single vertical generation unit.

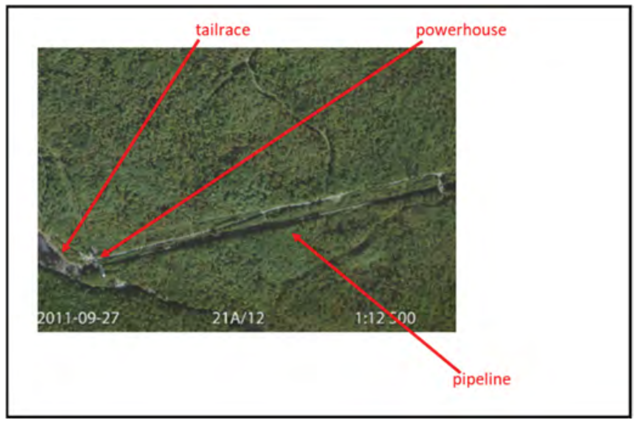

Photo 3: Ridge Development

The powerhouse can be accessed via the paved Jefferson Road and gravelled Sam Harris Road. Jefferson Road is located about two and a half miles east of Bear River along the Clementsvale Road and Sam Harris Road is located about two miles south and east along Jefferson Road. Once off Jefferson Road, the Sam Harris back road to the Ridge powerhouse meanders through a densely forested area for about three miles in a mostly southerly direction where it passes the powerhouse.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some limited material laydown area at site but more laydown area can be cleared.

There is room at site to bury clean concrete debris.

Following demolition planning categorizations apply to the Ridge facility:

- Intake Classification – Category B, penstock pipe is buried;
- Architectural Classification – Category B, the tailrace channel will require remediation to the original Bear River alignment.

- Outlet (Draft-tube) Classification – Category B, the tailrace channel will require remediation to the original Bear River alignment.

  Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other material, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.

- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Gulch Development

Completed in 1952 in the Town of Bear River, the Gulch plant provides approximately 6.0 MW from 250 feet of head with a single vertical turbo-generator unit.

The powerhouse is located at the corner of River Road and Parker Road in the Town of Bear River.

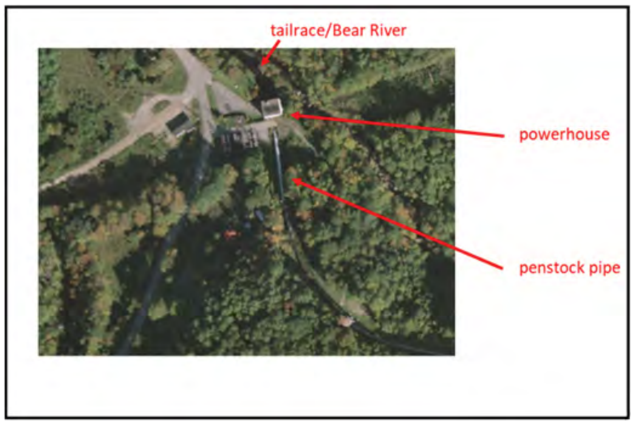

Photo 4: Gulch Development

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. There is ample available material lay-down area at this site and immediately across River Road.

It is recommended that demolition material not be buried at this site.

Following demolition planning categorizations apply to the Gulch facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, draft tube discharges directly into Bear River.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace. Provide erosion protection and protection against extreme tides
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of roofing, sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, main penstock butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure. The outlet for this structure in “in-stream”.
- Remove auxiliary buildings and related buried services including Town buried services or an on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater service piping and equipment.
- Disposal of construction and demolition debris, truck all materials to a designated disposal facility.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site. Provide erosion protection.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.

- Gravel roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Bear River Hydro Electric Generation Station

Ridge Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$207,650.00	Remediate tailrace
Site Access Removals	$0.00	N/A
Site Services Removals	$10,000.00	Site sewage disposal system to be removed.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$200,300.00	Includes roof structure removal, removal of superstructure walls; partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	Removal of tailrace gate.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$59,158.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$63,384.00	
Site Decommissioning Estimate Subtotal Ridge Development	**$647,242.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 3

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Bear River Hydro Electric Generation Station

Gulch Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$299,700.00	Remediate tailrace.
Site Access Removals	$2,500.00	Includes removal of paved parking area.
Site Services Removals	$10,000.00	Site sewage disposal to be removed.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$302,200.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$10,000.00	Auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$7,500.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$82,560.80	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$88,458.00	
Site Decommissioning Estimate Subtotal Gulch Development	**$904,668.80**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 4

3. Black River Hydro Electric System

The Black River Hydro Generating System, located on the Black River and Gaspereau River, in the Gaspereau Valley south of Wolfville in Kings County, Nova Scotia is comprised of five Hydro-electric generating developments and six generating units. Furthest upstream powerhouse is at Methals Falls, which feeds water through Black River Lake to the Hollow Bridge Development which in turn feeds water via Lumsden Pond to the Lumsden powerhouse. From there, water traverses to Hells Gate Development, where two generating units are located. Downstream of Hells Gate flow of the Black River becomes part of the larger Gaspereau River. Downstream of the confluence of the Black and Gaspereau rivers is the White Rock Generating Station from where water is discharged into the lower reaches of the Gaspereau River and its marine estuary.

At this generating system power houses were originally constructed from about the 1930's to the 1950's by the Avon River Power Company and Nova Scotia Light and Power, precursors to the Nova Scotia Power Commission and Nova Scotia Power Inc. (NSPI).

a) Methals Development

In 1948 a powerhouse was constructed at Methals Falls at the upstream end of Black River Lake. This development impounded water in Methals Pond and harnessed about 45 feet of head while providing generating capacity of about 3.2 MW from a single vertically oriented generating unit. The reinforced concrete powerhouse structure is coupled to a reinforced concrete intake structure by a relatively short penstock pipe (less than 100 feet long).

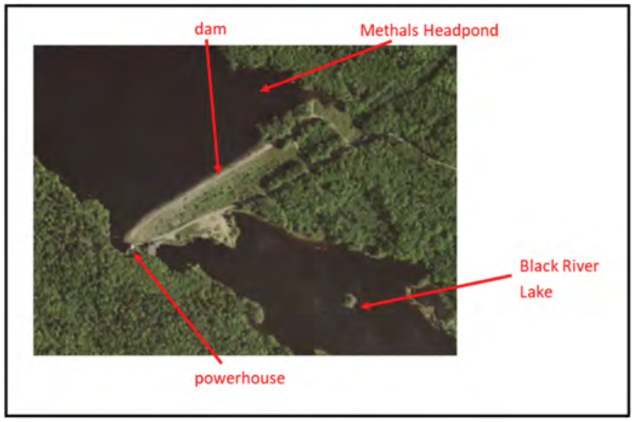

Photo 5: Methals Development

The powerhouse is accessed via the gravelled surface Methals Road, from Black River Road and Deep Hollow road. Methals Road runs about five miles through cottage country and wood lands along the northwest shore of Black River Lake. The road is gated part way along its length, once past the cottages area.

Methals draft tube and tailrace outflow discharges directly into Black River Lake which acts as a storage pond for the Hollow Bridge Development about seven miles downstream.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials issues at this site that would adversely affect demolition planning. There is ample material laydown area at site.

There is ample room at this site to bury suitable concrete debris, devoid of rebar, and embedded metals.

Following demolition planning categorizations apply to the Methals facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the draft tube discharges flow directly into Black River Lake.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables, and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those turbo-generator components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing and related miscellaneous materials and components. Set aside, stockpile for disposal.
- Remove reinforced concrete roof structure.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Dismantle, tear-down exterior reinforced concrete walls and related components and stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab at generator level. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. This powerhouse appears to be located “in-stream” and therefore will require complete removal. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, and related freshwater piping and equipment.

- Disposal of construction and demolition debris – truck selected material to Annapolis or Halifax for construction debris disposal, while suitable other material such as pulverized concrete devoid of rebar and embedded metals can be buried at site.
- Deliver/sell stockpiled salvage material.
- Infill foundation substructure excavation location with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. An outlet channel for flow from points upstream to Black River Lake may have to be constructed.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Gravel access road should remain in place to facilitate ground-search rescue and fire-fighting activities, however, bridge over existing spillway channel should be removed.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Hollow Bridge Development

Completed in 1940, Hollow Bridge is fed from the upstream storage of Black River Lake via a twin sliding gate at the Hollow Bridge Power Canal inlet. The power canal is about one and a half miles long and incorporates an intake structure and steel head gate for a fibreglass (FRP) pipeline and penstock (with a steel surge tank tower) which feeds the powerhouse turbo-generator. About 147 feet of head produces about 5.4 MW of generating capacity from a single vertical generating unit.

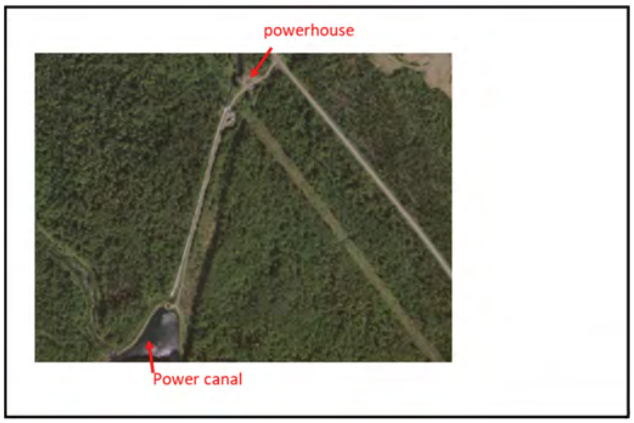

Photo 6: Hollow Bridge Development

The power canal acts as a diversion for the original river and a spillway has been constructed in the canal. The spillway sends excess water to Lumsden Pond via a constructed spillway channel. The main spillway for Black River Lake is at Forks Dam, located at the south side of the lake and some distance from Hollow Bridge Development. It sends excess water from Black River Lake into the Avon River, which is downstream of the Avon River Hydro Electric Generation System.

Hollow Bridge powerhouse is accessed via a gated gravel driveway off the gravel portion of the Black River Road about a half mile south and east of the intersection of Black River Road and Davison Street. The powerhouse is visible about 200 feet from the main road.

Outflow from Hollow Bridge draft-tube enters a constructed tailrace channel approximately 1200 feet long which transports flow to Lumsden Pond where water is thence directed to the Lumsden powerhouse for generation. That tailrace channel will require extensive remediation as part of the decommissioning effort.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Some material laydown space is available at this site. There appears to be an opportunity to bury selected suitable demolition materials at this site.

Following demolition categorizations apply to the Hollow Bridge facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, a lengthy tailrace channel will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those turbo-generator components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support Trusses and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Dismantle exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, main penstock butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.

- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris, where appropriate for disposal, or remove directly from site.
- Disposal of construction and demolition debris – transport selected material to a designated disposal facility, while suitable other material such as pulverized concrete devoid of rebar and embedded metals can be buried at site.
- Deliver/sell stockpiled salvage material.
- Infill foundation substructure location with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace channel with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

c) Lumsden Development

The Lumsden powerhouse was completed in 1942 and is fed from the Lumsden Pond head pond via a large concrete penstock embedded in the main earthen dam. The development harnesses about 60 feet of head to provide about 2.8 MW of generating capacity from a single vertically oriented generating unit.

At Lumsden the forebay and tailrace are located at the original river bed for the Black River. Spillway flow is directed into the Lumsden tailrace.

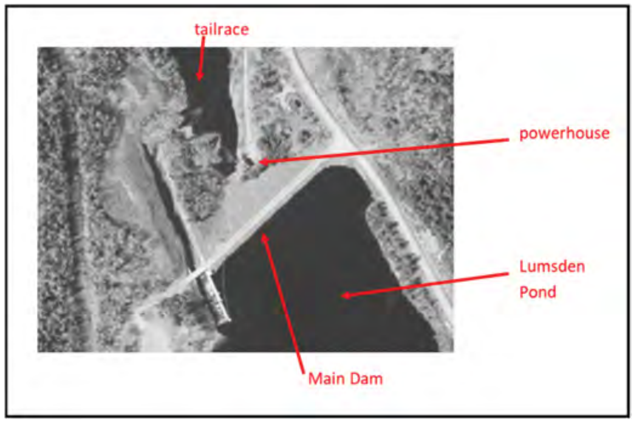

Photo 7: Lumsden Development

Lumsden powerhouse is accessed via a gravelled gated driveway about 1500 feet long directly from Black River Road about a quarter mile north of Corkum and Burns Road.

Outflow from Lumsden draft-tube enters directly into the tailrace at the original Black River alignment and makes its way into the Hells Gate power canal which in turn, transports flow to the Hells Gate powerhouse for generation.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or hazardous materials or environmental issues at this site that would adversely affect demolition planning. Only limited material laydown space is available at this site.

A considerable earthen cofferdam will be required to isolate substructure removal work since the powerhouse discharges water directly into the large tailrace channel/river.

Following demolition categorizations apply to the Lumsden facility:

- Intake Classification - Category B, penstock pipe is buried below ground;
- Architectural Classification – Category A, reinforced concrete, steel and masonry;
- Outlet (Draft-tube) Classification – Category A, the draft tube discharges flow directly into the Black River.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and

filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.

- Removal of HVAC equipment and localized heating units for areas within the building and those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those turbo-generator components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support trusses and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal, or remove directly from site.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Dismantle superstructure exterior walls and related components, stockpile demolition material for disposal or remove directly from site.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal or remove directly from site.
- Remove exposed interior steel penstock, main penstock butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. This powerhouse appears to be located “in-stream” and therefore full substructure removal is required. Stockpile debris, where appropriate, for disposal or remove directly from site.
- Disposal of construction and demolition debris – transport selected material to a designated disposal facility, while suitable other material such as pulverized concrete devoid of rebar and embedded metals can be buried at site.
- Deliver/sell stockpiled salvage material.
- Infill foundation substructure location with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. An outlet channel from points upstream may have to be constructed.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Remove access road driveway.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

d) Hells Gate Development

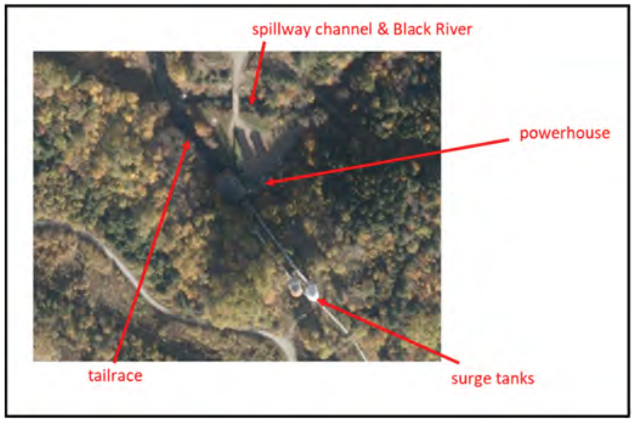

Photo 8: Hells Gate Development

The Hells Gate Development is comprised of two generating units known as Hells Gate No. 1 and Hells Gate No. 2. They share a single powerhouse structure which was first constructed to house Unit No. 1 in about 1930. The powerhouse was expanded to accommodate Unit No. 2 in about 1949. Each vertical unit each provides about 3.4 MW from about 185 feet of head for a total of about 6.8 MW. Each unit is serviced by a dedicated overhead bridge crane and is fed by a dedicated exposed steel penstock pipe with flow originating at the gated concrete intake structure at the power canal forebay.

At Hells Gate the power canal and forebay comprise a diversion to the main Black River which comprises the main spillway channel for the development, and flows through an area locally known as “Three Pools”.

The tailrace incorporates a slight off-set diversion to the original Black River alignment but discharges outflow to the original river alignment. Spillway flow at Hells Gate follows the original Black River arrangement from the power canal inlet and spillway diversion dam to the tailrace channel.

Hells Gate powerhouse is accessed via a gravelled gated roadway known as Hells Gate Road, about 2200 feet long on a relatively steep down-grade directly from Black River Road, located about a half mile southwest of Nowlan Mountain Road.

Outflow from Hells Gate enters almost directly into the original Black River and makes its way to confluence of the Black and Gaspereau rivers about 1500 feet downstream of the powerhouse. From there, flow makes its way into White Rock Pond and the associated power canal for that development.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Significant material laydown space is available at this site.

There appears to be some opportunity at this site for buried disposal of selected suitable materials.

Following demolition categorizations apply to the Hells Gate facility:

- Intake Classification - Category A, twin exposed above ground penstocks;
- Architectural Classification – Category A, reinforced concrete, steel and masonry;

- Outlet (Draft-tube) Classification – Category A, the draft tubes discharge flow almost directly into the Black River.

  Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls (for both units) including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components (for both units) such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Cranes, although a temporary power source and connection for the cranes may be required. Those turbo-generator components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, roof support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Cranes and stockpiled turbo generators main components, sort and stockpile at site for salvage and disposal.
- Dismantle exterior and interior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstocks, main penstock butterfly valves and related parts; also remove scroll cases, throat rings, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove remnant reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris as where appropriate for disposal.
- Disposal of construction and demolition debris – transport selected material to a designated disposal facility, while suitable other material, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver/sell stockpiled salvage material.
- Infill foundation substructure location with compacted granular material and appropriate demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site.
- Improve site surface drainage as required.

- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Remove remaining auxiliary buildings at the powerhouse site and along the access road, and on-site sewage disposal system.
- Gravel access road should remain in place to facilitate ground-search rescue and fire-fighting activities. The access bridge across spillway channel should be removed in consideration of probable limited flow capacity under the structure, and probable increased flow in the original Black River.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

e) White Rock Development

Completed in 1952, the White Rock Development is comprised of a single vertical unit with output capacity of about 3.2 MW from about 58 feet of head. The powerhouse is fed by a dedicated exposed FRP penstock pipe with flow originating at a gated concrete intake structure at the head of the power canal.

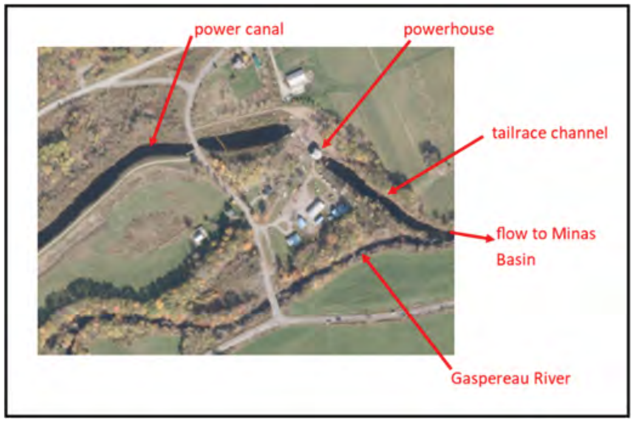

Photo 9: White Rock Development

The White Rock the Power Canal and forebay comprise a diversion to the main Gaspereau River. The powerhouse outlet tailrace channel completes the diversion arrangement, reincorporating flow into the Gaspereau River about 800 feet downstream of the powerhouse. Spillway flow at White Rock follows the original Gaspereau River from the power canal inlet and spillway diversion dam. From the spillway and tailrace flows carries into the Gaspereau River estuarial region.

White Rock powerhouse is located at the north east end of the NSPI White Rock Shops work yard, on Black River Road.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or hazardous materials or environmental issues at this site that would adversely affect demolition planning. Significant material laydown space is available at this site.

As part of a site rehabilitation, the 800 foot-long tailrace of White Rock powerhouse to the Gaspereau River will require rehabilitation.

Following demolition categorizations apply to the Hells Gate facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, a moderately wide and lengthy tailrace channel will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and

filters and related piping, throttle linkage components, electrical communication cables and miscellaneous smaller equipment piping.

- Removal of HVAC equipment and localized heating units for areas within the building and those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the tailrace outlet to the Gaspereau River.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those turbo-generator components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, roof support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generators main components, sort and stockpile at site for salvage and disposal.
- Dismantle exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor and entrance main floor reinforced concrete slab sand mass concrete structure. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove remnant reinforced concrete foundation substructure to a few feet below new finish grade elevation. Stockpile debris as where appropriate for disposal.
- Disposal of construction and demolition debris – transport selected materials to a designated disposal facility, while suitable other material, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver/sell stockpiled salvage material.
- Infill foundation substructure location and tailrace with compacted granular material and selected demolition debris to the tailrace cofferdam. Grade to match or compliment surroundings. The cofferdam can remain once graded to match site.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Black River Hydro Electric Generation System

Methals Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$242,300.00	
Site Access Removals	$10,000.00	Includes re-grading at site access roads.
Site Services Removals	$10,000.00	Includes removal of buried water and waste-water buried.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$196,050.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No miscellaneous auxilliary structures at this site
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$63,627.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$600.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$68,172.00	
Site Decommissioning Estimate Subtotal Methals Development	**$696,299.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 5

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Black River Hydro Electric Generation System

Hollow Bridge Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$209,600.00	Remediate 1200 ft. long tailrace channel.
Site Access Removals	$5,000.00	Includes re-grading at site access roads.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$157,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No miscellaneous auxilliary structures at this site
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$2,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$53,911.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$57,762.00	
Site Decommissioning Estimate Subtotal Hollow Bridge Development	**$589,523.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 6

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Black River Hydro Electric Generation System

Lumsden Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$244,200.00	Considerable cofferdams required at this site.
Site Access Removals	$35,000.00	Includes re-grading at site access roads.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$178,150.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No miscellaneous auxilliary structures at this site
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$63,571.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$68,112.00	
Site Decommissioning Estimate Subtotal Lumsden Development	**$695,783.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 7

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Black River Hydro Electric Generation System

Hell's Gate Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$300,650.00	
Site Access Removals	$40,000.00	Includes re-grading at site access roads.
Site Services Removals	$15,000.00	Site sewage disposal system and freshwater systems to be removed.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$285,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$8,000.00	Auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$70,600.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$15,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$12,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$12,500.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$21,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$93,772.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$1,000.00	Allowance
General Parts	-$2,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,800.00	Allowance
Insulated Wire and Cables No. 2	-$1,800.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$100,470.00	
Site Decommissioning Estimate Subtotal Hell's Gate Development	**$1,024,892.00**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 8

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Black River Hydro Electric Generation System

White Rock Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$300,650.00	Remediate 800 ft. long Tailrace channel.
Site Access Removals	$40,000.00	No site sewage disposal system at this location.
Site Services Removals	$15,000.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$285,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$8,000.00	No miscellaneous auxilliary structures at this site
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$70,600.00	Single vertical turbo-generator unit.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$15,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$12,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$12,500.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$21,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$93,772.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$1,000.00	Allowance
General Parts	-$2,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,800.00	Allowance
Insulated Wire and Cables No. 2	-$1,800.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$100,470.00	
Site Decommissioning Estimate Subtotal White Rock Development	**$1,024,892.00**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 9

4. Dickie Brook Hydro Electric System

The Dickie Brook Development is a small stand-alone single powerhouse development located near Guysborough Town. Dickie Brook consists of two horizontal turbo-generator units which utilize water from Tom's Lake and upstream storage for generation. Water is fed to the turbo-generator via an above ground polyethylene and steel penstock pipeline. Outflow is discharged directly into the estuarial region of the Salmon River.

a) Dickie Brook Development

In 1948 the Dickie Brook Hydro-Electric Generation Station was commissioned and put into service 3 miles south and west of Guysborough Town.

At the Dickie Brook Development, water from Toms Lake head pond is directed to the Dickie Brook powerhouse via a polyethylene pipeline and steel penstock pipe. The powerhouse two horizontally oriented turbo-generators each produce about 1.3 MW of power from approximately 298 feet of head for a total capacity of 2.6 MW. There is original accommodation for an unconstructed third unit in the penstock arrangement at this site.

The reinforced concrete generator/turbine floor of the powerhouse is integral with the outlet draft tubes and powerhouse substructure.

Access to the powerhouse is south on Trunk Rte. 16 via Guysborough Town to paved Larry's River Road. About a mile and a half along Larry's River Road, turn onto gravelled Mountain Road. The powerhouse is located about 400 feet along Mountain Road from Larry's River Road, on the left.

Demolition planning for this facility will consider that the intake penstock will be dewatered and removed and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at this site, and there may be potential for buried disposal at site for some demolition generated materials.

Since the powerhouse is built on the estuarial portion of the Salmon River, it is subjected to tidal influences and has been flooded on multiple occasions when a storm-surge has been experienced. Although the powerhouse is a relatively small and shallow structure a considerable cofferdam may be required to enable safe substructure removals.

A significant cofferdam may be required to aide in substructure removals. Erosion protection and adequate height to handle tidal influences will be necessary.

Following demolition planning categorizations apply to the Dickie Brook facility:

- Intake Classification - Category A, a exposed above ground steel intake pipe is located at the rear of the structure;
- Architectural Classification – Category C, other. Wood, steel and concrete framed and cladded structure on a concrete foundation sub-structure;
- Outlet (Draft-tube) Classification – Category A, draft tube outlet discharges directly into the Salmon River estuarial region.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; Rotor and Generator Shaft; Speed Ring, Wicket Gates and related parts; Turbine Shaft, Head-cover and Turbine; Stator and steel draft-tube can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Disassembly of Roofing, Sheathing and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Disassembly of exterior superstructure and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab and related reinforced concrete substructure. Stockpile demolition material for disposal. This powerhouse outlets directly to the tidal marine estuary of the Salmon River and is therefore considered to be “in-stream”.
- Remove auxiliary buildings including house and garage.
- Remove buried services, including site waste water disposal system, well and any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected material to a designated construction debris disposal facility, while suitable other materials such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.

- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Dickie Brook Hydro Electric Generation System

Dickie Brook Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$330,500.00	Outlet discharges directly to Salmon River estuary, lengthy cofferdam required, draft-tubes removal, tailrace remediation and erosion protection required.
Site Access Removals	$0.00	Powerhouse site is directly accessed from Mountain Road without formal driveways.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$167,950.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$12,500.00	Remove administration facility (house) and garage.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$32,600.00	Two horizontal turbo-generator units.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$4,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$4,000.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$5,000.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$69,725.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$250.00	Allowance
General Parts	-$800.00	Allowance
Insulated Wire and Cables No. 1	-$800.00	Allowance
Insulated Wire and Cables No. 2	-$800.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$74,706.00	
Site Decommissioning Estimate Subtotal Dickie Brook Development	**$764,331.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 10

5. Fall River Hydro Electric System

The Fall River Development consists of a single hydro-electric development and powerhouse. This stand-alone development consists of a single horizontal turbo-generator unit which utilizes water from Miller Lake and upstream storage for generation. Flow is fed to the single horizontal turbo-generator via a partially buried reinforced fibre-glass penstock pipeline. Outflow is discharged via a tailrace channel which carries the flow back to the original Fall River alignment where it discharges into Lake Thomas and the Shubenacadie River watershed.

a) Fall River Development

In 1985 a new hydro-electric power generation station was commissioned in Fall River, 15 miles north of Halifax. This plant replaced an earlier power generating station at or near this site which operated for several decades before being decommissioned in the 1950's or 1960's.

Inflow from Miller Lake is diverted from the original water course and falls via a penstock pipeline to the powerhouse where a single turbo-generator unit produces about 500 kW (0.5 MW) of power from about 83 feet of head. The penstock is partly buried along its length and is underground at the rear of the powerhouse. The tailrace channel returns flow to the original Fall River alignment downstream of the powerhouse.

The powerhouse structure is a steel cladded structural steel frame supported on a reinforced concrete slab and draft-tube sub-structure.

Access to the powerhouse is via Trunk Highway Rte. 2 and the gravelled surface Ray's Lane in Fall River.

Demolition planning for this facility will consider that the intake penstock will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some material laydown area available at this site, but little potential yard area for burying demolition generated debris.

Following demolition planning categorizations apply to the Fall River facility:

- Intake Classification - Category B, a buried FRP intake pipe is located at the rear of the structure;
- Architectural Classification – Category C, other. Steel framed and cladded structure on a shallow concrete foundation structure;
- Outlet (Draft-tube) Classification – Category B, a constructed tailrace channel will require remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).

- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; Generator; scroll case and turbine assembly; shafts and related parts can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed. Note that the turbo-generator is a small Barber Unit which can probably be removed with limited disassembly.
- Disassembly of Roofing, Sheathing and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Disassembly of exterior superstructure cladding and related components, stockpile demolition material for disposal.
- Remove structural steel superstructure framework.
- Remove and demolish main floor reinforced concrete slab and related reinforced concrete substructure. Stockpile demolition material for disposal.
- Remove buried services and any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck to a construction debris disposal facility located near Halifax.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace channel with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Fall River Hydro Electric Generation System

Fall River Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$134,950.00	Remediate tailrace channel.
Site Access Removals	$3,000.00	Remove driveway.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$92,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$6,500.00	Remove office building in this location.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$17,000.00	One horizontal turbo-generator unit.
Turbo Generator Control Removals	$5,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$7,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$4,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$3,500.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$8,000.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$35,554.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$150.00	Allowance
General Parts	-$750.00	Allowance
Insulated Wire and Cables No. 1	-$750.00	Allowance
Insulated Wire and Cables No. 2	-$750.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$38,094.00	
Site Decommissioning Estimate Subtotal Fall River Development	**$388,698.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 11

6. Lequille Hydro Electric System

Lequille Development is one of three conventional stand-alone hydro-electric developments that discharge water from South Mountain watersheds into the Annapolis River or other tributaries to the Annapolis River and the Annapolis Basin. The other two such developments are located at Nictaux and at Paradise. A fourth development, the Annapolis Tidal Power Generation Station, is also on the Annapolis River but is outside the scope of this study.

Each of these three facilities are located on their own tributary rivers, have their own watersheds and are fed via pipelines and buried penstock pipes from impoundment head ponds and storage reservoirs located in the upper reaches of the South Mountain in the Annapolis Valley area.

These developments were constructed in the 1950's and 1960's by the Nova Scotia Power Commission and Nova Scotia Light and Power Company, precursors to NSPI.

a) Lequille Development

Completed in 1968 at Lequille, at the toe of the South Mountain, about three miles south east of Annapolis Royal in Annapolis County off Trunk Route 8, the Lequille Development harnesses approximately 386 feet of head to provide 11.1 MW of generating capacity from a single vertically oriented turbo-generator.

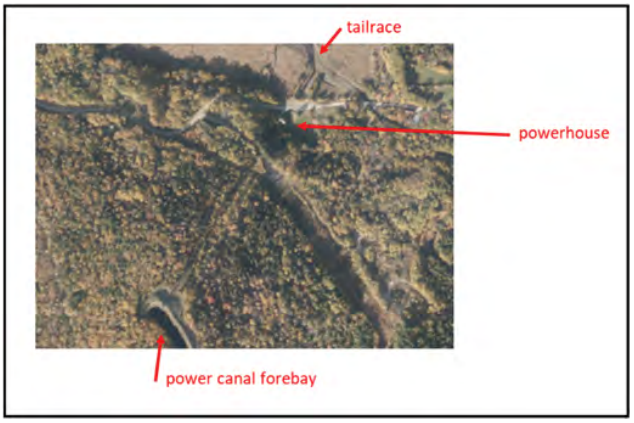

Photo 10: Lequille Development

The powerhouse is situated on Dugway Road and discharges water into Allains Brook.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. There is ample available material lay-down area at this site, though not immediately adjacent to the powerhouse.

The tailrace tunnel under paved Dugway Road shall be concrete filled to conserve the integrity of the roadway. Auxiliary structures include a garage over-looking the powerhouse site, which shall be removed.

Although the powerhouse structure is designed to appear to be as period masonry construction, it is in fact a modern reinforced concrete installation.

Following demolition planning categorizations apply to the Avon No. 2 facility:

- Intake Classification - Category B, penstock pipe is buried below ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, the draft tube and tailrace consist of a tunnel under the adjacent local paved road to a tailrace timber outfall structure, which feeds a small tailrace channel to Allains Brook and thus to the Annapolis Basin.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communication cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet structure and tailrace. This cofferdam will have to be adequate to isolate the demolition works from the tides of the Annapolis Basin and the Bay of Fundy.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, main penstock butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation and abandon, secure the tailrace tunnel crossing under Dugway Road.

- Infill foundation substructure excavation with compacted granular material and selected clean demolition debris to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site.
- Remove auxiliary buildings and buried services including the on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater piping and equipment and paved driveways and roads.
- Disposal of construction and demolition debris, truck selected materials to a designated disposal facility, while suitable material, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, fill the tailrace tunnel with pumped concrete to ensure any future structural deterioration will not result in failure of the roadway; remove the timber outfall structure; remediate the tailrace channel with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state. Note that the tailrace remediations will be subject to tidal influences.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition. There is considerable cost in concreting the tailrace channel.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Lequille Hydro Electric Generation System

Lequille Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$507,500.00	Tailrace tunnel to be concrete filled.
Site Access Removals	$2,500.00	Includes removal of paved parking area.
Site Services Removals	$10,000.00	Site sewage disposal system to be removed.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$265,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$8,000.00	Auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$39,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$5,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	Removal of tailrace gate.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$101,925.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$109,206.00	
Site Decommissioning Estimate Subtotal Lequille Development	**$1,117,681.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 12

7. Mersey River Hydro Electric System

At the Mersey River Hydro Electric System there are six run of the river hydro-electric developments each with two turbo-generating units that utilize water from the Mersey River for electrical generation and discharge water directly back into the river or via a tailrace diversion outflow canal.

The Mersey River hydro developments are as follows: Upper Lake Falls Development on the main system flowage and storage at the southeast end of Lake Rossignol where the Mersey River exits the Lake; Lower Lake Falls Development, located about one and a half miles downstream and east of Upper Lake Falls; Big Falls Development, which is located about three miles downstream and southeast of Lower Lake Falls; Lower Great Brook Development which is about eight miles downstream and southeast of Big Falls; Deep Brook Development which is about five miles east of Lower Great Brook; and Cowie Falls Development which is located in the Village of Milton, Queens County, about 2 miles downstream and southeast of Deep Brook.

Construction on hydro power developments on the Mersey River started in the 1920's by the Bowater Mersey Paper Company Limited as a means to provide electricity for processes in the newly constructed paper mill located near the mouth of the Mersey River in Liverpool Harbour (Brooklyn, NS). Construction continued into the 1950's and in the 1960's, the generating assets were eventually taken over from BowaterMersey by the Nova Scotia Power Commission, a precursor to NSPI.

In recent decades concrete powerhouse structures on the Mersey River have been befallen with structural deterioration associated with Alkali Aggregate Reactivity (AAR). This condition will affect demolition planning and related equipment selection.

a) Upper Lake Falls Development

At the Upper Lake Falls Development (Mersey No. 1 and 2), completed in about 1929, inflow from Lake Rossignol is channelled through the integral powerhouse gated intake structure and turbo generators and to the tailrace channel at what appears to be the original Mersey River alignment.

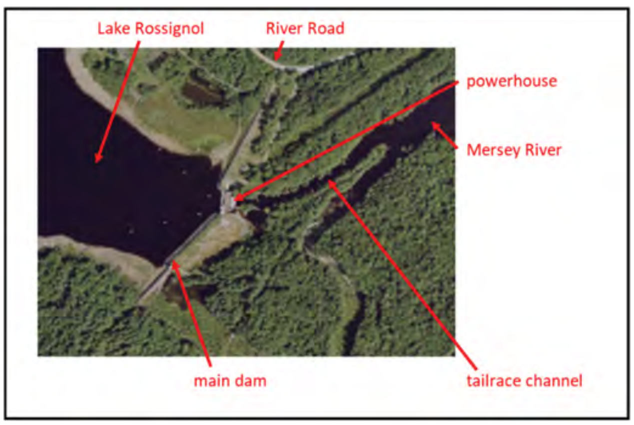

Photo 11: Upper Lake Falls Development

The Upper Lake Falls Development utilizes two vertically oriented turbo-generators, each with a 2.7 MW generating capacity providing about 5.4 MW total, from about 35 feet of head.

Turbo-generators are fed directly from the lake forebay via a dual concrete intake structure which is integral with the powerhouse. Each generating unit has its own concrete intake chamber and draft-tube outlet to the tailrace channel.

The powerhouse incorporates a generator floor and support structure over a heavy turbine floor and related supports. The pressurized intake chamber is found below the turbine floor, while the draft tube outlet and building substructure are located beneath the intake chamber. The head cover for each unit is located at the turbine floor. Steel penstock pipes and butterfly valves are accessed in the basement (turbine floor) area for both developments.

Access to the powerhouse is via a 600 foot long gravelled driveway access located about 20 miles northwest of Milton via gravel topped River Road at Lake Rossignol.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site.

Ample room is available at site to bury clean concrete demolition debris.

Since the powerhouse is located on the original Mersey River Lake Rossignol outlet alignment and the alignment and construction likely involved considerable rock excavation, the original alignment may no longer be suitable for the Mersey River. A remediated site arrangement may include a short river diversion to avoid potential erosion and local flooding problems associated with having the river flow through a filled area located in the original river alignment.

Following demolition planning categorizations apply to the Upper Lake Falls facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, since the Lake Rossignol outlet for the Mersey River may require some realignment, part of the tailrace channel will require some remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source

and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.

- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish superstructure exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove head gates and related equipment and components and demolish intake structure.
- Remove and demolish turbine floor reinforced concrete slab and interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including throat ring, head cover, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. This structure is considered to be “in-stream”. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Re-construct the river outlet from Lake Rossignol as and where required.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate and infill the tailrace as and where required with clean gravel and crushed stone, and clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Lower Lake Falls Development

At the Lower Lake Falls Development (Mersey No. 3 and 4), also completed in about 1929, inflow from the Upper Lake Falls tailrace channel is diverted from the original river alignment to a power canal forebay located approximately a half mile east of the spillway and original river alignment. Inflow to the turbo-generators is through the integral powerhouse gated intake structure and turbo generators and to the tailrace diversion channel which runs for 1500 feet to the original Mersey River alignment.

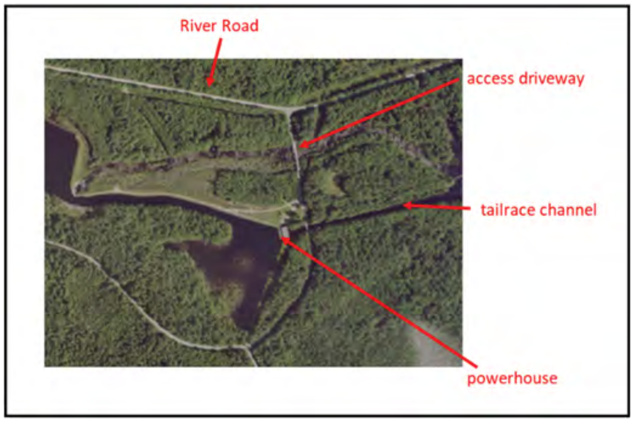

Photo 12: Lower Lake Falls Development

The Lower Lake Falls Development utilizes two vertically oriented turbo-generators, each with a 3.6 MW, for a total of 7.2 MW generating capacity while harnessing about 48 feet of head.

Turbo-generators are fed directly from the forebay via a dual concrete intake structure which is integral with the powerhouse. Each generating unit has its own concrete intake chamber and draft-tube outlet to the tailrace channel.

The powerhouse incorporates a generator floor and support structure over a heavy turbine floor and related supports. The pressurized intake chamber is found below the turbine floor, while the draft tube outlet and building substructure are located beneath the intake chamber. The head cover for each unit is located at the turbine floor.

Access to the powerhouse is via a bridge over the spillway channel and a 500 foot long gravelled driveway access located about 18 miles northwest of Milton via gravel topped River Road.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at this site.

Although not in the water course following site infrastructure removals, due to the structural configuration, most of the powerhouse substructure will require removal.

There is adequate room at site for buried disposal of clean concrete debris.

Following demolition planning categorizations apply to the Lower Lake Falls facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;

- Outlet (Draft-tube) Classification – Category B, a lengthy constructed tailrace channel will require remediation.

  Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior superstructure walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove head gates and related equipment and components and demolish intake structure.
- Remove and demolish turbine floor reinforced concrete slab and interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.

- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected clean demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace channel with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

c) Big Falls Development

At the Big Falls Development (Mersey No. 5 and 6), also completed in about 1929, inflow from Lower Lake Falls tailrace is collected and diverted to the powerhouse gated intake structure and turbo generators and to the approximately 1000 foot long tailrace channel where outflow is re-diverted back to the original riverbed alignment.

Photo 13: Big Falls Development

The Big Falls Development utilizes two vertically oriented turbo-generators, each with a 4.5 MW, for a total of 9 MW generating capacity from approximately 58 feet of head.

Turbo-generators are fed directly from the lake forebay via a newly redesigned and constructed dual concrete intake structure which is integrally connected with the powerhouse. Each generating unit has its own concrete intake chamber, and lower draft-tube outlet to the tailrace channel. Original (pre-reconstruction) configuration of the intake chamber at this site was very similar to that found at Lower Lake Falls.

The powerhouse incorporates a generator floor and support structure over a heavy turbine floor and related support structure. The pressurized intake chamber is found below the turbine floor, while the draft tube outlet and building substructure are located beneath the intake chamber. The head cover for each unit is located at the Turbine floor.

Access to the powerhouse is via a 200 foot-long bridge over the spillway channel and a half mile long gravelled access road from River Road about 15 miles northwest of Milton.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site.

Although not in the water course following site infrastructure removals, due to the structural configuration, most of the powerhouse substructure will require removal.

There appears to be adequate space at site for disposal of clean materials by burying.

Following demolition planning categorizations apply to the Big Falls facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;

- Outlet (Draft-tube) Classification – Category B, a lengthy constructed tailrace channel will require remediation.

  Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior superstructure walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove head gates and related equipment and components and demolish reconfigured intake structure.
- Remove and demolish turbine floor reinforced concrete slab and interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.

- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the lengthy tailrace channel with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

d) Lower Great Brook Development

At the Lower Great Brook Development (Mersey No. 7 and 8), completed in about 1955, inflow from the Big Falls tailrace re-enters the river some distance upstream of the Lower Great Brook Facility and is channelled through the integral powerhouse intake structure and turbo generators and to the draft tubes which deposit the water directly back into the Mersey River.

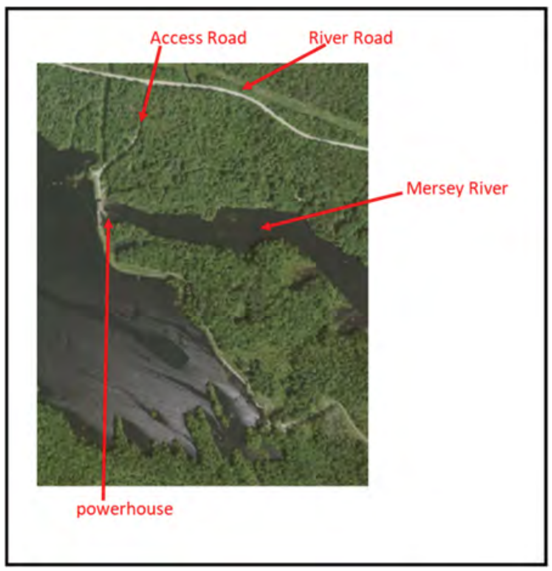

Photo 14: Lower Great Brook Development

The Lower Great Brook facility dam and powerhouse arrangement straddles the Mersey River, the powerhouse and dam are located in the main alignment of the river, they directly impound the river, no river diversion is found at this site.

Lower Great Brook Development utilizes two vertically oriented turbo-generators, each with a 2.26 MW, for a total of 4.56 MW generating capacity from about 22 feet of head.

Turbo-generators are fed directly from the river forebay via a dual gated concrete intake structure which is integral with the powerhouse structure. Each generating unit has its own concrete intake chamber, and lower draft-tube outlet to the tailrace channel. The head gates are located inside the powerhouse structure in a configuration which is remarkably similar to what is utilized at Tusket.

The powerhouse incorporates concrete mounts on the main floor for the stator and generator support while the head covers are accessed from the main floor which serves as the turbine floor. Therefore, the pressurized intake chamber is found directly below the main floor, while the draft tube outlet and building substructure are located beneath the intake chamber.

Access to the powerhouse is via an 800 foot long gravelled driveway access located about 6 miles west of Milton via gravel topped River Road.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some material laydown area available at site, more can be cleared and constructed if necessary.

Due to its position in the main Mersey River powerhouse, demolitions will require an extensive cofferdam arrangement.

Since the powerhouse is within the original Mersey River alignment, and that alignment and construction likely involved considerable rock excavation, a remediated site arrangement may include a short river diversion to avoid potential erosion and local flooding problems associated with having the river flow through a filled area located in the original river alignment.

Following demolition planning categorizations apply to the Lower Great Brook facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the generation station discharges flow directly into the Mersey River. There is no tailrace channel at this development.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.

- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a significant granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and around the powerhouse as required to hold back the waters of the Mersey River during demolition and removals.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed. Also remove head gates and related operating equipment, all of which is located inside the confines of the powerhouse.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator support pedestals and main reinforced concrete floor slab. Stockpile demolition material for disposal.
- Demolish intake structure.
- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. This powerhouse is considered to be located “in-stream”. Stockpile debris for disposal.
- Remove any buried services including any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material inside the cofferdam structure. The cofferdam can remain once graded to match site. Significant erosion protection will be required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.

- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Note that we have identified material salvage as an item herein, the actual value of that salvage will be small in consideration of resources required (men and equipment, cranes) to remove, sort, stockpile and move these materials to a suitable salvage facility. However, since there are multiple units at this site, it appears that there may be a small net benefit to salvaging turbo-generator parts and related miscellaneous metals. Mobilization and transportation costs can be shared between units, lowering the per-unit salvage costs.

e) Deep Brook Development

At the Deep Brook Development (Mersey No. 9 and 10), completed in about 1950, inflow from Lower Great Brook and the Mersey River is diverted at the Deep Brook Diversion Dam to the Deep Brook Head Pond, across and northeast of River Road, where it is channelled through a gated concrete intake structure and two reinforced concrete penstock conduits to the reinforced concrete intake chambers below the powerhouse main floor. Generators are supported from concrete pedestals and are accessed via a half-deck mezzanine structure. Head covers are accessed from the main floor. Each generating unit has its own concrete intake chamber, and lower draft-tube outlet to the tailrace channel. Flow exits the powerhouse draft tubes to a constructed tailrace channel which collects and carries water back to the original river alignment approximately southeast of River Road.

Deep Brook Development utilizes two vertically oriented turbo-generators, each with about a 4.5 MW generating capacity, for a total generating capacity of about 9.0 MW from about 46 feet of head.

Access to the powerhouse is via an approximately 700 foot long gravelled driveway access located about a mile northwest of Milton via River Road.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site, but additional laydown area in closer proximity to the powerhouse can be cleared and constructed as necessary.

There appears to be adequate space at site to allow for some debris disposal by burying.

The tailrace channel is wide and deep at Deep Brook. A significant cofferdam will be required.

Following demolition planning categorizations apply to the Deep Brook facility:

- Intake Classification - Category B, the facility features twin buried reinforced concrete intake penstocks;
- Architectural Classification – Category B, reinforced concrete and structural steel;

- Outlet (Draft-tube) Classification – Category B, a lengthy and broad constructed tailrace channel will require significant remediation.

  Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a significant granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator pedestals and main floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. Stockpile for disposal.
- Remove buried services including any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.

- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the half mile long and 150 foot wide tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

f) Cowie Falls Development

At the Cowie Falls Development (Mersey No. 11 and 12), completed in about 1938, inflow from Deep Brook and the Mersey River is channelled through the gated integral powerhouse intake structure and turbo generators and to the tailrace channel at what appears to be the original Mersey River alignment.

Cowie Falls Development utilizes two vertically oriented turbo-generators, each with approximately 3.6 MW generating capacity for a total of 7.2 MW from approximately 42 feet of head.

Turbo-generators are fed directly from the lake forebay via a dual concrete gated intake structure which is integral with the powerhouse. Each generating unit has its own concrete intake chamber, and lower draft-tube outlet to the tailrace channel. The intake at Cowie Falls is very similar in configuration to what is installed at Upper Lake Falls.

The powerhouse incorporates a generator floor and support structure over a heavy turbine floor and related support structure. The pressurized intake chamber is found below the turbine floor, while the draft tube outlet and building substructure are located beneath the intake chamber. The head cover for each unit is accessed from the Turbine floor.

Access to the powerhouse is via an approximately 1500 foot long gravelled driveway access located in Milton via Trunk Highway Rte. 8.

Demolition planning for this facility will consider that the intake chambers will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site.

Since the powerhouse is located on the original Mersey River alignment, and that alignment and construction likely involved considerable rock excavation, the original alignment may no longer be suitable for the Mersey River. A remediated site arrangement may include a short river diversion past the powerhouse location to avoid potential erosion and local flooding problems associated with having the river flow through a filled area located in the original river alignment.

Following demolition planning categorizations apply to the Cowie Falls facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, since the Mersey River may require some realignment, part of the tailrace channel will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and mechanical controls and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish superstructure exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove head gates and related equipment and components and demolish intake structure.
- Remove and demolish turbine floor reinforced concrete slab and interior/exterior walls at that level. Stockpile demolition material for disposal.

- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. This powerhouse will be considered to be located “in-stream” upon site infrastructure removals. Stockpile debris for disposal.
- Remove buried services including any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Construct new powerhouse/tailrace diversion.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Significant erosion protection will be required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey Hydro Electric Generation System

Upper Lake Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$465,700.00	Tailrace to be remediated, diversion may be required.
Site Access Removals	$5,000.00	Regrade driveway.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$552,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs. Separate Generator and Turbine floors at this location.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	N/A
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$4,000.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$45,000.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$136,931.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$146,712.00	
Site Decommissioning Estimate Subtotal Upper Lake Falls Development	**$1,498,643.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 13

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey River Hydro Electric Generation System

Lower Lake Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$370,400.00	1500 ft long tailrace to be remediated.
Site Access Removals	$1,500.00	Remove short driveway, access bridges to remain.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$522,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs. Separate Generator and Turbine floors at this location
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	N/A
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$4,000.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$35,800.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$121,475.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$130,152.00	
Site Decommissioning Estimate Subtotal Lower Lake Falls Development	**$1,328,627.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 14

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey River Hydro Electric Generation System

Big Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$392,400.00	1000 ft long tailrace to be remediated.
Site Access Removals	$4,000.00	Remove short driveway, access bridge to remain.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$672,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs. Separate Generator and Turbine floors at this location.
Auxiliary Buildings Removals (not associated with Production Plant)	$5,000.00	Remove auxilliary buildings.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$4,000.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$43,200.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$142,408.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$152,580.00	
Site Decommissioning Estimate Subtotal Big Falls Development	**$1,558,888.00**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 15

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey River Hydro Electric Generation System

Lower Great Brook Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$685,900.00	Large cofferdam required at this site to isolate work area from the Mersey River.
Site Access Removals	$20,000.00	Remove driveway.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$406,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary buildings at this location.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$28,900.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$144,132.80	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,000.00	Allowance
Insulated Wire and Cables No. 1	-$2,000.00	Allowance
Insulated Wire and Cables No. 2	-$2,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$154,428.00	
Site Decommissioning Estimate Subtotal Lower Great Brook Development	**$1,579,060.80**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 16

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey River Hydro Electric Generation System

Deep Brook Development		
Item Description	Estimated Decommissioning Costs	Assumptions/Notes
SITE REMEDIATIONS		
Site Remediation Issues	$1,121,900.00	Very broad tailrace, about 1/2 mile long to be remediated.
Site Access Removals	$8,000.00	Remove driveway.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$442,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary buildings at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$20,300.00	Includes tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$194,689.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$208,596.00	
Site Decommissioning Estimate Subtotal Deep Brook Development	**$2,133,985.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 17

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Mersey River Hydro Electric Generation System

Cowie Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$546,400.00	New diversion may be required.
Site Access Removals	$30,000.00	Remove driveway.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$552,800.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary buildings at this location.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$58,100.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$16,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$10,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$45,000.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$147,784.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$158,340.00	
Site Decommissioning Estimate Subtotal Cowie Falls Development	**$1,618,024.00**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 18

8. Nictaux Hydro Electric System

Nictaux Development is one of three conventional stand-alone hydro-electric developments that discharge water from South Mountain watersheds into the Annapolis River or other tributaries to the Annapolis River and the Annapolis Basin. The other two such developments are located at Paradise and at Lequille. A fourth development, the Annapolis Tidal Power Generation Station, is also on the Annapolis River but is outside the scope of this study.

Each of these three facilities are located on their own tributary rivers, have their own watersheds and are fed via pipelines/buried penstock pipes from impoundment head ponds and storage reservoirs located in the upper reaches of the South Mountain in the Annapolis Valley area.

These developments were constructed in the 1950's and 1960's by the Nova Scotia Power Commission and Nova Scotia Light and Power Company, precursors to NSPI.

a) Nictaux Development

In 1954 the Nictaux Development was completed at Nictaux Falls at the toe of the South Mountain at Nictaux Falls, Annapolis County, south of and across the Annapolis River from Middleton. The Nictaux Development harnesses about 380 feet of head to provide about 6.8 MW of generation capacity from a single vertical turbo-generator unit. This plant replaced an older facility at this site which utilized a much smaller head pond and much less head.

The powerhouse can be accessed about three miles south of Middleton off Trunk Highway Route 10 via Nictaux Falls Road and Torbrook Road in Nictaux Falls.

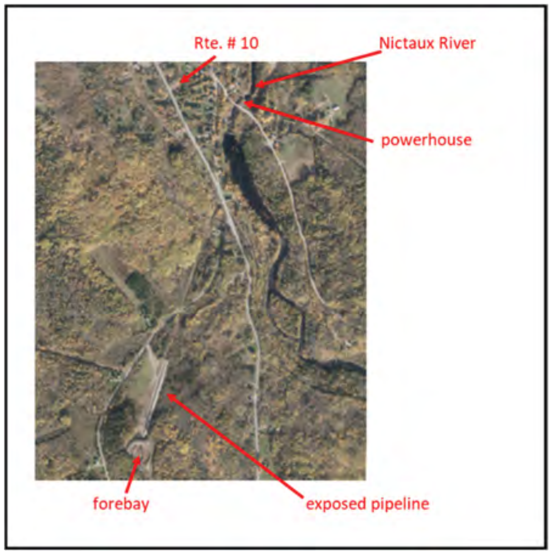

Photo 15: Nictaux Development

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is very limited material laydown area at site.

There is limited room at site to bury concrete debris.

Following demolition planning categorizations apply to the Nictaux facility:

- Intake Classification - Category B, penstock pipe is buried below ground;

- Architectural Classification – Category A, reinforced concrete, steel and masonry;
- Outlet (Draft-tube) Classification – Category A, the draft tube discharges flow directly into the Nictaux River.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, and support trusses, structural steel and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal or remove directly from site.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal or remove directly from site.
- Dismantle exterior walls and related components, stockpile demolition material for disposal or remove directly from site.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal or remove directly from site.
- Remove exposed interior steel penstock, butterfly valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure. The powerhouse outlet is “in-stream”. Stockpile debris for disposal or remove directly from site.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility.

- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Nictaux River Hydro Electric Generation System

Nictaux Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$217,950.00	
Site Access Removals	$3,000.00	Includes re-grading at site access roads.
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$217,650.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No miscellaneous auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$35,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$5,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$6,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$61,247.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$65,622.00	
Site Decommissioning Estimate Subtotal Nictaux Development	**$670,219.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 19

9. Paradise Development

Paradise Development is one of three conventional stand-alone hydro-electric developments that discharge water from South Mountain watersheds into the Annapolis River or other tributaries to the Annapolis River and the Annapolis Basin. The other two such developments are located at Nictaux and at Lequille. A fourth development, the Annapolis Tidal Power Generation Station is also on the Annapolis River but is outside the scope of this study.

Each of these three facilities are located on their own tributary rivers, have their own watersheds and are fed via pipelines and buried penstock pipes from impoundment head ponds and storage reservoirs located in the upper reaches of the South Mountain in the Annapolis Valley area.

These developments were constructed in the 1950's and 1960's by the Nova Scotia Power Commission and Nova Scotia Light and Power Company, precursors to NSPI.

a) Paradise Development

Completed in 1950 at Paradise Brook, at the toe of the South Mountain, across the Annapolis River and southwest of Paradise in Annapolis County, the Paradise plant provides about 5.0 MW from a single vertically oriented generating unit at about 463 feet of head.

The powerhouse can be accessed via a ¾ mile-long gravelled access road located off collector route 201, 3 miles southwest of Paradise.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. There is ample available material lay-down area at this site.

A lengthy tailrace channel comprising much of Paradise Brook will require remediation.

Following demolition planning categorizations apply to the Avon No. 2 facility:

- Intake Classification - Category B, penstock pipe is buried below ground;
- Architectural Classification – Category B, Reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, a lengthy tailrace channel will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.

- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, main penstock gate valve and related parts; also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris for disposal or remove directly from site.
- Remove auxiliary buildings and buried services including the on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater piping and equipment.
- Disposal of construction and demolition debris, truck selected materials to a designated disposal facility, while suitable materials, such as pulverized concrete devoid of rebar and embedded metals can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Access and other gravel roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.
- Once it is drained, remediate the roughly mile-long tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.

The bulk of the costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Paradise Hydro Electric Generation System

Paradise Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$297,800.00	Lengthy tailrace to be remediated.
Site Access Removals	$5,000.00	Includes re-grading at site access roads.
Site Services Removals	$10,000.00	Site sewage disposal system to be removed.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$222,650.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$5,000.00	Auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$29,650.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$8,500.00	Powerhouse
Electrical Control and Communication	$7,500.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$10,750.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$73,141.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,000.00	Allowance
Insulated Wire and Cables No. 1	-$1,000.00	Allowance
Insulated Wire and Cables No. 2	-$1,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$78,366.00	
Site Decommissioning Estimate Subtotal Paradise Development	**$801,057.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 20

10. Roseway River Hydro Electric System

At Roseway a single hydro-electric development powerhouse with two installed generating units has been constructed to harnesses the water of the Roseway River. Water is diverted from the river via a diversion dam and an approximately 800 foot long power canal. Water is discharged from the powerhouse into the Roseway River and its estuarial region via a constructed tailrace channel which is about a half mile long.

a) Roseway Development

The Roseway Development turbo-generators are fed via a twinned concrete headworks structure with separate dedicated gated inlets for each unit at the power canal forebay. Each unit is fed by its own penstock pipes, which remain partly exposed at the upstream walls of the powerhouse.

Unit No. 1 horizontally oriented Roseway turbo-generator was originally installed and commissioned in 1931 and was reconstructed in 1969. The unit features a now obsolete interconnected double rotor turbine system which splits the flow from the penstock and directs it to two separate turbines and scroll cases/draft-tubes located at each side of the centrally located generator unit. Although the unit is rated for 275 kW (0.275 MW) at approximately 25 feet of head, it has not regularly produced power for many years.

Unit No. 2 is a relatively small but more conventional vertically oriented unit that was originally installed at a previously decommissioned and abandoned powerhouse near Mahone Bay. This unit was moved to an expanded Roseway powerhouse in about 1949 where it has generated approximately 600 kW (0.6 MW) from 25 feet of head.

The powerhouse can be accessed via Trunk route 3 west of Shelburne, north on Upper Clyde Road about a half mile, and then east on Powerdam Road, which serves as an approximately 800 feet long gated paved access driveway.

Demolition planning for this facility will consider that the intake penstock pipelines will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some limited material laydown area available at site.

Clean masonry and concrete materials can be buried at site and utilized in backfilling of the powerhouse substructure.

Following demolition planning categorizations apply to the Roseway facility:

- Intake Classification - Category A, penstock pipes are partially exposed and above ground, although some site alterations have caused the pipes to be partly buried by accessway construction and improvements;
- Architectural Classification – Category A, reinforced concrete, some structural steel and masonry construction, some wood frame (also some wood-frame construction);
- Outlet (Draft-tube) Classification – Category B, the lengthy tailrace channel will require remediation to the original Roseway River alignment.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed. Also remove head gates and related operating equipment, all of which is located inside the confines of the powerhouse.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead crane components and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floors reinforced concrete slabs. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including penstock parts, valving, throttling components, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected materials to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar or embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.

- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Roseway River Hydro Electric Generation System

Roseway Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$210,250.00	800 ft long tailrace to be remediated.
Site Access Removals	$6,000.00	Paved driveway to be removed.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$192,100.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	N/A
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$40,500.00	One vertical and one horizontal turbo-generator unit.
Turbo Generator Control Removals	$5,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$6,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$6,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$59,197.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$200.00	Allowance
General Parts	-$850.00	Allowance
Insulated Wire and Cables No. 1	-$850.00	Allowance
Insulated Wire and Cables No. 2	-$850.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$63,426.00	
Site Decommissioning Estimate Subtotal Roseway Development	**$648,423.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 21

11. Sheet Harbour Hydro Electric System

The Sheet Harbour Hydro Electric System consists of two hydro-electric developments and two powerhouses. Each development consists of three vertically oriented turbo-generating units that utilize water from lakes and rivers forming part of the East River of Sheet Harbour. The two powerhouses are associated with the upstream Malay Falls Development and the downstream Ruth Falls Development.

Sheet Harbour developments originally provided electricity to the Sheet Harbour area as an "island" system. In other words, Sheet harbour had electric power, but surrounding areas did not. That changed in the 1960's and 1970's as the modern power grid was developed and constructed by the Nova Scotia Power Commission.

a) Malay Falls Development

Work was completed on the first two units at Malay Falls in 1924, with a third unit coming on-line in 1954. The three vertically oriented turbo-generators each provide about 1.1 MW, which is developed from approximately 41 feet of head for a total of 3.3 MW. Inflow from Marshall Flowage and Malay Falls head pond and power canal is channelled through the Malay Falls intakes and draft tube, which discharges directly into the East River of Sheet Harbour.

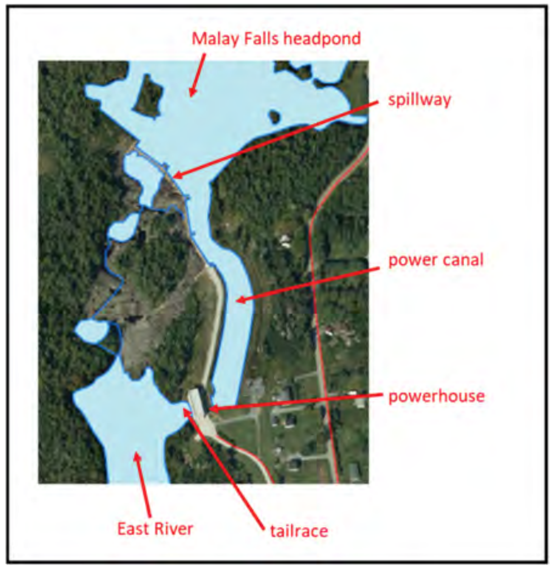

Photo 16: Malay Falls Development

The combined powerhouse incorporates a heavy generator floor and a large lower triple intake chamber, with gated inlets and chambering for each of the three turbo-generators. Support structure for the heavy generator floor which supports the stators (and also the shafts and turbines) is by way of a heavy reinforced concrete slab supported from stout reinforced concrete intake unit separation walls and the concrete substructure below. Head covers, wicket gate assemblies and operating assemblies (except for the actual governors) are submerged in the intake chambers, much like similarly configured units at Tusket.

Access to the powerhouse is located about 6 miles approximately north of Sheet Harbour via paved Collector Rte. 374 which roughly follows the East River, thence into Malay Falls via the dedicated paved loop road for that area. In addition to the powerhouse, there are several small support buildings and gravelled driveways at the site.

Demolition planning for this facility will consider that the power canal will be dewatered and in-filled by others involved in dam structure removals and related site remediations. All electrical and communications equipment directly related to transmission will be removed by others. It is also considered that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site.

Depending on bedrock conditions, there may be limited potential at this site for burying demolition generated materials.

Following demolition planning categorizations apply to the Malay Falls facility:

- Intake Classification - Category C, intake assemble and head gates are constructed integrally with the powerhouse;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the draft tube outflow discharges directly into the East River of Sheet Harbour.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of main turbo-generator components for three units such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish superstructure exterior walls and related components, stockpile demolition material for disposal.
- Remove head gates and related operating mechanisms, and demolish intake structure.
- Remove and demolish generator floor reinforced concrete slab and related exterior and interior support walls at that level, as well as the concrete intake chambers. Stockpile demolition material for disposal.

- Remove exposed interior steel parts; including throat ring, head cover, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal. This powerhouse outlets directly to the East River of Sheet Harbour and is considered to be “in-stream”.
- Remove and demolish submerged turbine floor and related substructure mass concrete and substructure interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove auxiliary buildings such as administration trailer, storage barn, and garage, and miscellaneous structures and buried services including the on-site sewage disposal system, sanitary pumps and piping, well and any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The tailrace cofferdam can remain once graded to match site. Large sized rock fill may be required in this application. Provide erosion protection as required. Note that due to its depth, the power canal must be filled in to prevent the river from assuming that alignment through the powerhouse location.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Ruth Falls Development

The first two Ruth Falls Development units were completed in 1927, with a follow-on third unit installed and completed in about 1936. Units No. 1 and 2 each provide about 2.2 MW of generation capacity, while Unit 3 has an output capacity of about 2.85 MW. This provides a total output of about 7.25 MW at Ruth Falls. The three vertically oriented units are fed water from the Ruth Falls power canal forebay and a penstock blasted through the hillside bedrock which provides about 109 feet of head. The penstock is trifurcated below ground at the rear of the powerhouse. Outflow from the units discharges directly into the estuarial waters of the East River of Sheet Harbour.

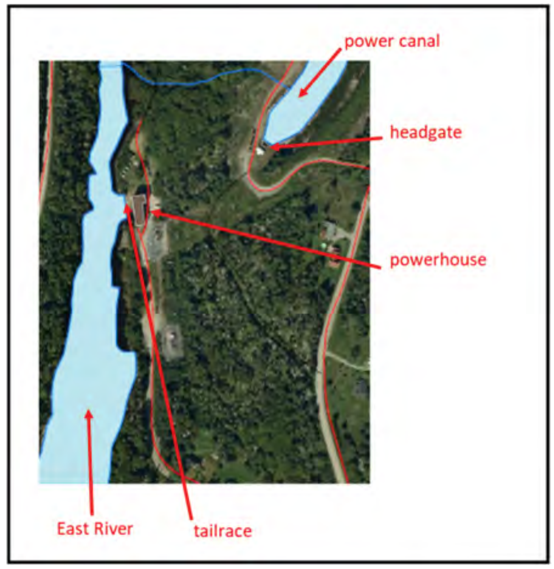

Photo 17: Ruth Falls Development

A heavy generator floor and related support structure are configured over a turbine (basement) floor and related support substructure at Ruth Falls. The units are fed through the trifurcated penstock and dedicated butterfly valves arrangement to form plate steel scroll cases. The head cover for each unit is accessed from the turbine floor area. The concrete draft tube arrangement discharges directly to the East River of Sheet Harbour at tidewater level.

Access to the powerhouse is via gravel topped Ruth Falls Road which is located approximately one mile and a half north of Sheet Harbour on paved East River Road.

Demolition planning for this facility will consider that the power canal forebay is dewatered and possibly in-filled, and that the intake penstock is dewatered and in-filled. All electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some limited material laydown area available at this site.

There is very little potential for burying demolition debris at this site due to the close proximity of bedrock with the surface. Existing DFO facilities at this site will remain. A significant cofferdam may be required to assist in substructure removals. Erosion protection and height adequate to handle tidal influences will be necessary.

Following demolition planning categorizations apply to the Ruth Falls facility:

- Intake Classification - Category B, buried penstock;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the draft tubes discharge directly into the East River of Sheet Harbour.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet.
- Removal of main turbo-generator components for three units such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior superstructure walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove and demolish turbine floor and related reinforced concrete substructure. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including steel penstocks, penstock liners and butterfly valves, scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal. This powerhouse outlets directly to the tidal marine estuary of the East River of Sheet Harbour and is considered to be “in-stream”.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, well(s) and any freshwater piping and equipment and any auxiliary buildings associated with hydro production activities.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility.
- Deliver or sell stockpiled salvage material.

- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediation will be required at the draft tube tailrace outlets with clean gravel and crushed stone as required. Erosion protection will be required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Access road and related driveways to remain to assist in fire-fighting and search and rescue activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Sheet Harbour Hydro Electric Generation System

Malay Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$290,000.00	Plant outlets directly to East River of Sheet Harbour. Significant cofferdam and erosion protection will be required along with some tailrace channel remediation. Power Canal will require at least partial infilling.
Site Access Removals	$6,000.00	Remove asphalt and re-grade driveways.
Site Services Removals	$14,000.00	Remove site sewage disposal system and freshwater supply at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$397,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs. Turbine floor at this location is submerged in intake chamber.
Auxiliary Buildings Removals (not associated with Production Plant)	$25,000.00	Remove multiple base-camp buildings.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$89,000.00	Three vertical turbo-generator units.
Turbo Generator Control Removals	$25,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$4,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$20,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$8,000.00	Powerhouse
Electrical Control and Communication	$14,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$46,000.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$109,166.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$200.00	Allowance
General Parts	-$3,000.00	Allowance
Insulated Wire and Cables No. 1	-$2,500.00	Allowance
Insulated Wire and Cables No. 2	-$2,500.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$116,964.00	
Site Decommissioning Estimate Subtotal Malay Falls Development	**$1,192,630.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 22

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Sheet Harbour Hydro Electric Generation System

Ruth Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$290,000.00	Plant outlets directly to estuarial region of East River of Sheet Harbour. Significant cofferdam and erosion protection will be required. Penstock will require a concrete bulkhead arrangement and/or infilling.
Site Access Removals	$7,500.00	Remove asphalt and re-grade access, parking area.
Site Services Removals	$10,000.00	Remove site sewage disposal system and well system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$402,000.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs. Separate Generator and Turbine floors at this location.
Auxiliary Buildings Removals (not associated with Production Plant)	$1,500.00	Shed removal.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$89,000.00	Three vertical turbo-generator units.
Turbo Generator Control Removals	$25,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$4,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$20,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$8,000.00	Powerhouse
Electrical Control and Communication	$14,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$46,000.00	Includes head gates and tailrace gates.
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$106,758.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$800.00	Allowance
General Parts	-$3,500.00	Allowance
Insulated Wire and Cables No. 1	-$2,500.00	Allowance
Insulated Wire and Cables No. 2	-$2,500.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$114,384.00	
Site Decommissioning Estimate Subtotal Ruth Falls Development	**$1,165,042.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 23

12. Sissiboo River Hydro Electric System

There are three hydro-electric developments that comprise the Sissiboo River Hydro-Electric Generation System. These developments discharge water into the Sissiboo River which in turn flows into St. Mary's Bay.

Fourth Lake is located at the top (upstream) of the system. Water flows through the single Fourth Lake turbo-generator and from there makes its way along the Sissiboo River and into the Sissiboo head pond where water is channelled through the single Sissiboo Falls plant generating unit. From the Sissiboo powerhouse water is directed to the Weymouth Head pond and thence through the two generating units located in the Weymouth powerhouse. Water is discharged from the Weymouth powerhouse into the Sissiboo River a few miles south of Weymouth.

These developments were constructed in the 1960's and 1980's by the Nova Scotia Power Commission and NSPI.

a) Fourth Lake Development

Completed in 1983, the Fourth Lake Development harnesses approximately 70 feet of head and provides 3.0 MW of electrical generation capacity from a relatively small horizontally oriented single turbo-generator. (Configuration of this unit closely resembles a ship's bow thruster.)

The powerhouse can be accessed via paved local collector roads and gravelled woods roads and is located approximately 20 miles east of Weymouth near New France.

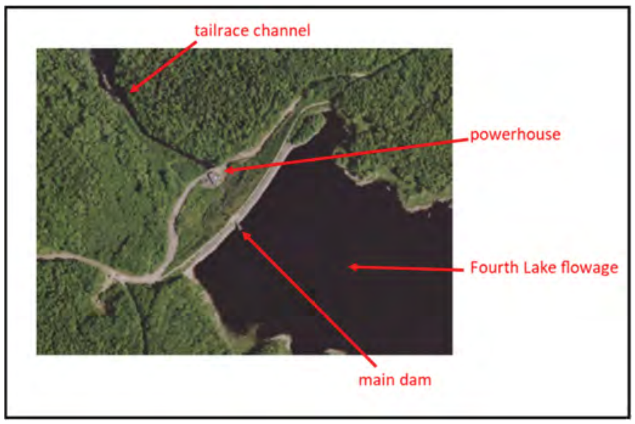

Photo 18: Fourth Lake Development

Constructed below grade, the powerhouse is fed by a steel lined penstock buried in the main earthen dam.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. There is some limited material laydown area at site. However, if more laydown area is needed, such space can be cleared of vegetation and constructed.

Following demolition planning categorizations apply to the Fourth Lake facility:

- Intake Classification - Category B, buried penstock;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, draft tube and tailrace empty directly into Third Lake Rip (appears to match alignment of original streambed) and flow makes its way from there to Third Lake.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.
- Removal of the compact turbine components, the generator and related components can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be removed from the compact powerhouse and stockpiled outside by an all-terrain mobile crane for planned salvage and disposal.
- Removal of roofing, sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane, sort and stockpile at site for salvage and disposal.
- Excavate and demolish exterior walls and related component and sub-structure. Stockpile demolition material for disposal. This powerhouse will probably be located “in-stream” upon removal of site infrastructure.
- Remove and demolish main floor reinforced concrete slab and related miscellaneous substructure components. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, by-pass piping, by-pass butterfly valve and related parts; also remove steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove buried services including site sewage disposal system and related piping, as well as any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected material to a designated construction debris disposal facility, while suitable other material, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.

- Backfill and infill foundation substructure and draft-tube excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Once it is drained, remediate and in-fill the tailrace with clean gravel and crushed stone and well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Sissiboo Falls Development

Completed in 1961 at Sissiboo Falls, located approximately 12 miles east of Weymouth via Sissiboo Road. The plant provides 6.0 MW from about 87 feet of head from a relatively large single vertically oriented turbo-generator unit.

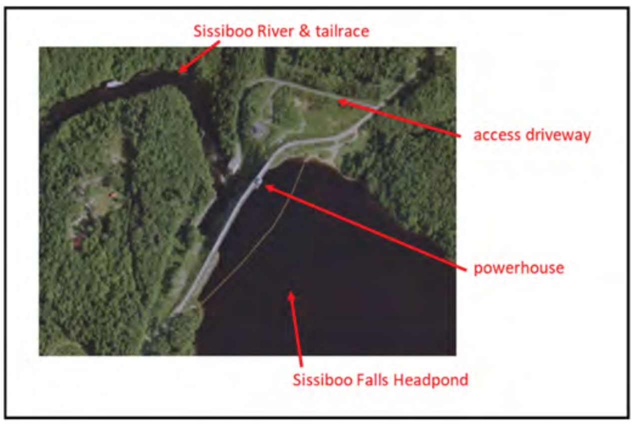

Photo 19: Sissiboo Falls Development

The powerhouse is located at the right side (looking downstream) of the Sissiboo spillway channel and Sissiboo River at the base of the Sissiboo Falls gravity dam and spillway. It is fed via an exposed penstock from the main dam intake structure.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous material or environmental issues at this site that would adversely affect demolition planning. There is limited available material lay-down area at this site.

If demolition generated material is to be buried at site, the burial work should not be in close proximity of the river.

A significant cofferdam will be required due to close proximity to the spillway channel and Sissaboo River.

Following demolition planning categorizations apply to the Sissiboo Falls facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;

- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the draft-tube discharges flow directly into the Sissiboo River.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and around the left side of the powerhouse. Provide erosion protection against extreme river flow as required.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required inside or outside the powerhouse for salvage and disposal.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components, as required, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstock, also remove scroll case, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure. This powerhouse is located “in-stream”.
- Remove buried services including an on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater piping and equipment.
- Disposal of construction and demolition debris, truck selected material to a designated disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.

- Infill foundation substructure excavation with compacted clean granular material to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site. Provide erosion protection.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Remove gravel access road driveway to powerhouse.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal and site protection/remediation post demolition.

c) Weymouth Falls Development

The Weymouth Development consists of two similar vertical turbo-generators in a shared powerhouse structure, known as Weymouth No. 1 and Weymouth No. 2. The generating units are somewhat similar to the single Sissiboo turbo-generator.

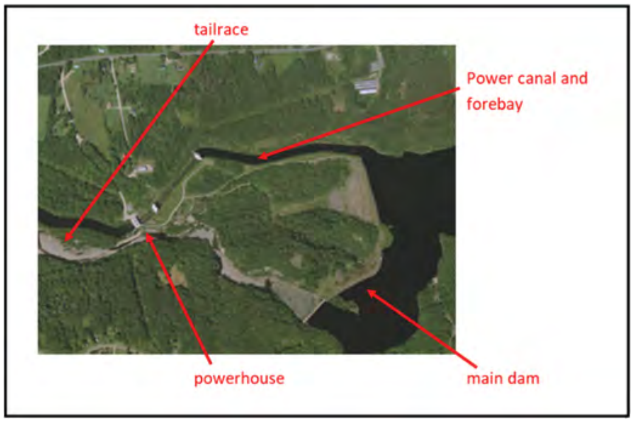

Photo 20: Weymouth Falls Development

The No.1 plant was completed in 1961 at Weymouth Falls, located about 3 miles east of Weymouth via Sissiboo Road. Construction and commissioning was completed on the adjoining Weymouth No. 2 in about 1967. The plant provides about 9.0 MW from each unit for a total of 18 MW from about 122 feet of head.

Fed by twin pipelines from the power canal intake structure, the development is characterised by two large bowl surge tanks at the rear of the powerhouse at the penstock pipes.

The development incorporates a significant diversion at the power canal and intake, and a similar tailrace diversion. The powerhouse tailrace and the spillway channel converge in the Sissiboo river alignment about 2000 feet downstream of the powerhouse. Considerable remediation work will be required to restore the tailrace channel.

Demolition planning for this facility will consider that the intake penstock pipeline will be dewatered and removed by others, all electrical and communications equipment directly related to transmission will be removed by others and that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. There is some significant available material lay-down area at this site.

Following demolition planning categorizations apply to the Weymouth facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;

- Outlet (Draft-tube) Classification – Category B, the draft tube discharges into a lengthy tailrace channel that will require significant remediation.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet. Provide over-topping and erosion protection against extreme tides as required.
- Removal of main turbo-generator components for both units such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required inside or outside the powerhouse for salvage and disposal.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo generator main components for both units, as required, sort and stockpile at site for salvage and disposal.
- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab. Stockpile demolition material for disposal.
- Remove exposed interior steel penstocks, also remove scroll cases, throat rings, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for disposal and salvage.
- Remove reinforced concrete foundation substructure to a few feet below new finished grade elevation.
- Remove buried services including an on-site sewage disposal system, sanitary pumps and piping, any well and related freshwater piping and equipment.
- Disposal of construction and demolition debris, truck selected materials to a designated disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar and embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.

- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the existing tailrace cofferdam structure. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Existing access road driveway to powerhouse, intake and main dam, spillway can remain to aid in fire-fighting and ground search rescue.
- Once it is drained, remediate the almost half-mile long tailrace as required to the high-water tidal mark with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Sissaboo River Hydro Electric Generation System

Fourth Lake Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$309,950.00	Remediate Tailrace
Site Access Removals	$0.00	N/A
Site Services Removals	$0.00	No site sewage disposal system at this site.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$189,950.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary structures at this site
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$19,750.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$7,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$7,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$66,063.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$250.00	Allowance
General Parts	-$750.00	Allowance
Insulated Wire and Cables No. 1	-$750.00	Allowance
Insulated Wire and Cables No. 2	-$750.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$70,782.00	
Site Decommissioning Estimate Subtotal Fourth Lake Development	**$724,195.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 24

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Sissiboo River Hydro Electric Generation System

Sissiboo Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$629,700.00	Large cofferdam required to isolate powerhouse from river.
Site Access Removals	$10,000.00	Remove driveway
Site Services Removals	$12,000.00	Remove site sewage disposal system at this location
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$279,600.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$45,300.00	Single Vertical turbo-generator unit.
Turbo Generator Control Removals	$8,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$12,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$5,000.00	Powerhouse
Electrical Control and Communication	$6,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$15,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$118,977.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$1,200.00	Allowance
Insulated Wire and Cables No. 1	-$1,200.00	Allowance
Insulated Wire and Cables No. 2	-$1,200.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$127,476.00	
Site Decommissioning Estimate Subtotal Sissiboo Falls Development	**$1,304,653.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 25

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Sissaboo River Hydro Electric Generation System

Weymouth Falls Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$511,650.00	Considerable tailrace channel remediation.
Site Access Removals	$0.00	N/A
Site Services Removals	$12,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$397,500.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$10,000.00	Remove auxilliary structures at this site.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$90,600.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$17,500.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$9,000.00	Powerhouse
Electrical Control and Communication	$10,500.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$10,400.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$17,000.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$127,304.80	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$1,000.00	Allowance
General Parts	-$2,400.00	Allowance
Insulated Wire and Cables No. 1	-$2,400.00	Allowance
Insulated Wire and Cables No. 2	-$2,400.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$136,398.00	
Site Decommissioning Estimate Subtotal Weymouth Falls Development	**$1,392,152.80**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 26

13. St. Margaret's Bay Hydro Electric System

The St. Margaret's Bay Hydro Electric System consists of three hydro-electric developments and two powerhouses. Each development consists of two vertically oriented turbo-generating units that utilize water from two main lake and river systems. The Coon Pond Development and the Sandy Lake Development share a powerhouse structure at the upper end of Mill Lake, while the Tidewater Development collects and generates from the Sandy Lake and Coon Pond outflows.

St. Margaret's Bay Developments were originally constructed by predecessors of the Nova Scotia Light and Power (NSLP) as a more powerful and reliable motive power source for electric tram cars that were becoming active in the city of Halifax in the early 1900's. Horse-drawn tram service in Halifax had its start the 1860's and, within 30 years, that service began transitioning to electric powered tram service. However, by the 1920's, with the primitive and worn electric tram fleet facing replacement, it became obvious that more electrical generating capacity would be required to operate a fully electric and "modern" tram system. Therefore, in the early 1900's, work was started on construction of the nearby St. Margaret's Bay Hydro Electric Generating System.

Work was completed at Coon Pond and Tidewater in 1922, with the completion of the Sandy Lake Development in 1928, bringing overall system capacity to about 10.7 MW. The "modern" Birney tram car fleet operated in the city from about 1923 to about 1949, upon which they were replaced by electric trolley buses. Those electric trolley busses were replaced with a diesel bus fleet in about 1969 when the city took over ownership and operation of transit services in Halifax.

a) Coon Pond and Sandy Lake Developments

Coon Pond Development was completed in about 1922 and provided about 1.25 MW from each of its two vertically oriented turbo-generator units. Inflow from the Pockwock Lake system is channelled through Coon Pond and a pipeline to the Coon Pond Development units, which develop approximately 162 feet of head. Note that in recent years only one of the Coon Pond units has been available for service.

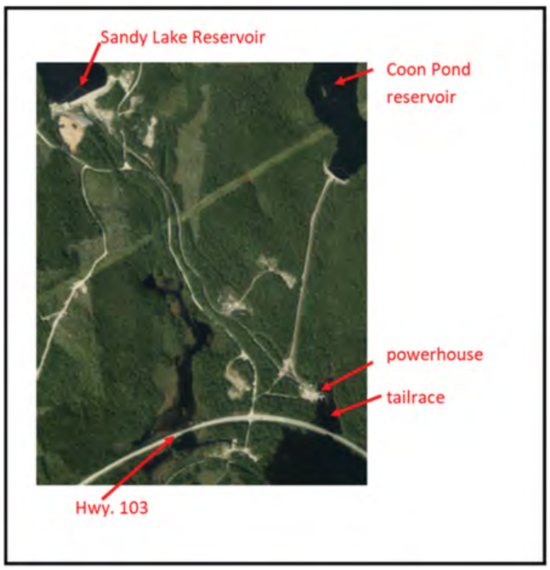

Photo 21: Coon Pond & Sandy Lake Development

At the Sandy Lake side of the power house, completed in about 1928, two vertical units each provide approximately 2.1 MW from 125 feet of head via a pipeline penstock from the Sandy Lake head pond.

The combined powerhouse incorporates a generator floor and support structure over a heavy turbine floor and concrete substructure and related support structure. The intakes for both Coon Pond and Sandy Lake units utilize bifurcated penstocks with main line butterfly valves and formed plate steel scroll case arrangements. The head covers for Coon Pond units are accessed from the generator floor, while the head covers for Sandy Lake units are located at and accessed from the Turbine floor.

Powerhouse and surge tanks are visible from Highway 103. Access to the powerhouse is via existing gravel topped Bowater's Roads in the Tantallon vicinity which cross Highway 103, 2 miles west of Exit 5 via an approximately 800 foot long gated and gravelled driveway located 150 feet north of the highway.

Outflow from Coon Pond and Sandy Lake developments discharge the downstream Tidewater Development. The head pond and lake will be removed by others, as with other system head ponds.

Demolition planning for this facility will consider that the intake pipelines will be dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at site.

There appears to be ample room at site for burying demolition generated debris, but granite bedrock is close to the surface. Therefore, it may not be practical to consider buried disposals at this site.

As discovered during previous renovations activities at the powerhouse, concrete utilized in the superstructure and substructure construction is in very good condition, does not demonstrate any effects of degradation by alkali aggregate reactivity and is very hard and durable. Therefore, concrete demolition will be a considerable undertaking at this site.

Following demolition planning categorizations apply to the Coon Pond and Sandy Lake facility:

- Intake Classification - Category A, penstock pipe is exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, since outflow forms Mill Lake, once outflow is gone, the tailrace area and the former lake will require significant remediation and restoration.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace.

- Removal of main turbo-generator components for all four units, such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish superstructure exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove and demolish turbine floor mass concrete and related substructure and interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including penstock and butterfly valves, scroll case and throat ring, head cover, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck to a construction debris disposal facility located close to Halifax.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate and infill the tailrace as and where required (and to at least Highway #103 limits) with clean gravel and crushed stone, and clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Tidewater Development

The Tidewater Development was completed in 1922 and provides 2.0 MW of generation capacity from each of its two vertically oriented turbo-generator units which develop that power from approximately 95 feet of head fed from Mill Lake head pond. Outflow from the units discharges directly into the marine waters of St. Margaret's Bay at tidewater elevation.

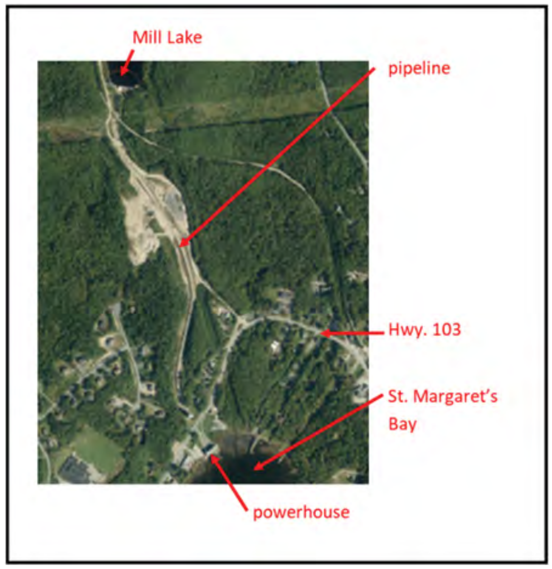

Photo 22: Tidewater Development

A generator floor and related support structure are configured over a turbine (basement) floor and related support substructure at Tidewater. The penstock pipes are fed through a bifurcated penstock and butterfly valves to formed plate steel scroll cases. The head cover for each unit is accessed from the generator floor.

Access to the powerhouse is via two gravel topped driveways off Trunk Route 3 about a mile west from Collector Road 213.

Demolition planning for this facility will consider that the intake pipeline is dewatered and all electrical and communications equipment directly related to transmission will be removed by others. It is also taken into consideration that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is significant material laydown area available at this site.

Although there is ample laydown area at this site, due to expected close proximity of bedrock to the surface, there may be limited opportunity to dispose of demolition generated materials by burying.

Following demolition planning categorizations apply to the Tidewater facility:

- Intake Classification - Category A, penstock pipes are exposed above ground;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category A, the draft tubes discharge directly into the Head of St. Margaret's Bay.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and

filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.

- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.
- Removal of Roofing, Sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Demolish exterior superstructure walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Remove and demolish turbine floor reinforced concrete slab and related concrete substructure. The outlet for this powerhouse is at the shoreline of a marine estuary. Therefore it is considered to be "in-stream". Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including steel penstocks and butterfly valves, throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment and auxiliary buildings associated with hydro production activities.
- Disposal of construction and demolition debris – truck to a construction debris disposal facility located near Halifax.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted clean granular material to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediation will be required at the draft tube tailrace outlets with clean gravel and crushed stone as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Remove access driveways.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

St. Margaret's Bay Hydro Electric Generation System

Coon Pond & Sandy Lake Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$509,300.00	Large tailrace area to be remediated.
Site Access Removals	$3,500.00	Remove driveway.
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$489,000.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	No auxilliary buildings at this location.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$146,000.00	Four vertical turbo-generator units.
Turbo Generator Control Removals	$34,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$25,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$10,000.00	Powerhouse
Electrical Control and Communication	$12,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$7,500.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$36,000.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$147,313.60	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$500.00	Allowance
General Parts	-$2,700.00	Allowance
Insulated Wire and Cables No. 1	-$2,700.00	Allowance
Insulated Wire and Cables No. 2	-$2,700.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$157,836.00	
Site Decommissioning Estimate Subtotal Coon Pond & Sandy Lake Development	**$1,611,849.60**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 27

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

St. Margaret's Bay Hydro Electric Generation System

Tidewater Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$281,900.00	Discharges directly into Head of St. Margaret's Bay marine estuary.
Site Access Removals	$15,000.00	Remove two driveways.
Site Services Removals	$10,000.00	Remove freshwater supply and site sewage disposal system at this locations.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$252,750.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$10,000.00	Remove administration building and garage structure auxilliary buildings at this location.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$70,600.00	Two vertical turbo-generator units.
Turbo Generator Control Removals	$17,000.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$25,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$10,000.00	Powerhouse
Electrical Control and Communication	$12,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$21,000.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$85,506.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$400.00	Allowance
General Parts	-$2,000.00	Allowance
Insulated Wire and Cables No. 1	-$2,000.00	Allowance
Insulated Wire and Cables No. 2	-$2,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$91,614.00	
Site Decommissioning Estimate Subtotal Tidewater Development	**$934,170.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 28

14. Tusket River Hydro Electric System

At the Tusket River Hydro Electric System there is one hydro-electric development with a single powerhouse that discharges water into the Tusket River and its estuarial region. This plant is known as the Tusket Development.

At the Tusket Development water is diverted to a power canal by a diversion dam and spillway structure from Lake Vaughan at Tusket Falls and is discharged into a constructed tailrace channel approximately 1600 feet long which is at tidewater level.

a) Tusket Development

The Tusket Development utilizes three vertically oriented turbo-generators which are fed directly from the power canal forebay via a triple intake structure.

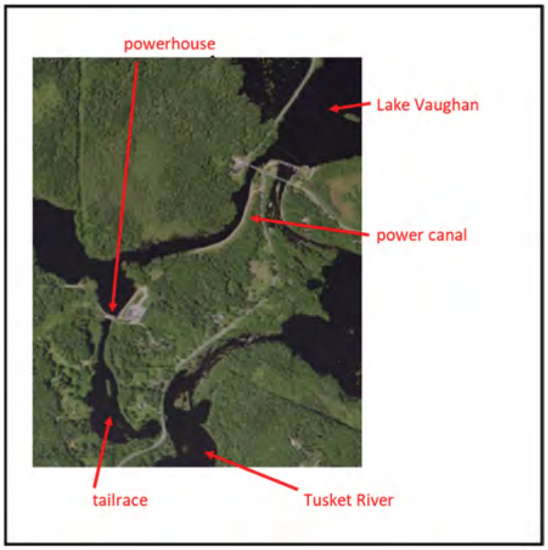

Photo 23: Tusket Development

The powerhouse structure incorporates a generator floor and support structure over a heavy turbine floor and related support structure. The pressurized intake chamber is found below the turbine floor, while the draft tube outlet and building substructure are located beneath the intake chamber.

The powerhouse incorporates an unfinished fourth unit intake and substructure which is currently utilized to assist with downstream fish passage at the site. There is no powerhouse superstructure associated with this feature. Therefore, concrete superstructure demolitions will be necessary for the portion of the powerhouse incorporating the three turbo-generators and the generator floor, but demolition work for the turbine floor concrete substructure and intake chambers will be for four units.

Tusket Development was constructed in 1929. It has three installed turbo-generators, each producing about 725 kW (0.725 MW) for a total of about 2.175 MW from about 22 feet of head. There is no fabricated metal scroll case arrangement in the intake area, but a head cover and wicket gates control assembly are installed instead on a raised concrete curb just above intake floor level, which provides a means for controlling flow past each of the turbines and associated throat-rings to the draft tube and into the tailrace channel.

The powerhouse can be accessed via the paved Raynardton Road, which is approximately two miles northeast from its intersection with Hwy 103, and a gravelled access (Bennys Lane) that runs west from Raynardton Road for about 1000 feet to the powerhouse. Bennys Lane loops back about a half-mile where it reconnects with Raynardton Road at the power canal inlet and diversion dam at Lake Vaughan.

Demolition planning for this facility will consider that the intake structure and forebay will be dewatered, and all electrical and communications equipment directly related to transmission will be removed by others. It will also be assumed that there are no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is some material laydown area available at site, but that more laydown area can be cleared.

Although not in the water course after demolition, the powerhouse structural configuration will require most of the substructure to be removed during the demolition exercise.

Following demolition planning categorizations apply to the Tusket facility:

- Intake Classification - Category C, concrete intake structure is integral with the powerhouse structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, the tailrace channel will require remediation to the original Tusket River alignment.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Construct additional material lay-down area as required.
- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace. This structure will have to be adequate to withstand tidal influences.
- Removal of main turbo-generator components such as Exciter; top frame; Rotor and Generator Shaft; Speed Ring, Wicket Gates, shafts and related assembly and parts; Turbine Shaft, Head-cover and Turbine; and Stator can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed. Also remove head gates and related operating equipment, all of which is located inside the confines of the powerhouse.
- Removal of roofing, sheathing, support structure and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.

- Demolish exterior walls and related components, stockpile demolition material for disposal.
- Remove and demolish generator floor reinforced concrete slab and related exterior support walls at that level. Stockpile demolition material for disposal.
- Demolish concrete intake structure.
- Remove and demolish turbine floor reinforced concrete slab and interior/exterior walls at that level. Stockpile demolition material for disposal.
- Remove exposed interior steel parts; including throat ring, steel draft-tube parts and other related miscellaneous items. Stockpile and sort for salvage and disposal.
- Remove reinforced concrete foundation substructure to at least the draft tube level. Stockpile debris for disposal.
- Remove buried services including the on-site sewage disposal system, sanitary pumps and piping, any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck selected material to a designated construction debris disposal facility, while suitable other materials, such as pulverized concrete devoid of rebar or embedded metals, can be buried at site.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Once it is drained, remediate the tailrace with clean gravel and crushed stone, as well as clean fill as required. Grade surfaces, hydro-seed and/plant trees or other vegetation to return this area to a near natural state.
- Gravel woods roads in the area should remain in place to facilitate ground-search rescue and fire-fighting activities.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Tusket Hydro Electric Generation System

Tusket Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$610,100.00	1600 ft long tailrace to be remediated
Site Access Removals	$0.00	N/A
Site Services Removals	$10,000.00	Remove site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$699,250.00	Includes roof structure removal, removal of superstructure walls, partial removal of sub-structure; infilling of the powerhouse and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$1,000.00	Remove steel structure over unit four downstream fish passage.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$94,500.00	Three vertical turbo-generator units.
Turbo Generator Control Removals	$25,300.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,500.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$24,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$17,500.00	Powerhouse
Electrical Control and Communication	$11,500.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$5,200.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$27,900.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$174,692.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$1,500.00	Allowance
General Parts	-$3,600.00	Allowance
Insulated Wire and Cables No. 1	-$3,600.00	Allowance
Insulated Wire and Cables No. 2	-$3,600.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$187,170.00	
Site Decommissioning Estimate Subtotal Tusket Development	**$1,909,312.00**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 29

15. Wreck Cove Hydro Electric System

The Wreck Cove Hydro Electric Generating System is made up two hydro-electric developments, Gisborne and Wreck Cove that collect and harness a portion of the water resources of the Cape Breton Highlands. This system is by far the largest hydro generation asset in Nova Scotia, with the Wreck Cove Development producing more electricity than all other Nova Scotia hydro-electric generation assets combined.

The base camp site for the system is located about a mile inland from the Cabot Trail about 20 miles approximately south of Ingonish.

a) Gisborne Development

Gisborne Development was constructed and commissioned in about 1982 a few years after completion and commissioning of the Wreck Cove Development, as an add-on to the system, enabling generation from the differential head between Gisborne Flowage and Wreck Cove Flowage storages.

At Gisborne, water from Gisborne flowage (which also serves as Gisborne head pond) is directed to the powerhouse via a buried steel penstock pipe. The powerhouse's horizontally oriented turbo-generator produces approximately 3.5 MW of power from 62 feet of head and discharges into Wreck Cove Flowage. Water is then directed to the main Wreck Cove Powerhouse via tunnel to the submerged concrete intake structure in Surge Lake.

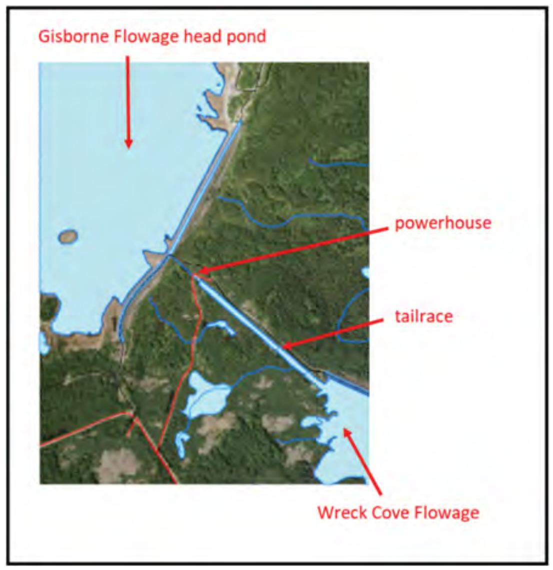

Photo 24: Gisborne Development

This site was originally a piped sluiceway upon commissioning of the main Wreck Cove powerhouse, which enabled the controlled transfer of water from the higher Gisborne reservoir to the Wreck Cove Flowage. When the powerhouse was constructed the controlled transfer of stored water was maintained as a flow by-pass feature and incorporated into the design of the mostly below-grade reinforced concrete powerhouse structure.

Note that the Gisborne reservoir is formed by a diversion dam. Once infrastructure is removed, the reservoir will revert to its original configuration and will drain to the west, away from Gisborne and Wreck Cove Flowage.

The reinforced concrete generator/turbine floor of the powerhouse is integral with the outlet draft tube and powerhouse substructure.

Demolition planning for this facility will consider that the intake penstock will be dewatered and removed and that water is removed from Gisborne Lake, and system flow patterns have been restored to original routings. (This will negate the requirement for an upstream cofferdam during demolition work). All electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is limited material laydown area available at this site and that some additional lay-down area may have to be constructed or prepared.

Since the powerhouse is built mostly below grade in a gorge between two reservoirs, machine access to the work area will be more difficult that at most other powerhouse sites. As a result, it may be necessary to employ larger cranes and smaller demolition equipment to better facilitate access. However, it may be possible to catty out only a partial substructure at this site since the powerhouse will no longer be considered to be “in-stream”.

Note that though the powerhouse is a relatively small and structure a considerable cofferdam may be required at the powerhouse access to enable safe substructure removals. Once the powerhouse substructure is removed, selected demolition material deemed suitable for disposal by burying at or near site will be so disposed. Other material will be disposed off-site at a suitably recognized disposal facility. The location of the powerhouse will then be filled with appropriate material generated from quarry facilities at or near the site.

Following demolition planning categorizations apply to the Gisborne facility:

- Intake Classification - Category B, a buried intake penstock is located at the rear of the structure;
- Architectural Classification – Category B, reinforced concrete and structural steel;
- Outlet (Draft-tube) Classification – Category B, draft tube outlet discharges into a constructed 2000 foot long channel leading to Wreck Cove Flowage.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), silt fence, silt curtain and oil boom.
- Removal of accessible lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of HVAC equipment and localized heating units for areas within the building and for those heaters strategically placed to provide assistance for turbo-generator operation.
- Installation of a granular and relatively water-tight earth-fill cofferdam at the draft-tube outlet and tailrace channel.
- Removal of main turbo-generator components such as Exciter; and Generator assembly; Wicket Gates and related parts; Turbine Shaft, Head-cover and Turbine can be facilitated with the existing powerhouse overhead Bridge Crane, although a temporary power source and connection for the crane may be required. Those components can then be set aside as required for salvage and disposal once the roof structure is removed.

- Disassembly of Roofing, Sheathing and related miscellaneous parts and components. Set aside, stockpile for salvage and disposal.
- Remove overhead Bridge Crane and stockpiled turbo-generator main components, sort and stockpile at site for salvage and disposal.
- Excavation at and disassembly of exterior concrete walls and related components, stockpile demolition material for disposal.
- Remove and demolish main floor reinforced concrete slab and related reinforced concrete substructure. Stockpile demolition material for disposal.
- Remove buried services and any freshwater piping and equipment.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility.
- Deliver or sell stockpiled salvage material.
- Infill foundation substructure excavation with compacted granular material and selected demolition debris to the tailrace cofferdam. The cofferdam can remain once graded to match site. Provide erosion protection as required.
- Infill and remediate the tailrace channel with granular site generated material, grade as necessary, place topsoil and plant trees, hydro-seed or plant other appropriate vegetation as required.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping over the entire powerhouse site as may be required for public safety and to facilitate surface drainage requirements.
- Remove powerhouse access road/driveway, but maintain other gravel roadways in the area for firefighting, and for search and rescue purposes.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

b) Wreck Cove Development

Wreck Cove Development was completed and commissioned in 1978 and consists of two large vertically oriented turbo-generators each producing about 105 MW from as much as 1200 feet of head, which is fed from Surge Lake head pond located at the top of the mountain.

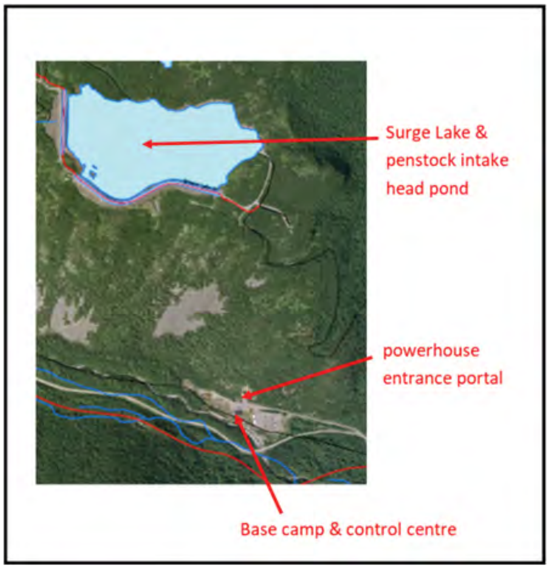

Photo 25: Wreck Cove Development

The powerhouse is accessed from the Wreck Cove Base camp via the powerhouse entry portal and a 1600 foot access tunnel that opens into a man-made cavern in which the powerhouse has been constructed. A very steep 1600 foot long concrete lined penstock was bored into the mountain from Surge Lake to the powerhouse as a means to convey water to the turbo-generators. The penstock bifurcates to provide direct flow to each of the large vertically oriented turbo-generator units. Outflow from the two units is via a one-mile long tailrace tunnel to the Atlantic Ocean.

A significant HVAC system has been employed at this site to ensure adequate air flow to and from the powerhouse in all conditions.

The main Wreck Cove powerhouse is very large in comparison to other facilities in the NSPI hydro inventory. Due to its length and ample diameter, the access tunnel is normally traversed by motor vehicle. At the end of the tunnel the powerhouse opens up at the main or top floor of the facility. Generators are located below the reinforced concrete main floor of the powerhouse and are supported from reinforced concrete structures that extend from the lower Turbine Floor and which are ultimately supported from bedrock. At the reinforced concrete Turbine Floor, located below the Generator floor, there is access to the exterior and interior of the scroll cases and penstock, including the interior of the main line spherical valves. Also at that level the head cover and 39 inch diameter generator shaft is accessible. Below the Turbine floor is the draft-tube access floor, where spherical valves exteriors are can be accessed. Draft-tubes are accessed through steel access manholes at that level.

Demolition planning for this facility will consider that Surge Lake and the intake penstock will be dewatered and that system flow patterns have been restored to original routings. All electrical and communications equipment directly related to transmission will be removed by others. It is also assumed that there will be no outstanding asbestos abatement or other hazardous materials or environmental issues at this site that would adversely affect demolition planning. Note that there is ample material laydown area available at this site, but that parts and equipment will require partial disassembly to enable removals through the access tunnel.

Once machinery and equipment has been removed from the main powerhouse, HVAC systems can be removed and the facility can be abandoned. Because of the manner in which the powerhouse has been constructed it will be impractical to attempt to demolish and remove interior structural components and infill the facility with granular or other materials. Rather, it will be more practical to close and secure the three possible main entry points located at: the Main Tunnel access; the penstock; and the Tailrace Tunnel outlet. At each of those locations a heavy concrete (and possibly steel) bulkhead can be constructed to bar unauthorized entry post abandonment. The access and penstock tunnels openings bulkheads can be further infilled with rock fill. The tailrace outlet tunnel concrete portal should be removed to reduce potential hazards to the public, and then the new tailrace bulkhead can also be buried in rock fill. Note that it may be necessary to provide some sort of long-term venting for the abandoned facility.

Following demolition planning categorizations apply to the Wreck Cove facility:

- Intake Classification - Category B, a buried intake penstock is located at the rear of the structure;
- Architectural Classification – Category C, Other. The powerhouse, penstock and tailrace have been hewn from the mountain bedrock.
- Outlet (Draft-tube) Classification – Category A, although a lengthy tailrace tunnel is employed at this site, that tunnel discharges directly into the Atlantic Ocean. Since the tailrace tunnel will be blocked off and not be removed, and a significant cofferdam will not be required, Category A will apply.

Therefore the following tasks have been considered in the demolition planning and costs derivation exercise:

- Install silt, debris and environmental containments, temporary security fencing (chain-link), a silt curtain and an oil boom in the tailrace tunnel, silt curtain and silt fences as and where necessary during tailrace portal removal and infilling.
- Removal of lubricating oil and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator mechanical and electrical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems and filters and related piping, throttle linkage components, electrical and communications cables and miscellaneous smaller equipment and piping.
- Removal of main turbo-generator components for each turbo generator such as Exciter; Rotor poles and Windings; Rotor Hub, Generator Shaft; Speed Ring, Wicket Gates and related parts; Turbine Shaft, Head-cover and Turbine; Stator, Cooling System and steel draft-tube stop logs can be facilitated with the existing powerhouse overhead bridge crane and other lift devices, although a temporary power source and connection for the crane may be required. Those components can then be stockpiled outside the powerhouse as required for further disassembly, salvage and disposal. Larger components can be cut into smaller pieces for easier handling.
- Remove overhead Bridge Crane, other lifting devices and stockpiled turbo-generator and other related mechanical components, sort and stockpiled outside the powerhouse at site for salvage and disposal.
- Removal of HVAC system equipment and ducting.
- Remove buried sewage disposal services and any freshwater piping and equipment.

- Remove auxiliary buildings. This will include all buildings at the base camp including the main office and control centre and garage, structures which may otherwise remain at the original site construction base camp, such as maintenance garages and houses along the main site paved access road from the Cabot Trail.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility.
- Deliver or sell stockpiled salvage material.
- Place topsoil, sods/hydro-seed, miscellaneous rudimentary landscaping as may be required for public safety and to facilitate surface drainage requirements.
- Improve site surface drainage at the base camp location as required and improve or remove the paved base camp access road. Other roads should remain in place and accessible for firefighting and ground search and rescue purposes.

The bulk of costs associated with the decommissioning exercise include building demolition and related materials disposal, and site protection and remediation post demolition.

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Wreck Cove Hydro Electric Generation System

Gisborne Development		
Item Description	Estimated Decommissioning Costs	Assumptions/Notes
SITE REMEDIATIONS		
Site Remediation Issues	$283,000.00	Outlet discharges directly to tailrace channel which leads to Wreck Cove Flowage. Gisborne flowage out-flow will be redirected to original natural alignment, tailrace channel remediation required.
Site Access Removals	$0.00	N/A
Site Services Removals	$0.00	No site sewage disposal system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$159,200.00	Includes roof structure removal, removal of superstructure walls, excavation and partial removal of sub-structure including by-pass sluice; infilling of the powerhouse with site generated granular material and an estimate of off-site disposal costs.
Auxiliary Buildings Removals (not associated with Production Plant)	$0.00	N/A
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$20,000.00	One horizontal turbo-generator unit.
Turbo Generator Control Removals	$5,500.00	Includes disassembly and removal of governor systems, pumps, servos and associated piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$3,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$9,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$3,000.00	Powerhouse
Electrical Control and Communication	$5,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$7,500.00	Limited HVAC at this site.
Plant Operating Equipment Removals	$7,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$59,662.40	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$350.00	Allowance
General Parts	-$500.00	Allowance
Insulated Wire and Cables No. 1	-$500.00	Allowance
Insulated Wire and Cables No. 2	-$500.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$63,924.00	
Site Decommissioning Estimate Subtotal Gisborne Development	**$654,436.40**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 30

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Wreck Cove Hydro Electric Generation System

Wreck Cove Development		
Item Description	**Estimated Decommissioning Costs**	**Assumptions/Notes**
SITE REMEDIATIONS		
Site Remediation Issues	$327,500.00	Plan outlets directly to Gulf of St. Lawrence and Cabot Strait. Some oil booms may be required at tailrace tunnel, erosion protection for exposed structures and infill. Base camp returned to brownfield site, some hydro-seeding.
Site Access Removals	$85,000.00	Remove asphalt and re-grade selected access roads and parking area(s).
Site Services Removals	$20,000.00	Remove site sewage disposal system and domestic water supply system at this location.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$776,000.00	Includes removal of secondary interior structures and components, construction of reinforced concrete vented bulkheads at the entrance tunnel portal and at the tailrace tunnel outlet portal and selected internal concrete nfilling as necessary.
Auxiliary Buildings Removals (not associated with Production Plant)	$60,000.00	Remove auxilliary buildings including administration centre, garages, houses and miscellaneous structures.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$132,000.00	Two vertical turbo-generator units, includes removals of rotor parts turbine and shafts, bearings, stator, supports and cooling water systems.
Turbo Generator Control Removals	$65,500.00	Includes disassembly and removal of govenor systems, pumps, servos and associated piping, spherical valves and related miscellaneous valves and piping.
ELECTRICAL		
On-Site Distribution Lines Removals	$15,000.00	Interior and exterior at powerhouse.
Electrical Power Systems Removals	$40,000.00	Powerhouse
Other Auxiliary Systems and Equipment Removals	$16,000.00	Powerhouse
Electrical Control and Communication	$20,000.00	Powerhouse
COMMON SERVICES		
Building Ventilation & Heating Removals	$67,000.00	Extensive HVAC at this site including ducting in entrance tunnel including but not limtied to removal of draft-tube gates and related operating mechanism, powerhouse overhead crane(s) and removal of tailrace tunnel outlet portal gate.
Plant Operating Equipment Removals	$80,600.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$30,000.00	
Estimated Administration & Overhead Expenses	$194,275.20	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$5,000.00	Allowance
General Parts	-$50,000.00	Allowance
Insulated Wire and Cables No. 1	-$15,000.00	Allowance
Insulated Wire and Cables No. 2	-$15,000.00	Allowance
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$208,152.00	
Site Decommissioning Estimate Subtotal Wreck Cove Development	**$2,052,027.20**	

Notes:

1. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
2. HST is additional to stated estimated costs.

Figure 31

V. POWERHOUSE DEMOLITIONS SUMMARY AND CONCLUSIONS

Decommissioning of NSPI Hydro Production powerhouses will be an endeavor which will depend heavily on efficient coordination of various trades including but not limited to heavy-lift contractors, HVAC specialists, mechanics and electricians. Detailed planning and scheduling will be necessary for the project.

Construction of structural enhancements may be required as part of the decommissioning exercise. Some of these features may remain in place post decommissioning, while others may be temporary and will be removed. The following is a summary of the decommissioning costs:

Nova Scotia Power Hydro Production

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

HYDRO SYSTEM DECOMMISSIONING COSTS BY SYSTEMS & DEVELOPMENTS

2018-10-14

NSPI HYDRO SYSTEM	NSPI HYDRO DEVELOPMENT AREA	Decommissioning Costs/Development	Decommissioning Costs/Hydro System
Avon River Hydro System	Avon No. 1 Development	$ 890,993.60	
	Avon No. 2 Development	$ 862,380.40	$ 1,753,374.00
Bear River Hydro System	Ridge Development	$ 647,242.40	
	Gulch Development	$ 904,668.80	$ 1,551,911.20
Black River Hydro System	Methals Development	$ 696,299.20	
	Hollow Bridge Development	$ 589,523.20	
	Lumsden Development	$ 695,783.20	
	Hell's Gate Development	$ 1,024,892.00	
	White Rock Development	$ 1,024,892.00	$ 4,031,389.60
Dickie Brook Hydro System	Dickie Brook Development	$ 764,331.60	$ 764,331.60
Fall River Hydro System	Fall River Development	$ 388,698.40	$ 388,698.40
Lequille Hydro System	Lequille Development	$ 1,117,681.60	$ 1,117,681.60
Mersey River Hydro System	Upper Lake Falls Development	$ 1,498,643.20	
	Lower Lake Falls Development	$ 1,328,627.20	
	Big Falls Development	$ 1,558,888.00	
	Lower Great Brook Development	$ 1,579,060.80	
	Deep Brook Development	$ 2,133,985.60	
	Cowie Falls Development	$ 1,618,024.00	$ 9,717,228.80
Nictaux Hydro System	Nictaux Development	$ 670,219.20	$ 670,219.20
Paradise Hydro System	Paradise Development	$ 801,057.60	$ 801,057.60
Roseway River Hydro System	Roseway Development	$ 648,423.60	$ 648,423.60
Sheet Harbour Hydro System	Malay Falls Development	$ 1,192,630.40	
	Ruth Falls Development	$ 1,165,042.40	$ 2,357,672.80
Sissiboo River Hydro System	Fourth Lake Development	$ 724,195.20	
	Sissiboo Falls Development	$ 1,304,653.60	
	Weymouth Falls Development	$ 1,392,152.80	$ 3,421,001.60
St. Margaret's Bay Hydro System	Coon Pond & Sandy Lake Development	$ 1,611,849.60	
	Tidewater Development	$ 934,170.40	$ 2,546,020.00
Tusket River Hydro System	Tusket Development	$ 1,909,312.00	$ 1,909,312.00
Wreck Cove Hydro System	Gisborne Development	$ 654,436.40	
	Wreck Cove Development	$ 2,052,027.20	$ 2,706,463.60
	Total	**$ 34,384,785.60**	**$ 34,384,785.60**

Note: For more detailed summary of decommissioning costs - see individual development summaries (Figures 1-31).

Figure 32: Hydro System Decommissioning Costs – By Systems and Developments

VI. APPENDICES

Appendix 1 - BIO Sketch J. B. Yates, P. Eng.

Since the early 1980's, J. B. Yates, P. Eng. has developed a wide range of experience in structural, heavy civil and multi-disciplinary engineering projects encompassing concept development, design, construction planning and supervision, and investigations and reporting.

Those projects have involved new construction, condition assessments, repairs and enhancements at: hydro-electric facilities, thermal generation facilities and related infrastructure; offshore oil production platforms and fabrication plants; marine facilities (Wharves, Jetties and Bridges); rail infrastructure improvements projects; activities at operational military bases (including remote sensing and detection arrays, explosive storage facilities and general marine infrastructure); buildings and foundations; roads and highways; water, sewer and storm drainage systems; and other related infrastructures including but not necessarily limited to design of reinforced concrete, masonry, structural steel, timber/wood and earthen structures.

Past Experience

Mr. Yates has over 30 of years of experience in Civil and Structural engineering and related disciplines for infrastructure such as dam and water control infrastructure and powerhouses, bridges, wharfs and marine structures. Mr. Yates has made significant contributions to projects including the Strait Crossing (bridge linking PEI to the mainland), Hibernia off-shore oil development and the Cohassett-Panuke off shore oil development at Sable Island, as well as rail structures and related infrastructure engineering.

He has been heavily involved in civil and mechanical related assessments, maintenance, improvements and rehabilitation planning for over 40 Hydro Electric and Thermal Generating Sites for Nova Scotia Power, Emera Energy, Minas Basin Pulp and Power and Berwick Electric in Nova Scotia and for Nalcor in Newfoundland and Labrador. Work has been carried out on similar infrastructure for Halifax Water, NSBI and the Nova Scotia Department of Transportation and Infrastructure Renewal (TIR).

In marine areas, Mr. Yates has been lead engineer for assessments of the IEL wharf and Sheet Harbour Industrial Port wharf for NSBI; Pier 9 assessments and repairs for the Halifax Port Corporation, NSPI Tufts Cove Seawall and cooling water intakes; assessment and refurbishment planning for the Adams and Knickle Wharf in Lunenburg; a newly reconstructed pier for the Lunenburg Yacht Club; and design of a new wharf and boathouse substructure for Mr. R. Risley in Chester. As well he has carried out design and implementation planning for repairs to hurricane damaged marine infrastructure in various Caribbean locals.

Mr. Yates has worked for several major engineering consulting firms in Nova Scotia in a senior project engineering capacity as engineering lead and as a project manager. Mr. Yates has been Principal of J. B. Yates Engineering Limited since 1996.

Education and Technical Affiliations:

Mr. Yates graduated from Technical University of Nova Scotia (Nova Scotia Technical College) in 1981, with a Bachelor Engineering (Civil). Mr. Yates received Professional Engineer status in 1983.

A fully registered member of Engineers Nova Scotia (formerly the Association of Professional Engineers of Nova Scotia) since 1983, Mr. Yates has been a member of the American Concrete Institute and is a member of the Canadian Dam Association and served as Canadian Dam Association Board representative for Nova Scotia from 1996 to 2000.

APPENDIX 2 - CV

JAMES B. YATES, P.ENG. SENIOR STRUCTURAL/CIVIL ENGINEER

Education:
Bachelor of Engineering, Civil, Technical University of Nova Scotia, 1981

Professional Associations:
Association of Professional Engineers of Nova Scotia
Canadian Dam Association (including member of National Executive Board, Nova Scotia Representative from 1997 to 2002).

Career:
1996 to present: J.B. Yates Engineering Limited
1990 - 1996: Vaughan Engineering Associates Limited
1988 - 1990: O'Halloran Campbell Consultants Ltd.
1986 - 1988: Triton Engineering Ltd.
1983 - 1986: J.D. Koppernaes Engineering Ltd.
1981 - 1983: Canadian British Consultants Ltd. (CBCL Ltd.)

Experience:
Over Thirty Years of Experience in a wide range of structural, heavy civil, mechanical and multi-disciplinary engineering projects encompassing design, assessments, construction planning and supervision, investigations, evaluations and repairs and improvements including derivation of cost estimates for: hydroelectric and thermal generation powerhouses and related facilities across Nova Scotia; marine facilities (wharves and jetties) and support infrastructure; offshore oil production platforms and fabrication plants; roads and highways; water, sewer and storm drainage systems; fisheries enhancement facilities (fish ladders, passages and barriers); and related infrastructure. Experience with industrial, commercial, and residential buildings structures includes: design of building structures, building envelope and sub-structure design; condition assessments and engineering evaluations, design of repairs and construction management. Mr. Yates has extensive experience with design of reinforced concrete, masonry, structural steel, wood-frame, timber and earthen structures.

Work History: Major responsibilities have included design development, technical support, coordination and services during construction for the following projects:

Industrial and Power Projects:

- For Nova Scotia Power Inc.: Engineering design, evaluation, construction cost estimates derivation and construction management for implementation of improvements and repairs to hydroelectric assets including but not limited to turbo-generators (and related structural and mechanical components), earthen, concrete and timber dams and spillways; intake (head-works, head-gates) structures and associated operating machinery; various sluiceways and related gates (including overhauls in 2004 and 2005 of Annapolis Causeway sluice gates) and related machinery; life extension projects for steel, fibreglass and wood pipelines and penstocks, and surge tanks condition assessments and remediations; powerhouse substructures, superstructures and related infrastructure; power canals; access roads and related items; environmental remediations/improvements including fisheries enhancement projects for over fifty generation units at over thirty hydroelectric developments.
- Inspections condition assessments, remediations designs for various main-line penstock butterfly (and similar) valves for NSPI, Minas Basin Pulp and Power and Berwick Electric.
- Lead Engineer for the rehabilitation and reconstruction of Parson's Dam for Minas Basin Pulp and Power in St. Croix, Nova Scotia. This project included the installation of vertical post tensioned steel anchor bars of various lengths (up to about 100 feet) installed through the crest of the concrete gravity dam and into the underlying bedrock strata.
- Dam Safety Review for the St. Croix River Hydroelectric Generating System for Minas Basin Pulp and Power.
- A system-wide head-gate study for Nova Scotia Power's Hydro Production Department.

- Design of replacement pipeline and penstock for Berwick Electric's hydroelectric generating station.
- Design of remediations and repairs to Middle River dam and sluiceway for the Nova Scotia Department of Transportation and Infrastructure Renewal.
- Lead engineer on development and installation of intake maintenance bulkhead gates for head works at Nalcor's Star Lake Hydro Electric Development in Newfoundland and Labrador.
- Provision of mechanical and structural engineering support and assistance for major generation unit overhauls carried out by NSPI Hydro Production from 1994 to 2012.
- Various condition assessments and reporting for dams, spillways and related component infrastructure for NSPI, NSTIR, NSLands, Minas Basin Pulp and Power and Nalcor including work associated with Dam Safety Reviews.
- Investigations and assessments and design of repairs including remedy of water infiltration issues for various buildings including hydroelectric powerhouses, thermal generation power stations and ancillary structures for NSPI's Hydro Production division at over 40 locations across Nova Scotia.
- Engineering for civil and structural components of Nova Scotia Power's 150 MW Trenton 6 Generating Station, including C.W. intake, fly-ash system supports, coal stockpiles material handling, site building foundations, site buried services and others.
- Boiler support structure engineering at Nova Scotia Power's Pt. Aconi Generating Station during construction.
- Harbour-front remediations, cooling water intake reconstruction, consolidation of buried services infrastructure network and upgrading of marine fuel offloading facility for Nova Scotia Power Inc.'s 350 MW Tuft's Cove thermal generation station.
- Design of a structural base and installation of a 500-tonne press for HMC Dockyard's Ship Repair Unit.
- Assessment of Imperial oil refinery heating plant brick and masonry smoke stack and design of repairs.
- Maccan thermal electric generating station brick stack assessment and reporting.
- Structural and civil designs for various of fish plants and their components and related infrastructure at various locations in Nova Scotia.
- Engineering for three submerged (underwater) degaussing ranges for HMC ships in and around Halifax Harbour for D.N.D.
- Design of a "cable float" work platform to be used in conjunction with Synchro-lift ship lifting and maintenance facility for HMC Dockyard.
- Lead Engineer on assessment of existing and design for new explosive blast protection barrier structures for the Canadian Military in Halifax Nova Scotia.
- Design and construction supervision for repairs and improvements (and new construction) for dozens of fish passage and related infrastructure located in Nova Scotia.

Marine and Offshore Facilities:

- Site investigations and design for improvements/repairs and improvements for various marine facilities and related components or infrastructure in Antigua, St. Kitts, Grenada and St. Lucia, West Indies.
- Investigations, conceptual designs and engineering support and construction cost estimates for rehabilitation of hurricane battered container port and cruise ship jetty facilities at St. John′s Antigua W.I., Basseterre St. Kitts W.I., and Vieux Fort St. Lucia W.I.
- Assessment of and preliminary engineering for improvements to Adams and Knickle Wharf in Lunenburg, Nova Scotia.
- Condition assessment for Liverpool Harbour breakwater for NS Lands.
- Pier 9/9A Repairs, Halifax Port Corporation.
- Fairview Cove Container Terminal Infrastructure Assessment for Halifax Port Corporation.
- Wharf rehabilitation and general waterfront development/improvements for Louisburg, N.S.
- IEL Wharf structural analysis, Woodside, N.S.
- Design for a new public access wharf facility adjacent the IEL Wharf in Woodside, N.S. for the N.S.

Department of Economic Development.

≠ Assessments of Port of Sheet Harbour Industrial Park wharf.
≠ Provision of engineering for development of the assembly yard for Strait Crossing Inc. in Borden PEI in support of construction of the Confederation Bridge linking PEI to New Brunswick.
≠ Engineering Manager and Fabrication Planner for Utility Shaft Modules Fabrication and Load-out, for Hibernia Offshore Oil Development Project.
≠ Lead Design Engineer for Deck Erection Supports for Cohasset Panuke Offshore Oil Development Project topsides modules fabrication and load-out.
≠ Analysis and derivation of required measures to correct dimensional distortions experienced during fabrication of the Cohasset Panuke topsides modules.
≠ Planning of fabrication yard layout, module movements and crane lifting operations for Cohasset Panuke topsides modules for M&M Offshore Ltd.
≠ Lead Engineer for computation of weight control and three dimensional centres of gravity data necessary for engineering of crane lifts for components and finished Cohasset Panuke topsides modules for M&M Offshore Ltd.

Building Projects:

≠ Design for piled foundations and steel superstructure for Metal fabrication plant for Woodside Fabricators Ltd.
≠ Structural evaluations for various buildings on Saint Mary's University Campus, and design of required remediation.
≠ Various residential inspections and assessments for Atlantic Home Warranty Program.
≠ Gunnery support training facility and related infrastructure for HMC Dockyard, Halifax.
≠ Various structural assessments and design for structural component additions at several N.S. schools for the provincial Department of Education and/or related school boards.
≠ Various pre-engineered steel building foundation designs for J.L. Nichols Contracting.
≠ Major structural and architectural enhancements for Royal Canadian Legion, Caen Branch 164, Eastern Passage, Nova Scotia.
≠ Structural design for Rita's Tea Room, Big Pond, Nova Scotia
≠ Various building modifications, Ship Repair Unit, CFB Halifax.
≠ Addition to Forbes' Chev Olds, Dartmouth, N.S. (now MacPhee Ford)
≠ Structural modifications and addition to Inn on the Lake, N.S.
≠ Operations and Maintenance Manual draft for CFB Halifax MARCOM building.
≠ Design and construction supervision of an industrial building at Woodside Industrial Park.
≠ Building assessments and building envelope inspections at Main Street, Tacoma Drive and Fielding Avenue for First Mutual Properties.
≠ Structural assessments and engineering for heritage and other structures and sets associated with filming and production of "The Scarlet Letter" motion picture in Shelburne, Nova Scotia.
≠ Structural and mechanical engineering support for sets and props associated with "The Sea Wolf" motion picture, filmed in Halifax.

Other Civil Projects:

≠ Seven kilometres of Trans-Canada Highway at Salt Springs, N.S.
≠ Rehabilitations for North Mountain Roadway in Highlands National Park, Cape Breton, N.S.
≠ Various new and existing municipal projects including water transmission and distribution systems; trunk sanitary sewers and treatment facilities throughout the Halifax Regional Municipality (including components of the Halifax Harbour Clean-up).
≠ Victoria Street Reconstruction, Town of Amherst.

NOVA SCOTIA POWER INC.

HYDRO PRODUCTION

ANNAPOLIS TIDAL POWER GENERATION STATION

Powerhouse Demolition Study

PREPARED BY:

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October 19, 2018

CONTENTS

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EXECUTIVE SUMMARY

Examinations and derivations of conceptual plans and related cost estimates for decommissioning of the Annapolis Tidal Power Generating Station are presented herein.

The report focuses on planning and costs derivations for structural demolition of the powerhouse and removals of related generating equipment such as the turbo-generator, governor, wicket gates operating system and associated components and control mechanisms found within the confines of the powerhouse.

Decommissioning cost derivation is based on published contractor rates and material costs for labour and equipment and estimated time to complete specific tasks. Contractor and sub-contractor costs for mobilization to site is included in the estimate.

In order to effectively decommission the Annapolis facility, many of the steps required for a unit overhaul must be carried out to enable access to water passage components and related machinery.

By utilizing existing plant infrastructure, such as intake and outlet stoplogs for unit dewatering, implementation of exterior earthen or steel sheet pile cofferdams can be avoided.

However, due to the nature of this facility and its exposure to some of the world's highest tides, construction of some permanent structural enhancements inside the powerhouse water passage will be necessary as part of the decommissioning process to secure this facility and the existing roadway transportation link that passes over the structure.

The total estimated decommissioning costs for the Annapolis Tidal Power Generating Station and adjacent Interpretive Centre is approximately $6,458,390. CAN, plus applicable taxes.

POWERHOUSE DEMOLITION STUDY

1. Introduction

The following pages and attachments represent an estimate of demolition costs associated with conceptual powerhouse decommissioning plans for the Annapolis Tidal Power Generation Station.

a) History

At Annapolis Royal, the Annapolis River widens significantly. For many years the only access to the Town from the north side of the river was via boat from the nearby community of Granville Ferry or over land via Bridgetown. In the early twentieth century, a bridge was constructed across the river rendering the ferry obsolete and finally providing an effective link between the two neighbouring towns.

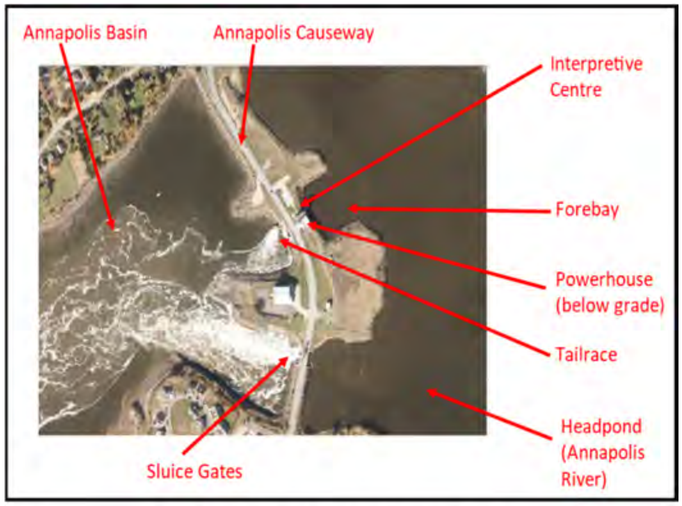

Photo 1 : Annapolis Tidal Power Generating Station

By the early 1950's, the roughly 60 miles of dykes, along the river's north and south perimeters which protected agricultural lands from salt-water intrusion were exhibiting significant deterioration. Instead of reconstructing miles of dykes it was determined by the province that construction of a single causeway could be a much more cost effective approach. Such a causeway would also allow for an effective means of replacing the aging and deteriorating steel bridge structure. In 1960, construction of the Annapolis Causeway was completed. Shortly following this, the existing bridge, which remained in service during causeway construction, collapsed.

The new rock-fill causeway structure incorporated a new roadway link between Annapolis Royal and the north side of the Annapolis River and featured a large twin-gate aboiteau facility (Annapolis Sluice Gates). This would allow river water to drain from the portion of the river upstream of the causeway on the low tides.

In the early 1980's work started on Nova Scotia's first operational tidal electric power generating station at the Annapolis Causeway. The reinforced concrete below-grade powerhouse and an adjacent above grade interpretive centre were constructed partway along the causeway at what was once known as Hog Island.

Commissioned into service in about 1984, the Annapolis Tidal Power Generation Station is made up of a single horizontal large diameter (approximately 25 feet) turbo-generator that harnesses the water of the Annapolis River and the tides of the Annapolis Basin/Bay of Fundy for electrical generation. This is the first and only functioning and fully operational tidal power generating station in the Americas.

Providing approximately 20 MW of capacity, the Annapolis Tidal Facility generates twice daily on the ebb tide, utilizing water impounded by the Annapolis Causeway barrage. The powerhouse intake, which is integral with the below grade powerhouse reinforced concrete structure provides water flow to the turbine via the hydraulically operated wicket gates system. Once water passes the stainless steel clad turbine/rotor assembly it exits the plant via the main outlet and tailrace. Above the turbine assembly and its metal housing and above the outlet structure is the accessible interior of the powerhouse and its operating machinery.

In this configuration, the causeway acts as a barrage and the aboiteau gates have been reconfigured into sluice gates. These gates are utilized to fill the upstream portion of the river with seawater on the rising tide, while outflow from the river on the falling tide is directed through the powerhouse. Due to the varying tides this powerhouse operates at variable head through the generation cycle. Although theoretically feasible for this equipment, the unit does not generate on the in-coming tide.

The powerhouse, which was constructed in a very large excavation at Hog Island, can handle a maximum flow of approximately 25,000 cfs during the generation cycle, which occurs twice daily and lasts for about 5 hours per cycle. When necessary, during very high flow periods, the sluice gates are opened to supplement outflow at low tide and reduce the risk of flooding upstream.

Featuring a large intake arrangement and a large horizontal combined turbine and rotor arrangement, water is directed though the intake and turbine and to the downstream tailrace area once differential head at the barrage (causeway) is adequate to support the generation of electricity. Control mechanisms and maintenance facilities are incorporated into the below-grade reinforced concrete facility.

Typical crew access to the interior of the powerhouse is via the Interpretive Centre, which also houses the plant control room at ground level. For access to the main powerhouse for removal or insertion of large or heavy equipment, a ground level fiber-reinforced plastic (FRP) dome can be removed from the roof of the main powerhouse.

In times of overhaul and maintenance, the powerhouse water passage is de-watered. This is achieved by the installation of steel stop log assemblies at the intake and outlets of the plant water passage. Installation of stop logs involves an established procedure, experienced dive crews and significant mobile crane and other transport and lifting equipment. Once the logs are in place and sealed, the water passage can be pumped dry and manually cleaned out prior to the installation of required scaffolding and commencement of work that may be required in the water passage.

Any planned demolition activity at the Annapolis Tidal Power Generating Station powerhouse will have to be initiated in the same manner that plant mechanical overhaul activities are carried out. As well, and prior to demolition works, the operation of the existing sluicegates will have to be transformed back to the original aboiteau process. The sluice gates are required to remain in operation as long as the causeway is in place, and will be handed back to the provincial government upon decommissioning of the tidal power generating facility.

b) Demolition Estimate Criteria

This study is intended to provide a reasonable approximation of expected costs for conceptual demolition plans, including consideration for site security (public safety) during demolition works; worker safety; environmental protection for the site; removal from site of features and equipment associated with the powerhouse structure and its operation; and removal and disposal off-site of generated demolition debris not suitable for buried disposal at site. Note that demolition methodology has been derived to reflect basic safety and environmental requirements (by law and/or policy of the regulatory authority having jurisdiction and NSPI).

Estimated costs are compiled and presented in accordance with AACE International Recommended Practices for a Class 5 estimate and are arranged to be in conformance with Canadian Council of Ministers of the Environment (CCME) National Guidelines for the Decommissioning of Industrial Sites. The primary characteristic for a typical Class 5 estimate is that the maturity level of project definition and deliverables is at about 0 percent to 2 percent. In addition, the purpose for the estimate is normally for concept screening and the methodology for derivation of the estimate includes approximations based on judgement, analogy and limited mathematical determinations. The published expected accuracy range for such an estimate shows a typical variation in low and high ranges as follows: the low range is minus 20 percent to minus 50 percent, while the high range is +30 percent to +100 percent.

According to AACE, estimate accuracy is generally driven by the following:

- Level of non-familiar technology on each project;
- Complexity of the project;
- Quality of reference cost estimating data;
- Experience and skill level of the estimator;
- Estimating techniques employed;
- Time and level of effort budgeted to prepare the estimate;
- Unique or remote nature of project locations;
- The accuracy of the composition of the input and output streams.

Demolition methodology requirements for the Annapolis facility are unique and have been derived in consideration of specific site conditions, powerhouse configuration and construction arrangement, as well as location and accessibility for men and machinery and proximity to required resources and potential disposal sites and their associated tariffs (tipping fees).

Conceptual demolition plans represented by this study consider current posted contractor man-hour rates as well as current published machine/equipment demolition and/or other required tasks for the site.

The costs detailed in this report are representative of demolition of assets directly associated with the existing powerhouse and existing machinery and mechanical equipment used in the generation of electricity. Demolition of equipment used in the transmission and distribution of that electricity is not included. Costs for removals of facilities/devices and other infrastructure not directly associated with the powerhouse structure and its generating equipment are not included in this study, except as specifically noted otherwise.

Note that one of the parameters of this report is to minimize possible costs associated with on-going maintenance and operations of facilities expected to remain in place. Therefore, as practical, constructed features associated with the powerhouse and its operation will be infilled and isolated or removed and the site will be remediated to reflect pre-powerhouse construction or near to pre-powerhouse construction condition where possible. Note that in some cases there may be cause to review and consider implementation of features and facilities that may enhance public safety at these sites. However, such examination and consideration will be best employed at a more detailed planning stage.

Removal of fish ladders or other fish passage infrastructure is to be carried out by others. Costs, which may be associated with required permits, licenses, environmental assessments, or costs associated with land or other acquisitions necessary for site decommissioning, are not included in this study.

In order to reduce some of the demolition and material disposal costs, construction debris such as plain concrete and masonry materials will be buried within the space of the existing powerhouse. Other materials, such as steel rebar, structural steel and other building materials, will be removed from site and disposed of off-site at appropriately licensed disposal and recycling facilities. Site will be left in “brown-field” condition.

A hazardous materials assessment is not included.

Please also note that the decommissioning cost estimate herein does not include broad environmental assessments or costs for unforeseen environmental clean-ups (buried dump sites, etc.).

Asbestos has been identified in various locations in various powerhouse sites over the years and efforts have been undertaken to have that material removed or rendered inert when discovered. It is expected that this material may occasionally be encountered during demolition work and that special precautions will be necessary when it is encountered to ensure safe removal from site. However, there is no allowance for that work in the estimate contained herein.

Costs associated with the removal of polychlorinated biphenyls (PCB’s) and oil-filled cable is also not included in this study. As well, costs associated with clean-up of PCB contaminations outside the vessels or normal containments are not included.

The costs associated with engagement of local Mi’kmaq communities is not included in this cost estimate.

Derivation of costs associated with archaeological assessments and specific investigations at sites of archaeological significance are not included in this study. It is expected that there will be little potential for such costs at this recently man-made site.

Specific methodology for the demolition exercises will vary depending upon how each tenderer/contractor would plan to carry out the work, and what equipment might be at the tenderers'/contractors' disposal. It is the intent of this report to provide reasonable median demolition cost estimates based on location, known conditions, characteristics and requirements, which might affect costs.

Construction of conventional earth-fill cofferdams will not be considered for this site. Due to thef significant water depths and extreme tides, utilization of earth fill cofferdams will not be practical. Instead, this site will utilize existing infrastructure and components to afford accessibility during demolition and isolation from the tides of the Annapolis Basin and the Bay of Fundy, as well as debris containment during demolition. Silt-booms, silt fences and oil spill containment booms and provision of oil-spill clean-up tools and equipment may be required from time to time during planned demolitions. However, no specific costs have been included in the estimate to cover any environmental clean-up activities that may be collateral to the proposed demolition work.

The demolition process will involve the procurement of services of experienced contractors and related site supervision.

Demolition contractor(s) will be involved through a tendering process that would be arranged to ensure that only appropriately experienced contractors would be engaged. Work carried out by those crews would include removal of in-plant mechanical and electrical operating equipment and related components, removal of turbo-generator and related parts and demolition and removal of below-grade powerhouse structure, as required. The adjacent interpretive centre structure and systems contained therein in support of powerhouse operation will also be removed.

Credit for limited material salvage values is included in stated pricing. This issue is discussed further on in this section.

The demolition contractor will be responsible for all off-site material disposals.

Site access obstructions, such as fencing, ditches or strategically located fill or boulders, may be required. No permanent site road gates are considered at this time.

A general decommissioning/demolition procedure for this site will consist of the following:

1. Develop a Demolition, Material Removal and Disposal, Site Remediation and Public Safety Plan. This may involve preparation of drawings, specifications and tender documents.
2. Prepare, apply for and obtain site specific environmental and related approvals (and obtain permits under the Navigable Waters Protection Act, where applicable) in order to proceed with the Planned Decommissioning Works. Note: Costs for these activities are not included in this estimate.
3. Tender and Award of Planned Decommissioning Works

4. Contractor General Mobilization, Removals and installation of temporary facilities as required.
5. Demolition of Interpretive Centre structure
6. Decommissioning and demolition of powerhouse.
7. Site Remediations and Access Removals and Site Access Obstruction installation, as required.
8. Clean-up, implementation of long term site security plan as deemed necessary.

A detailed breakdown of basic required demolition steps for each site is listed in Section 2 of this document.

Demolition cost estimates herein include interest and other overhead costs expected to be incurred during the demolition process. Related engineering and planning costs, as well as site supervision, are included in the demolition cost estimate.

2. Facility Description and Conceptual Demolition Methodology

General overall demolition methodology will involve various steps in establishing site security, worker safety and environmental protection during the dismantling, demolition, infilling and restoration process.

In order to carry out a decommissioning exercise at this site, much of the preparatory work will closely resemble tasks more commonly associated with maintenance, overhaul and repair activities. First and foremost will be a requirement to de-water the powerhouse water passage. However, due to the great height requirements, probable environmental restrictions, extreme tidal range (about 30 feet) and therefore associated extreme related costs, this site is not suitable for implementation of earthen cofferdams at the intake channel or outlet tailrace. However, since the site is equipped with steel stop logs that are specifically intended to provide a water-tight barrier for the intake and outlet, it is recommended that this equipment be installed to facilitate de-watering. Installation of the stop logs will require mobilization of an experienced dive crew and various pieces of heavy lift equipment. It may take about a week to complete that task and dewater the plant. Once installed, the steel logs will not be removed.

Vehicular traffic of Highway No. 1 traverses the causeway and joins the community of Granville Ferry on the North Side of the Annapolis River and Annapolis Basin to the Town of Annapolis Royal at the south bank of the river and the Annapolis Basin. If practical and deemed safe for the public, the causeway roadway will remain open and in-service during planned demolition works except at planned times when roadway travel is impeded by scheduled work such as tailrace stop logs installation. During those times restricted travel on the Causeway will be controlled by flagging crews, as appropriate.

A water transmission main pipeline joining the Town of Annapolis Royal and Granville Ferry was constructed and installed in the causeway and past the powerhouse in about the 1990’s. Along with the highway and the causeway, this infrastructure will remain in service post powerhouse decommissioning.

The current sluiceway will remain in service but will revert to its original purpose and operation as an aboiteau, releasing water from the upstream Annapolis River to the Annapolis Basin on the low tide post powerhouse decommissioning. This sluiceway must remain in operational service so long as the causeway is utilized in order to protect agricultural land from seawater inundation and to minimize the potential for flooding in the town.

Powerhouse reinforced concrete turbine floor (basement floor level) is set below the elevation of the Annapolis river bottom. As with all concrete structural components in the powerhouse that concrete slab is several feet thick and is heavily steel reinforced. Heavily reinforced concrete walls provide a turbine pit, well or chamber to house the metal casings that form the water-tight horizontal throat-ring and draft-tube around the turbine/rotor assembly and stator. Those casings join the intake structure to the outlet structure.

Metal platforms and access ways afford a means for access to the exterior of the turbo-generator unit. At the floor area over the intake structure and comprising its concrete roof are the cooling water pumps and the main electrical panels associated with plant operation (via the main control room at ground level in the separate but adjacent Interpretive Centre structure). At the floor over the intake chamber is also located internal access to the turbine bearings assemblies and the rotor shaft.

A heavily reinforced structural slab forming the draft-tube roof doubles as a slab for the maintenance and work-shop area. This heavy structure also supports a retrofitted upper level steel mezzanine deck addition.

Various lift devices are found in the powerhouse and include at least one jib crane and an overhead bridge crane. Those components are used extensively during overhauls and general maintenance work and will be useful for various tasks during the decommissioning process.

A significant HVAC system has been employed at this site to ensure adequate air flow to and from the powerhouse in all operating conditions.

The heavily reinforced concrete roof of the powerhouse is found at about finished grade at the causeway. That structure includes access to assist in steel stop-log installation at the intake and at the outlet and also supports Highway No. 1 where it traverses the powerhouse structure. A removable FRP access dome can be opened to permit access for moderately large components into and out from the powerhouse as well as some ventilation. That cover can also be used to keep the work area inside the structure relatively dry as appropriate during decommissioning works. This feature will allow for considerable component removals and infill material placement prior to removal of larger roof segments.

There is also access to the upstream and downstream dewatering sumps, which are essential to draining the water passages of the plant. Large rental pumps are installed at the bottoms of both (approximately) 80-foot deep shafts and are used to drain the water passage once the steel stop logs are installed.

The base of each dewatering shaft is accessible via steel ladders and intermediate platforms. The environment around the ladders and platforms is corrosive and they may have to be inspected and certified prior to usage.

The plant control room, secondary generators and amenities, such as M/F washroom facilities, are housed in the adjacent Interpretive Centre. As well, the main powerhouse stairs and elevator accesses are located within the foot-print of the Interpretive Centre and off-set from the main powerhouse structure. Therefore the Interpretive Centre will remain in service during decommissioning activities to allow for access to powerhouse lower levels during decommissioning and removals work and will be removed in the closing stages of decommissioning.

Due to the robust nature of the facility's reinforced concrete structure, only limited reinforced concrete associated with the roof structure (and away from the existing highway No. 1) will be removed. The existing draft-tube roof and shop floor will remain in place to provide lateral structural stabilization (during infilling) to the powerhouse walls that will support Highway No. 1. Once machinery and metal miscellaneous components are removed from the plant, the un-watered remaining and stripped-out hole will be clean and filled with heavy granular compacted material and fresh in-fill concrete demolition generated material (where appropriate).

By limiting generated concrete demolition material volumes costs for demolition, sorting and disposal of those materials will be significantly reduced. Due to its location and proximity to the Annapolis River, demolition material that is generated from this site will be disposed of at an appropriately licenced facility in the Annapolis Valley area.

To prevent powerhouse infill from eventually washing away due to sea-water infiltration and piping resulting from the area's extreme tidal range and corrosion of the steel stop logs, heavy new reinforced concrete bulkhead walls will be necessary for the intake and outlet to supplement the service of the steel stop logs. The steel stop logs are strong enough to retain and resist the weight of seawater against the drained water passage in a non-corroded condition but they are not adequate for retaining the much denser granular infill. Retaining that heavier granular material will significantly exceed the structural capacity of the steel logs. The stop logs will be utilized as outer forms for the new concrete bulkheads. Those bulkheads will be constructed in three or more concrete pours each to ensure that the steel stop logs are not over-stressed by fresh un-hydrated concrete.

Note that there is ample material laydown area available at this site.

Since the powerhouse is built mostly below grade machine access, the work area for infilling will be more difficult than at most other powerhouse sites. As a result, it may be necessary to employ larger cranes and smaller demolition equipment and fill compaction equipment during the course of the work.

Although specific planning for demolition and restoration works will be the responsibility of the chosen contractors, the conceptual demolition plan will include the following considerations:

- Contractor mobilization to site and installation of temporary site infrastructure to support planned activities.
- Installation of silt, debris and environmental containments as required, temporary security/safety fencing (chain-link) and gates and other barrier arrangements, silt fences, silt curtains and oil booms upstream and downstream of the powerhouse. Oil spill clean-up kits to be placed at strategic locations inside the plant.
- Installation of stop logs at the powerhouse intake and outlet to isolate the water passage, dewater and remove organic accumulations.
- Install scaffolding in water passage as required for safe access to components to be removed.
- Begin forming and rebar placement for intake and outlet concrete bulkhead walls.

- Removal of accessible lubricating and hydraulic oil and related parts and equipment and previously undrained closed-system cooling water (for recycling).
- Removal of small machinery and turbo generator electrical and mechanical controls including but not limited to compressors and tanks, governors and related pressure tanks, bearing cooling systems, piping and filters and related piping, throttle linkage components including hydraulic rams, hydraulic pressure piping and valves, miscellaneous smaller equipment and piping and control consoles and cabinets and related cables.
- Removal of HVAC equipment, and localized heating and/or cooling units and related ducting for areas at or around the turbo-generator and within the powerhouse building.
- Removal of walkways, catwalks, ladders, accesses, stairs and mezzanines in main powerhouse as necessary.
- Note that some temporary shoring and other support structures may have to be constructed or employed during the disassembly and demolition efforts to ensure structural stability and worker safety during building removal efforts.
- Removal of main turbo-generator components such as Wicket Gates and related parts; stator covers and hydro-static seals. Removal of these components can be facilitated with the existing powerhouse overhead bridge and jib cranes, although a temporary power source and connection for the cranes may be required. Removed components can then be set aside as required for salvage and disposal.
- Removal of remaining miscellaneous steel and mechanical components.
- Limited roof removal (as required) to facilitate in-fill placement.
- Remove overhead crane and stockpiled turbo-generator components, sort and stockpile at site for salvage and disposal.
- Remove lower level sump pumps and related piping.
- Infill the empty powerhouse structure with compacted granular rock-fill material and clean demolition material such as plain concrete and masonry debris determined to be suitable for use as infill.
- Infill specific locations of the empty powerhouse structure with fill concrete.
- Improve site surface drainage as required.
- Place topsoil, sods/hydro-seed and miscellaneous rudimentary landscaping over the entire powerhouse site.
- Remove powerhouse and Interpretive Centre access road/driveway. Remove asphalt from site.
- Remove auxiliary structures such as the administration building and small stores buildings, as well as buried services such as sanitary piping to the local sewerage system and any freshwater piping and equipment.
- Demolish Interpretive Centre structure, remove windows, doors and miscellaneous components prior to demolition of the structure, and remove the administrative building.

- Deliver or sell stockpiled salvage material.
- Disposal of construction and demolition debris – truck to a designated construction debris disposal facility at Torbrook, Annapolis Country.
- Where practical, selected metals and other materials may be separated and harvested for salvage value. Note though that such activities may be prohibitively costly, precluding the practicality of such endeavors. For example: according to design specifications the large turbine is constructed of carbon steel which is cladded with stainless steel. Although the stainless steel has a significantly higher salvage value than carbon steel, efforts will not be undertaken to separate the materials.
- The powerhouse site will be restored to pre-construction "brown-field" site condition, at the existing Annapolis Causeway.
- Significant efforts in multi-disciplinary engineering and other related technical support will be required during demolition and restoration planning and site works for the powerhouse.

Note that although we have identified material salvage as an item herein, the actual value of that salvage may be small considering the resources required (men and equipment, cranes) to remove, sort, stockpile and truck these materials to a suitable salvage facility. However, nominal salvage values will be entered on the accompanying cost estimate spreadsheet as a negative value to reflect potential salvage credit value.

Site Decommissioning Estimate Summary for Asset Retirement Obligations (ARO) Study

Annapolis Tidal Power Generating Station

Item Description	Estimated Decommissioning Costs	Assumptions/Notes
SITE REMEDIATIONS		
Site Remediation Issues	$178,000.00	
Site Access Removals	$20,000.00	Includes surface remediations at powerhouse site and environmental protection during demolition. Includes re-grading at site access roads and removal of asphalt at Interpretive Centre and helipad.
Site Services Removals	$12,000.00	Includes removal of buried water and waste-water buried services at Powerhouse/Interpretive Centre and Administration buildings.
BUILDINGS & STRUCTURES		
Powerhouse & Related Auxiliary Structures Removals	$1,759,000.00	Includes partial roof structure removal, removal of below-grade walkways, stair structures and mezzanine structures; demolition of the Interpretive Centre, infill of powerhouse with granular materials and estimate of off-site disposal costs.
Intake/Outfall Decommissioning	$2,740,000.00	Includes installation of stop logs, dewatering (inc. pumps), construction of reinforced concrete bulkheads upstream and downstream in the water passage and related dowels, reinforcing steel, formwork and scaffolding.
Auxiliary Buildings Removals (not associated with Production Plant)	$10,000.00	Removal of site Administrative Building.
BOILERS & AUXILIARIES		
Boilers & Auxiliaries - NOT APPLICABLE	$0.00	N/A
TURBINES, GENERATORS & AUXILIARIES		
Turbo Generator Removals	$325,000.00	Includes dismantling, removal and stockpiling of turbo-generator components including but not limited to: stator and covers; hydrostatic seals and related systems; wicket gate assemblies; speed ring; turbine/rotor; bearings; shafts; water passage casings; and related miscellaneous components
Turbo Generator Control Removals	$34,700.00	Includes disassembly and removal of governor systems, hydraulic rams, pumps, servos and associated piping
ELECTRICAL		
On-Site Distribution Lines Removals	$12,500.00	
Electrical Power Systems Removals	$15,000.00	
Other Auxiliary Systems and Equipment Removals	$12,500.00	
Electrical Control and Communication	$10,000.00	
COMMON SERVICES		
Building Ventilation & Heating Removals	$50,000.00	Extensive Ventilation system at this site.
Plant Operating Equipment Removals	$38,500.00	
GENERAL AND DISTRIBUTED		
Field Facilities & Decommissioning (Mobilization incl)	$50,000.00	
Estimated Administration & Overhead Expenses	$589,926.00	
SALVAGE		
Scrap Metals - General (Inc. Turbine)	-$9,900.00	45 tons allowance at $0.11 per lb (Scrap Carbon Steel)
General Parts	-$2,100.00	10,000 lbs allowance at $0.21 per lb
Insulated Wire and Cables No. 1	-$14,000.00	8000 lbs allowance at $1.75 per lb (Copper)
Insulated Wire and Cables No. 2	-$4,800.00	8000 lbs allowance at $0.60 per lb (Copper)
ENGINEERING & PROJECT MANAGEMENT		
Engineering & Project Management	$632,064.00	
Estimated Decommissioning Costs Tidal Plant Sub-Total	**$6,458,390.00**	

Notes:
1. Interpretive Centre houses powerhouse control room, back-up station service generator panels, main ventilation system inlets and filters, and powerhouse access stairs and elevator. Therefore, the Interpretive Centre is considered to be an integral part of the powerhouse.
2. Transmission cable, substations and related transformers to be removed by others in preparation for general demolition.
3. HST is additional to stated estimated costs.

Figure 1

3. Demolition Costs

Since the work described herein would be carried out by contractors, costs for demolition work throughout this study are based on standard current contractor pricing and contractor unit rates, although some of those rates may be averaged or optimized to better reflect actual market conditions.

This study has utilized the following sources for provision of costs for construction/demolition rates for men and equipment, including overhead costs and profit (plus HST):

Elliot Excavators Ltd.

- Bobcat E85 Mini-Excavator [redacted] plus transport to site
- Hitachi 35 Mini-Excavator with hydraulic hamme [redacted] plus transport to site
- Volvo 210 Excavator [redacted] plus transport to site
- John Deere 350 Excavator [redacted] plus transport to site
- John Deere 350 Excavator with hydraulic hammer [redacted] plus transport to site
- Komatsu D39 Dozer [redacted] plus transport to site
- Pick-up truck [redacted].

A.W. Leil Cranes

- 18 ton boom truck [redacted] including travel to and from site
- 28 ton boom truck [redacted] including travel to and from site
- 200 ton mobile crane [redacted] plus mobilization and demobilization costs and travel to and from site.

J. Mason Contracting Limited

- Un-skilled labour [redacted]
- Skilled trades rate [redacted]
- Foreman Rate [redacted], including truck

Dale Fabrication Inc.

- Dump truck and Driver [redacted]

Disposal Site Tipping Fees:

Costs for tipping fees at Halifax C&D Recycling Ltd. in Goodwood, and at Torbrook C&D Disposal and Recovery near the Town of Annapolis Royal have been utilized in costs estimation. Published rates for those tipping fees are as follows:

Halifax C&D Recycling

1. Concrete with Rebar (no metal projections) $0.025 per kg
2. Concrete with Rebar(with metal projections) $0.050 per kg
3. Mixed loads $0.115 per kg

Torbrook C&D Disposal and Recovery

1. Construction and sorted demolition debris
    - Brick, block, concrete $0.057 to $0.076 per kg
    - Asphalt $0.057 to $0.076 per kg
    - Asphalt shingles $0.057 to $0.076 per kg
    - Drywall $0.057 to $0.076 per kg
    - Wood Brush $0.057 to $0.076 per kg
2. Construction and Demolition Debris (Mixed) $0.110 to $0.146 per kg
3. Scrap Metals (This is a disposal fee, not a salvage value) $0.057 to $0.076 per kg

Estimated disposal costs derived in this study per site consider estimated demolition material volumes and weights generated at each site for disposal, and include trucking at hourly rates including driver, and estimated disposal site tipping fees.

4. Salvage Values

Pertinent posted material salvage values for Mississauga Ontario on July 16, 2018 are as follows:

Copper (bare)	$3.10/lb
Iron	$0.08/lb
Carbon Steel	$0.11/lb
Stainless steel	$0.65/lb
Yellow brass	$2.25/lb
Mixed aluminum	$0.62/lb
Electric motors and generators	$0.21/lb
Insulated wire no. 1	$1.75/lb
Insulated wire no. 2	$0.60/lb
Aluminum wire	$0.90/lb

Note that nickel and other valuable metal materials will be available in small quantities but will in all likelihood not be worth efforts required to separate for salvage.

Copper windings on turbo-generator rotor poles may take considerable effort to remove and separate from the base metal stubs and may not be worth efforts required for such material separation and sorting.

The existing turbine is a combined assembly of the unit turbine and rotor, is about 25 feet in diameter, and exceeds 30 tons. This turbine assembly must be removed as part of the demolition process. Therefore it may be practical to salvage this component. Although the turbine appears to be constructed of stainless steel, visible stainless material is only cladding and the base metal is carbon steel. Since it will probably be impractical to separate the cladding from the base metal, the turbine assembly salvage value will not likely exceed the salvage value of plain carbon steel. Therefore the salvaged turbine may have a value of about $6600. This value is small in comparison to the overall estimate of decommissioning costs for this site.

Where there is reasonable potential for salvage credits, a negative value has been provided on the pertinent spreadsheet estimate.

5. Decommissioning Estimate Summary and Conclusions

Decommissioning of the Annapolis powerhouse will be an endeavor which will depend heavily on efficient coordination of various trades including dive teams, heavy-lift contractors, HVAC specialists, mechanics and electricians, to name just a few. Detailed planning and scheduling will be necessary for the project.

Construction of several structural enhancements, such as permanent reinforced concrete structural bulkheads at the inlet and outlet of the plant water passage will be necessary. Those bulkheads will preclude the necessity for construction of massive exterior earthen cofferdams at this site. Such cofferdams would be prone to tidal action and would require volumes of material which would cost several millions of dollars to construct.

General process for decommissioning will initially involve shutting down production operations at the facility and de-watering the plant water passage. Mechanical and electrical equipment and structural steel components removals would follow. Turbine/rotor assembly removal will probably first involve cutting that massive component into smaller, easier to handle pieces.

The empty powerhouse will be filled with suitable clean granular material and clean concrete debris. Lean concrete will be placed where appropriate (to fill less accessible areas) to complete the infilling task.

Because it houses powerhouse features such as the main control room, back-up power, powerhouse main stair and elevator access and ventilation inlets, filters and ducting, the Interpretive Centre shall be considered to be integral with powerhouse operation and therefore part of the powerhouse.

Total costs for decommissioning this facility as described herein is estimated to be approximately $6,458,390. CAN, plus applicable taxes.

APPENDICES

Appendix 1 - BIO Sketch J. B. Yates, P. Eng.

Since the early 1980's, J. B. Yates, P. Eng. has developed a wide range of experience in structural, heavy civil and multi-disciplinary engineering projects encompassing concept development, design, construction planning and supervision, and investigations and reporting.

Those projects have involved new construction, condition assessments, repairs and enhancements at: hydro-electric facilities, thermal generation facilities and related infrastructure; offshore oil production platforms and fabrication plants; marine facilities (Wharves, Jetties and Bridges); rail infrastructure improvements projects; activities at operational military bases (including remote sensing and detection arrays, explosive storage facilities and general marine infrastructure); buildings and foundations; roads and highways; water, sewer and storm drainage systems; and other related infrastructures including but not necessarily limited to design of reinforced concrete, masonry, structural steel, timber/wood and earthen structures.

Past Experience

Mr. Yates has over 30 of years of experience in Civil and Structural engineering and related disciplines for infrastructure such as dam and water control infrastructure and powerhouses, bridges, wharfs and marine structures. Mr. Yates has made significant contributions to projects including the Strait Crossing (bridge linking PEI to the mainland), Hibernia off-shore oil development and the Cohassett-Panuke off shore oil development at Sable Island, as well as rail structures and related infrastructure engineering.

He has been heavily involved in civil and mechanical related assessments, maintenance, improvements and rehabilitation planning for over 40 Hydro Electric and Thermal Generating Sites for Nova Scotia Power, Emera Energy, Minas Basin Pulp and Power and Berwick Electric in Nova Scotia and for Nalcor in Newfoundland and Labrador. Work has been carried out on similar infrastructure for Halifax Water, NSBI and the Nova Scotia Department of Transportation and Infrastructure Renewal (TIR).

In marine areas, Mr. Yates has been lead engineer for assessments of the IEL wharf and Sheet Harbour Industrial Port wharf for NSBI; Pier 9 assessments and repairs for the Halifax Port Corporation, NSPI Tufts Cove Seawall and cooling water intakes; assessment and refurbishment planning for the Adams and Knickle Wharf in Lunenburg; a newly reconstructed pier for the Lunenburg Yacht Club; and design of a new wharf and boathouse substructure for Mr. R. Risley in Chester. As well he has carried out design and implementation planning for repairs to hurricane damaged marine infrastructure in various Caribbean locals.

Mr. Yates has worked for several major engineering consulting firms in Nova Scotia in a senior project engineering capacity as engineering lead and as a project manager. Mr. Yates has been Principal of J. B. Yates Engineering Limited since 1996.

Education and Technical Affiliations:

Mr. Yates graduated from Technical University of Nova Scotia (Nova Scotia Technical College) in 1981, with a Bachelor Engineering (Civil). Mr. Yates received Professional Engineer status in 1983.

A fully registered member of Engineers Nova Scotia (formerly the Association of Professional Engineers of Nova Scotia) since 1983, Mr. Yates has been a member of the American Concrete Institute and is a member of the Canadian Dam Association and served as Canadian Dam Association Board representative for Nova Scotia from 1996 to 2000.

JAMES B. YATES, P.ENG. SENIOR STRUCTURAL/CIVIL ENGINEER

Education:
Bachelor of Engineering, Civil, Technical University of Nova Scotia, 1981

Professional Associations:
Association of Professional Engineers of Nova Scotia
Canadian Dam Association (including member of National Executive Board, Nova Scotia Representative from 1997 to 2002).

Career:
1996 to present: J.B. Yates Engineering Limited
1990 - 1996: Vaughan Engineering Associates Limited
1988 - 1990: O'Halloran Campbell Consultants Ltd.
1986 - 1988: Triton Engineering Ltd.
1983 - 1986: J.D. Koppernaes Engineering Ltd.
1981 - 1983: Canadian British Consultants Ltd. (CBCL Ltd.)

Experience:
Over Thirty Years of Experience in a wide range of structural, heavy civil, mechanical and multi-disciplinary engineering projects encompassing design, assessments, construction planning and supervision, investigations, evaluations and repairs and improvements including derivation of cost estimates for: hydroelectric and thermal generation powerhouses and related facilities across Nova Scotia; marine facilities (wharves and jetties) and support infrastructure; offshore oil production platforms and fabrication plants; roads and highways; water, sewer and storm drainage systems; fisheries enhancement facilities (fish ladders, passages and barriers); and related infrastructure. Experience with industrial, commercial, and residential buildings structures includes: design of building structures, building envelope and sub-structure design; condition assessments and engineering evaluations, design of repairs and construction management. Mr. Yates has extensive experience with design of reinforced concrete, masonry, structural steel, wood-frame, timber and earthen structures.

Work History: Major responsibilities have included design development, technical support, coordination and services during construction for the following projects:

Industrial and Power Projects:

- For Nova Scotia Power Inc.: Engineering design, evaluation, construction cost estimates derivation and construction management for implementation of improvements and repairs to hydroelectric assets including but not limited to turbo-generators (and related structural and mechanical components), earthen, concrete and timber dams and spillways; intake (head-works, head-gates) structures and associated operating machinery; various sluiceways and related gates (including overhauls in 2004 and 2005 of Annapolis Causeway sluice gates) and related machinery; life extension projects for steel, fibreglass and wood pipelines and penstocks, and surge tanks condition assessments and remediations; powerhouse substructures, superstructures and related infrastructure; power canals; access roads and related items; environmental remediations/improvements including fisheries enhancement projects for over fifty generation units at over thirty hydroelectric developments.
- Inspections condition assessments, remediations designs for various main-line penstock butterfly (and similar) valves for NSPI, Minas Basin Pulp and Power and Berwick Electric.
- Lead Engineer for the rehabilitation and reconstruction of Parson's Dam for Minas Basin Pulp and Power in St. Croix, Nova Scotia. This project included the installation of vertical post tensioned steel anchor bars of various lengths (up to about 100 feet) installed through the crest of the concrete gravity dam and into the underlying bedrock strata.
- Dam Safety Review for the St. Croix River Hydroelectric Generating System for Minas Basin Pulp and Power.
- A system-wide head-gate study for Nova Scotia Power's Hydro Production Department.

- Design of replacement pipeline and penstock for Berwick Electric's hydroelectric generating station.
- Design of remediations and repairs to Middle River dam and sluiceway for the Nova Scotia Department of Transportation and Infrastructure Renewal.
- Lead engineer on development and installation of intake maintenance bulkhead gates for head works at Nalcor's Star Lake Hydro Electric Development in Newfoundland and Labrador.
- Provision of mechanical and structural engineering support and assistance for major generation unit overhauls carried out by NSPI Hydro Production from 1994 to 2012.
- Various condition assessments and reporting for dams, spillways and related component infrastructure for NSPI, NSTIR, NSLands, Minas Basin Pulp and Power and Nalcor including work associated with Dam Safety Reviews.
- Investigations and assessments and design of repairs including remedy of water infiltration issues for various buildings including hydroelectric powerhouses, thermal generation power stations and ancillary structures for NSPI's Hydro Production division at over 40 locations across Nova Scotia.
- Engineering for civil and structural components of Nova Scotia Power's 150 MW Trenton 6 Generating Station, including C.W. intake, fly-ash system supports, coal stockpiles material handling, site building foundations, site buried services and others.
- Boiler support structure engineering at Nova Scotia Power's Pt. Aconi Generating Station during construction.
- Harbour-front remediations, cooling water intake reconstruction, consolidation of buried services infrastructure network and upgrading of marine fuel offloading facility for Nova Scotia Power Inc.'s 350 MW Tuft's Cove thermal generation station.
- Design of a structural base and installation of a 500-tonne press for HMC Dockyard's Ship Repair Unit.
- Assessment of Imperial oil refinery heating plant brick and masonry smoke stack and design of repairs.
- Maccan thermal electric generating station brick stack assessment and reporting.
- Structural and civil designs for various of fish plants and their components and related infrastructure at various locations in Nova Scotia.
- Engineering for three submerged (underwater) degaussing ranges for HMC ships in and around Halifax Harbour for D.N.D.
- Design of a "cable float" work platform to be used in conjunction with Synchro-lift ship lifting and maintenance facility for HMC Dockyard.
- Lead Engineer on assessment of existing and design for new explosive blast protection barrier structures for the Canadian Military in Halifax Nova Scotia.
- Design and construction supervision for repairs and improvements (and new construction) for dozens of fish passage and related infrastructure located in Nova Scotia.

Marine and Offshore Facilities:

- Site investigations and design for improvements/repairs and improvements for various marine facilities and related components or infrastructure in Antigua, St. Kitts, Grenada and St. Lucia, West Indies.
- Investigations, conceptual designs and engineering support and construction cost estimates for rehabilitation of hurricane battered container port and cruise ship jetty facilities at St. John′s Antigua W.I., Basseterre St. Kitts W.I., and Vieux Fort St. Lucia W.I.
- Assessment of and preliminary engineering for improvements to Adams and Knickle Wharf in Lunenburg, Nova Scotia.
- Condition assessment for Liverpool Harbour breakwater for NS Lands.
- Pier 9/9A Repairs, Halifax Port Corporation.
- Fairview Cove Container Terminal Infrastructure Assessment for Halifax Port Corporation.
- Wharf rehabilitation and general waterfront development/improvements for Louisburg, N.S.
- IEL Wharf structural analysis, Woodside, N.S.
- Design for a new public access wharf facility adjacent the IEL Wharf in Woodside, N.S. for the N.S.

Department of Economic Development.
- Assessments of Port of Sheet Harbour Industrial Park wharf.
- Provision of engineering for development of the assembly yard for Strait Crossing Inc. in Borden PEI in support of construction of the Confederation Bridge linking PEI to New Brunswick.
- Engineering Manager and Fabrication Planner for Utility Shaft Modules Fabrication and Load-out, for Hibernia Offshore Oil Development Project.
- Lead Design Engineer for Deck Erection Supports for Cohasset Panuke Offshore Oil Development Project topsides modules fabrication and load-out.
- Analysis and derivation of required measures to correct dimensional distortions experienced during fabrication of the Cohasset Panuke topsides modules.
- Planning of fabrication yard layout, module movements and crane lifting operations for Cohasset Panuke topsides modules for M&M Offshore Ltd.
- Lead Engineer for computation of weight control and three dimensional centres of gravity data necessary for engineering of crane lifts for components and finished Cohasset Panuke topsides modules for M&M Offshore Ltd.

Building Projects:
- Design for piled foundations and steel superstructure for Metal fabrication plant for Woodside Fabricators Ltd.
- Structural evaluations for various buildings on Saint Mary’s University Campus, and design of required remediation.
- Various residential inspections and assessments for Atlantic Home Warranty Program.
- Gunnery support training facility and related infrastructure for HMC Dockyard, Halifax.
- Various structural assessments and design for structural component additions at several N.S. schools for the provincial Department of Education and/or related school boards.
- Various pre-engineered steel building foundation designs for J.L. Nichols Contracting.
- Major structural and architectural enhancements for Royal Canadian Legion, Caen Branch 164, Eastern Passage, Nova Scotia.
- Structural design for Rita’s Tea Room, Big Pond, Nova Scotia
- Various building modifications, Ship Repair Unit, CFB Halifax.
- Addition to Forbes’ Chev Olds, Dartmouth, N.S. (now MacPhee Ford)
- Structural modifications and addition to Inn on the Lake, N.S.
- Operations and Maintenance Manual draft for CFB Halifax MARCOM building.
- Design and construction supervision of an industrial building at Woodside Industrial Park.
- Building assessments and building envelope inspections at Main Street, Tacoma Drive and Fielding Avenue for First Mutual Properties.
- Structural assessments and engineering for heritage and other structures and sets associated with filming and production of “The Scarlet Letter” motion picture in Shelburne, Nova Scotia.
- Structural and mechanical engineering support for sets and props associated with “The Sea Wolf” motion picture, filmed in Halifax.

Other Civil Projects:
- Seven kilometres of Trans-Canada Highway at Salt Springs, N.S.
- Rehabilitations for North Mountain Roadway in Highlands National Park, Cape Breton, N.S.
- Various new and existing municipal projects including water transmission and distribution systems; trunk sanitary sewers and treatment facilities throughout the Halifax Regional Municipality (including components of the Halifax Harbour Clean-up).
- Victoria Street Reconstruction, Town of Amherst.

December, 2018

Mr. Kyle Blades
Nova Scotia Power Inc.
1223 Lower Water Street
Halifax, NS

Dear Mr. Blades,

Re: NSPI Hydro-system Decommissioning: Estimation Wetland Alteration Permitting Costs

Introduction and Background

Strum Consulting was retained by Nova Scotia Power Inc. (NSPI) to conduct a desktop study to evaluate the costs associated with delineating, permitting, and monitoring wetland alterations that would occur if a number of their hydro-systems were decommissioned, and all infrastructure (dams, dykes, powerhouses, etc.) were removed, and water levels were returned to historic levels. The following is a list of the hydro-systems that were evaluated:

- The Avon River hydro-system;
- The Bear River hydro-system;
- The Black River hydro-system;
- The Dickie Brook hydro-system;
- The Fall River hydro-system;
- The Harmony hydro-system;
- The Lequille hydro-system;
- The Mersey hydro-system;
- The Nictaux hydro-system;
- The Paradise hydro-system;
- The Roseway Hydro-system;
- The Sheet Harbour hydro-system;
- The Sissiboo hydro-system;
- The St. Margarets Bay hydro-system;
- The Tusket hydro-system; and
- The Wreck Cove hydro-system.

As many of these hydro-systems have been in place for decades, wetland habitat has developed and adapted to the artificial water management regimes of the water bodies associated with the hydro-systems (e.g. head ponds, reservoirs, and downstream watercourses). Wetlands that are contiguous (affected by) with these managed water bodies may be degraded as a result of the changing of the hydrological regime that would occur as a result of the decommissioning of the hydro-systems.

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For example, a defining factor of wetlands is that the depth of groundwater is within approximately 30 cm of the soil surface. As such, a drop in the groundwater level in a wetland area due to the removal of a dam could result in substantial degradation of wetland habitat.

The Nova Scotia *Environment Act* requires an approval for conducting certain activities that impact wetlands, and altered wetlands require compensation to ensure that there is no net loss of wetland habitat as per the Province's Wetland Conservation Policy. Under this policy, any wetland alterations that exceed 100 m^2 in area (with a few exceptions) must be permitted and compensated for, usually by undertaking a wetland creation project in which new wetland area is created. As such, any wetlands altered by the decommissioning of infrastructure associated with the hydro-systems would need to be compensated for under the policy.

This report evaluates the costs that would be associated with permitting wetlands that would be altered as a result of decommissioning the hydro-systems.

Methodology

In order to estimate the wetland permitting costs, the area of wetland that is contiguous with the hydro-systems must first be determined.

Contiguous wetland area is areas of wetland habitat that are affected by the water management regime of managed waterbodies associated with the hydro-systems (e.g. headponds, reservoirs, etc.). Contiguous wetlands may be fringing with the managed waterbodies, or located close enough that they would be affected by groundwater alterations that would occur should the water level elevation in the waterbodies be changed (likely lowered as a result of decommissioning). The flooding or draining of wetland habitat is considered an alteration under Nova Scotia's Wetland Conservation Policy.

Also included as contiguous wetland area is wetland area associated with large watercourses (e.g. rivers and streams) that are heavily influenced (e.g. downgrade and sourced primarily) by the spillage from managed water bodies. The hydrological regime of these wetlands would be affected by the removal of hydro-system infrastructure, resulting in a wetland alteration.

Determination of Contiguous Wetland Area

The desktop wetland study was completed by reviewing the following data sources:

- Google Earth Pro (2016 satellite imagery);
- NSDNR Wetland Inventory (2002);
- NS Wet Areas Mapping Database (WAM) (2012);
- NS 10k Topographic Database – Hydrographic Network (2015);
- LiDAR and Bathymetry data (NS Power 2013); and
- Field Identified Wetlands (NS Power)

Selection of Wetlands around Waterbodies

The waterbody polygons used in this study came from the NS Hydrographic Network, and the wetland polygons came from the NSDNR Wetland Inventory. Using ArcGIS Desktop 10.6 (ArcGIS), a 50 m buffer was generated along the outside of all waterbodies with hydro-system infrastructure in order to select for wetlands which fall within 50 m of the shore (Select by Location tool in ArcGIS). The total wetland area associated with each waterbody was then calculated.

Selection of Wetlands around Large Watercourses

The large watercourse polygons used in this study came from the NS Hydrographic Network, and the wetland polygons came from the NSDNR Wetland Inventory. In ArcGIS, large watercourses draining into and out of the waterbodies were selected and a 10 m buffer was generated along the outside of the watercourses to select for wetlands which fall within 10 m of the watercourses (Select by Location tool in ArcGIS). The total wetland area associated with each watercourse was then calculated.

Estimation of Wetland Alteration Permitting Costs

The area of contiguous wetland for each system was used to estimate the permitting costs for delineating, assessing, and permitting the area of wetland that would be affected by the decommissioning of each hydro-system. The following considerations were considered in these cost estimations:

- Field Costs - Field costs were estimated based on the rates in NSPI's Master Service Agreement, and the estimated costs for a team of two biologists to delineate 100 ha of wetland.
- Permit Reporting and Submission Costs - The cost to prepare and submit wetland alteration permit applications to NSE.
- Follow up Monitoring Costs - Based on the assumption that two years of post-construction monitoring will be required as per the alteration permit approvals terms and conditions at all altered wetlands

Estimation of Compensation Costs

Consideration was given to the following four factors in estimating the wetland compensation costs:

1) Un-mapped wetland area;
2) Post alteration wetland establishment;
3) Wetland functional value; and
4) Wetland area creation cost.

Un-mapped Wetland Area

An allowance for the area of un-mapped wetland that is not represented in the desktop resources used in this study should be incorporated into the compensation cost estimates. The NSDNR wetland inventory is based on wetlands that were identified from aerial imagery, and as such treed wetlands (e.g. treed swamps) are under-represented in the inventory. Through Strum's extensive experience in delineating wetlands in forested environments, we estimate that as much as 15% to 35% of any forested landscape is comprised of treed wetlands. For the purpose of this assessment a multiplier of

+25% was used to account for additional wetland area that is not represented in the desktop resources used.

Post Alteration Wetland Establishment

It is likely that wetland area would re-establish itself once the hydro-systems are decommissioned and surface and ground water levels re-establish equilibrium. It is not possible to determine exactly how much wetland area would establish. For the purpose of this assessment, we estimated that 15% of the wetland area that would be lost as a result of the decommissioning would re-establish itself naturally within the watershed, but this estimation may fluctuate based on a number of factors, including the bathymetric profile of the waterbodies, groundwater interactions, and lake bottom substrate (e.g. rich organic silty lake bottoms vs. rocky lake bottoms).

Wetland Degradation Area Multiplier

Based on the contiguous wetland area determined for each hydro-system, the wetland degradation area could be estimated. The wetland degradation area is the area of wetland habitat that would be degraded and included in the wetland area that requires compensation as a result of the changing of the hydrological regime that would result should the hydro-systems be decommissioned. As a number of factors could influence the wetland degradation area, including the water level change as a result of decommissioning, surface and groundwater interactions, and wetland habitat type, three scenarios for the wetland degradation area will be evaluated. These scenarios are described below:

- <u>Low-Range Degradation Area Estimate</u> – Low-range wetland degradation estimates would include scenarios where the wetlands that are contiguous with managed water bodies would suffer minor to intermediate degradation as a result of the decommissioning of the hydro-system's infrastructure. Examples of scenarios that would result in low levels of wetland degradation would include scenarios where the water level is drawn down less than 1 m, where the hydrology of a wetland is maintained in large-part by precipitation or groundwater / surface water emanating from upgrade, or where significant wetland area may be able to re-establish itself once water levels are drawn down (such as were silty rich soils exist in the lake). The low-range wetland degradation multiplier is 50% of the original wetland area.

- <u>Mid-Range Degradation Area Estimate</u> - Mid-range wetland degradation estimates would include scenarios where the wetlands that are contiguous with managed water bodies would suffer intermediate to severe degradation as a result of the decommissioning of the hydro-system's infrastructure. Examples of scenarios that would result in mid-levels of wetland degradation would include scenarios where the water level is drawn down more than 1 m but less than 3 m, where the hydrology of a wetland is not well maintained by precipitation or groundwater / surface water emanating from upgrade, or where it is unlikely that significant wetland area would be able to re-establish itself once water levels are drawn down. The mid-range wetland degradation multiplier is 65% of the original wetland area.

- <u>High-Range Degradation Area Estimate</u> – High-range wetland degradation estimates would include scenarios where the wetlands that are contiguous with managed water bodies would suffer severe degradation as a result of the decommissioning of the hydro-system's infrastructure. Examples of scenarios that would result in high levels of wetland degradation would include scenarios where the water level is drawn down more than 3 m, where the hydrology of a wetland is not maintained at all by precipitation or groundwater / surface water emanating from upgrade, or where it is unlikely that significant wetland area would be able to re-establish itself once water levels are drawn down, such as when the lakebed is rocky and devoid of rich organic material that would form the basis of suitable wetland soils. The mid-range wetland degradation multiplier is 85% of the original wetland area.

Wetland Area Creation and Compensation Cost Analysis
The cost of creating wetland habitat for the purpose of compensating for wetland area alterations varies depending on economies of scale and market prices. Typical costs for creating wetland area in Nova Scotia range from \$2.75 to \$4.00 per m^2. Furthermore, Wetlands permitted for alteration under Nova Scotia's Wetland Conservation Policy typically require a 2:1 or higher compensation ratio, whereby 2 m^2 of wetland habitat must be created for every 1 m^2 of wetland that is altered. High functioning wetlands (as determined in the wetland assessment process) may be subject to higher compensation rations (e.g. 3:1 or 4:1). Given the current state of the wetland creation market, the wetland creation component of the compensation costs may be substantial for the decommissioning of any hydro-system.

Prior to estimating wetland compensation cost, it would be more efficient to study compensation options for each hydro-system individually, and determine a unique compensation scenario for each system. For example, rather than a full decommissioning of all water bodies, it may be possible to strategically pick a number of managed water bodies that are known to host large areas of contiguous wetland. The water management regime of these water bodies can then be altered to maintain or enhance the wetland habitat on these waterbodies, which may reduce the compensation requirement for the hydro-system, or even act as a compensation project through the enhancement of wetland habitat.

The cost of the compensation costs analysis would be based on the size of each system and the amount of wetland area that would be disturbed if the system was decommissioned. For these cost estimates each system was assigned one of three size classifications (small, medium, and large) based on its total contiguous wetland area. The cost to prepare a compensation analysis for a small system was estimated at \$4,500, and \$7,500 for a medium size system, and \$10,500 for a large system.

Results

<u>Estimation of Wetland Alteration Permitting Costs</u>
The estimated wetland alteration permitting costs are itemized and provided for each hydro-system in Table 1 (attached). The permitting cost estimates range from \$7,750.00 (for the Roseway Hydro-System), and \$230,013.00 (for the Wreck Cove Hydro-system). The total for permitting all wetlands associated with all of the assessed hydro-systems is estimated at \$1,088,972.00.

Estimation of Compensation Costs Analysis

The estimated compensation analysis costs are detailed in Table 2 (attached). The compensation analysis costs range from $4,500.00 for small hydro-systems to $10,500.00 for large hydro-systems. The total cost to study all 16 hydro-systems and prepare reports with compensation options would be approximately $114,000.00.

Discussion and Recommendations

It should also be noted that Nova Scotia's Environmental Assessment Regulations (made under Section 49 of the *Environment Act,* 1994-1995) require that an environmental assessment be completed for undertakings that would disrupt 2 ha or more of any wetland. Based on this, it is likely that environmental assessments would be required for each decommissioning project, the costs of which are not included in this study. There is also a risk that the decommissioning projects may not be approved by the Minister of the Environment as per their authority under the *Environment Act*. We recommend that NSPI consult with NS Environment on the requirements for environmental assessments for these decommissioning projects.

Closure

The wetland area estimates included in this report are based on the most current desktop resources available and may not accurately represent the actual wetland areas in the study area. Furthermore, the assumptions used in preparing the wetland alteration permitting cost estimates and compensation cost estimates are based on our expert opinion given our experience and the available information, and may not accurately reflect the actual costs or wetland impact areas.

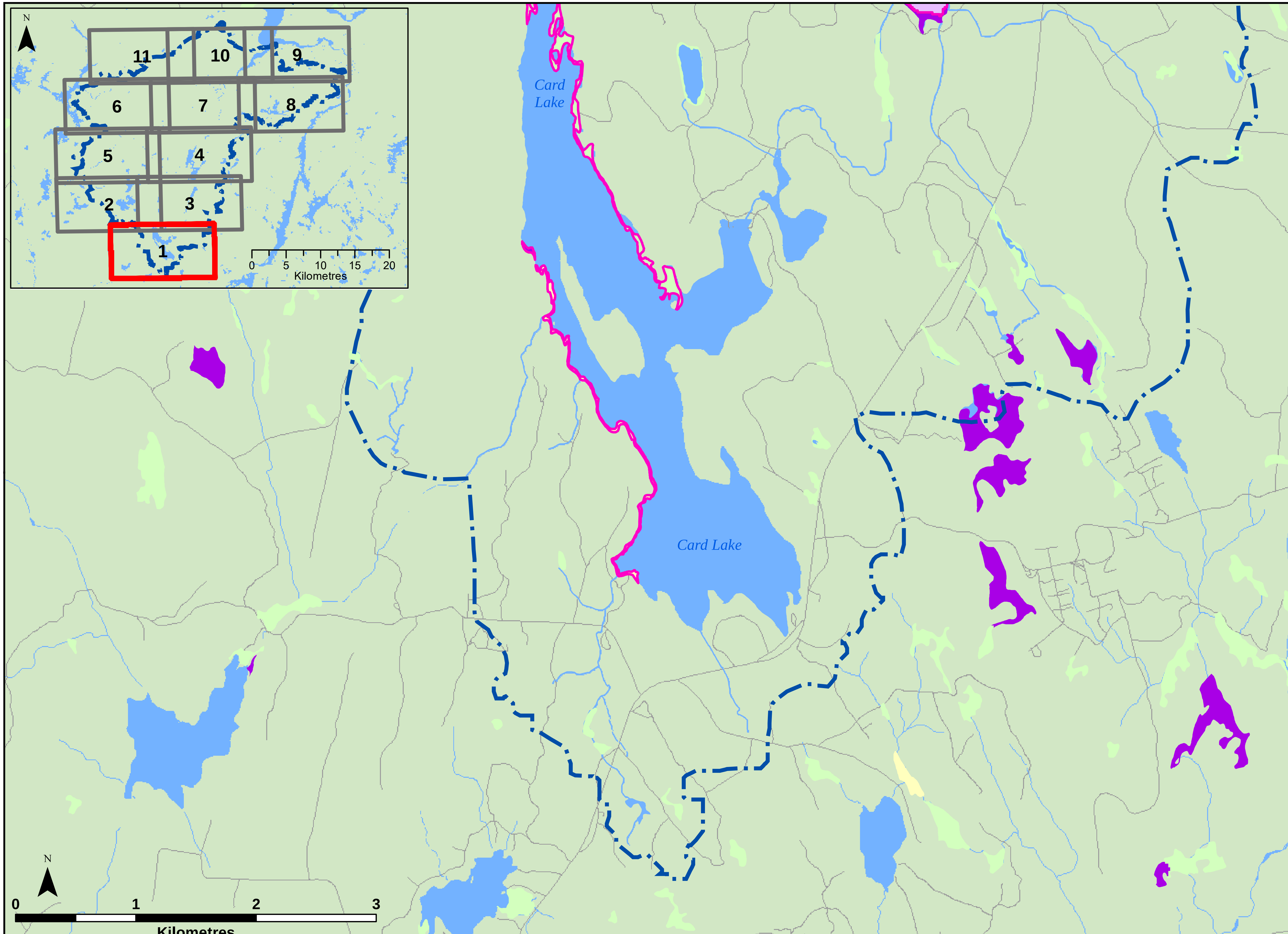
This report was prepared by Scott Dickey, MREM, Environmental Scientist, and Meghan Marriott, MSc., GIS Technologist and Environmental Scientist, and was reviewed by Shawn Duncan, Vice President.

Thank you for the opportunity to conduct this desktop assessment. Please contact us with any questions you may have.

Thank you,

Scott Dickey, MREM
Environmental Scientist
sdickey@strum.com

Shawn Duncan, BSc.
Vice President
sduncan@strum.com



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Avon Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
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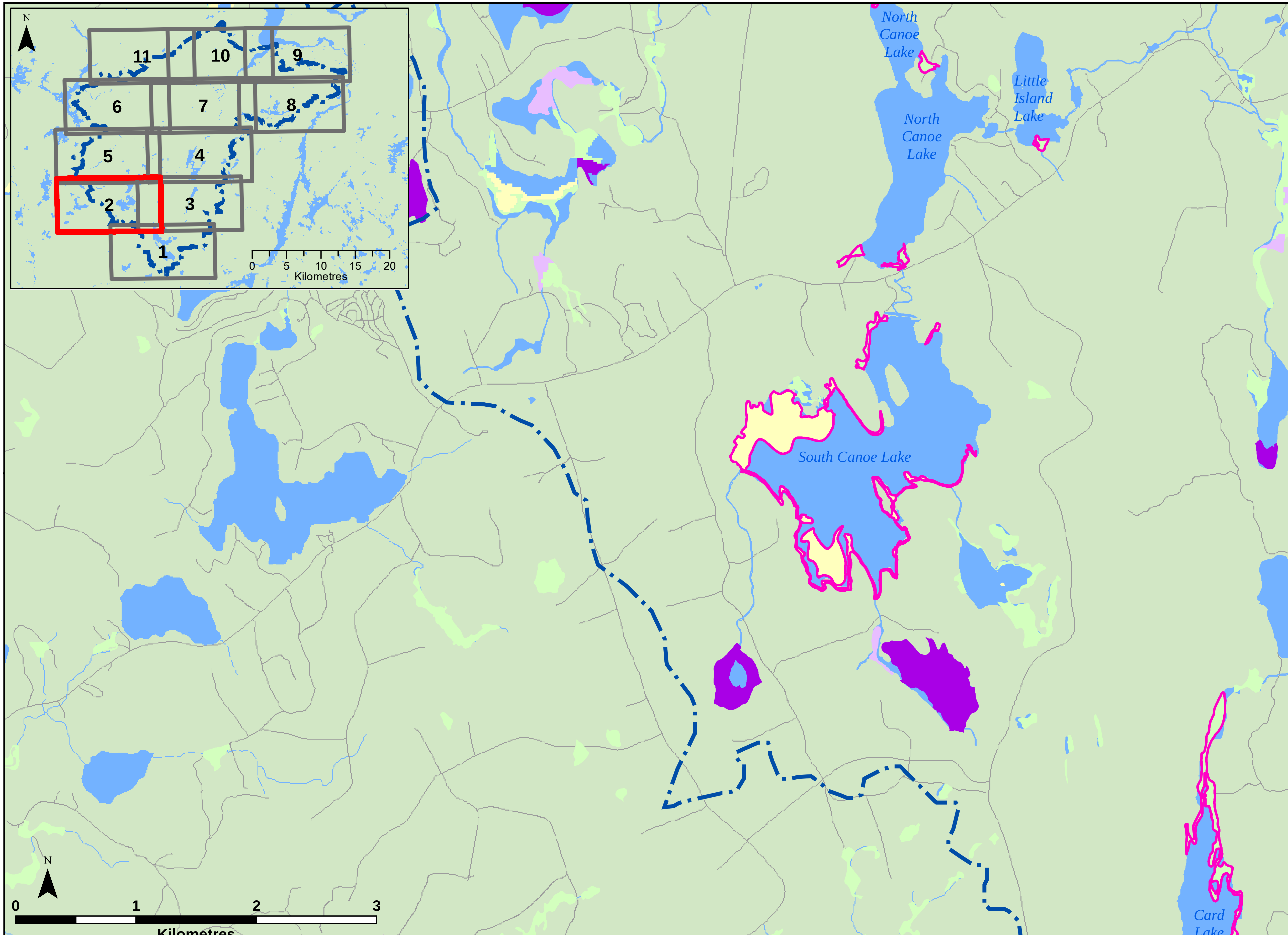
Checked By: S. Dickey	



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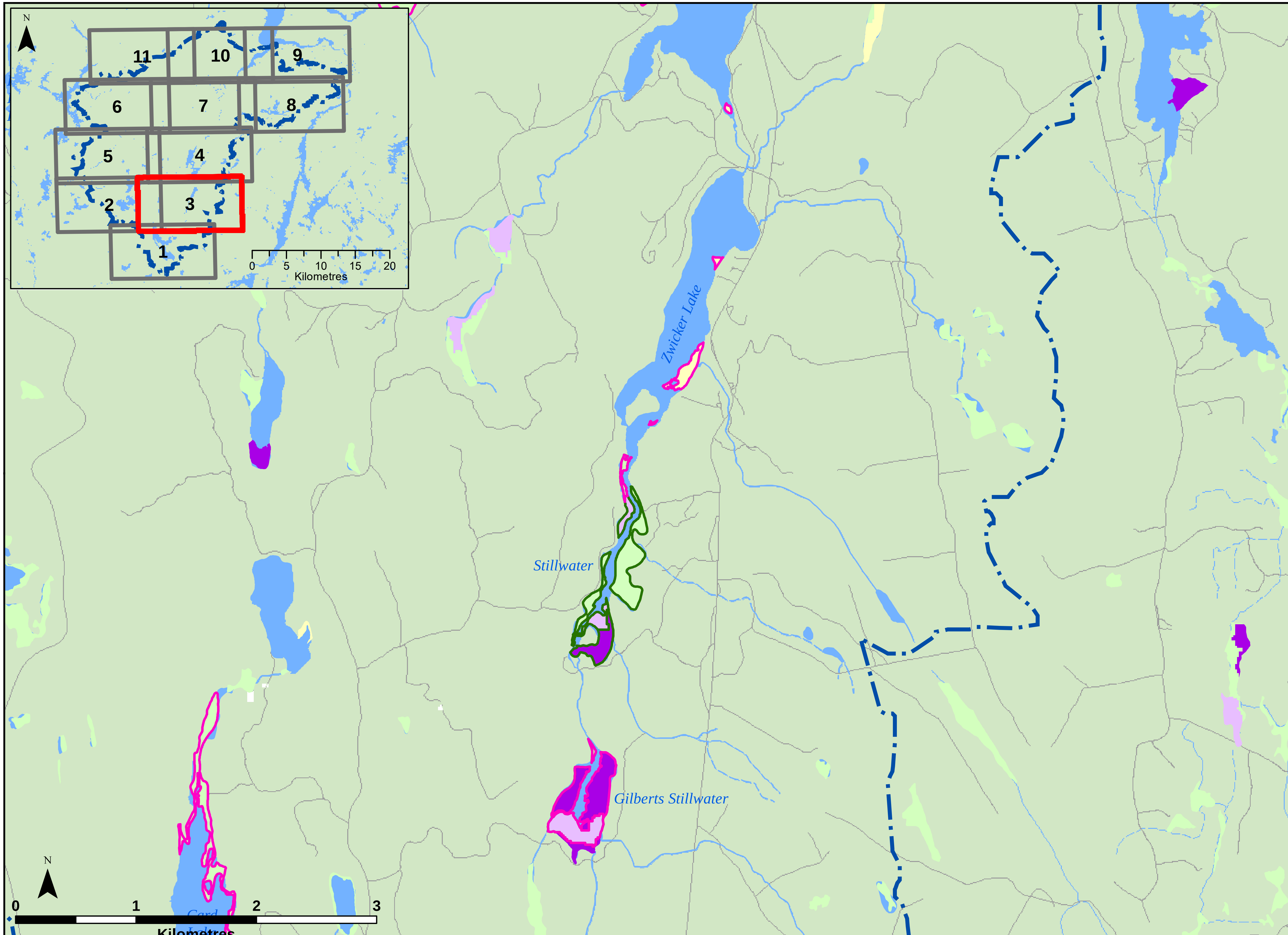

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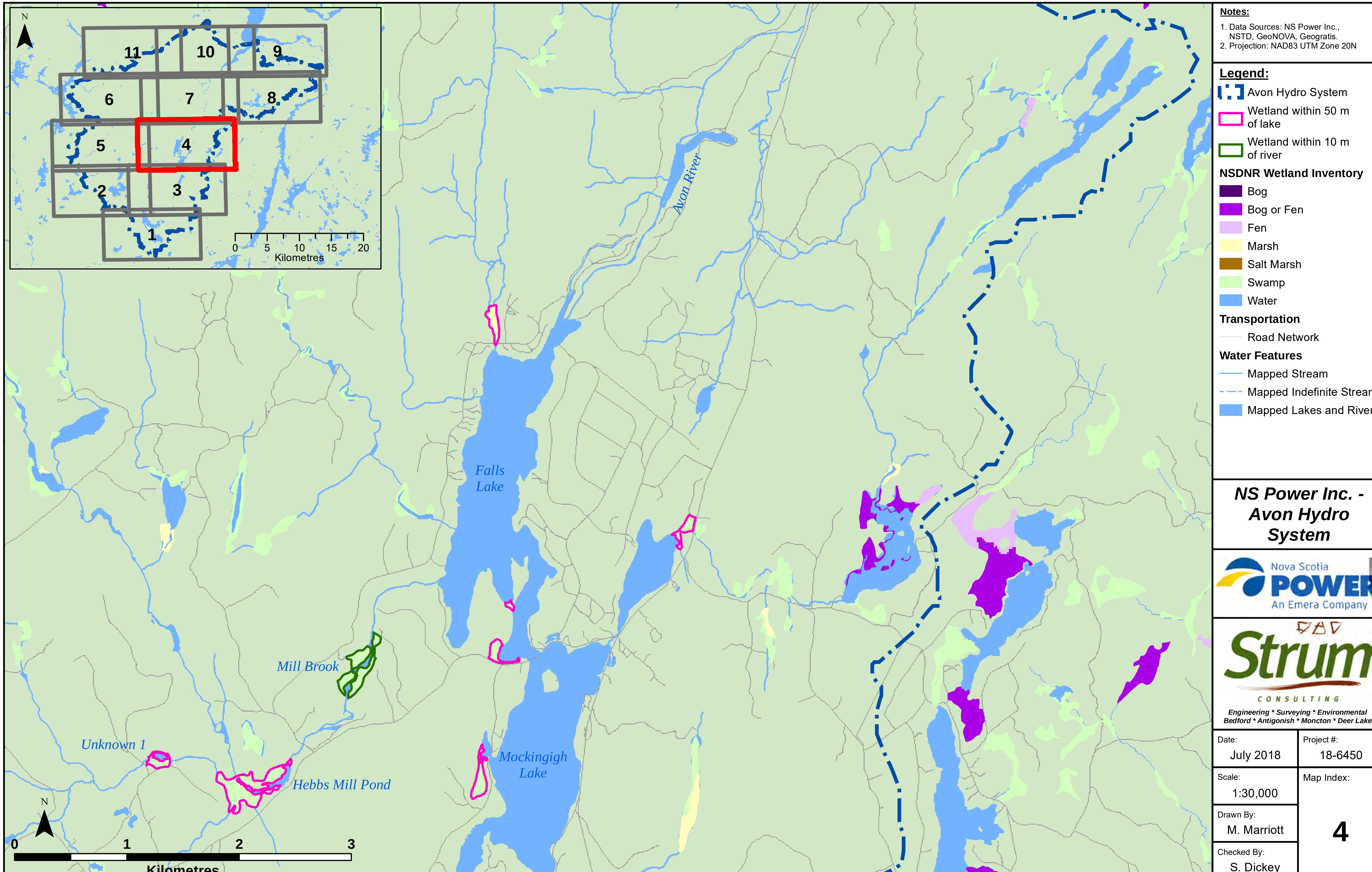
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Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 4
Drawn By: M. Marriott
Checked By: S. Dickey
Falls Lake
Avon River
Mill Brook
Unknown 1
Hebbs Mill Pond
Mockingigh Lake
0 1 2 3
Kilometres
0 5 10 15 20
Kilometres
1 2 3 4 5 6 7 8 9 10 11

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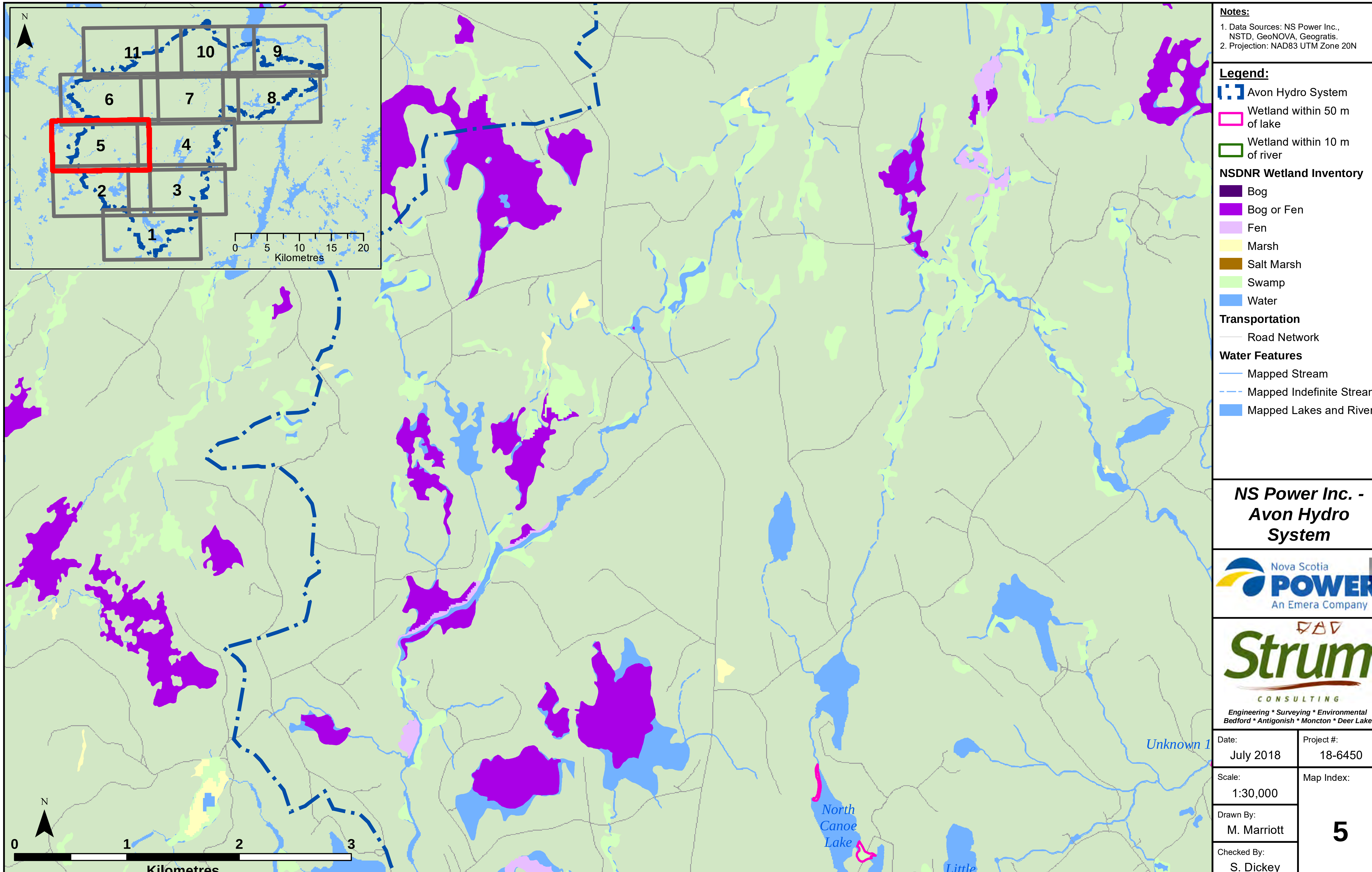

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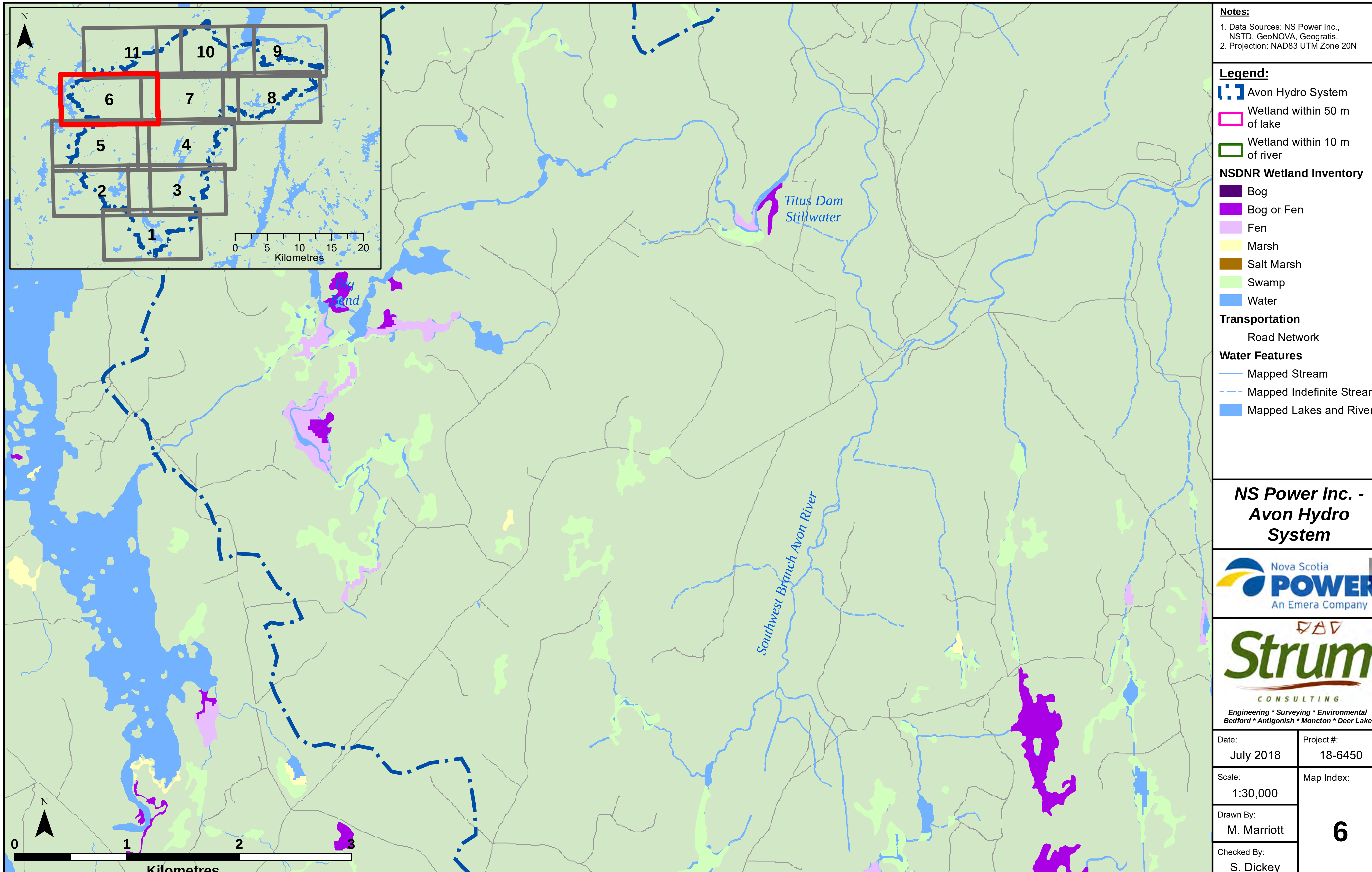

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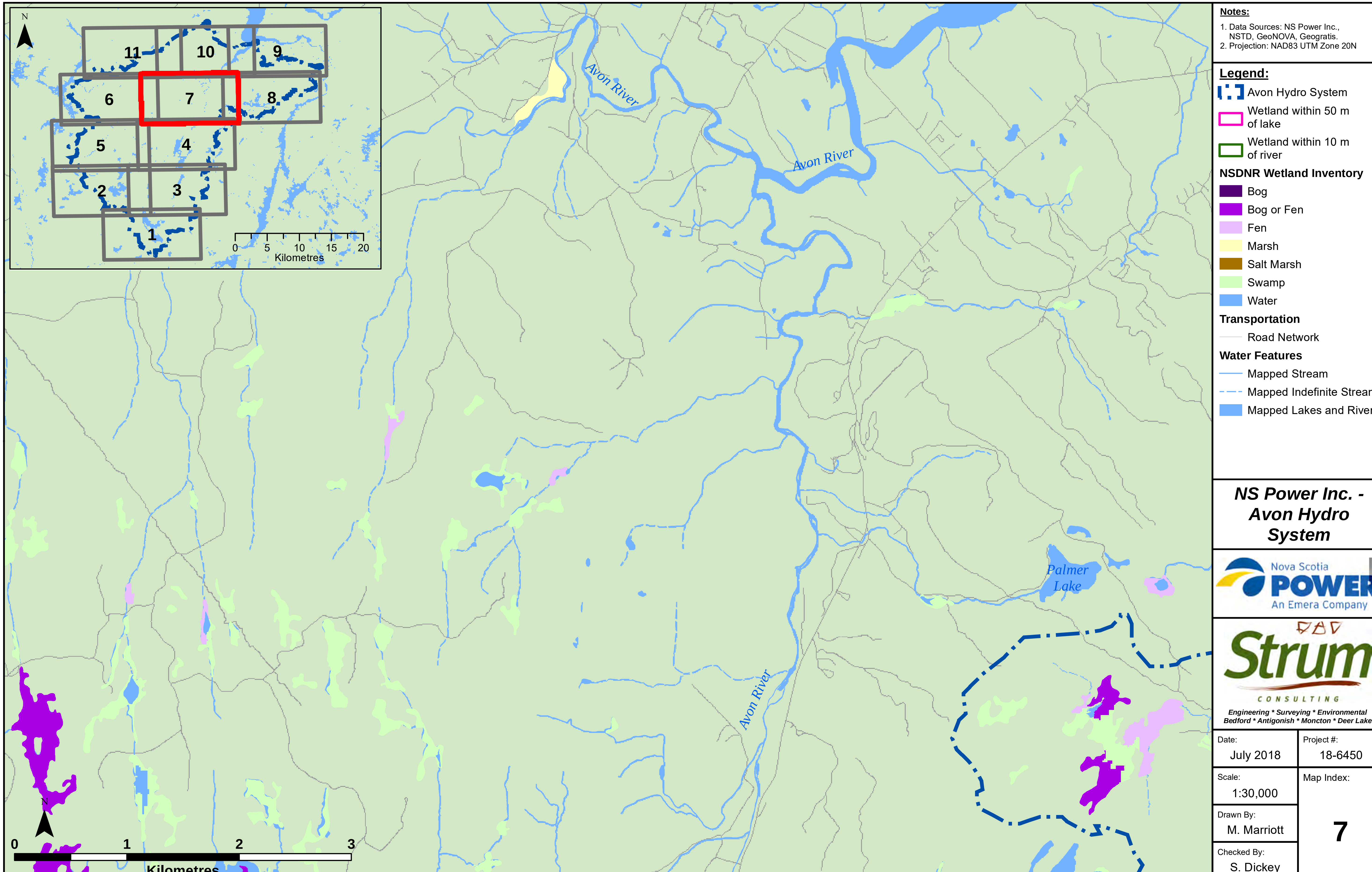

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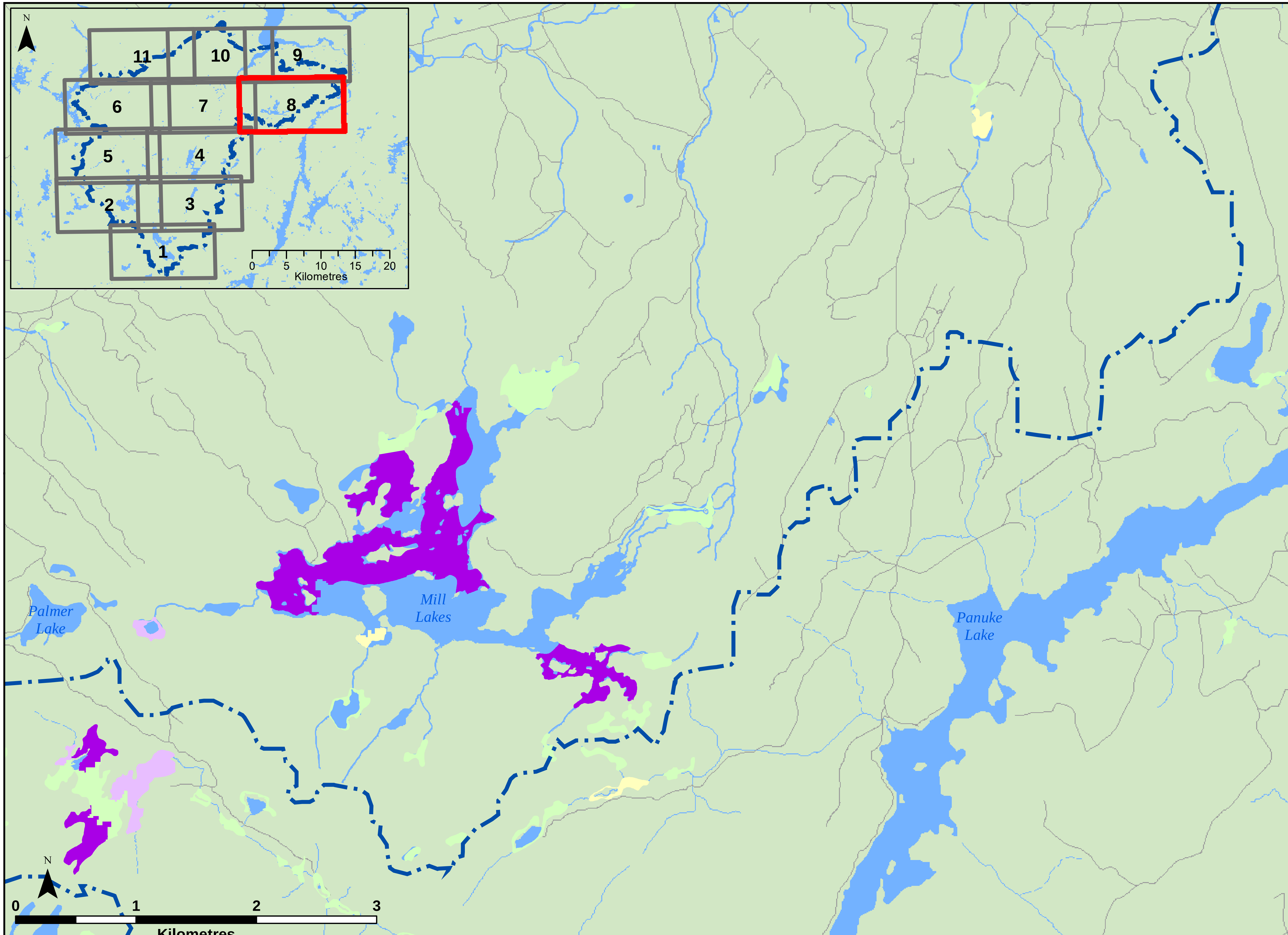

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Date: July 2018	Project #: 18-6450
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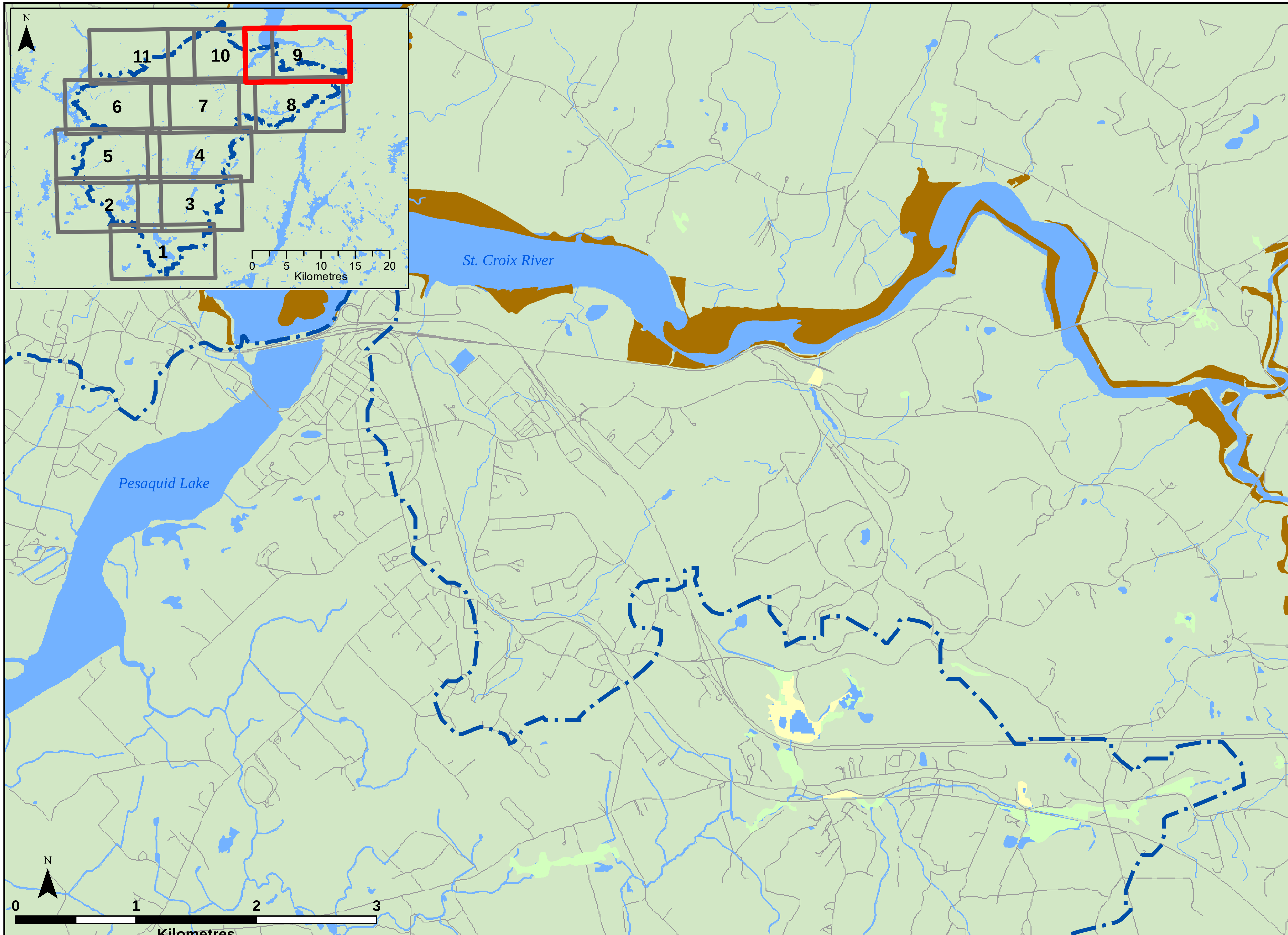

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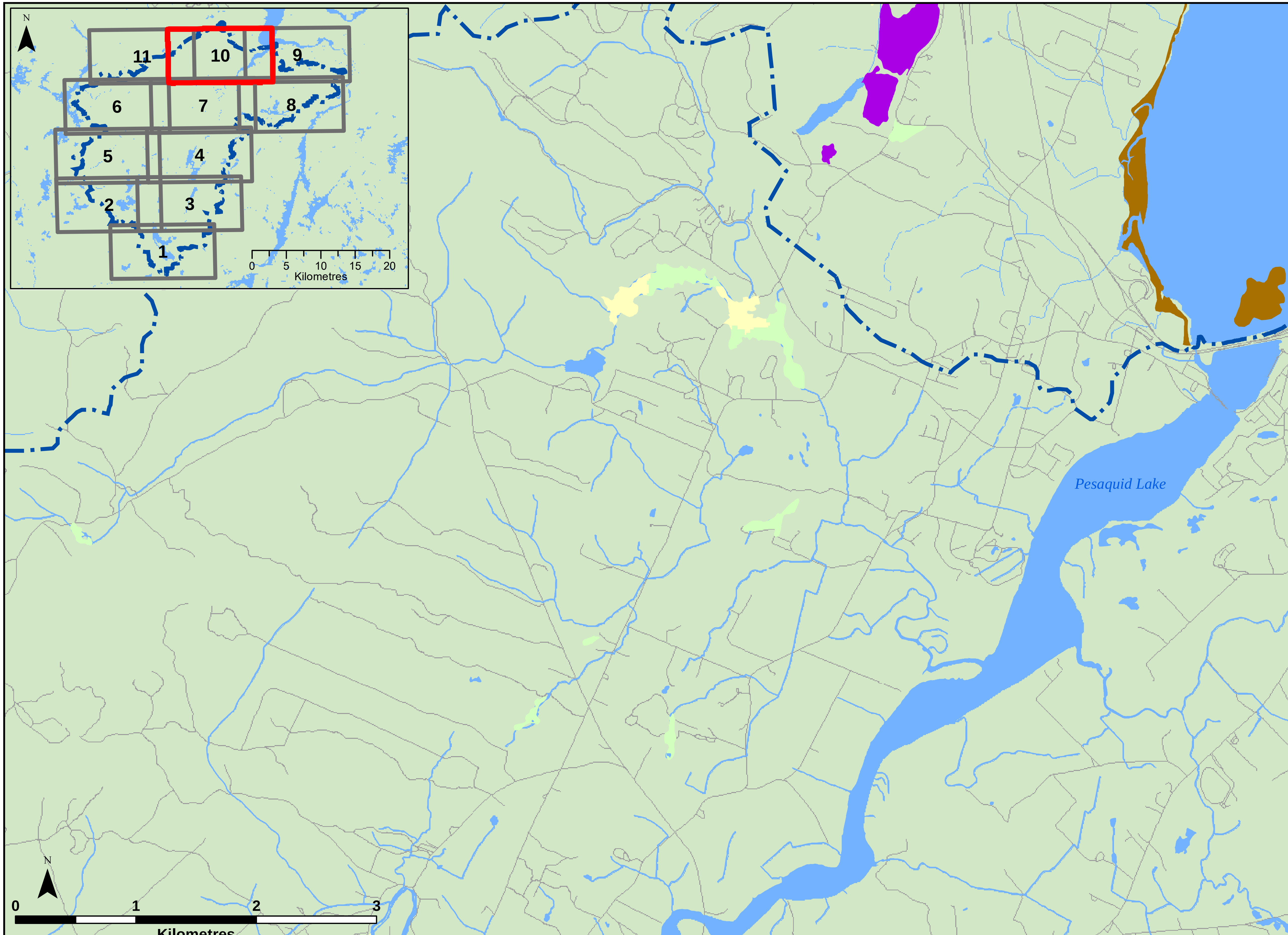

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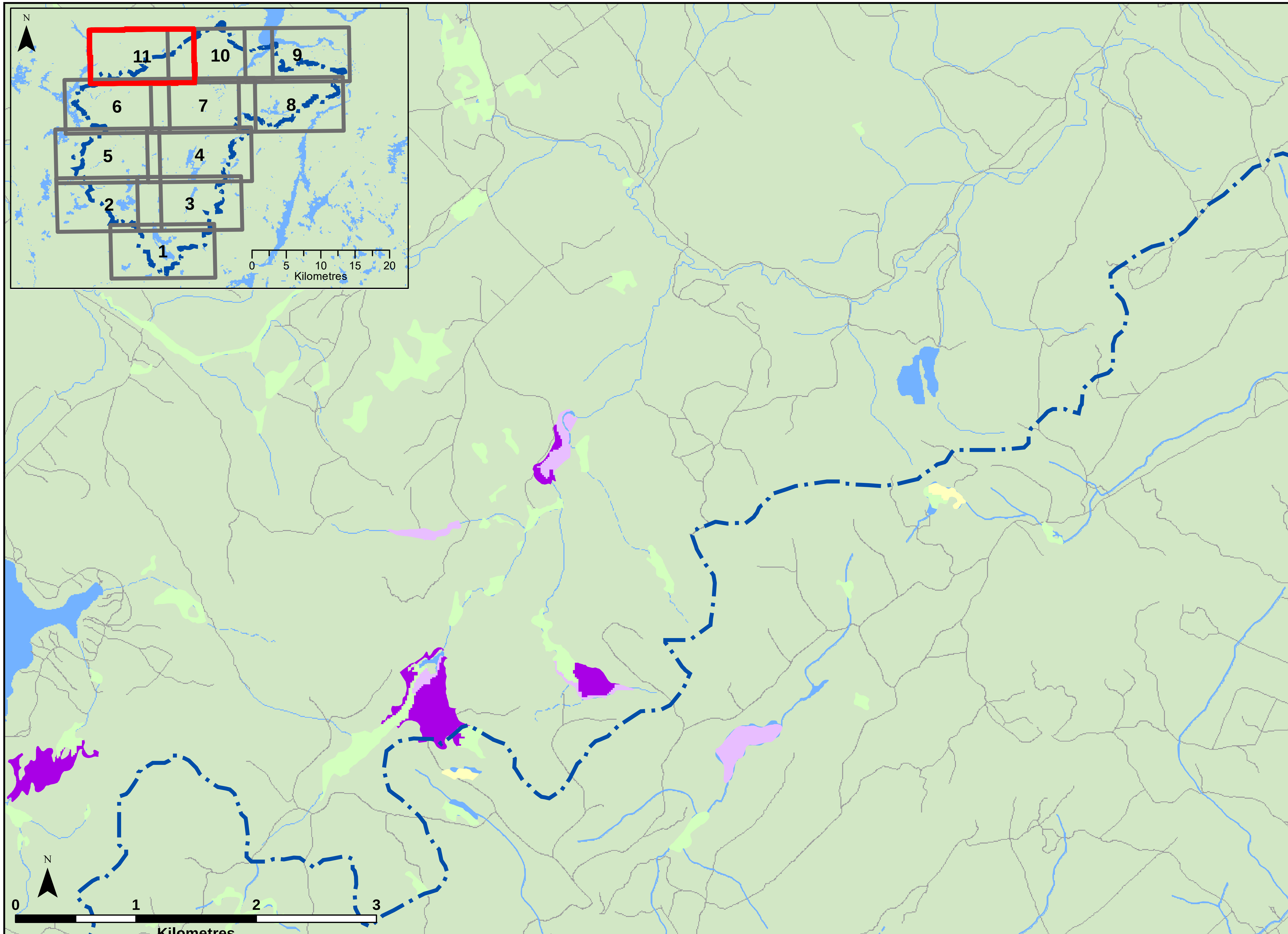

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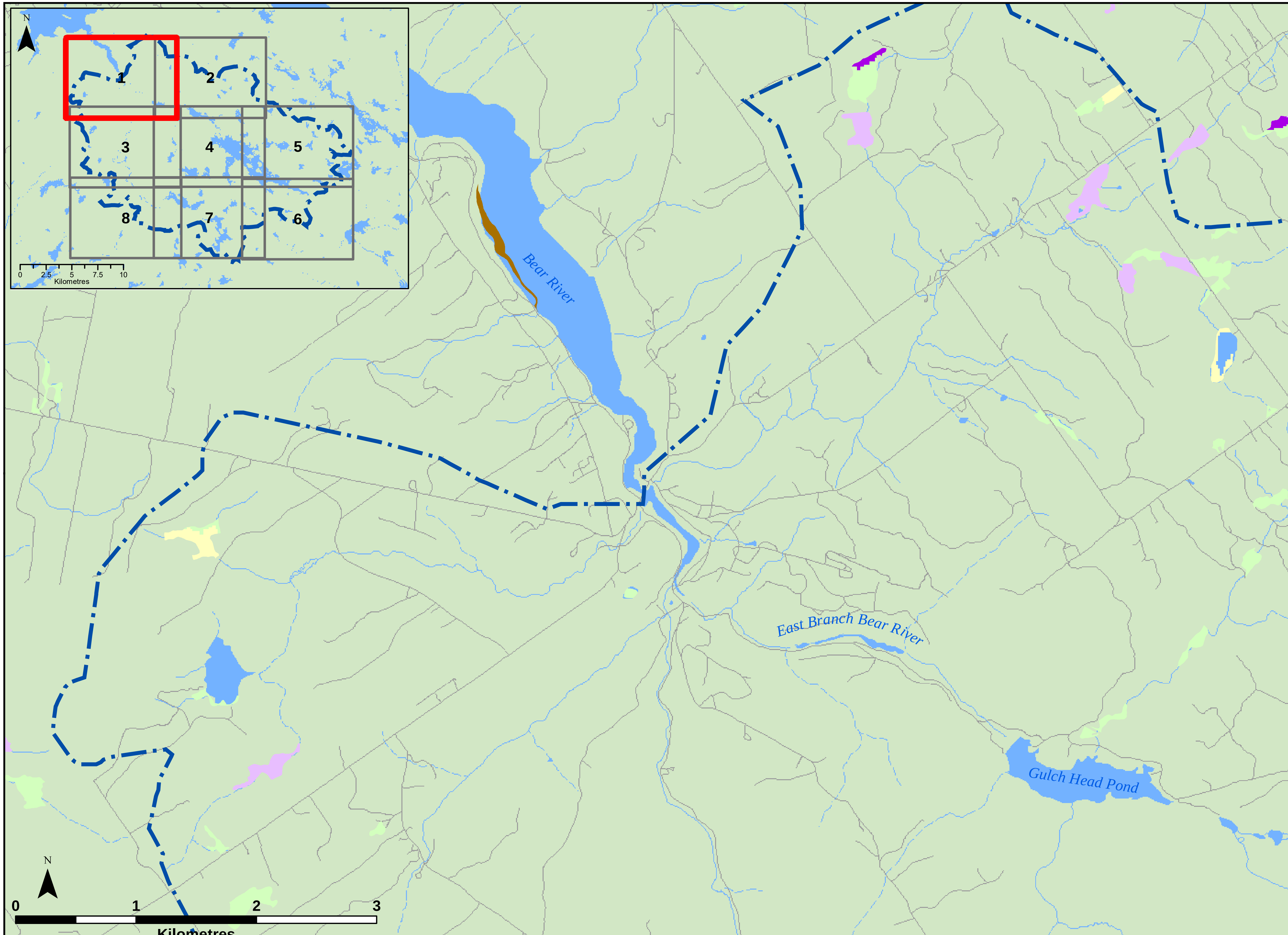

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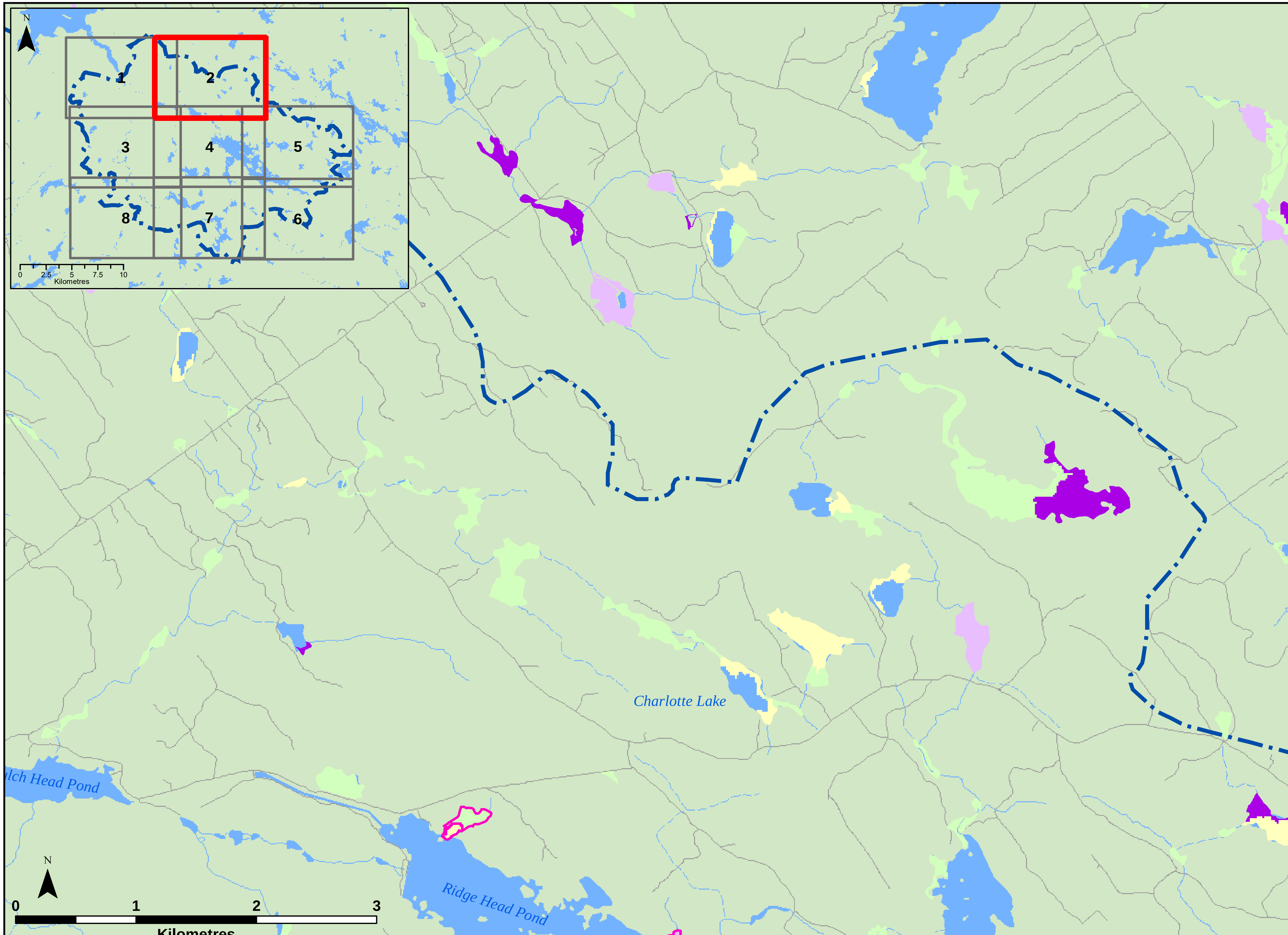

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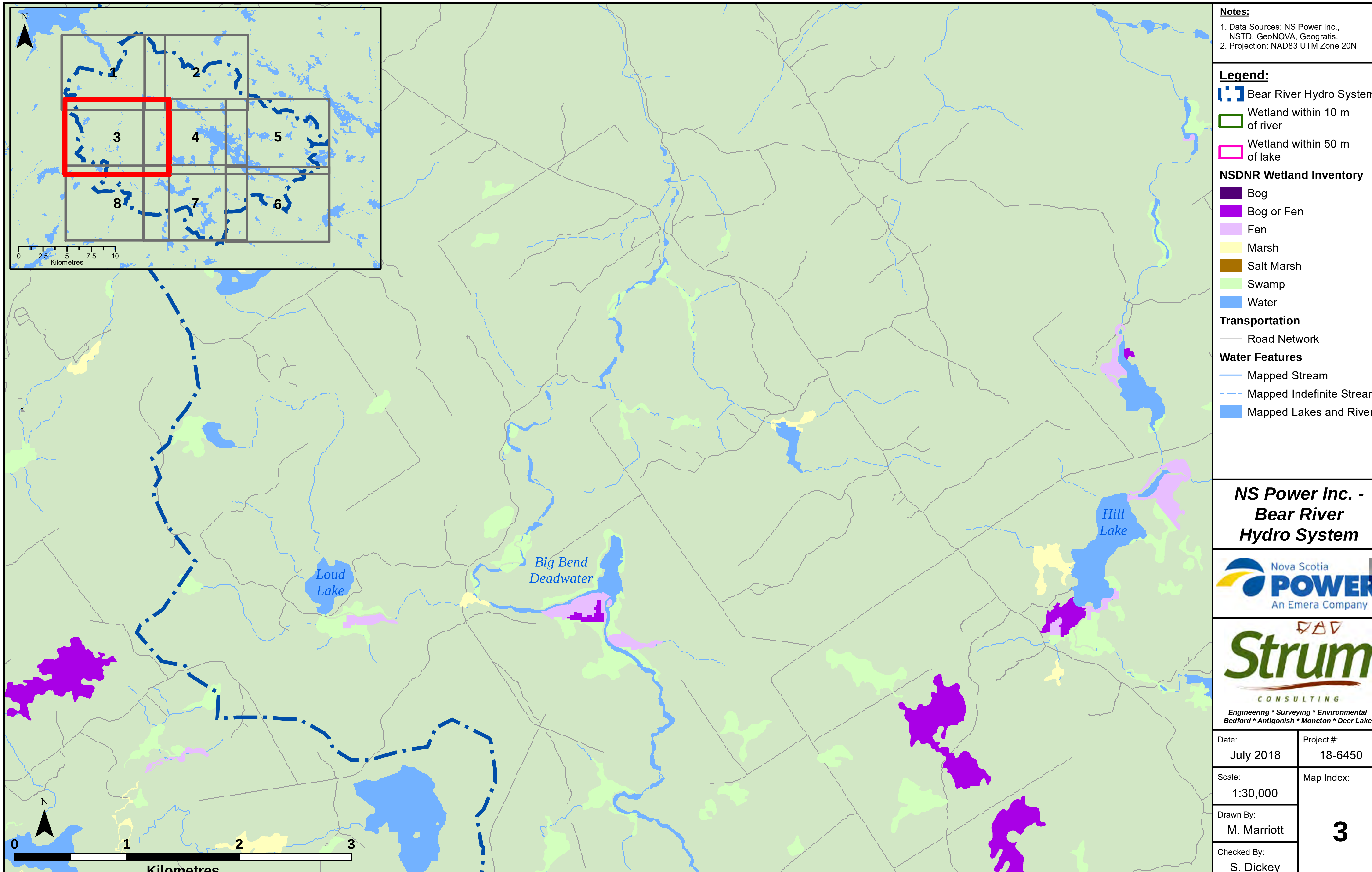

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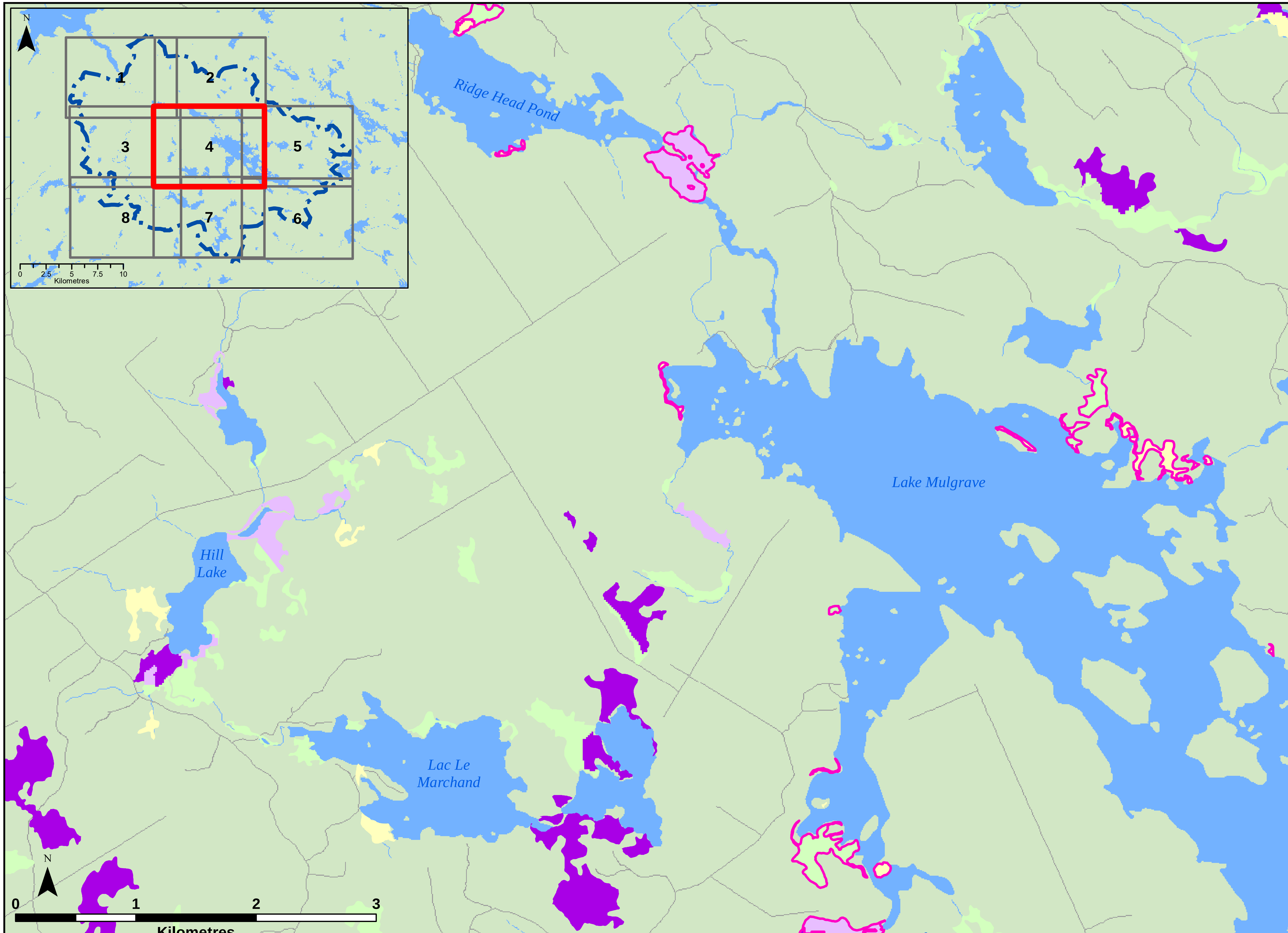

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Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

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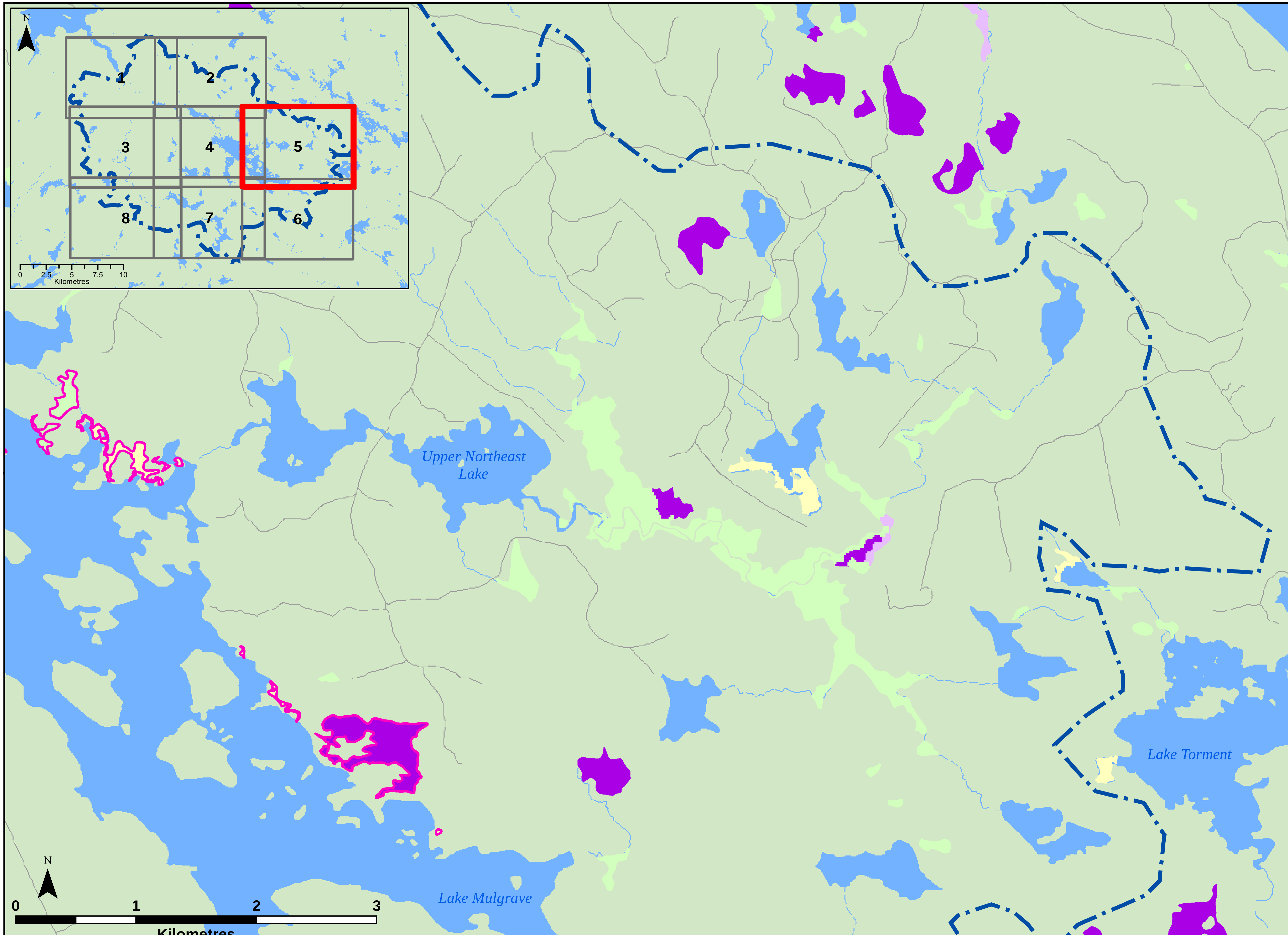

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Bear River Hydro System
- Wetland within 10 m of river
- Wetland within 50 m of lake

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Bear River Hydro System

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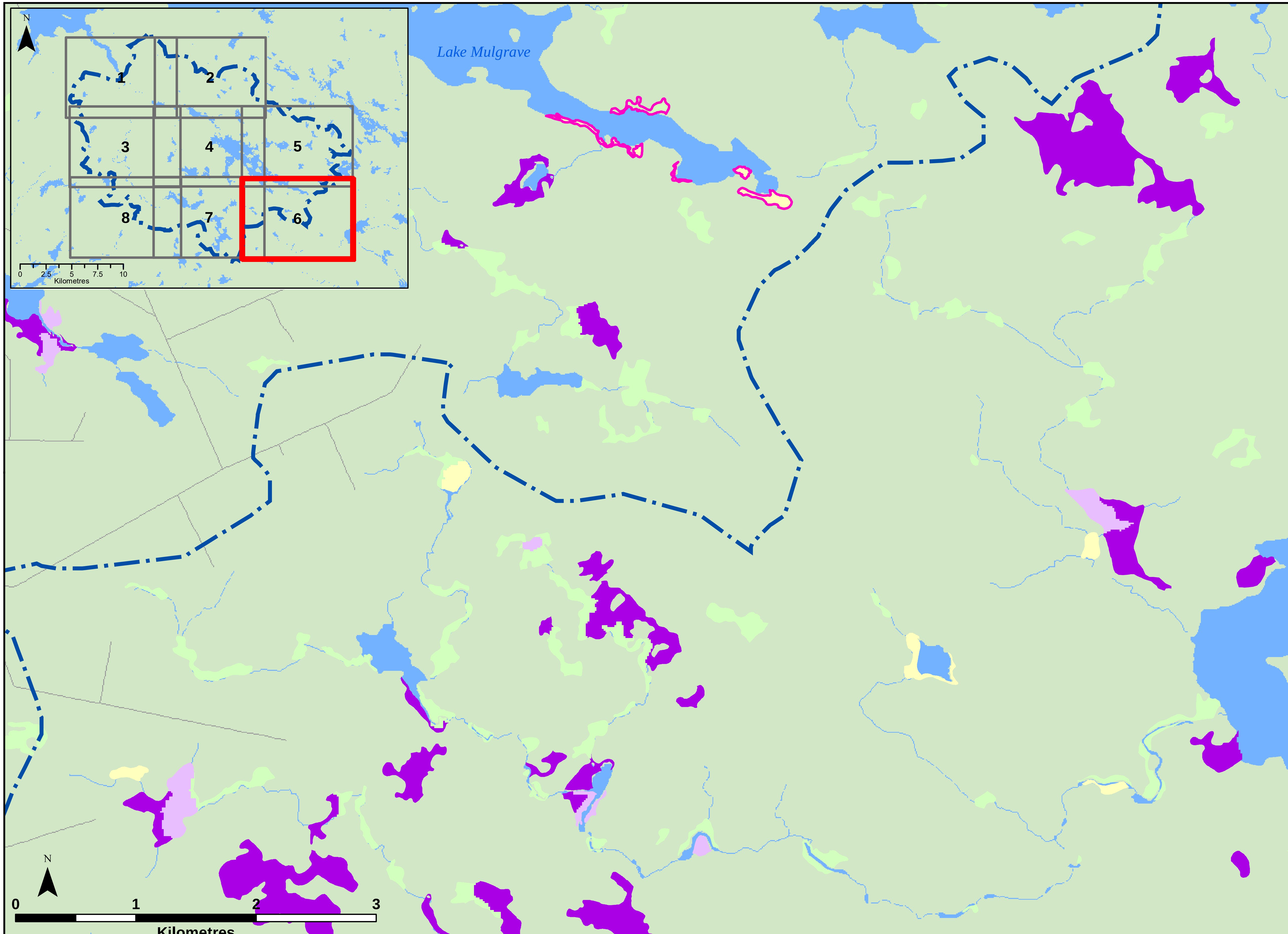
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Bear River Hydro System

Wetland within 10 m of river

Wetland within 50 m of lake

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Bear River Hydro System

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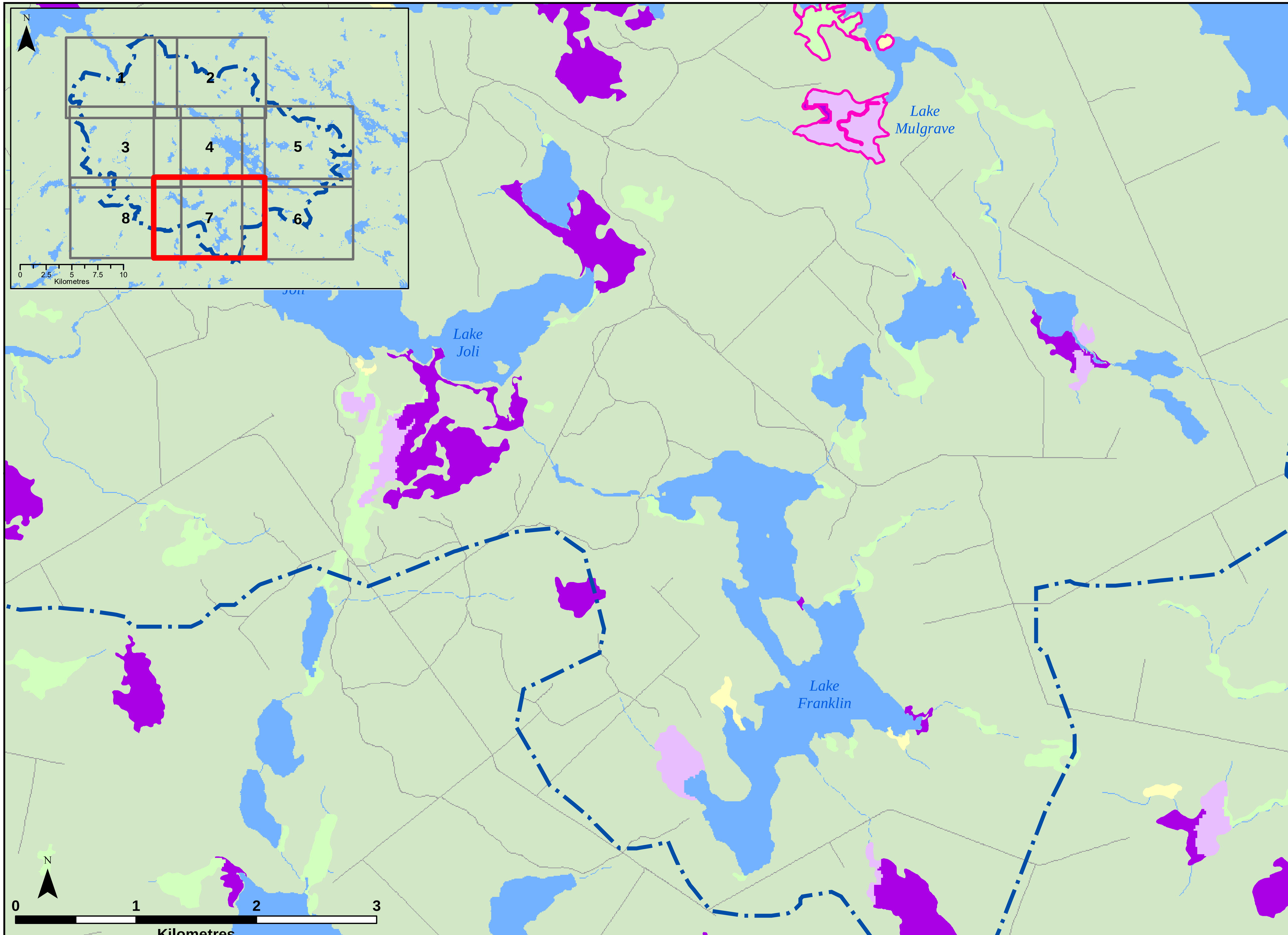
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Bear River Hydro System
- Wetland within 10 m of river
- Wetland within 50 m of lake

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Bear River Hydro System

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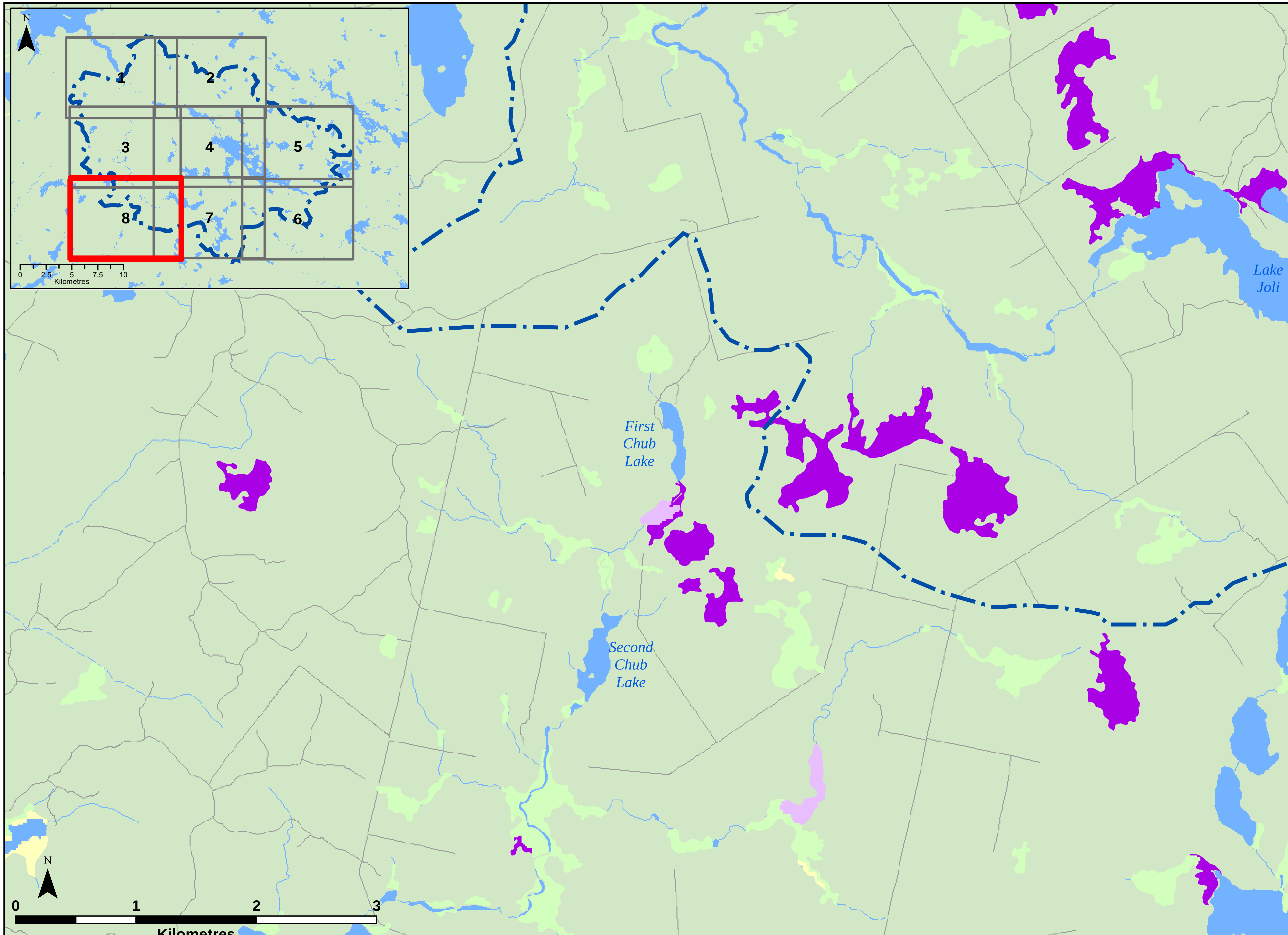
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 7
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Bear River Hydro System
- Wetland within 10 m of river
- Wetland within 50 m of lake

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Bear River Hydro System

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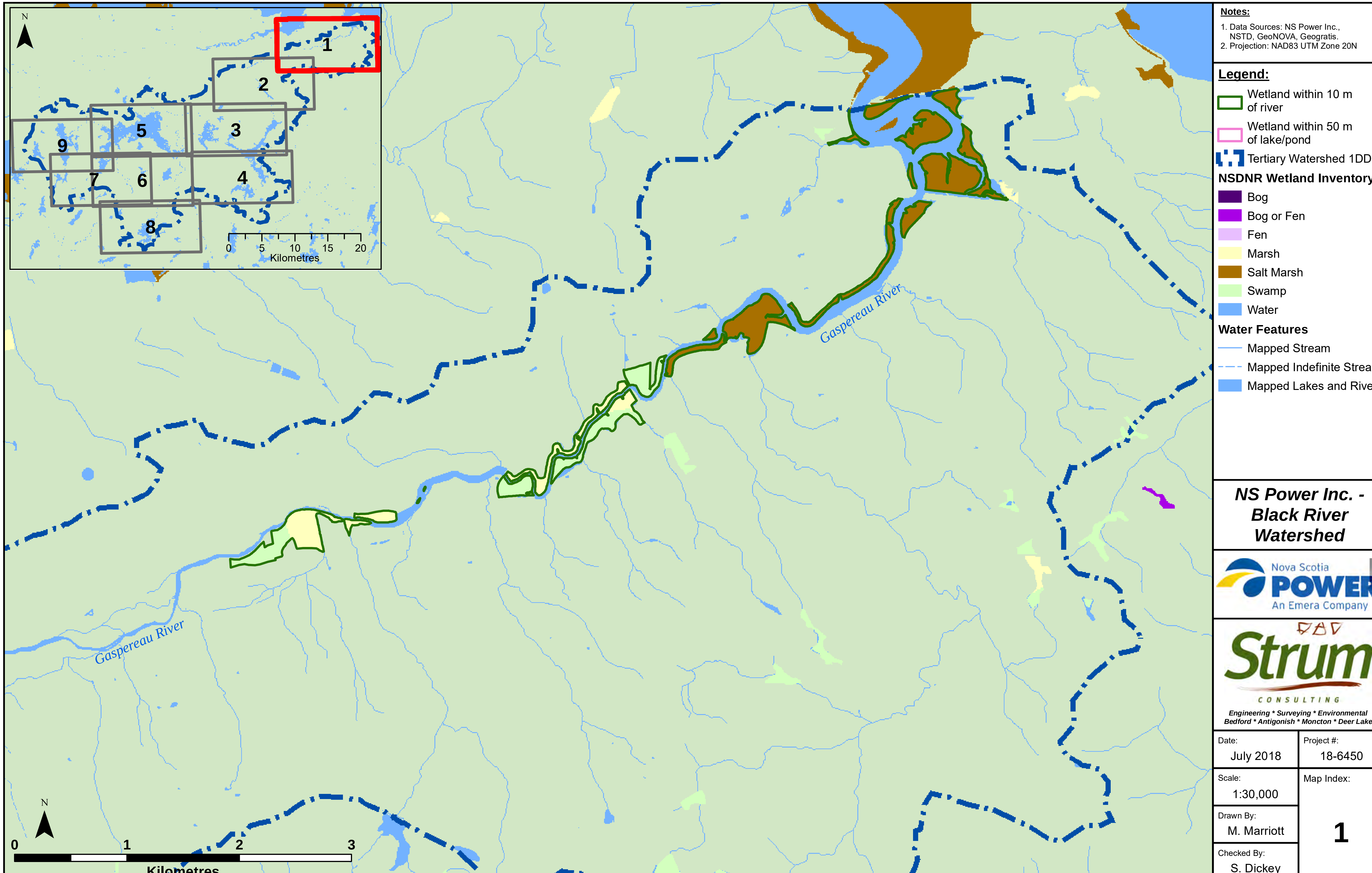
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wetland within 10 m of river
Wetland within 50 m of lake/pond
Tertiary Watershed 1DD
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Black River Watershed
Nova Scotia POWER An Emera Company
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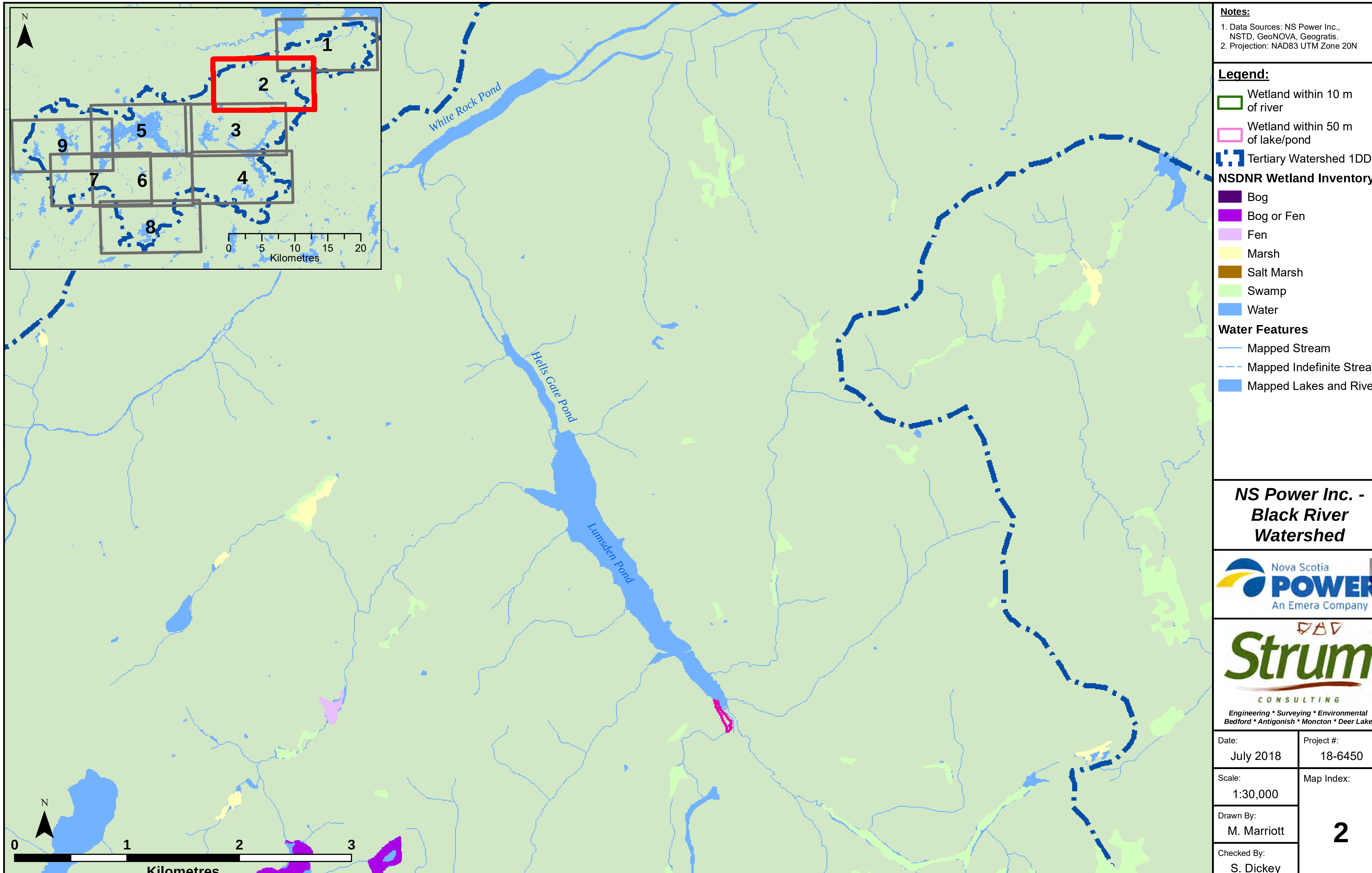
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 1
Drawn By: M. Marriott
Checked By: S. Dickey
Gaspereau River
Gaspereau River
N
0 1 2 3
Kilometres
N
1 2 3 4 5 6 7 8 9
0 5 10 15 20
Kilometres


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wetland within 10 m of river
Wetland within 50 m of lake/pond
Tertiary Watershed 1DD
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Black River Watershed
Nova Scotia POWER
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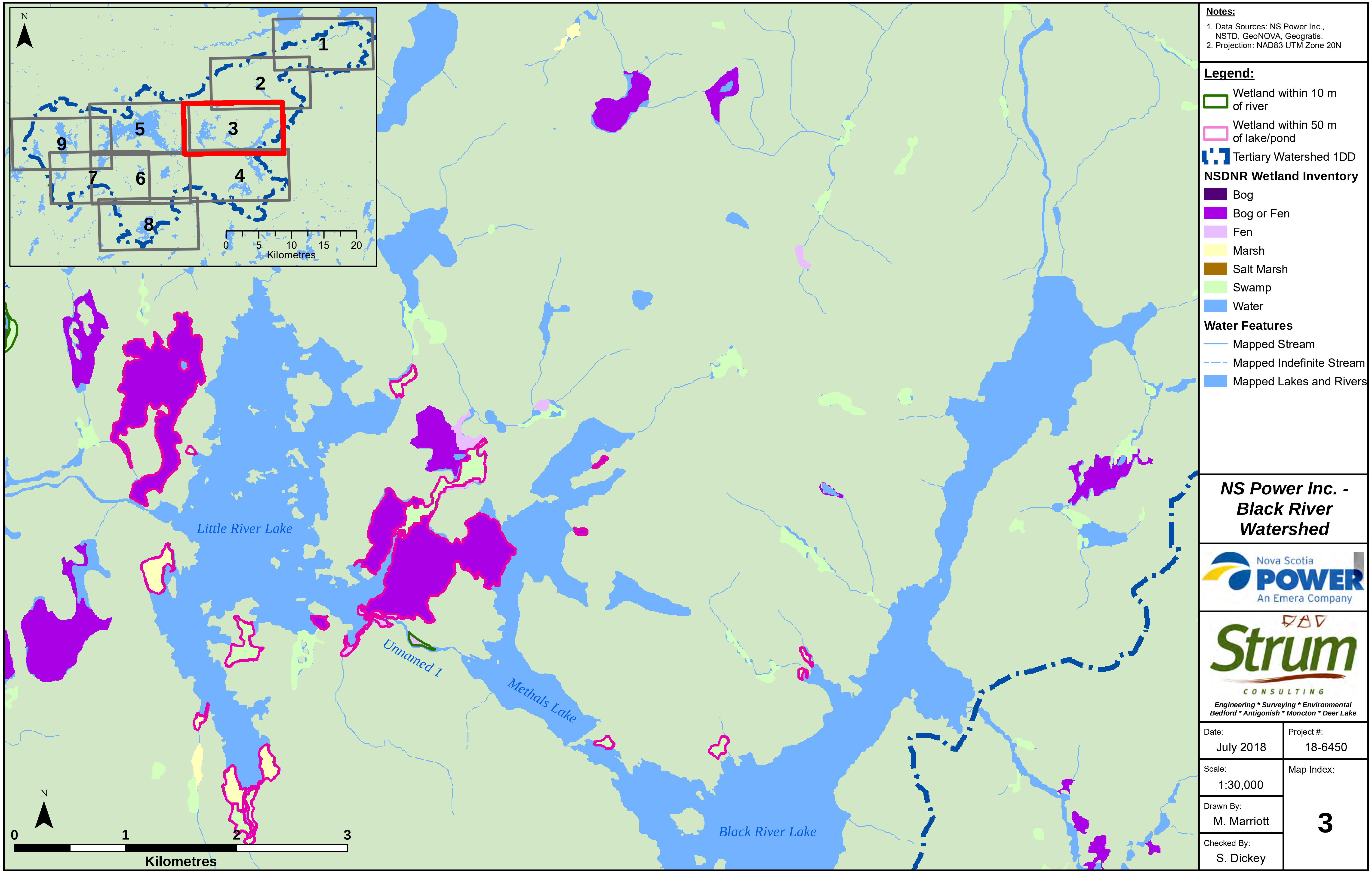
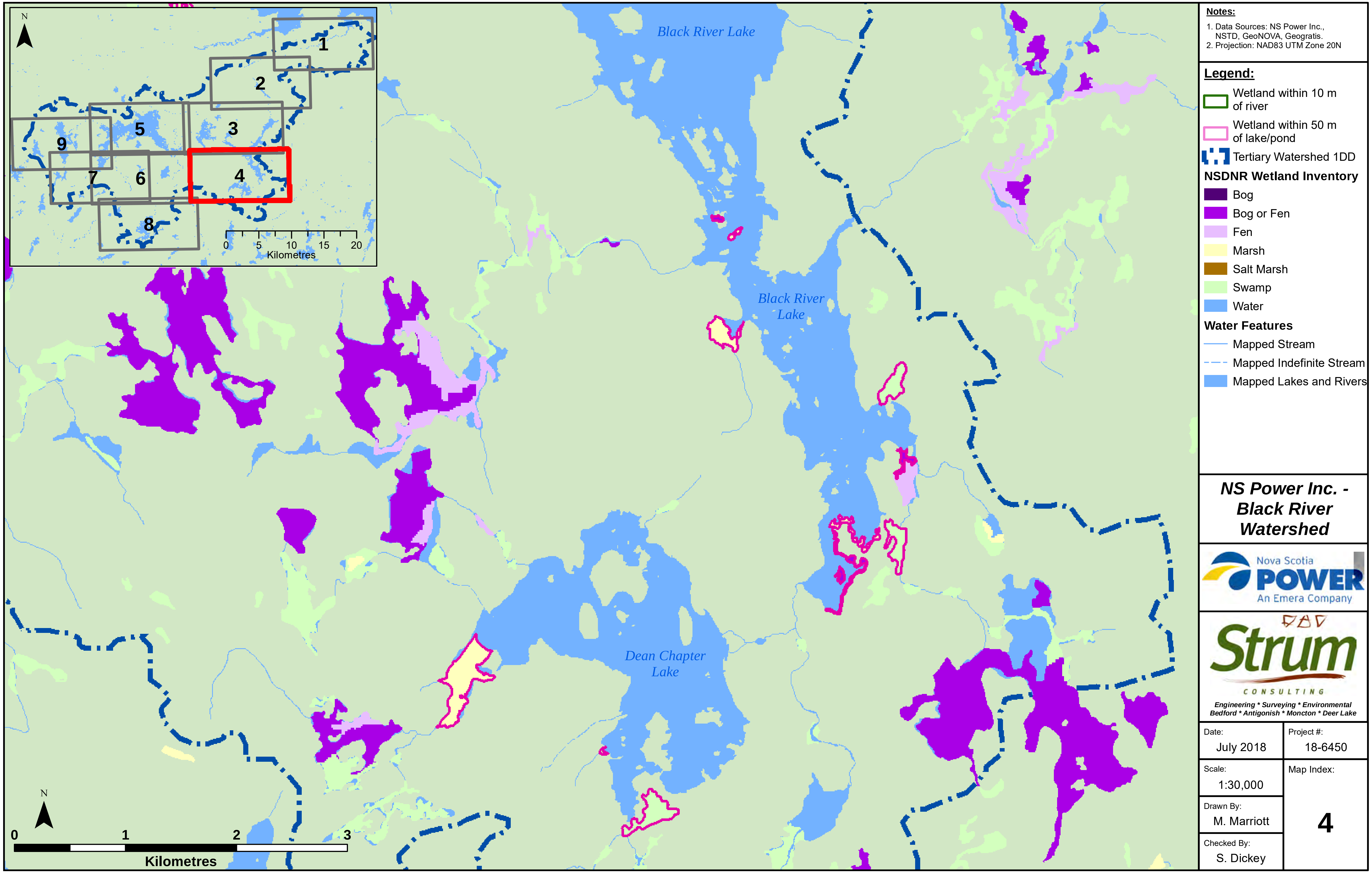
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date:
July 2018
Project #:
18-6450
Scale:
1:30,000
Map Index:
2
Drawn By:
M. Marriott
Checked By:
S. Dickey
White Rock Pond
Hells Gate Pond
Lumsden Pond
N
0
1
2
3
Kilometres
1
2
3
4
5
6
7
8
9
0
5
10
15
20
Kilometres

REDACTED (CONFIDENTIAL INFORMATION REMOVED)




Black River Lake
Black River Lake
Dean Chapter Lake
1
2
3
4
5
6
7
8
9
0 5 10 15 20
Kilometres
N
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wetland within 10 m of river
Wetland within 50 m of lake/pond
Tertiary Watershed 1DD
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Black River Watershed
Nova Scotia POWER
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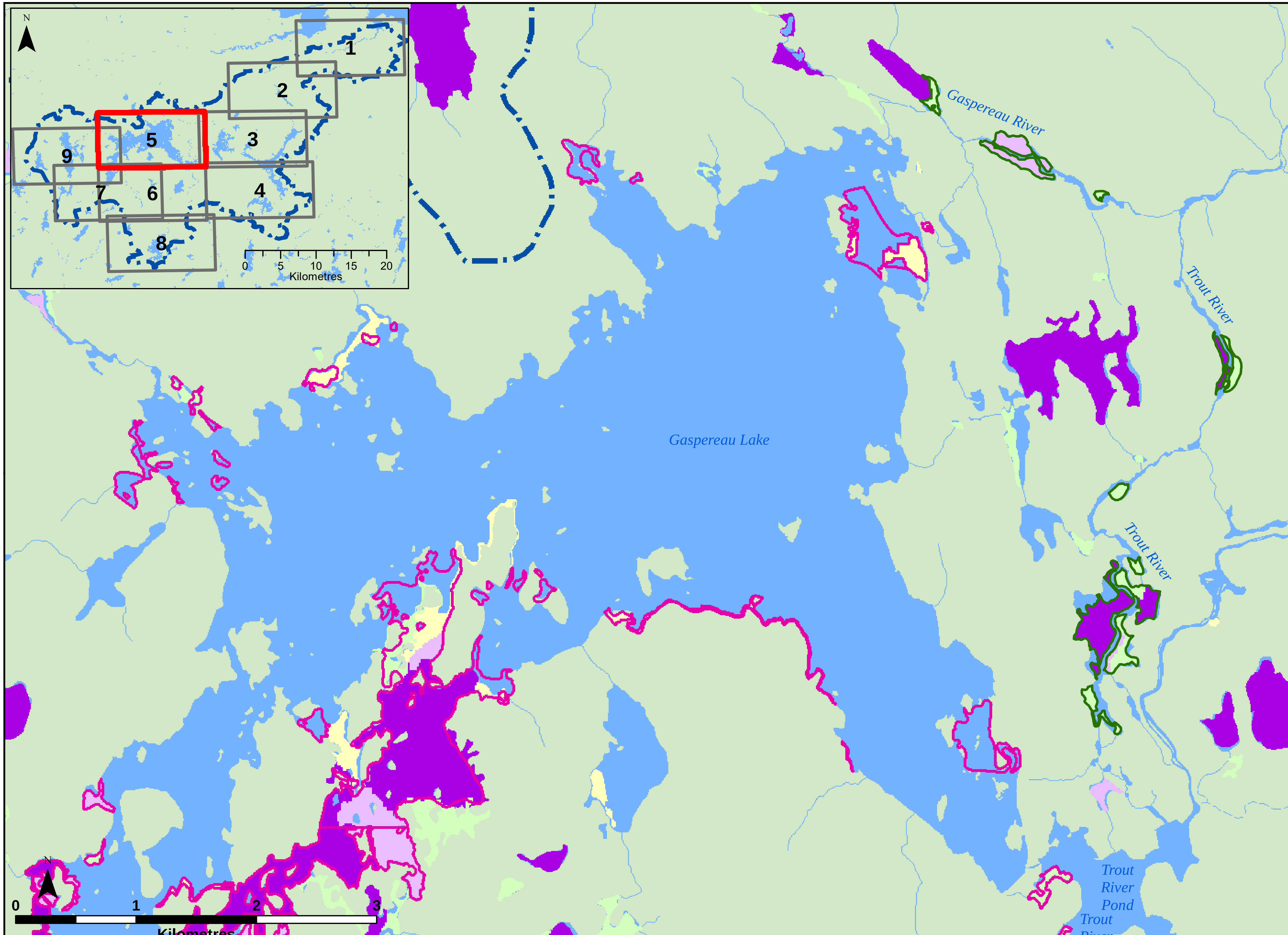
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 4
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Wetland within 10 m of river
- Wetland within 50 m of lake/pond
- Tertiary Watershed 1DD

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Black River Watershed

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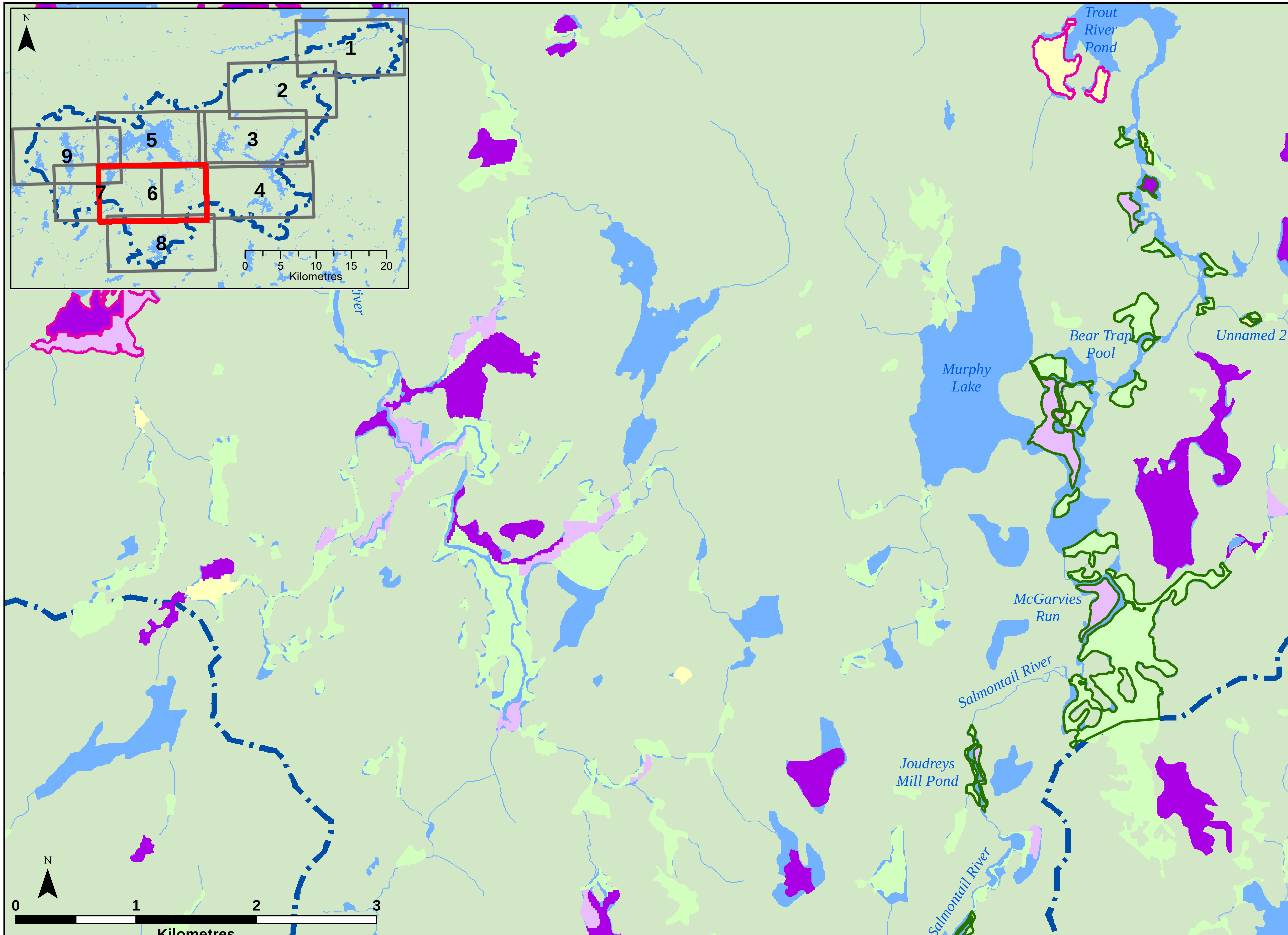
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wetland within 10 m of river
- Wetland within 50 m of lake/pond
- Tertiary Watershed 1DD

NSDNR Wetland Inventory
- Bog
- Bog or Fen
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- Marsh
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- Swamp
- Water

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Black River Watershed

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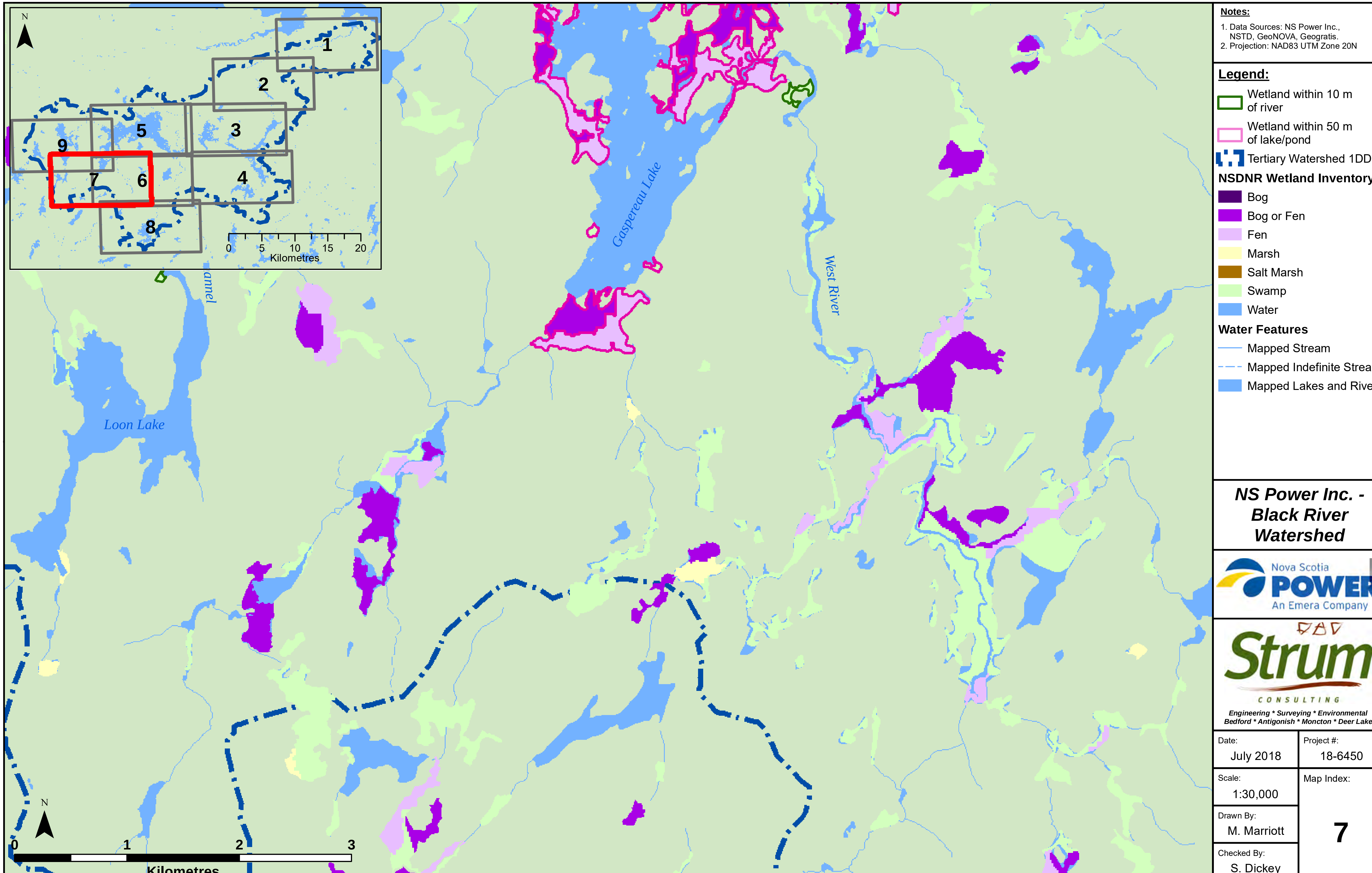
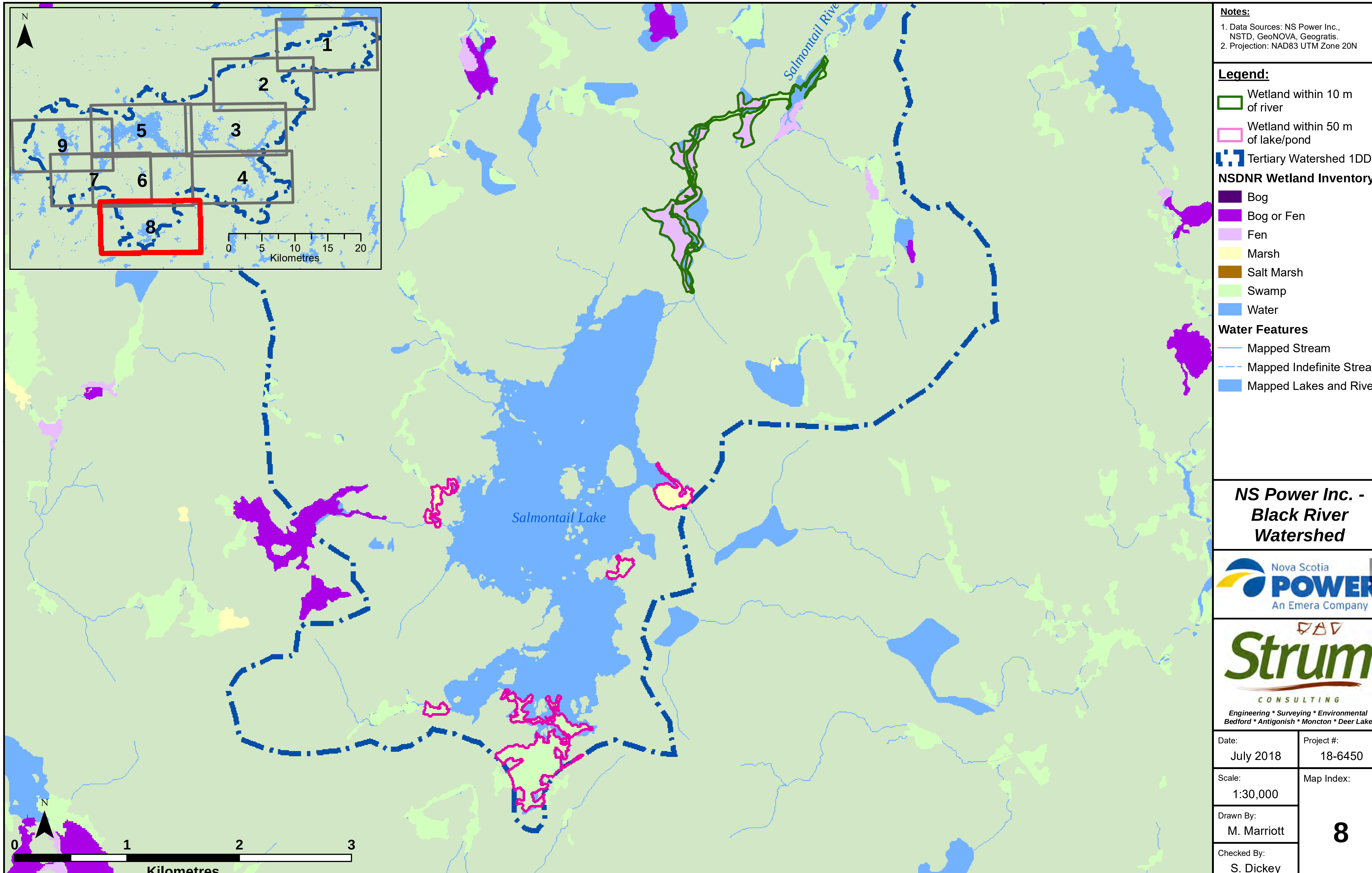
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)




Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wetland within 10 m of river
Wetland within 50 m of lake/pond
Tertiary Watershed 1DD
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Black River Watershed
Nova Scotia POWER
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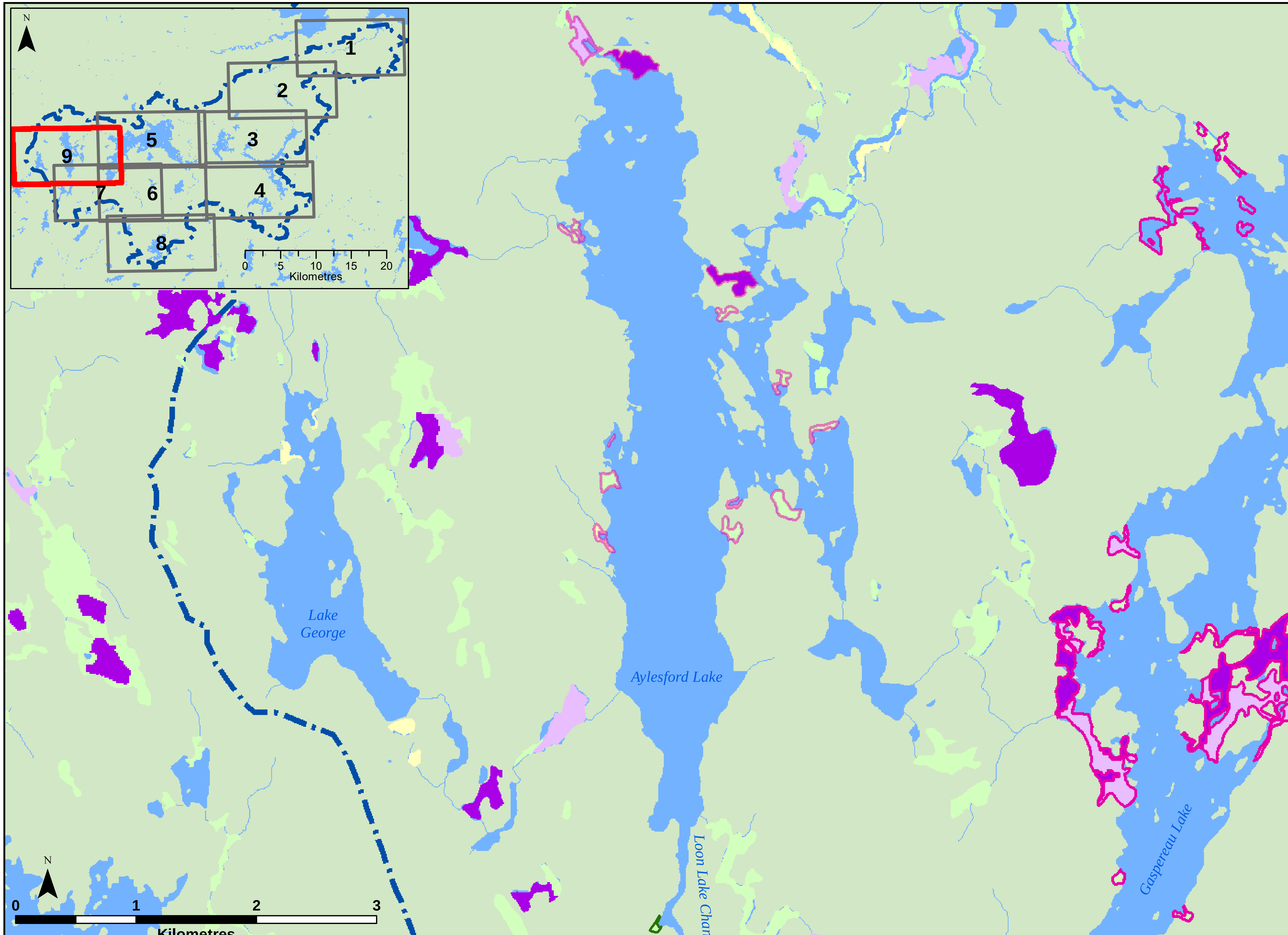
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date:
July 2018
Project #:
18-6450
Scale:
1:30,000
Map Index:
8
Drawn By:
M. Marriott
Checked By:
S. Dickey
Salmontail Lake
Salmontail Rive
N
0
1
2
3
Kilometres
1
2
3
4
5
6
7
8
9
0
5
10
15
20
Kilometres

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wetland within 10 m of river
- Wetland within 50 m of lake/pond
- Tertiary Watershed 1DD

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Black River Watershed

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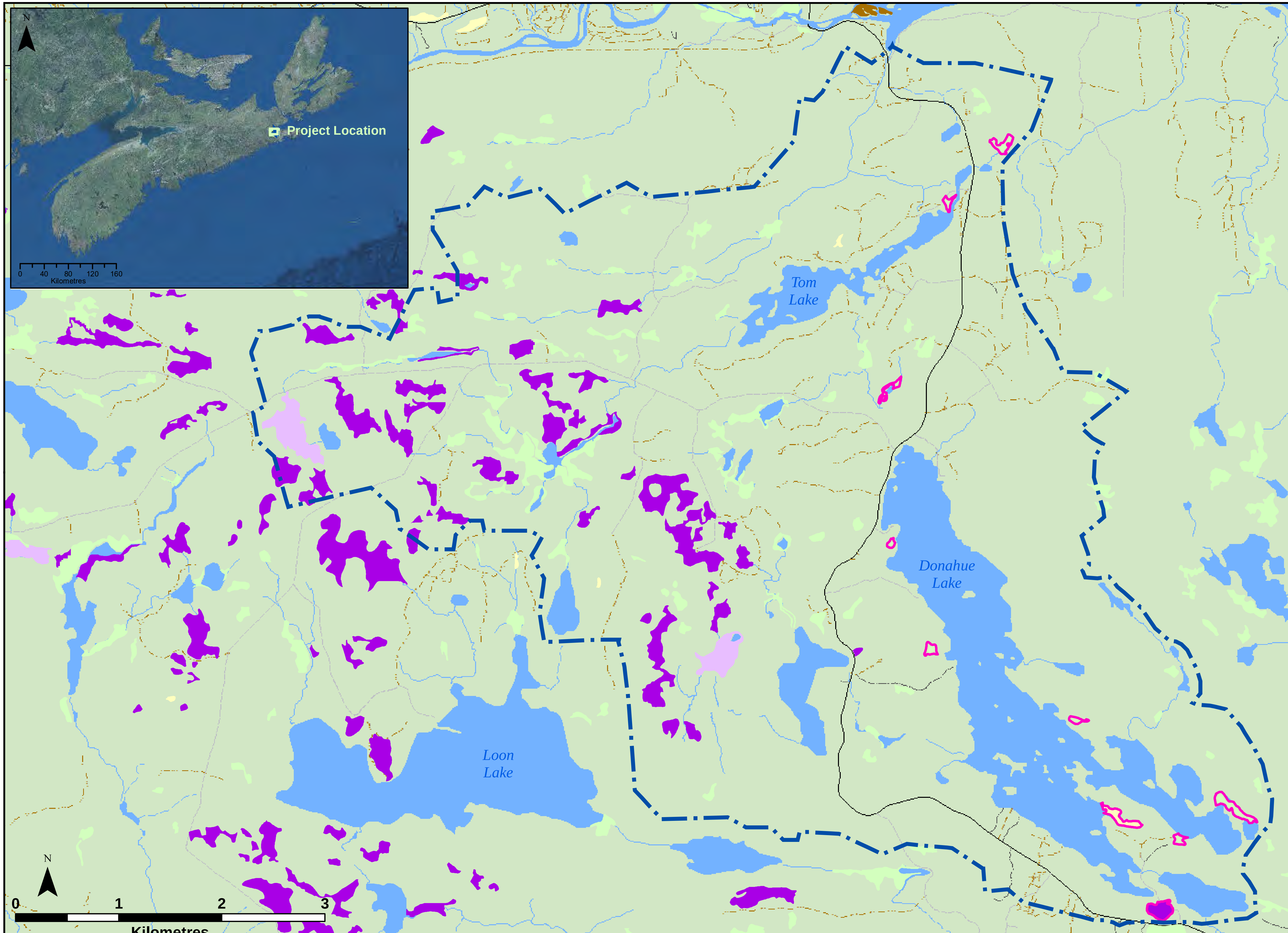
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Inset Basemap: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. Projection: NAD83 UTM Zone 20N

Legend:

- Dickie Brook Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Dickie Brook Hydro System

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*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:35,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	

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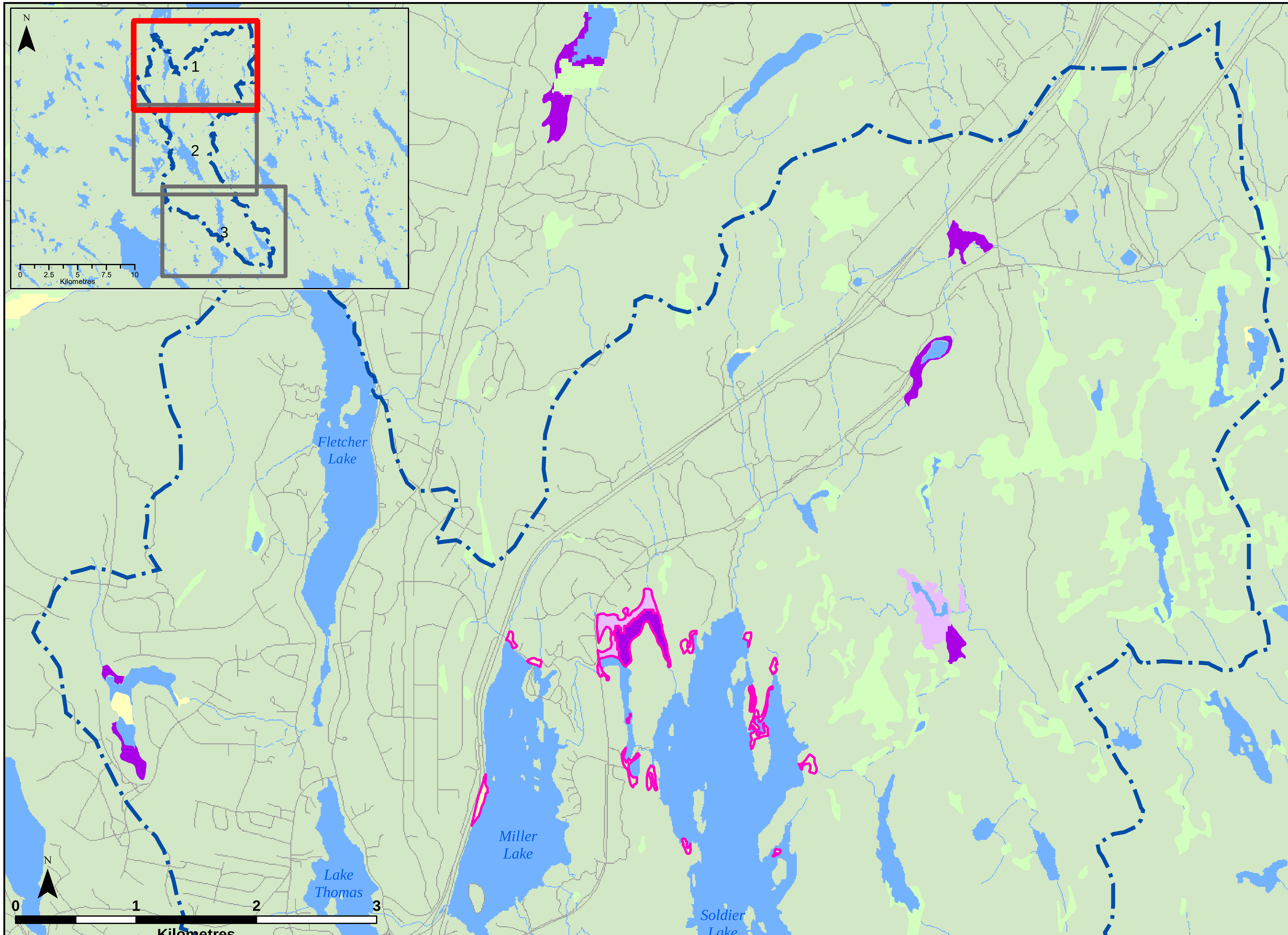

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Fall River Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Fall River Hydro System

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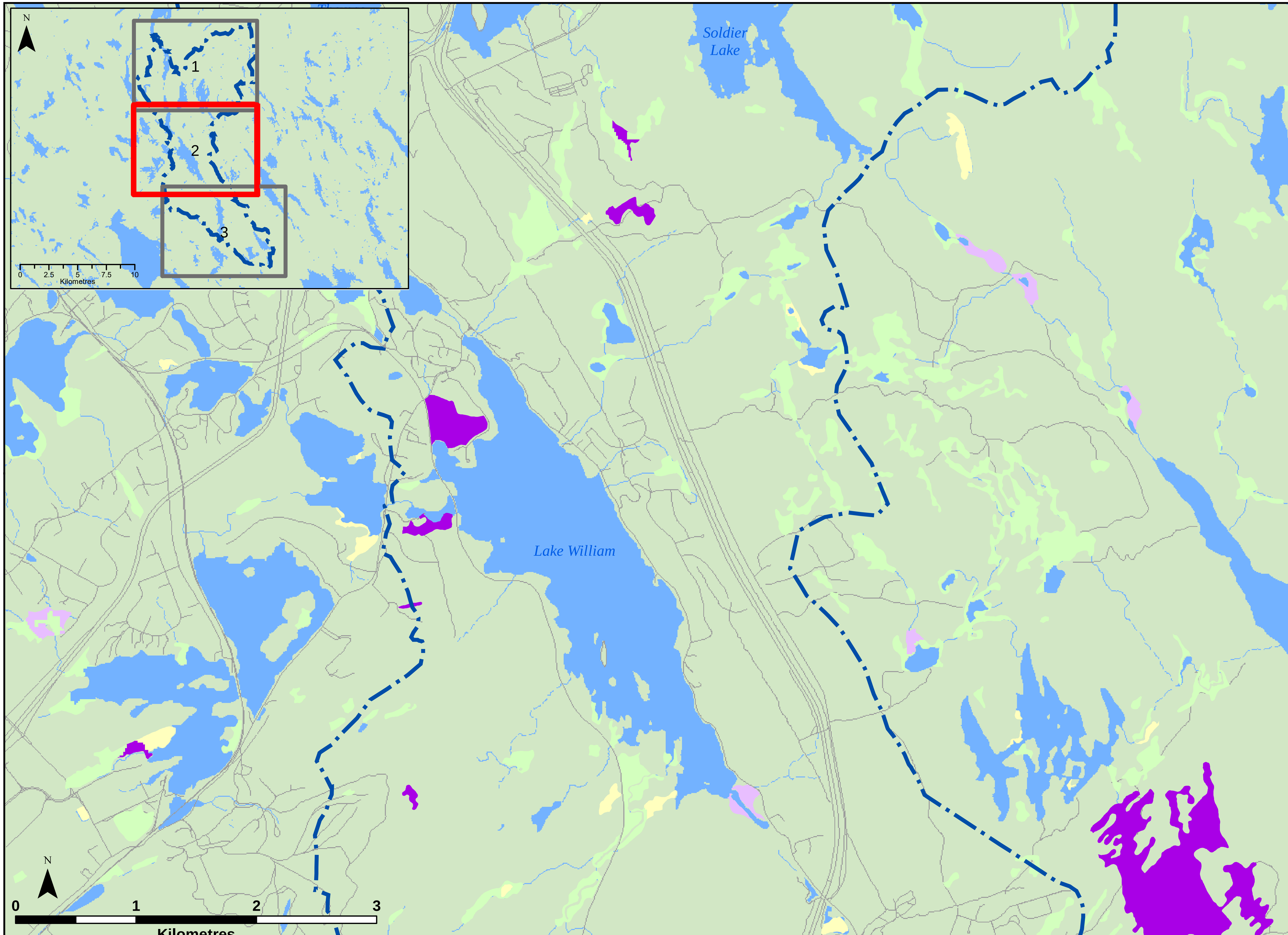
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Fall River Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Fall River Hydro System

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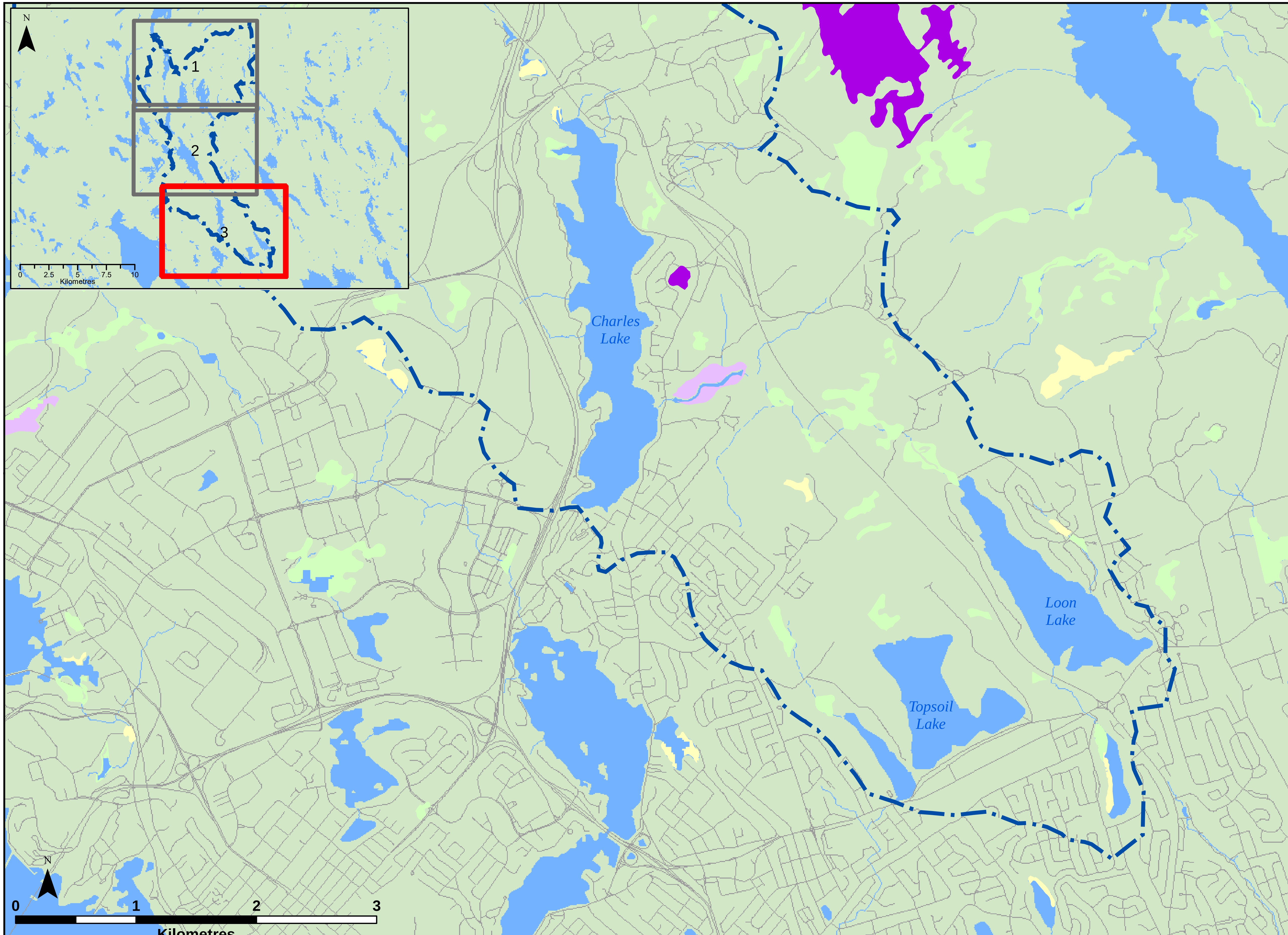
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Fall River Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Fall River Hydro System

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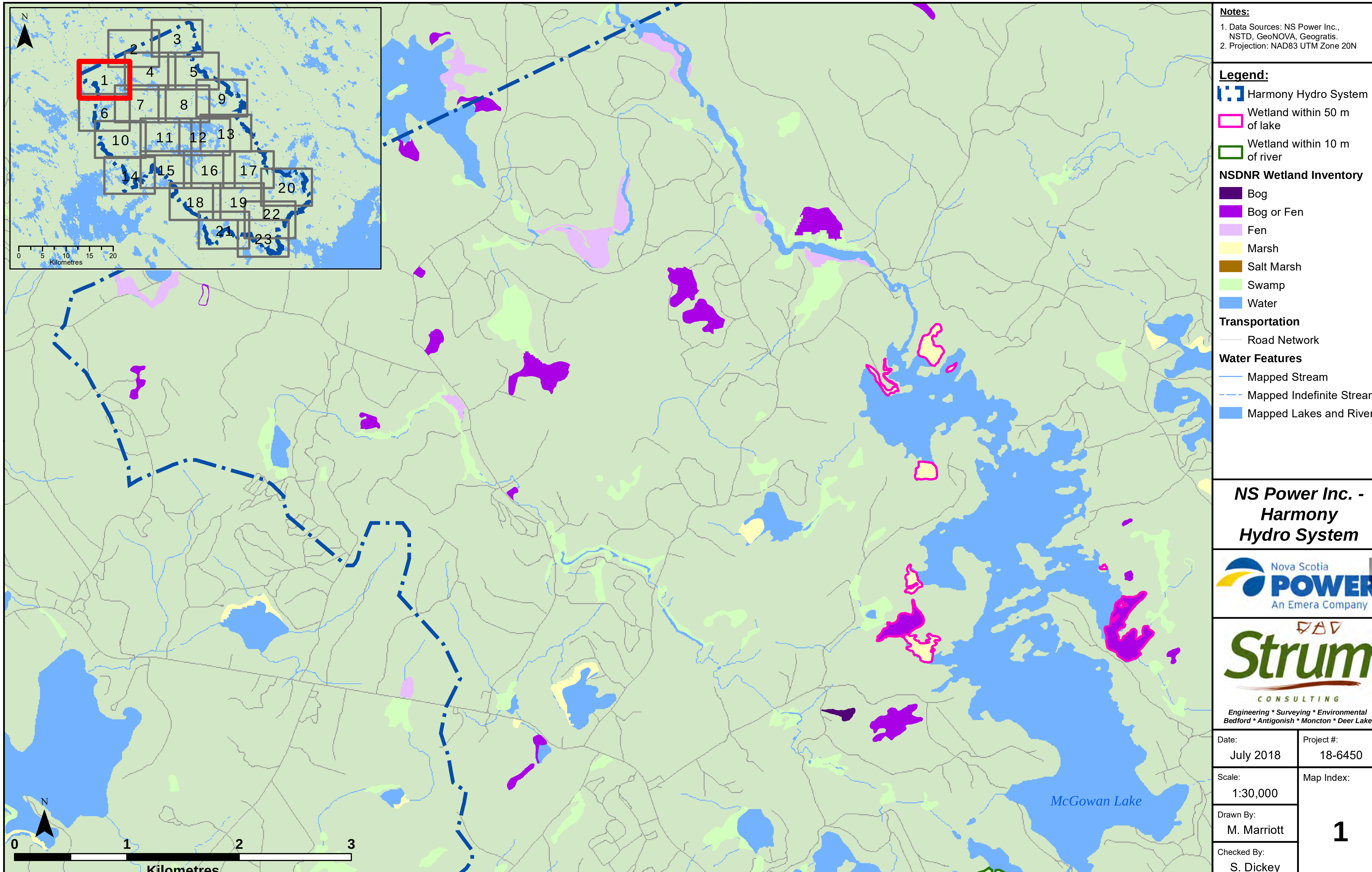
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Harmony Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Harmony Hydro System
Nova Scotia POWER An Emera Company
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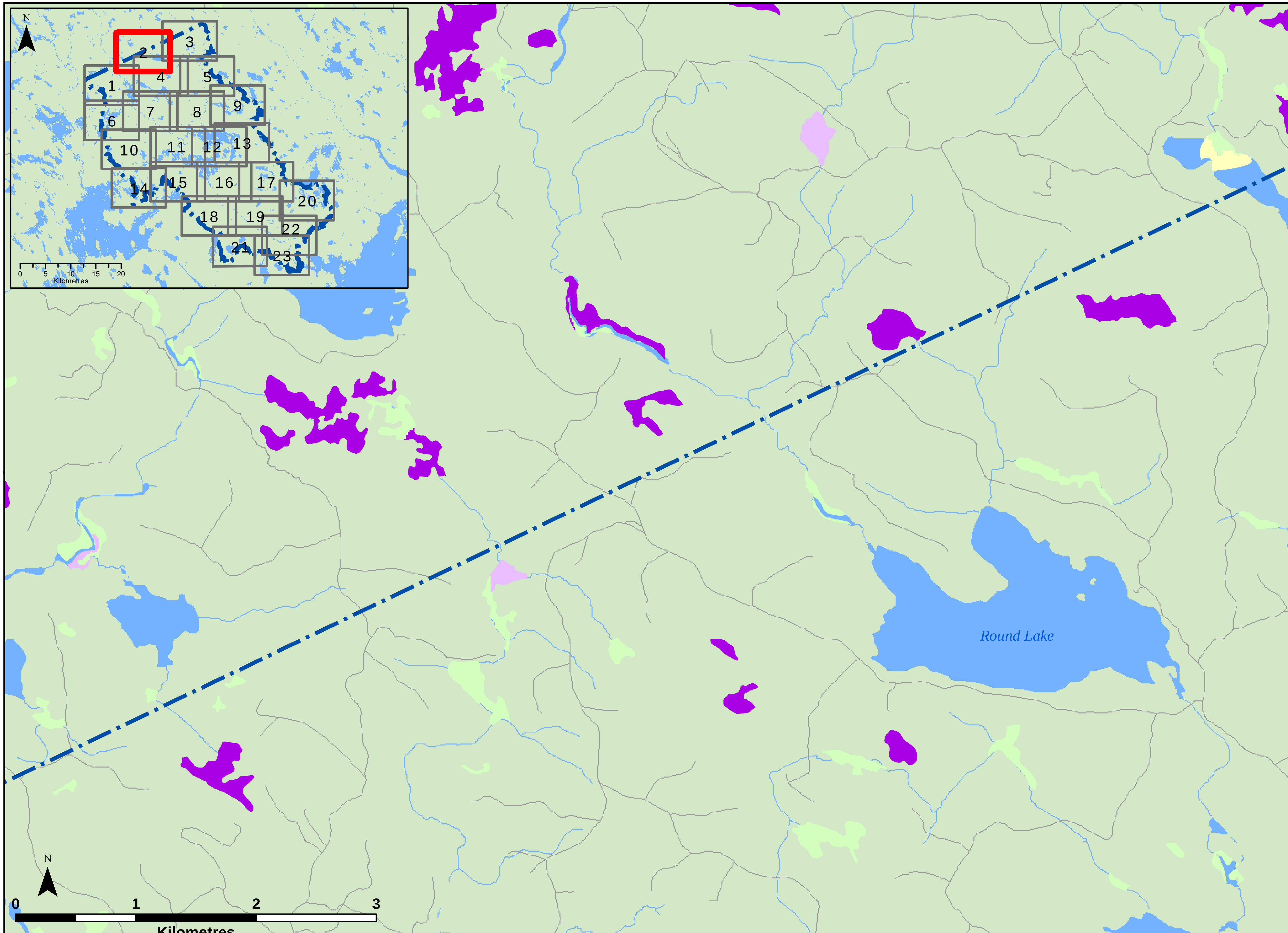
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 1
Drawn By: M. Marriott
Checked By: S. Dickey
McGowan Lake
0 1 2 3
Kilometres
N



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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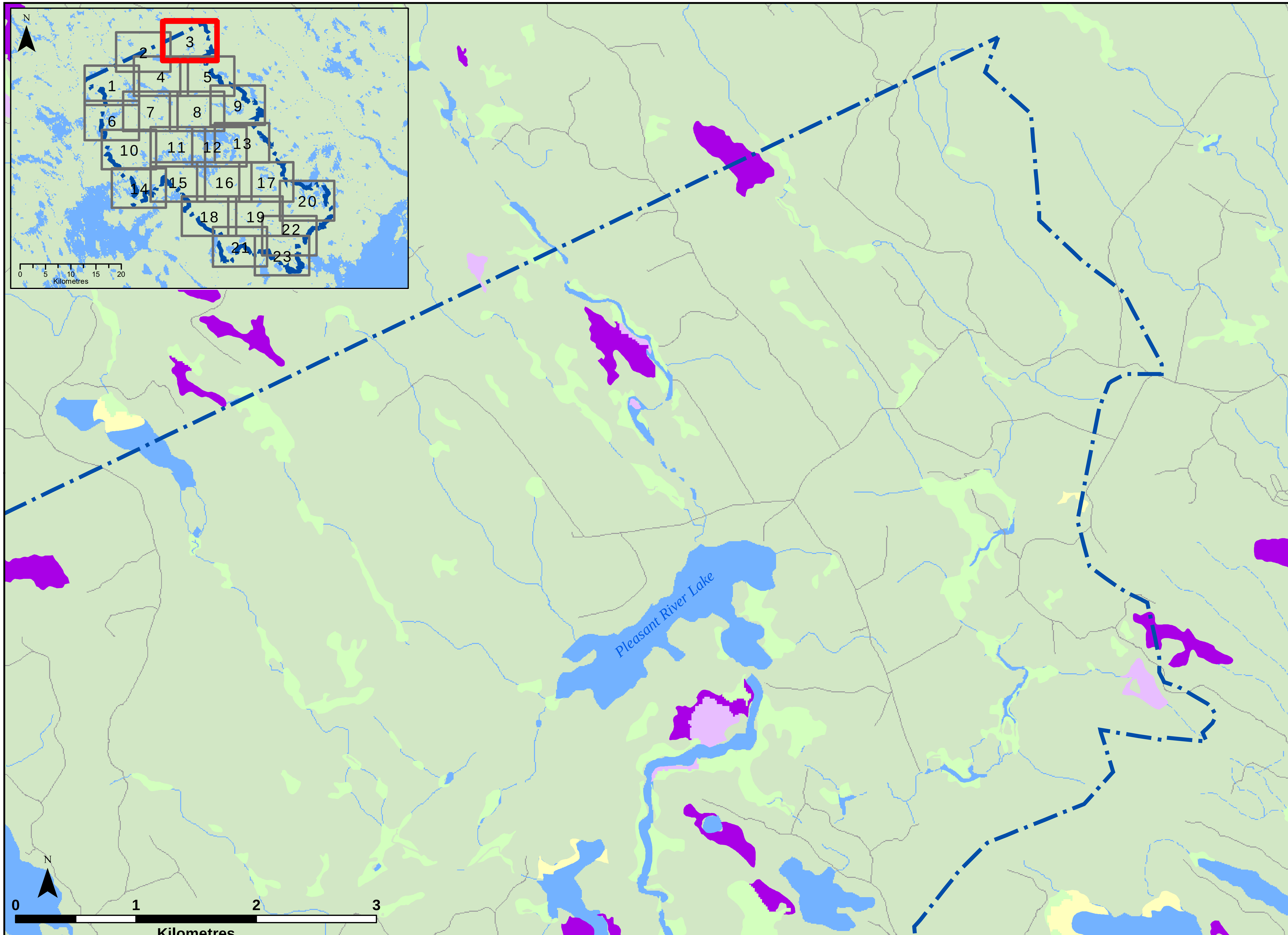
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
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Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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Strum CONSULTING
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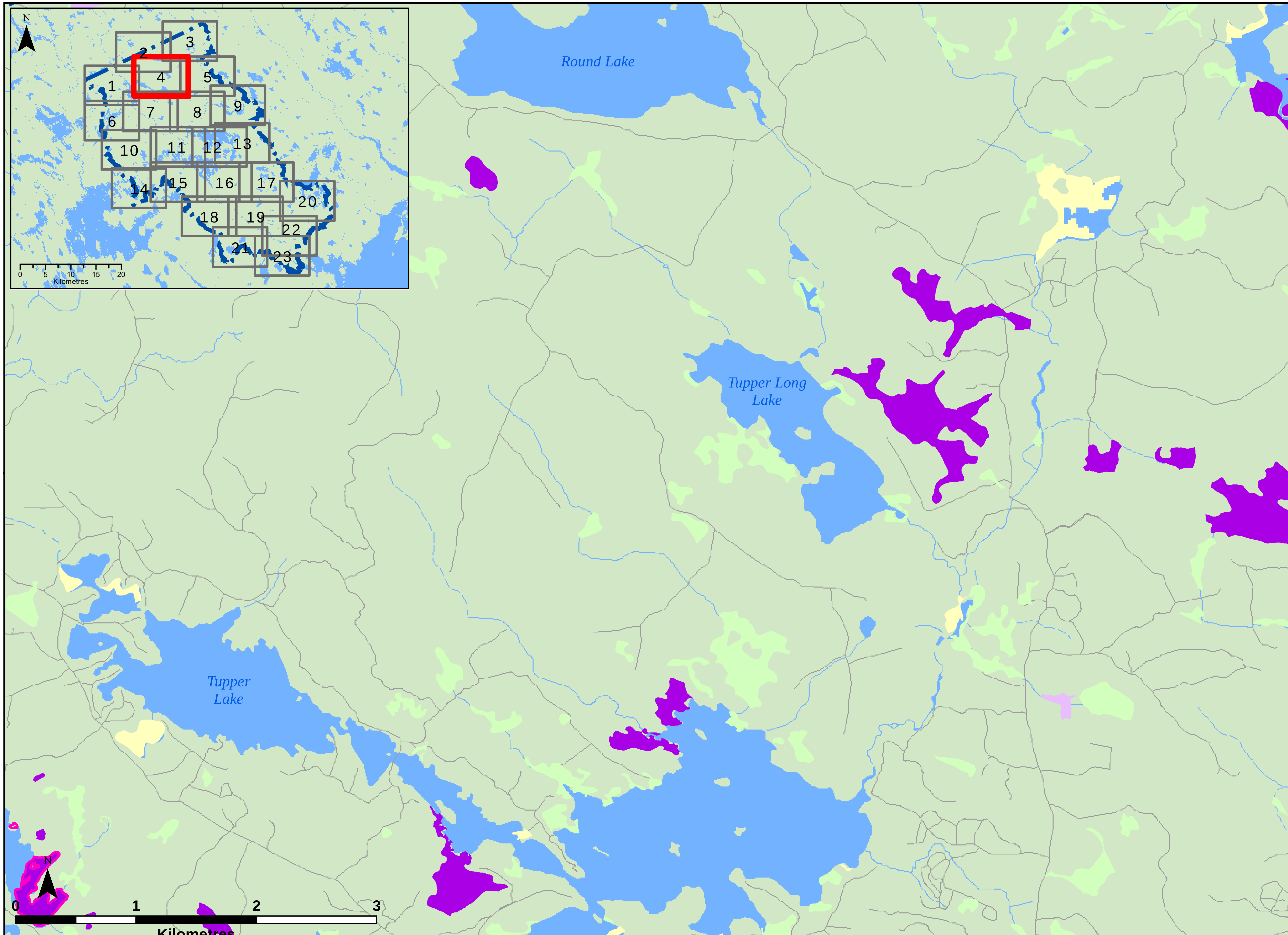
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
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Transportation

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- Mapped Stream
- Mapped Indefinite Stream
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NS Power Inc. - Harmony Hydro System

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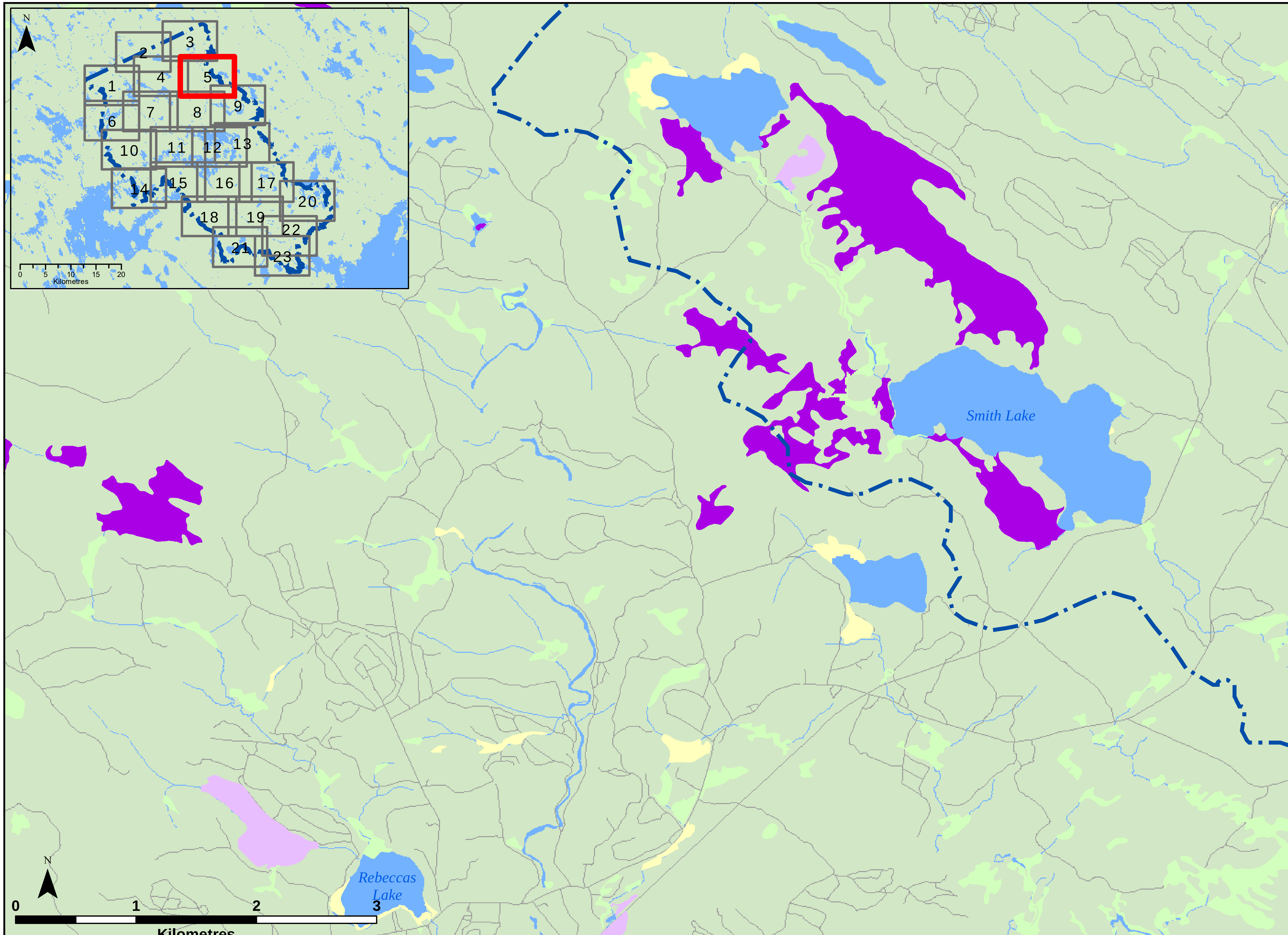
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
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NSDNR Wetland Inventory
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- Mapped Stream
- Mapped Indefinite Stream
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NS Power Inc. - Harmony Hydro System

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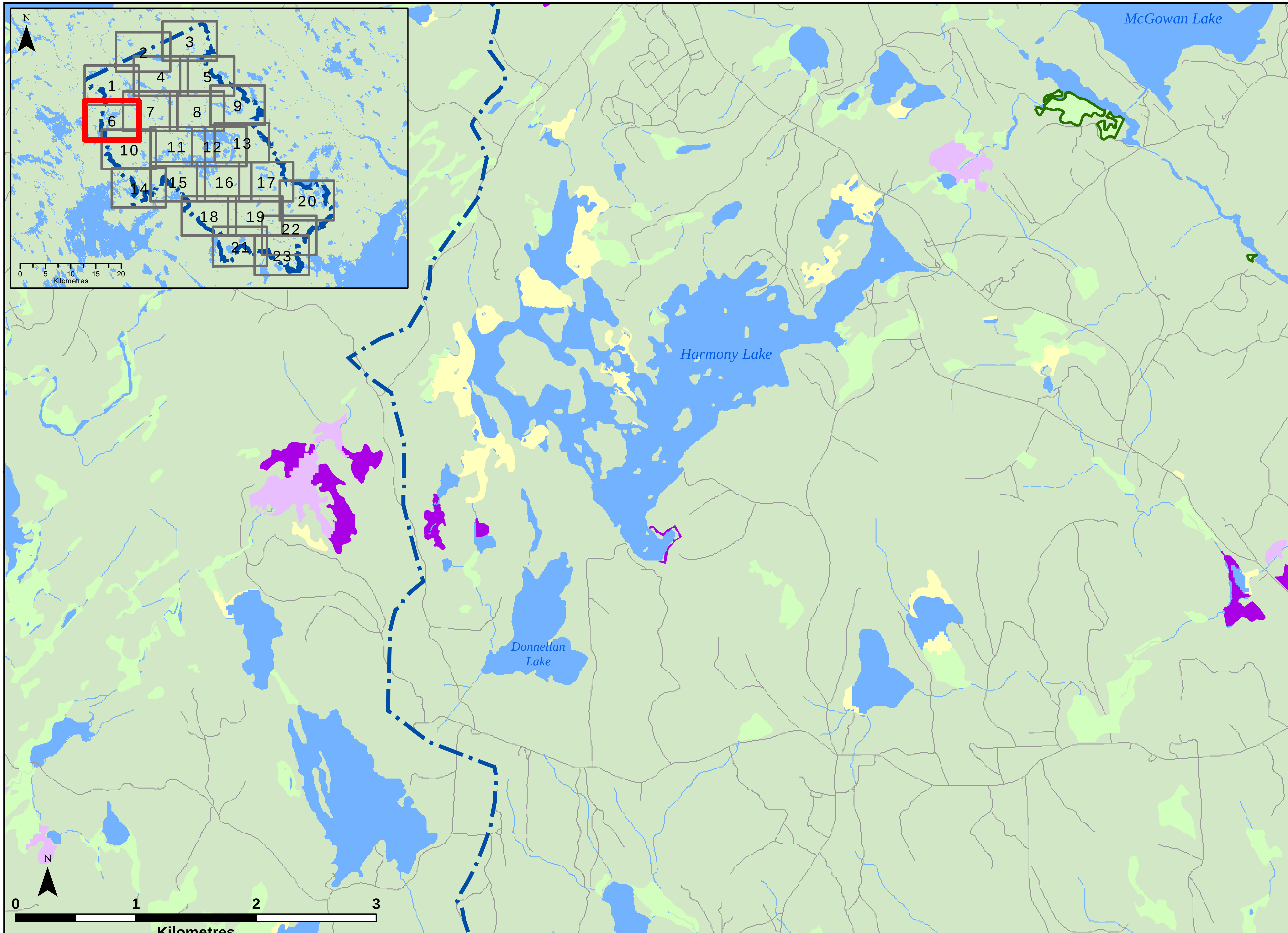
*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
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- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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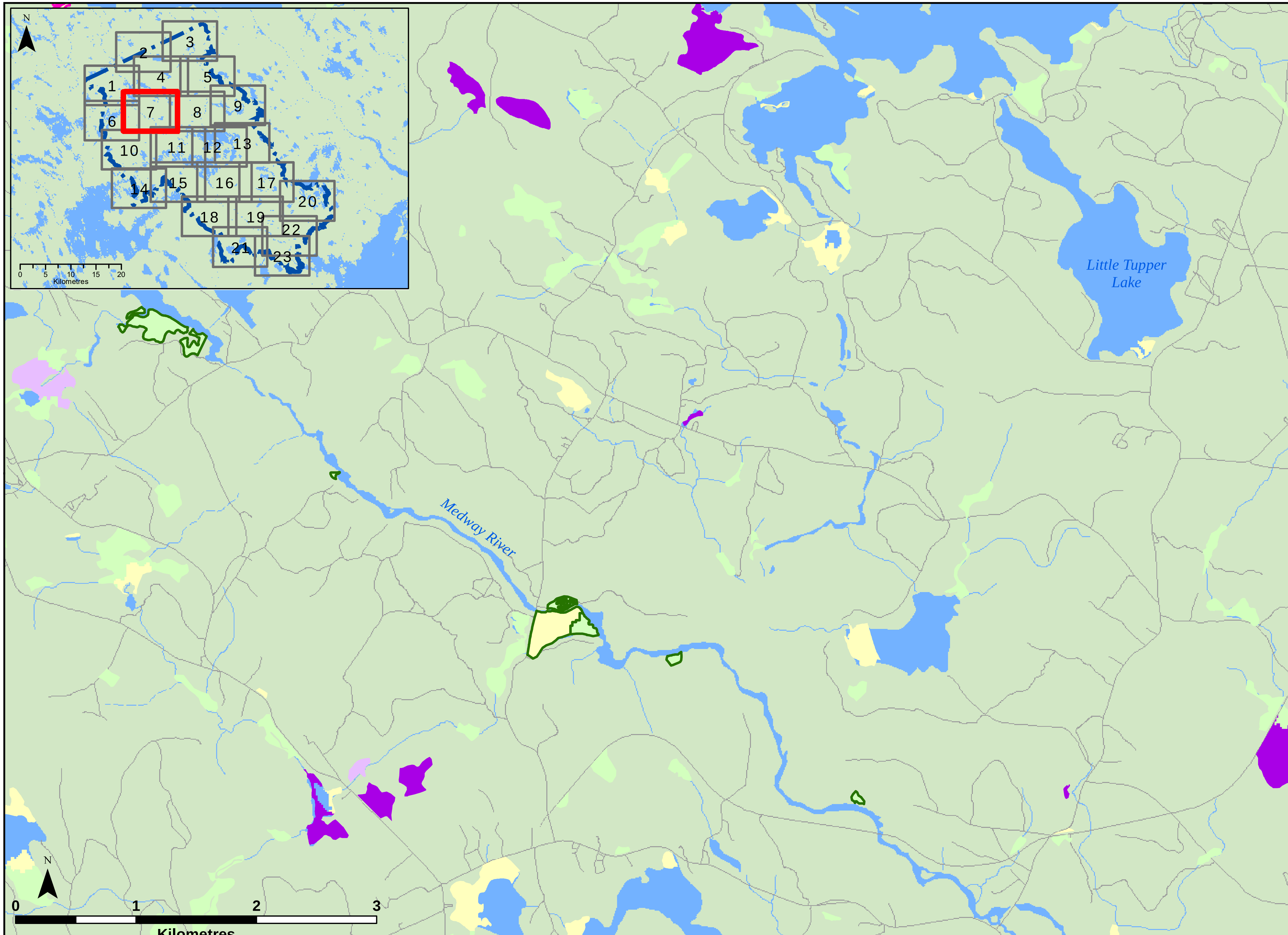
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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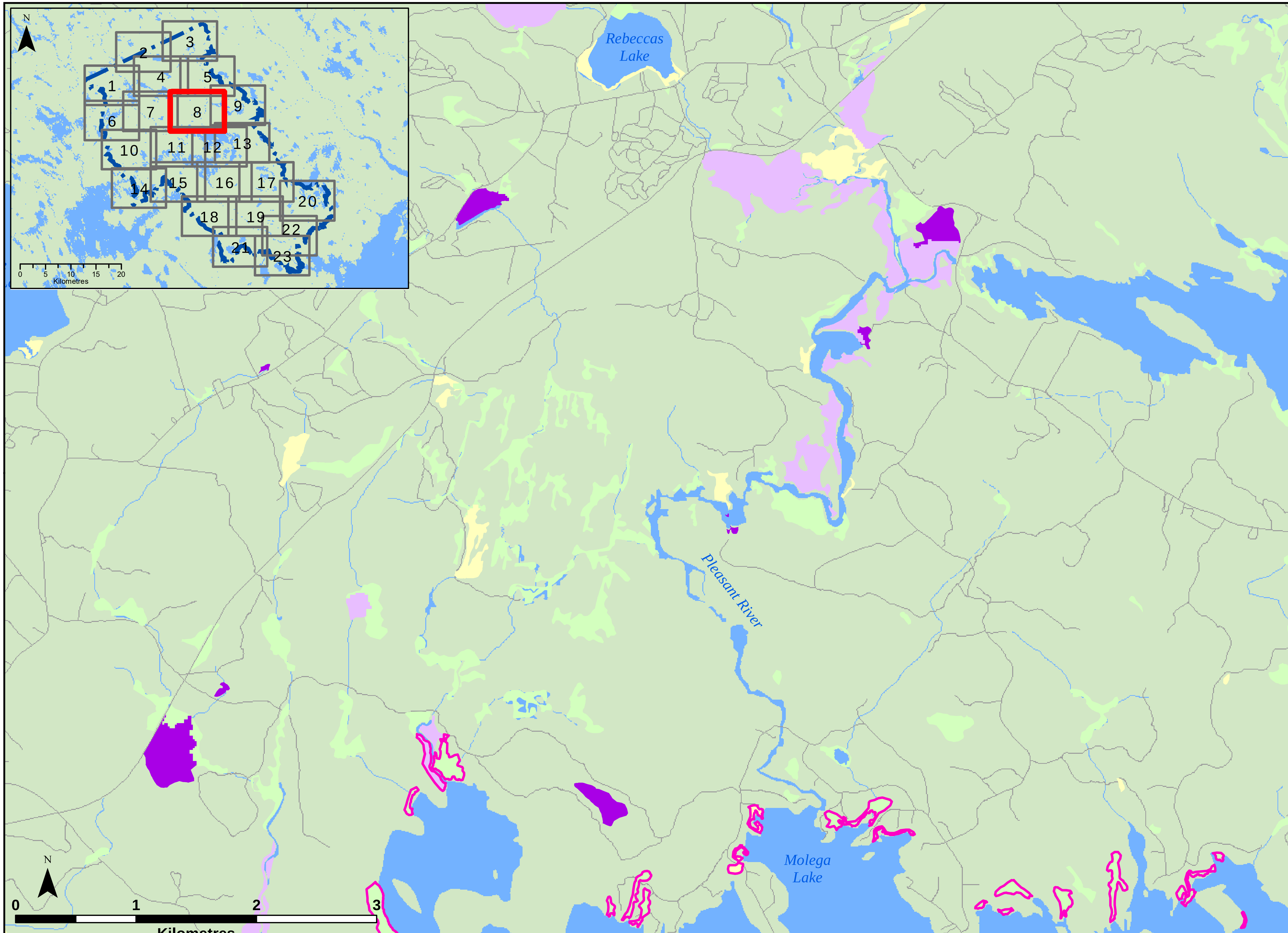
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 7
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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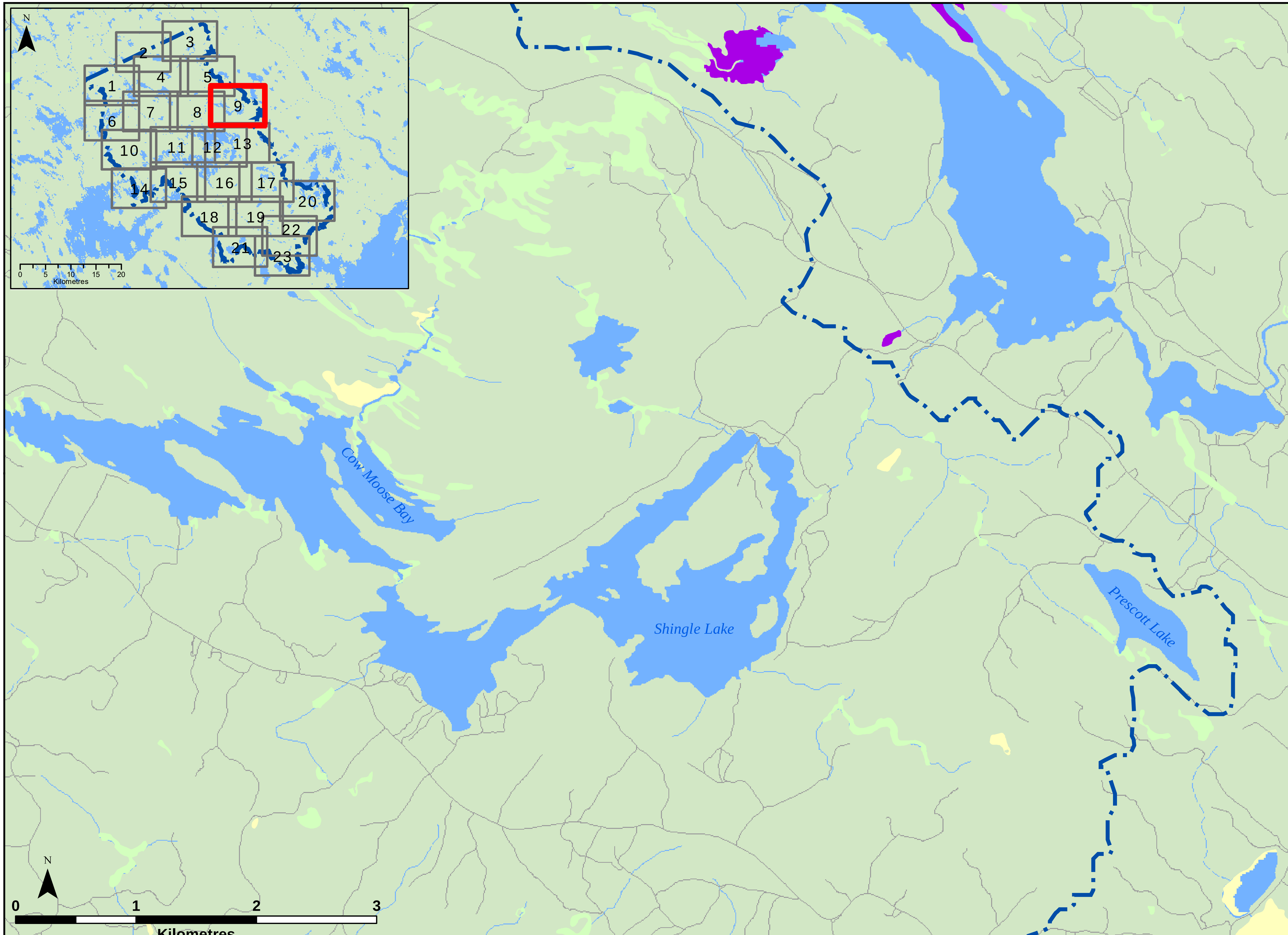
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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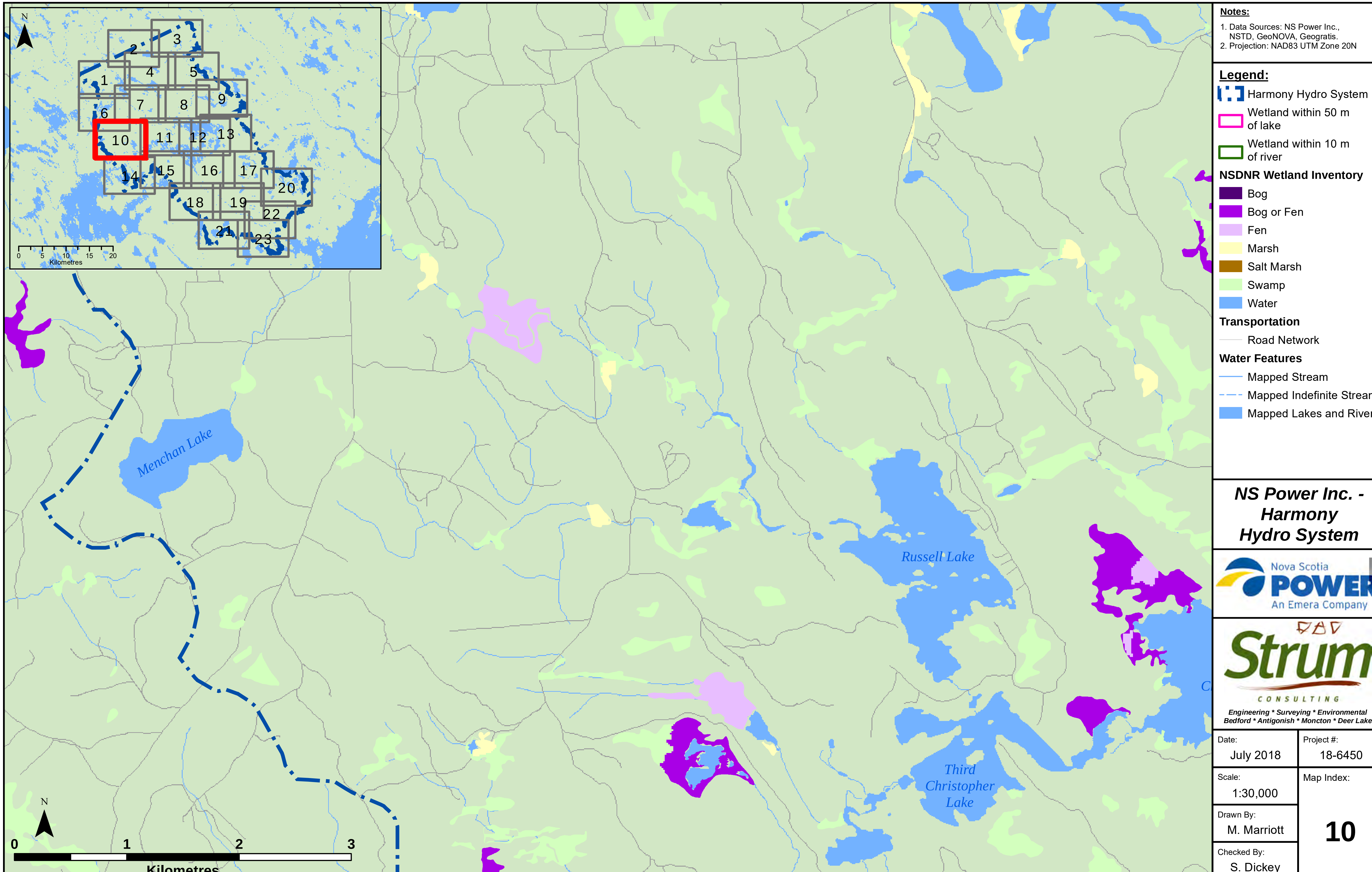
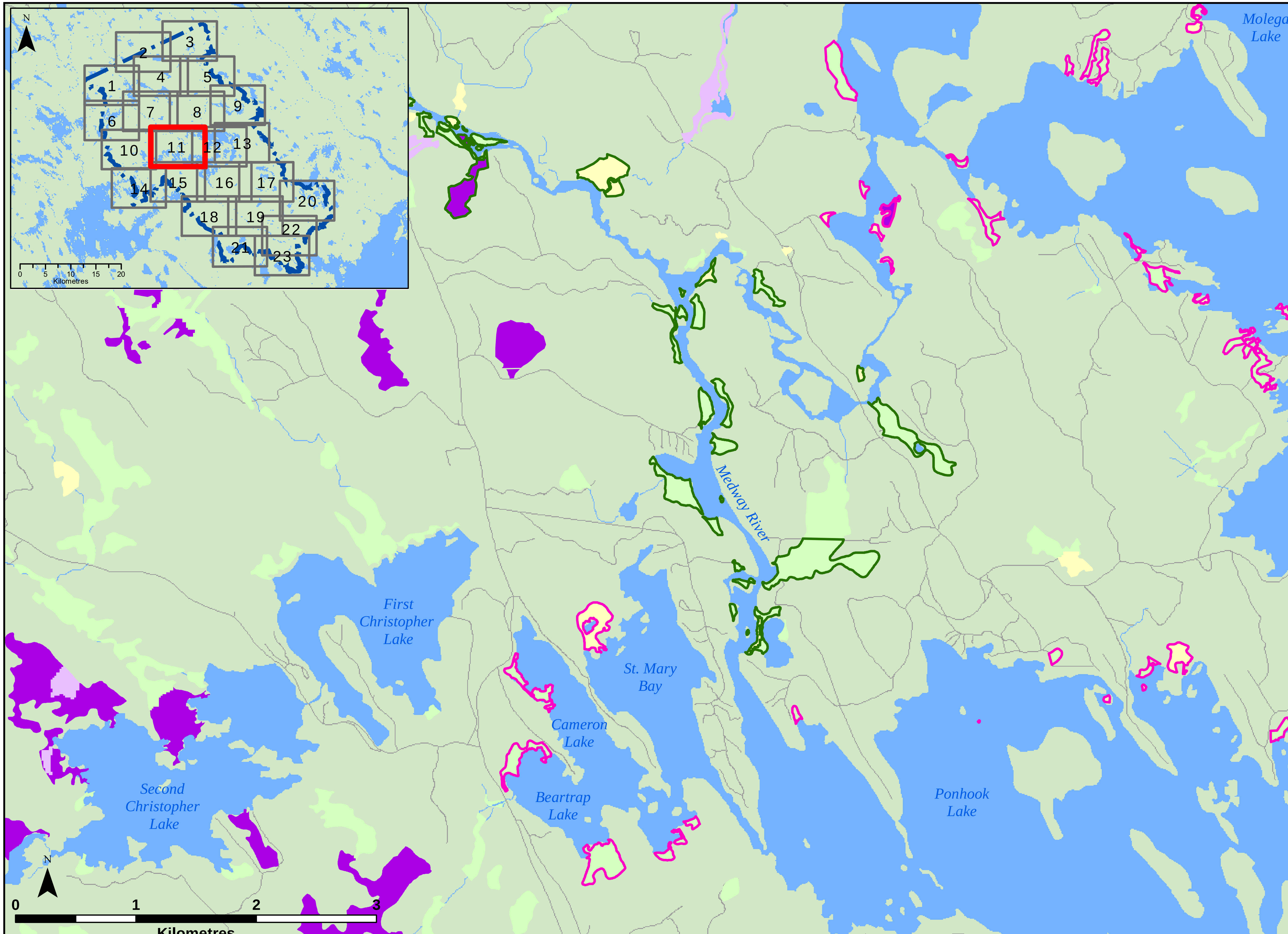
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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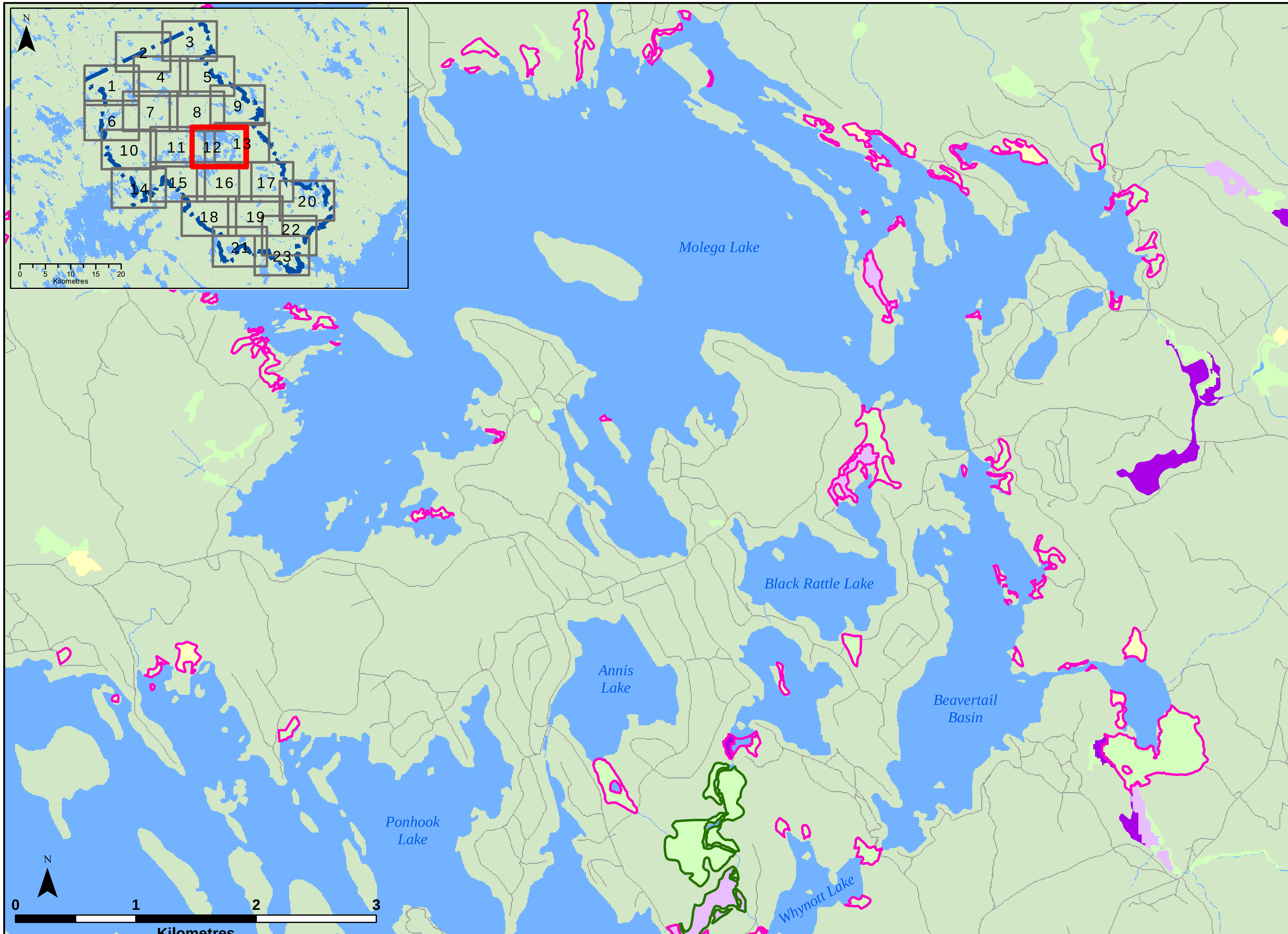
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 11
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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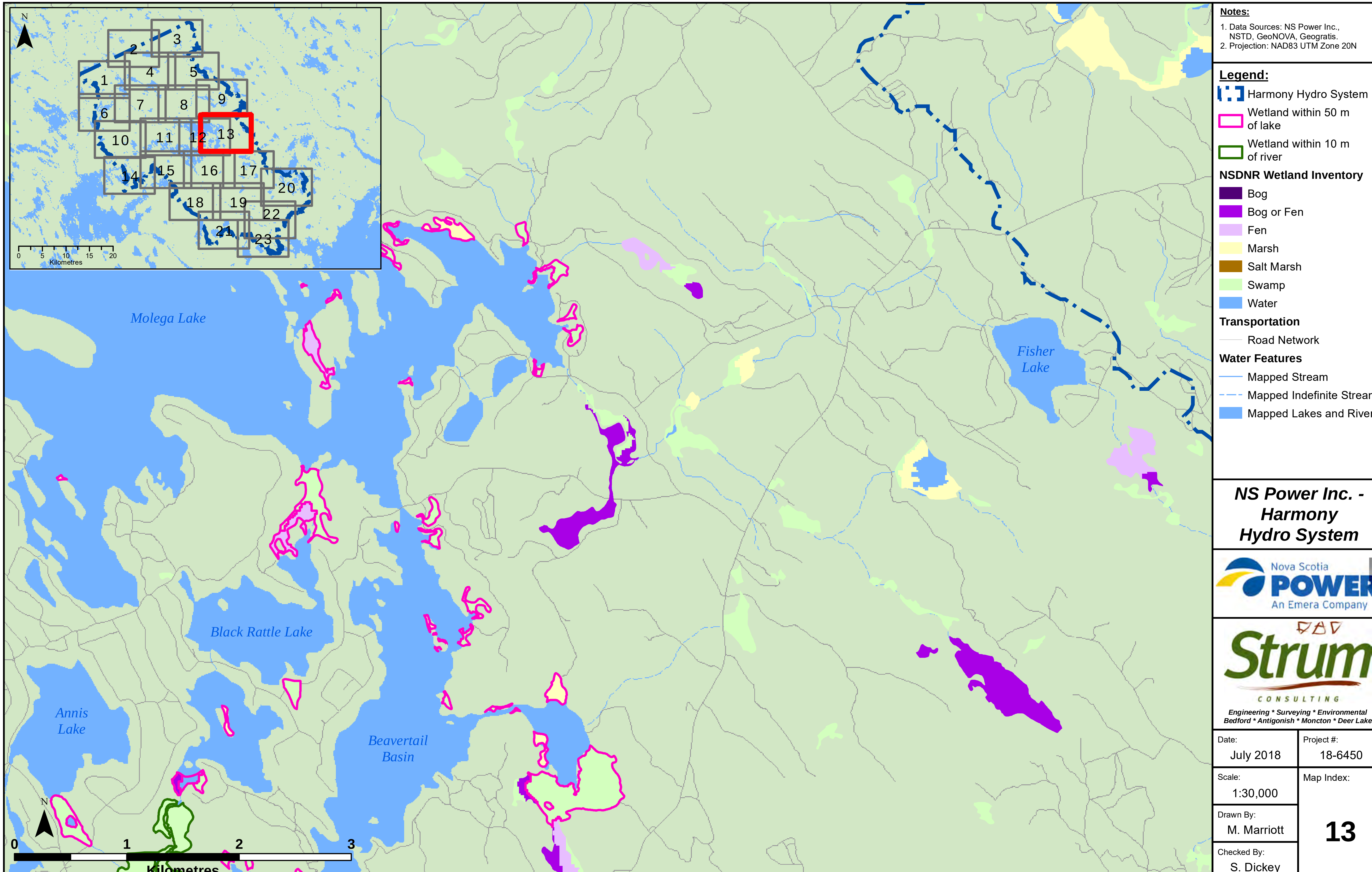
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 12
Drawn By: M. Marriott	
Checked By: S. Dickey	


Molega Lake
Black Rattle Lake
Annis Lake
Beavertail Basin
Fisher Lake
0 1 2 3
Kilometres
N
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Harmony Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Harmony Hydro System
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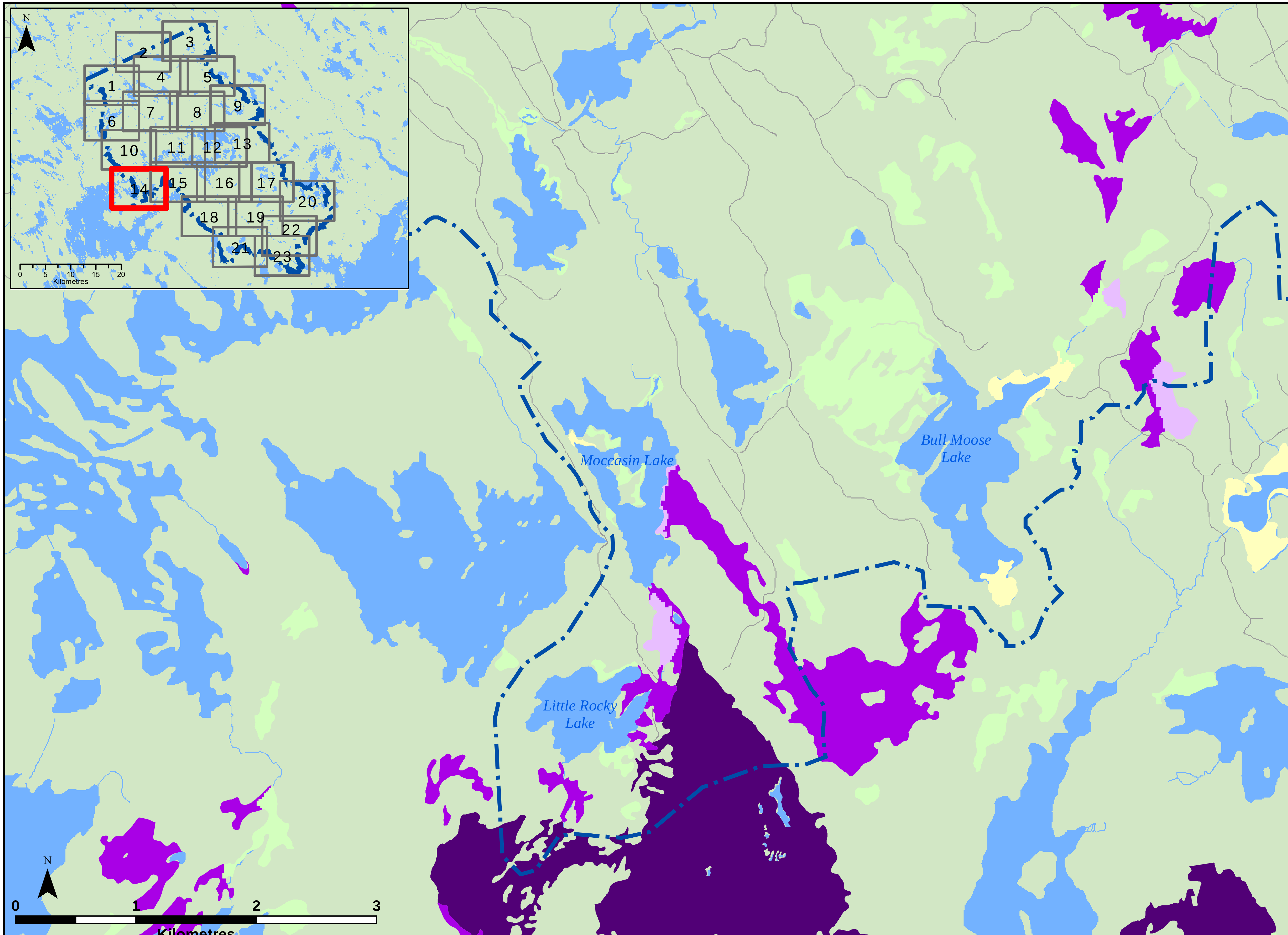
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 13
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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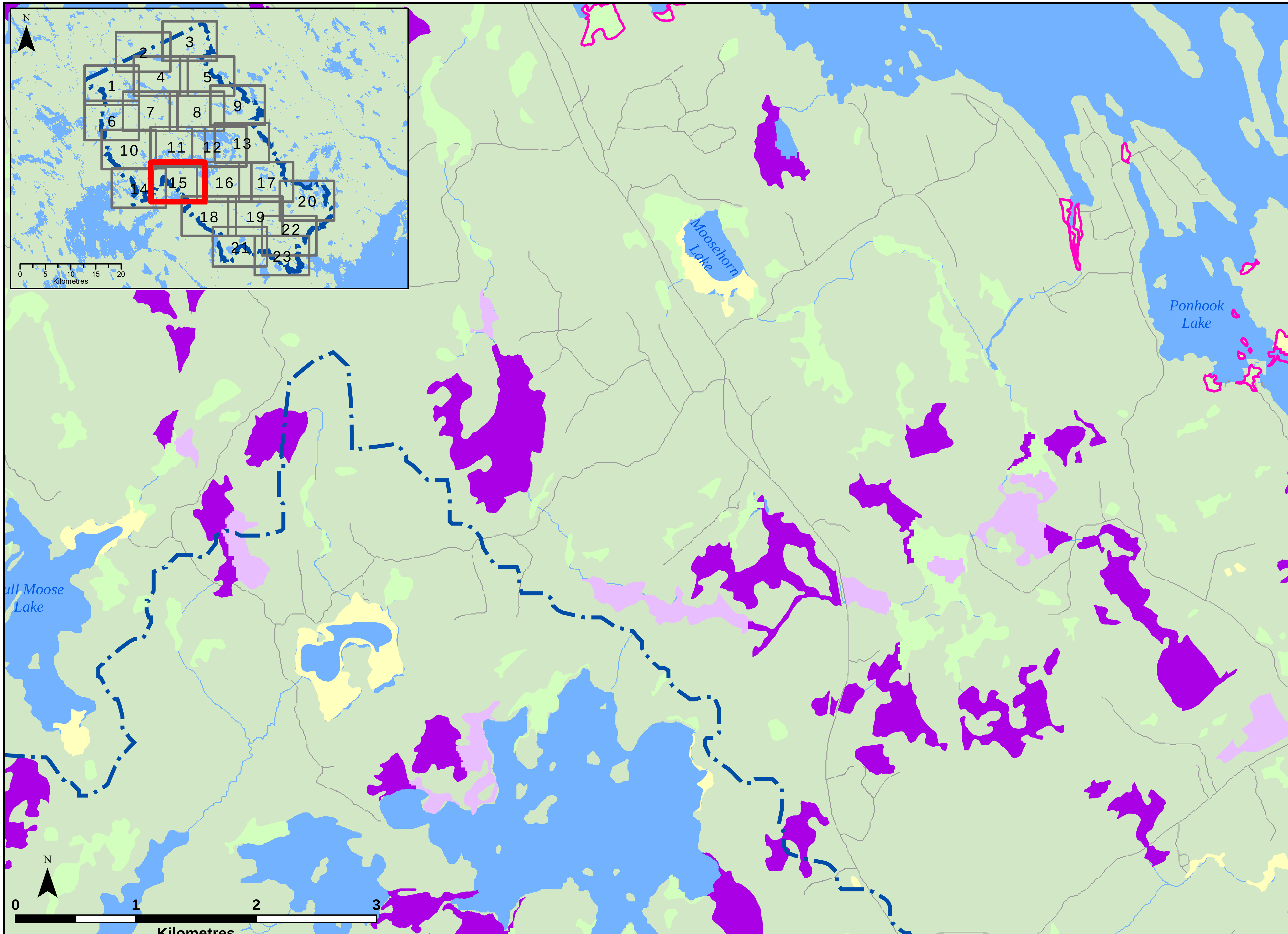
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 14
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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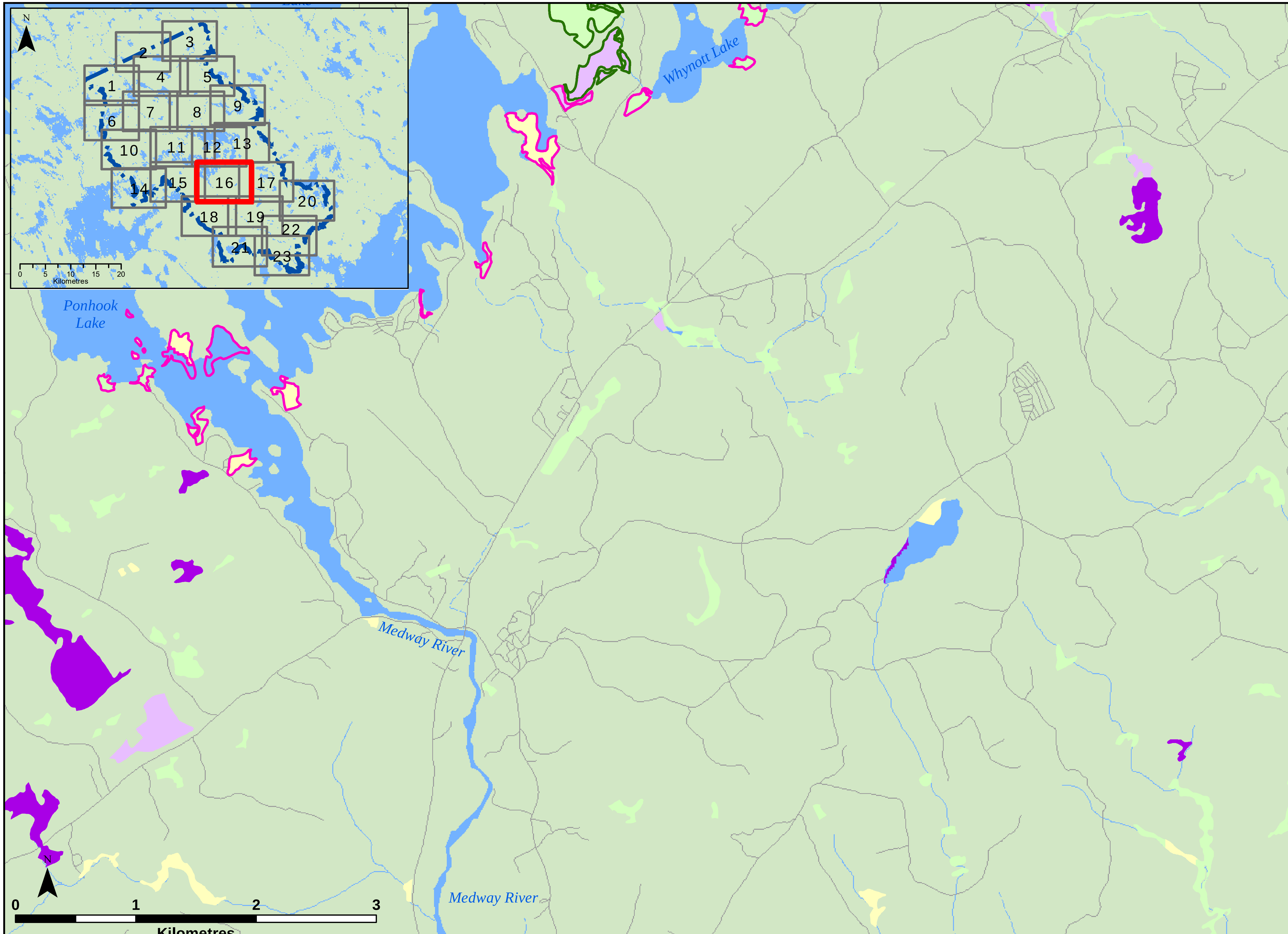
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 15
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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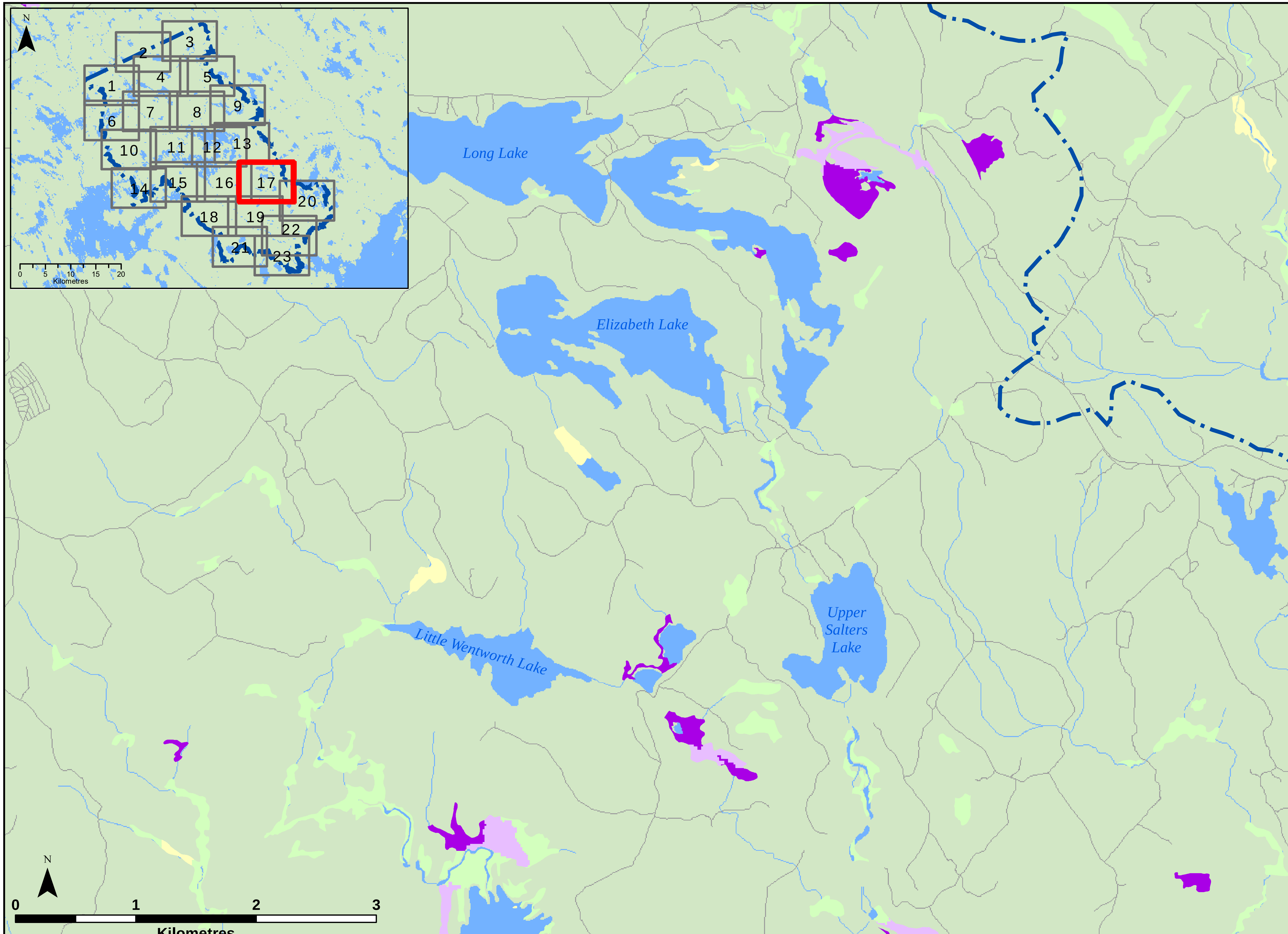
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 16
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Harmony Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river

NSDNR Wetland Inventory

Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water

Transportation

Road Network

Water Features

Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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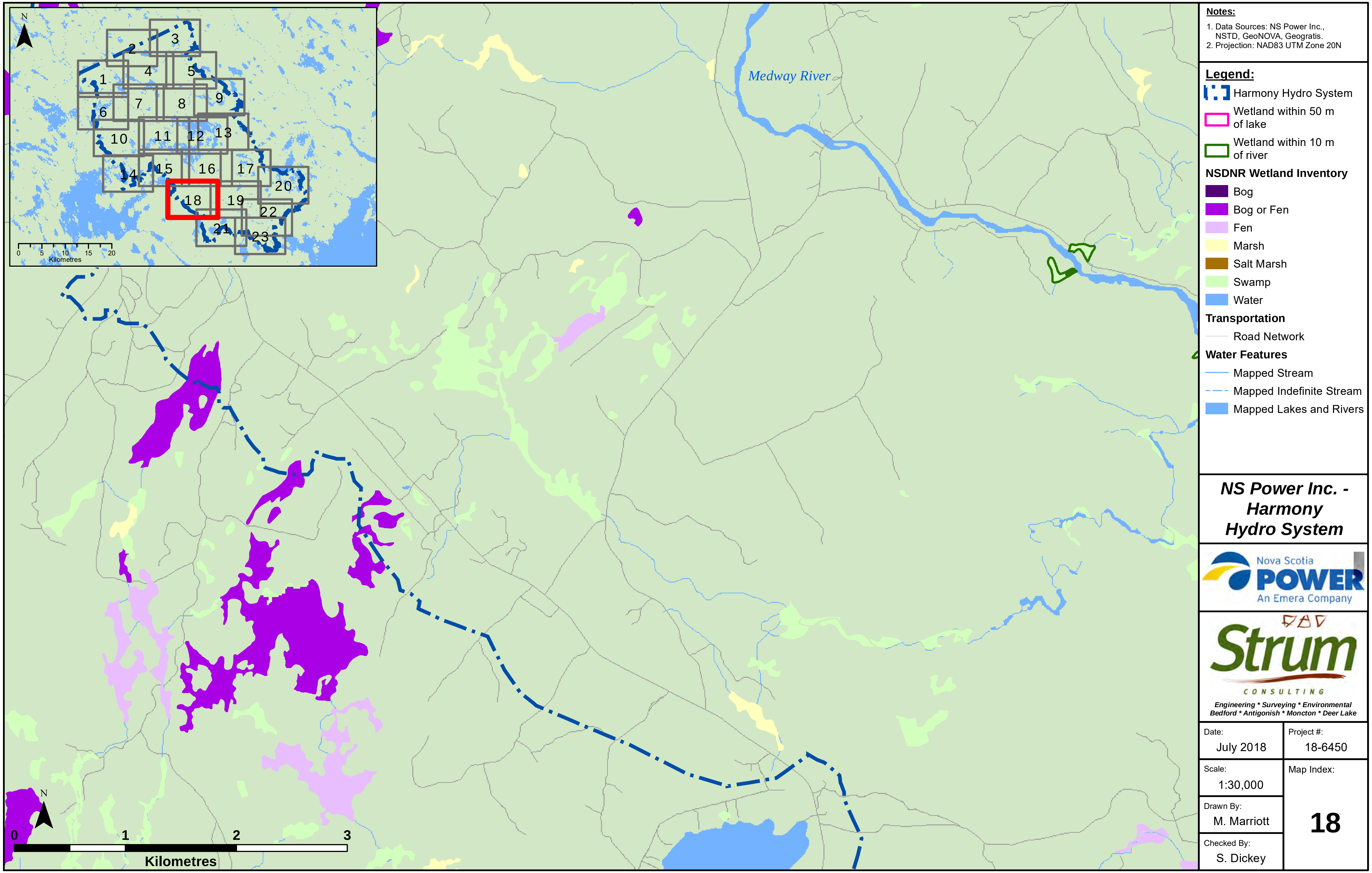
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 17
Drawn By: M. Marriott	
Checked By: S. Dickey	


Medway River
N
0 1 2 3
Kilometres
0 5 10 15 20
Kilometres
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Harmony Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Harmony Hydro System
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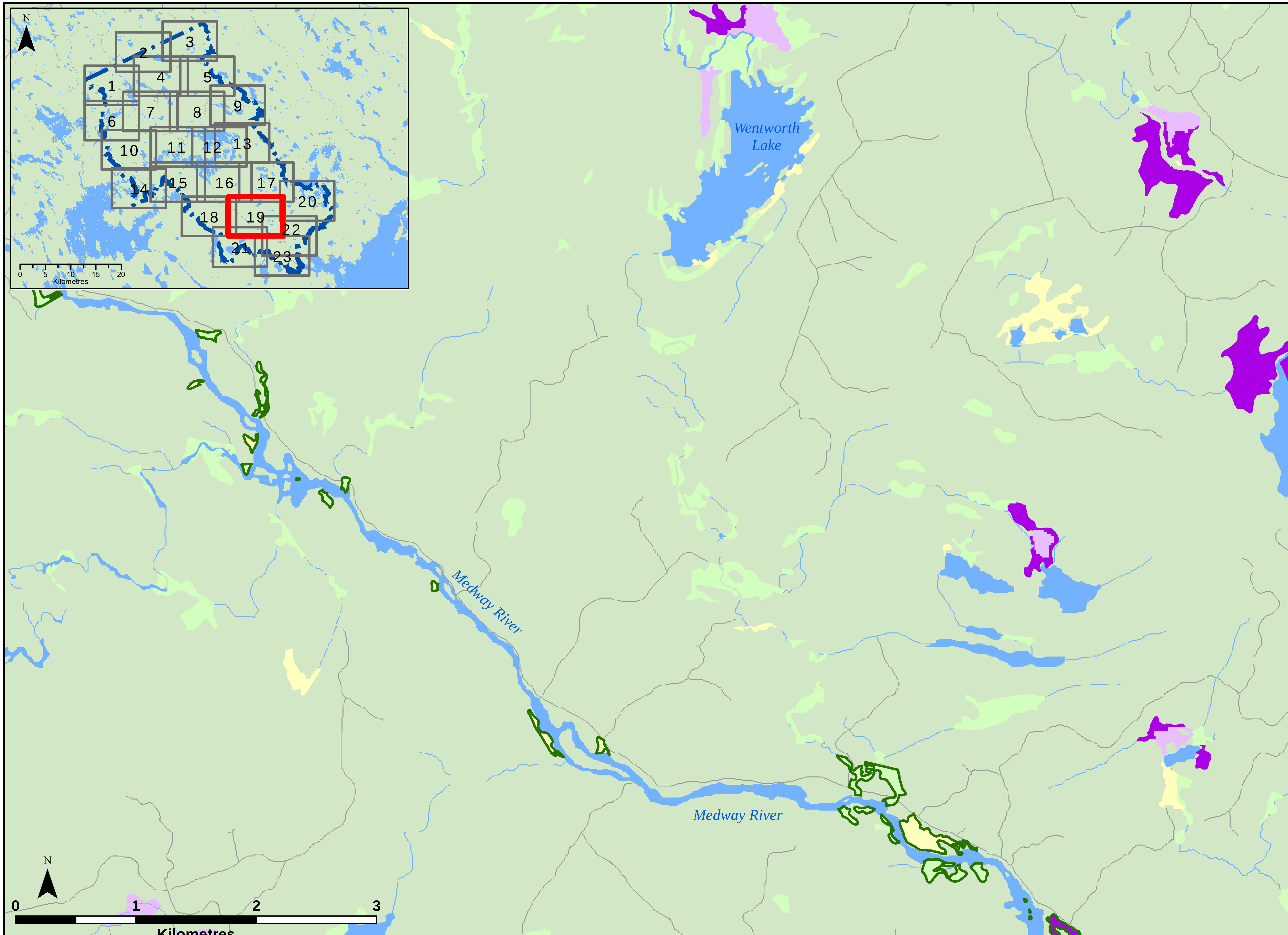
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 18
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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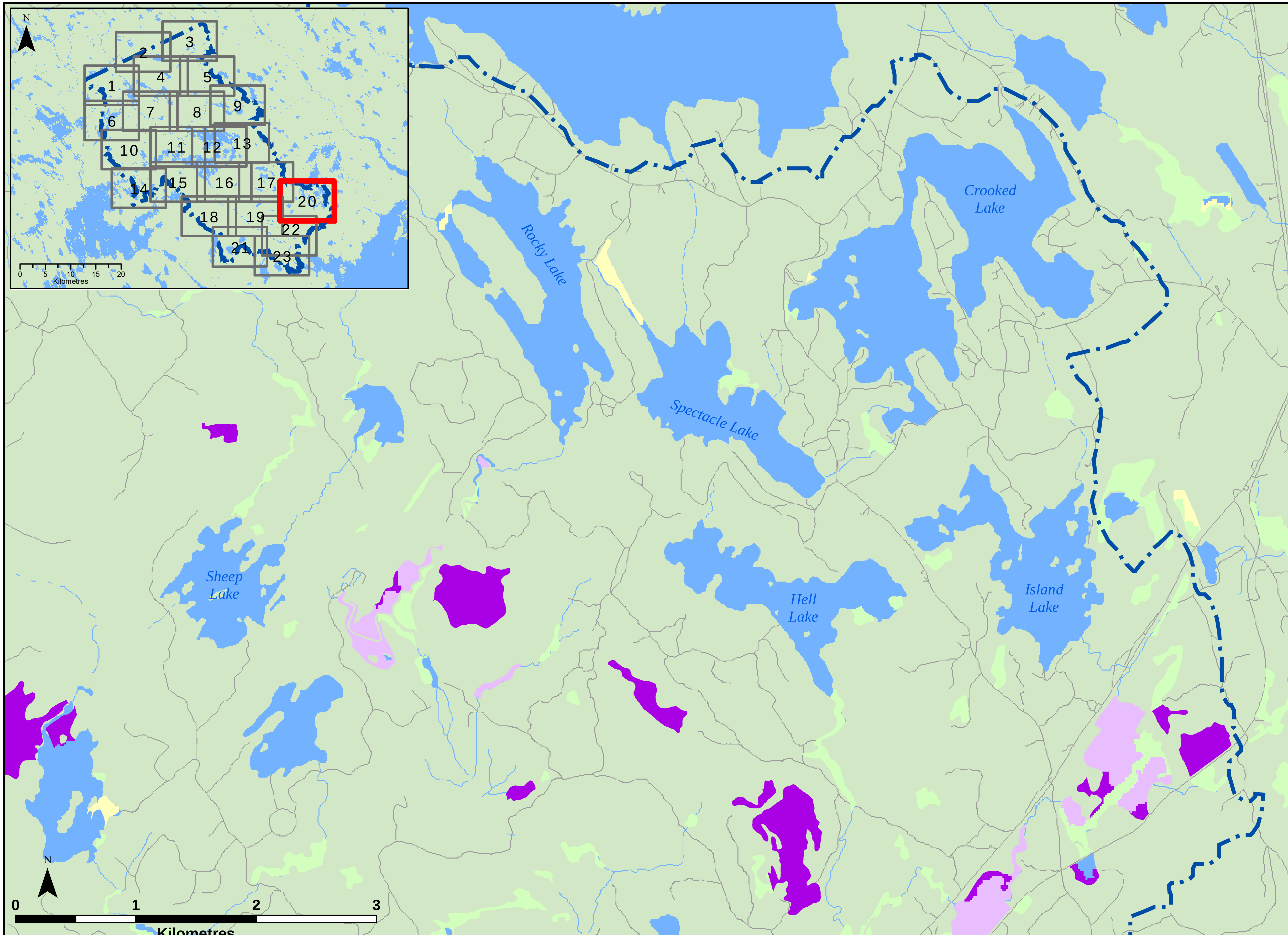
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 19
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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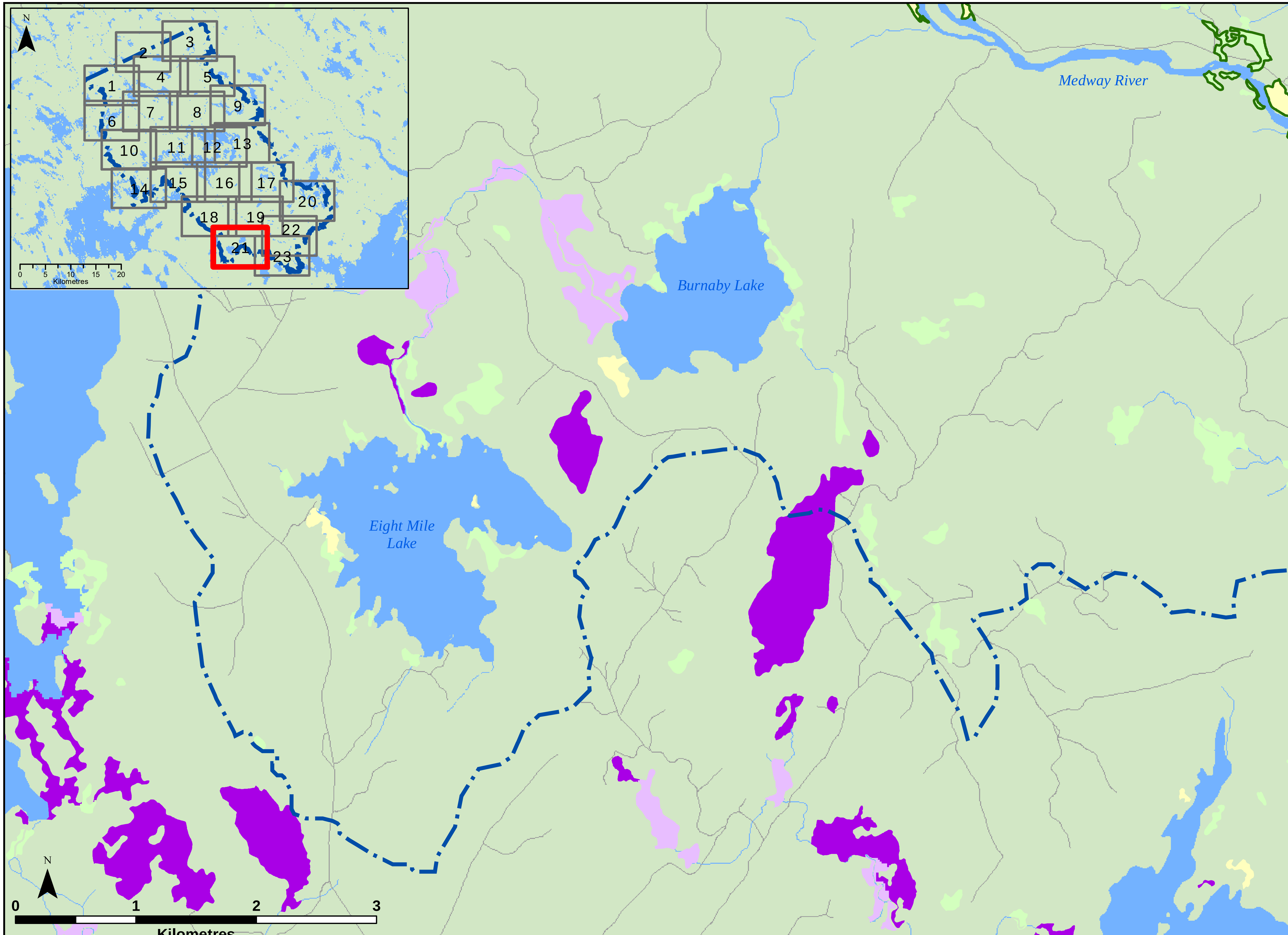
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 20
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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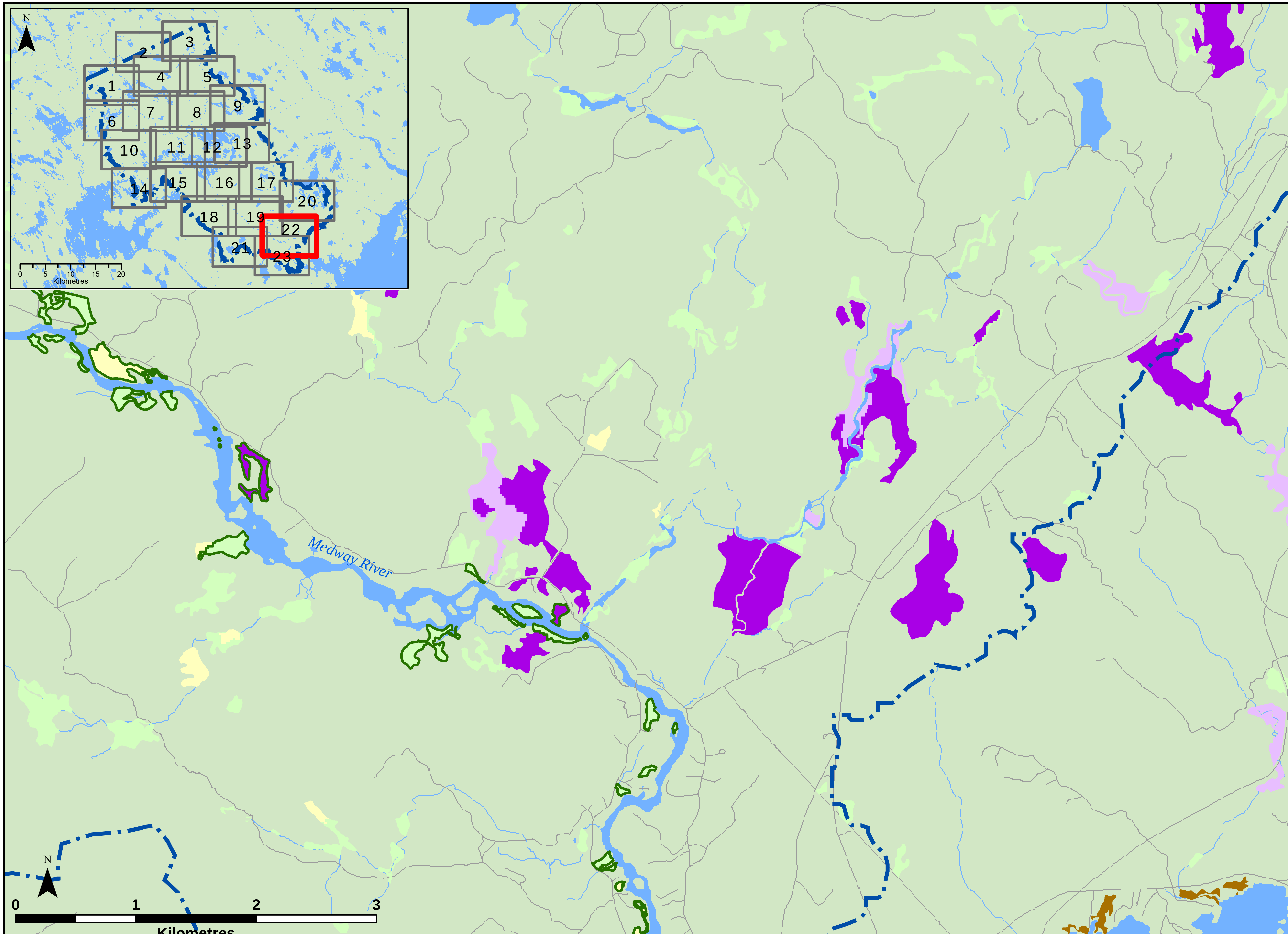
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 21
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Harmony Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Harmony Hydro System

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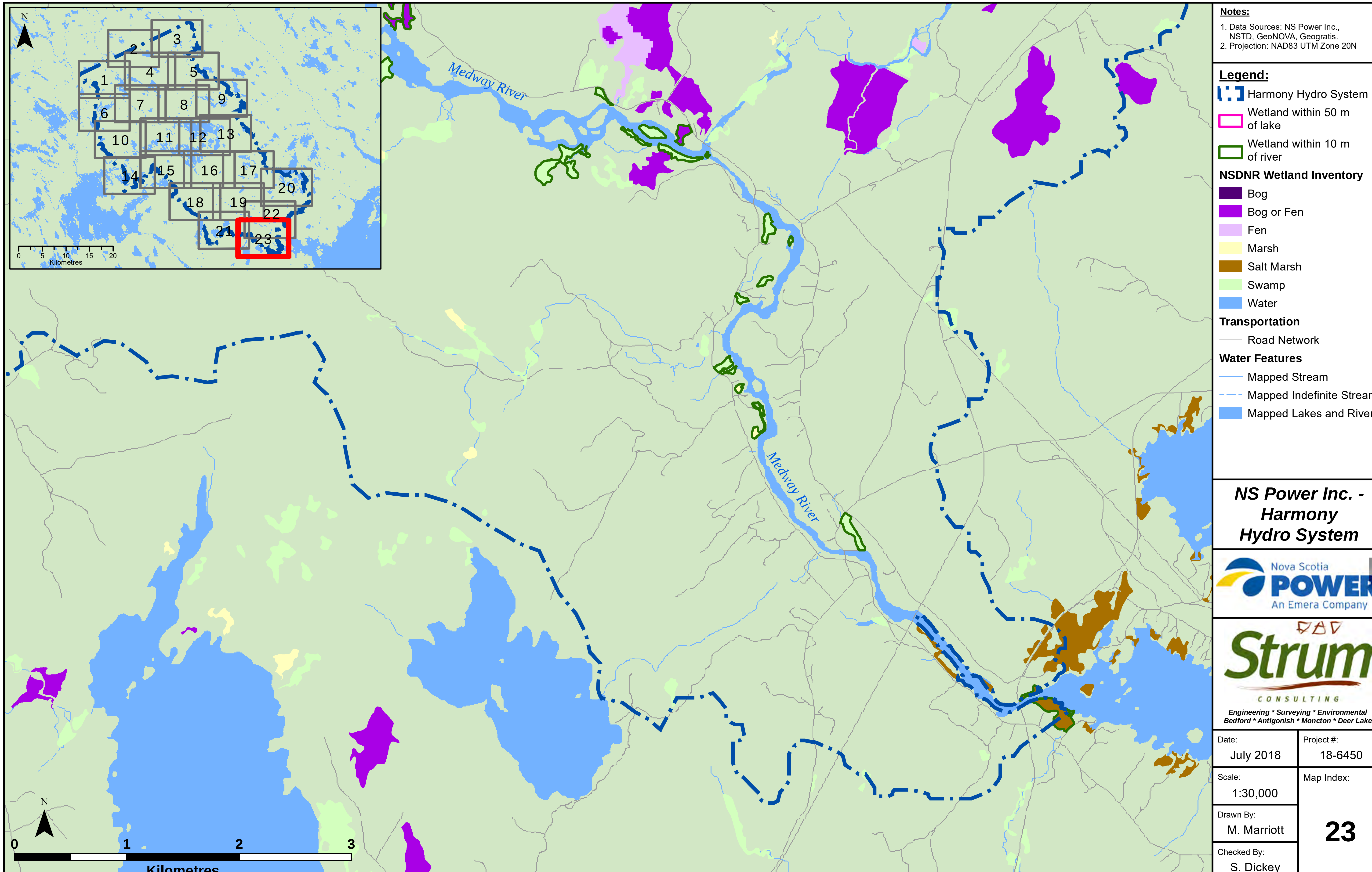
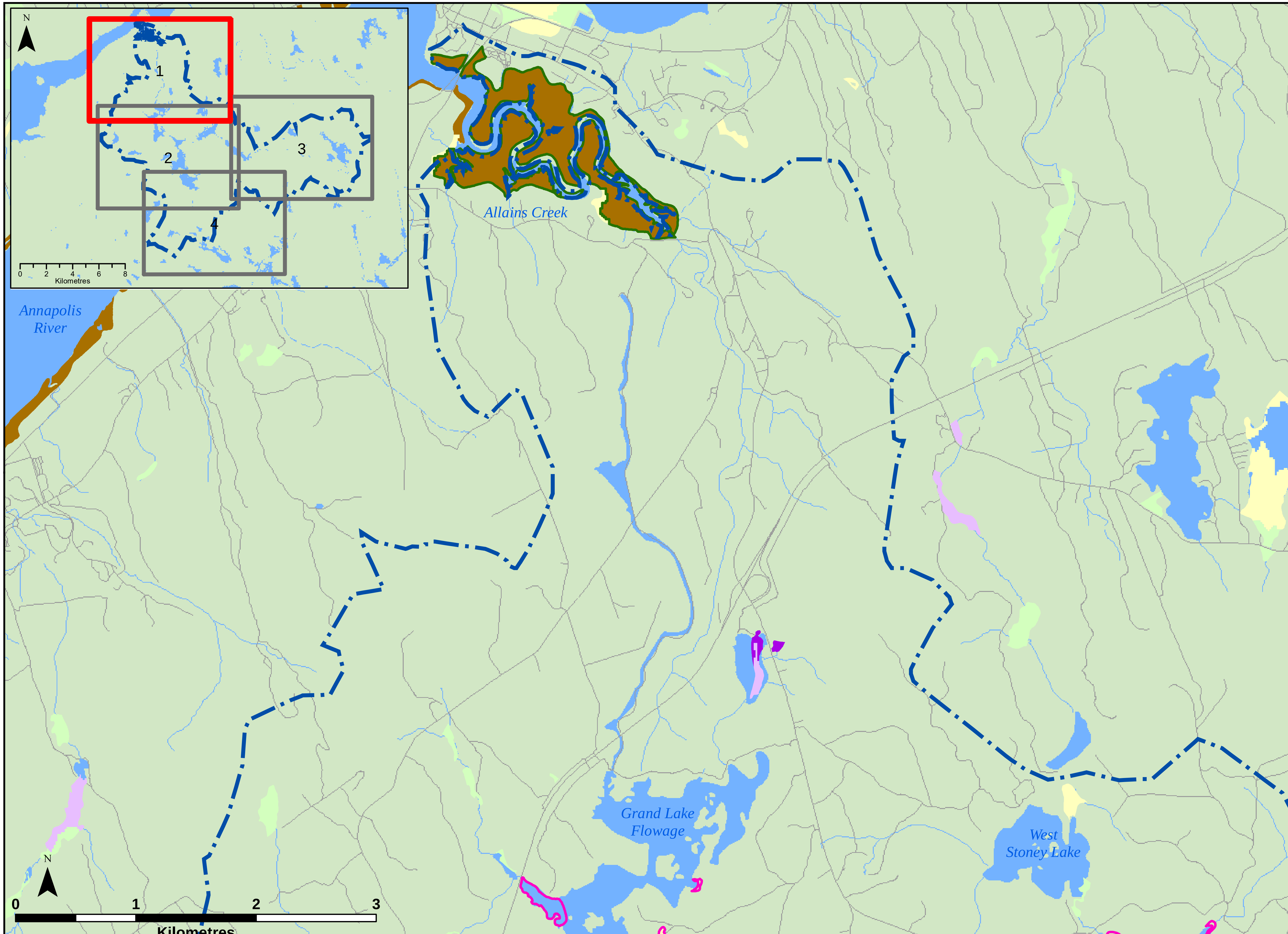
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 22
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Lequille Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Lequille Hydro System

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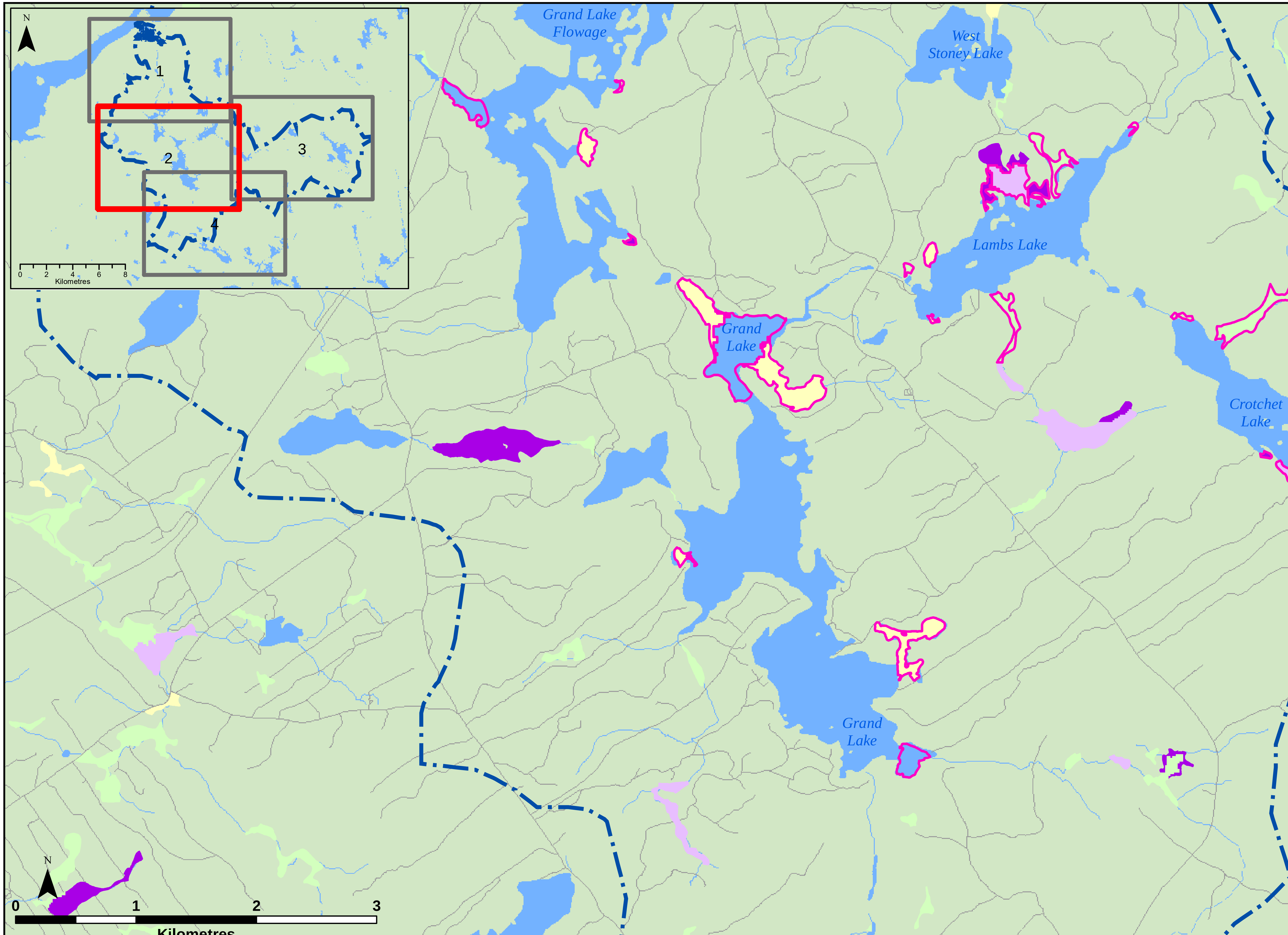
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Lequille Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Lequille Hydro System

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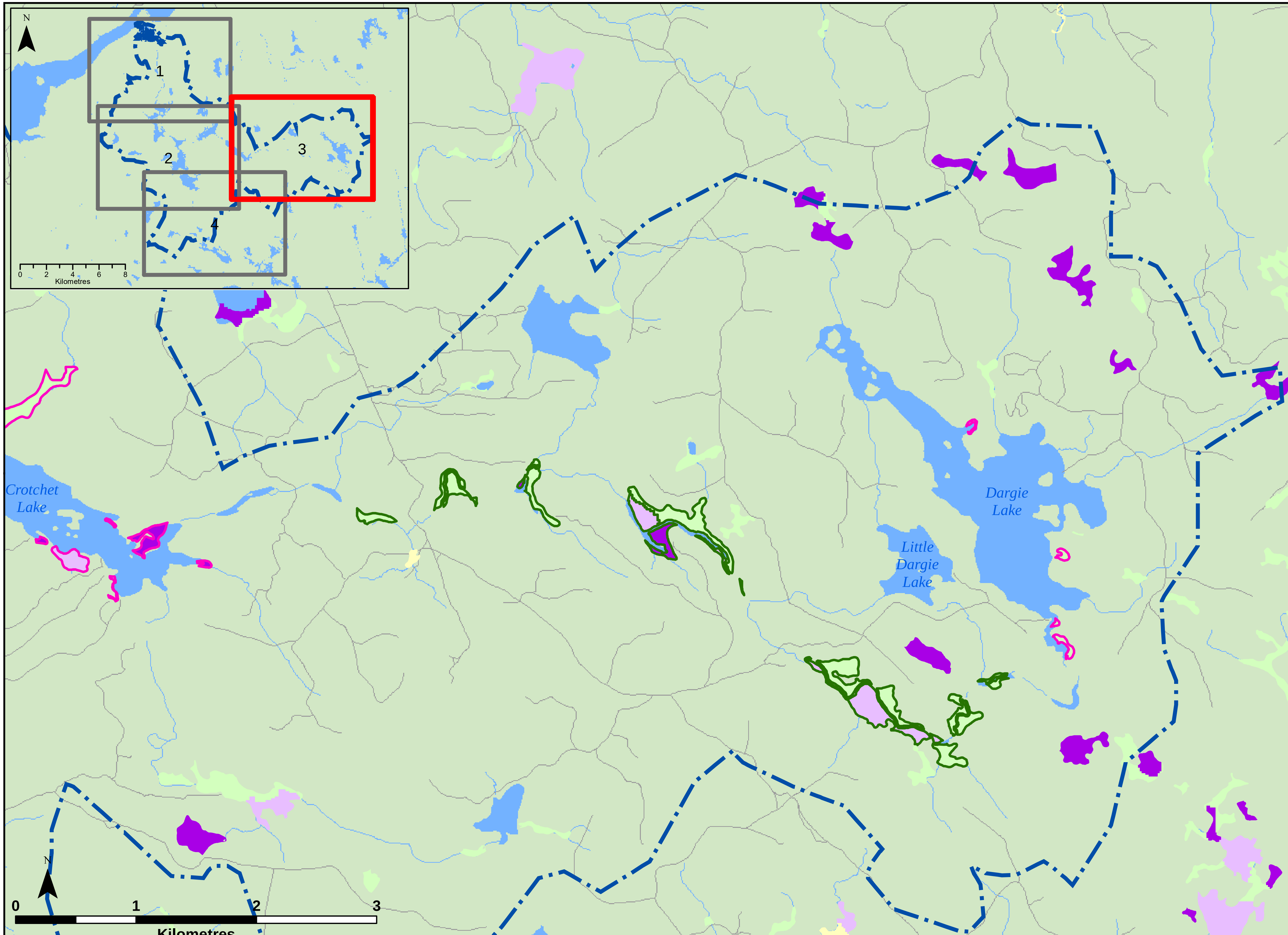
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Lequille Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Lequille Hydro System

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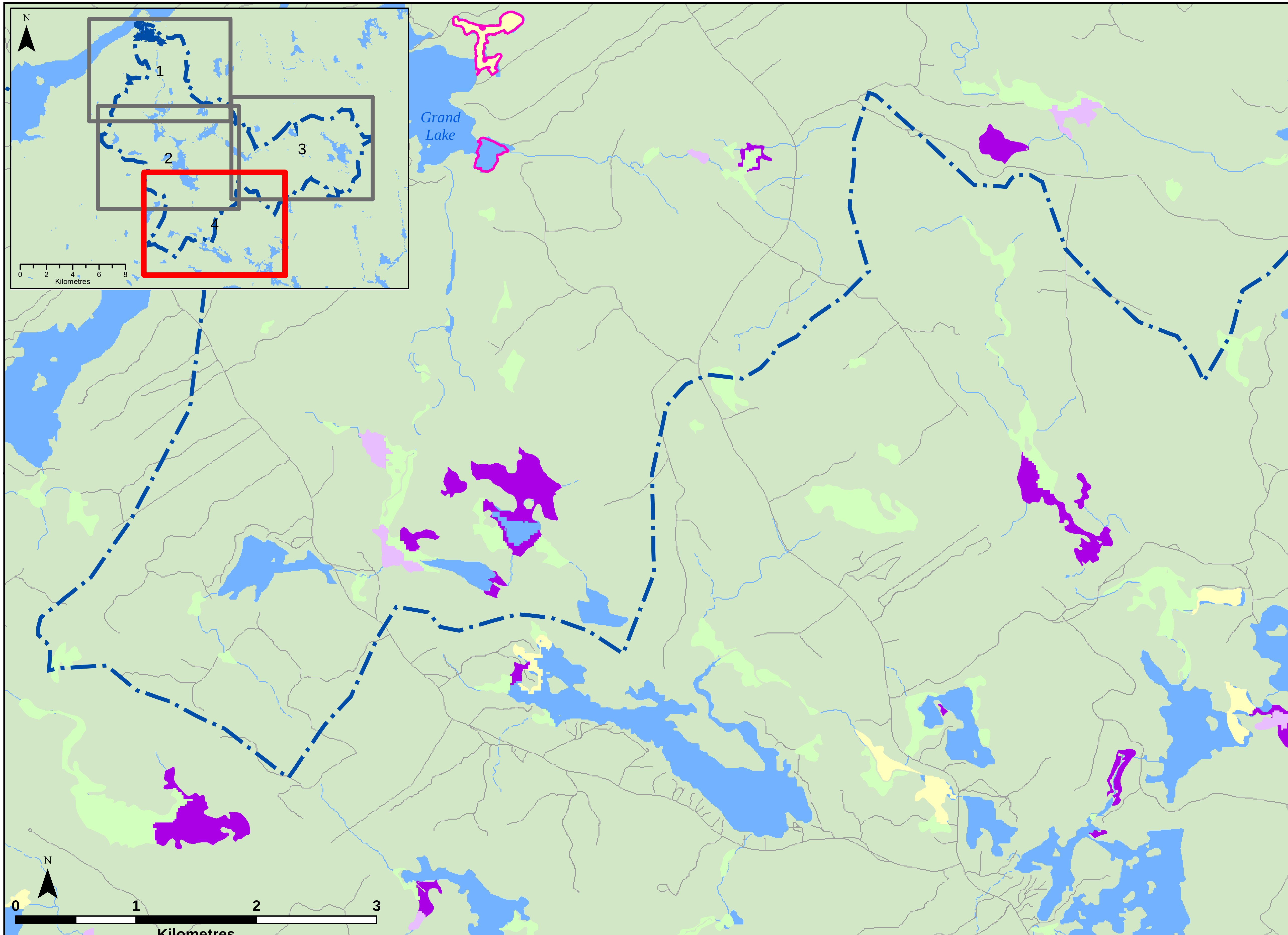
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Lequille Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Lequille Hydro System

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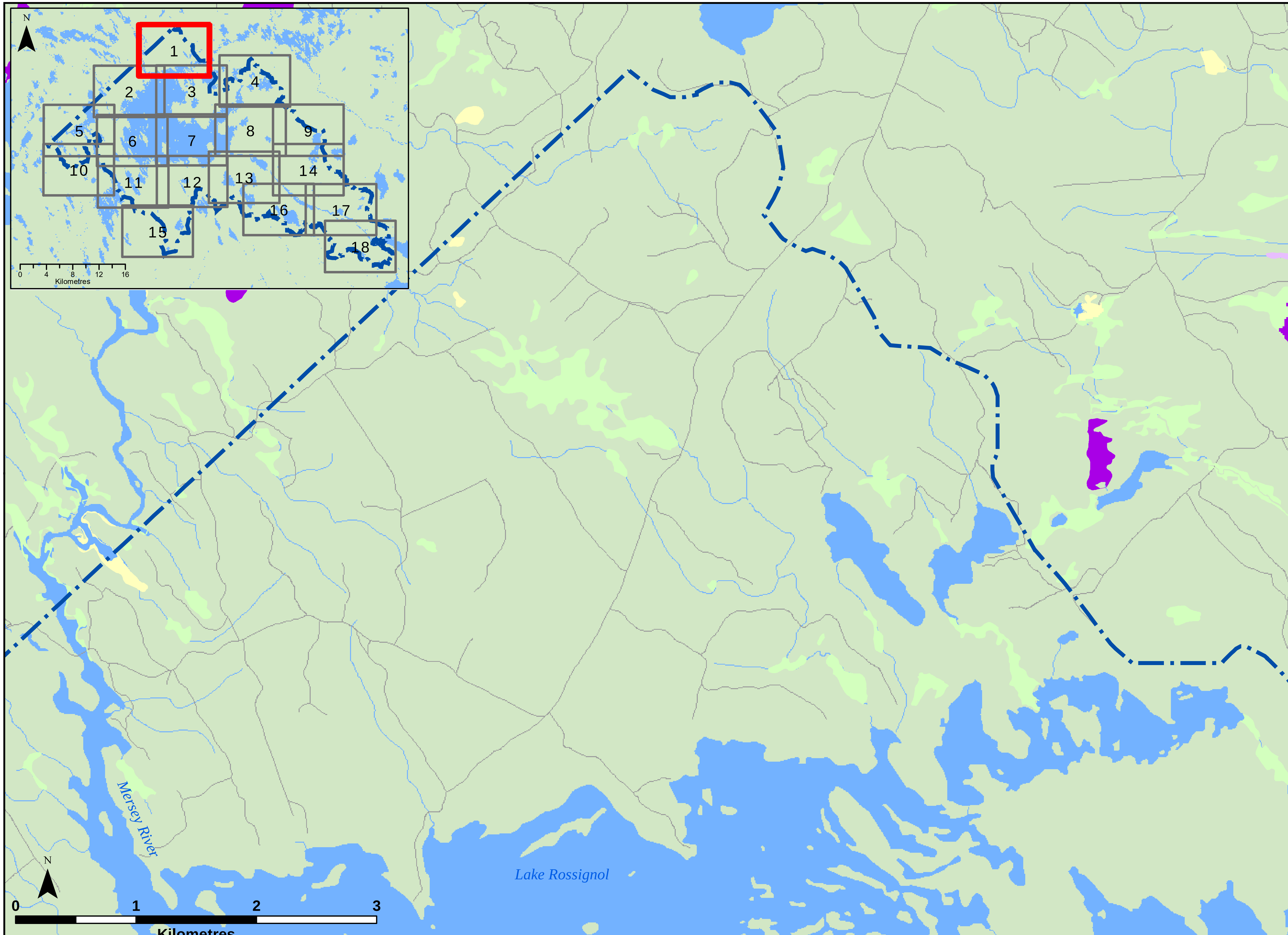
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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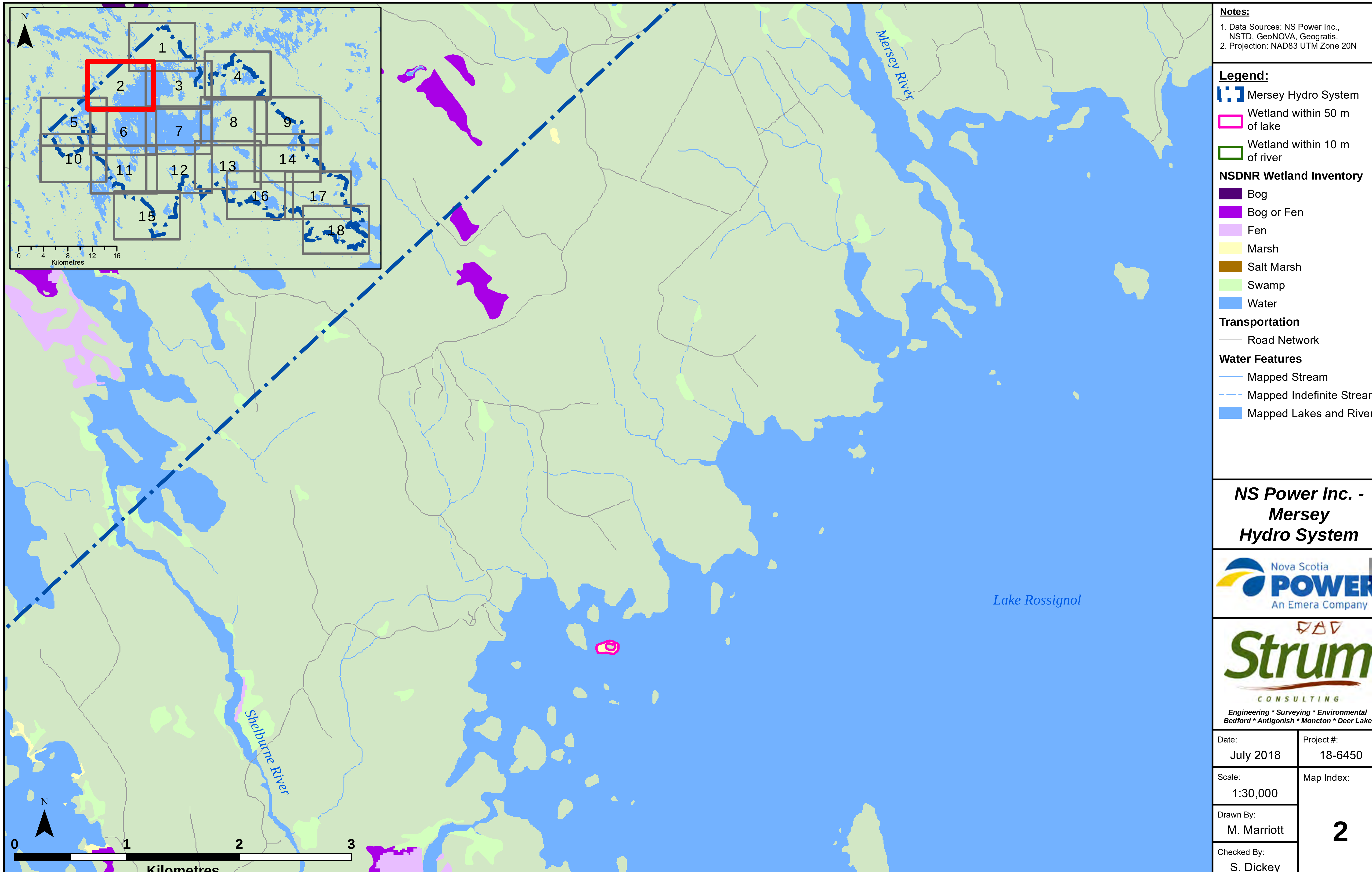
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Mersey Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Mersey Hydro System
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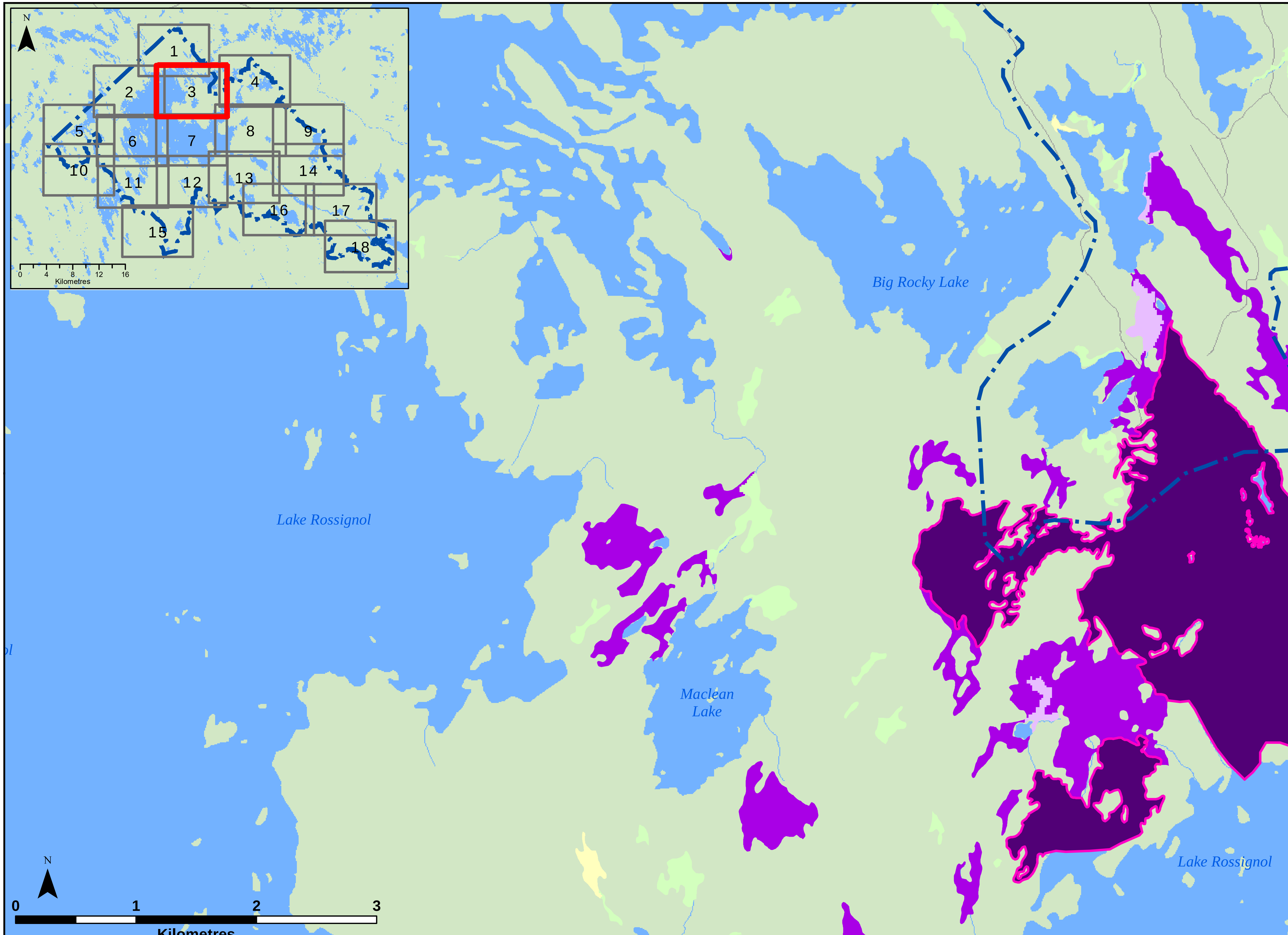
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 2
Drawn By: M. Marriott
Checked By: S. Dickey
Mersey River
Lake Rossignol
Shelburne River
Kilometres
0 1 2 3
N
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
0 4 8 12 16
Kilometres



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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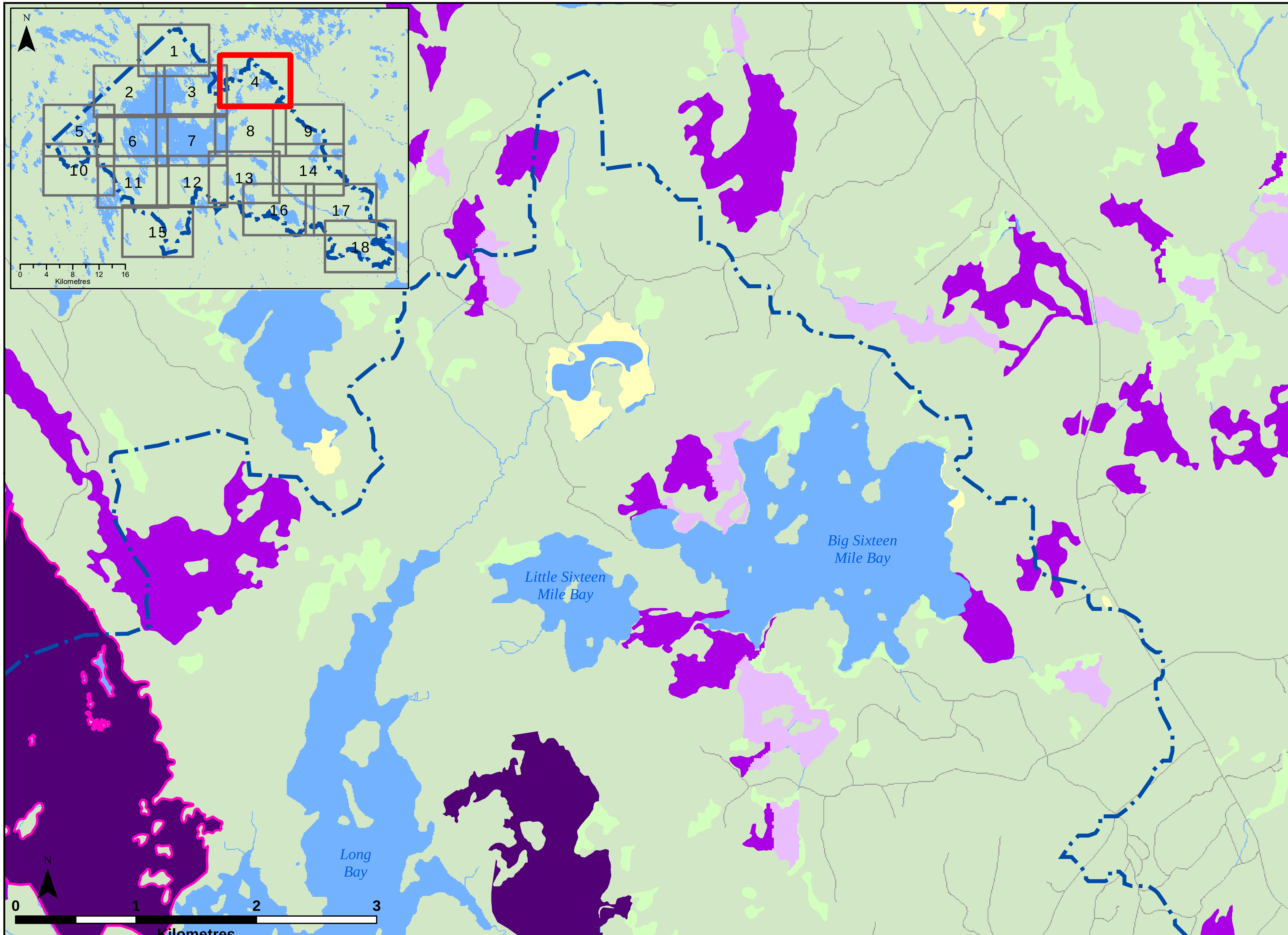
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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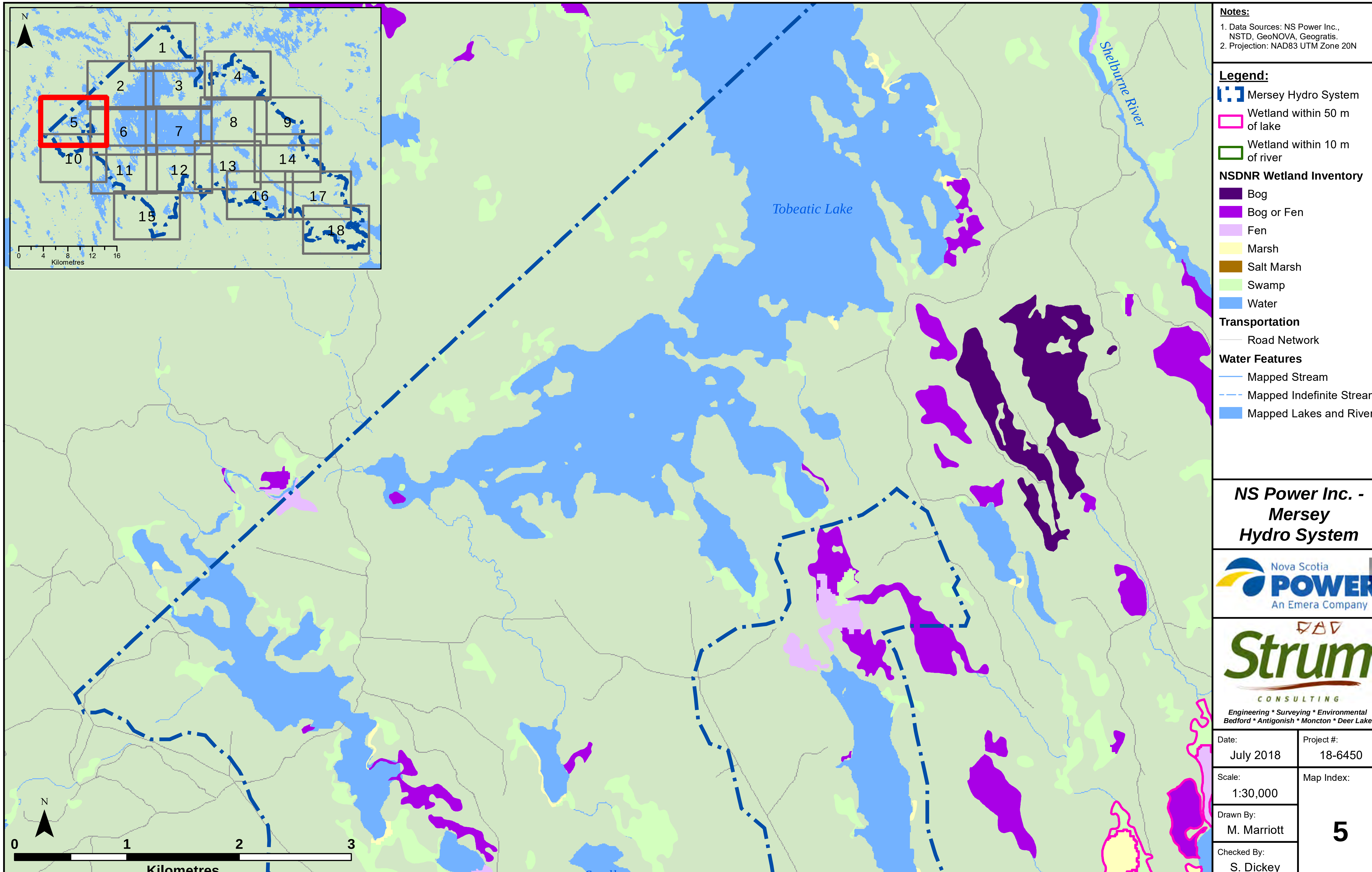
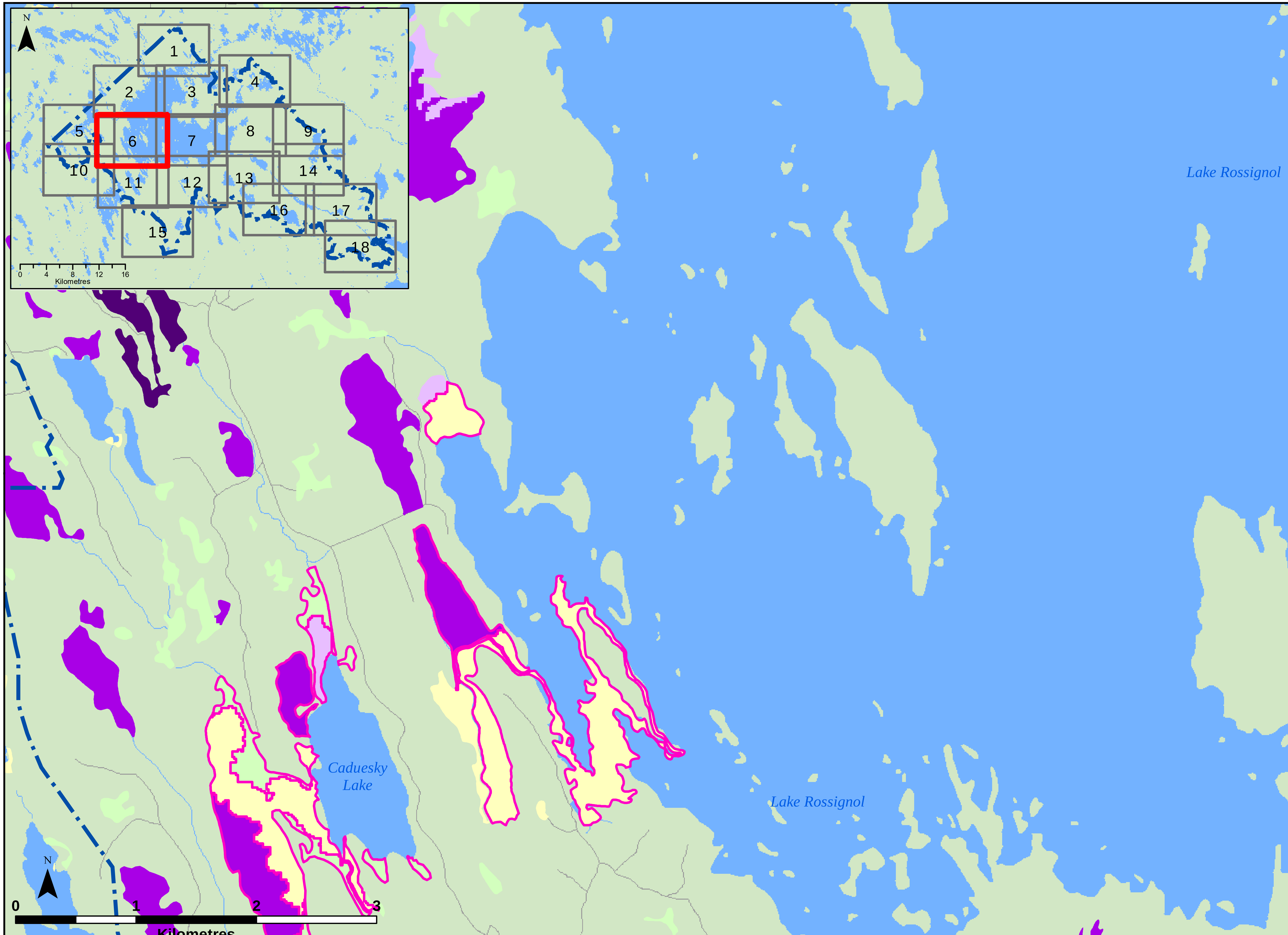
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)





Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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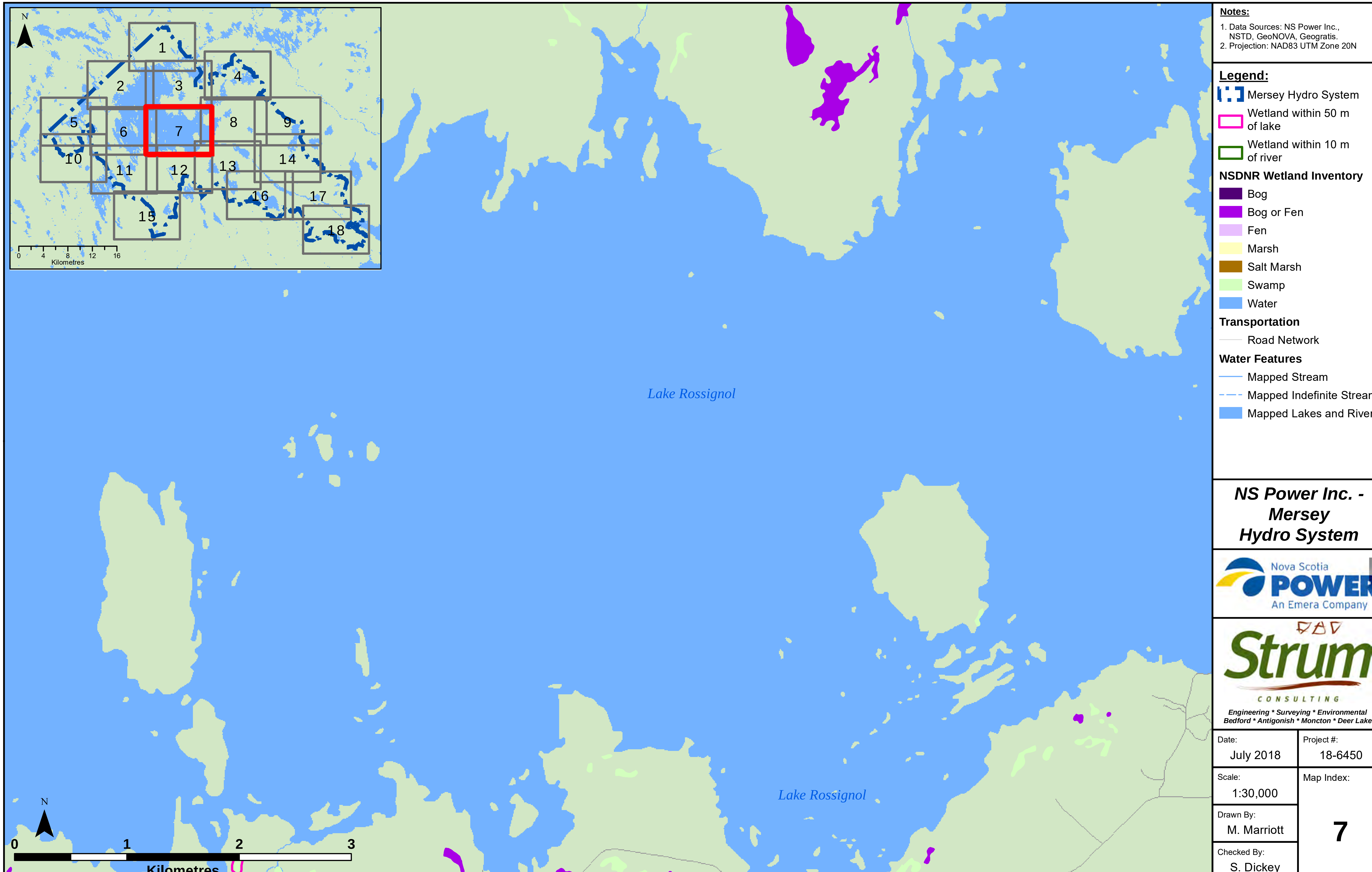
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Mersey Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Mersey Hydro System
Nova Scotia POWER
An Emera Company
Strum
CONSULTING
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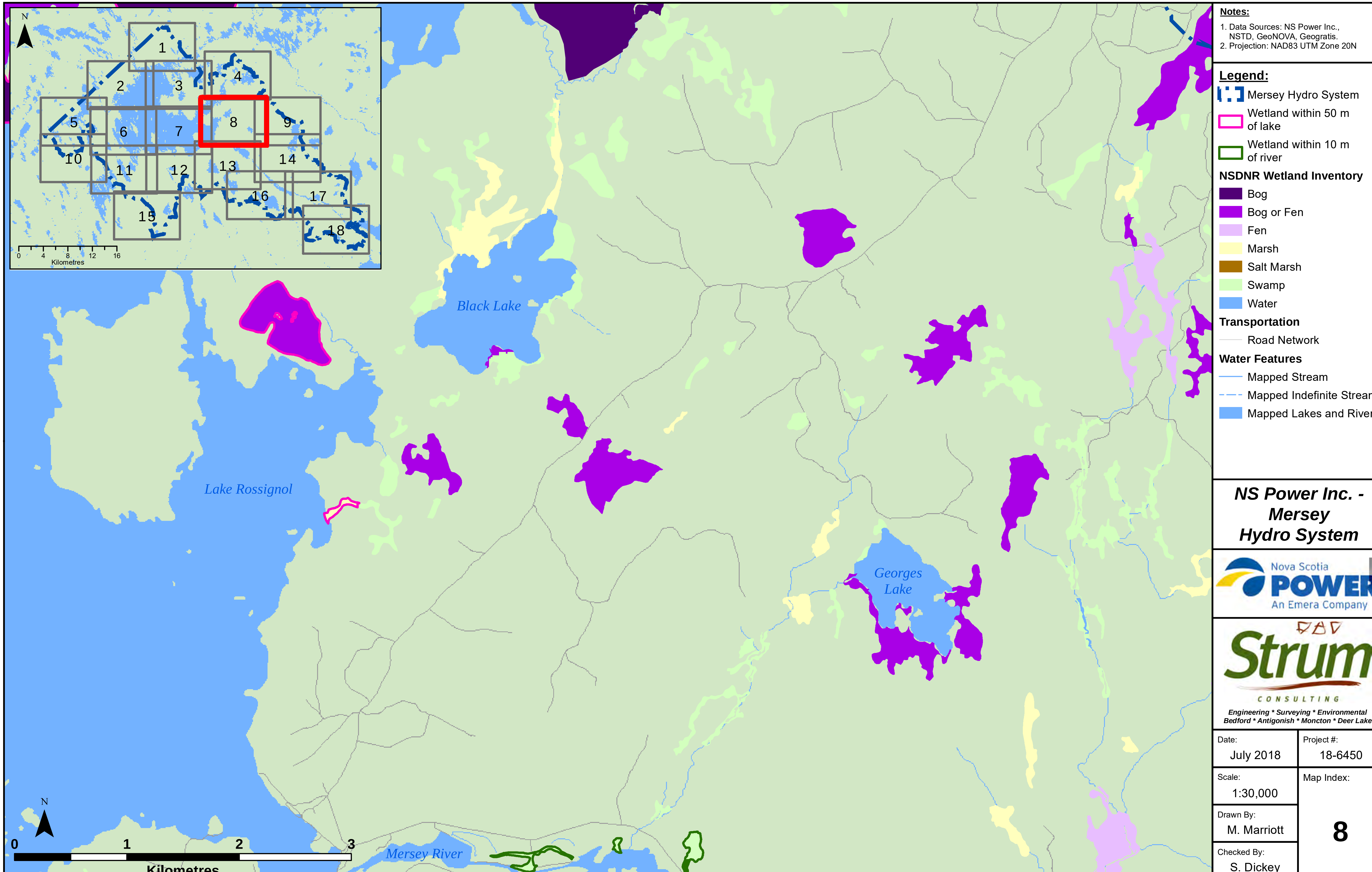
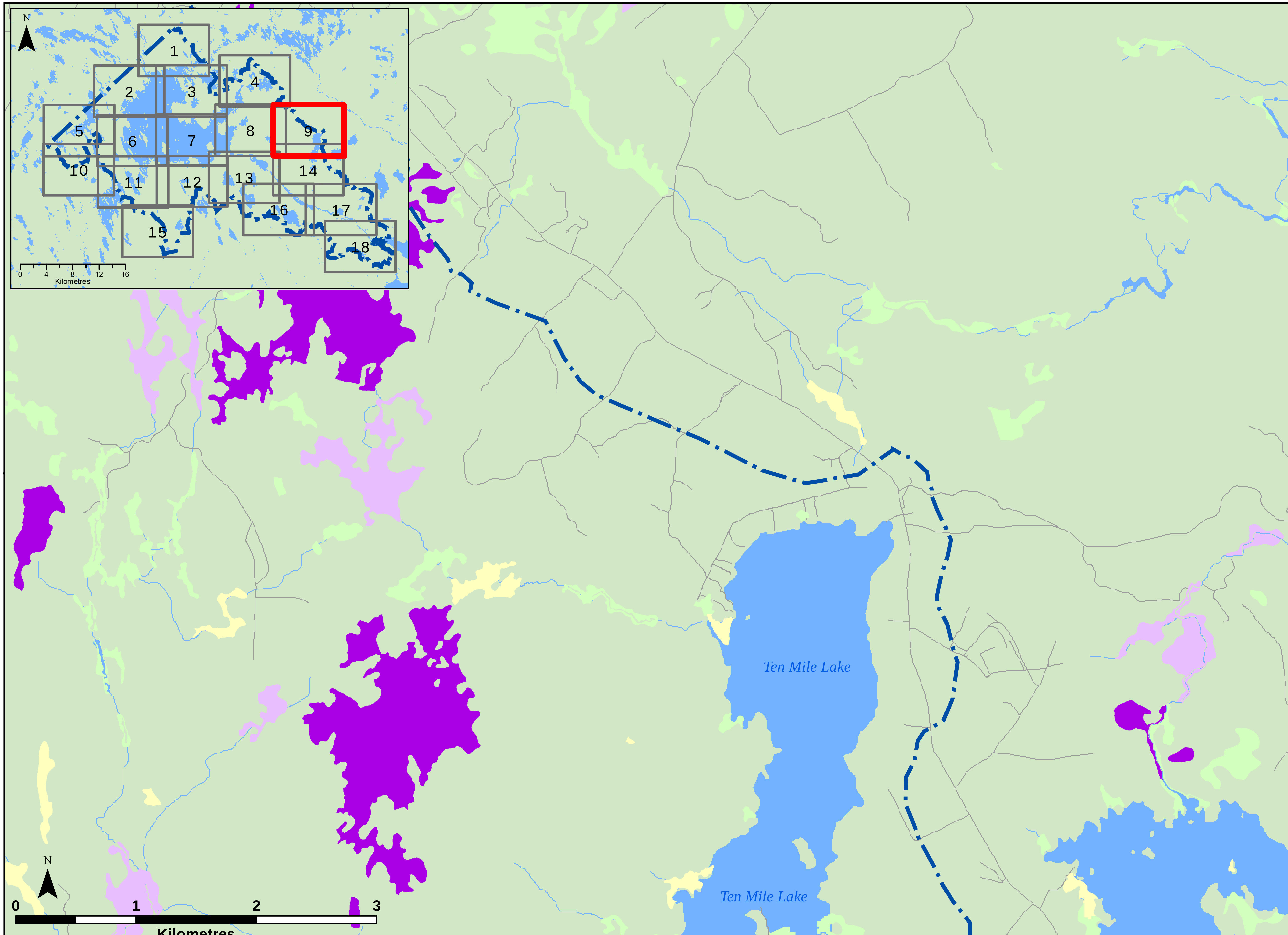
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 7
Drawn By: M. Marriott
Checked By: S. Dickey
Lake Rossignol
Lake Rossignol
N
0 1 2 3
Kilometres
0 4 8 12 16
Kilometres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

REDACTED (CONFIDENTIAL INFORMATION REMOVED)





Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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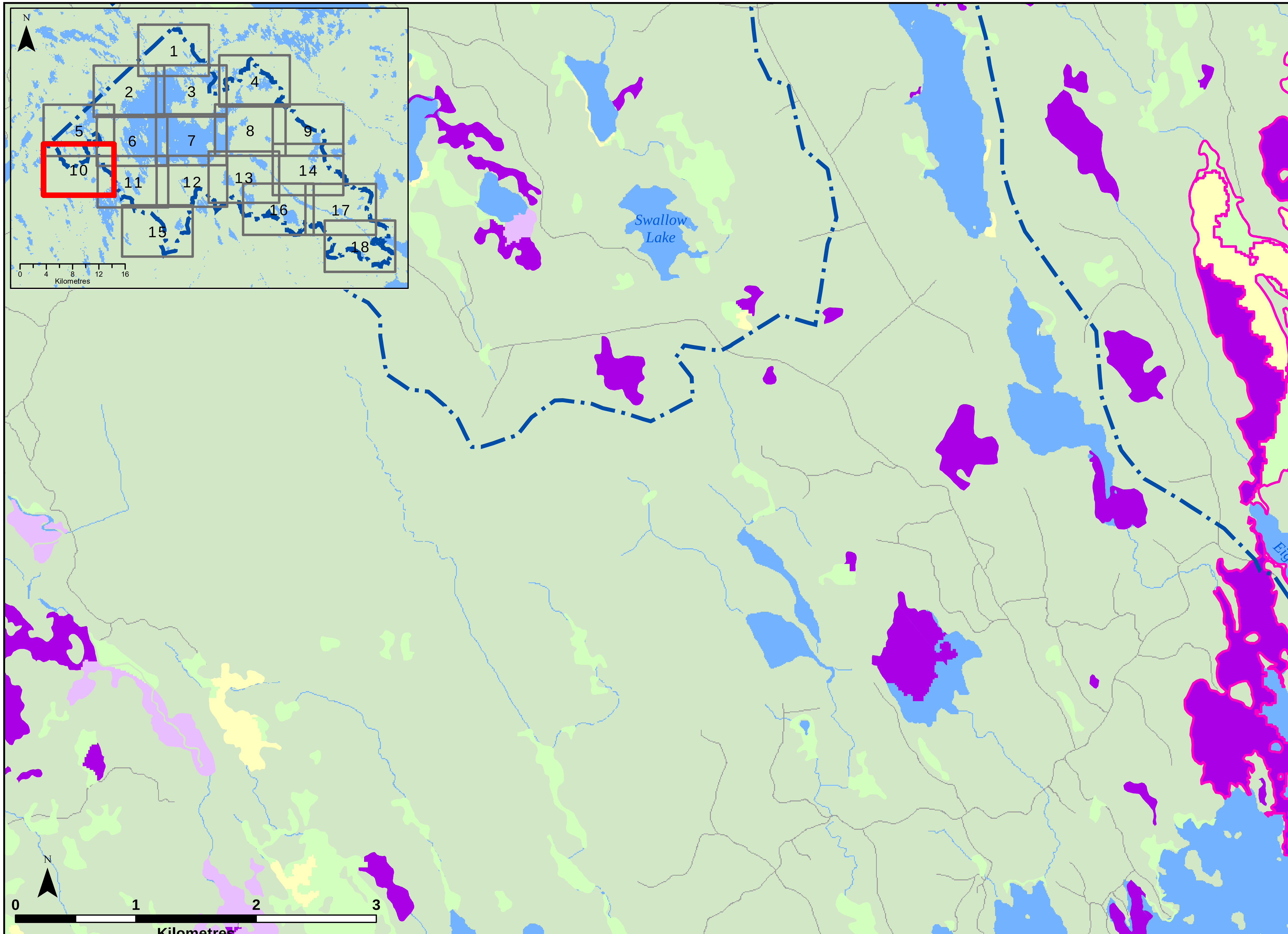
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 10
Drawn By: M. Marriott	
Checked By: S. Dickey	

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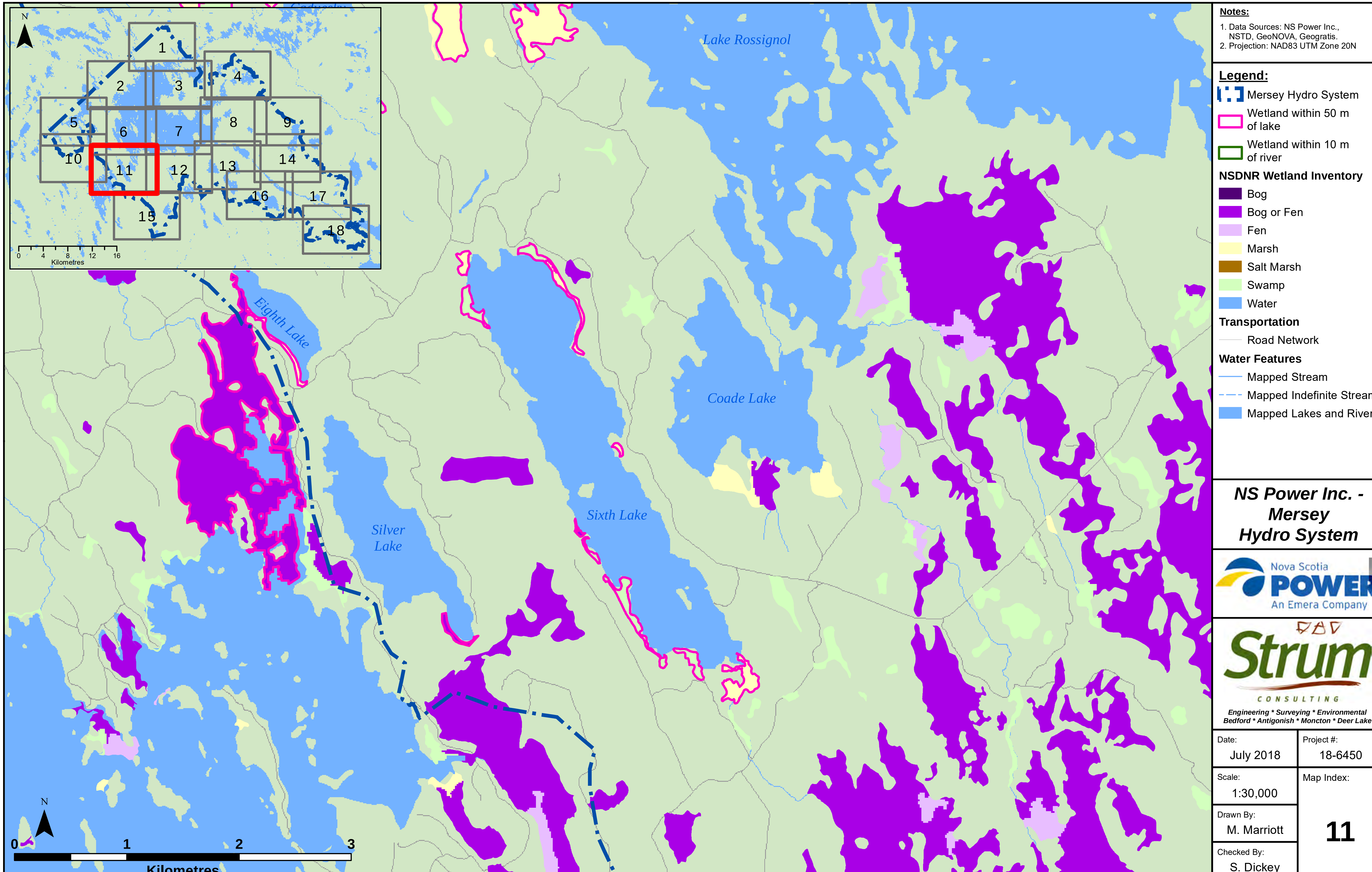

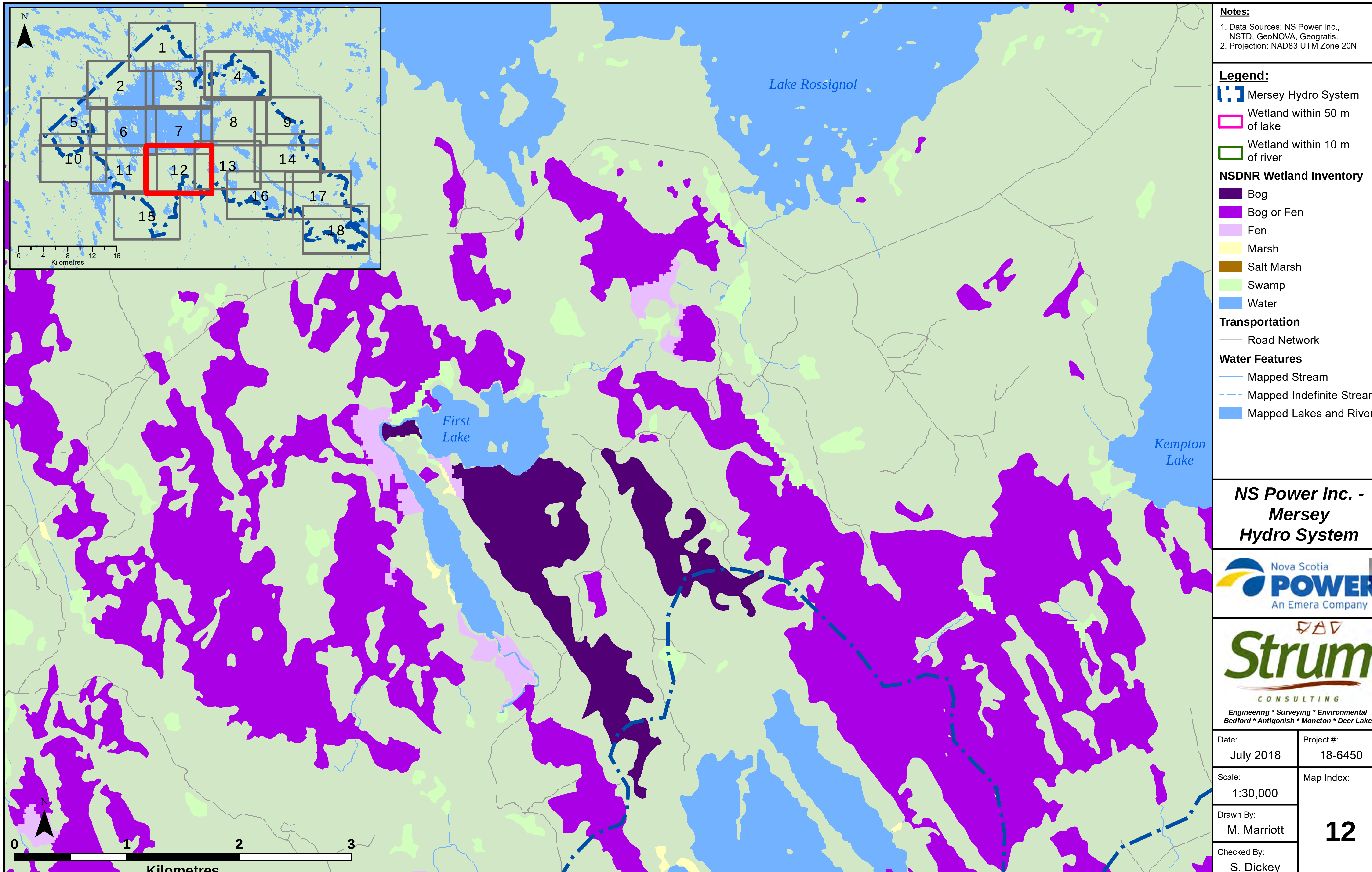
Lake Rossignol
First Lake
Kempton Lake
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0 4 8 12 16
Kilometres
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Mersey Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Mersey Hydro System
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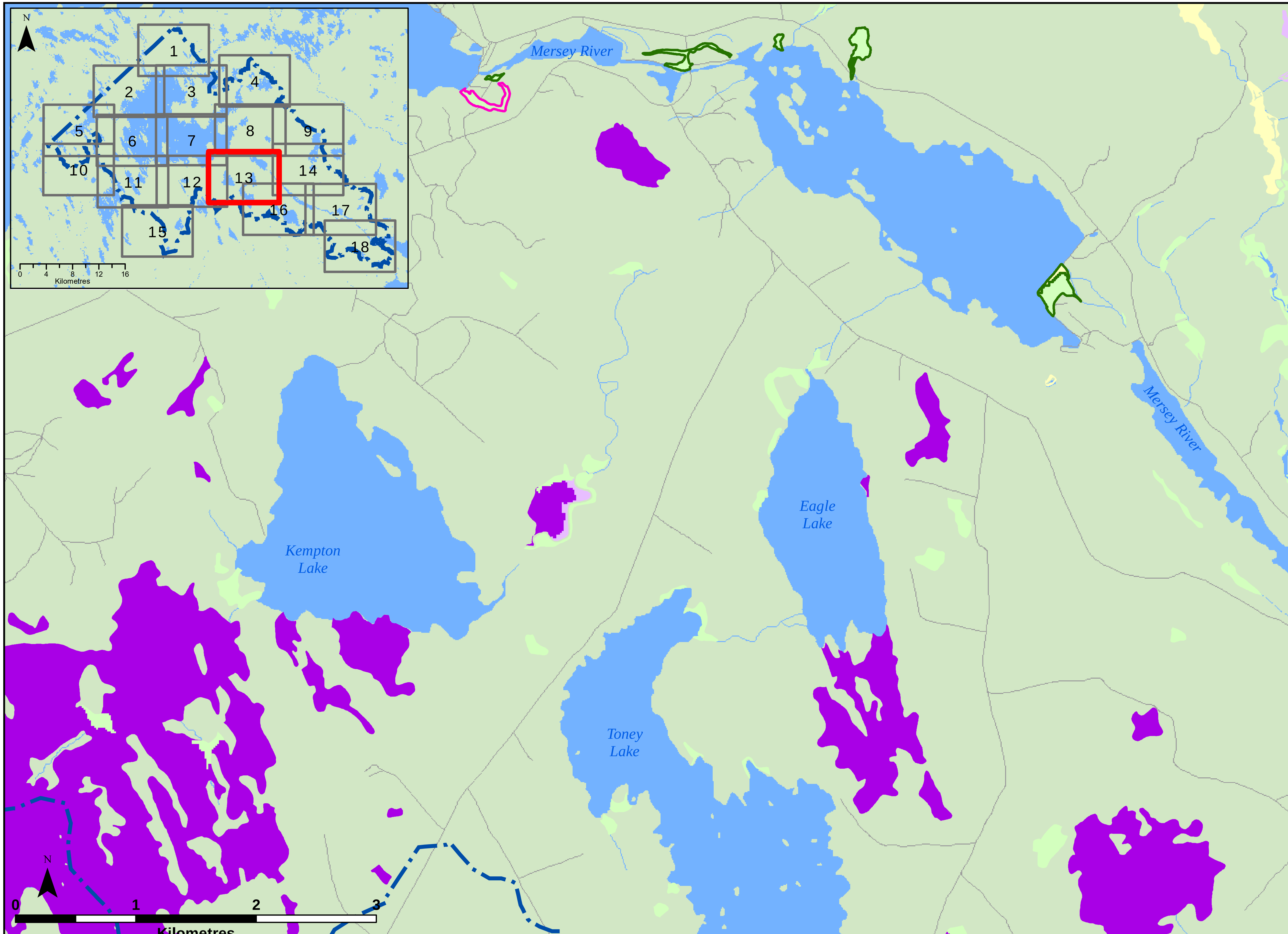
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 12
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 13
Drawn By: M. Marriott	
Checked By: S. Dickey	

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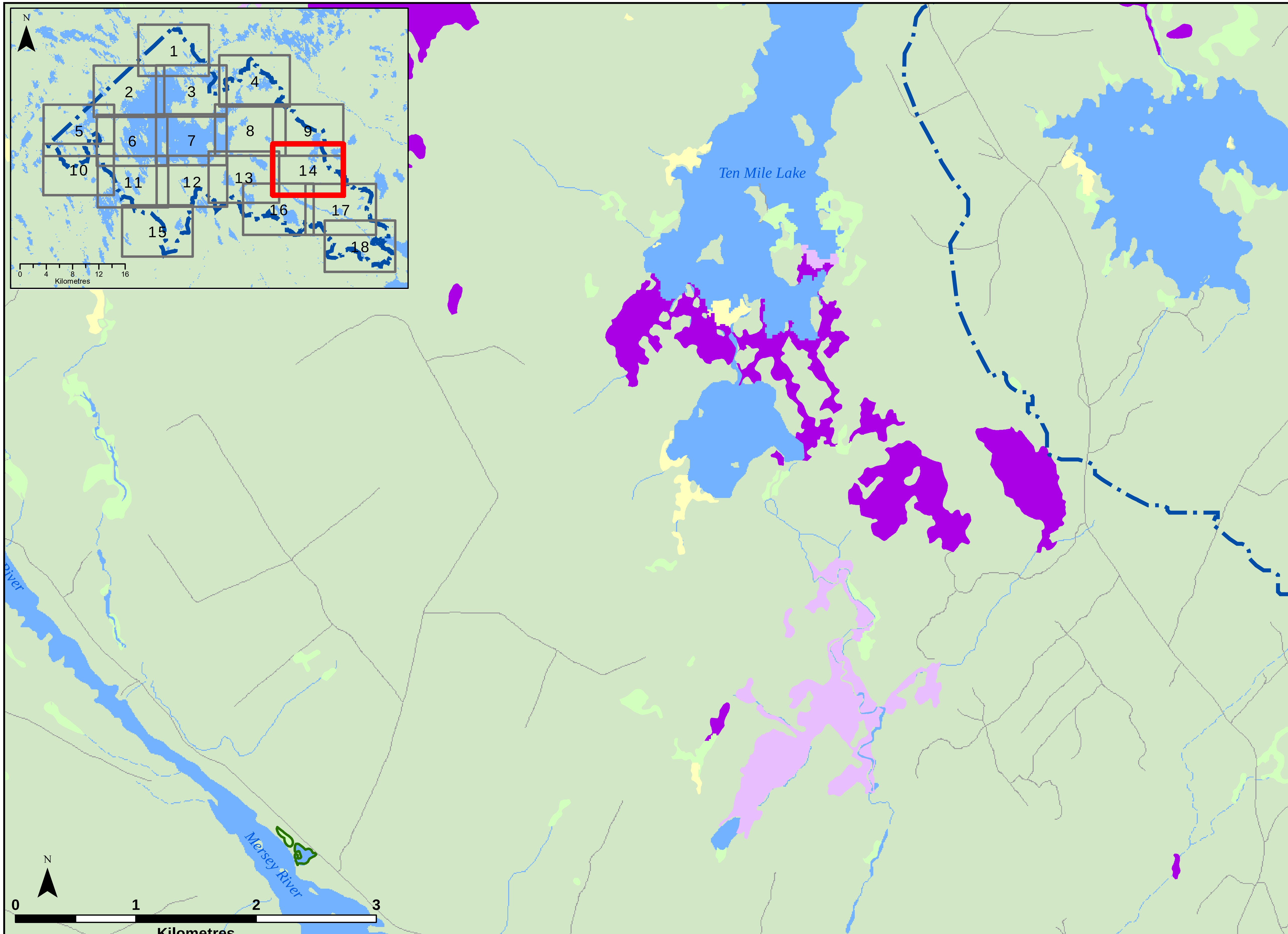

Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 14
Drawn By: M. Marriott	
Checked By: S. Dickey	

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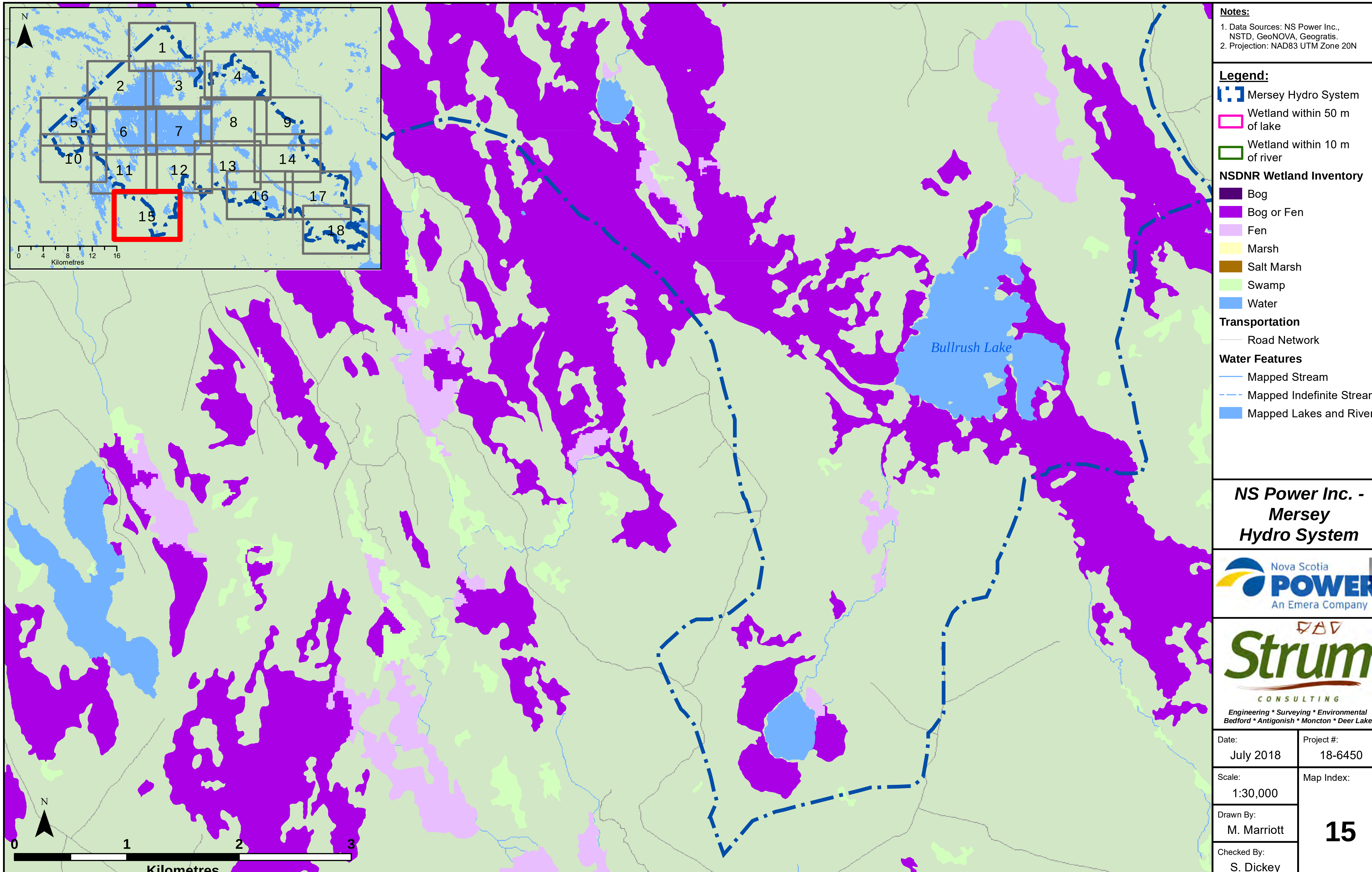

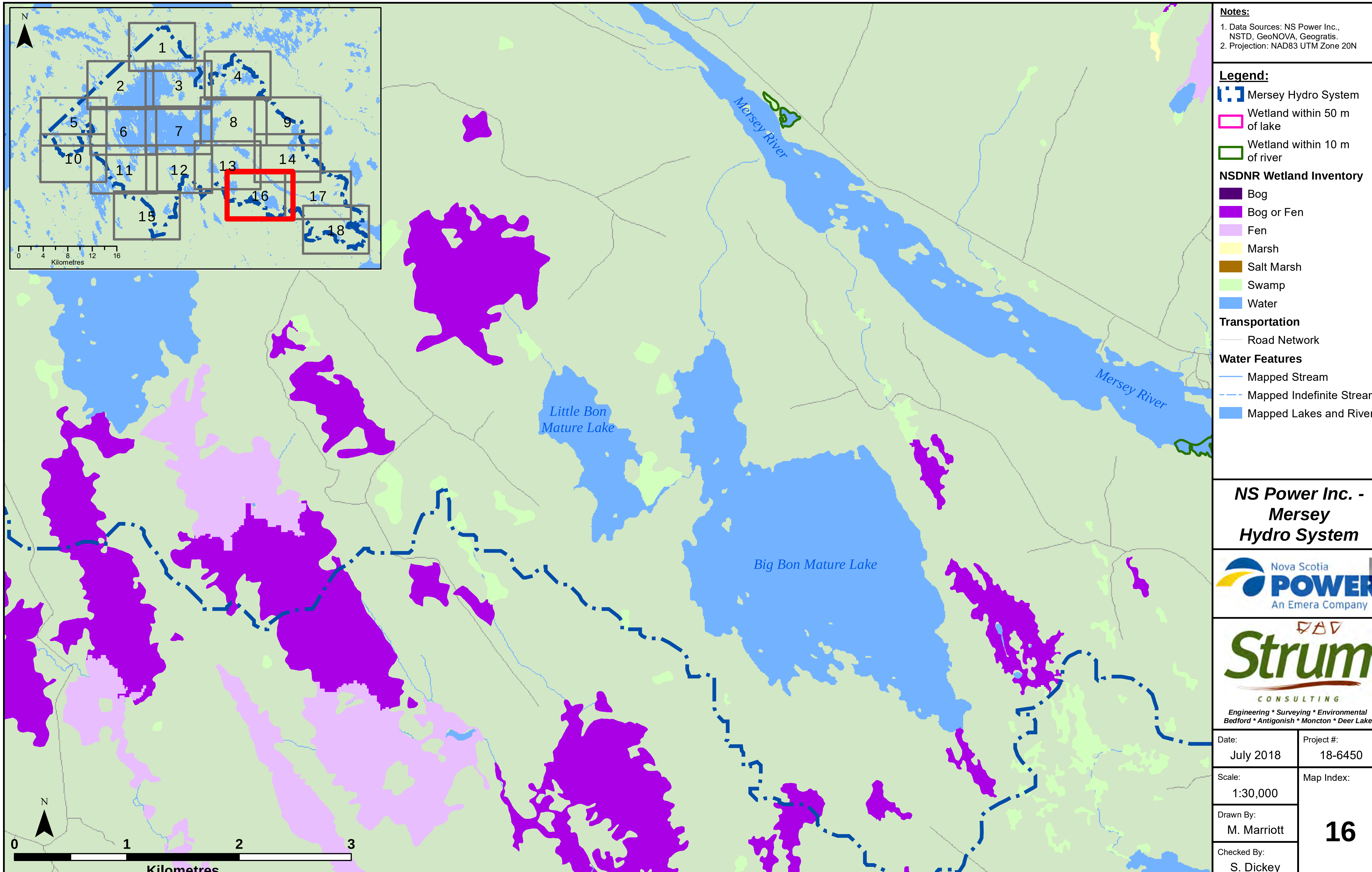
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Mersey Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
Mersey River
Mersey River
Little Bon Mature Lake
Big Bon Mature Lake
N
0 1 2 3
Kilometres
N
0 4 8 12 16
Kilometres
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
NS Power Inc. - Mersey Hydro System
Nova Scotia POWER
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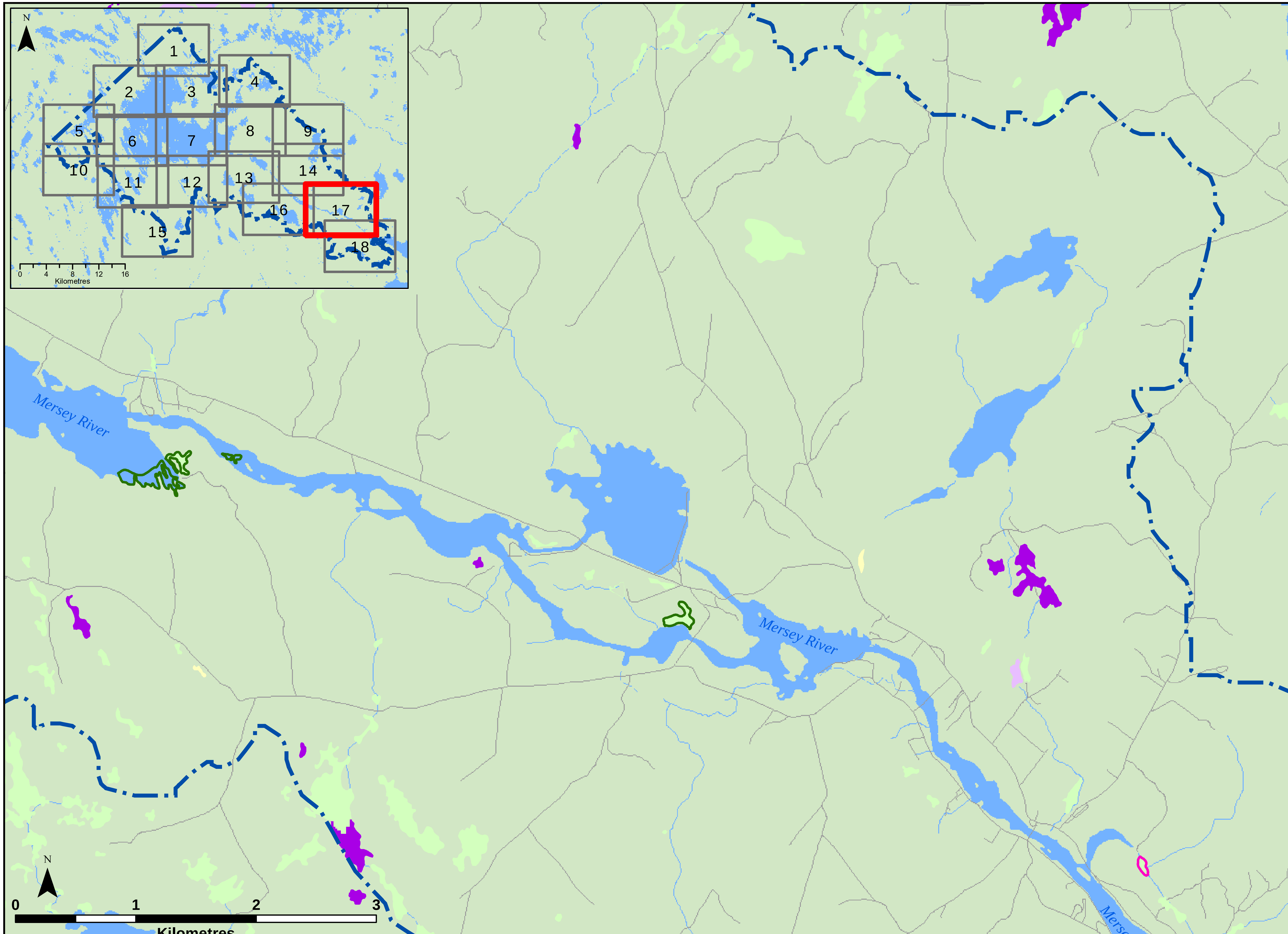
Bedford * Antigonish * Moncton * Deer Lake
Date:
July 2018
Project #:
18-6450
Scale:
1:30,000
Map Index:
16
Drawn By:
M. Marriott
Checked By:
S. Dickey

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Mersey Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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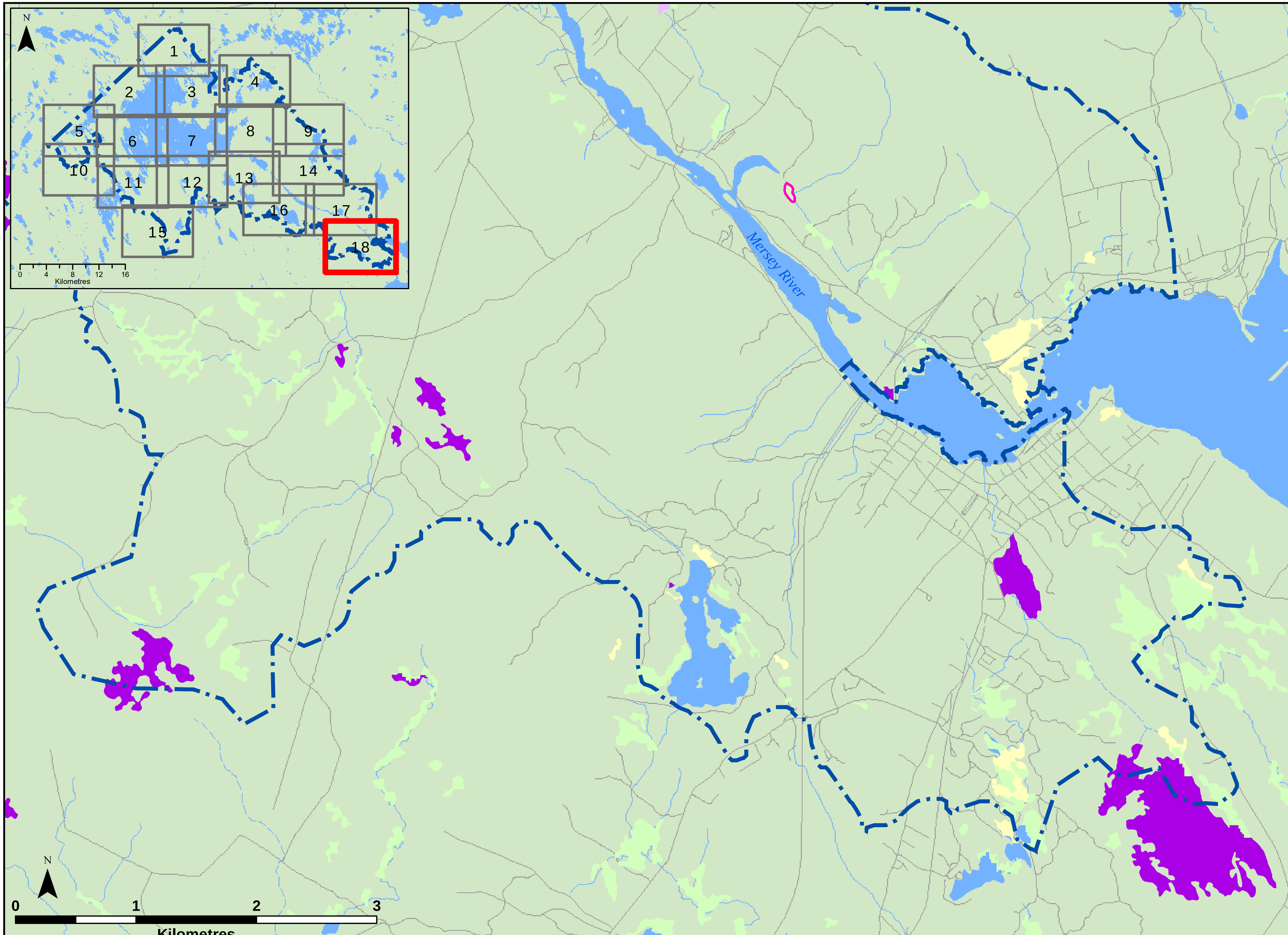
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 17
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
Mersey Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - Mersey Hydro System

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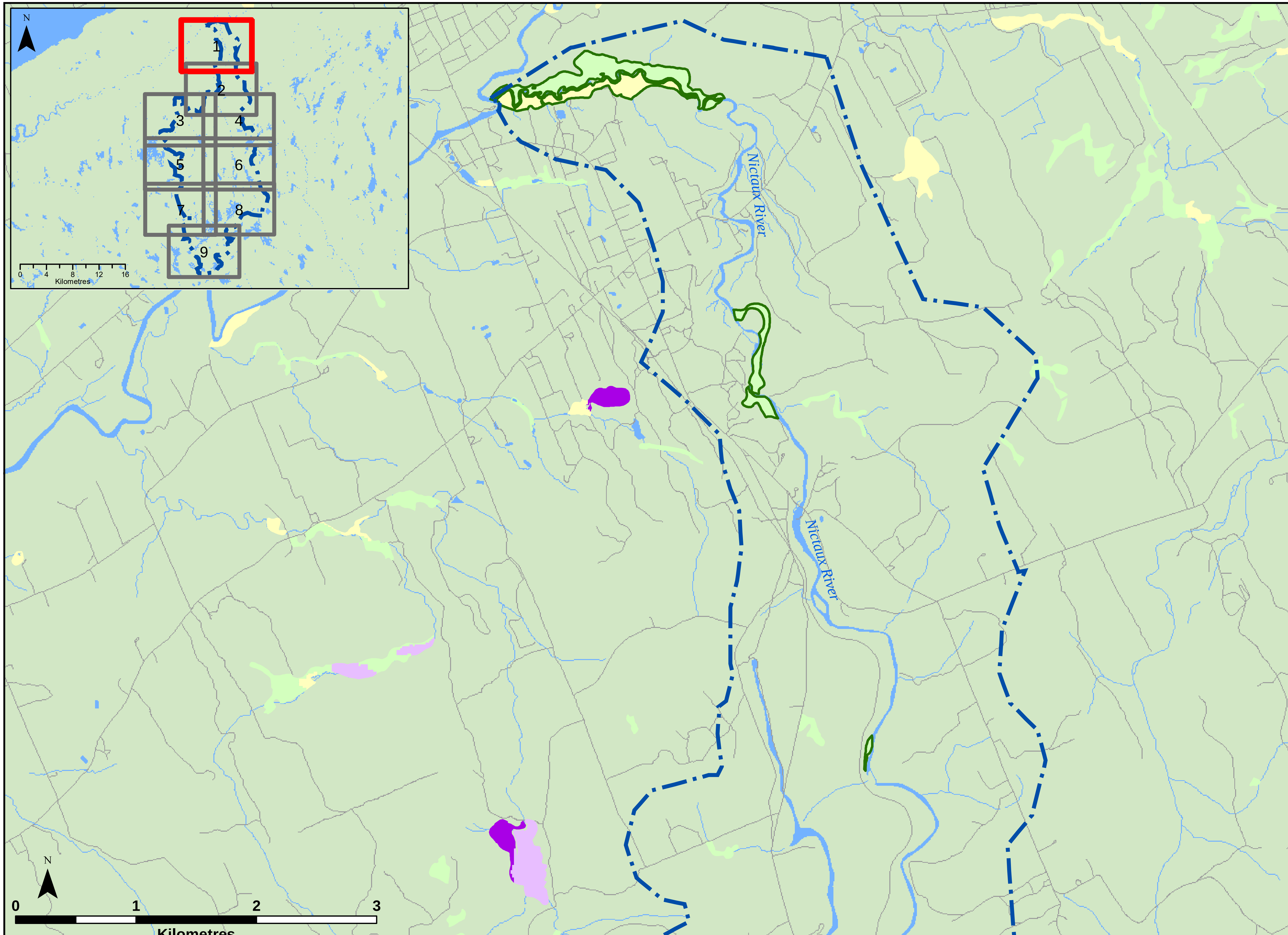
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 18
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Nictaux Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Nictaux Hydro System

Nova Scotia POWER An Emera Company

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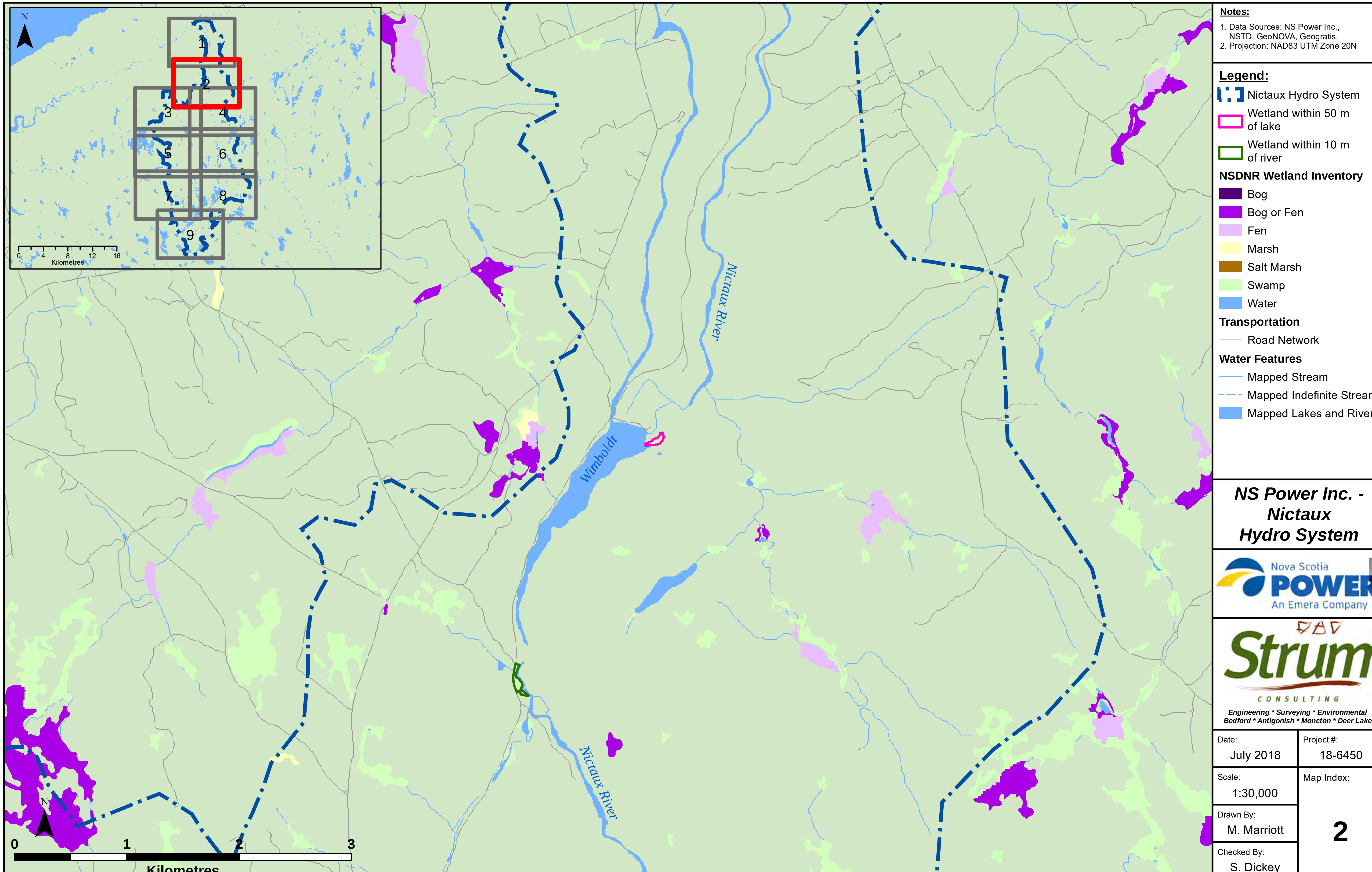
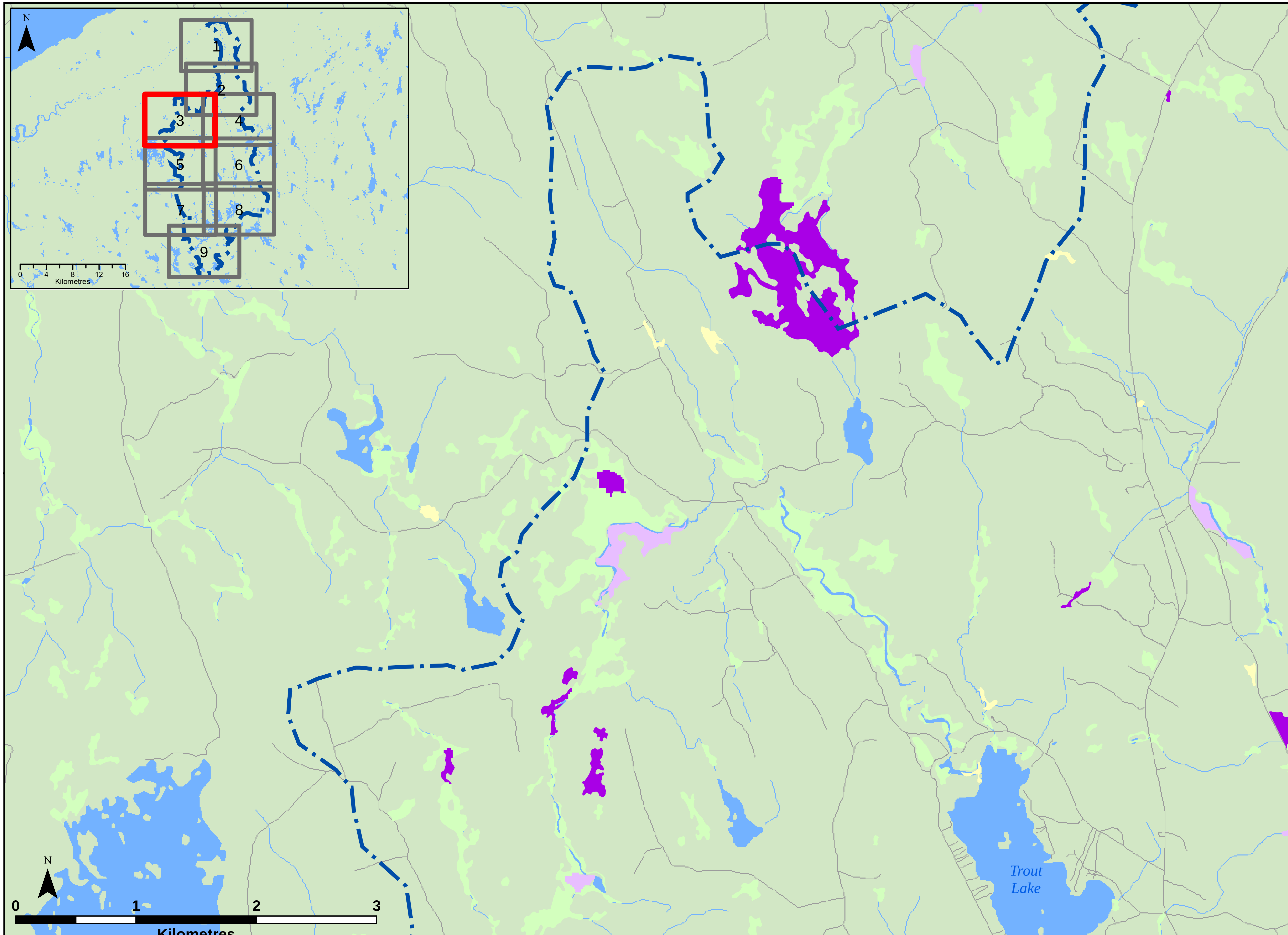
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)





Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Nictaux Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Nictaux Hydro System

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Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	

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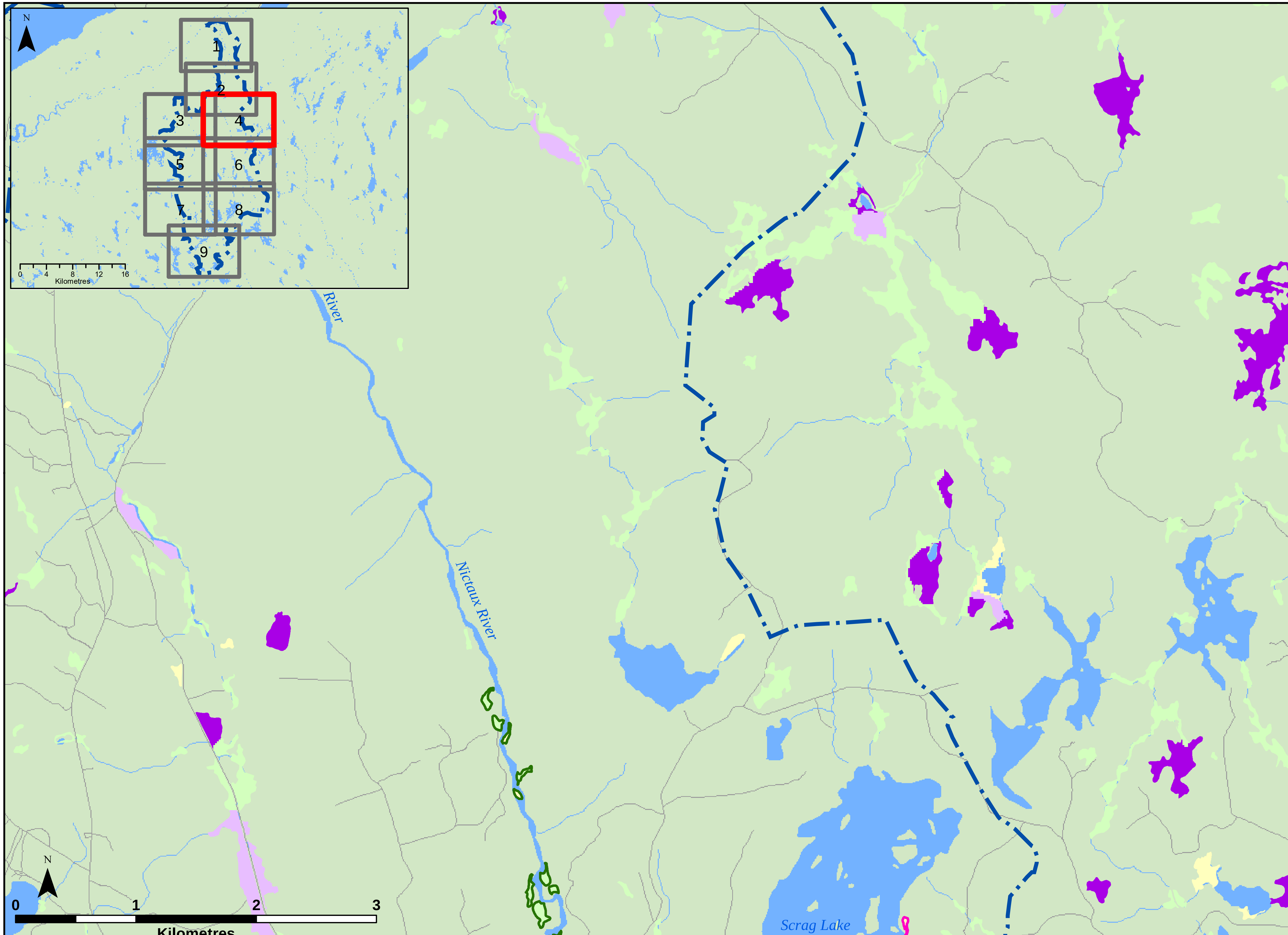

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Nictaux Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Nictaux Hydro System

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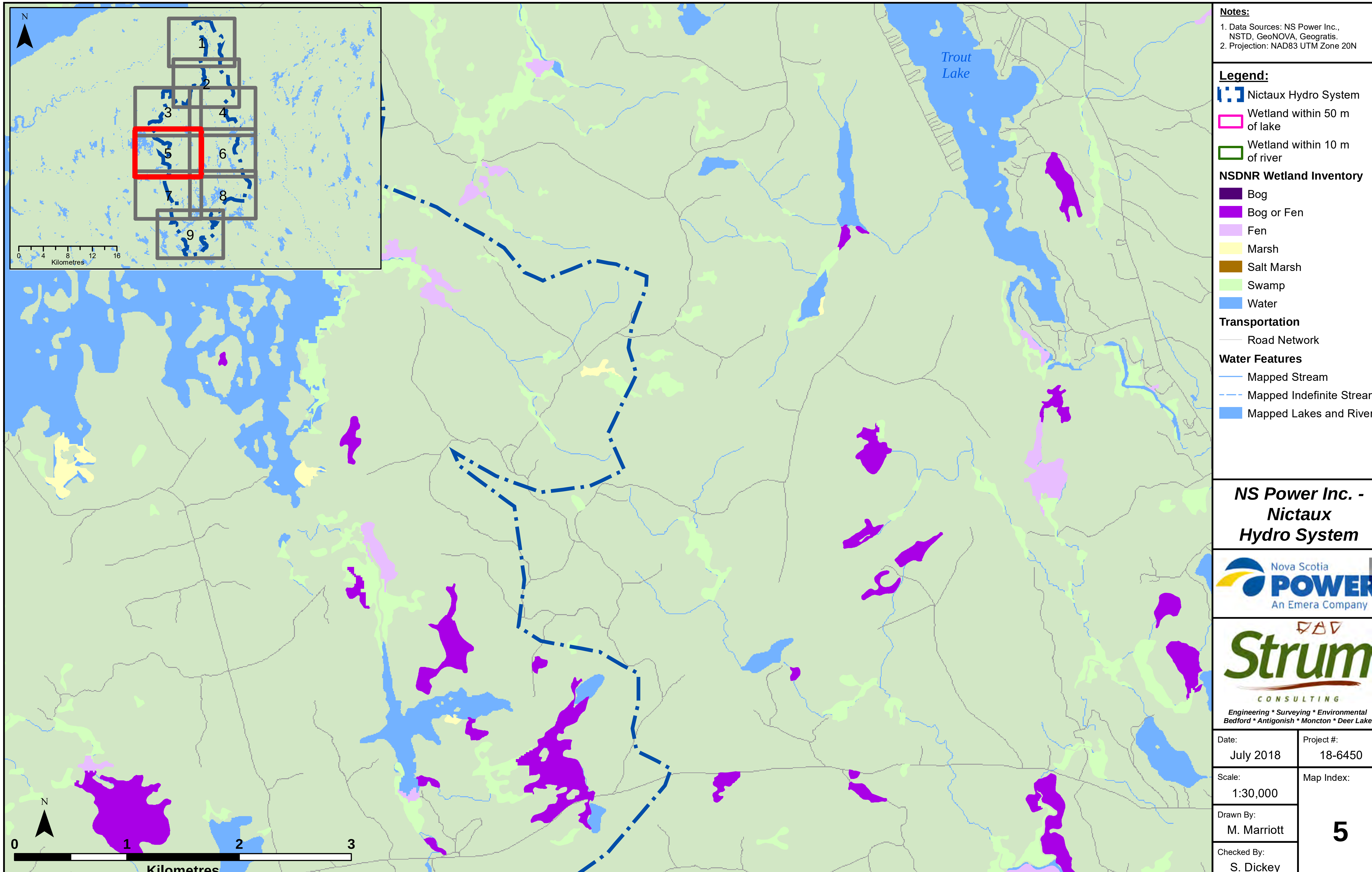
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	


Trout Lake
N
1
2
3
4
5
6
7
8
9
0 4 8 12 16
Kilometres
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Nictaux Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Nictaux Hydro System
Nova Scotia POWER An Emera Company
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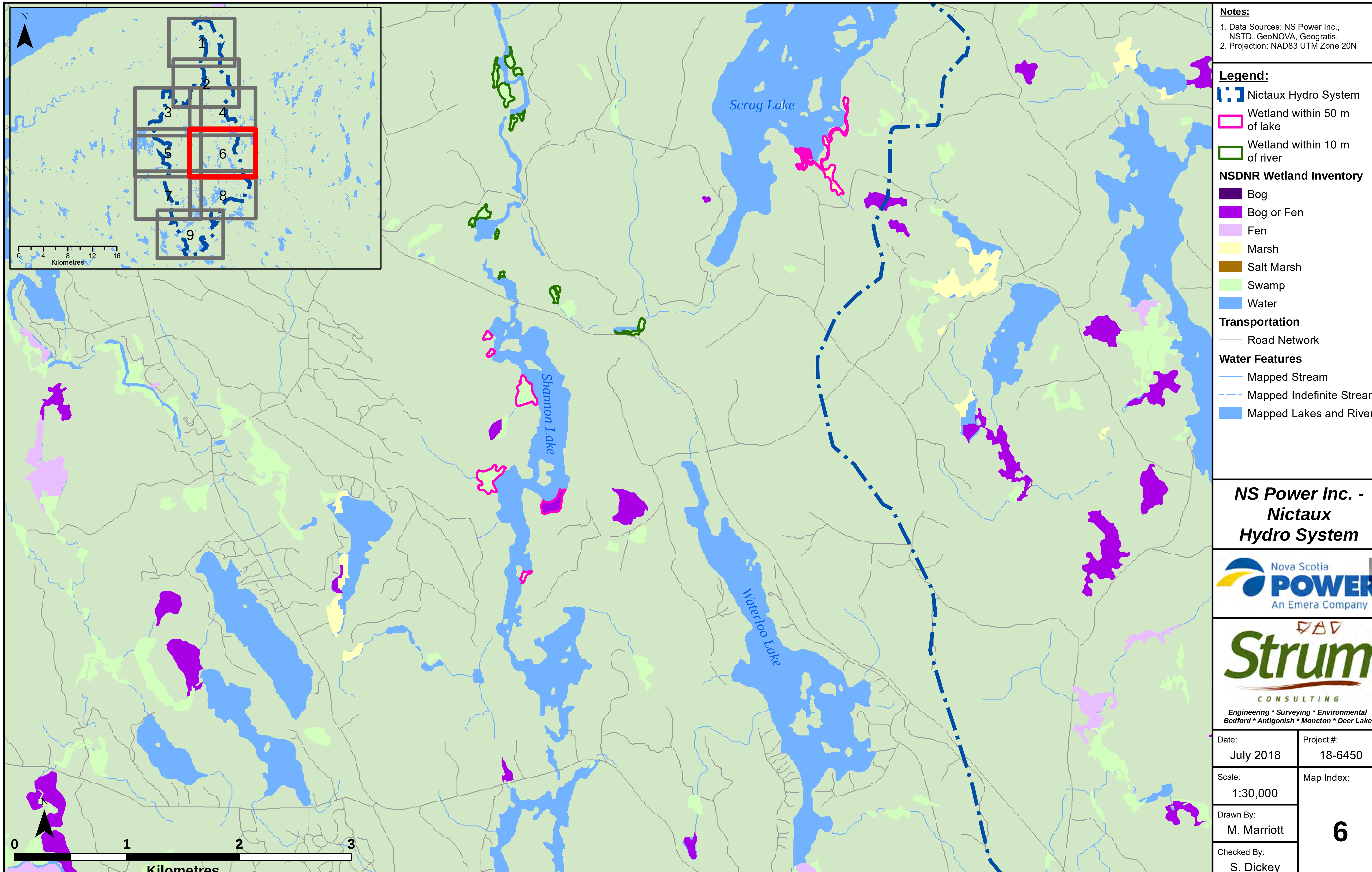
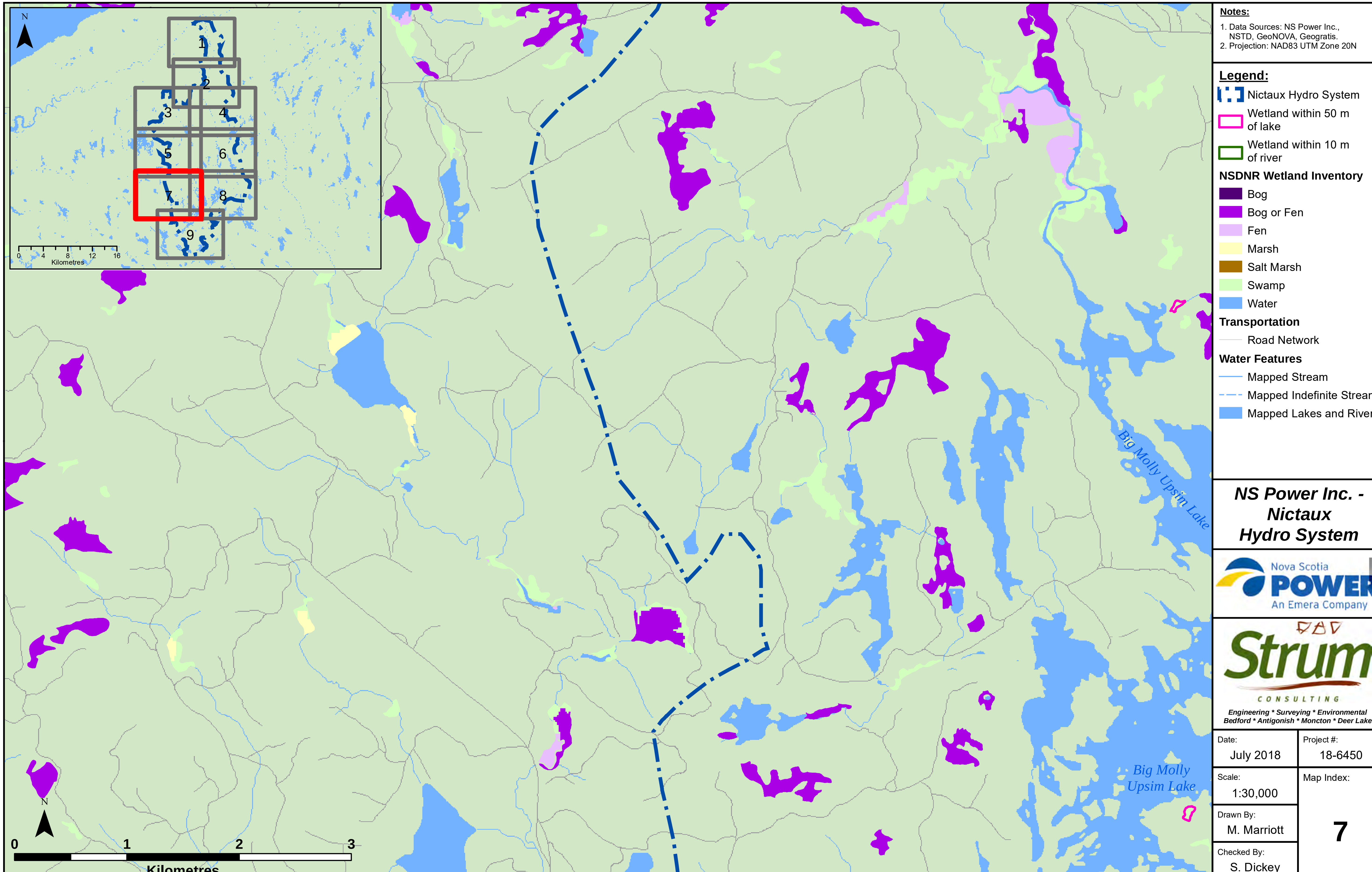
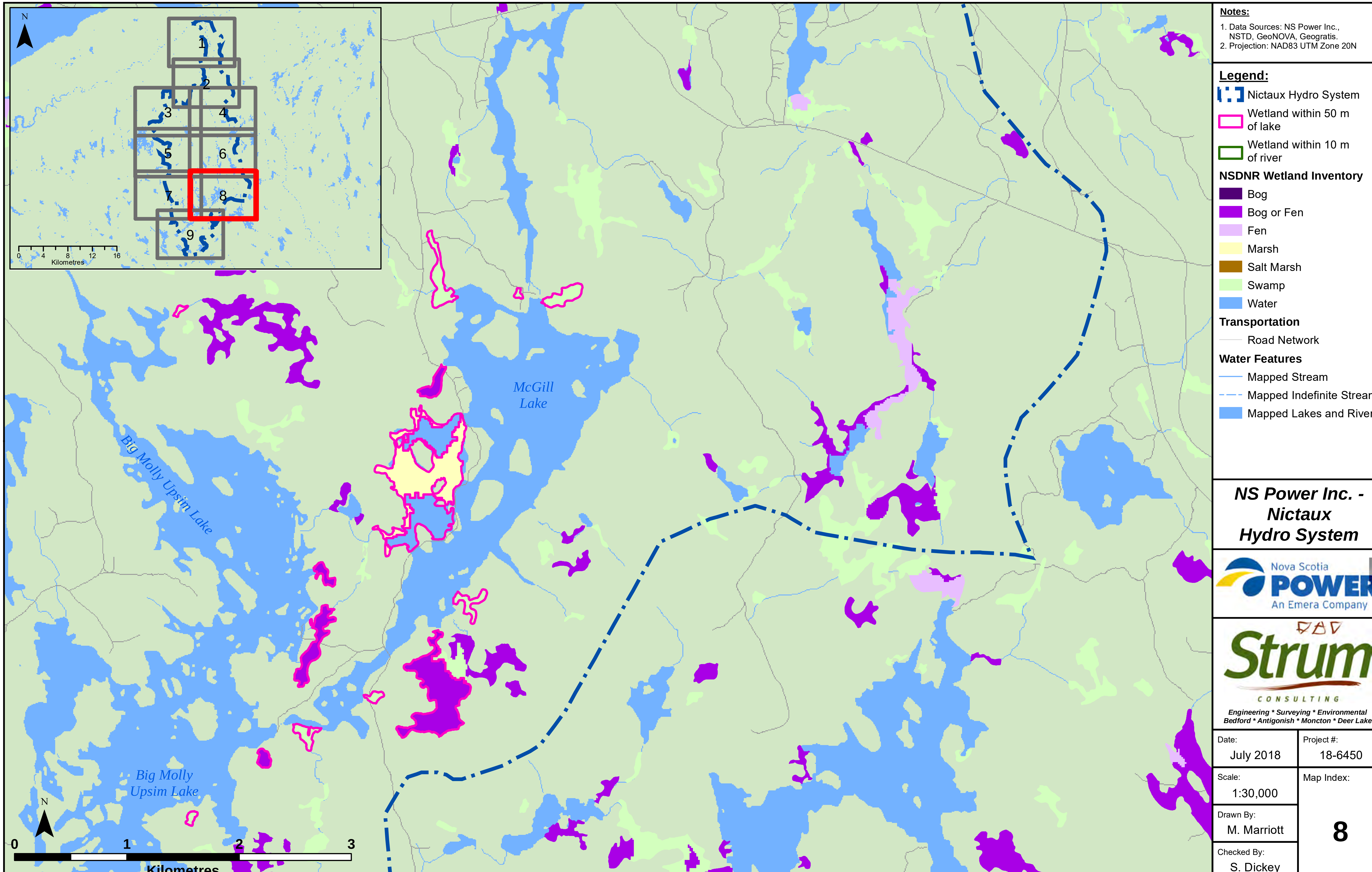
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 5
Drawn By: M. Marriott
Checked By: S. Dickey

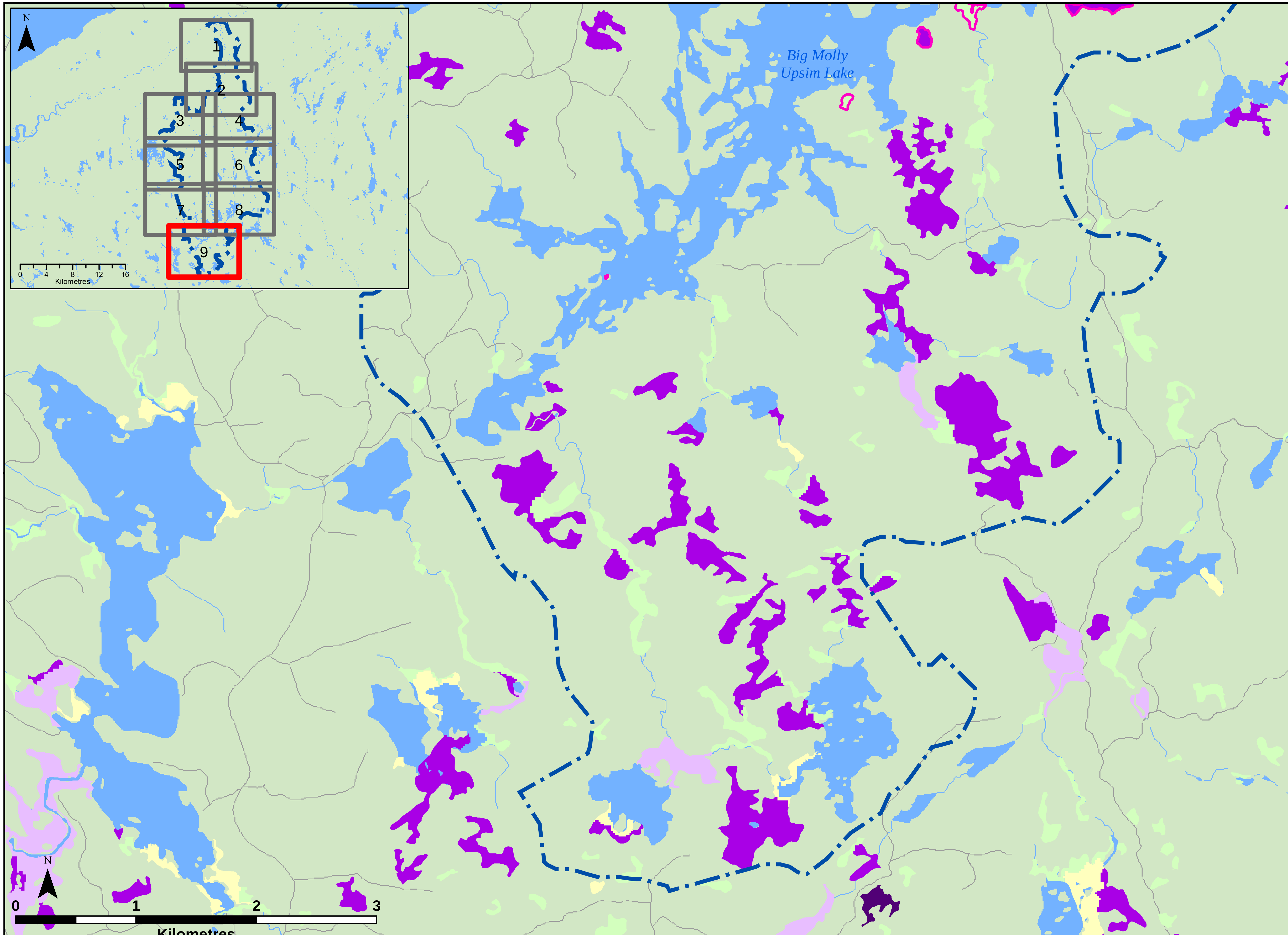

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Nictaux Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
Scrag Lake
Shannon Lake
Waterloo Lake
0 1 2 3
Kilometres
NS Power Inc. - Nictaux Hydro System
Nova Scotia POWER
An Emera Company
Strum
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 6
Drawn By: M. Marriott
Checked By: S. Dickey

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



REDACTED (CONFIDENTIAL INFORMATION REMOVED)





Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Nictaux Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Nictaux Hydro System

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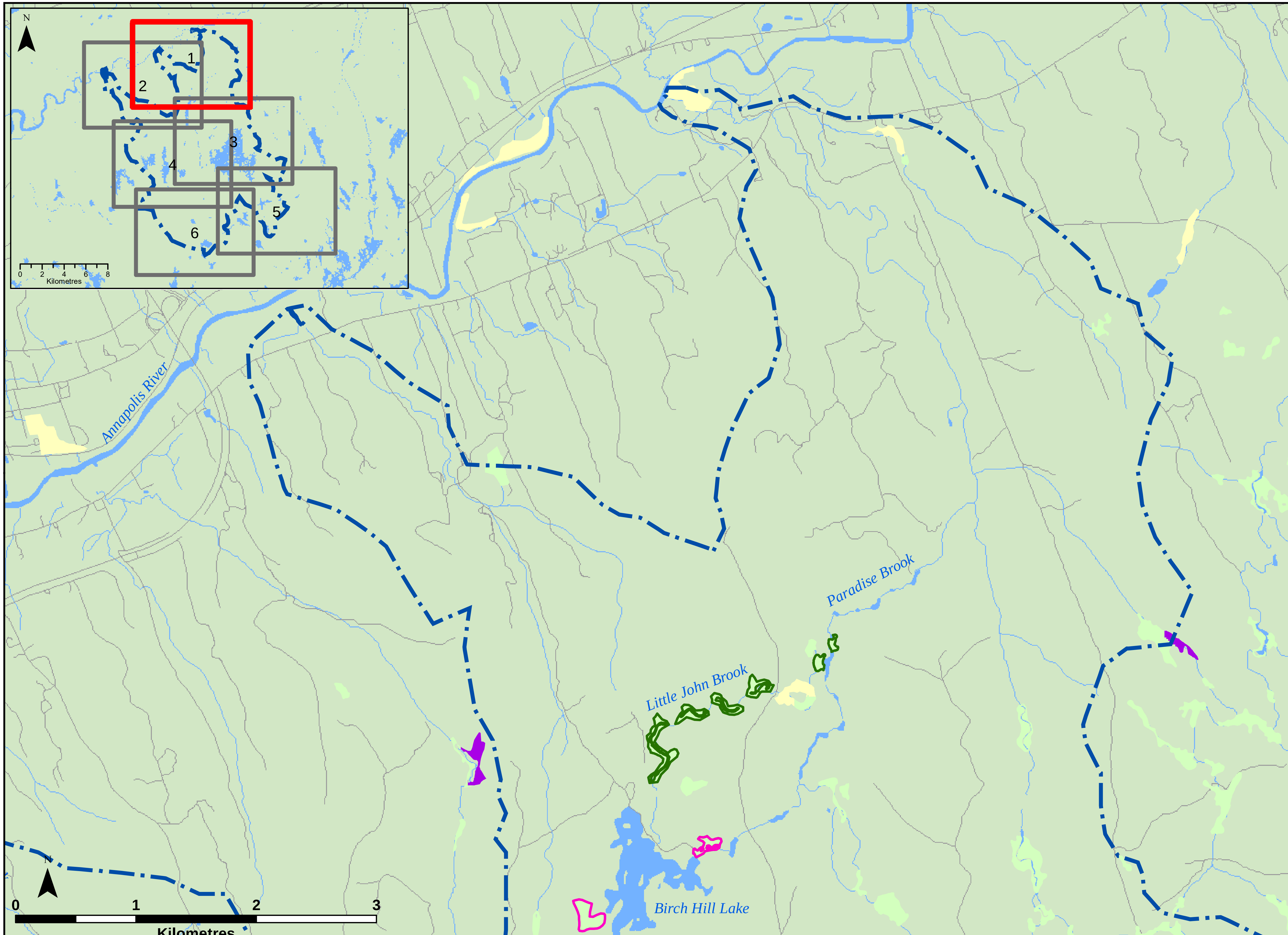
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Paradise Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Paradise Hydro System

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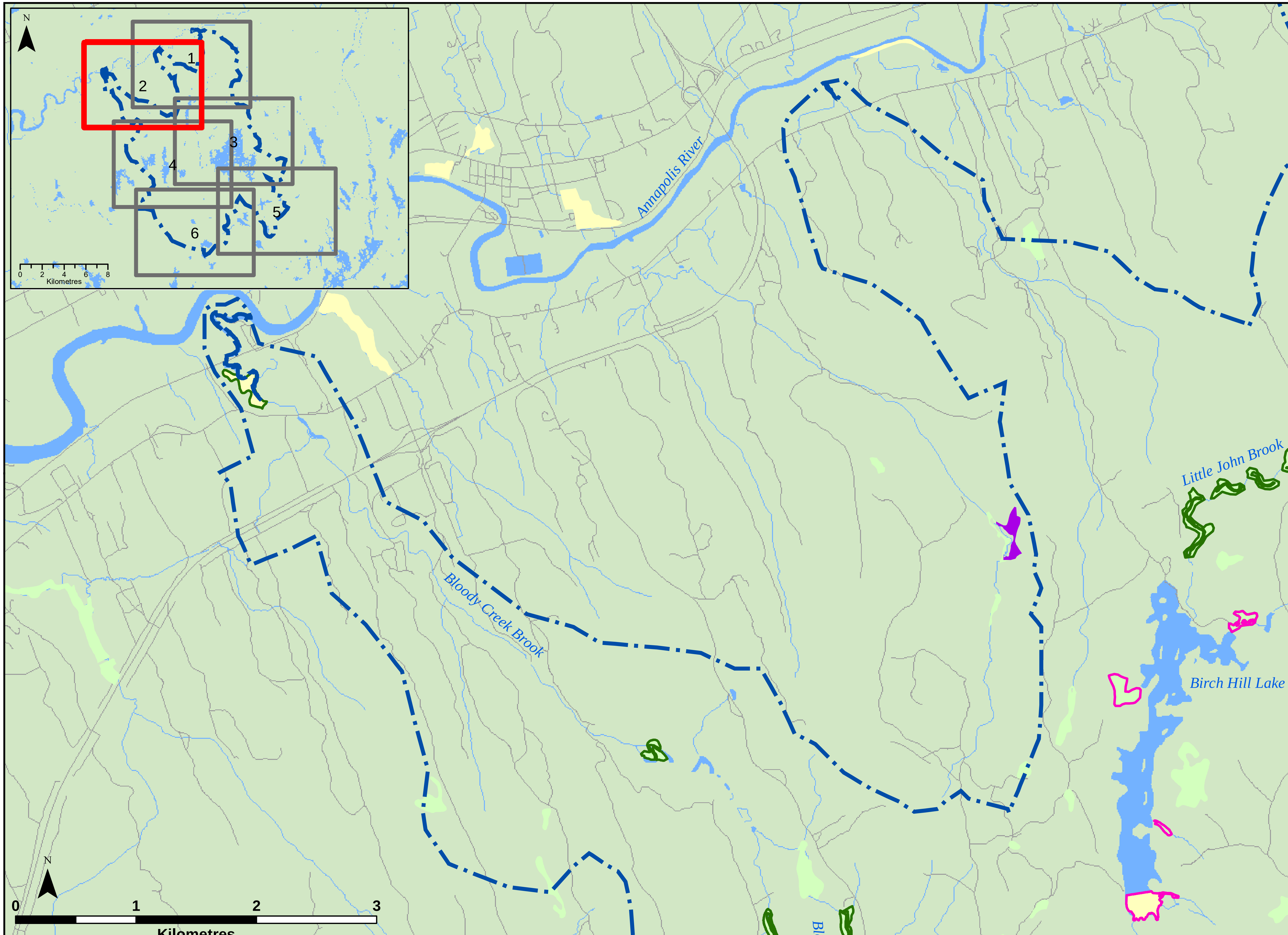
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Paradise Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

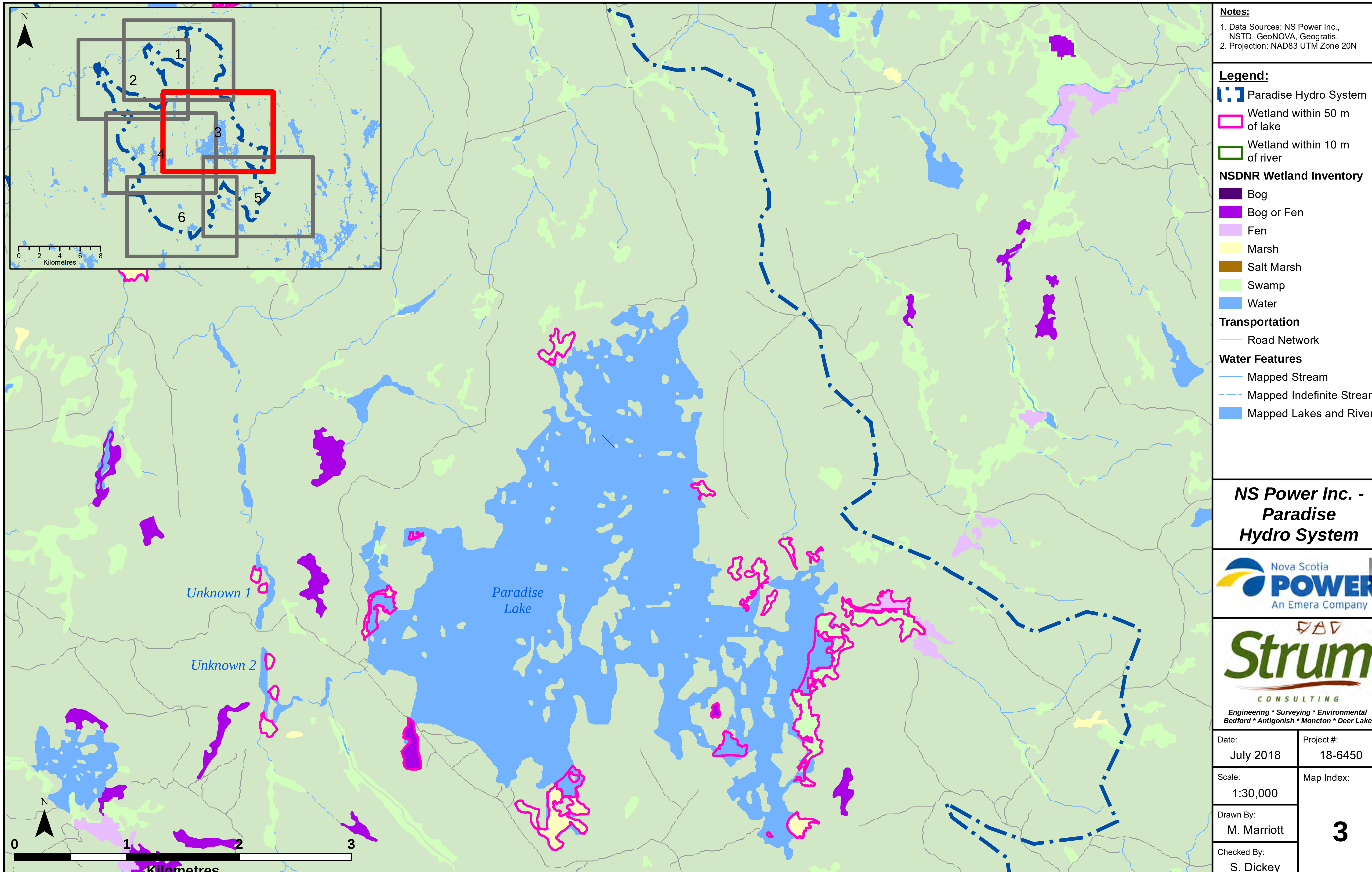
Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Paradise Hydro System

Nova Scotia POWER An Emera Company

Strum CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	


N
1
2
3
4
5
6
0 2 4 6 8
Kilometres
Unknown 1
Unknown 2
Paradise Lake
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Paradise Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Paradise Hydro System
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Strum CONSULTING
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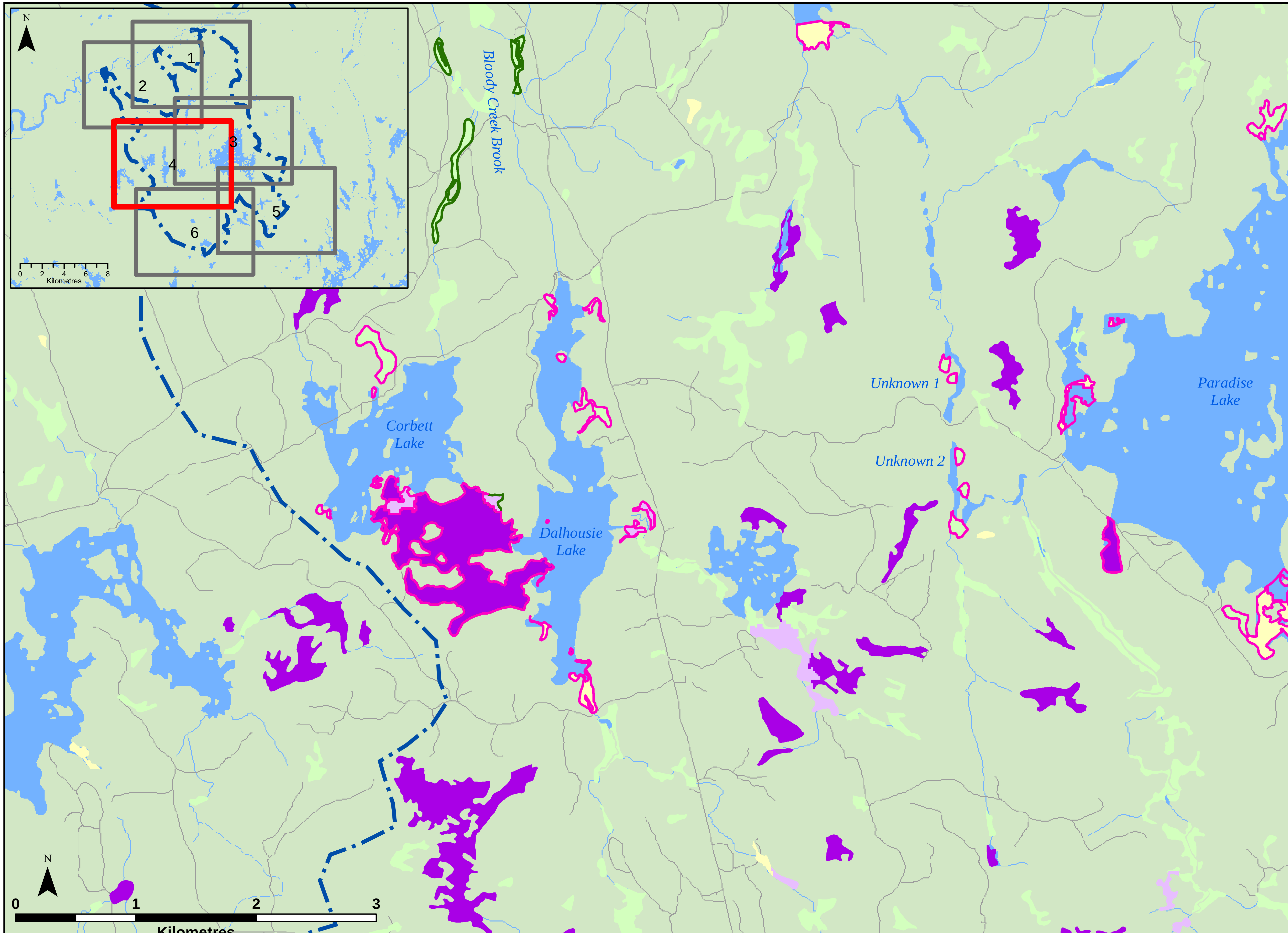
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 3
Drawn By: M. Marriott
Checked By: S. Dickey

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Paradise Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Paradise Hydro System

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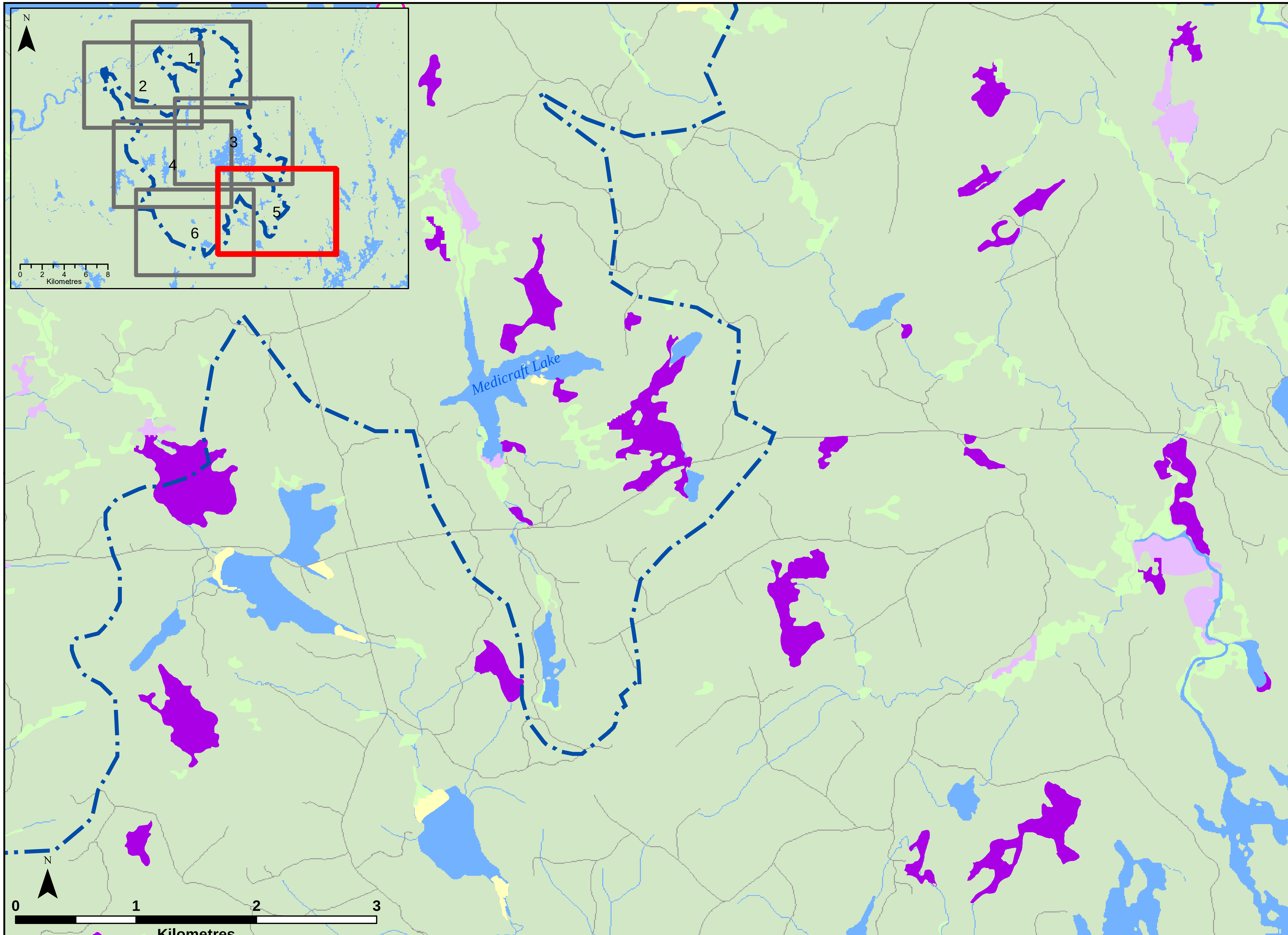
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Paradise Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Paradise Hydro System

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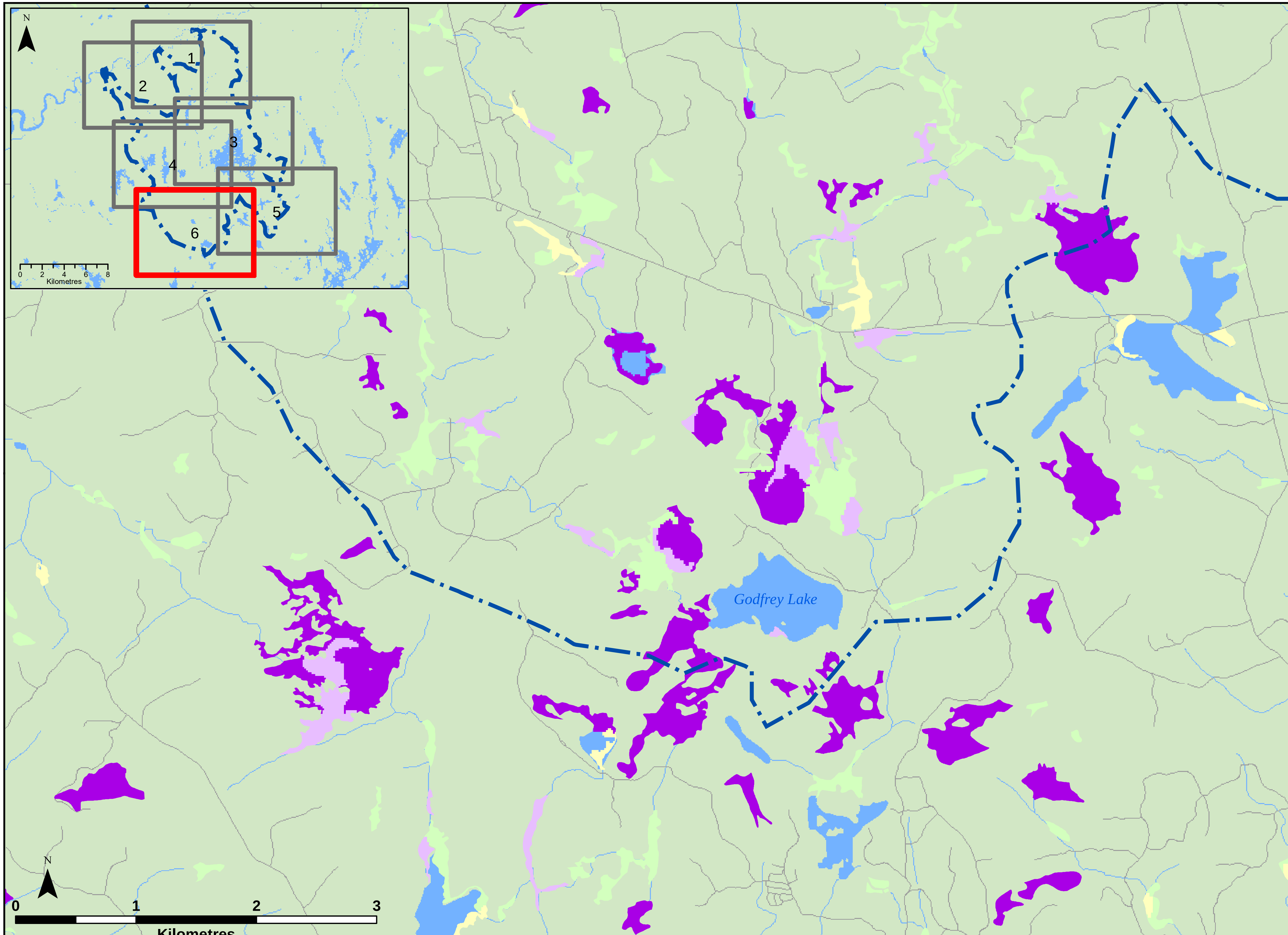
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Paradise Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river

NSDNR Wetland Inventory

Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water

Transportation

Road Network

Water Features

Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - Paradise Hydro System

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Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	

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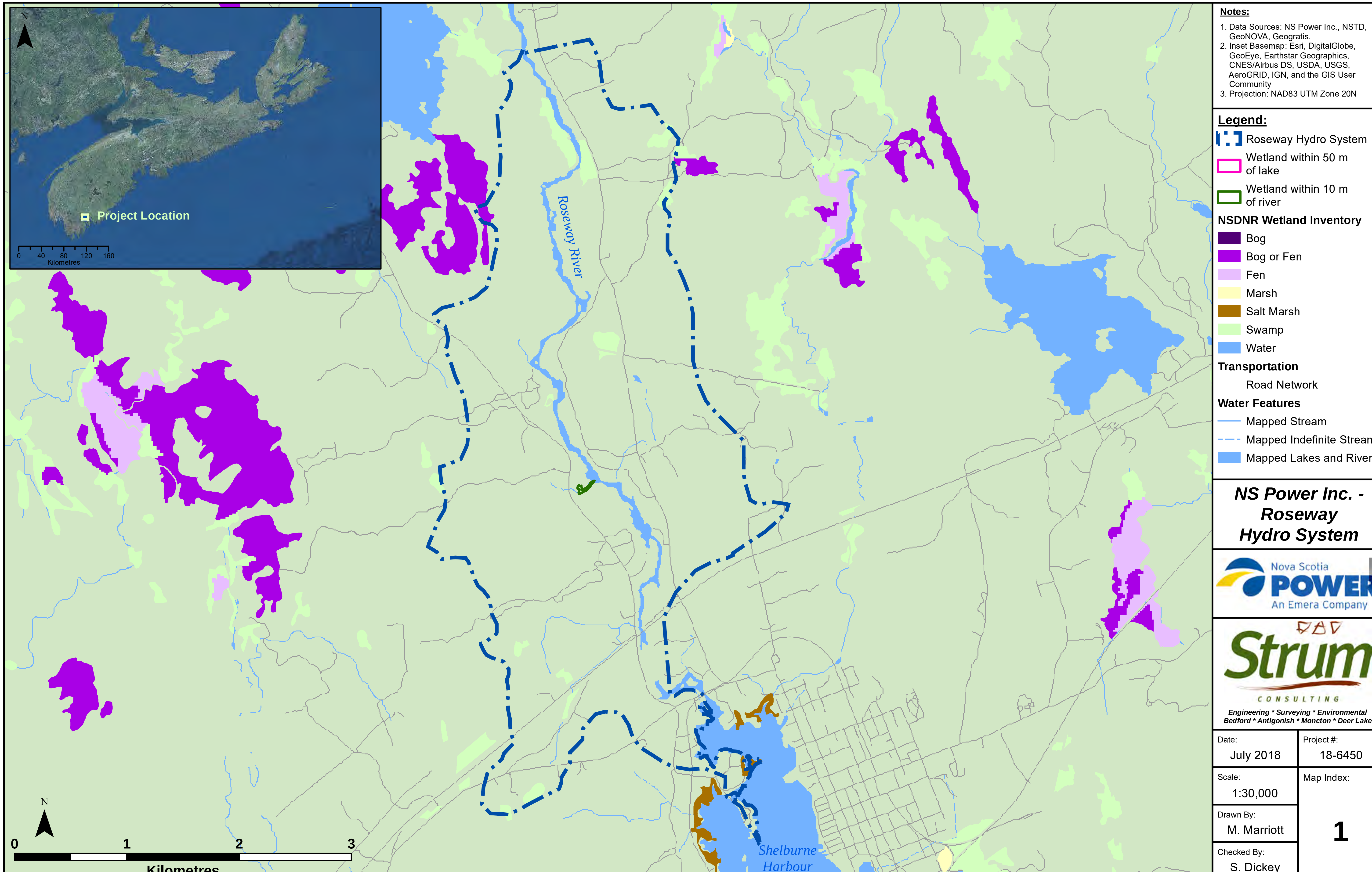

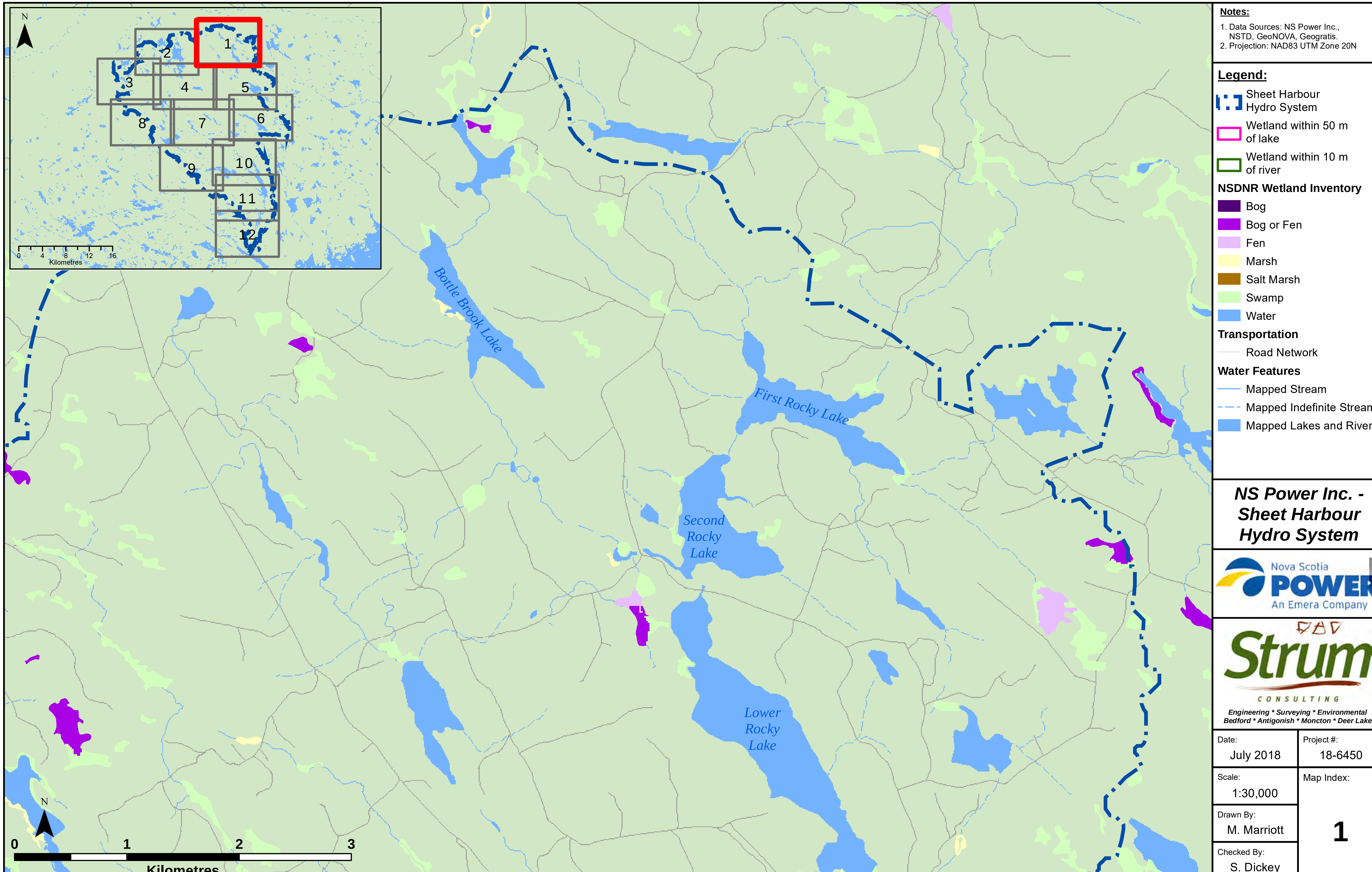
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sheet Harbour Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sheet Harbour Hydro System
Nova Scotia POWER An Emera Company
Strum CONSULTING
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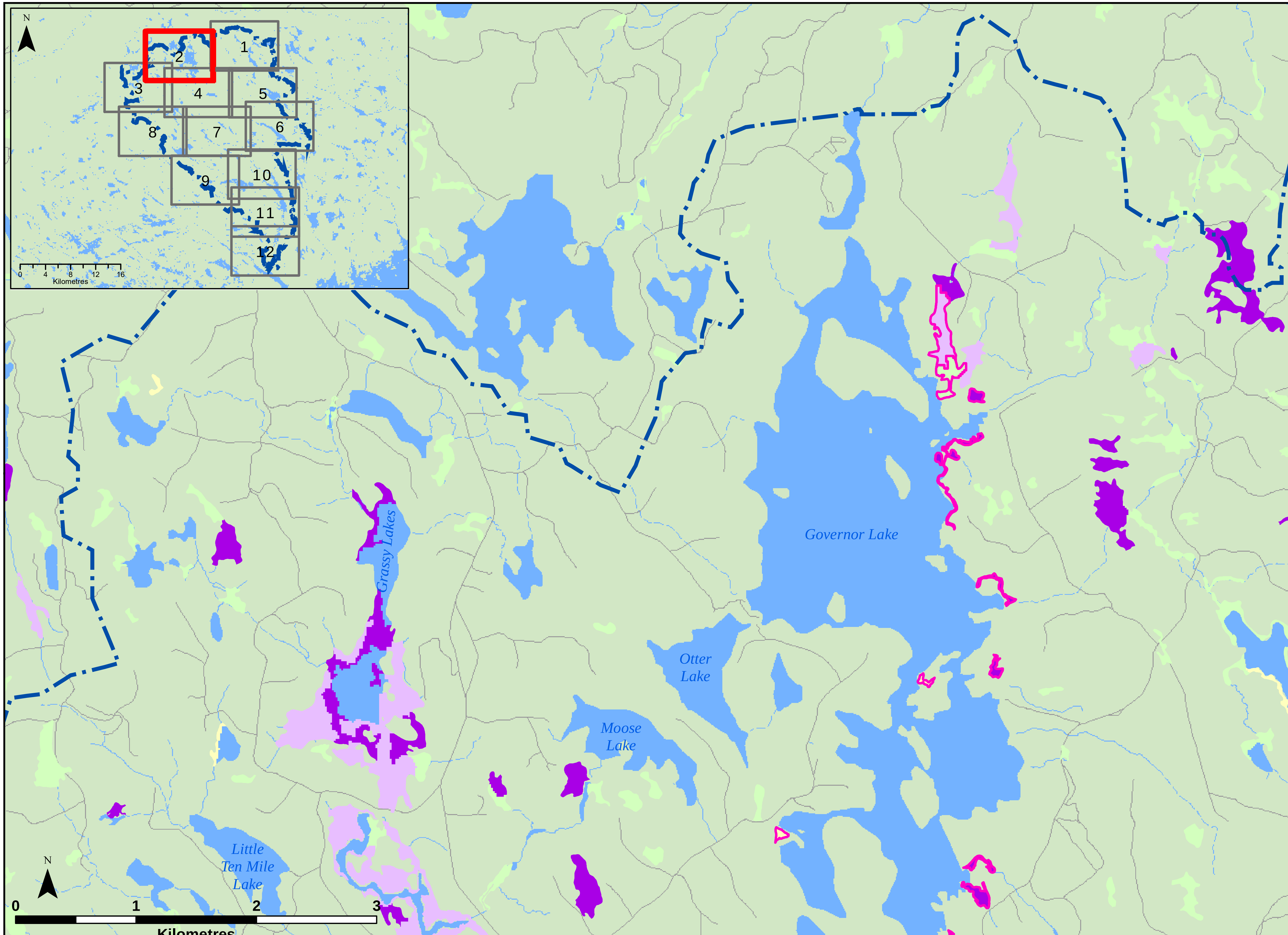
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 1
Drawn By: M. Marriott
Checked By: S. Dickey
Bottle Brook Lake
First Rocky Lake
Second Rocky Lake
Lower Rocky Lake
Kilometres
0 1 2 3
N
1 2 3 4 5 6 7 8 9 10 11 12
0 4 8 12 16
Kilometres

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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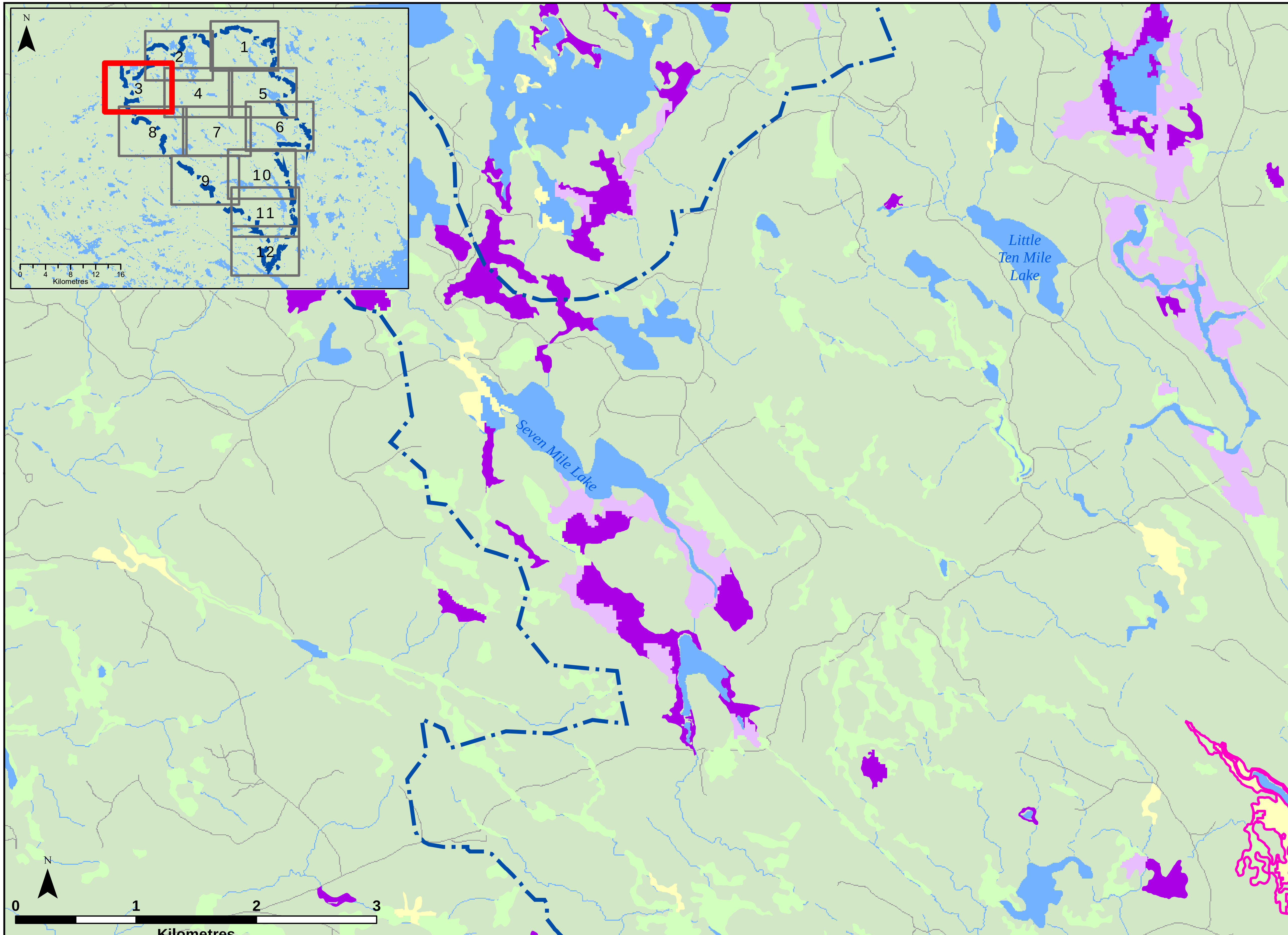
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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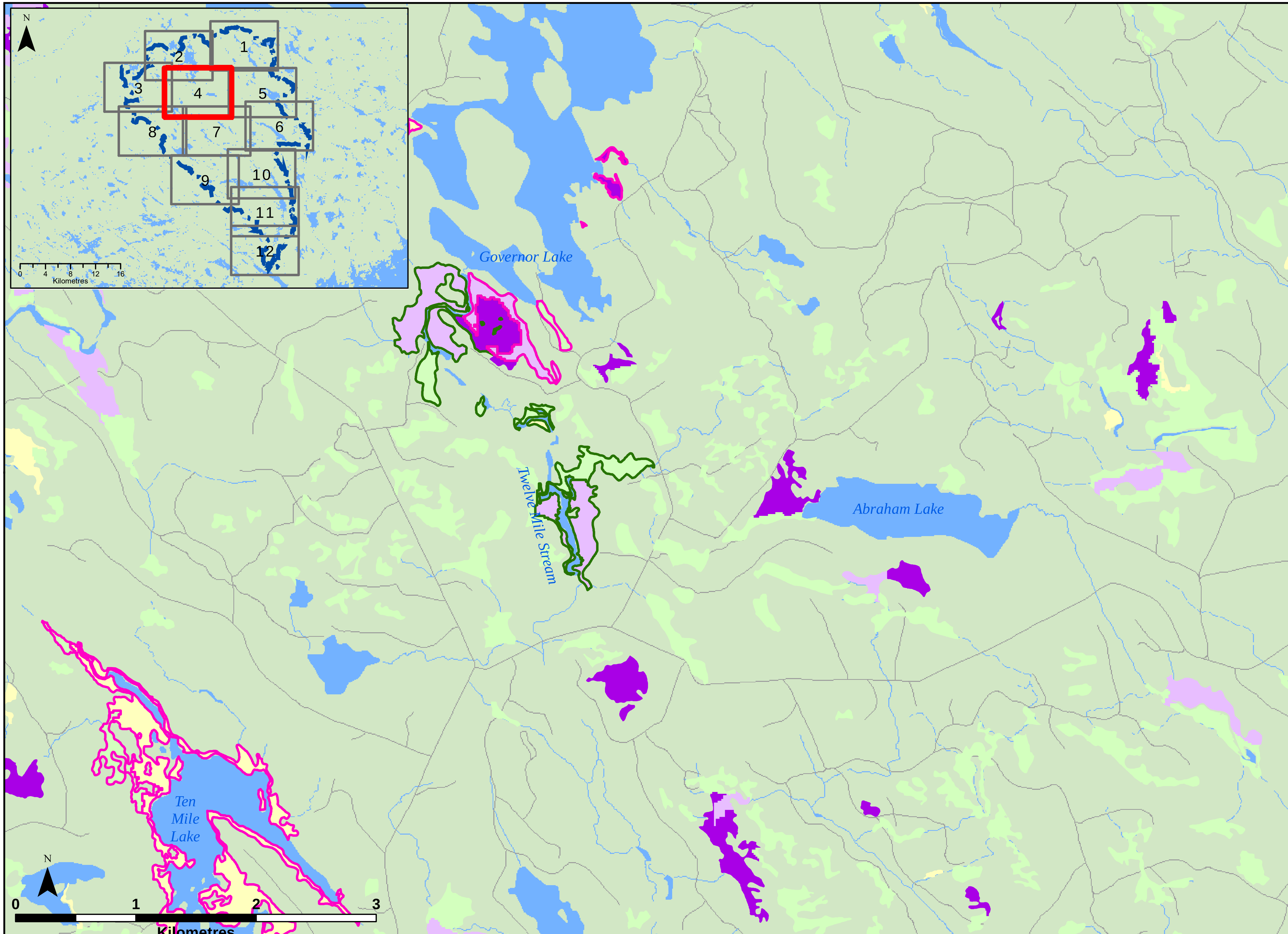
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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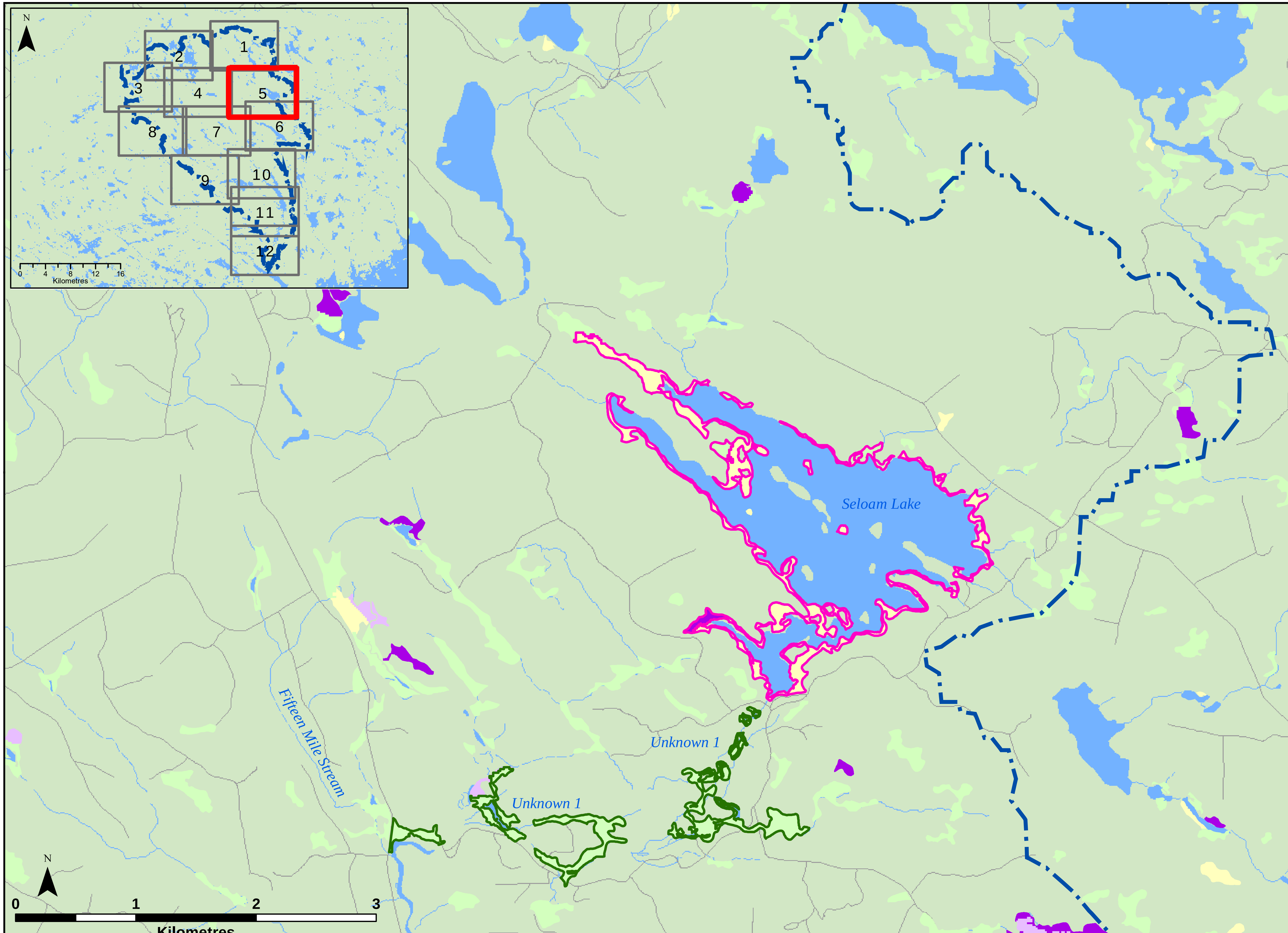
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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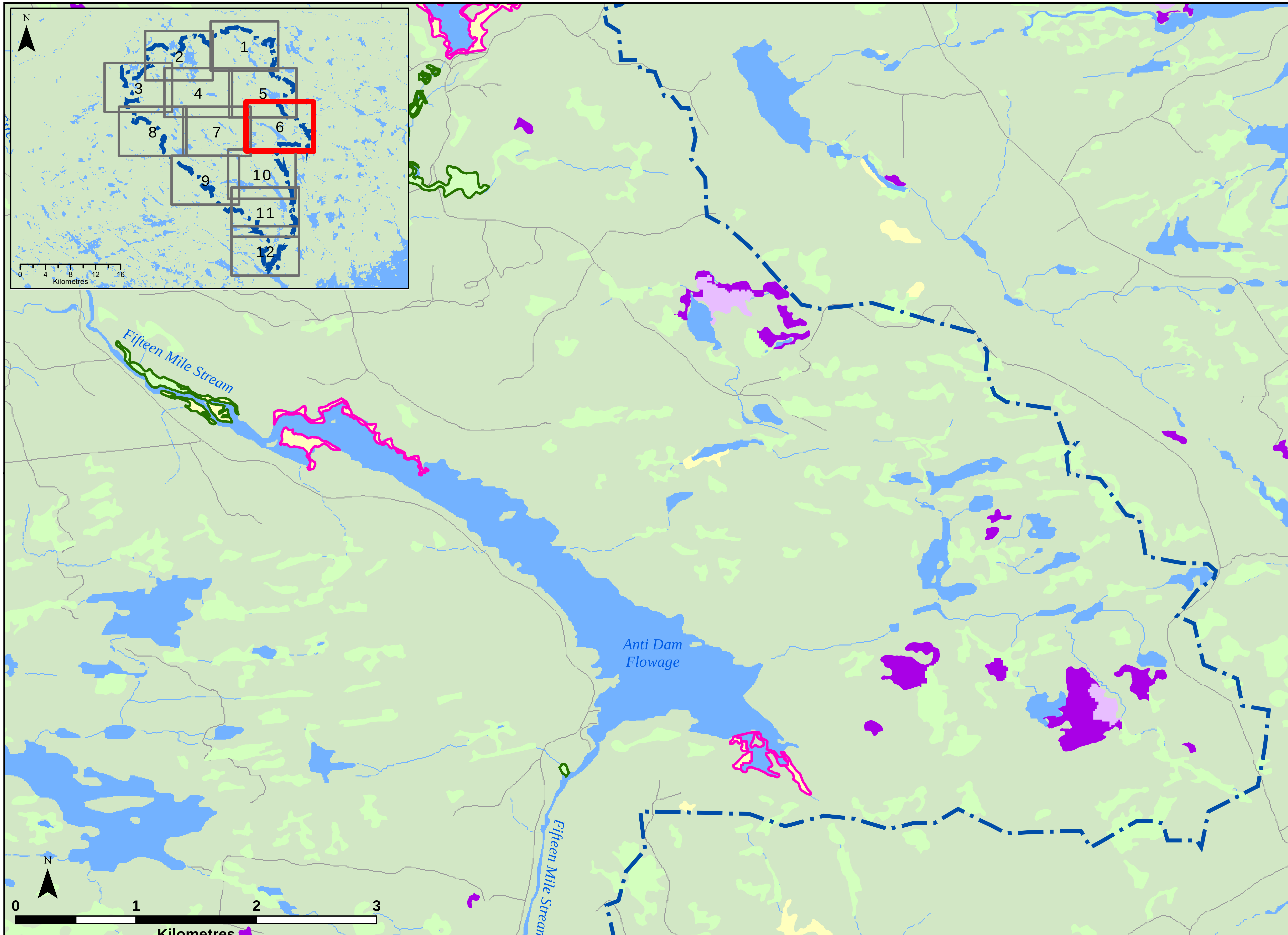
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Sheet Harbour Hydro System

Wetland within 50 m of lake

Wetland within 10 m of river

NSDNR Wetland Inventory

Bog

Bog or Fen

Fen

Marsh

Salt Marsh

Swamp

Water

Transportation

Road Network

Water Features

Mapped Stream

Mapped Indefinite Stream

Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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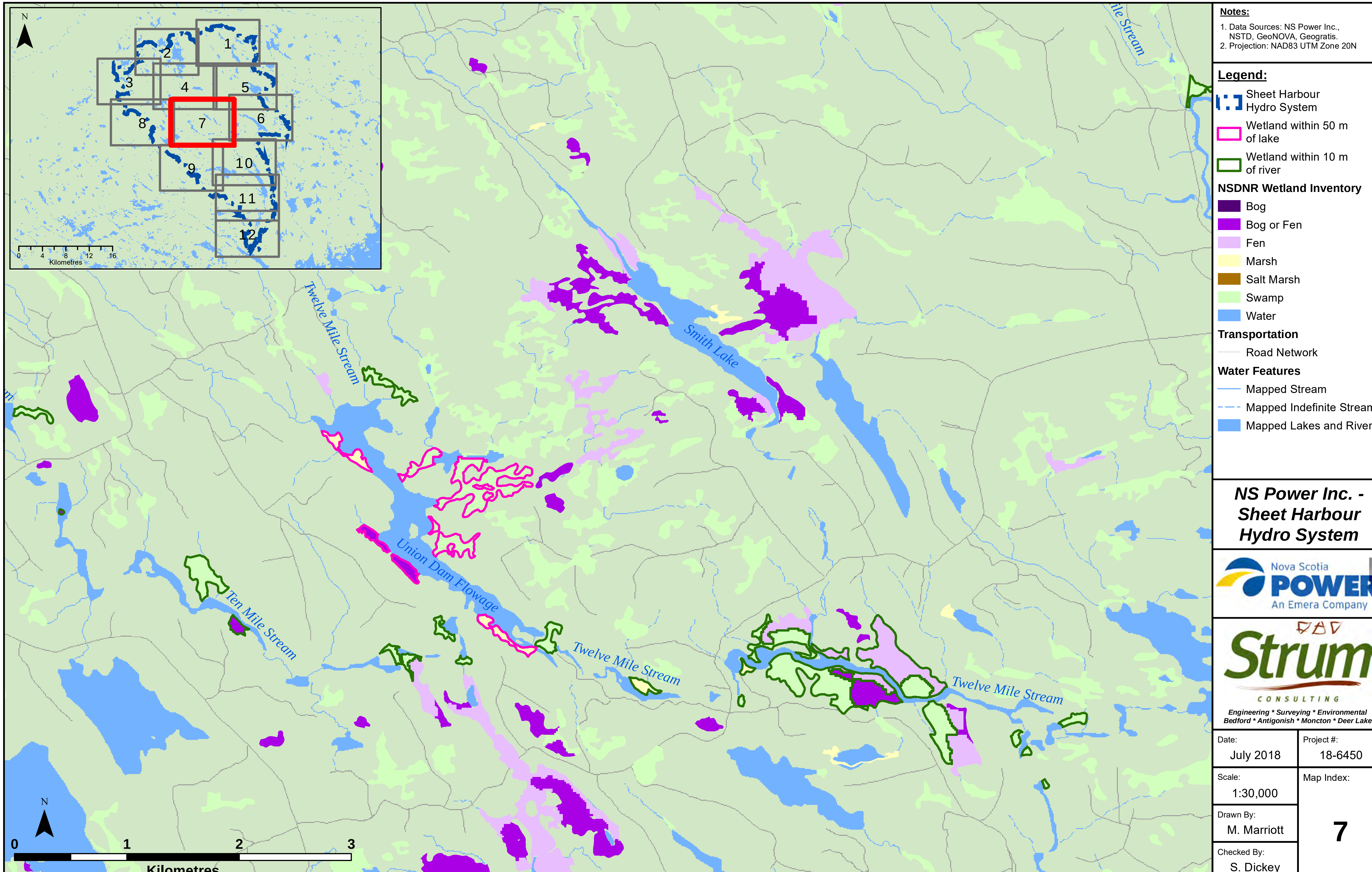
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	


1
2
3
4
5
6
7
8
9
10
11
12
0 4 8 12 16
Kilometres
Twelve Mile Stream
Smith Lake
Union Dam Flowage
Ten Mile Stream
Twelve Mile Stream
Twelve Mile Stream
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sheet Harbour Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sheet Harbour Hydro System
Nova Scotia POWER An Emera Company
Strum CONSULTING
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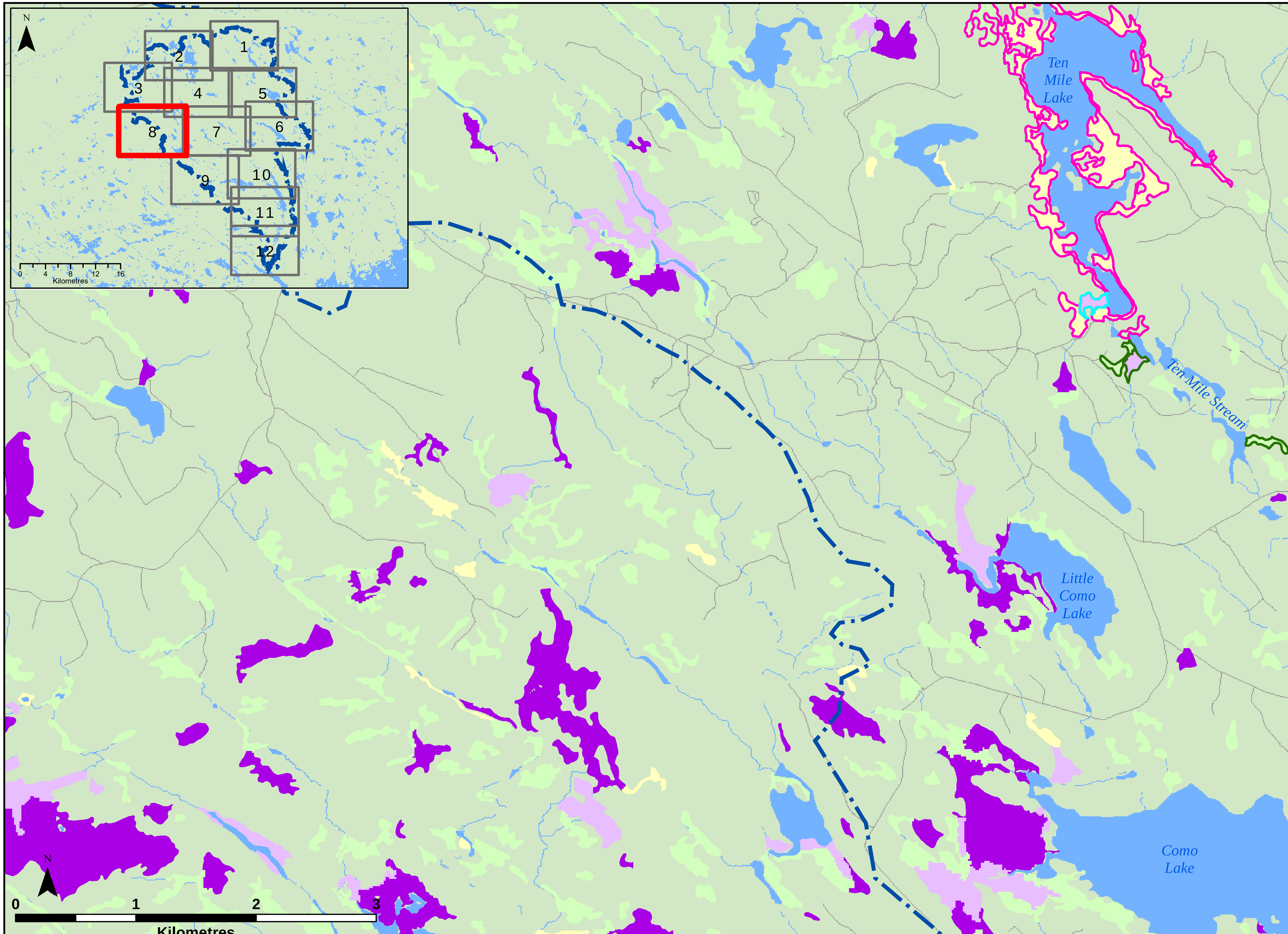
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 7
Drawn By: M. Marriott
Checked By: S. Dickey

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Sheet Harbour Hydro System

Wetland within 50 m of lake

Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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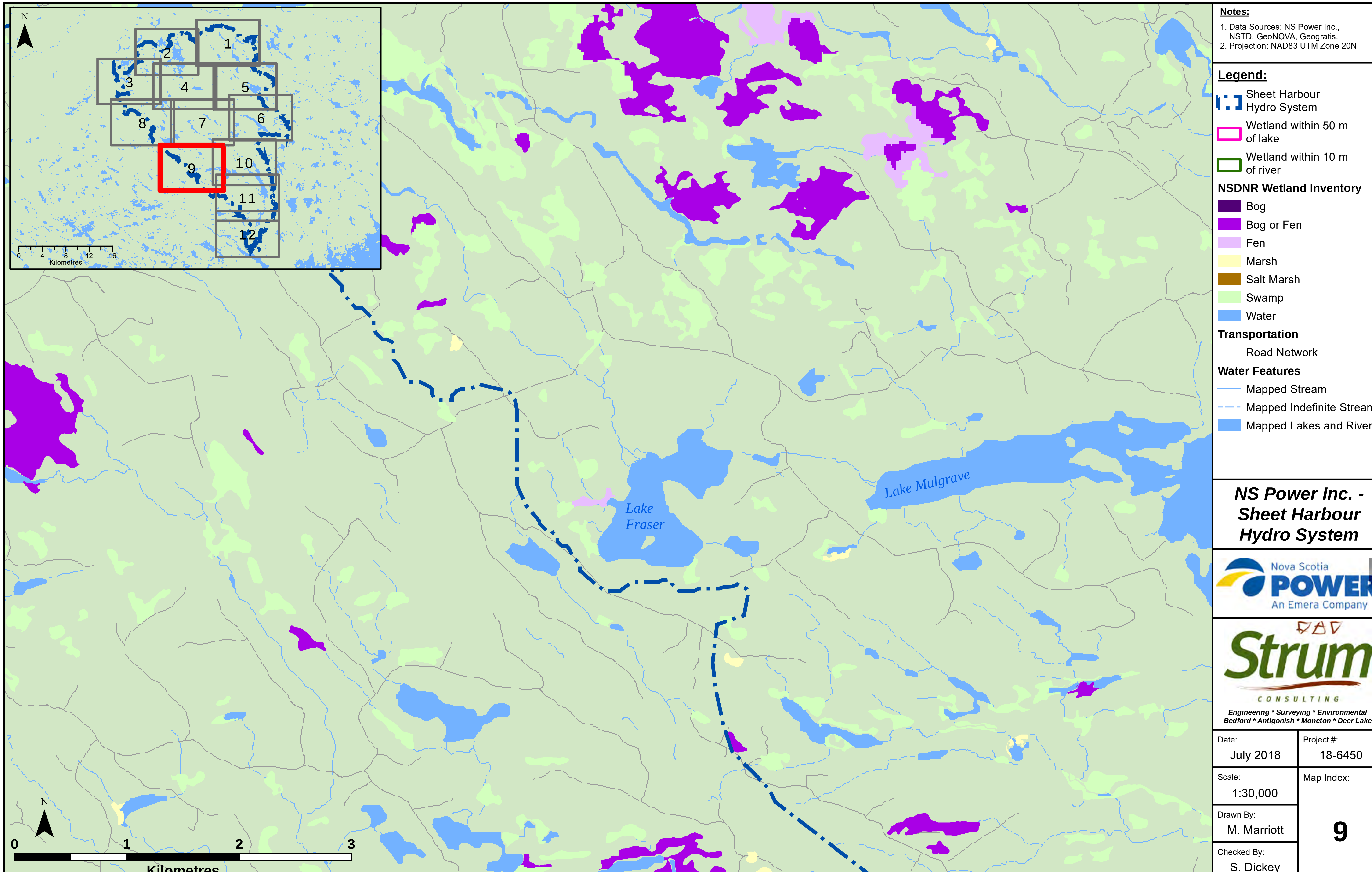
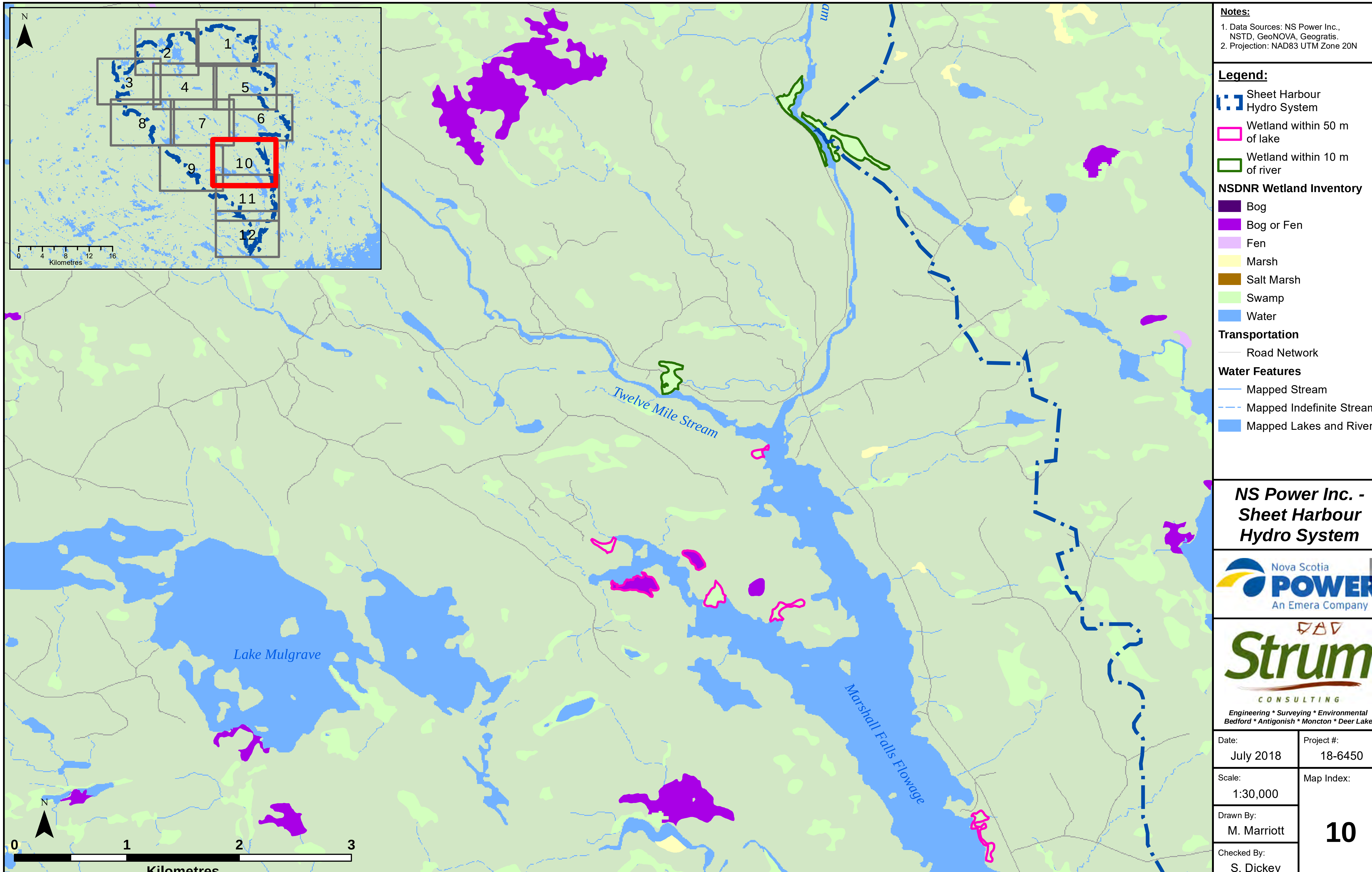
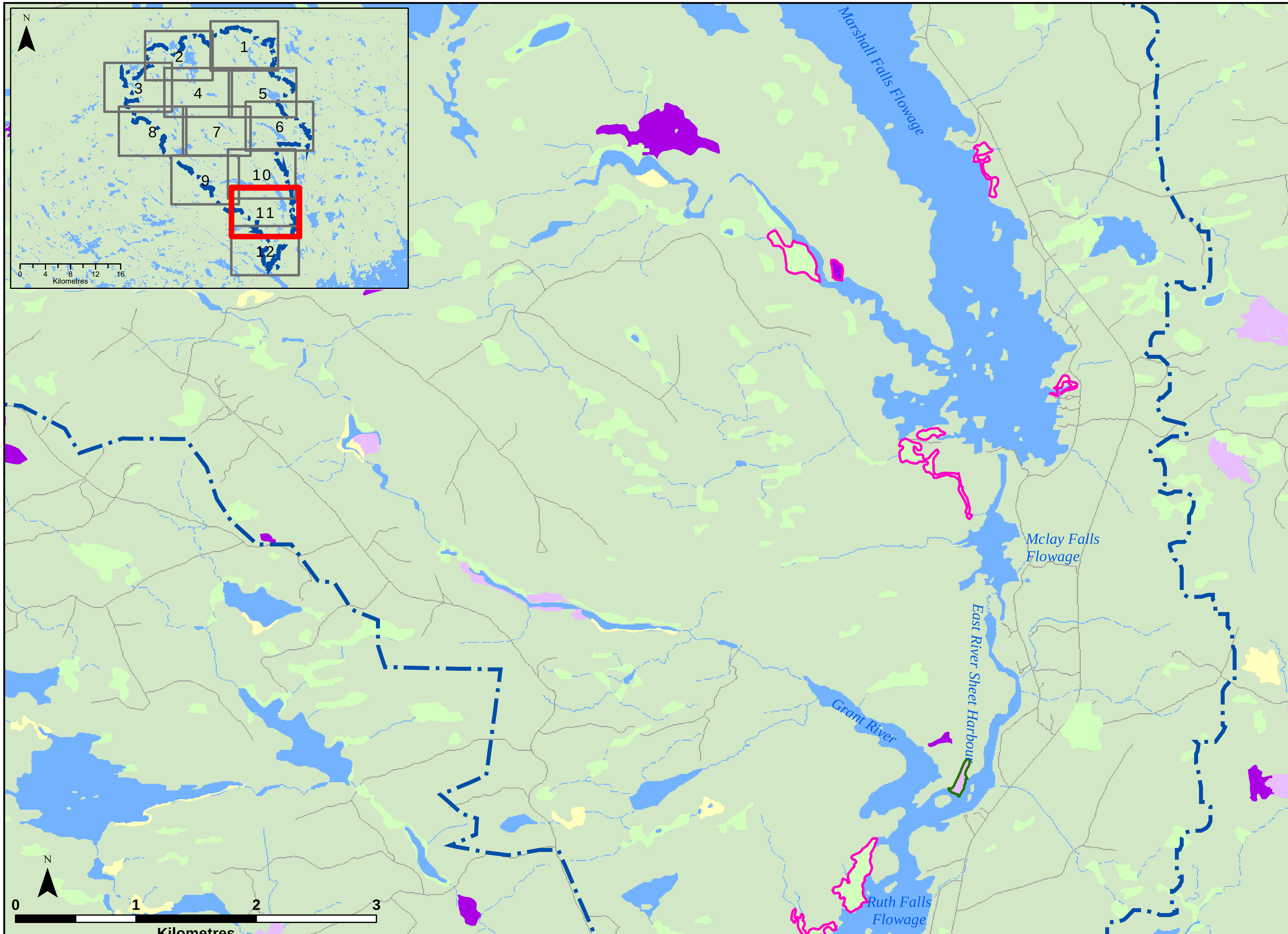
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
Drawn By: M. Marriott	
Checked By: S. Dickey	


Lake Fraser
Lake Mulgrave
0 1 2 3
Kilometres
N
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sheet Harbour Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sheet Harbour Hydro System
Nova Scotia POWER
An Emera Company
Strum
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 9
Drawn By: M. Marriott
Checked By: S. Dickey


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sheet Harbour Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sheet Harbour Hydro System
Nova Scotia POWER
An Emera Company
Strum
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date:
July 2018
Project #:
18-6450
Scale:
1:30,000
Map Index:
10
Drawn By:
M. Marriott
Checked By:
S. Dickey
Twelve Mile Stream
Lake Mulgrave
Marshall Falls Flowage
N
0
1
2
3
Kilometres
1
2
3
4
5
6
7
8
9
10
11
12
0 4 8 12 16
Kilometres

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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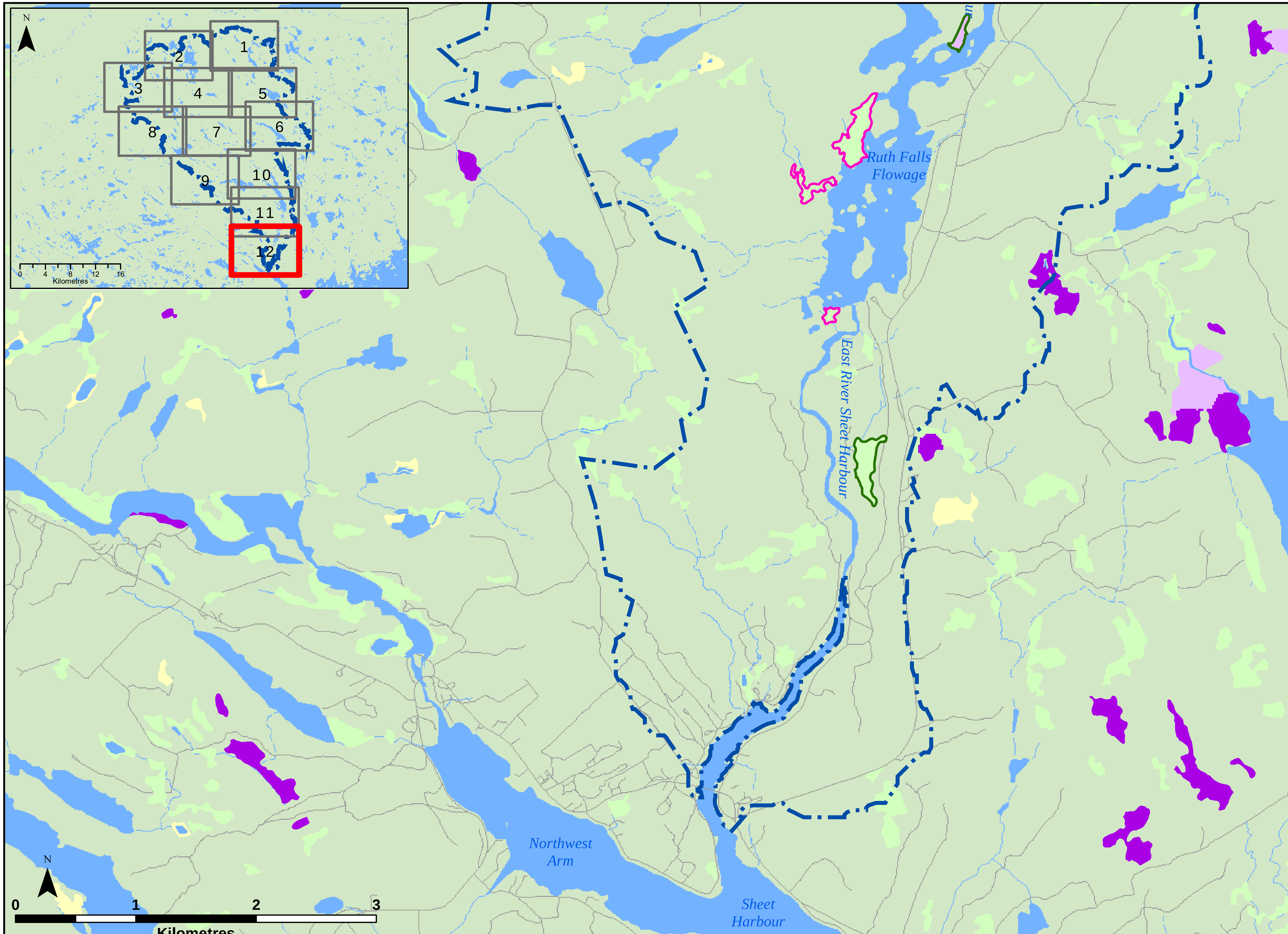
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 11
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Sheet Harbour Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sheet Harbour Hydro System

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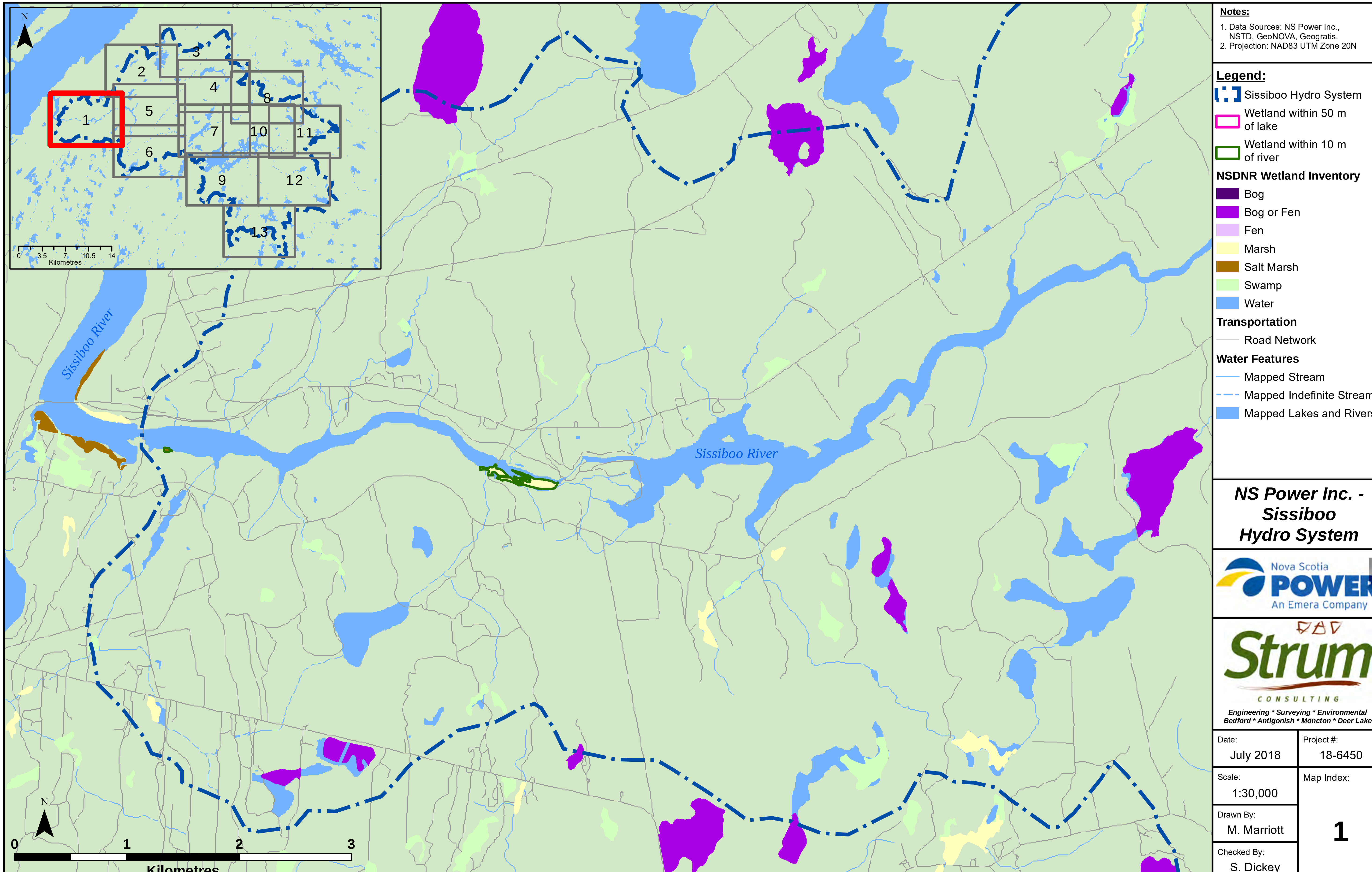
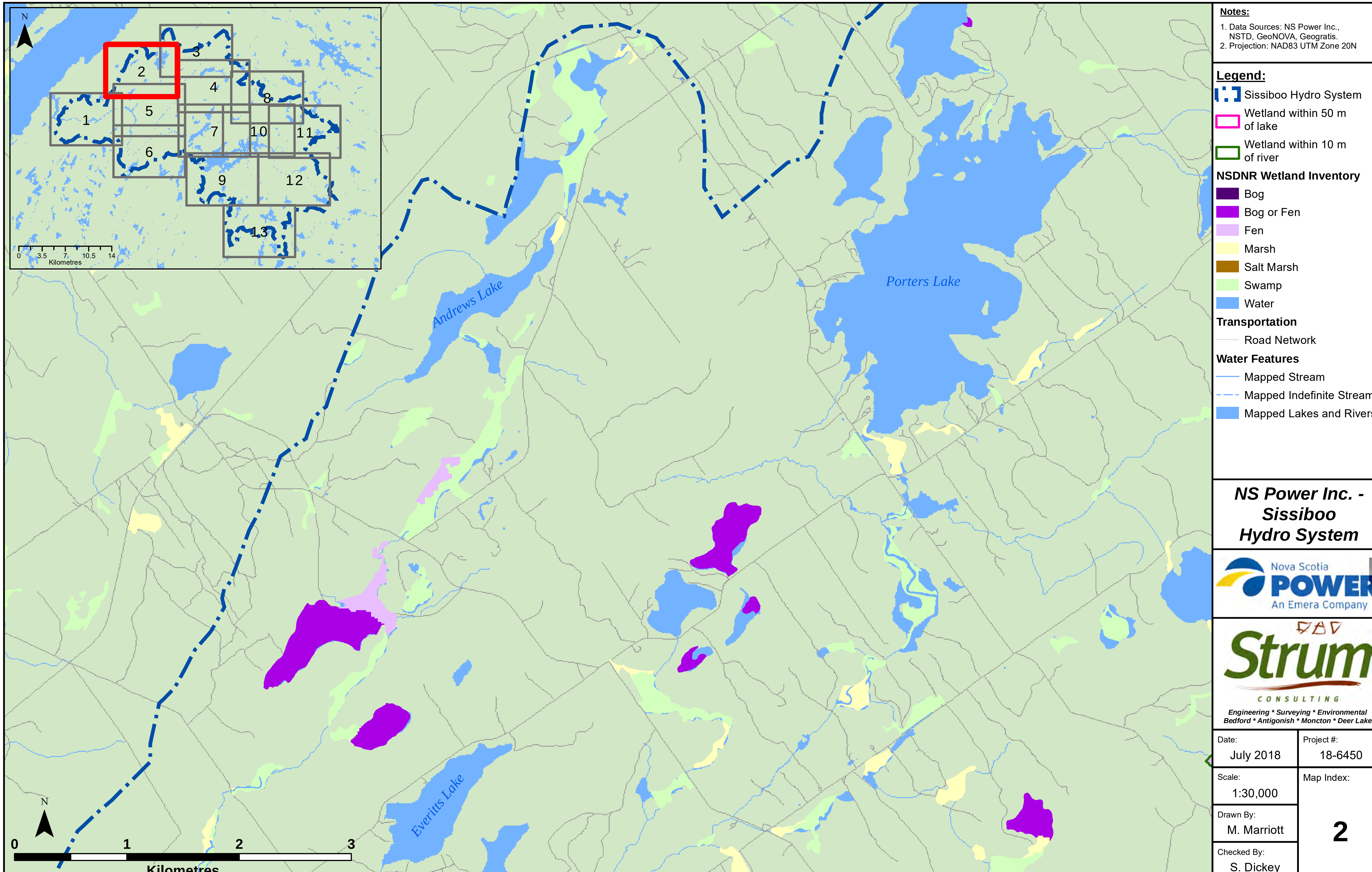
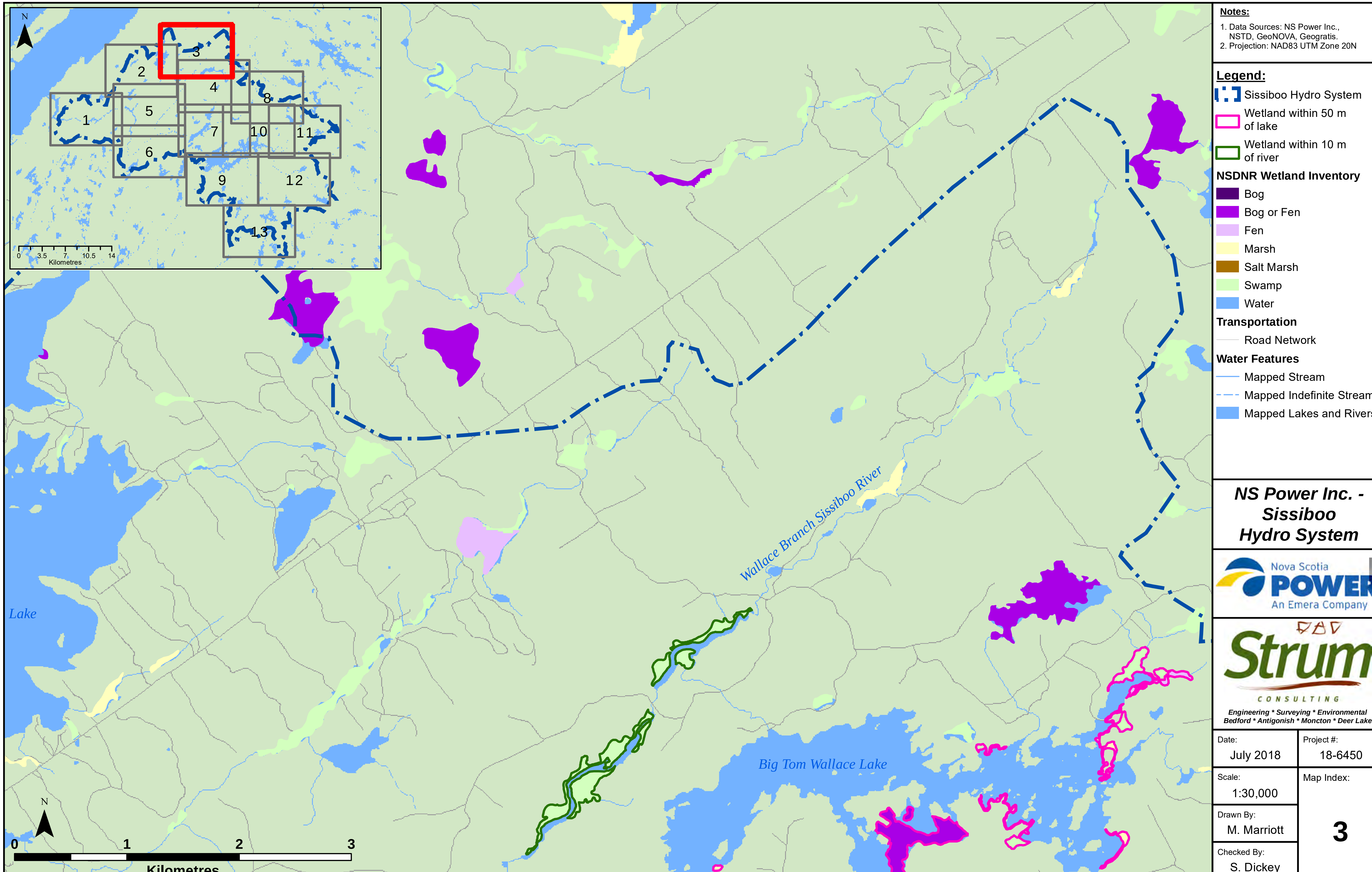
*Bedford * Antigonish * Moncton * Deer Lake*

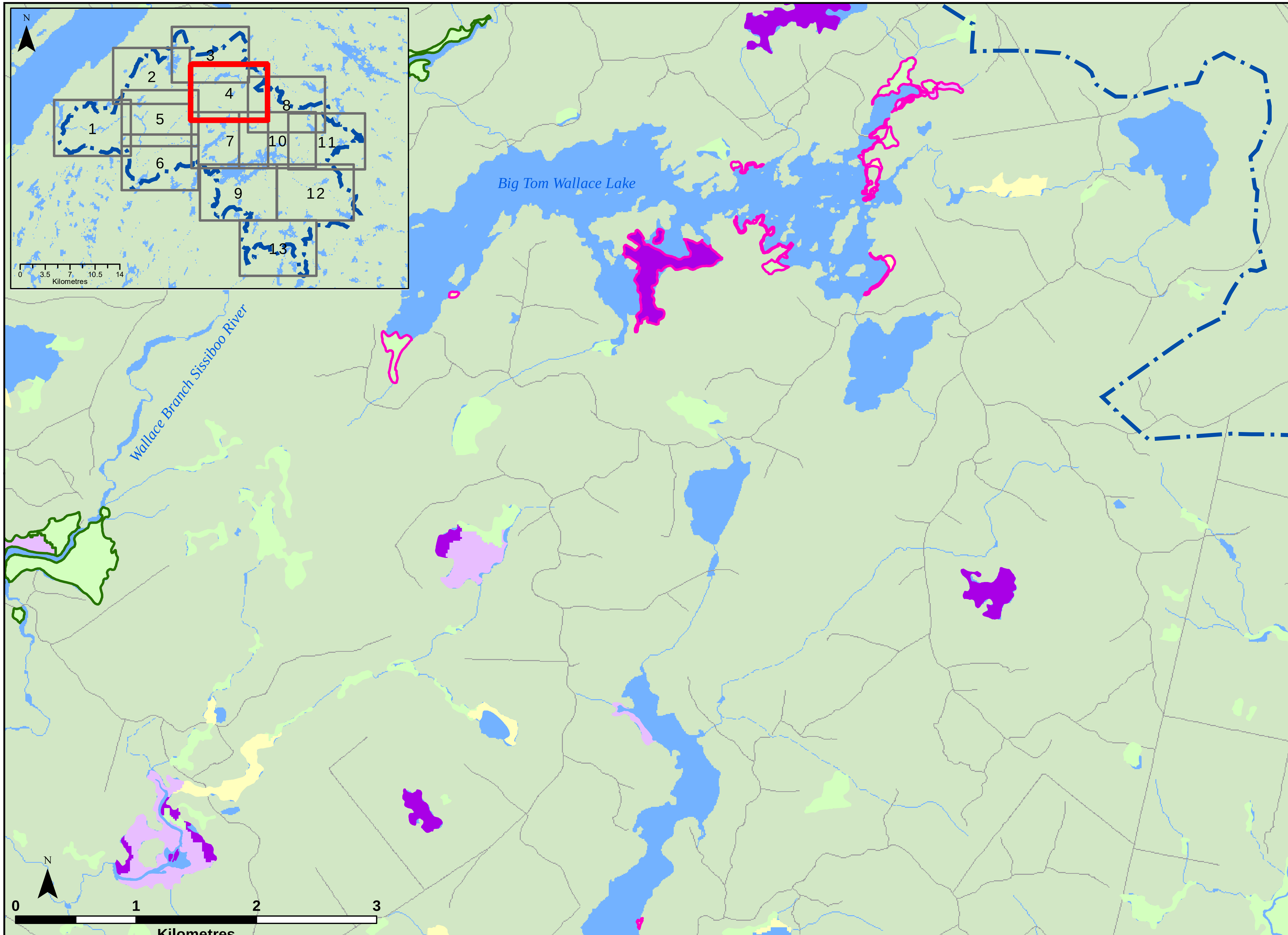
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 12
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sissiboo Hydro System
Nova Scotia POWER
An Emera Company
Strum
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 1
Drawn By: M. Marriott
Checked By: S. Dickey
Sissiboo River
Sissiboo River
N
1
2
3
4
5
6
7
8
9
10
11
12
13
0
1
2
3
Kilometres

REDACTED (CONFIDENTIAL INFORMATION REMOVED)




Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sissiboo Hydro System
Nova Scotia POWER An Emera Company
Strum CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 3
Drawn By: M. Marriott
Checked By: S. Dickey
Wallace Branch Sissiboo River
Big Tom Wallace Lake
Lake
N
0 1 2 3
Kilometres
1 2 3 4 5 6 7 8 9 10 11 12 13
0 3.5 7 10.5 14
Kilometres



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sissiboo Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sissiboo Hydro System

Nova Scotia POWER An Emera Company

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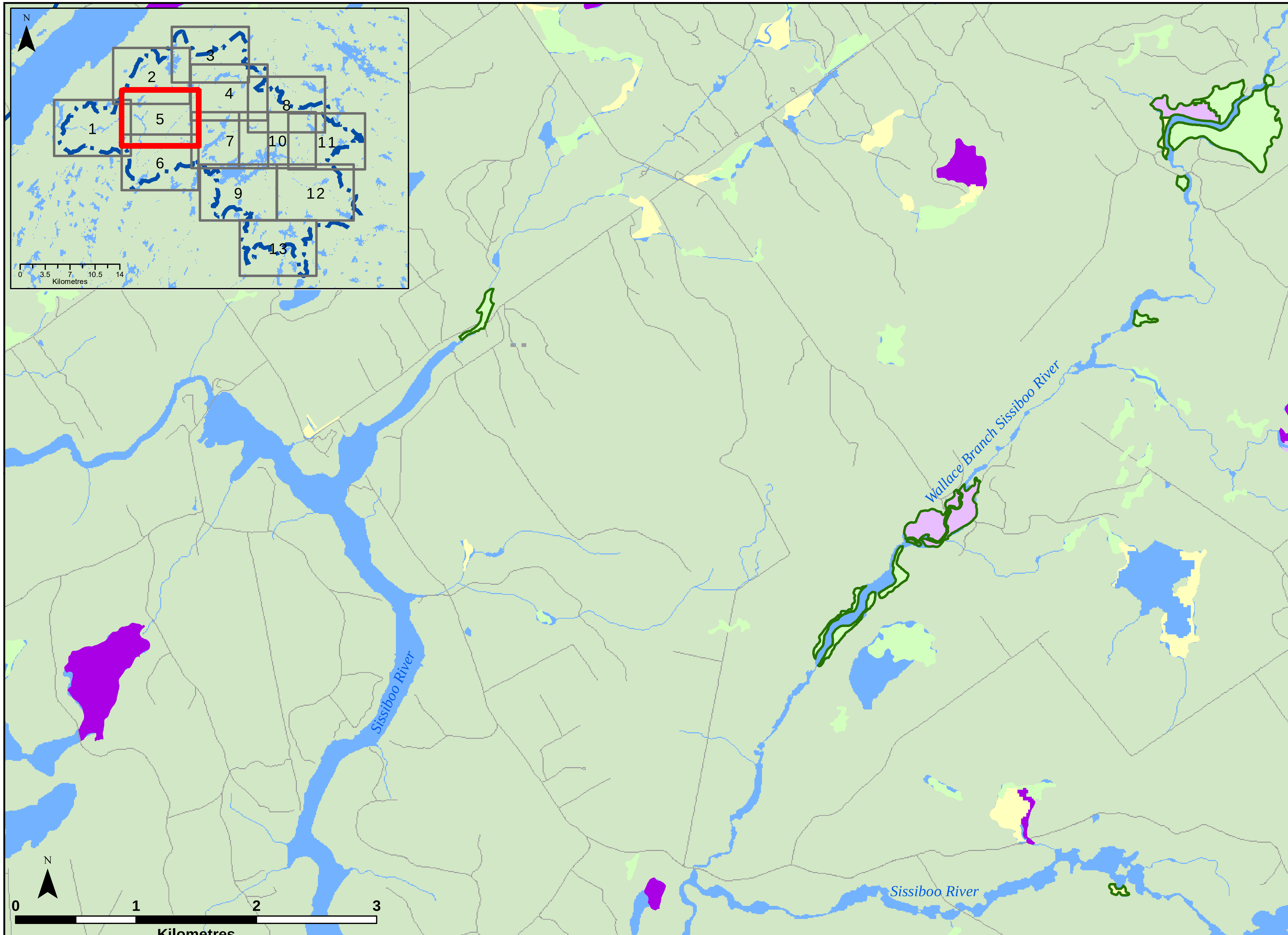
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sissiboo Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sissiboo Hydro System

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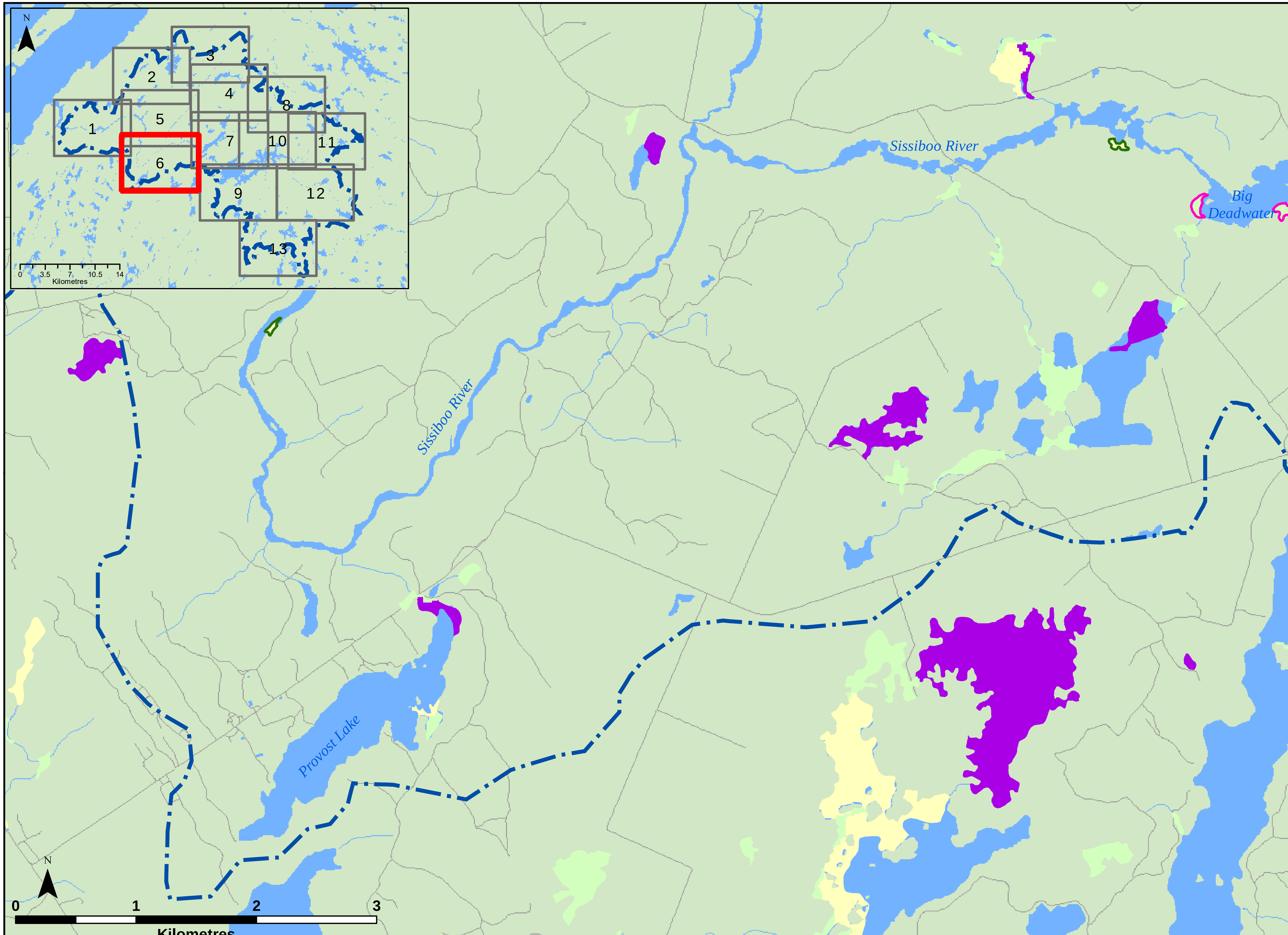
*Engineering * Surveying * Environmental*
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - Sissiboo Hydro System

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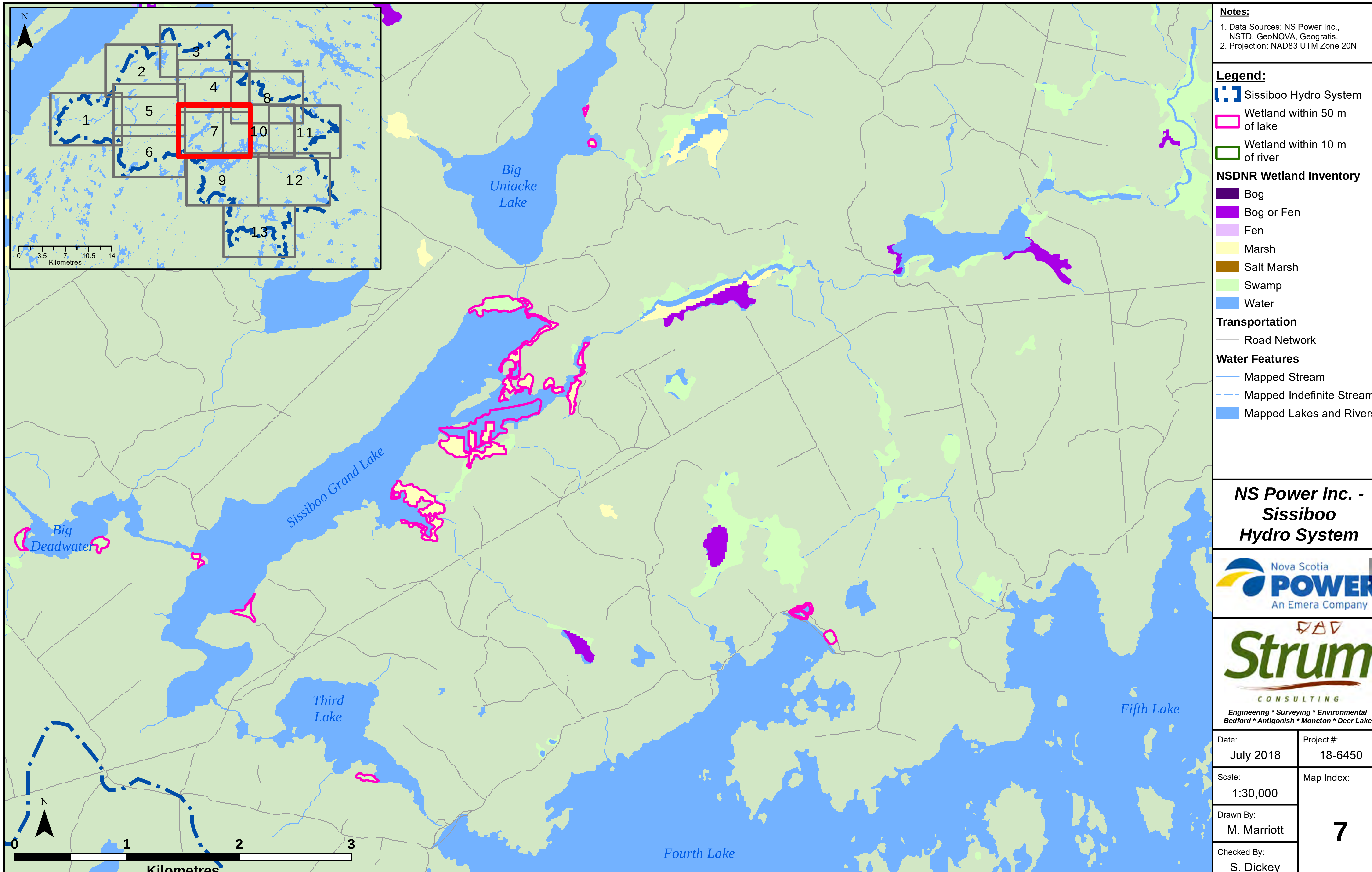
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
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Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sissiboo Hydro System
Nova Scotia POWER An Emera Company
Strum CONSULTING
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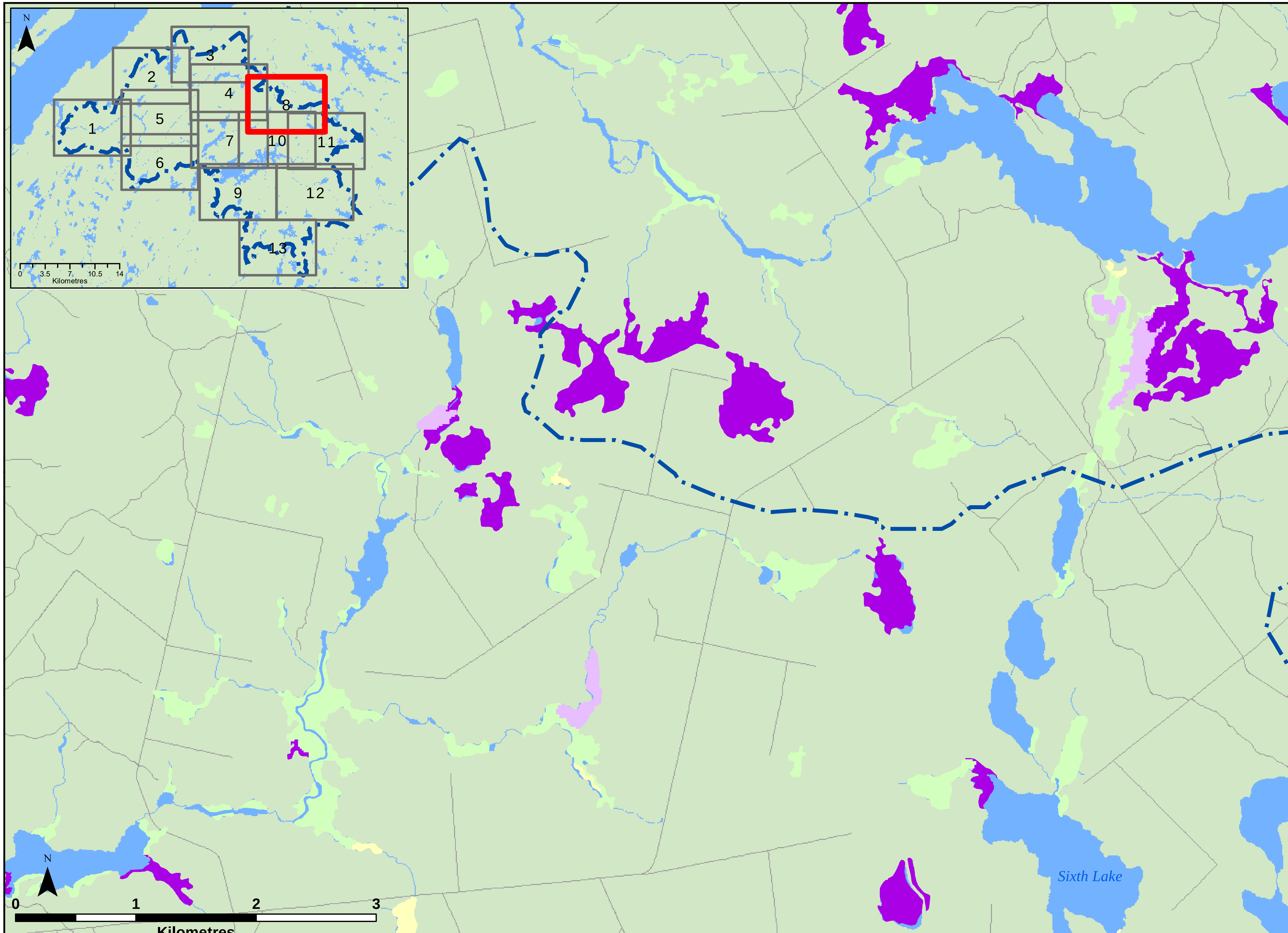
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 7
Drawn By: M. Marriott
Checked By: S. Dickey
Big Uniacke Lake
Sissiboo Grand Lake
Big Deadwater
Third Lake
Fifth Lake
Fourth Lake
N
0
1
2
3
Kilometres
1
2
3
4
5
6
7
8
9
10
11
12
13
0 3.5 7 10.5 14
Kilometres



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Sissiboo Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Sissiboo Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
Drawn By: M. Marriott	
Checked By: S. Dickey	

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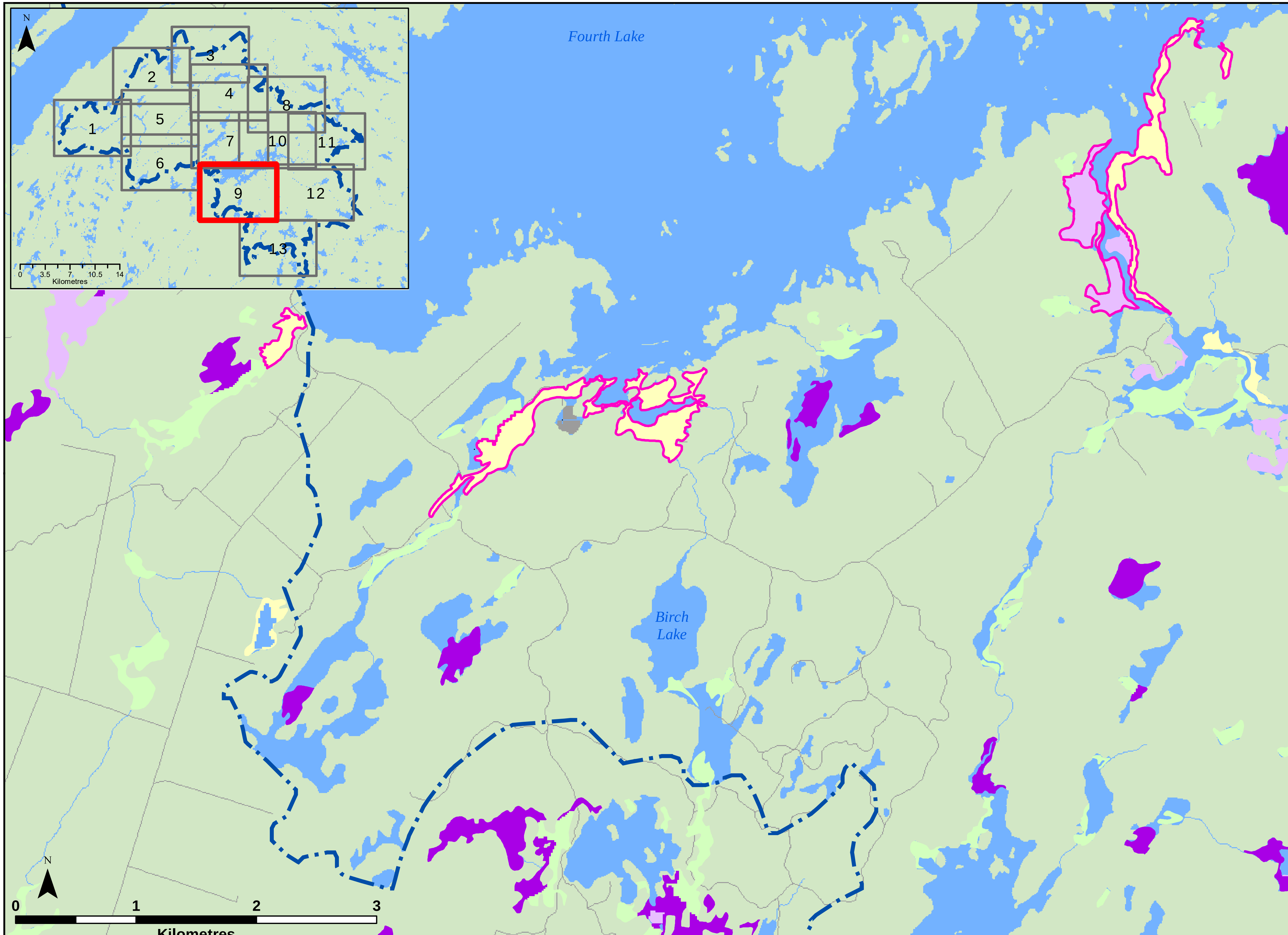

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - Sissiboo Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	

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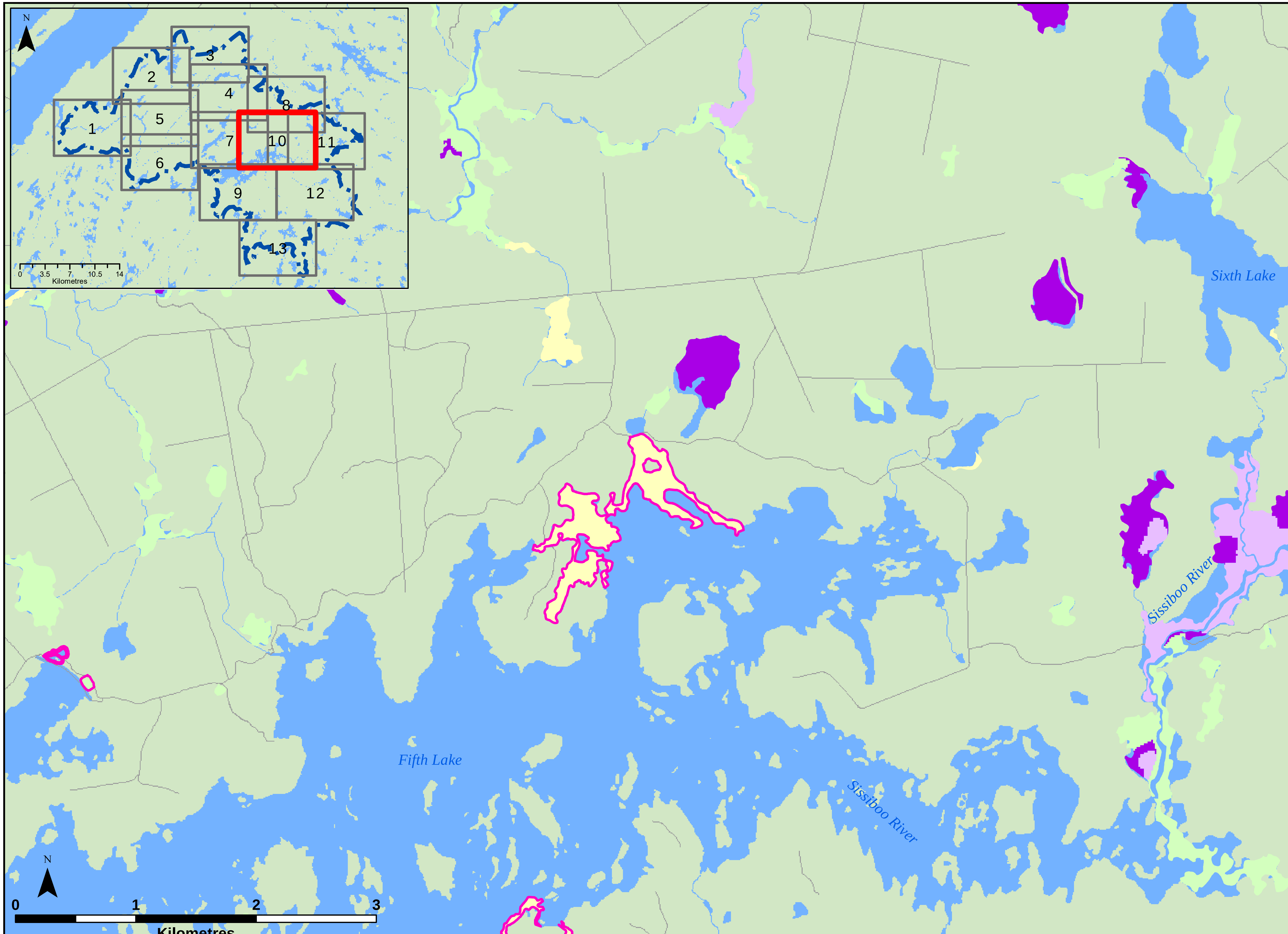

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Sissiboo Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
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- Fen
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- Salt Marsh
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Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
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NS Power Inc. - Sissiboo Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 10
Drawn By: M. Marriott	
Checked By: S. Dickey	

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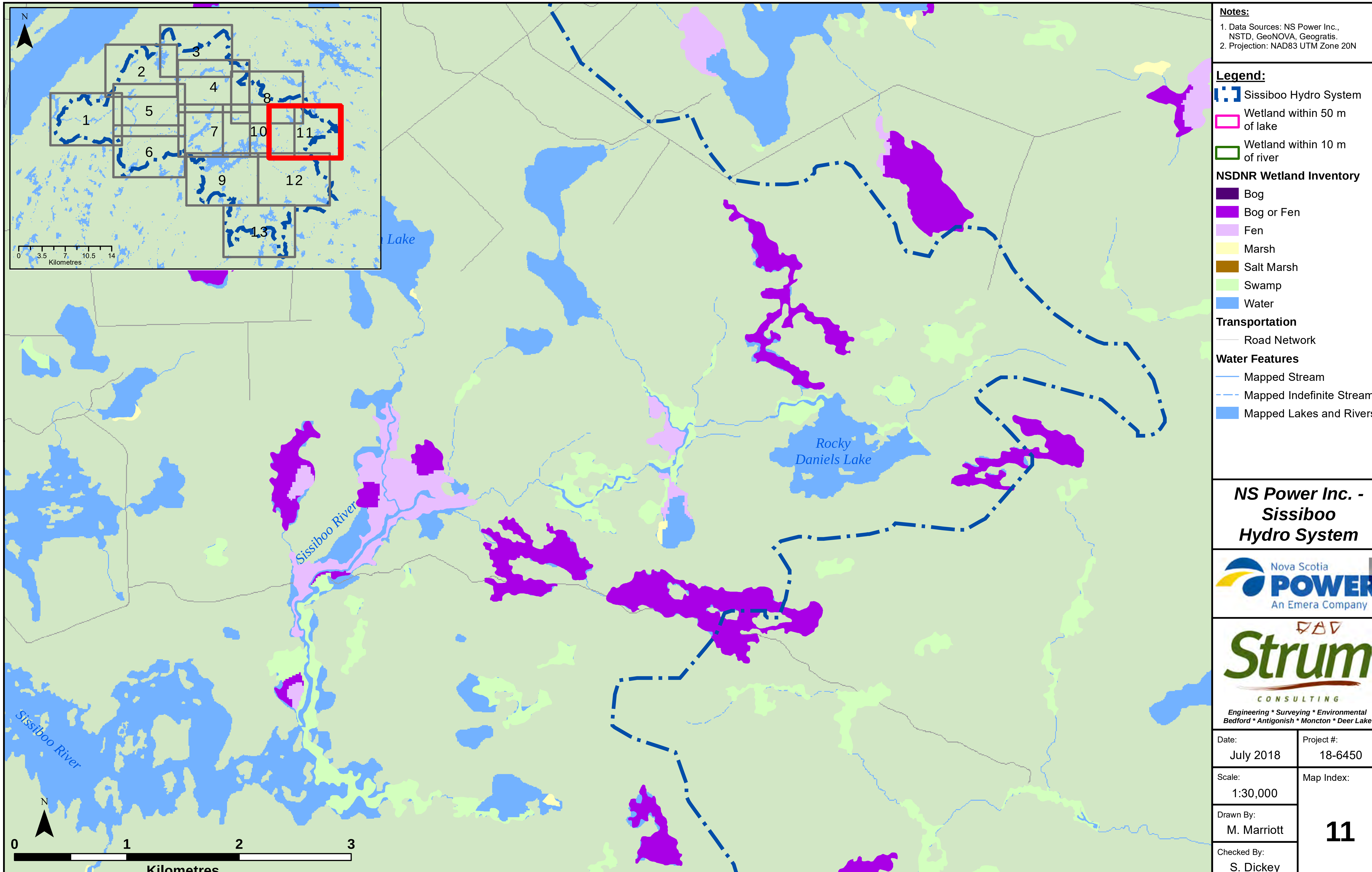

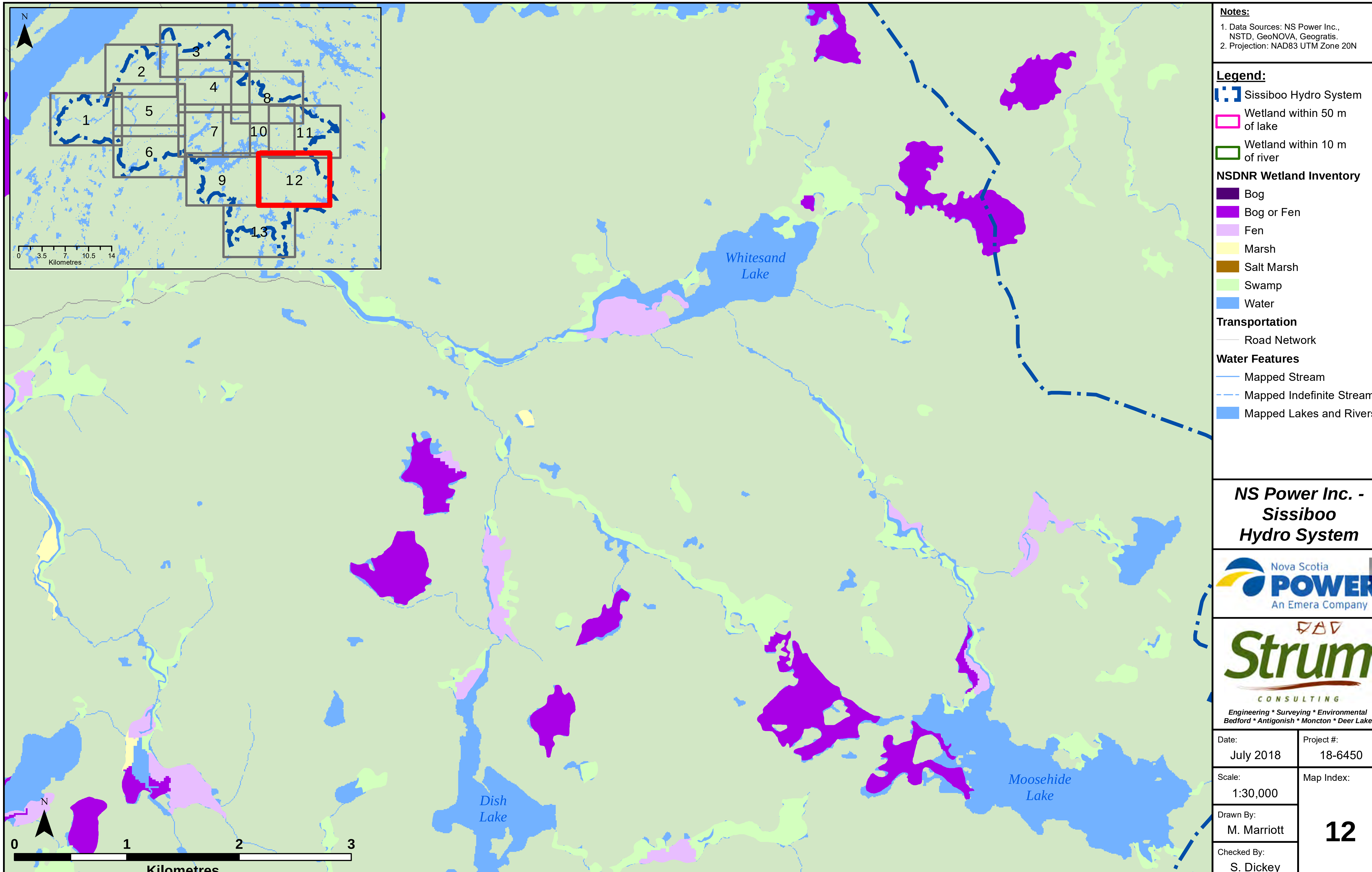
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Sissiboo Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Sissiboo Hydro System
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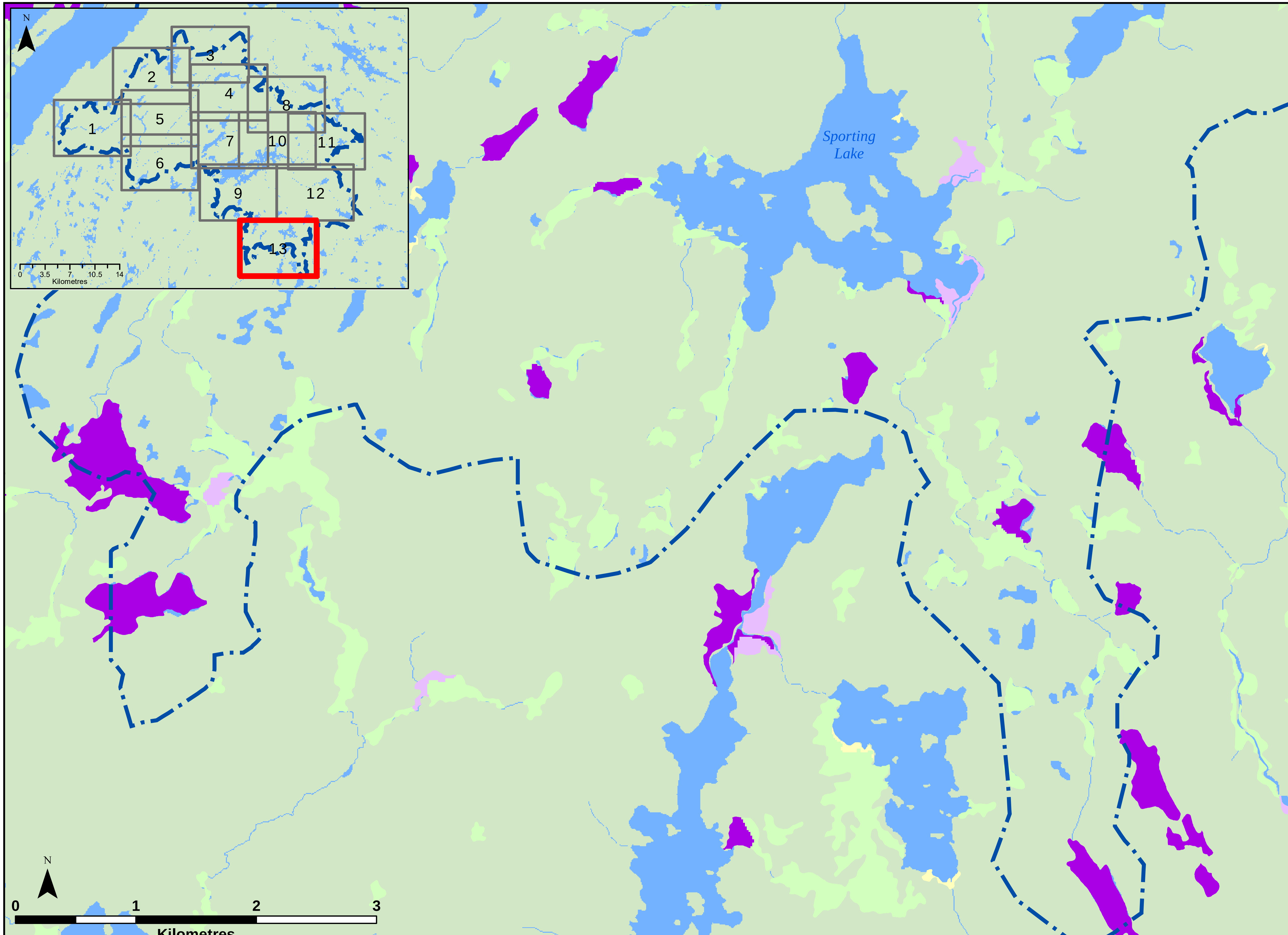
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 12
Drawn By: M. Marriott
Checked By: S. Dickey
Whitesand Lake
Dish Lake
Moosehide Lake
0 1 2 3
Kilometres
N

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Sissiboo Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 13
Drawn By: M. Marriott	
Checked By: S. Dickey	

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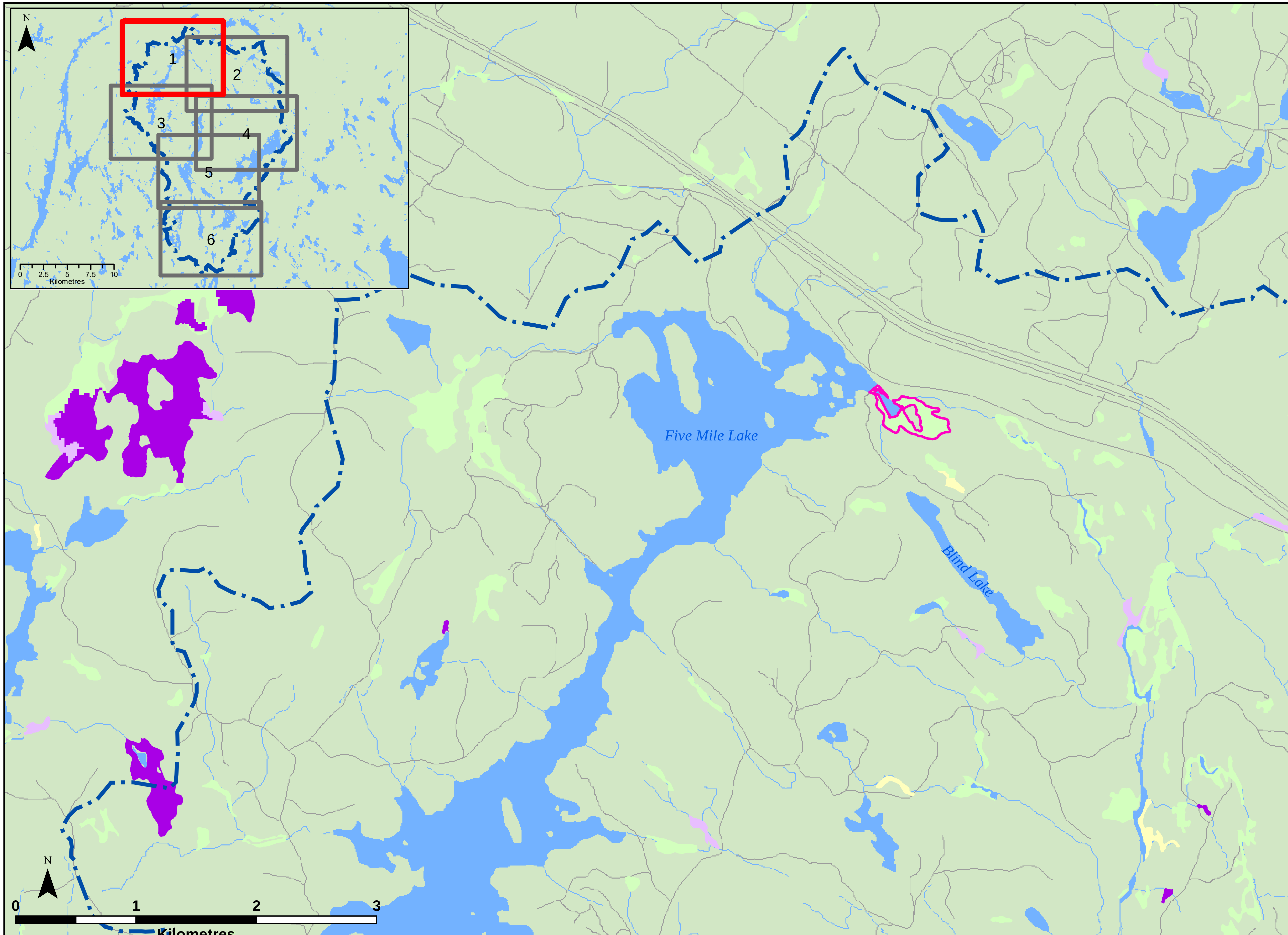

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- St. Margarets Bay Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - St. Margarets Bay Hydro System

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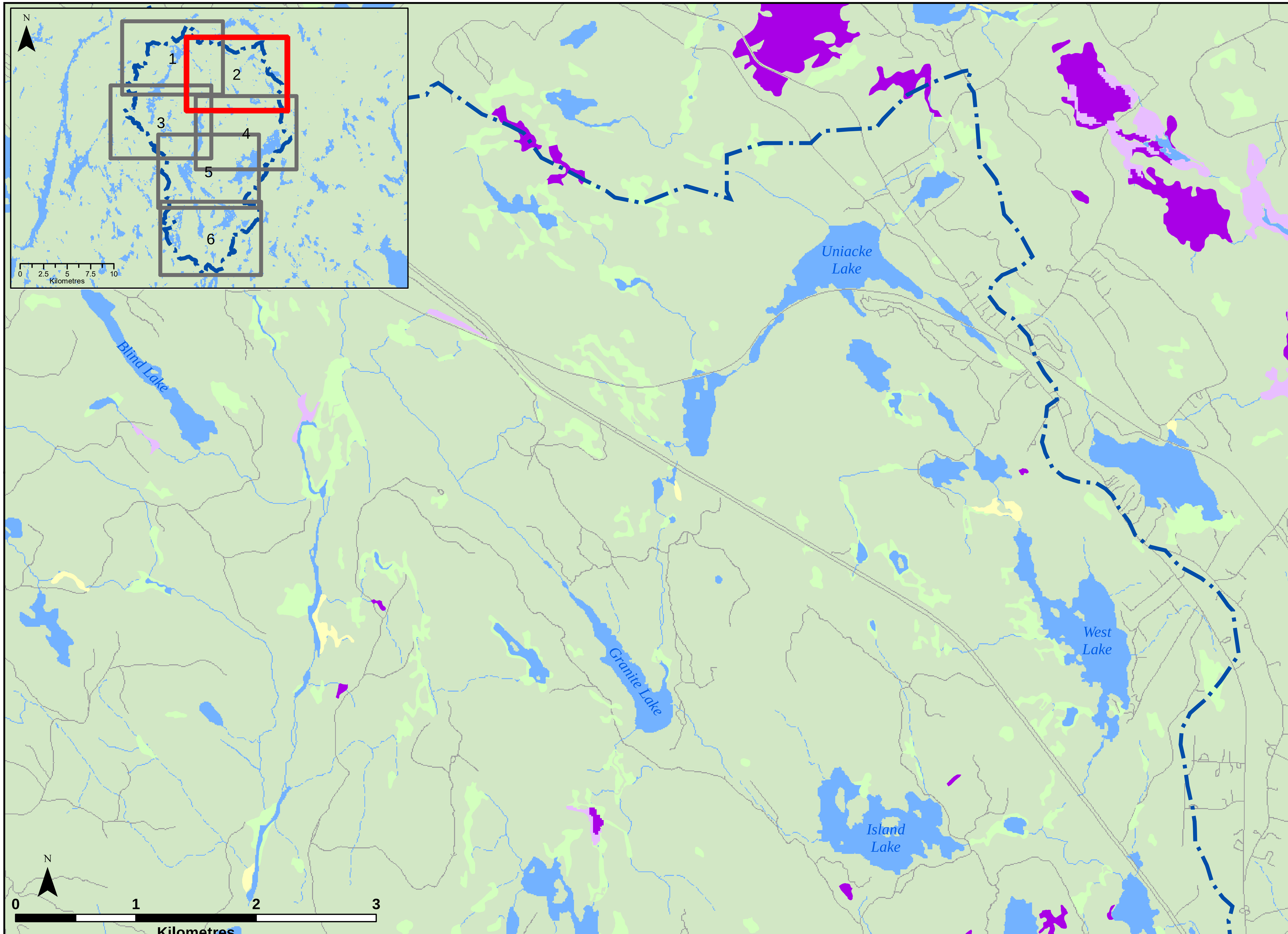
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
St. Margarets Bay Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers

NS Power Inc. - St. Margarets Bay Hydro System

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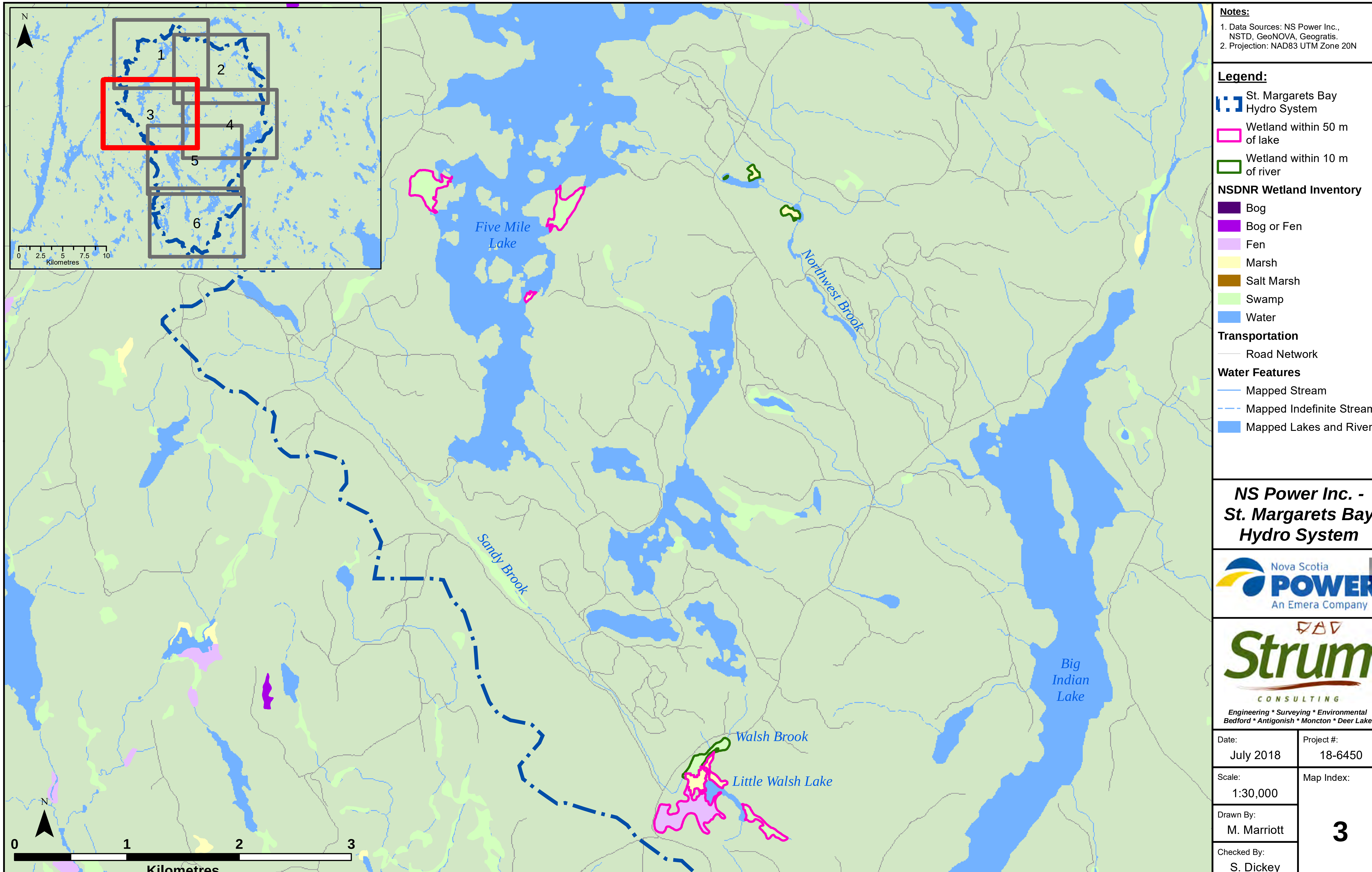
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 2
Drawn By: M. Marriott	
Checked By: S. Dickey	


Five Mile Lake
Northwest Brook
Sandy Brook
Big Indian Lake
Walsh Brook
Little Walsh Lake
0 1 2 3
Kilometres
N
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
St. Margarets Bay Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - St. Margarets Bay Hydro System
Nova Scotia POWER An Emera Company
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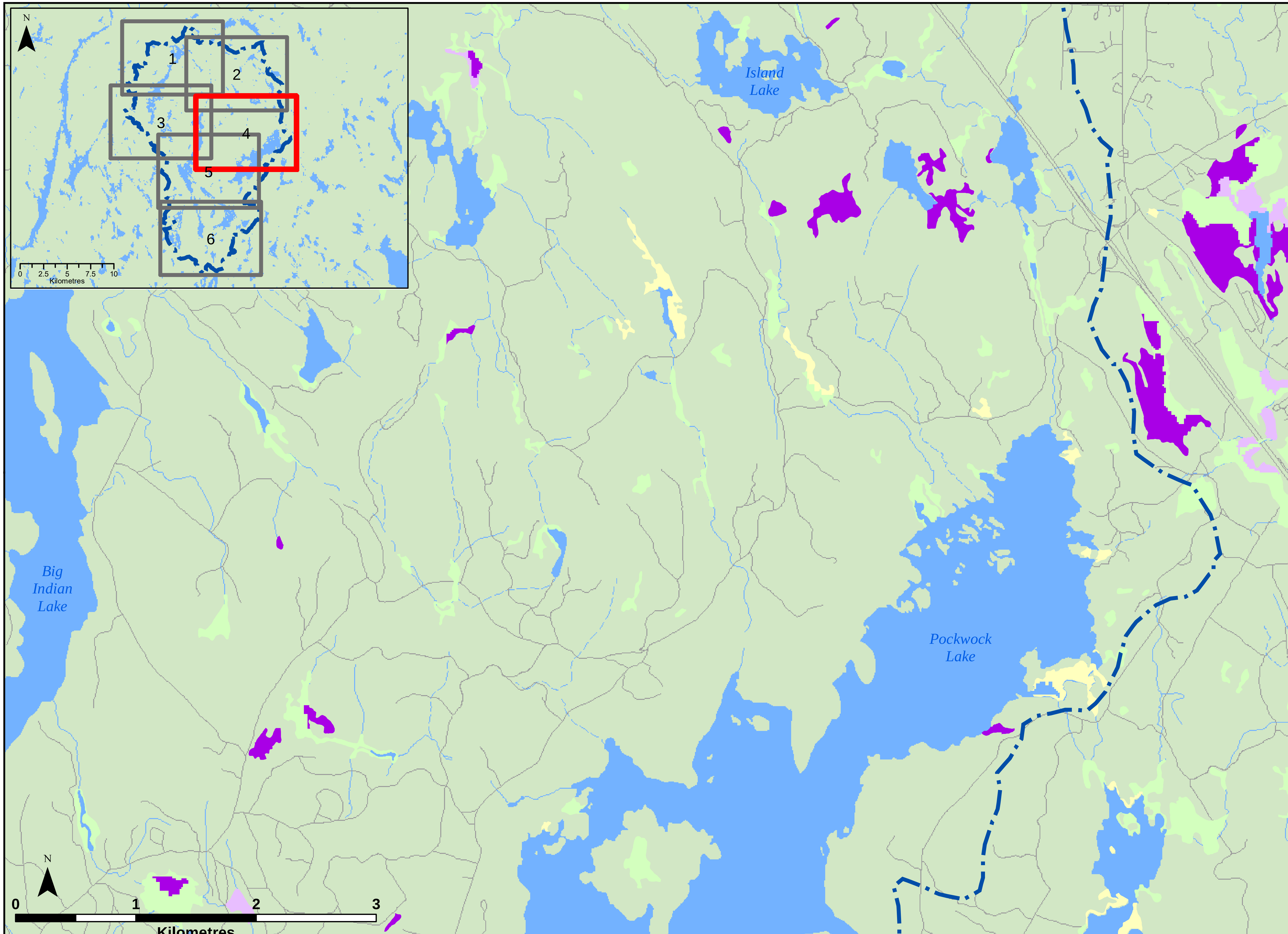
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 3
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- St. Margarets Bay Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - St. Margarets Bay Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

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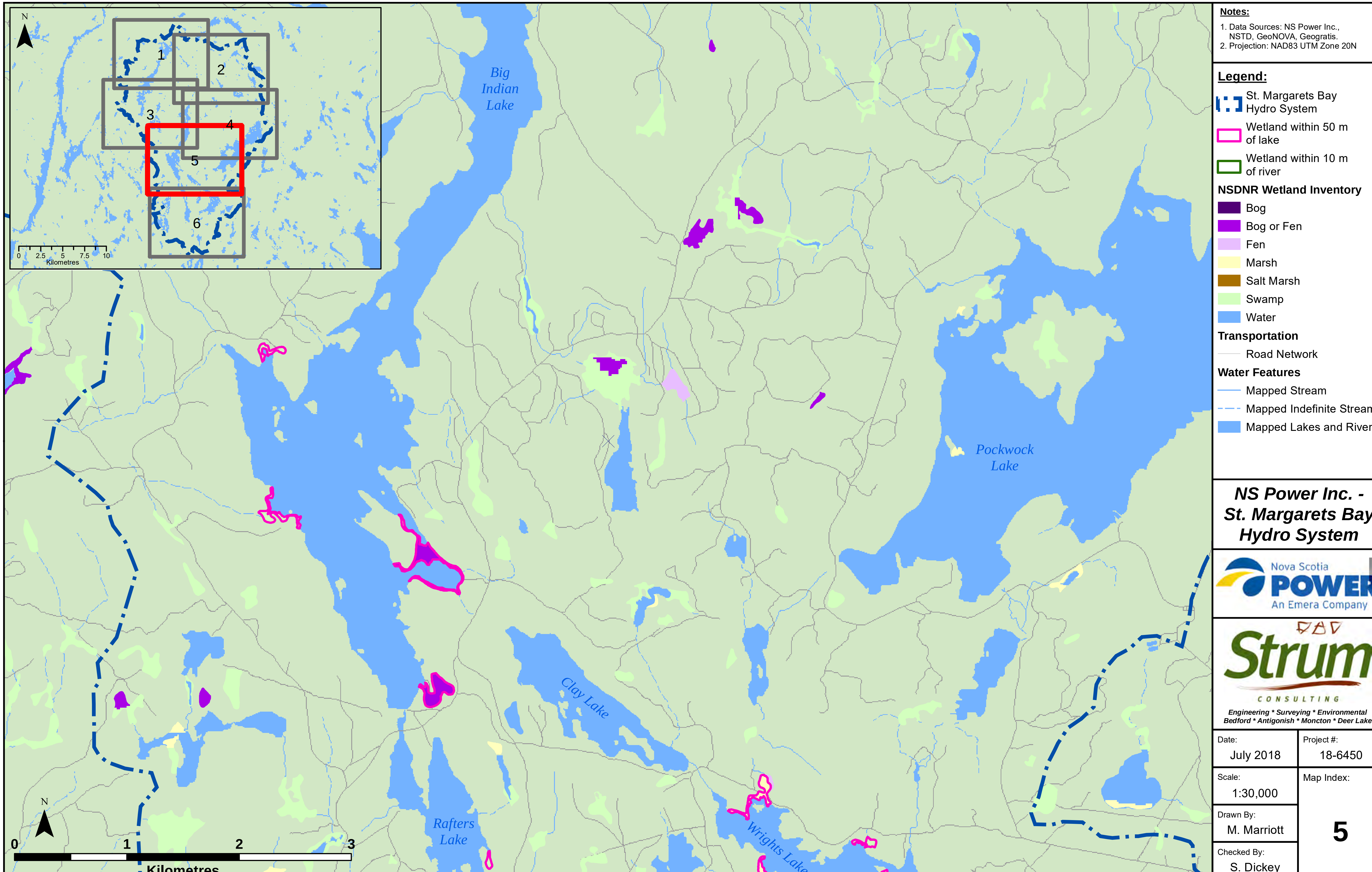

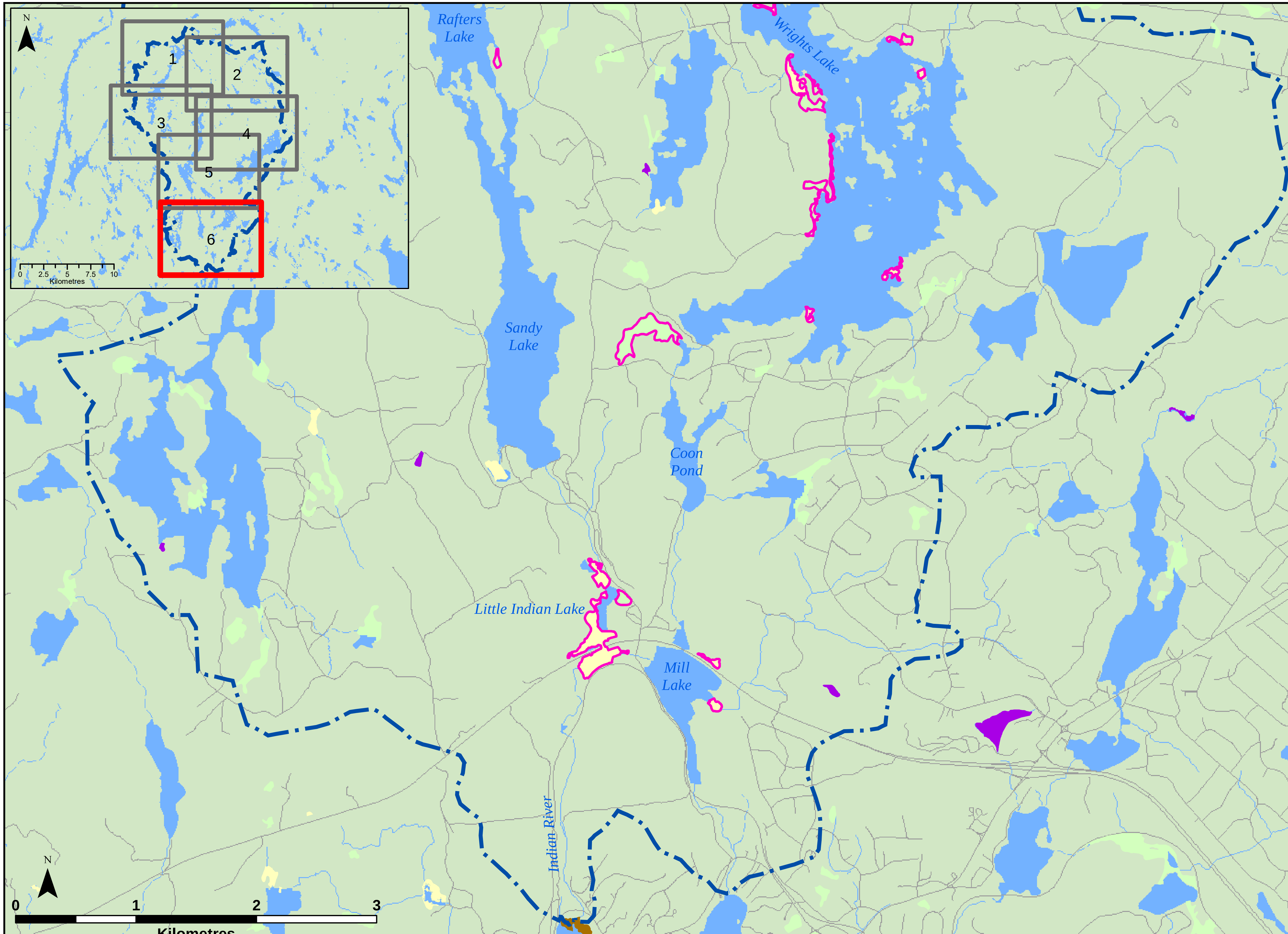

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- St. Margarets Bay Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - St. Margarets Bay Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	

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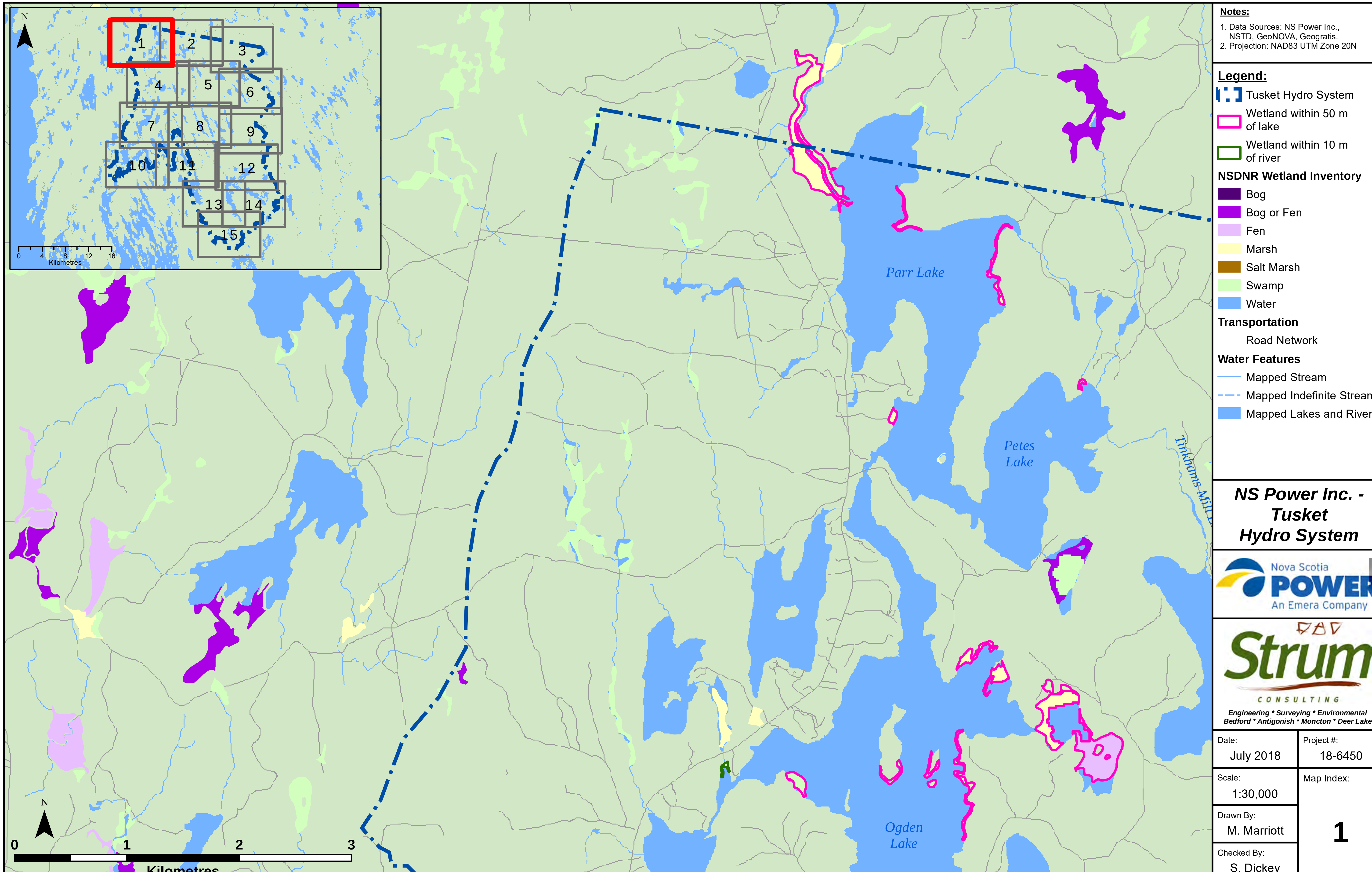

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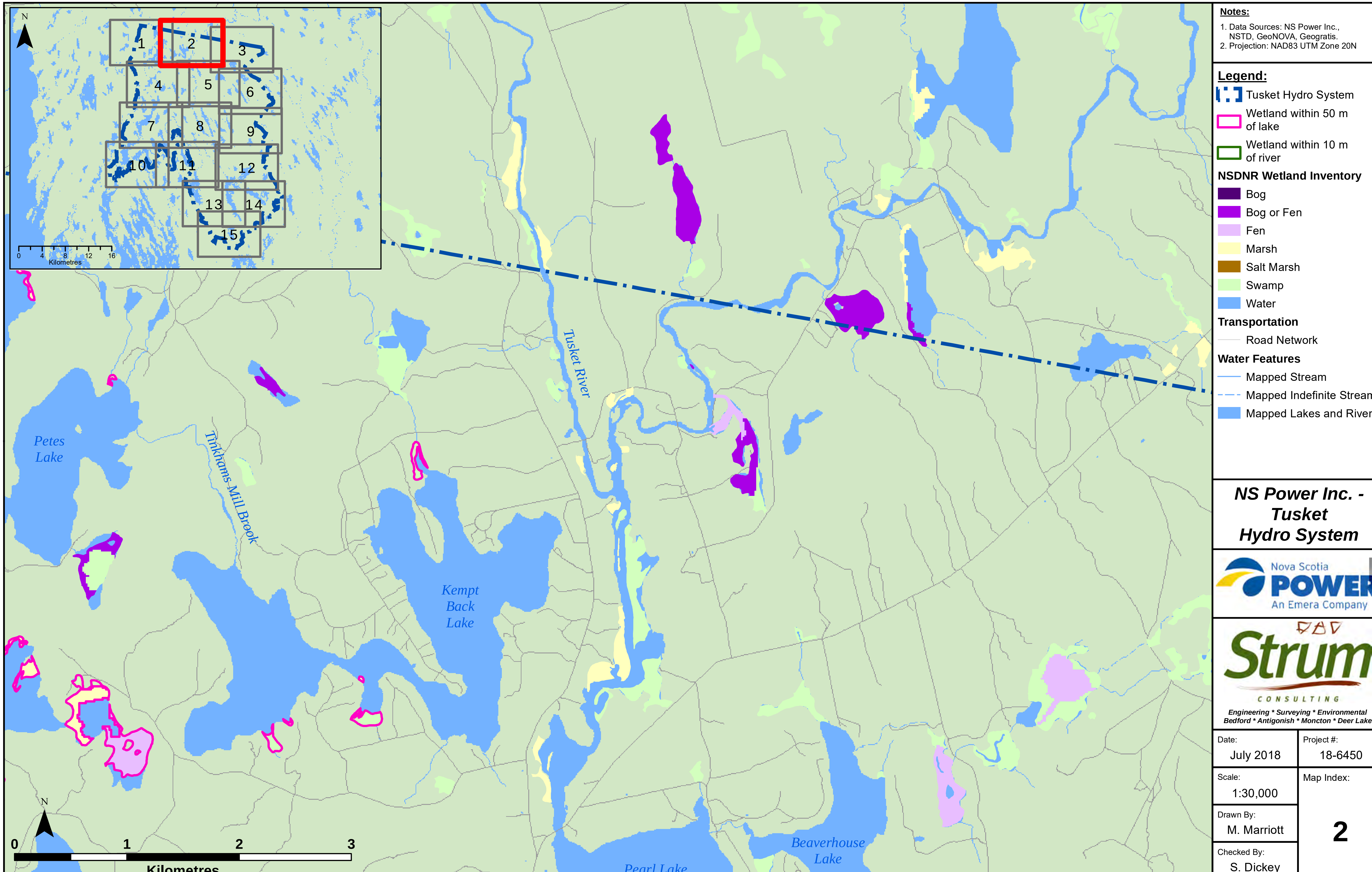

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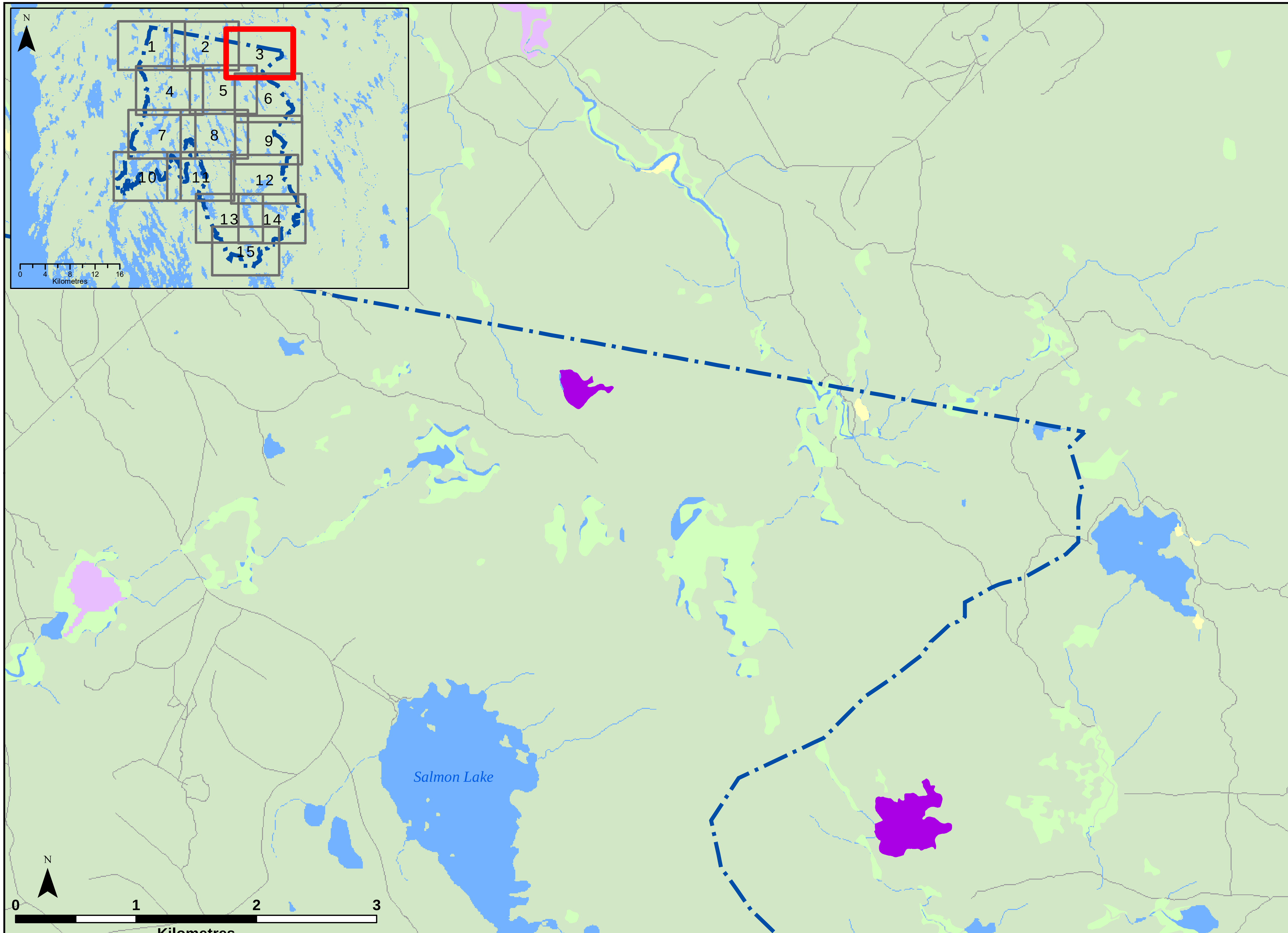

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Tusket Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

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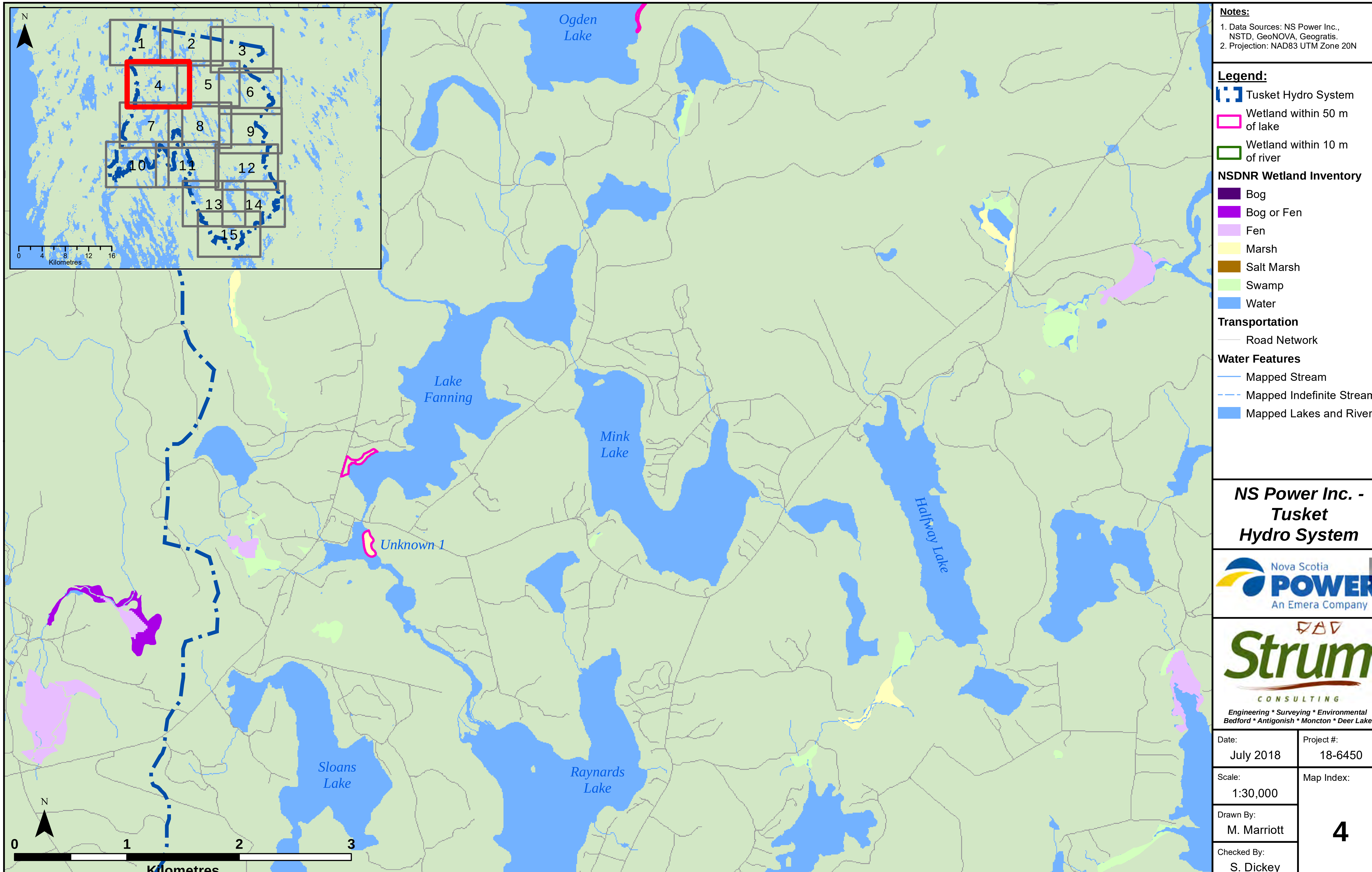
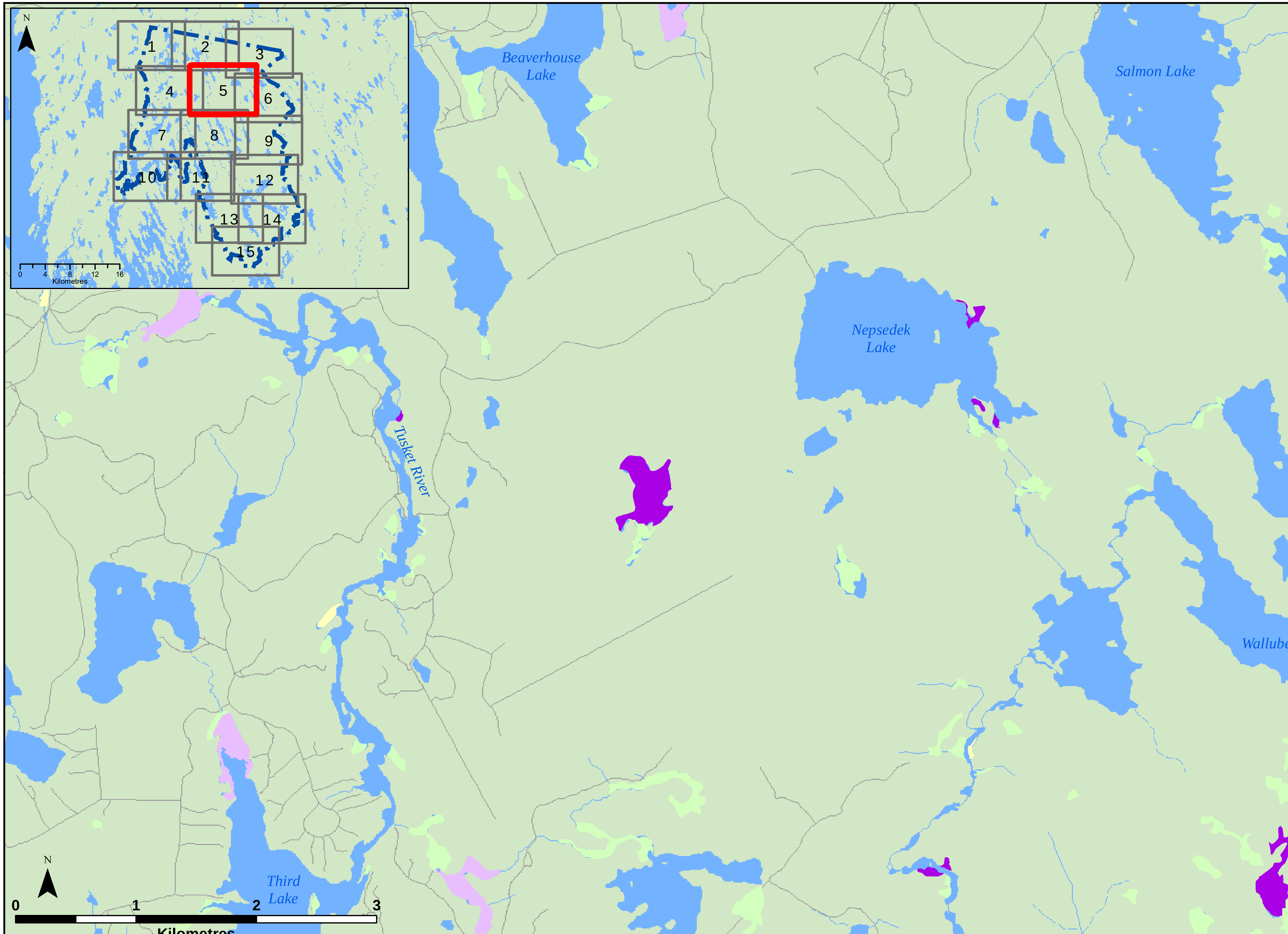
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	


Ogden Lake
Lake Fanning
Mink Lake
Unknown 1
Halfway Lake
Sloans Lake
Raynards Lake
0 1 2 3
Kilometres
N
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Tusket Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Tusket Hydro System
Nova Scotia POWER An Emera Company
Strum CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 4
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Tusket Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
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Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

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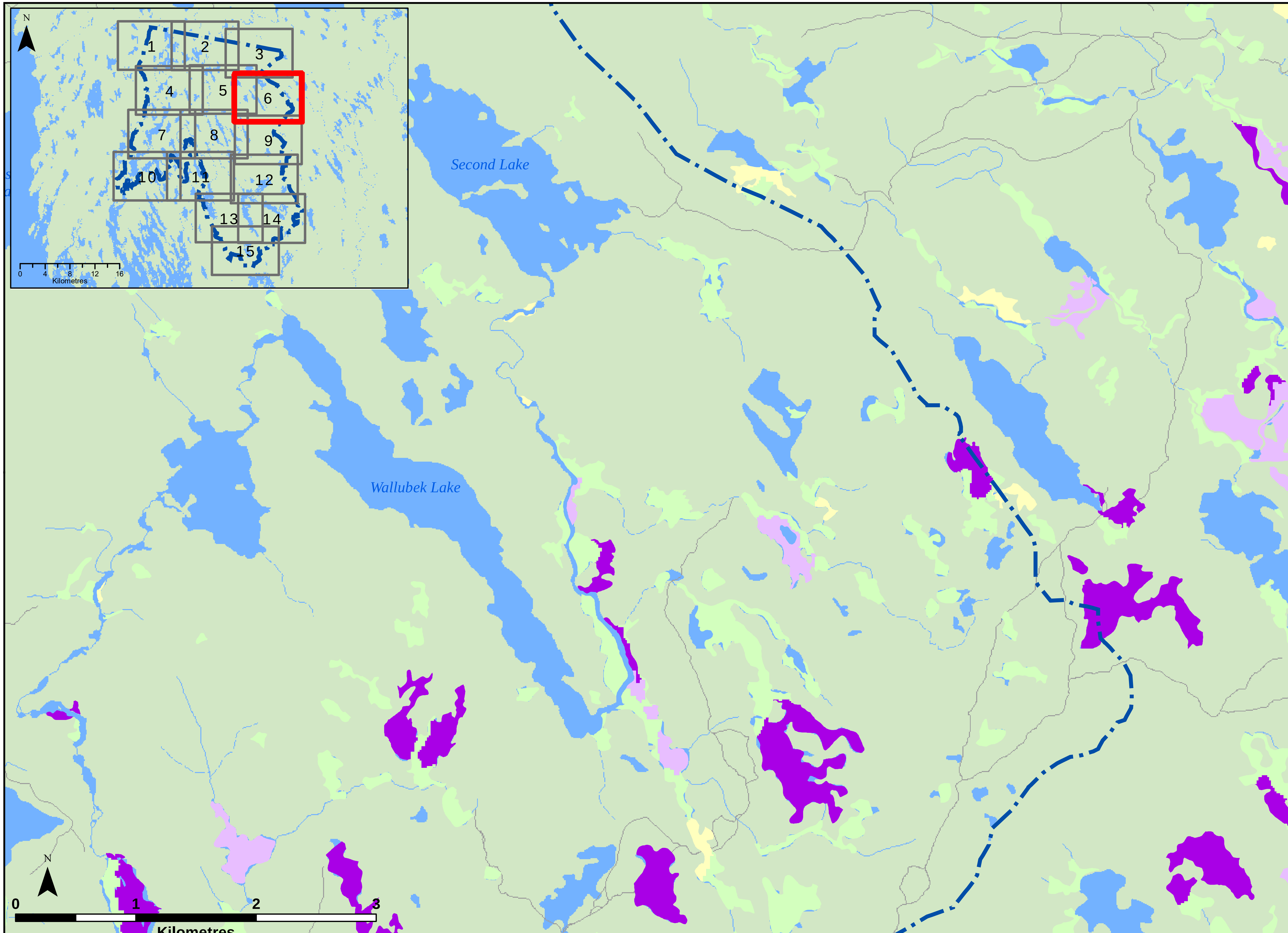
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Tusket Hydro System
- Wetland within 50 m of lake
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NSDNR Wetland Inventory
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NS Power Inc. - Tusket Hydro System

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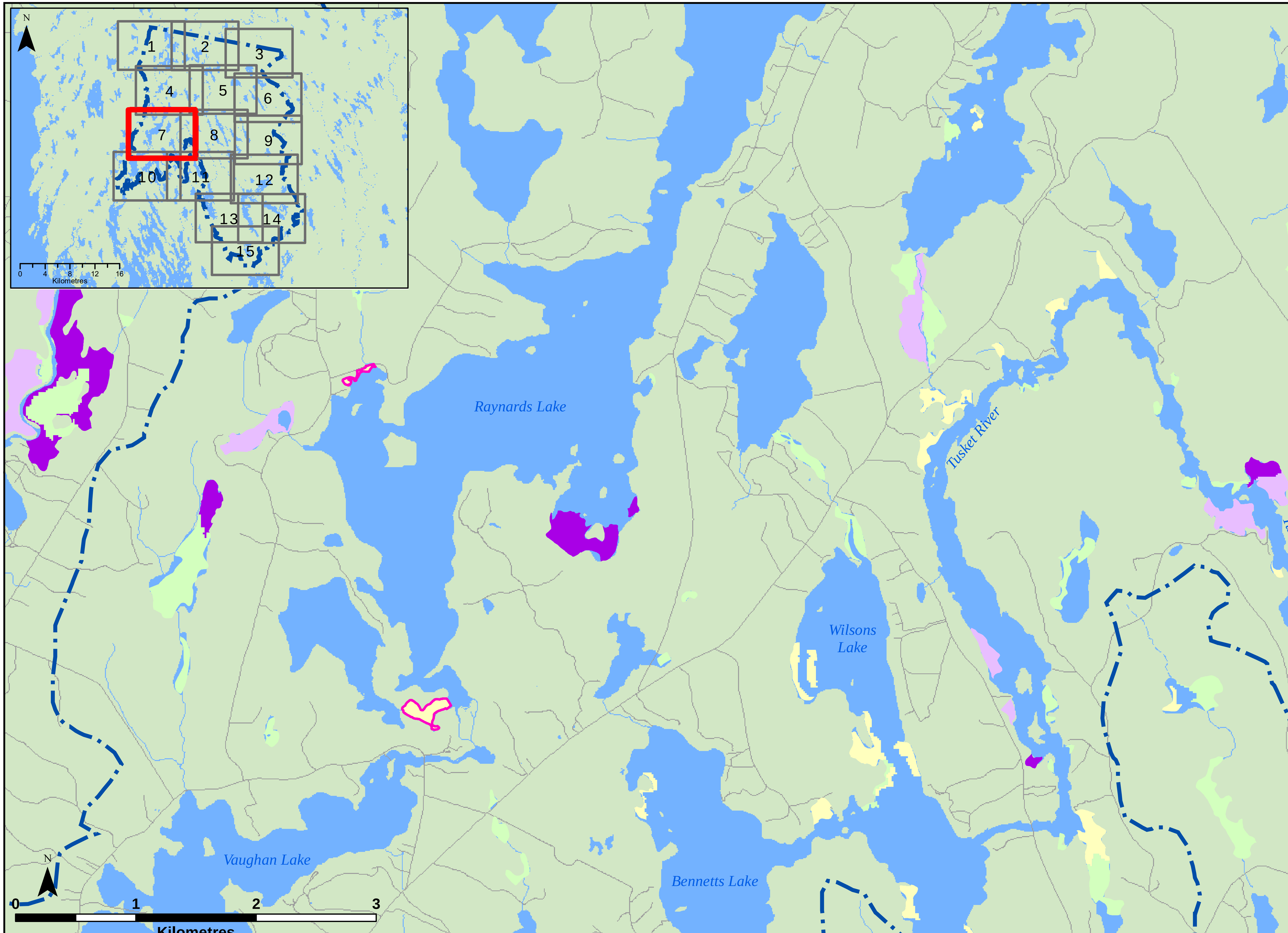
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

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NS Power Inc. - Tusket Hydro System

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Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 7
Drawn By: M. Marriott	
Checked By: S. Dickey	

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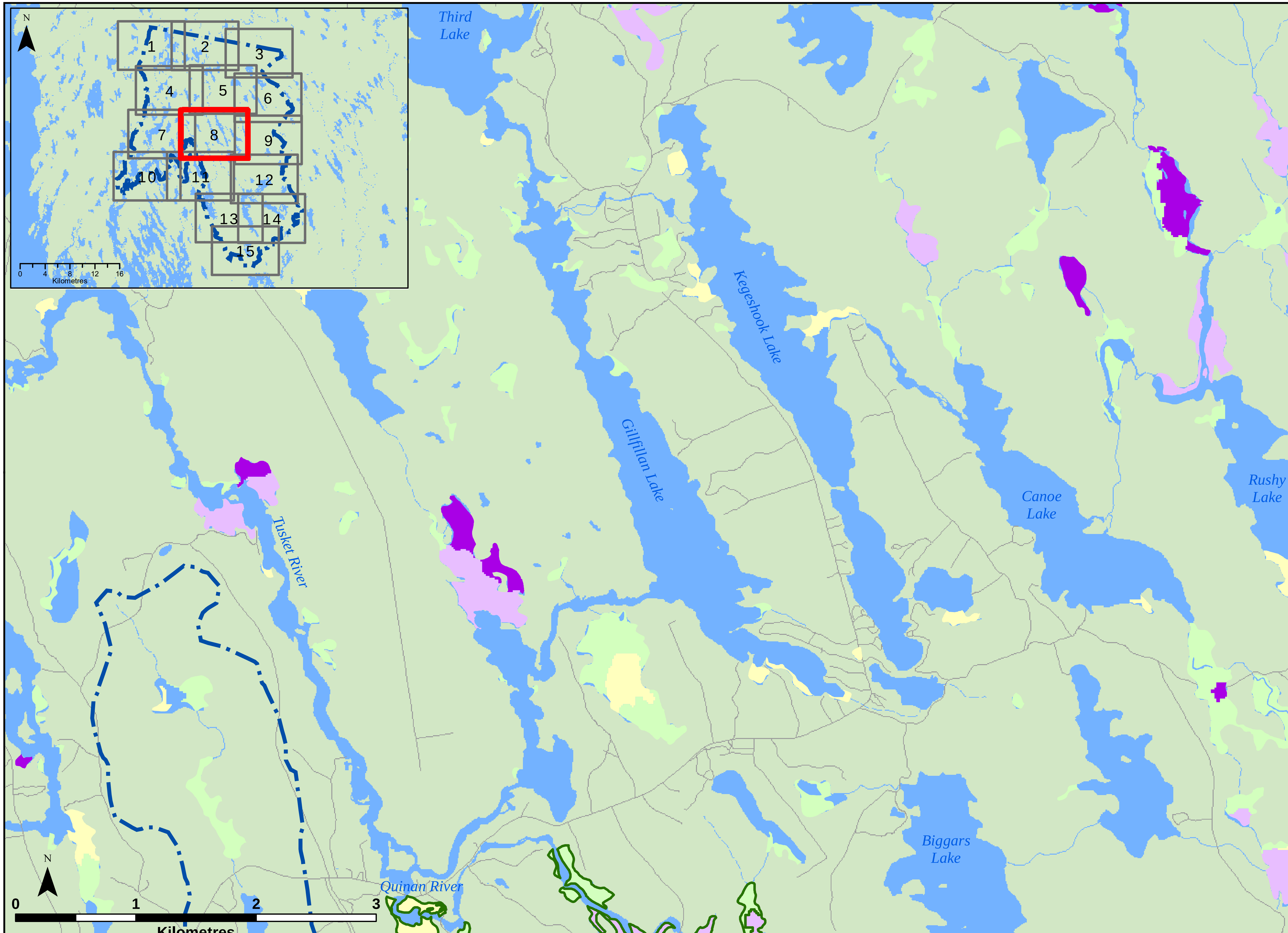

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

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- Mapped Indefinite Stream
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NS Power Inc. - Tusket Hydro System

Nova Scotia POWER An Emera Company

Strum CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
Drawn By: M. Marriott	
Checked By: S. Dickey	

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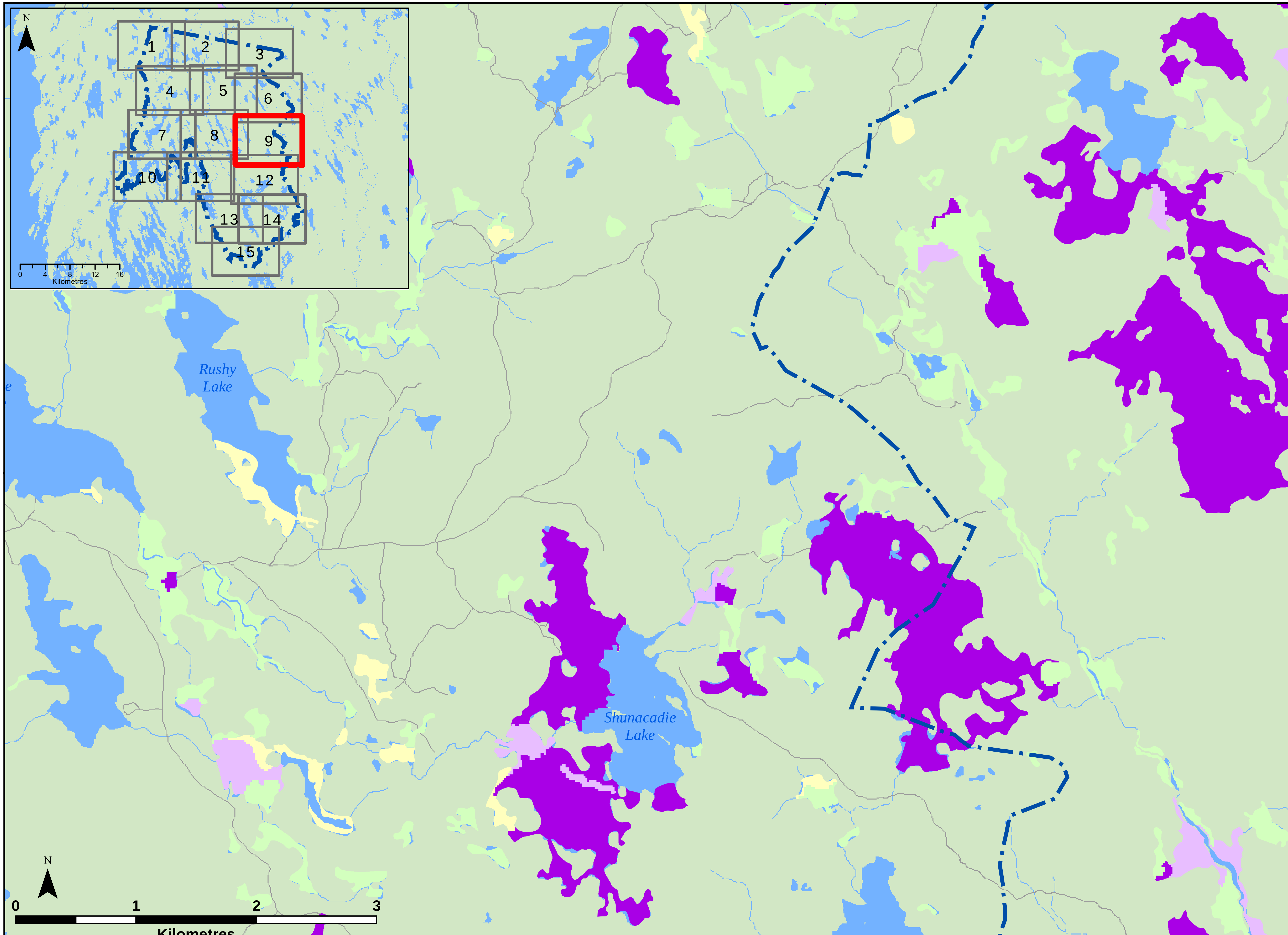

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Tusket Hydro System
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Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

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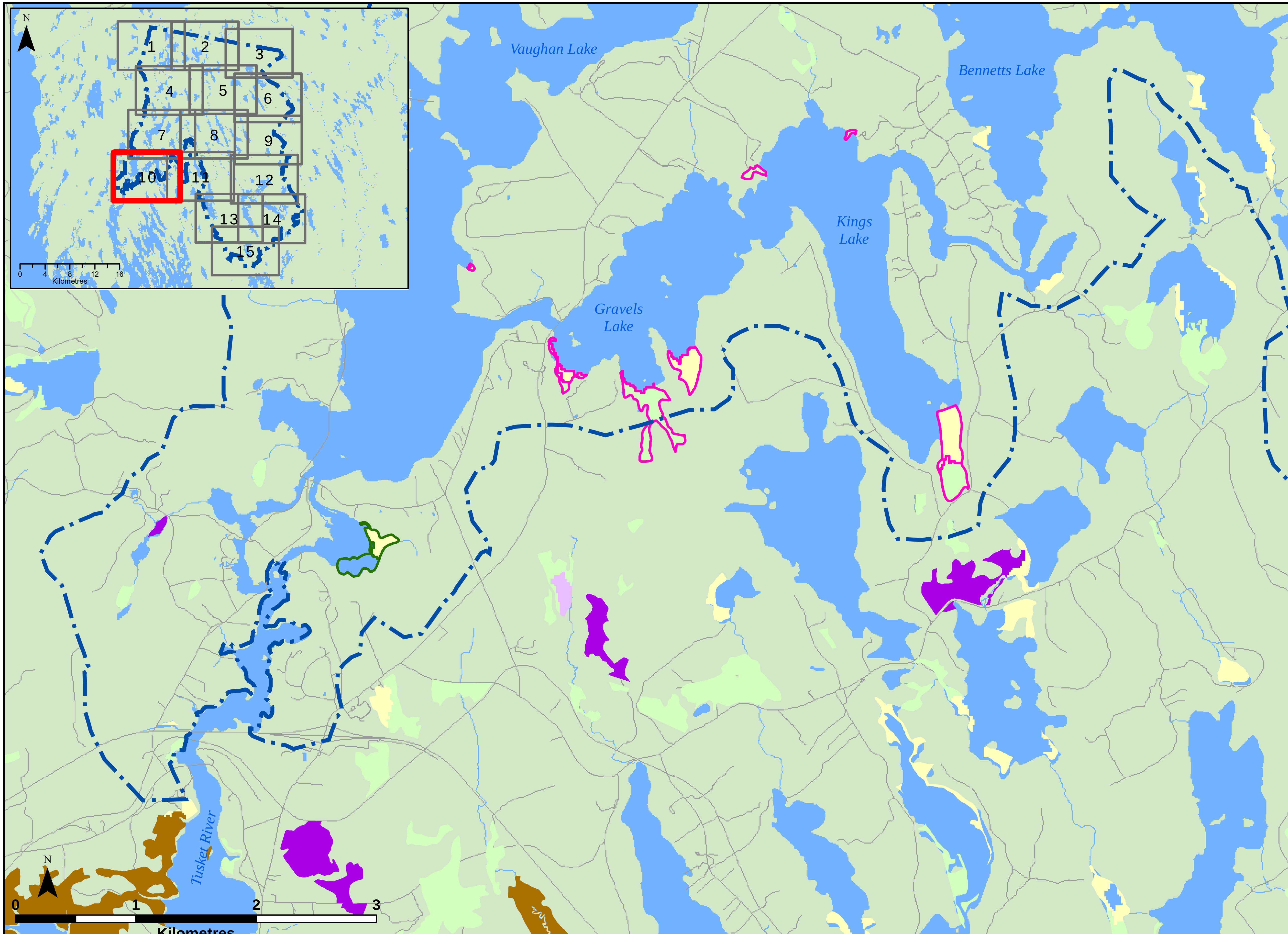
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Tusket Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

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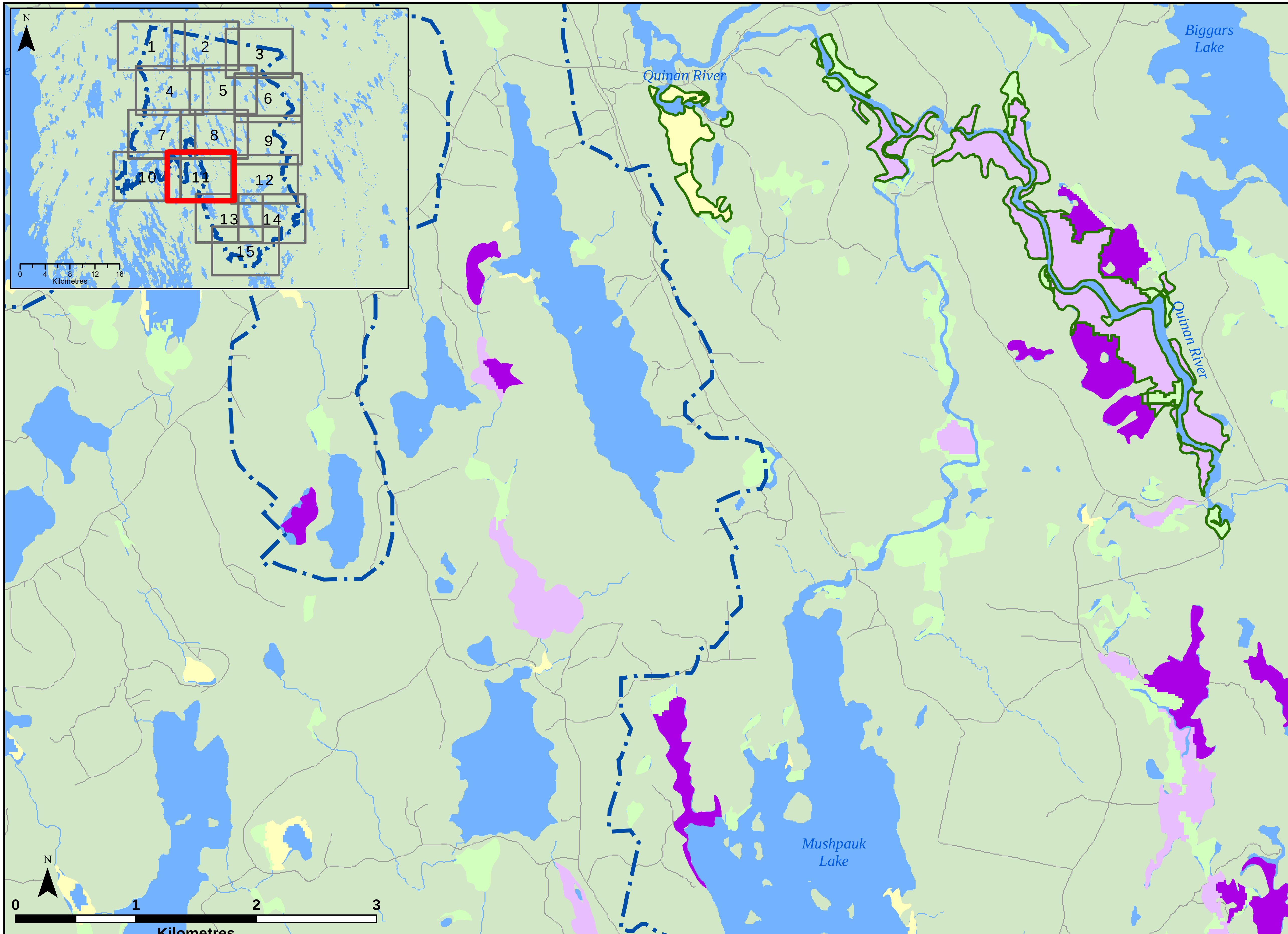
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 10
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Tusket Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

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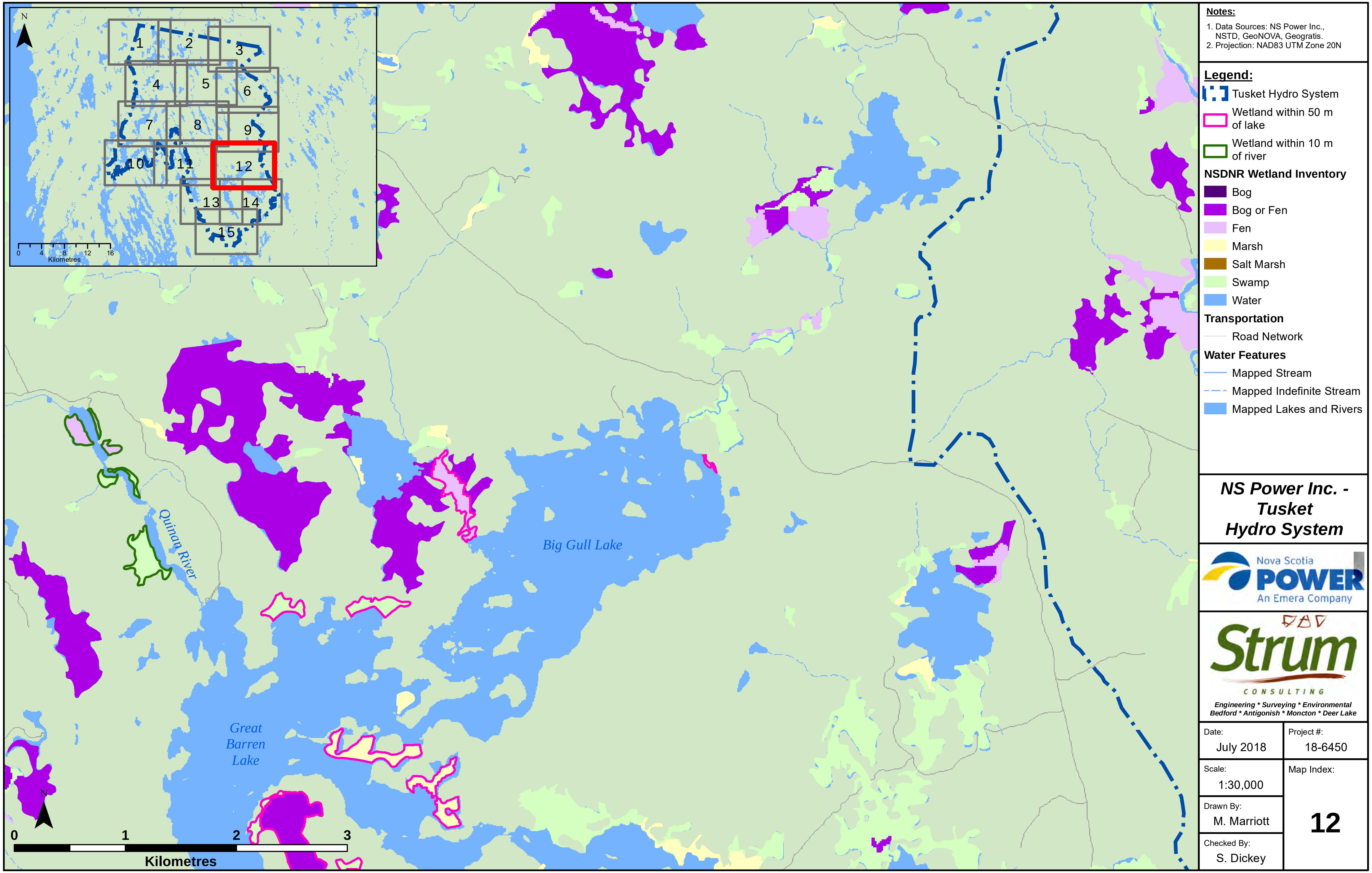
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 11
Drawn By: M. Marriott	
Checked By: S. Dickey	


Big Gull Lake
Great Barren Lake
Quinan River
0 1 2 3
Kilometres
0 4 8 12 16
Kilometres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Tusket Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Tusket Hydro System
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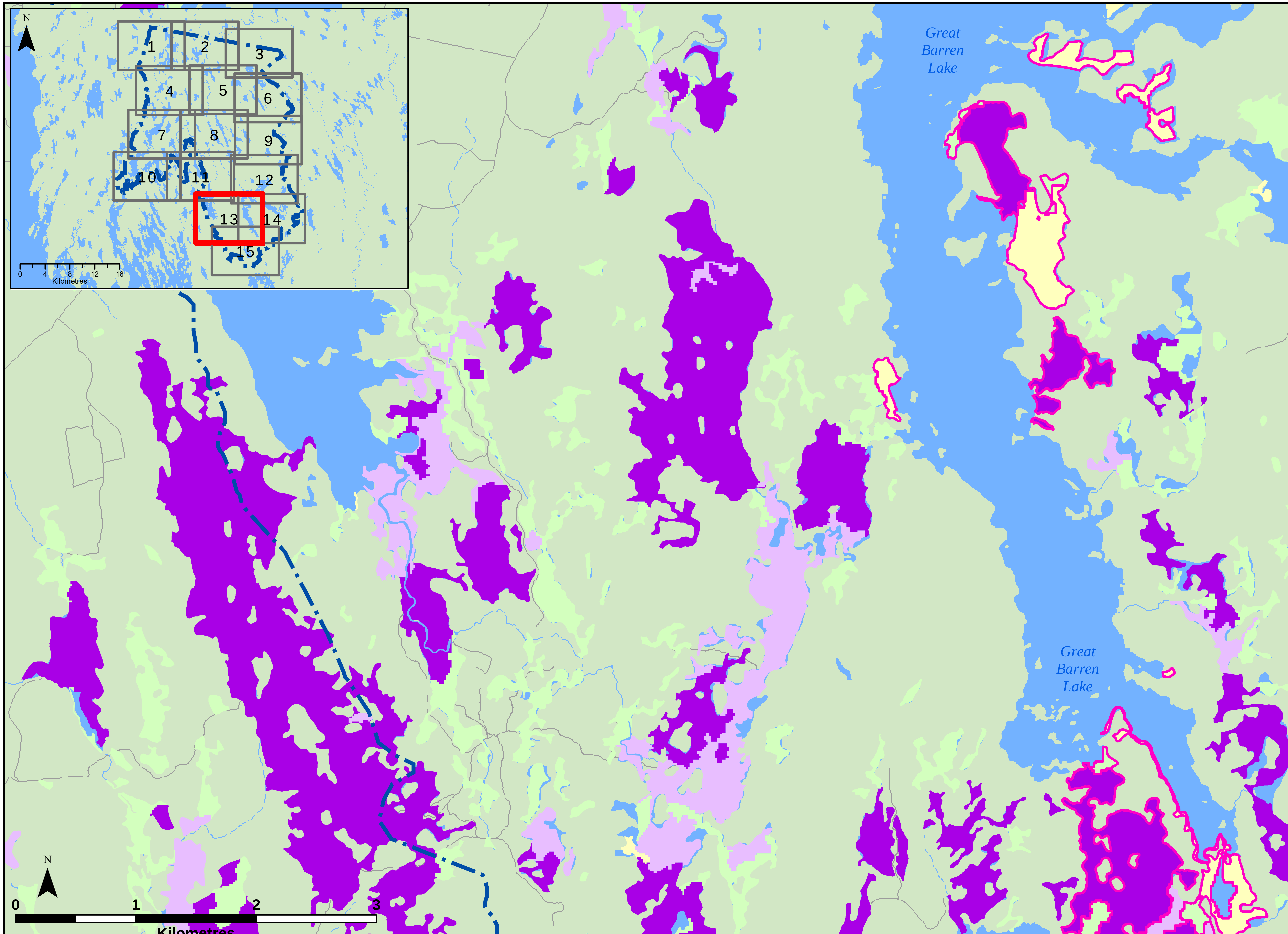
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 12
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Tusket Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Tusket Hydro System

Nova Scotia POWER An Emera Company

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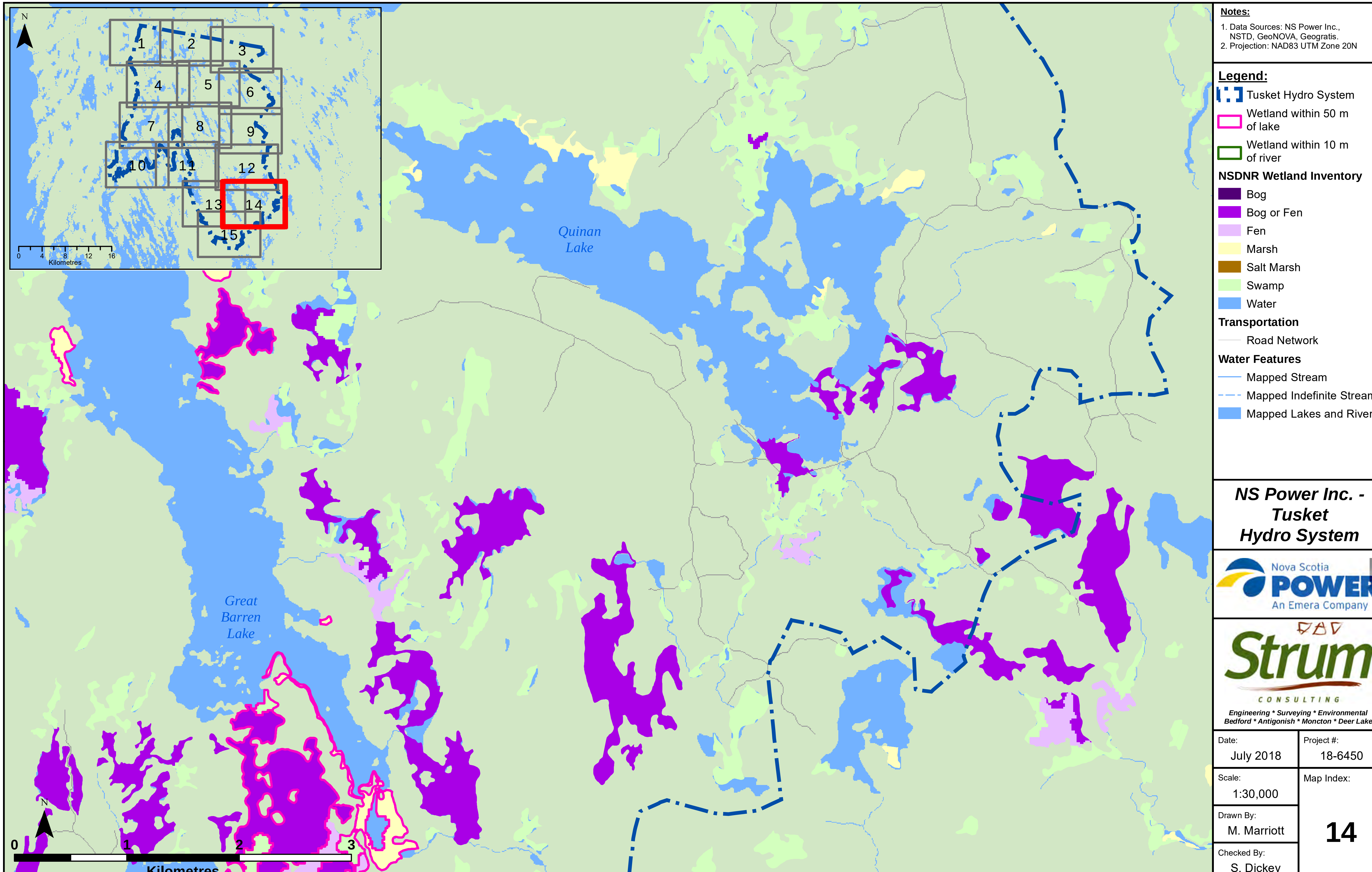
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 13
Drawn By: M. Marriott	
Checked By: S. Dickey	


Quinan Lake
Great Barren Lake
0 1 2 3
Kilometres
0 4 8 12 16
Kilometres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Tusket Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Tusket Hydro System
Nova Scotia POWER
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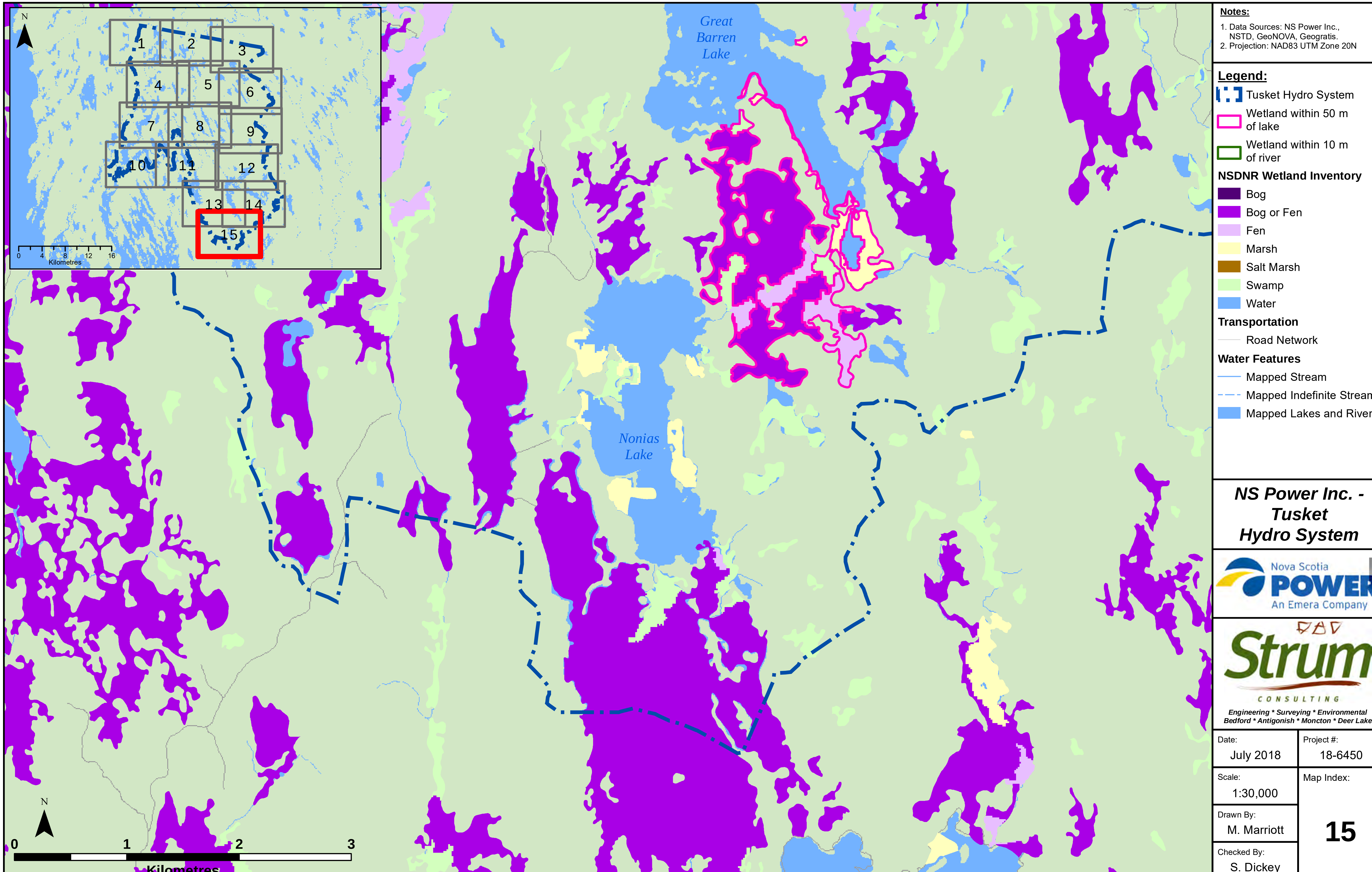
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 14
Drawn By: M. Marriott
Checked By: S. Dickey



Great Barren Lake
Nonias Lake
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Kilometres
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10
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13
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15
0 4 8 12 16
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Tusket Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Tusket Hydro System
Nova Scotia POWER
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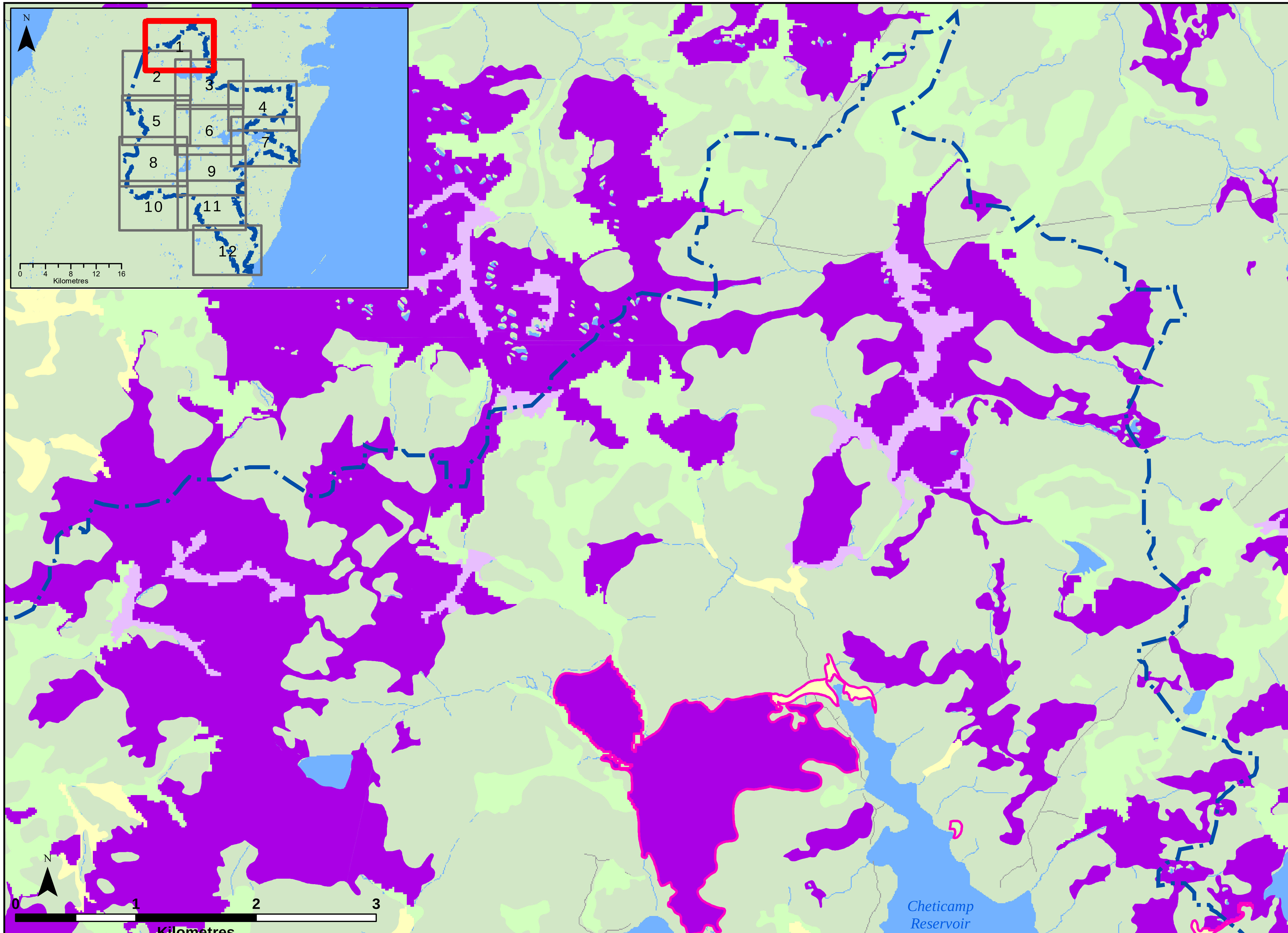
Strum
CONSULTING
Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date:
July 2018
Project #:
18-6450
Scale:
1:30,000
Map Index:
15
Drawn By:
M. Marriott
Checked By:
S. Dickey

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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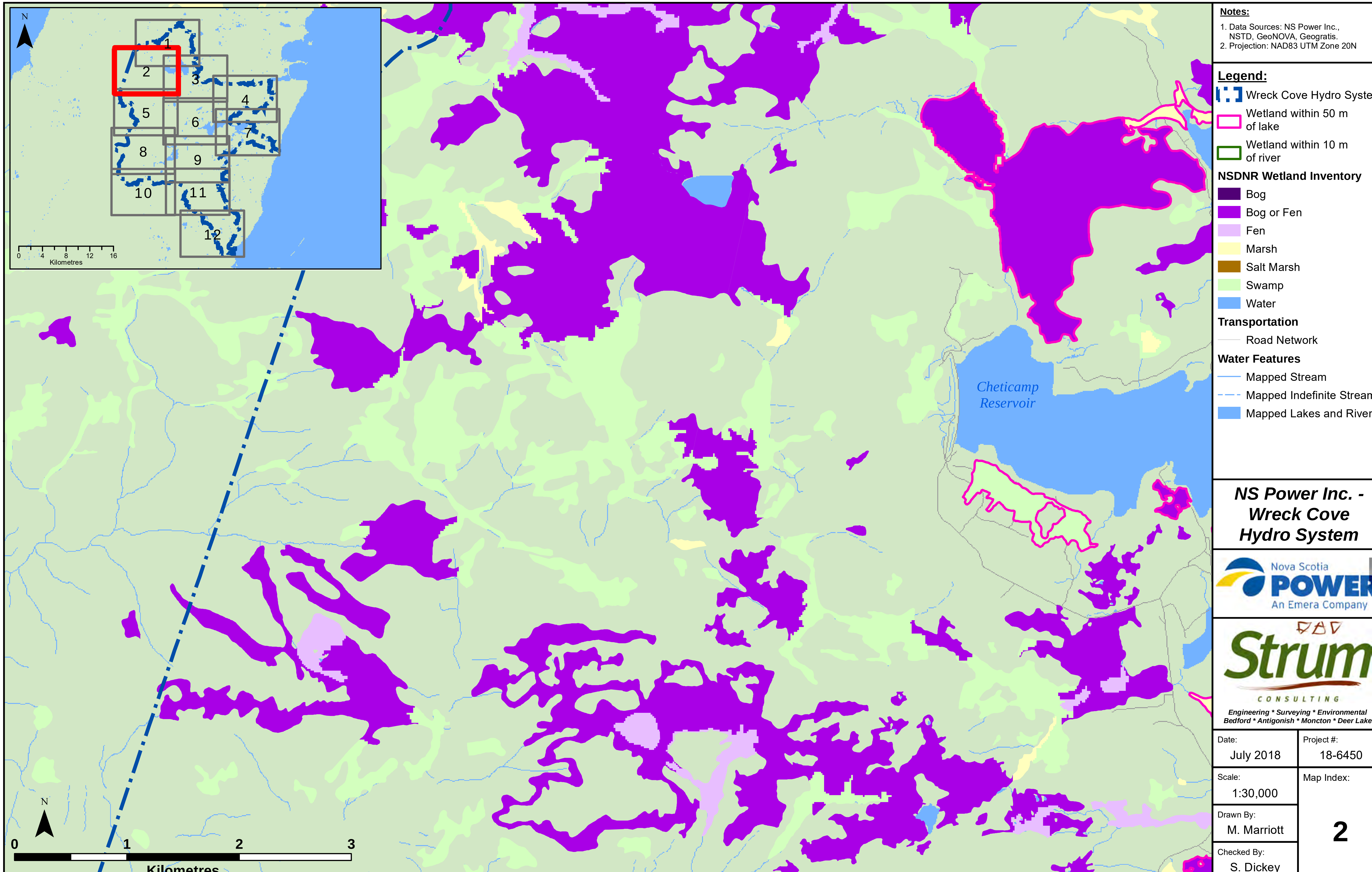
Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 1
Drawn By: M. Marriott	
Checked By: S. Dickey	


Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wreck Cove Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
Cheticamp Reservoir
0 1 2 3
Kilometres
NS Power Inc. - Wreck Cove Hydro System
Nova Scotia POWER An Emera Company
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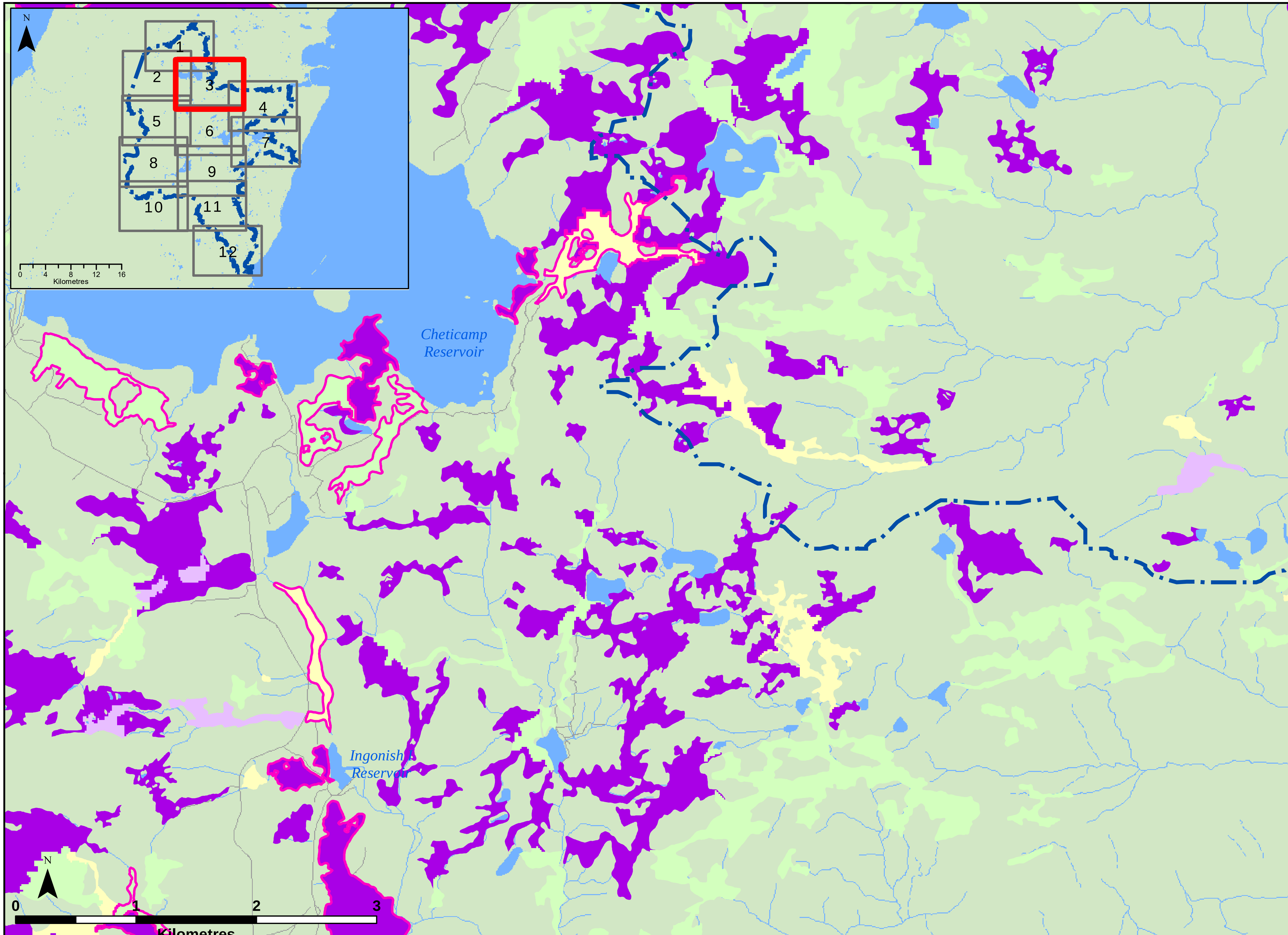
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 2
Drawn By: M. Marriott
Checked By: S. Dickey



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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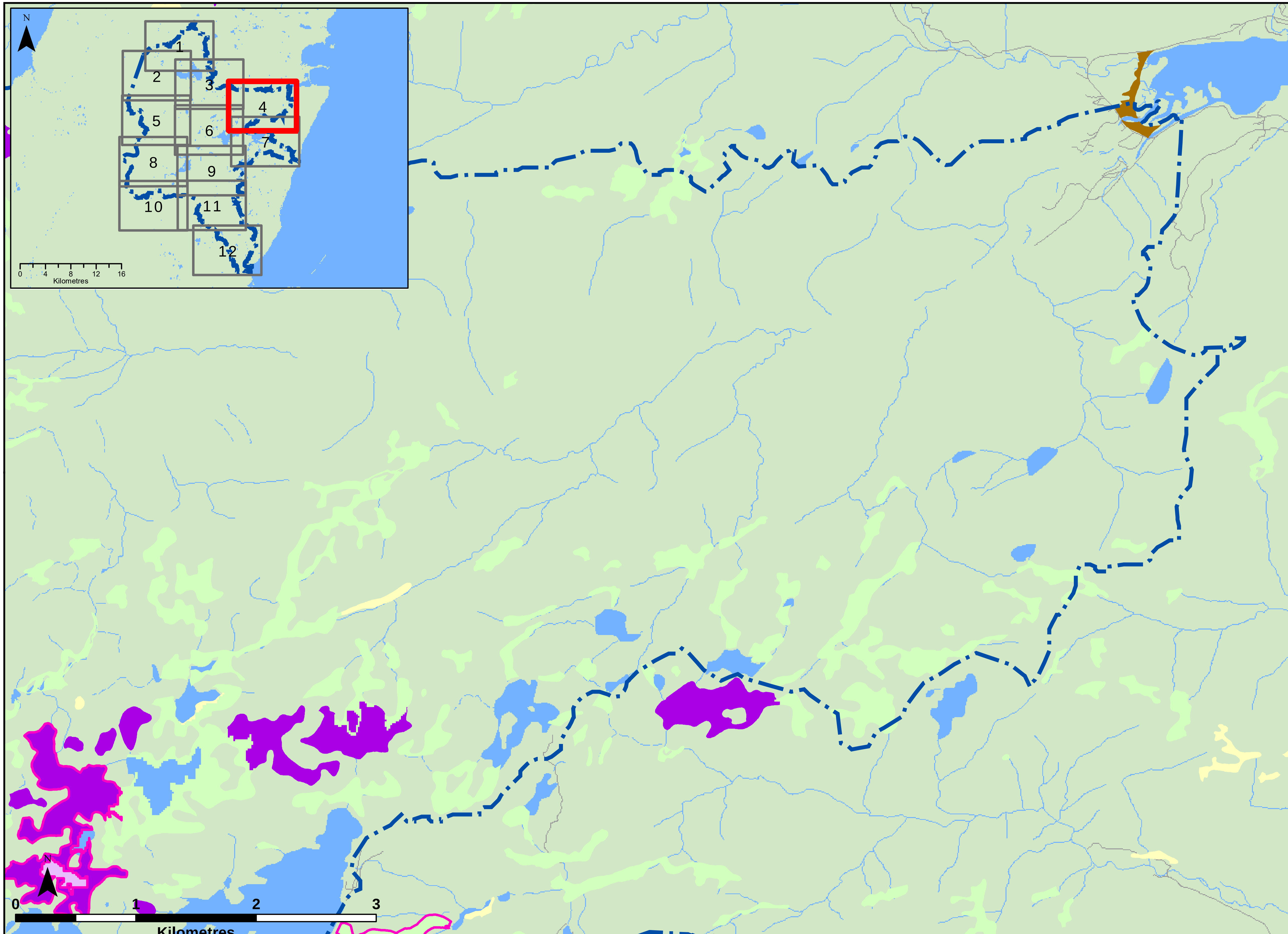
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 3
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

Wreck Cove Hydro System

Wetland within 50 m of lake

Wetland within 10 m of river

NSDNR Wetland Inventory

Bog

Bog or Fen

Fen

Marsh

Salt Marsh

Swamp

Water

Transportation

Road Network

Water Features

Mapped Stream

Mapped Indefinite Stream

Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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*Bedford * Antigonish * Moncton * Deer Lake*

Date:	Project #:
July 2018	18-6450
Scale: 1:30,000	Map Index: 4
Drawn By: M. Marriott	
Checked By: S. Dickey	

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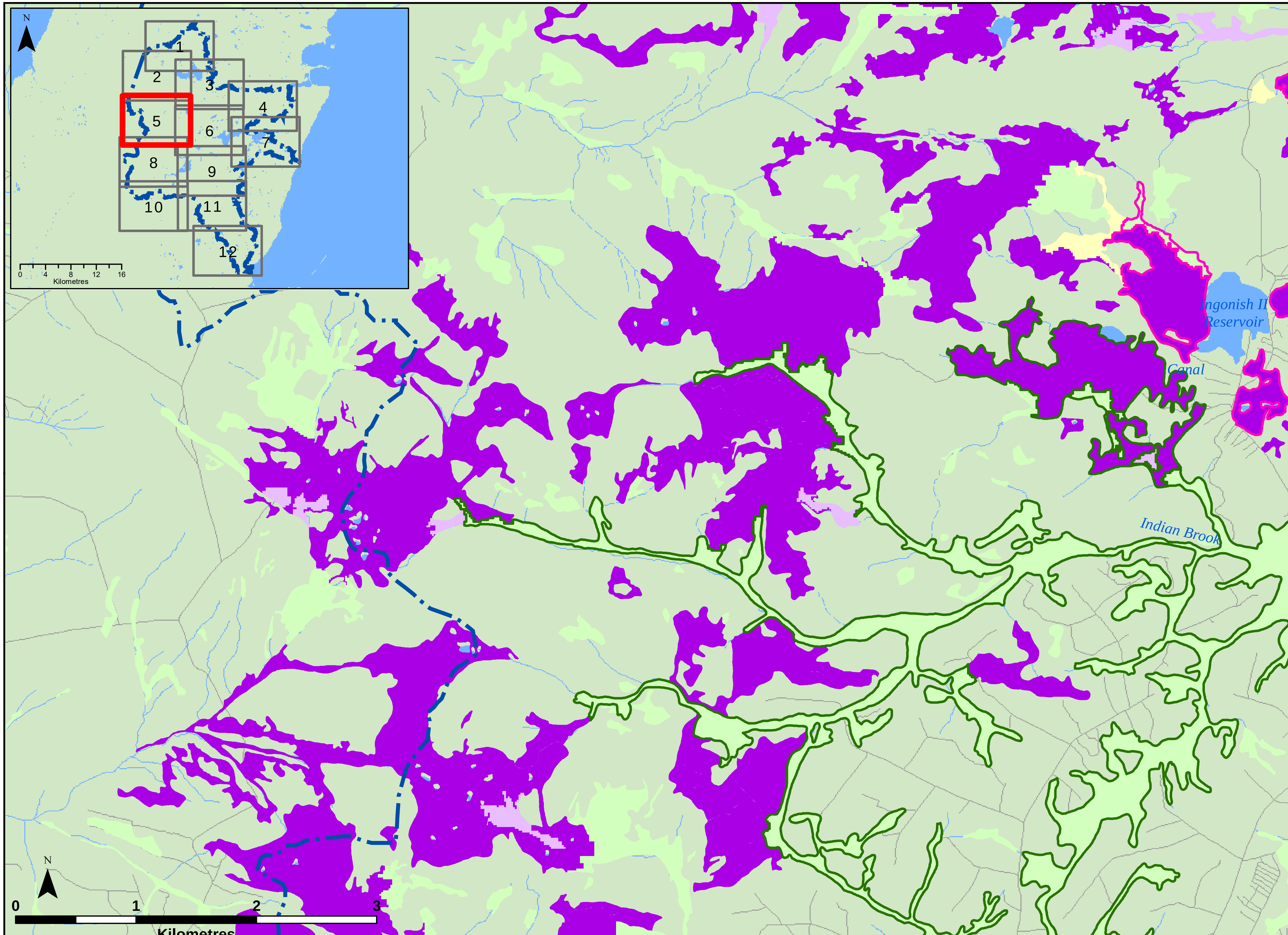

Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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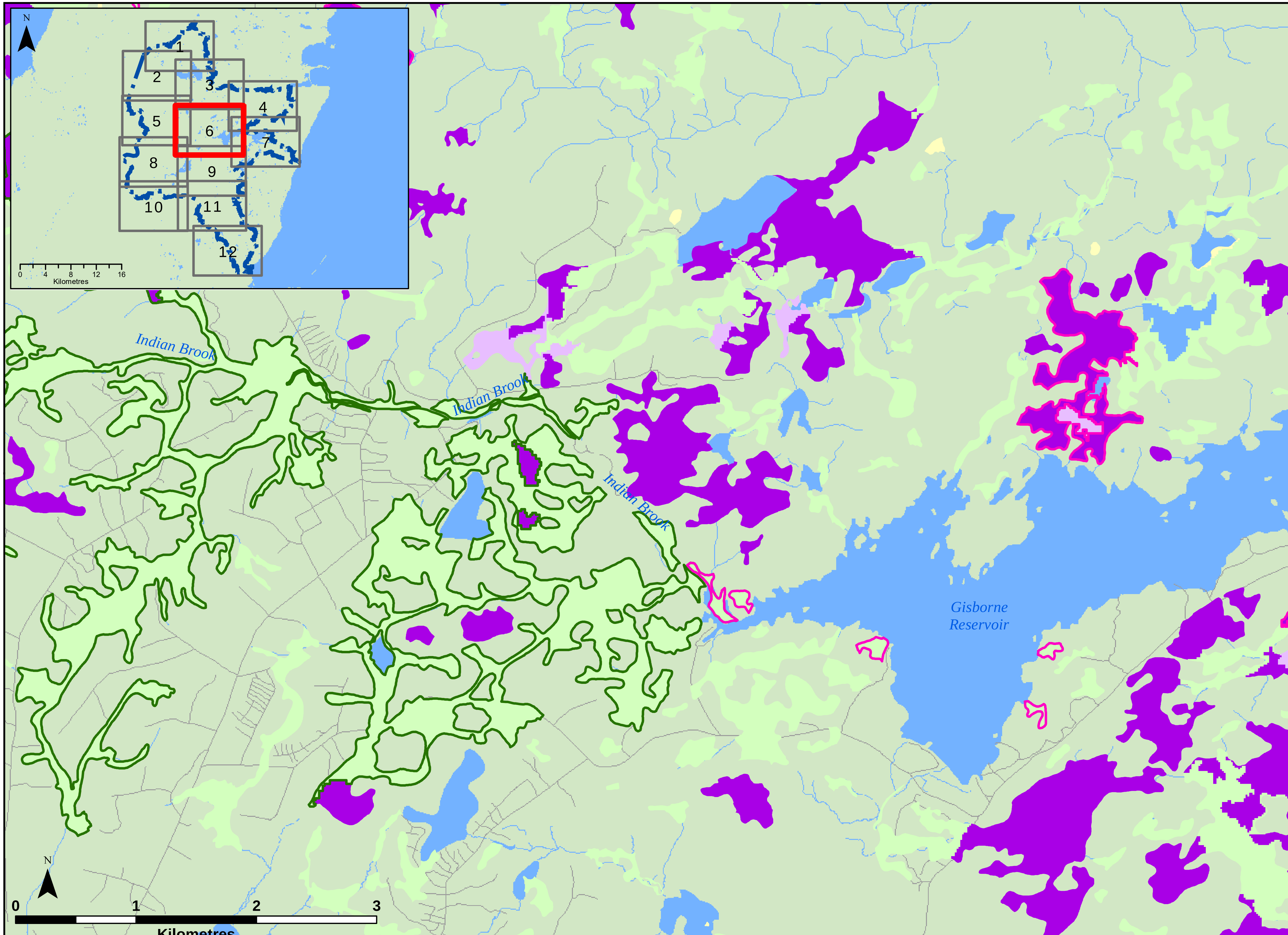
Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 5
Drawn By: M. Marriott	
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

Nova Scotia POWER An Emera Company

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Bedford * Antigonish * Moncton * Deer Lake

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 6
Drawn By: M. Marriott	
Checked By: S. Dickey	

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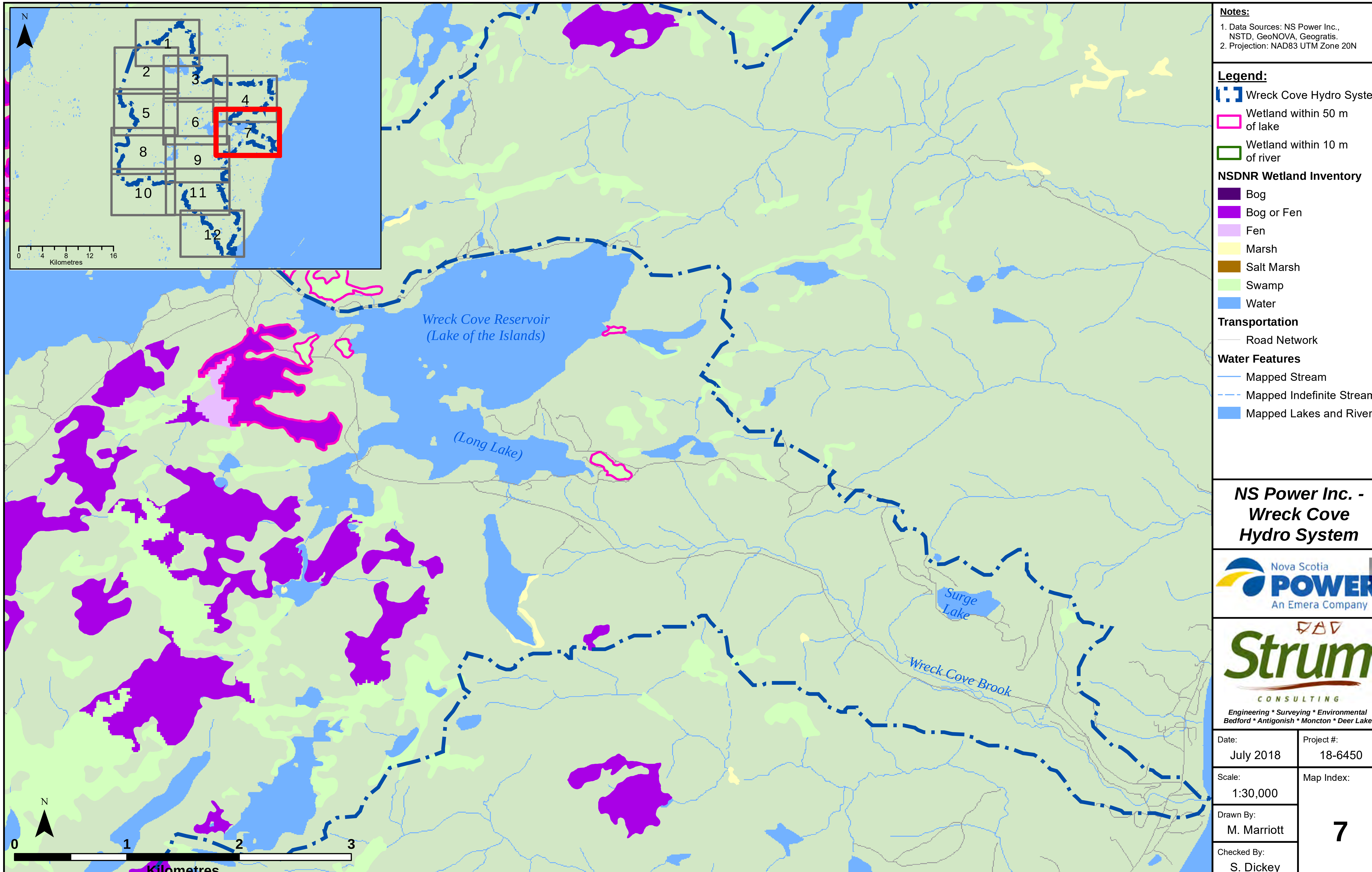

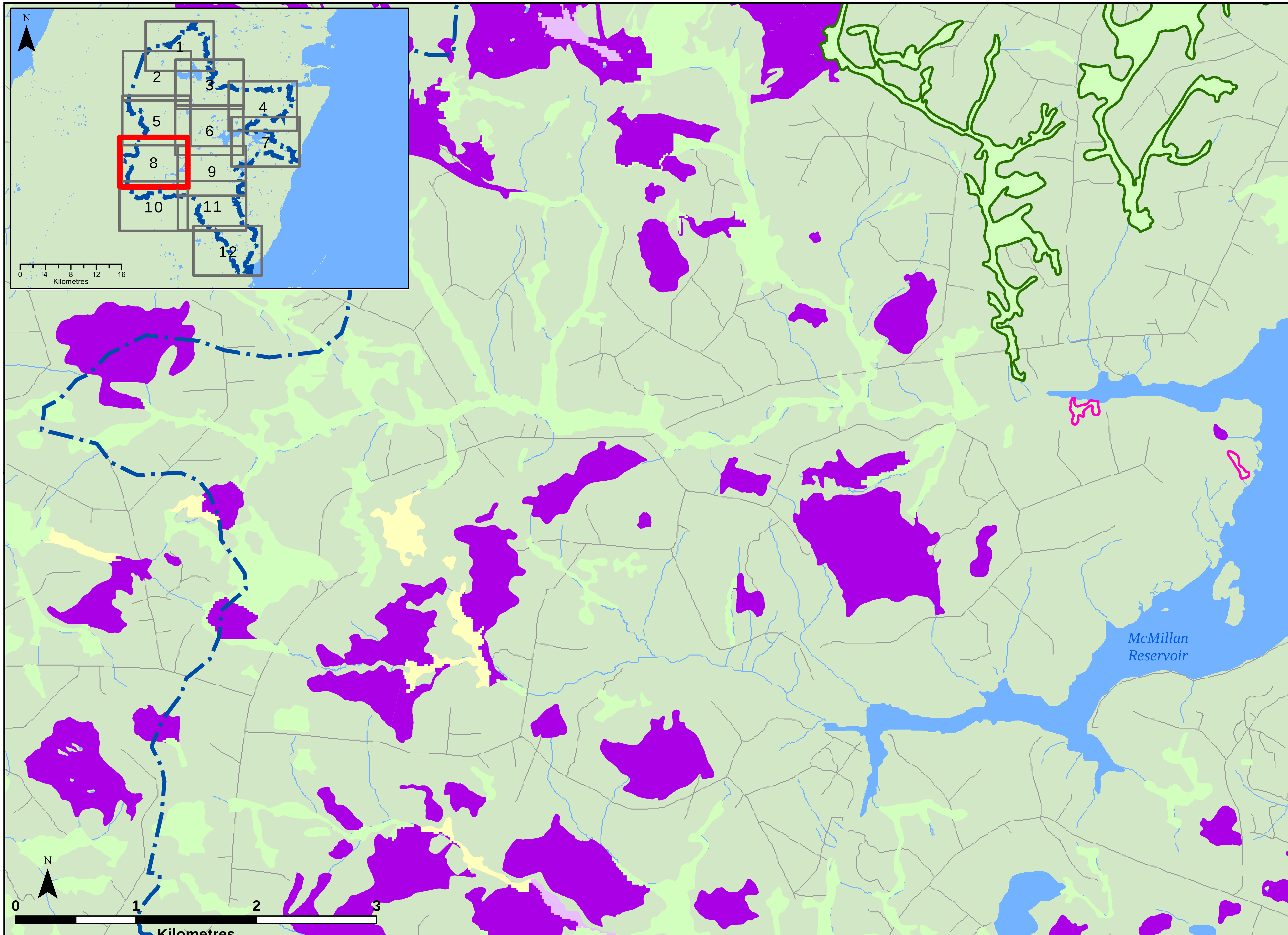

Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 8
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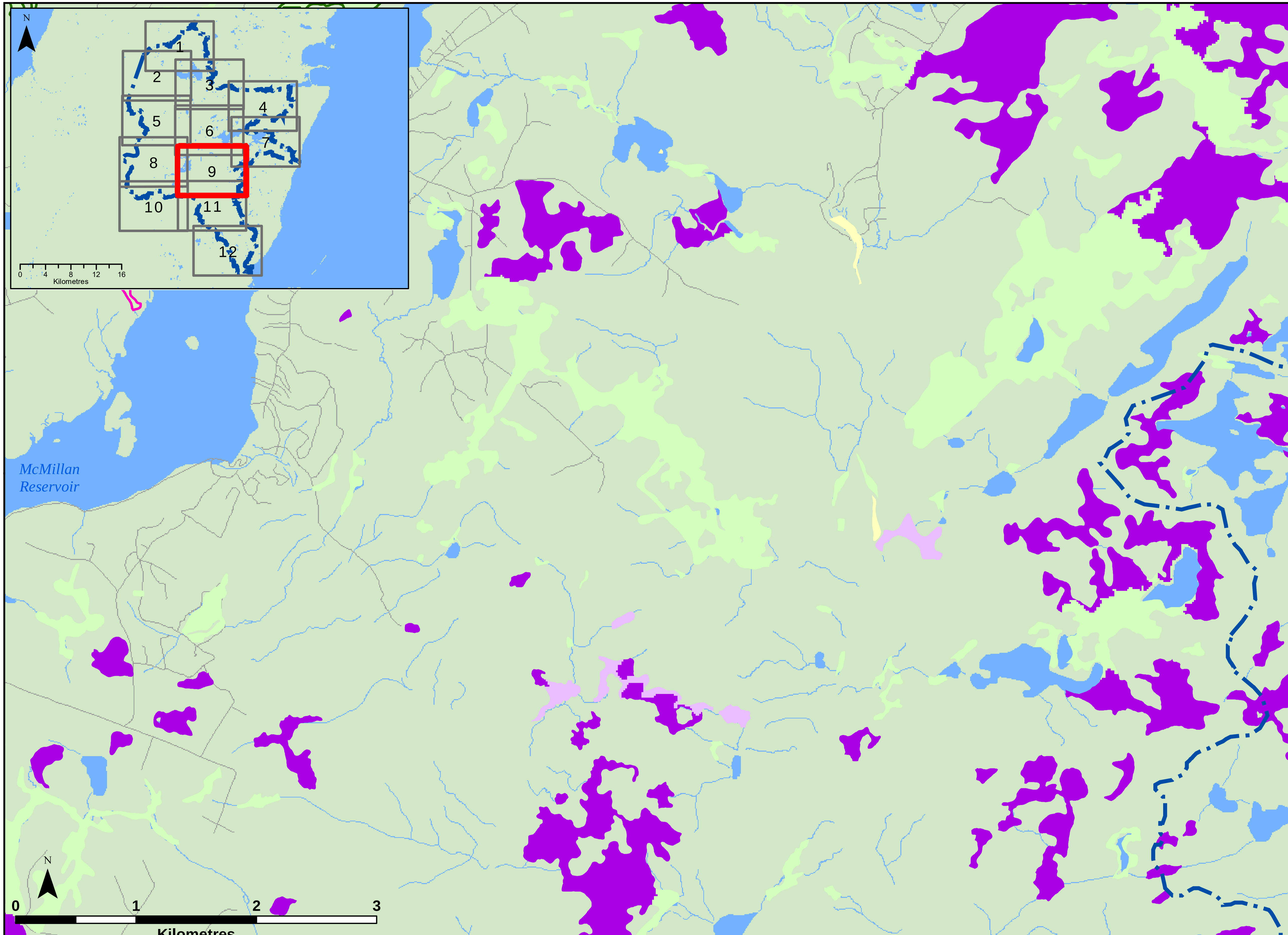
Checked By: S. Dickey	



Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:
- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory
- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation
- Road Network

Water Features
- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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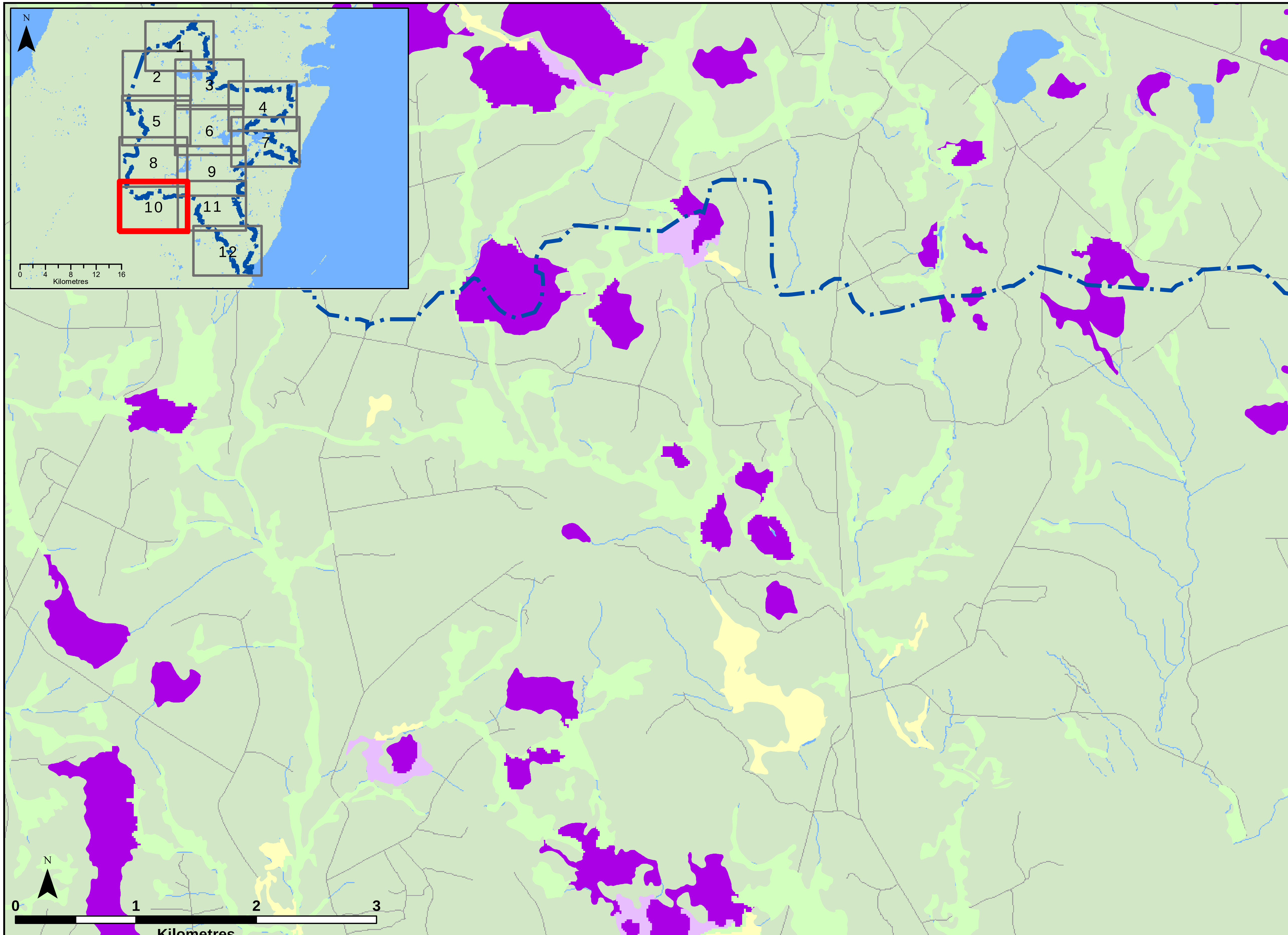
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 9
Drawn By: M. Marriott	
Checked By: S. Dickey	

REDACTED (CONFIDENTIAL INFORMATION REMOVED)



Notes:

1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N

Legend:

- Wreck Cove Hydro System
- Wetland within 50 m of lake
- Wetland within 10 m of river

NSDNR Wetland Inventory

- Bog
- Bog or Fen
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water

Transportation

- Road Network

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers

NS Power Inc. - Wreck Cove Hydro System

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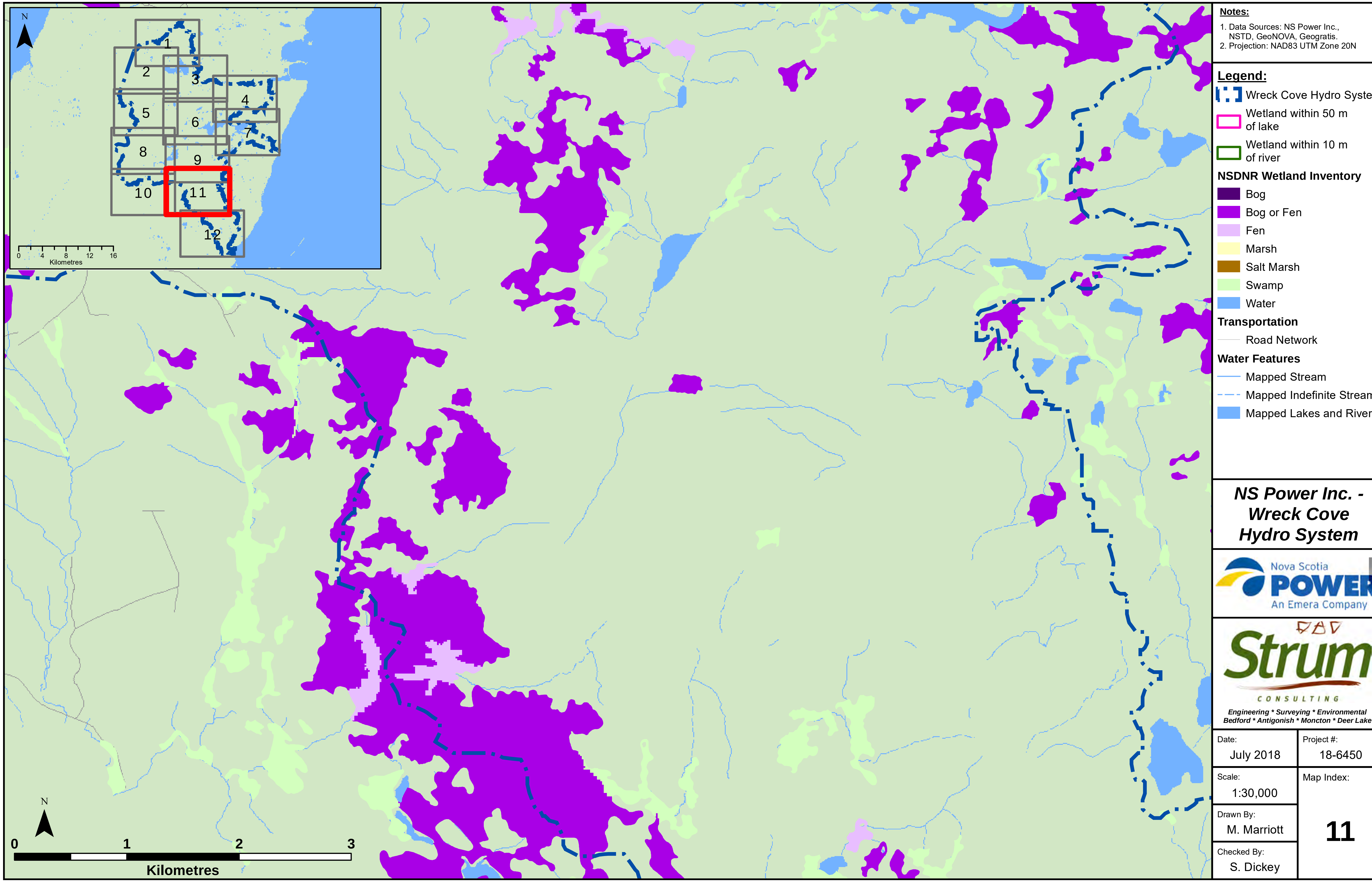
*Bedford * Antigonish * Moncton * Deer Lake*

Date: July 2018	Project #: 18-6450
Scale: 1:30,000	Map Index: 10
Drawn By: M. Marriott	
Checked By: S. Dickey	


N
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0 4 8 12 16
Kilometres
N
0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wreck Cove Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Wreck Cove Hydro System
Nova Scotia POWER An Emera Company
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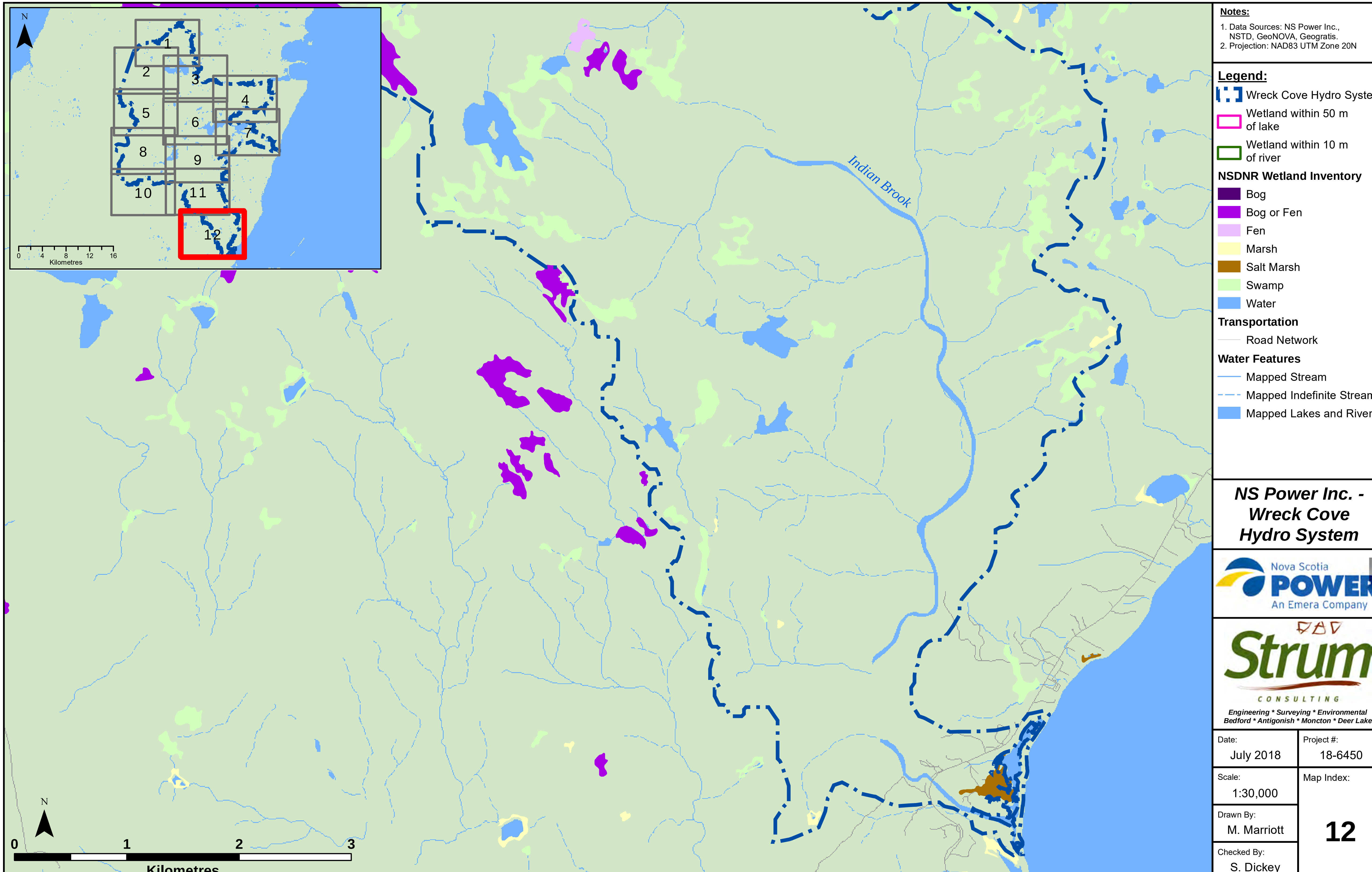
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 11
Drawn By: M. Marriott
Checked By: S. Dickey


N
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0 4 8 12 16
Kilometres
Indian Brook
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0 1 2 3
Kilometres
Notes:
1. Data Sources: NS Power Inc., NSTD, GeoNOVA, Geogratis.
2. Projection: NAD83 UTM Zone 20N
Legend:
Wreck Cove Hydro System
Wetland within 50 m of lake
Wetland within 10 m of river
NSDNR Wetland Inventory
Bog
Bog or Fen
Fen
Marsh
Salt Marsh
Swamp
Water
Transportation
Road Network
Water Features
Mapped Stream
Mapped Indefinite Stream
Mapped Lakes and Rivers
NS Power Inc. - Wreck Cove Hydro System
Nova Scotia POWER An Emera Company
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Engineering * Surveying * Environmental
Bedford * Antigonish * Moncton * Deer Lake
Date: July 2018
Project #: 18-6450
Scale: 1:30,000
Map Index: 12
Drawn By: M. Marriott
Checked By: S. Dickey

Table 1. Wetland Alteration Permitting Cost Estimates

Project # 18-6450

Hydrosystem	Water Body	Contiguouse Wetland Area (ha)	Total Contiguouse Wetland Area (ha)	Field Costs	Permit Reporting and Submission Costs	Total Expenses Costs	Total Permitting Cost	Followup Monitoring Cost	Total (Permiting+ Monitoring) Cost
Avon River	The Stillwater	24.90	171.39	$ 12,600.00	$ 3,000.00	$ 1,028.70	$ 16,628.70	$ 8,314.35	$ 24,943.05
	Mill Brook	6.82							
	Avon River	12.56							
	Mockingigh Lake	3.24							
	Little Island Lake	0.82							
	Hebbs Mill Pond	10.81							
	Gilberts Stillwater	21.70							
	Falls Lake	4.32							
	Murphy Lake	1.89							
	North Canoe Lake	3.93							
	South Canoe Lake	47.34							
	Unknown 1	1.62							
	Zwicker Lake	4.91							
	Card Lake	26.53							
Bear River	Lake Mulgrave	91.51	114.63	$ 9,000.00	$ 3,000.00	$ 2,916.50	$ 14,916.50	$ 7,458.25	$ 22,374.75
	Ridge Head Pond	23.12							
Black River	Aylesford Lake	24.7	1144.70	$ 82,800.00	$ 3,000.00	$ 28,750.00	$ 114,550.00	$ 57,275.00	$ 171,825.00
	Salmontail Lake	46.9							
	Trout River Pond	18.0							
	Little River Lake	155.0							
	Methals Lake	30.8							
	Dean Chapter Lake	23.1							
	Black River Lake	25.5							
	Lumsden Pond	1.0							
	Hells Gate Pond	0.0							
	White Rock Pond	0.0							
	Gaspereau Lake	379.90							
	Bear Trap Pool	21.8							
	Gaspereau River	125.3							
	Loon Lake Channel	0.5							
	Salmontail River	127.9							
	Trout River	34.3							
	West River	128.0							
	Unnamed 1	1.0							
	Unnamed 2	1.0							
Dickie Brook	Donahue Lake	8.99	15.89	$ 1,800.00	$ 3,000.00	$ 783.00	$ 5,583.00	$ 2,791.50	$ 8,374.50
	Square Lake	3.32							
	Unknown 1	1.01							
	Tom Lake	0.74							
	Eastern Pond	1.83							
Fall River	Miller Lake	2.60	26.70	$ 3,600.00	$ 3,000.00	$ 338.70	$ 6,938.70	$ 3,469.35	$ 10,408.05
	Soldier Lake	6.83							
	Unknown 1	17.27							
Harmony	Medway River	169.96	469.49	$ 34,200.00	$ 3,000.00	$ 11,590.00	$ 48,790.00	$ 24,395.00	$ 73,185.00
	Labelle Brook	41.27							
	Annis Lake	6.07							
	Beaverdam Lake	4.43							
	Beavertail Lake	35.56							
	Black Rattle Lake	7.89							
	Hog Lake	17.15							
	McGowan Lake	32.76							
	Molega Lake	77.44							
Harmony	Ponhook Lake	69.47							
	Whynott Lake	7.49							
Lequille	Allains Creek	98.90	255.70	$ 19,800.00	$ 3,000.00	$ 6,663.00	$ 29,463.00	$ 14,731.50	$ 44,194.50
	Ten Mile River	52.42							
	Crotchet Lake	16.39							
	Dargie Lake	2.27							
	Grand Lake	65.54							
	Lambs Lake	20.18							
Mersey	Mersey River	25.22	1128.76	$ 82,800.00	$ 3,000.00	$ 28,550.00	$ 114,350.00	$ 57,175.00	$ 171,525.00
	Cadeusky Lake	183.66							
	Eight Lake	121.42							
	Lake Rossignol	771.66							
	Sixth Lake	26.00							
	The Cove	0.80							

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Table 1. Wetland Alteration Permitting Cost Estimates

Hydrosystem	Water Body	Contiguouse Wetland Area (ha)	Total Contiguouse Wetland Area (ha)	Field Costs	Permit Reporting and Submission Costs	Total Expenses Costs	Total Permitting Cost	Followup Monitoring Cost	Total (Permiting+ Monitoring) Cost
Nictaux	Nictaux River	55.78	178.05	$ 14,400.00	$ 3,000.00	$ 4,724.00	$ 22,124.00	$ 11,062.00	$ 33,186.00
	Big Molly Upsim Lake	11.79							
	McGill Lake	96.04							
	Scrag Lake	4.07							
	Shannon Lake	9.61							
	Wamboldt Lake	0.76							
Paradise	Bloody Creek Brook	14.09	297.17	$ 21,600.00	$ 3,000.00	$ 7,254.00	$ 31,854.00	$ 15,927.00	$ 47,781.00
	Little John Brook	9.82							
	Paradise Brook	3.34							
	Unknown 1	75.13							
	Birch Hill Lake	11.49							
	Corbett Lake	85.30							
	Dalhousie Lake	10.85							
	Paradise Lake	82.58							
	Unknown 1	1.36							
	Unknown 2	3.21							
Roseway	Roseway River	0.40	0.40	$ 2,000.00	$ 3,000.00	$ 500.00	$ 5,500.00	$ 2,250.00	$ 7,750.00
Sheet Harbour	East River	9.16	524.95	$ 37,800.00	$ 3,000.00	$ 12,818.00	$ 53,618.00	$ 26,809.00	$ 80,427.00
	Fifteen Mile Stream	23.59							
	Ten Mile Stream	20.42							
	Twelve Mile Stream	175.81							
	Unknown 1	35.26							
	Governor Lake	14.79							
	Marshall Falls Flowage	29.94							
	Ruths Falls Flowage	13.02							
	Seloam Lake	65.49							
	Ten Mile Lake	102.79							
	Union Dam Flowage	34.68							
Sissiboo	Sissiboo River	8.88	341.78	$ 25,200.00	$ 3,000.00	$ 8,582.00	$ 36,782.00	$ 18,391.00	$ 55,173.00
	Wallace Branch	88.24							
	Fourth Lake	157.86							
	Sissiboo Grand Lake	43.37							
	Third Lake	0.86							
	Big Uniacke Lake	0.51							
	Big Tom Wallace Lake	39.55							
	Big Deadwater	2.51							
St.Margarets Bay	Walsh Brook	7.75	97.84	$ 7,200.00	$ 3,000.00	$ 626.10	$ 10,826.10	$ 5,413.05	$ 16,239.15
	Northwest Brook	2.07							
St.Margarets Bay	Five Mile Lake	23.32							
	Big Indian Lake	12.41							
	Rafters Lake	0.50							
	Wrights Lake	12.51							
	Unknown 1	7.32							
	Little Indian Lake	12.60							
	Mill Lake	1.31							
	Little Walsh Lake	18.05							
Tusket	Quinan River	185.39	580.04	$ 43,200.00	$ 3,000.00	$ 14,849.00	$ 61,049.00	$ 30,524.50	$ 91,573.50
	Sweeneys Run	0.36							
	Tusket Falls	7.57							
	Gravels Lake	17.78							
	Great Barren Lake	286.84							
	Kempt Back Lake	6.18							
	Kings Lake	14.80							
	Lake Fanning	1.65							
	Odgen Lake	30.41							
	Parr Lake	21.59							
	Petes Lake	0.30							
	Raynards Lake	5.41							
	Unknown 1	1.57							
	Vaughan Lake	0.19							
Wreck Cove	Indian Brook	810.74	1533.45	$ 111,600.00	$ 3,000.00	$ 38,742.00	$ 153,342.00	$ 76,671.00	$ 230,013.00
	Cheticamp Reservoir	338.10							
	Gisborne Reservoir	69.51							
	Ingonish 1 Reservoir	21.39							
	Ingonish 2 Reservoir	127.59							
	McMillin Reservoir	3.43							
	Canal	79.62							
	Wreck Cove Reservoir	83.07							
								Grand Total	**$ 1,088,972.50**

Table 2. Compensation Cost Analysis Price Estimates — *Project # 18-6450*

Hydrosystem	Water Body	Contiguouse Wetland Area (ha)	Total Contiguouse Wetland Area (ha)	Hydro System Size	Compensation Cost Analysis Price Estimate
Avon River	The Stillwater	24.90	171.39	Medium	$ 7,500.00
	Mill Brook	6.82			
	Avon River	12.56			
	Mockingigh Lake	3.24			
	Little Island Lake	0.82			
	Hebbs Mill Pond	10.81			
	Gilberts Stillwater	21.70			
	Falls Lake	4.32			
	Murphy Lake	1.89			
	North Canoe Lake	3.93			
	South Canoe Lake	47.34			
	Unknown 1	1.62			
	Zwicker Lake	4.91			
	Card Lake	26.53			
Bear River	Lake Mulgrave	91.51	114.63	Small	$ 4,500.00
	Ridge Head Pond	23.12			
Black River	Aylesford Lake	24.7	1144.70	Large	$ 10,500.00
	Salmontail Lake	46.9			
	Trout River Pond	18.0			
	Little River Lake	155.0			
	Methals Lake	30.8			
	Dean Chapter Lake	23.1			
	Black River Lake	25.5			
	Lumsden Pond	1.0			
	Hells Gate Pond	0.0			
	White Rock Pond	0.0			
	Gaspereau Lake	379.90			
	Bear Trap Pool	21.8			
	Gaspereau River	125.3			
	Loon Lake Channel	0.5			
	Salmontail River	127.9			
	Trout River	34.3			
	West River	128.0			
	Unnamed 1	1.0			
	Unnamed 2	1.0			
Dickie Brook	Donahue Lake	8.99	15.89	Small	$ 4,500.00
	Square Lake	3.32			
	Unknown 1	1.01			
	Tom Lake	0.74			
	Eastern Pond	1.83			
Fall River	Miller Lake	2.60	26.70	Small	$ 4,500.00
	Soldier Lake	6.83			
	Unknown 1	17.27			
Harmony	Medway River	169.96	469.49	Medium	$ 7,500.00
	Labelle Brook	41.27			
	Annis Lake	6.07			
	Beaverdam Lake	4.43			
	Beavertail Lake	35.56			
	Black Rattle Lake	7.89			
	Hog Lake	17.15			
	McGowan Lake	32.76			

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Hydrosystem	Water Body	Contiguouse Wetland Area (ha)	Total Contiguouse Wetland Area (ha)	Hydro System Size	Compensation Cost Analysis Price Estimate
Harmony	Molega Lake	77.44		Medium	
	Ponhook Lake	69.47			
	Whynott Lake	7.49			
Lequille	Allains Creek	98.90	255.70	Medium	$ 7,500.00
	Ten Mile River	52.42			
	Crotchet Lake	16.39			
	Dargie Lake	2.27			
	Grand Lake	65.54			
	Lambs Lake	20.18			
Mersey	Mersey River	25.22	1128.76	Large	$ 10,500.00
	Cadeusky Lake	183.66			
	Eight Lake	121.42			
	Lake Rossignol	771.66			
	Sixth Lake	26.00			
	The Cove	0.80			
Nictaux	Nictaux River	55.78	178.05	Medium	$ 7,500.00
	Big Molly Upsim Lake	11.79			
	McGill Lake	96.04			
	Scrag Lake	4.07			
	Shannon Lake	9.61			
	Wamboldt Lake	0.76			
Paradise	Bloody Creek Brook	14.09	297.17	Medium	$ 7,500.00
	Little John Brook	9.82			
	Paradise Brook	3.34			
	Unknown 1	75.13			
	Birch Hill Lake	11.49			
	Corbett Lake	85.30			
	Dalhousie Lake	10.85			
	Paradise Lake	82.58			
	Unknown 1	1.36			
	Unknown 2	3.21			
Roseway	Roseway River	0.40	0.40	Small	$ 4,500.00
Sheet Harbour	East River	9.16	524.95	Medium	$ 7,500.00
	Fifteen Mile Stream	23.59			
	Ten Mile Stream	20.42			
	Twelve Mile Stream	175.81			
	Unknown 1	35.26			
	Governor Lake	14.79			
	Marshall Falls Flowage	29.94			
	Ruths Falls Flowage	13.02			
	Seloam Lake	65.49			
	Ten Mile Lake	102.79			
	Union Dam Flowage	34.68			
Sissiboo	Sissiboo River	8.88	341.78	Medium	$ 7,500.00
	Wallace Branch	88.24			
	Fourth Lake	157.86			
	Sissiboo Grand Lake	43.37			
	Third Lake	0.86			
	Big Uniacke Lake	0.51			
	Big Tom Wallace Lake	39.55			
	Big Deadwater	2.51			
St.Margarets Bay	Walsh Brook	7.75	97.84	Small	$ 4,500.00

Hydrosystem	Water Body	Contiguouse Wetland Area (ha)	Total Contiguouse Wetland Area (ha)	Hydro System Size	Compensation Cost Analysis Price Estimate
St.Margarets Bay	Northwest Brook	2.07		Small	
	Five Mile Lake	23.32			
	Big Indian Lake	12.41			
	Rafters Lake	0.50			
	Wrights Lake	12.51			
	Unknown 1	7.32			
	Little Indian Lake	12.60			
	Mill Lake	1.31			
	Little Walsh Lake	18.05			
Tusket	Quinan River	185.39	580.04	Medium	$ 7,500.00
	Sweeneys Run	0.36			
	Tusket Falls	7.57			
	Gravels Lake	17.78			
	Great Barren Lake	286.84			
	Kempt Back Lake	6.18			
	Kings Lake	14.80			
	Lake Fanning	1.65			
	Odgen Lake	30.41			
	Parr Lake	21.59			
	Petes Lake	0.30			
	Raynards Lake	5.41			
	Unknown 1	1.57			
	Vaughan Lake	0.19			
Wreck Cove	Indian Brook	810.74	1533.45	Large	$ 10,500.00
	Cheticamp Reservoir	338.10			
	Gisborne Reservoir	69.51			
	Ingonish 1 Reservoir	21.39			
	Ingonish 2 Reservoir	127.59			
	McMillin Reservoir	3.43			
	Canal	79.62			
	Wreck Cove Reservoir	83.07			
			Total		$ 114,000.00

Strum Consulting – Professional Qualifications and Experience – Wetland Services

Strum Consulting (Strum) offers a variety of environmental services related to wetland assessment, permitting and compensation services. We have over 8 years of experience in offering these services throughout Atlantic Canada. A description of these services and our qualifications to provide them are outlined below.

Wetland Delineation and Characterization – Strum staffs a number of wetland professionals with training and demonstrated experience in delineating and characterizing wetland area and habitat. Training includes a post-secondary degree in biology or environmental science, certification through coursework[1] in wetland delineation and characterization, and training and competency in geographic information system (GIS) software.

Wetland Functional Assessment – Strum's wetland professionals have received training in wetland functional assessment (which seeks to quantify the sociological and ecological value of wetland habitat) in wetland functional assessment under the Wetland Ecosystem Services Protocol for Atlantic Canada (WESPAC).

Wetland Alteration Permitting – Strum has extensive experience in working with Nova Scotia Environment's wetland permitting process. Strum has successfully permitted the alteration of hundreds of wetlands under *Nova Scotia's Wetland Conservation Policy*.

Wetland Compensation – Strum maintains two employees (Shawn Duncan and Heather Mosher) recognized by Nova Scotia Environment as wetland creation professionals. These individuals have demonstrated experience in conceptualizing, designing and creating wetland area for use as compensation area for altered wetland habitat. Strum has created dozens of hectares of wetland area across several wetland compensation projects, and has plans to add a number of additional wetland compensation projects to our portfolio in the near future.

[1]Wetland Delineation certification is provided by a qualified training institute such as the Fern Hill Institute of Plant Conservation / Acadia University, and the Maritime College of Forest Technology.

HYDRO ASSET ARCHAEOLOGY STUDY
COSTING DOCUMENT

Submitted to:

Nova Scotia Power Inc.

Submitted by:

Boreas Heritage Consulting Inc.
Project #18-007-01

DECEMBER 2018

BOREAS
Heritage Consulting Inc.

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

1.1 Introduction

Nova Scotia Power Incorporated (NSPI) currently owns and operates 33 hydroelectric plants on 17 hydro river systems across Nova Scotia, totaling 400 megawatts (MW) of generation capacity. The intent of this work scope is to have a desk-based archaeological assessment programme conducted for all hydroelectric systems across Nova Scotia. Furthermore, the objective of this study is to provide NS Power with a guide as to potential archaeological costs within NSPI's hydroelectric facilities/sites in the event such assets were removed. The costs contained within this Report are an estimate only, and further field reconnaissance would be required before final recommendations regarding archaeological potential within a defined study area can be made.

The following document contains archaeological and methodological assumptions that were used to determine archaeological potential and estimated costs associated with the development and/or reemoval of the provided asset locations. This is followed by a breakdown of hydro assets and associated costs of archaeological assessment related to the refurbishment or removal of these assets. Associated costs are broken down by recommendation with totals presented for each asset, and each stage of archaeological assessment.

2.0 ARCHAEOLOGICAL ASSUMPTIONS

2.1 Introduction

The purpose of this section is to provide the **Archaeological Assumptions** developed using existing heritage industry guidelines and best practices in Nova Scotia to allow for the development of cost estimates for archaeological work that may be required during the potential removal of hydroelectric assets owned by NSPI.

Archaeological sites in the province of Nova Scotia are protected by the *Special Places Protection Act* (SPPA), as designated under Sections 2(a), 7(1), 8(1) and 13(1), whether on Provincial Crown or private land. This protection applies to all archaeological sites, recorded or unknown, regardless of whether they are registered in the *Maritime Archaeological Resource Inventory* (MARI) database, administered by the Nova Scotia Department of Communities, Culture and Heritage (CCH). All archaeological work undertaken with the province of Nova Scotia is conducted under the terms of the SPPA and associated heritage research permit guidelines. As such, the guidelines and criteria for archaeological work carried out under an *Archaeological Resource Impact Assessment* (Category C) permit, which are designed to ensure significant archaeological or historical resources are protected from potential disturbance, must be followed and complied with when conducting archaeological assessment work for development proponents, such as NSPI. Although the specific scenarios discussed below are not necessarily addressed in the Category C guidelines of CCH, the information contained therein is based on existing archaeological and heritage guidelines and best practices in Nova Scotia.

The **Archaeological Assumptions** are guided by greater archaeological and planning principles, including *due diligence* and *avoidance* as preferred alternatives to disturbance of archaeological sites and contexts. Archaeological resources are non-renewable, and are significant for their historical, cultural, scientific and educational value to the Mi’kmaq, the local community and the general public. The Archaeological Assumptions contained herein were developed without communication with CCH, Mi’kmaw communities or the Kwilmu'kw Maw-klusuaqn Mi'kmaq Negotiation Office (KMKNO).

2.2 Archaeological Potential

Archaeological potential refers to areas with the likelihood of encountering significant archaeological resources. Criteria for determining archaeological potential are established by CCH and facilitate the development and implementation of appropriate archaeological resource management strategies within a defined study area. There are three key components to determining archaeological potential: background research; archaeological potential modelling; and, pedestrian reconnaissance. For the purpose of this document, the level of archaeological potential for each of the identified asset locations was determined based on previous background research and archaeological potential modelling by Boreas Heritage. No on-site archaeological reconnaissance, in whole or in part, was conducted to verify the archaeological potential for any portion of any hydroelectric system as part of this study. The assumptions and costings contained herein must therefore be supplemented by pedestrian reconnaissance, which involves systematic and intensive ground survey of a study area and may include subjective (targeted) shovel testing, before final recommendations can be made regarding archaeological potential within a defined study area.

The archaeological potential models were developed by analysing a range of natural and cultural attributes considered to have influenced past patterns of land use and settlement, and by extension, archaeological potential across the landscape. The result of the modelling is a continuous depiction of archaeological potential and archaeologically sensitive areas within each of the 17 hydroelectric systems. It is important to note, however, that human history in Nova Scotia has been documented for more than 12,000 years and has persisted through a series of climate shifts, including increases and decreases in annual precipitation and temperatures. The modern bioclimatic scheme, which incorporates several of the variables listed above, can only be assumed to be reliable for current environmental conditions. Increased precipitation and decreased mean annual temperatures may have changed the past nature of variables, such as aquatic features or forest cover. As a result, appropriate caution must be exercised when relying upon potential models, which depend on contemporary biophysical characteristics. Archaeological potential models should be employed in conjunction with detailed background studies and augmented with archaeological reconnaissance.

High Archaeological Potential refers to areas where biophysical characteristics (environmental, topographic and hydrographic factors), existing knowledge about archaeological sites, and historic land use indicates a perceived higher level of expectation that significant archaeological resources could be encountered. *Low Archaeological Potential* refers to areas where biophysical characteristics (environmental, topographic and hydrographic factors), existing knowledge about archaeological sites, and historic land use indicates a perceived lower level of expectation that significant archaeological resources could be encountered.

2.3 NSPI Asset Locations

NSPI has provided Boreas Heritage with digital shapefiles and spreadsheets listing assets and infrastructure to be assessed in this costing report. All asset locations discussed in the Hydro Asset Archaeology Costing Study are based on the updated shapefile and spreadsheet list (henceforth as Asset List), provided to Boreas Heritage by NSPI (***Appendix A***). The Asset List spreadsheet provides the following information: lists each asset by *Name*, offers asset *Classification* (plant, dam, large, medium, small), indicates relevant river *System*, describes *Foundation* type (bedrock, decommissioned, freeboard, leave in place, unprovided), construction material *Type* (various combinations: concrete, concrete core wall, concrete gravity, earthfill, rockfill, impervious fill, timber crib, timber core wall, unprovided), the asset *Shape Length* (metres), the asset *Shape Area* (square metres), and states NSPI's understanding of whether or not an asset is considered as previously cleared of archaeological concerns (*Clear* – yes, no, unprovided). The Asset List also provides the proposed and/or assumed impact areas associated with removal of these asset locations. Boreas Heritage is not responsible for any errors, omissions or inconsistencies with the data provided by NSPI.

Any assets or infrastructure locations not included in the Asset List, have not been addressed in this costing assessment. Any assets or infrastructure locations not included in the Asset List do not factor into the final cost. *ANY additional areas* not on the Asset List, and/or any modifications to the areas originally provided by NSPI are not covered by this report and *may result in additional costs*.

Additionally, all proposed impact areas supplied by NSPI are to be considered approximate only. As mentioned above, if any of these areas are updated or modified in any way from the data provided in the Asset List used for this costing assessment, these updates or modifications may result in additional costs not considered or covered in this report. As examples, any additional access routes, access route upgrades, laydown or temporary work areas, temporary offices or work camps, etc. None of the above examples have been considered or covered in this costing assessment and their inclusion in any proposed future works may affect final project costing.

Furthermore, NSPI provided Boreas Heritage a list of asset locations NSPI considers to be clear of archaeological requirements based on previous archaeological studies. This information, where available, is included in the Asset List. In situations where it was unclear whether previous archaeological studies had already assessed a proposed impact area, and the results of the original assessment indicated it was cleared of archaeological concerns, Boreas Heritage has been directed by NSPI to assume, for the purposes of determining potential costs associated with asset removal, these areas to be considered clear of future archaeological requirements.

2.4 Assumptions Related to Methodology

a) Asset Assessment

Boreas Heritage has made the following assumptions when considering the estimated costs associated with this Hydro Asset Archaeology Costing Study:

- Dams classified as *small* in the Asset List have been attributed a 20 metre-wide impact area intended to represent the construction footprint;
- Dams classified as medium or large have been attributed a 25 metre-wide buffer beyond the determined construction footprint;
- Dams constructed with earthfill and/or rockfill, AND *not constructed on bedrock*, are assumed to require *monitoring* only. In these cases, it is assumed by Boreas Heritage, development and/or removal of assets will remain inside the existing asset footprint, with the heavy machinery and all required disturbance activities being conducted from the top of the dam and downwards. In these cases, Boreas Heritage has assumed no impacts to areas outside the existing dam footprint will be required for dams described as small in the Asset List. For dams described as *medium* or *large* in the Asset List, a 25 metre-wide buffer has been added to account for the potential need to accommodate greater disturbance factors and workspace requirements;
- Dams constructed with any material, AND which are *constructed on bedrock*, as provided by NSPI in the Asset List, have been assumed by Boreas Heritage to not require additional archaeological assessment as any potential archaeological resources would not be present. Exceptions include: if the dam is later determined to NOT be constructed on bedrock, or if workspace is required beyond the current asset footprints and/or 25 metre-wide buffers, then NSPI must assume all responsibility for costs and liabilities associated with potential need for additional archaeology assessments and/or impact(s) to potential archaeological resources;
- For dams classified as *freeboard* and/or *left in place* in the Asset List, it is assumed by Boreas Heritage these assets will be left as is, in their current context and condition, and therefore do not require further archaeological assessment. If the dam is later determined to NOT to be *freeboard* and/or NOT to be left in place, then NSPI must assume all responsibility for costs and liabilities associated with potential need for additional archaeology assessments and/or impact(s) to potential archaeological resources;
- By direction of NSPI, canals were not included as part of this study as they were to be considered *freeboard* or *left in place*. While the asset list does include some canal locations, these were not directly addressed in the costing document;
- Where asset locations are in close proximity and potentially overlap, these assets were combined/grouped in order to streamline the costing process; and,
- All areas assessed under previous archaeological resource impact assessments are assumed to be clear of any additional archaeology requirements, unless recommendations were made in the original report for additional archaeological work. Boreas Heritage strongly cautions this assumption may change following

review by CCH, whom must be consulted prior to any asset development and/or removal activity.

b) Results and Costings

All findings, recommendations and assumptions presented in this report are for the purpose of costing only. Costings can be adjusted with updated information on the scope of potential disturbance and work areas. The findings of this costing report, as well as any and all work associated with removal of NSPI assets and infrastructure, need to be discussed and approved by CCH prior to commencing any ground disturbance activity.

Engagement with Mi'kmaw communities and the KMKNO may independently affect the estimated final costs contained in this costing report. The findings and recommendations of CCH and the Mi'kmaq may affect the actual costs associated of any proposed removal of assets or any other proposed developments.

Additional factors outside the scope of this study, such as the above-mentioned engagement with local Mi'kmaw communities and the KMKNO, regulatory requirements (CCH), as well as environmental requirements and engineering results, may also affect the costs presented in this document.

It must be considered, the costings provided in this costing study are based on incomplete and assumed data. Boreas Heritage cannot be certain the assumed and/or proposed development or removal areas provided in the Asset List actually overlap precisely with previously assessed areas. These determinations must be decided by CCH. It is only CCH that can determine if the assumed and/or proposed development or removal areas included in the Asset List are clear of archaeological concerns. As a result, any changes, recommendations or requirements by CCH may affect the final costs.

There are many unknown factors that may contribute to sources of error within the scope of the costing report. Therefore, Boreas Heritage recommends, where and when possible, that staged approach to managing and mitigating archaeological concerns related to the proposed asset developments and removal. Boreas Heritage believes the extent of shovel testing required for the proposed works included in the background study can be more accurately determined following the completion of relevant archaeological screening and reconnaissance. Additionally, the extent of any potential requirements for further archaeological assessment, including mitigative site excavation, can be more accurately determined following the completion of relevant shovel testing. Finally, it is important to emphasize the challenges and difficulty associated with estimating the costs in circumstances and scenarios relevant to this Hydro Asset Archaeology Costing Study, where there are many unknown factors. The greatest of limitations and the unknown factor with the greatest influence on costing estimates is the impossibility of accurately predicting what potential archaeological resources may be encountered, and more specifically their frequency, size and density, distribution, condition, content and significance – both cultural and archaeological.

Final costings are dependent upon a number of variables including, but not limited to: impact area, project duration, crew complement, travel time and distance, as well as research and reporting requirements.

2.5 Archaeological Assumptions

The **Archaeological Assumptions** are developed on the supposition that ALL hydroelectric assets/infrastructure, except those that do not represent risk or physical impediment to the reinstatement of the river, and which have not been listed as *left in place* in the NSPI Asset List, will be removed, resulting in a return of the river systems to pre-dam conditions. It is also assumed that *avoidance,* where feasible, is the preferred alternative to disturbance of an archaeological site, and mitigation through preservation will be considered before engaging in more intensive assessment. Implementation of any site-specific recommendation and/or mitigation measures must be authorized by the provincial regulator (CCH). Any recommendations and mitigation measures are also subject to site-specific engagement between the Mi'kmaw communities, KMKNO and NSPI.

a) Archaeological Reconnaissance

It is assumed archaeological reconnaissance will be undertaken to identify and delineate real areas exhibiting high archaeological potential, to confirm the results of the background research and archaeological potential modelling, and to document any archaeological resources identified during the background study and/or encountered during the visual assessment, as per existing standards and best practice. In the event that an area is considered to exhibit low archaeological potential, archaeological monitoring may be recommended for the purpose of obtaining additional information and/or to confirm the results of the assessment. This will provide information in sufficient quantity and quality to justify recommendations for clearance of low potential areas and allow for more efficient approvals of the same. During the pedestrian reconnaissance, strategies will be identified for the appropriate methodology and scope of more detailed assessment for areas considered to exhibit high archaeological potential.

As a base assumption for all asset locations (excluding *freeboard* or *leave in place*), archaeological reconnaissance is assumed in order to assess each location with specific concerns associated with removal of the asset. If previous reconnaissance has taken place, however, and NSPI confirms with CCH that the reconnaissance sufficiently covered the area of concern, new reconnaissance would not be required. This represents the minimum requirement (and minimum cost) for all asset locations.

b) Asset removal in High Potential Areas

If asset removal occurs in areas considered to exhibit high potential for encountering significant archaeological resources, it is assumed a program of systematic subsurface survey (shovel testing), will be undertaken. The objective of the subsurface survey is to confirm or refute the presence of archaeological resources and to delineate the extent of such resources should they be encountered. Shovel test pits, averaging 40 centimetres by 40 centimetres, will be dug through topsoil into subsoil at 5 metre intervals, as per existing standards and best practice. All soil removed from the test pits will be screened through 6 millimetre wire mesh to recover any artifacts within the excavated soil. Any archaeological resource encountered during the course of the shovel testing program will be recorded using GPS technology. If archaeological resources are discovered within a shovel test, additional assessment and mitigation may be required by CCH to determine the nature and extent of the deposit.

c) Archaeological Mitigation (Excavation)

In instances where significant archaeological resources will be disturbed by asset removal, it is assumed mitigation will be undertaken for the purpose of systematically recovering and recording archaeological resources by controlled excavation techniques, as per existing standards and best practice. A 2 metre by 2 metre excavation grid is the preferred methodology; however, implementation of any site-specific mitigation measures must be authorized by CCH and may vary on a case-by-case basis.

d) Archaeological Monitoring

Archaeological Monitoring may be required in those cases where development/impact is to take place in areas that cannot be adequately tested. The objectives of the archaeological monitoring are to observe any disturbance of the existing ground to ensure there are no archaeological resources present and to document any archaeological resources identified during the course of mechanical excavation. Archaeological monitoring consists of visual inspection of all ground disturbance activities (trenching/excavation) and focusses on the inspection of the impact area as excavation occurs. All areas of exposure are visually examined for artifacts and cultural features.

e) Asset Removal in Low Potential Areas

If asset removal occurs in areas considered to exhibit low potential for encountering significant archaeological resources, based on background research, archaeological potential modelling, pedestrian reconnaissance and, in some cases, archaeological monitoring, it is assumed recommendations will be made to clear the area of any requirement for further archaeological assessment and to allow potential development within the area to proceed as planned. Implementation of any site-specific recommendation must be authorized by CCH.

f) De-watering in Areas with Known Archaeological Resources

It is assumed archaeological reconnaissance/monitoring will be conducted when de-watering occurs and/or when historic shorelines are exposed, as per best practice. The objective is to identify and protect archaeological resources that might otherwise be removed by looters or curious pedestrians. Archaeological reconnaissance will cover the entire perimeter of any exposed shoreline with focused attention on all registered archaeological sites within the study area for the purpose of documentation, mitigative site management and artifact collection of exposed archaeological resources. Each identified archaeological site will be re-visited in order to record and photograph its archaeological resources, to document and update the current condition of the site and its integrity, and to simultaneously collect exposed artifacts. Artifact locations will be flagged and recorded using a GPS survey instrument. All recovered artifacts will be processed and conserved (if necessary) in accordance with provincial guidelines.

In areas where there are confirmed archaeological resources, two reconnaissance programs will be undertaken within six months of de-watering, one of which is assumed to occur following a heavy rain. If significant archaeological resources, as deemed by CCH, are encountered, additional reconnaissance may be warranted.

g) De-watering in Areas with No Known Archaeological Resources

It is assumed archaeological reconnaissance/monitoring will be conducted when de-watering occurs and/or when historic shorelines are exposed, as per best practice. The objective is to identify and protect potential archaeological resources that might otherwise be removed by looters or curious pedestrians. Archaeological reconnaissance will cover the entire perimeter of any exposed shoreline with focused attention on areas of recognized high archaeology potential for the purpose of documentation, mitigative site management and artifact collection of exposed archaeological resources.

The exception to this requirement would be in cases where previous archaeological reconnaissance had been completed and cleared for the same extent and area, and CCH confirmed that additional reconnaissance would not be required.

A reconnaissance program will be undertaken within six months of dewatering. If archaeological resources are encountered, see section 2 (f).

h) Disturbed Contexts

Disturbed context refers to an area in which the provenience, association, and matrix of archaeological data has been wholly or partially altered by transformational processes after original deposition. In areas of confirmed disturbed contexts, Archaeological Monitoring may be required (see section **2 (d)**).

i) Petroglyphs

In the event that Petroglyphs, previously recorded or otherwise, are exposed, on-going monitoring and recording is recommended, as per current best practice in Nova Scotia. The following guidelines relate to the conservation and recording of a petroglyph site, which will be subject to natural weathering and is at risk from vandalism:

- maintain site location anonymity
- record the petroglyphs using tracing and/or photography and/or moulding and/or casting
- record petroglyph using a tripod-mounted, high resolution digital camera (RAW format)
- record the petroglyphs using a 3D colour laser scanner
- store petroglyph site records and images in an archive

- routine monitoring of the site to record any deterioration or change; maintain an inventory of graffiti and other vandalism
- do not permit further moulding of the petroglyphs or any other form of contact recording such as inpainting

If an increase in natural weathering or vandalism is observed, or if there is an increase in the risk of vandalism, then a more substantial intervention may be considered.

3.0 ARCHAEOLOGICAL COSTINGS

3.1 Introduction

The following archaeological cost estimates have been developed for archaeological work that may be required during the potential removal of hydroelectric assets owned by NSPI. These costings are based on the methodological and archaeological assumptions detailed in this document. The cost estimates also rely on information from previous archaeological research and assessment conducted for these areas.

Table 1 presents the total costs for all systems, broken down by recommended course of action. The following sections present estimated costs for each hydro system, and are broken down by individual (or grouped) asset locations and by recommended course of action.

Table 1. Total System Costs for all Hydro Asset Locations

TOTAL SYSTEM COSTS					
System	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Annapolis	[redacted]				
Avon					
Bear River					
Black River					
Dickie Brook					
Fall River					
Harmony					
Lequille					
Mersey					
Nictuax					
Paradise					
Roseway					
Sheet Harbour					
Sissiboo					
St Margarets Bay					
Tusket					
Wreck Cove					
Total Cost					

The following costings represent the possible range of costs and not necessarily the likely cost of asset remmoval. As a base assumption for all asset locations (excluding *freeboard* or *leave in place*), archaeological reconnaissance is assumed in order to assess each location with specific concerns associated with removal of the asset and, therefore, represents the minimum requirement (and minimum cost) for all asset locations. Additional costs would depend on the findings of the archaeological reconnaissance, the level of archaeological potential identified, and the presence or absence of archaeological resources within the assumed work areas. As such, actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

3.2 ANNAPOLIS HYDRO SYSTEM - COSTING

The Annapolis Hydro System is situated within western Annapolis County, along the lower Annapolis River. Upstream from Annapolis Royal, the Annapolis Hydro System drains the Annapolis River watershed; however, as a tidal power generating facility, the system is designed primarily to harness the tidal difference created by extreme Bay of Fundy tides, on incoming and outgoing flows. NSPI system assets associated with the Annapolis Hydro System, which represents one generating unit with an operating capability of 3.7 MW (Meade 2000:15), are concentrated at the narrows between Granville Ferry and the town of Annapolis Royal, including the Annapolis Plant.

The following costings represent the possible range of costs associated with the removal of assets associated with the Annapolis Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 2. Summary of costings for individual asset locations – Annapolis Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Total Cost
Annapolis Hydro	[redacted]			
Total Cost				

Asset Location: Annapolis Plant, Office, Sluiceway and Gate

Based on previous background research and archaeological potential modelling, the area surrounding the **Annapolis Plant, Office, Sluiceway and Gate** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance followed by archaeological shovel testing and archaeological excavation.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

3.3 AVON HYDRO SYSTEM - COSTING

The Avon Hydro System is situated in Hants County and northern Lunenburg County, approximately 14 km southwest of the Town of Windsor. The system drains 182.5 km^2 of the South Branch Avon River, within the Avon River watershed. NSPI system assets associated with the Avon Hydro System, which represents two generating units with an operating capability of 7.5 MW (Meade 2000:15), are located between Mill Section and Sherwood along Highway 14. NSPI system assets for the Avon Hydro System include Avon 1 Powerhouse, Avon 1 Penstock, Avon 2 Penstock, MacDonald Dam, MacDonald Pond Dam, Falls Lake Dam, Zwicker Lake Dam, Card Lake Main Dam, Card Lake Wing Dam, South Canoe Dam, one pipeline and associated reservoirs.

The following costings represent the possible range of costs associated with the removal of assets associated with the Avon Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 3. Summary of costings for individual asset locations – Avon Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Card Lake Main and Wing Dams	[redacted]				
Card Lake Reservoir Drawdown					
Canoe Lake Dam					
Canoe Lake Reservoir Drawdown					
Falls Lake Dam					
Falls Lake and Zwicker Lake Drawdown					
Zwicker Lake Dam					
MacDonald Pond Dam and Spillway					
Avon 1 Plant and Penstock					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Avon 2 Pipeline and Penstock	[redacted]				
Macdonald Pond Drawdown					
Total System Cost					

Asset Location: **Card Lake Main and Wing Dams**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Card Lake Main Dam and Wing Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Card Lake Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Card Lake Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The historic lake shoreline was reconstructed using bathymetry data supplied by the Province of Nova Scotia.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Canoe Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Canoe Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Canoe Lake Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Canoe Lake Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The historic shoreline of Canoe Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Falls Lake Dam**

Type: Small Dam; Earthfill; Built on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Falls Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam constructed on bedrock, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Falls and Zwicker Lakes Reservoirs**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Falls Lake and Zwicker Lake Reservoirs** exhibit **High Potential** for archaeological resources when water levels are lowered. Previous archaeological reconnaissance of the Falls Lake and Mockingee Lake reservoirs (A2011NS83), identified numerous archaeological sites along the reservoir shoreline. The recommended course of action is archaeological reconnaissance of the lakeshore. The historic shoreline of Falls Lake and Mockingee Lakes using data from previously conducted archaeological reconnaissance. The shoreline of Zwicker Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Zwicker Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Zwicker Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **MacDonald Pond Dam and Spillway**

Type: Medium Dam; Concrete Dam on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **MacDonald Pond Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. One previous archaeological impact assessment has been conducted for NSPI at MacDonald Pond (A2005NS95). As a result of this survey, it was recommended that any ground disturbance within 100 metres of the historic shoreline be preceded by archaeological assessment (Stewart & Sanders 2006:9).

As the location is classified as a medium, concrete dam constructed on bedrock, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Avon 1 Plant and Penstock**

Type: Plant and Penstock

Based on previous background research and archaeological potential modelling, the area surrounding the **Avon 1 Plant and Penstock** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant and penstock.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Avon 2 Pipeline and Penstock**

Type: Pipeline and Penstock

Based on previous background research and archaeological potential modelling, the area surrounding the **Avon 2 Penstock** and portions of the **Avon 2 Pipeline** exhibit **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the pipeline and penstock.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **MacDonald Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **MacDonald Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. One previous archaeological impact assessment has been conducted for NSPI at MacDonald Pond (A2005NS95). An archaeological screening and reconnaissance survey was carried out in November 2005. At the time of the survey, water levels remained high preventing visual assessment of the historic shoreline, limited examination of exposures at the water's edge did not yield evidence of Mi'kmaq or Euro-Canadian cultural material (Stewart & Sanders 2006:8). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of MacDonald Pond could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.4 BEAR RIVER HYDRO SYSTEM - COSTING

The Bear River Hydro System is situated within Annapolis and Digby Counties, approximately 5 km southeast of the community of Bear River. The system drains 196 km2 of the Bear River and Sissiboo watershed, with water storage provided by the Gulch Flowage, Ridge Flowage, and Lake Mulgrave. Lake Mulgrave is the primary storage reservoir for the Bear River Hydro System. NSPI system assets associated with the Bear River Hydro System, which represent two generating units with an operating capacity of 9.2 MW (Meade 2000:15), include the Bear River Powerhouse, Gulch Main Dam, Gulch Pipeline, Gulch Spillway, Mulgrave Main Dam, Mulgrave Wing Dams 1-3, Ridge Main Dam, Ridge Pipeline, Ridge Powerhouse, Ridge Spillway and Ridge Wing Dams 1-2. The following discussion details the environmental and cultural setting of the greater study area, which facilitates the delineation of areas considered to exhibit archaeological potential. For the purposes of this assessment, the Bear River Hydro system has been divided into three distinct study areas: Gulch Flowage, Ridge Flowage, and Lake Mulgrave.

The following costings represent the possible range of costs associated with the removal of assets associated with the Annapolis Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 4. Summary of costings for individual asset locations – Bear River Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Bear River Plant	[redacted]				
Gulch Pipeline					
Gulch Main Dam and Spillway					
Gulch Flowage Drawdown					
Ridge Plant and Pipeline					
Ridge Main Dam and Spillway					
Ridge Wing Dams					
Ridge Flowage Drawdown					
Mulgrave Main and Wing Dams					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Lake Mulgrave Drawdown	[redacted]				
Total System Cost					

Asset Location: **Bear River Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Bear River Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Gulch Pipeline**

Type: Pipeline

Based on previous background research and archaeological potential modelling, portions of the area surrounding the **Gulch Pipeline** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the pipeline.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Gulch Main Dam and Spillway**

Type: Medium Dam; Spillway on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Gulch Main Dam Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2016NS083, however, and it was determined that the area surrounding the dam and spillway was **Low Potential** for archaeological resources (Redden et al. 2016a:21). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs

Asset Location: **Gulch Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Gulch Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Gulch Flowage was reconstructed using historic air photos (1945) and bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Ridge Plant and Pipeline**

Type: Plant and Pipeline

Based on previous background research and archaeological potential modelling, portions of the area surrounding the **Ridge Plant and Pipeline** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant and pipeline.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Ridge Main Dam and Spillway**

Type: Medium Dam; Spillway on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Ridge Main Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2009NS028. Archaeological shovel testing was recommended as a result of this previous study and, at this time, it is unclear whether the shovel testing was completed. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas previously recommended for shovel testing (Kelman 2009a:11) which fall within the assumed impact area associated with the Ridge Main Dam and Spillway.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Ridge Wing Dams 1 & 2**

Type: Small; Earthfill; Wing Dam 2 – Leave in Place

Based on previous background research and archaeological potential modelling, the area surrounding the **Ridge Wing Dams 1 & 2** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance and archaeological monitoring for the removal of Ridge Wing Dam 1. As Ridge Wing Dam 2 is classified as "Leave in Place" and will have no associated ground impacts, there are no further actions recommended for Ridge Wing Dam 2.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Ridge Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Ridge Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Ridge Flowage was reconstructed using historic air photos (1945) and bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Mulgrave Main and Wing Dams**

Type: Small; Earthfill;

Based on previous background research and archaeological potential modelling, the area surrounding the **Mulgrave Main and Wing Dams** exhibits **High Potential** for impacting archaeological resources. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Lake Mulgrave**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Lake Mulgrave** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Lake Mulgrave was reconstructed using historic air photos (1945) and bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.5 BLACK RIVER HYDRO SYSTEM - COSTING

The Black River Hydro System is situated within the Municipality of the County of Kings and drains approximately 462 km2 of the Gaspereau River Watershed (***Figures 4.5.1 & 4.5.2***). The Black River Hydro System is situated to take advantage of the topographical relief provided by South Mountain and captures the entire streamflow of the Gaspereau River and its largest tributary, the Black River, for the purpose of power generation (Meade 2000:20). NSPI system assets associated with the Black River Hydro System, which represents six generating units with an operating capacity of 20.7 MW, include the Aylesford Lake Dam, Black Brook Dam, Black River Dam, Dean Chapter Lake Dam, Forks Dam, MacMillan Dykes L, M, N, P, Dyke P Spillway, Forest Home Dyke, Forks Dam Spillway, Hatchard Lake Dam, Hell's Gate Dam & Spillway, Hell's Gate Plant, Hollow Bridge Pipeline, Hollow Bridge Plant, Lanes Mill Dam & Spillway, Little River Lake Main Dam, Little River Lake Wing Dam, Lumsden Dam & Spillway, Lunn Dam, MacMillan Dam, Methals Plant & Spillway, Midpoint Spillway, Muskrat Cove Dam, North Gaspereau Lake Dam, Salmontail Main Dam & Fishladder, and White Rock Plant.

The following costings represent the possible range of costs associated with the removal of assets associated with the Black River Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 5. Summary of costings for individual asset locations – Black River Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
White Rock Plant	[redacted]				
White Rock Dam and Spillway					
White Rock Pond Drawdown					
Hells Gate Plant					
Hells Gate Dam and Spillway					
Hells Gate Pond Drawdown					
Lumsden Dam and Plant					
Lumsden Pond Drawdown					
Hollow Bridge Plant and Pipeline					
Black River Lake Dam					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Black River Lake Drawdown	[redacted]				
Forks Dam					
Lunn Dam					
Dean Chapter Lake Dam					
Dean Chapter Lake Drawdown					
Salmontail Lake Main Dam					
Salmontail Lake Drawdown					
Hatchard Lake Dam					
Methals Dam And Plant					
Methals Drawdown					
Little River Lake Dam					
Little River Drawdown					
Trout River Dam					
Trout River Dykes					
Trout River Lake Drawdown					
Lanes Mills Dam & Spillway and Muskrat cove Dam					
North Gaspereau Lake Dam					
Gaspereau Lake Drawdown					
Midpoint Spillway					
Forest Home Dyke					
Aylesford Lake Dam					
Aylesford Lake Drawdown					
Total System Cost					

Asset Location: **White Rock Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **White Rock Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **White Rock Dam and Spillway**

Type: Medium Dam constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **White Rock Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. Portions of the area was previously assessed under Heritage Research Permit A2016NS078 (Garcin & Beanlands 2016a). The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway that was not previously assessed under A2016NS078.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **White Rock Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **White Rock Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of White Rock Pond was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Hells Gate Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Hells Gate Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Hells Gate Dam and Spillway**

Type: Medium Dam constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Hells Gate Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a medium dam constructed on bedrock, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Hells Gate Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Hells Gate Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of White Rock Pond could not be reconstructed with available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lumsden Dam and Plant**

Type: Medium Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Lumsden Dam and Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway. Archaeological monitoring is recommended for removal of the earthfill portions within the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Lumsden Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Lumsden Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Lumsden Pond was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Hollow Bridge Plant and Pipeline**

Type: Plant/Powerhouse and Pipeline

Based on previous background research and archaeological potential modelling, the area surrounding the **Hollow Bridge Plant and Pipeline** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permits A2015NS109, A2016NS005 and A2016NS063. Archaeological screening and reconnaissance, conducted in 2015 (A2015NS109) in association with refurbishment of the canal dykes and the establishment of a new spillway channel, resulted in the identification of nine areas of high potential for precontact and historic Mi'kmaw archaeological resources and/or Euro-Canadian archaeological resources (Garcin & Beanlands 2015a:31). Subsequent archaeological shovel testing and archaeological monitoring failed to identify any significant archaeological resources within the identified areas of high potential (Garcin & Beanlands 2016b, 2016c). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Black River Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Black River Lake Dam** exhibits **High Potential** for impacting archaeological resources. A Portion of the area was previously assessed under Heritage Research Permit A2015NS109 and determinded to be **Low Potential** (Garcin and Beanlands 2015). As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Black River Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Black River Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Black River Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Forks Dam**

Type: Medium Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Forks Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway. Archaeological monitoring is recommended for removal of the earthfill portions within the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Lunn Dam**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Lunn Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Dean Chapter Lake Dam**

Type: Small Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Dean Chapter Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Dean Chapter Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Dean Chapter Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Dean Chapter Lake was reconstructed using historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Salmontail Lake Main Dam**

Type: Small Dam; Earth/Rockfill;

Based on previous background research and archaeological potential modelling, the area surrounding the **Salmontail Lake Main Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Salmontail Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Salmontail Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Salmontail Lake was reconstructed using Landsat imagery (18 July 1999).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Hatchard Lake Dam**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Hatchard Lake Dam** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Methals Dam and Plant**

Type: Medium Dam; Earthfill; Spillway and Plant constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Methals Dam and Plant** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2012NS061, and the area was determined to exhibit **Lowe Potential** for archaeological resources (de Boer et al 2012a:12-13). It appears from the limited mapping in the assessment report that the previous study area may not cover the entire area assumed for removal of asstes. For the purpose of this costing document, however, and by the direction of NSPI, it is assumed that this area is determined to be **Low Potential** according to the previous archaeological study (A2012NS061). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Methals Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Methals Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Methals Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Little River Lake Main and Wing Dam**

Type: Small Dam; Timber/Rockfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Little River Lake Main and Wing Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dams.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Little River Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Little River Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Little River Lake was reconstructed using historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Trout River Dam (MacMillan Dam)**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Trout River Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Trout River Dykes (L,M,N,P)**

Type: Dyke P Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Trout River Dykes** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dykes/dams.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Trout River**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Trout River** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Little River Lake was reconstructed using historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lanes Mills Dam & Spillway and Muskrat Cove Dam**

Type: Small Dam; Earthfill and concrete

Based on previous background research and archaeological potential modelling, the area surrounding the **Lanes Mills Spillway** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. **This work has recovered significant archaeological resources to date**. The area was previously assessed under Heritage Research Permits A2007NS958, A2007NS083, A2008NS076, A2008NS090, A2009NS071, A2011NS070, A2012NS093, A2012NS107, A2012NS108, A2012NS110, A2012NS115, A2012NS134, A2012NS135, A2012NS136, A2013NS064, A2013NS065 and A2013NS066. For the purpose of this costing document, and by the direction of NSPI, it is assumed that this area is determined to be **Low Potential** as a result of the previous archaeological studies. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **North Gaspereau Lake Dam**

Type: Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **North Gaspereau Lake Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2007NS058, however, and it was determined that the area surrounding the North Gaspereau Lake Dam was determined to be **Low Potential** for archaeological resources (Kelman and Stewart 2007:9). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of asstes, additional assessment may be required, which would increase estimated costs.

Asset Location: **Gaspereau Lake Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Gaspereau Lake Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. Portions of the reservoir were assessed previously under Heritage Research Permit A2007NS058. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Gaspereau Lake was reconstructed using property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Black Brook Dam**

Type: Small; Earthfill/Concrete; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Black Brook Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2007NS058, however, and it was determined that the area surrounding the North Gaspereau Lake Dam was determined to be **Low Potential** for archaeological resources (Kelman and Stewart 2007:8). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Forest Home Dyke**

Type: Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Forest Home Dyke** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2007NS058, however, and it was determined that the area surrounding the North Gaspereau Lake Dam was determined to be **Low Potential** for archaeological resources (Kelman and Stewart 2007:9). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Aylesford Lake Dam**

Type: Small Dam; Earth/Rockfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Aylesford Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Aylesford Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Aylesford Lake Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. Analysis of bathymetry data provided by NSPI, as well as historic mapping and air photos (1945) could not detect a significant change in shoreline.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.6 DICKIE BROOK HYDRO SYSTEM - COSTING

The Dickie Brook Hydro System is situated within Municipality of the District of Guysborough and is approximately 5 km southeast from the community of Guysborough (***Figures 4.6.1 & 4.6.2***). The system drains 45.4 km2 of the Salmon River watershed, flowing north where it joins with Salmon River and exits into the Chedabucto Bay. NSPI system assets associated with the Dickie Brook Hydro System, which represents two generating units with an operating capacity of 2.6 MW, include the Donahue Spillway, Donahue Lake Dam, Toms Lake Wing Dam, Dickie Brook Pipeline, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Dickie Brook Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 6. Summary of costings for individual asset locations – Dickie Brook Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Donahue Spillway	[redacted]				
Donahue Lake Dam					
Donahue Lake Drawdown					
Toms Lake Wing Dam					
Toms Lake Drawdown					
Dickie Brook Pipeline					
Total System Cost					

Asset Location: **Donahue Spillway**

Type: Spillway

Based on previous background research and archaeological potential modelling, the area surrounding the **Donahue Spillway** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permits A2010NS111 and A2012NS100. Archaeological shovel testing of identified areas of high potential did not identify any archaeological resources (Beanlands 2010, 2012). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous studies were not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Donahue Lake Dam**

Type: Small Dam; Earthfill embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Donahue Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Donahue Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Donahue Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Donahue Lake was reconstructed using historic air photos (1943).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Toms Lake Wing Dam**

Type: Medium Dam; Earthfill embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Toms Lake Wing Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed by Jacques Whitford in the fall of 2008 (Unknown or

NO permit), and it was determined that the area surrounding the Toms Lake Wing Dams was determined to be **Low Potential** for archaeological resources (Jacques Whitford 2008:3). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Toms Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Toms Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Toms Lake was reconstructed using historic air photos (1943).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Dickie Brook Pipeline**

Type: Pipeline

Based on previous background research and archaeological potential modelling, the area surrounding the **Dickie Brook Pipeline** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the pipeline.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

3.7 FALL RIVER HYDRO SYSTEM - COSTING

The Fall River Hydro System is situated within Halifax Regional Municipality, approximately 20 kilometres north of the city of Halifax. The system drains 42.6 square kilometres of the Shubenacadie watershed, with water storage provided by Soldier Reservoir and Miller Headpond. Soldier Reservoir is the primary storage reservoir for the Fall River Hydro System. NSPI system assets associated with the Fall River Hydro System, include the Miller Lake Dam, Fall River Pipeline, Soldier Lake Dam, Soldier Lake Wing Dams, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Fall River Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 7. Summary of costings for individual asset locations – Fall River Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Total Cost
Miller Lake Dam	[redacted]			
Fall River Pipeline				
Miller Lake Drawdown				
Soldier Lake Dam				
Soldier Lake Wing Dam #1				
Soldier Lake Wing Dam #2				
Soldier Lake Drawdown				
Total System Cost				

Asset Location: **Miller Lake Dam**

Type: Small Dam; Concrete

Based on previous background research and archaeological potential modelling, the area surrounding the **Miller Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Fall River Pipeline**

Type: Pipeline

Based on previous background research and archaeological potential modelling, the area surrounding the **Fall River Pipeline** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the pipeline.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Miller Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Miller Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Miller Lake was reconstructed using historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Soldier Lake Main Dam**

Type: Small Dam; Concrete; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Soldier Lake Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A2008NS086. During the course of the study, it was determined that the area immediately surrounding the dam exhibited **Low Potential** for archaeological resources. An area of **High Potential**, however, was noted in the general vicinity of the study area (Kelman 2008:11). Assuming that proposed impacts associated with removal of assets avoid this area of high potential, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Soldier Lake Wing Dam #1**

Type: Small Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Soldier Lake Wing Dam #1** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permits A2008NS086 and A2009NS053, where several areas of high archaeological potential were identified in the immediate vicinity of the dam (Kelman 2008:12-13). Archaeological shovel testing of this area took place in 2009. Two shovel tests on the high-ground were positive for historic cultural material, however these finds related to modern twentieth-century use of the area and are not considered to be archaeologically significant. No precontact cultural material was recovered (Kelman 2009b:8). Assuming that potential ground disturbance associated with removal of assets stays within the area previously shovel tested, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Soldier Lake Wing Dam #2**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Soldier Lake Wing Dam #2** exhibits **High Potential** for impacting archaeological resources. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Soldier Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Soldier Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Soldier Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.8 HARMONY HYDRO SYSTEM - COSTING

The Harmony Hydro System is situated within the upper Medway River watershed, spanning northern Queens County and central Annapolis County. The system drains approximately 1,500 square kilometres of the upper Medway River watershed, with water storage provided by the McGowan Lake and Dean Lake Headpond. The McGowan Lake and Dean Lake Headpond is the only storage reservoir for the Harmony Hydro System, collecting flow from the upper Medway River, including Alma Lake, Croker Lake and Long Lake. NSPI system assets associated with the Harmony Hydro System, which represents one generating unit with an operating capacity of 0.7 MW, include the Harmony Lake Dam, Harmony Plant, Harmony Spillway and Fish Ladder as well as the Harmony headpond.

The following costings represent the possible range of costs associated with the removal of assets associated with the Harmony Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 8. Summary of costings for individual asset locations – Harmony Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Total Cost
Harmony Wing Dam	[redacted]			
Harmony Plant				
Harmony Lake Dam				
Harmony Lake Drawdown				
Total System Cost				

Asset Location: **Harmony Wing Dam**

Type: Small Dam; Earthfill embankment; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Harmony Wing Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the dam is constructed on bedrock there is **Low Potential** for impacting archaeological resources due to the assumed absence of any natural sediment or soil. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Harmony Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Harmony Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Harmony Lake Dam**

Type: Small Dam; Earthfill embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Harmony Lake Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permits A2006NS050, A2012NS064, and A2012NS143. These assessments resulted in the identification of several areas considered to exhibit **High Potential** for encountering subsurface archaeological material.

Cultural Resource Management Group excavated 63 shovel tests on the small island below the Harmony Spillway, and on the northern shore, with negative results (Sanders and Stewart 2006). In 2012, Davis MacIntyre and Associates identified an isolated chalcedony flake "on a roadbed to the northwest of the main dam" (de Boer et al. 2012b). This isolated artifact is unregistered. A total of 42 shovel tests were placed at three high potential areas in the immediate vicinity of the McGowan Lake dam. One shovel test proved positive, yielding a single quartz flake. In response to this find, a 1 x 4 metre trench was excavated to identify additional subsurface artifacts and to establish stratigraphic context. No additional Precontact material was identified. The excavation yielded 13 wire nails, one iron spike and a small concentration of charcoal (de Boer et al. 2012b:10).

As a result of the 2012 archaeological shovel testing, it was suggested that archaeological resources could be located in very close proximity to the study area. Should development plans change in the future it was recommended that further archaeological work be conducted (de Boer et al. 2012b:13). Assuming that potential ground disturbance associated with removal of assets stays within the area previously shovel tested, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Harmony Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Harmony Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. The shoreline of Harmony Lake was reconstructed using historic mapping.

In 1983, the McGowan Lake and Dean Lake Headpond was the focus of an archaeological salvage project during a headpond draw-down in which water levels were reduced by approximately 5 m (de Boer et al. 2012b:5). The project resulted in the identification and recording of five historic petroglyphs sites, three precontact isolated finds, two precontact artifact concentrations and a precontact multicomponent occupation site. Selective subsurface testing was conducted at BcDg-02.

The McGowan Lake and Dean Lake Headpond, within the Harmony Hydro System, represents an area of significant archaeological resources. The 11 registered archaeological sites in this relatively concentrated area speak to the precontact use and occupancy of this area by the Mi’kmaq. Additionally, the unusual occurrence of five historic petroglyph sites makes this a highly significant and unique cultural area, with exceptional cultural and heritage value. It is recommended that any changes to the current water levels of the McGowan Lake and Dean Lake Headpond involve careful consideration and discussions with the Mi’kmaw communities, KMKNO and the Nova Scotia Department of Communities, Culture and Heritage - Special Places Division, regarding how to manage and protect the context and integrity of the archaeological resources that will be exposed.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. Any site specific mitigation measures directly associated with the protection of the identified petroglyphs are outside the scope of this study and may result in increased costs.

3.9 LEQUILLE HYDRO SYSTEM - COSTING

The Lequille Hydro System is located in western Annapolis County, along the Allains River watershed (locally “Allains Creek” or “Lequille River”). The Allains River flows north from South Mountain and empties into the Annapolis River at the town of Annapolis Royal. The catchment area of the Lequille Hydro System includes the Dargie Lake Dam, Grand Lake Dam, Lequille Main and Wing Dams, the Lequille Plant as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Lequille Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 9. Summary of costings for individual asset locations – Lequille Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Dargie Lake Dam	[redacted]				
Dargie Lake Drawdown					
Grand Lake Dam					
Grand Lake Drawdown					
Lequille Main and Wing Dams					
Grand Lake Flowage Drawdown					
Lequille Plant					
Total System Cost					

Asset Location: **Dargie Lake Dam**

Type: Small Dam; Earthfill embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Dargie Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Dargie Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Dargie Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Dargie Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Grand Lake Dam**

Type: Small Dam; Earthfill embankment; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Grand Lake Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2016NS052. The whole area surrounding the dam is considered to be high potential due to the presence of registered archaeological sites both upstream and downstream of the dam (Garcin & Beanlands 2016d:21). As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Grand Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Grand Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Grand Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lequille Main and Wing Dams**

Type: Small and Medium Dams; Earthfill embankment; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Lequille Main and Wing Dams** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2016NS052, A2017NS059 and A2018NS060.

In 2016, Boreas Heritage conducted an archaeological reconnaissance and screening of the Lequille Main and Wing Dams at the north end of Grand Lake Flowage. Four high potential areas were identified in association with the Lequille Main Dam and adjacent wing dams (Garcin & Beanlands 2016d). Late in the summer of 2017, Boreas Heritage placed 399 shovel tests at four areas previously assessed as having high potential for buried archaeological resources in association with the Lequille Main Dam and adjacent wing dams (Garcin & Beanlands 2017a). This subsurface assessment yielded negative results for archaeological remains. Assuming that potential ground disturbance associated with removal of assets stays within the previously assessed study area, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Grand Lake Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Grand Lake Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Grand Lake Flowage was reconstructed using bathymetry data provided by NSPI and historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lequille Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Lequille Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

3.10 MERSEY HYDRO SYSTEM - COSTING

The Mersey Hydro System captures all the water from the Mersey River watershed which flows southeast from western Annapolis County through the centre of Queens County. A small proportion of the Mersey Hydro System collects water from Jordan Lake, in northeast Shelburne County. From its headwaters at Sandy Bottom Lake, near Milford, the Mersey Rivers follows the alignment of Highway 8 to Maitland Bridge and Kejimkujik National Park and National Historic Site. Further downstream, the Mersey River empties into the Lake Rossignol Reservoir and flows into the Atlantic Ocean at Liverpool. NSPI assets for the Mersey Hydro System include the Cowie Falls Wing Dam, Cowie Falls Main Dam and Spillway, Deep Brook Dam, Powerhouse and Wing Dam, Deep Brook Diversion Dam and Canal Embankment, Lower Great Brook Spillway and Wing Dam, Lower Great Brook Dam, Big Falls Dam, Lower Lake Falls Dam, Upper Lake Falls Dam, Sixth Lake Dam, Eighth Lake Dam, Jordan Main Dam, as well as associated headponds

The following costings represent the possible range of costs associated with the removal of assets associated with the Mersey Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 10. Summary of costings for individual asset locations – Mersey Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Cowie Falls Wing Dams	-	-	-	-	$ -
Cowie Falls Main Dam and Spillway	[redacted]				
Cowie Falls Drawdown					
Deep Brook Dam, Powerhouse and Wing Dam					
Deep Brook Diversion Dam and Canal Embankment					
Deep Brook Drawdown					
Lower Great Brook Spillway and Wing Dam					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Lower Great Brook Dam	[redacted]				
Lower Great Brook Drawdown					
Big Falls Main Dam					
Big Falls Drawdown					
Lower Lake Falls Dam					
Lower Lake Falls Drawdown					
Upper Lake Falls Dam					
Upper Lake Falls Drawdown					
Sixth Lake Dam					
Sixth Lake Drawdown					
Eighth Lake Dam					
Eighth Lake Drawdown					
Jordan Main Dam					
Jordan Lake Drawdown					
Total System Cost					

Asset Location: **Cowie Falls Wing Dams (1, 2 and 3)**

Type: Freeboard Dams

Based on previous background research and archaeological potential modelling, the area surrounding the **Cowie Falls Wing Dams** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2015NS069. As this location is a Freeboard dam, however, no further work is recommended.

Asset Location: **Cowie Falls Main Dam and Spillway**

Type: Medium Dam; Earthfill (Cowie Falls Main Dam)
Medium Dam; Constructed on bedrock (Sluiceway and Spillway)

Based on previous background research and archaeological potential modelling, the area surrounding the **Cowie Falls Main Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2015NS069.

In 2015, Boreas Heritage conducted a screening and reconnaissance survey of high potential areas within five potential redevelopment footprints associated with NSPI assets along the lower Mersey River, including Cowie Falls (Garcin & Beanlands 2015b). This initial project was followed by a shovel testing programme of identified areas of high potential (Garcin & Beanlands 2016e). At the foot of the Cowie Falls Main Dam, two areas of high archaeological potential were identified and subsequently shovel tested, resulting in one newly identified precontact site. Provided that potential impacts avoid the registered site, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Cowie Falls Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Cowie Falls Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. The headpond was previously assessed under Heritage Research Permits A2004NS054 and A2012NS114. These studies resulted in the identification and documentation of 16 previously unregistered archaeological sites (Sanders et al 2014a). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Cowie Falls was reconstructed using bathymetry data provided by NSPI and historic air photos (1929-1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Deep Brook Dam and Powerhouse and Road Wing Dam**

Type: Medium Dam; Earthfill with impervious fill

Based on previous background research and archaeological potential modelling, the area surrounding the **Deep Brook Dam and Powerhouse and Road Wing Dam** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2015NS069.

In 2015, Boreas Heritage conducted a screening and reconnaissance survey of high potential areas within five potential redevelopment footprints associated with NSPI assets along the lower Mersey River, including Deep Brook (Garcin & Beanlands 2015b). This initial project was followed by a shovel testing programme of identified areas of high potential (Garcin & Beanlands 2016e). As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Deep Brook Diversion Dam and Canal Embankment**

Type: Spillway and Sluiceway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Deep Brook Diversion Dam and Canal Embankment** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2015NS069.

In 2015, Boreas Heritage conducted a screening and reconnaissance survey of high potential areas within five potential redevelopment footprints associated with NSPI assets along the lower Mersey River, including Cowie Falls (Garcin & Beanlands 2015b). This initial project was followed by a shovel testing programme of identified areas of high potential (Garcin & Beanlands 2016). At the foot of the Deep Brook Main Dam, four areas of high archaeological potential were identified and subsequently shovel tested, resulting in two newly identified precontact sites. Provided that potential impacts avoid the registered site, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Deep Brook Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Deep Brook Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. The headpond was previously assessed under Heritage Research Permit A2004NS054. This survey covered the whole lower Mersey River, and resulted in the identification and documentation of 36 previously unregistered archaeological resource sites associated with the Deep Brook headpond (Sanders et al 2014a). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Deep Brook was reconstructed using bathymetry data provided by NSPI and historic air photos (1929-1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lower Great Brook Spillway and Wing Dam**

Type: Freeboard Dam (Spillway only)

Based on previous background research and archaeological potential modelling, the area surrounding the **Lower Great Brook Dam, Plant and Spillways** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2015NS069. Archaeological shovel testing of identified areas of high potential in the vicinity of the Lower Great Brook Spillway and Wind Dam did not identify any archaeological resources.

As this location is a Freeboard dam and has been previously tested, no further work is recommended.

Asset Location: **Lower Great Brook Dam**

Type: Medium Dam; Earthfill with concrete core

Based on previous background research and archaeological potential modelling, the area surrounding the **Lower Great Brook Dam** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011, A2015NS069, A2017NS078 and A2018NS028. During the course of these previous assessments, a number of areas of High Potential were documented and tested, with the identification of one archaeological site, BaDf-128 at the toe of the Lower Great Brook Dam (Garcin & Beanlands 2015b, 2016e; Hicks et al 2018). Given the close proximity to registered archaeological site BaDf-128, archaeological monitoring is recommended for portions of the Lower Great Brook Dam in the vicinity of this site, provided that ground disturbance associated with asset removal is confined to the dam footprint. It is also recommended that the study area undergo archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Lower Great Brook Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Lower Great Brook Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. The headpond was previously assessed under Heritage Research Permit A2004NS054. This survey covered the whole lower Mersey River, and resulted in the identification and documentation of 42 previously unregistered archaeological resource sites associated with the Deep Brook headpond (Sanders et al 2014a). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Lower Great Brook was reconstructed using bathymetry data provided by NSPI and historic air photos (1929-1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Big Falls Main Dam and Spillway**

Type: Large Dam; Earthfill with concrete core
Spillway, Sluiceway and Bulkhead Dam constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Big Falls Dam, Plant and Spillway** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011, A2015NS069, A2017NS077 and A2018NS013. The initial reconnaissance project was followed by a shovel testing programme of identified areas of high potential (Garcin & Beanlands 2015b, 2016e). At the foot of the Big Falls Main Dam, six areas of high archaeological potential were identified and subsequently shovel tested, resulting in seven newly identified precontact sites and revisiting site BaDf-38. Given the close proximity to registered archaeological sites BaDf-97, BaDf-31, BaDf-110 and BaDf-122, archaeological assessment is recommended for portions of the Big Falls Dam in close proximity to these sites. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area) as well as areas within close proximity to registered archaeological sites.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Big Falls Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Big Falls Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. The headpond was previously assessed under Heritage Research Permit A2004NS054 and A2011NS042. This survey covered the whole lower Mersey River, and resulted in the identification and documentation of 28 previously unregistered archaeological resource sites associated with the Deep Brook headpond (Sanders et al 2014a). In 2011, a second systematic surface survey (A2011NS042) of the Big Falls headpond was carried out. This survey resulted in the identification and recording of an additional 28 previously unregistered archaeological sites (Sanders et al 2014b). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Big Falls was reconstructed using bathymetry data provided by NSPI and historic air photos (1929-1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Lower Lake Falls Dam and Spillway**

Type: Medium Dam; Earthfill with concrete core
Freeboard Dam (Wing Dams)

Based on previous background research and archaeological potential modelling, the area surrounding the **Lower Lake Falls Dam Plant and Spillway** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2014NS105 and A2015NS001. In 2014, Boreas Heritage (Garcin & Beanlands 2014a), conducted a screening and reconnaissance (A2014NS105) of an area at the foot of the Lower Lake Falls Main Dam, which resulted in the identification of six areas of high archaeological potential. In 2015, archaeological shovel testing was conducted (A2015NS001), which yielded no significant archaeological resources and no evidence of historically significant cultural modification, however, an isolated quartz scraper was identified on the surface (Garcin & Beanlands 2015c:33). As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Lower Lake Falls Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Lower Lake Falls Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. The headpond was previously assessed under Heritage Research Permit A2004NS054. This survey covered the whole lower Mersey River, and resulted in the identification and documentation of two previously unregistered archaeological resource sites associated with the Lower Lake Falls headpond (Sanders et al 2014a). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Lower Lake Falls was reconstructed using bathymetry data provided by NSPI and historic air photos (1929-1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Upper Lake Falls Dam Plant and Spillway**

Type: Large Dam; Earthfill with concrete core; Mainly constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Upper Lake Falls Dam Plant and Spillway** exhibits **High Potential** for impacting archaeological resources. Ongoing archaeological work at this location will influence the final costing and work requirements – depending on location and extent of planned impacts. This work has recovered significant archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS011 and A2105NS069. In 2015, Boreas Heritage conducted a screening and reconnaissance survey of high potential areas within five potential redevelopment footprints associated with NSPI assets along the lower Mersey River, including Upper Lake Falls (Garcin & Beanlands 2015b). This initial project was followed by a shovel testing programme of identified areas of high potential (Garcin & Beanlands 2016). No archaeological resources were identified during the course of this study. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of areas determined to be of High Potential, that have not been previously assessed (outside of 2015 study area). Given the close proximity to significant archaeological site BaDfg-02, archaeological monitoring is recommended for portions of the Upper Lake Falls Dam in close proximity to this site (Left Wing Dam).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Upper Lake Falls Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Upper Lake Falls Headpond** (Lake Rossignol) exhibits **High Potential** for archaeological resources when water levels are lowered. The first archaeological survey of the Lake Rossignol Reservoir was not conducted until 1985 (Christianson 1985). Christianson recorded approximately 50 new sites around the reservoir, representing activities spanning the last 5,000 years through to the historic logging era. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Upper Lake Falls was reconstructed using historic air photos (1929-1945) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Sixth Lake Dam**

Type: Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Sixth Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Sixth Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Sixth Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Sixth Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Eighth Lake Dam**

Type: Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Eighth Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Eighth Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Eighth Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Eighth Lake could not be reconstructed using available data sources.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Jordan Lake Dam and Wing Dams**

Type: Small Dam; Earthfill (Main Dam)
Wing Dams

Based on previous background research and archaeological potential modelling, the area surrounding the **Jordan Lake Dam** exhibits **High Potential** for impacting archaeological resources. The area was previously assessed under Heritage Research Permit A1997NS038. During the course of this study, one new archaeological site was registered at the north end of the dam. The whole area remains **High Potential** for archaeological resources. As such, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the wing dams, as well as archaeological monitoring of the earthfill portion of Jordan Lake Dam, assuming ground impacts are confined to the existing dam footprint. Any potential disturbance outside of the assumed impact area may require further archaeological assessment resulting in additional costs.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Jordan Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Jordan Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Jordan Lake was reconstructed using historic air photos (1928).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.11 NICTAUX HYDRO SYSTEM - COSTING

The Nictaux Hydro System is in central Annapolis County, along the Nictaux River watershed. The Nictaux River flows north from South Mountain and empties into the Annapolis River at the town of Middleton. NSPI assets for the Nictaux Hydro System include the Nictaux Dam and Plant, Nictaux Main Dam and Spillway, Trout Lake Spillway, Scragg Lake Dam & Discharge Structure, McGill Lake Dam, Curl Hole Dam and Spillways, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Nictaux Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 11. Summary of costings for individual asset locations – Nictaux Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Nictaux Dam and Plant	[redacted]				
Nitaux Main Dam and Spillway					
Nictaux Headpond Drawdown					
Trout Lake Spillway					
Trout Lake Drawdown					
Scragg Lake Dam & Discharge Structure					
Scragg Lake Drawdown					
McGill Lake Dam					
McGill Lake Drawdown					
Curl Hole Dam and Spillways					
Molly Upsim Drawdown					
Total System Cost					

Asset Location: **Nictaux Powerhouse and Dam**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Nictaux Powerhouse Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS107 and A2016NS009. As a result of these studies, three areas of high potential for archaeological resources were identified (Glen & MacNeil 2015) and, subsequently, one of these areas was subjected to archaeological shovel testing (Glen 2016). The shovel testing conducted by DMA was unable to reach culturally sterile soil and, therefore, they were unable to confirm the presence or absence of archaeological resources at this location and recommended either mechanical testing (auguring) or on-site archaeological monitoring for any future ground disturbance in the area (Glen 2016:16). As a result the recommended course of action is archaeological reconnaissance with archaeological monitoring of the Nictaux Dam, as it overlaps with the area of recommended monitoring by DMA.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Nictaux Main Dam and Spillway**

Type: Large Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Nictaux Main Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS075. While the study states that the study area is to be considered **Low Potential** for archaeological resources, the recommendations suggest that there is potential for buried archaeological resources (de Boer et al 2012c:12-13). The recommendations put forth in that document are directed towards the replacement of the rip-rap only and may not apply to potential impacts associated with removal of assets. For the purpose of this costing document, and by the direction of NSPI, it is assumed that this area is determined to be **Low Potential** according to the previous archaeological study (A2012NS075). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Nictaux Headpond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Nictaux Headpond** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Nictaux Headpond was reconstructed using historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Trout Lake Spillway**

Type: Spillway

Based on previous background research and archaeological potential modelling, the area surrounding the **Trout Lake Spillway** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the spillway.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Trout Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Trout Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Trout Lake could not be reconstructed using available datasets.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Scragg Lake Dam and Discharge Structure**

Type: Small Dam; Earthfill and concrete; Discharge structure built on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Scragg Lake Dam and Discharge Structure** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS079, however, and the area was considered to exhibit **Low Potential** for archaeological resources (MacIntyre et al 2012). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Scragg Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Scragg Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Scragg Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **McGill Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **McGill Lake Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2012NS078 and A2013NS026, which identified two areas of high archaeological potential (de Boer et al. 2012d). Subsequent testing of these areas proved negative for cultural material and it was recommended that the area be cleared of archaeological concerns (Glen & MacIntyre 2013). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **McGill Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **McGill Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of McGill Lake was reconstructed using bathymetry data provided by NSPI and historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Curl Hole Dam and Spillways**

Type: Small Dam; Earthfill (Curl Hole Dam)
Freeboard Dykes (Big Molly Upsim Dykes and Overflows)
Spillways (Curl Hole Spillways 1 & 2)

Based on previous background research and archaeological potential modelling, the area surrounding the **Curl Hole Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2012NS080 and A2013NS025, which identified one area of moderate potential located immediately east of Curl

Hole Dam (de Boer at al. 2012e). Subsequent testing of this area proved negative for cultural materials and it was recommended that the area be cleared of archaeological concerns (Crowell & McIntyre 2013). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Molly Upsim Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Molly Upsim Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of McGill Lake was reconstructed using bathymetry data provided by NSPI and historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.12 PARADISE HYDRO SYSTEM - COSTING

The Paradise Hydro System is located along the Paradise Brook watershed in central Annapolis County, on the north slope of South Mountain. The catchment area of the Paradise Hydro System includes the following secondary tributaries: Roxbury Brook, Little John Brook, Joudrey Brook, and Hannam Brook, as well as the upper Bloody Creek watershed, including Harris Brook. NSPI assets for the Paradise Hydro System along Paradise Brook include the Paradise Pipeline, Saunders Pond Dam, Roxbury Main and Wing Dams, Paradise Lake Dam, Neives Lake Dam, Neives Pump Station, Corbett Lake Dam, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Paradise Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 12. Summary of costings for individual asset locations – Paradise Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Paradise Pipeline	[redacted]				
Saunders Pond Dam					
Saunders Pond Dam Spillway					
Saunders Pond Drawdown					
Roxbury Main and Wing Dams					
Paradise Lake Dam					
Paradise Lake Drawdown					
Neives Lake Dam					
Neives Pump Station					
Neives Dam Drawdown					
Corbett Lake Dam					
Corbett Lake Drawdown					
Total System Cost					

Asset Location: **Paradise Pipeline**

Type: Pipeline

Based on previous background research and archaeological potential modelling, portions of the area surrounding the **Paradise Pipeline** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the pipeline that is within areas of high archaeological potential.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Saunders Pond Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Saunders Pond Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Saunders Pond Dam Spillway**

Type: Small Dam; Earthfill; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Saunders Pond Dam Spillway** exhibits **High Potential** for impacting archaeological resources. As the dam is constructed on bedrock there is **Low Potential** for impacting archaeological resources due to the assumed absence of any natural sediment or soil. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Saunders Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Saunders Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Saunders Pond was reconstructed using historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Roxbury Main and Wing Dams**

Type: Small Dam; Earthfill;

Based on previous background research and archaeological potential modelling, the area surrounding the **Roxbury Main and Wing Dams** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Paradise Lake Dam**

Type: Small Dam; Earthfill;

Based on previous background research and archaeological potential modelling, the area surrounding the **Paradise Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Paradise Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Paradise Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Paradise Lake was reconstructed using historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Neives Lake Dam**

Type: Small Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Neives Lake Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2012NS081, A2012NS171 and A2013NS064, which identified one area of high archaeological potential. Subsequent testing recovered a single quartz flake indicating the potential for precontact archaeological resources (de Boer et al. 2012f:9). While further testing did not reveal any further precontact artifacts, it was recommended in the *Neives Lake Dam Spillway Addendum*, submitted to CCH by DMA, that archaeological monitoring be conducted should these areas be impacted by future development. As a result, the recommended course of action is archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Neives Pump Station**

Type: Pump Station

Based on previous background research and archaeological potential modelling, the area surrounding the **Neives Pump Station** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this areas. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Dalhousie Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Dalhousie Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Dalhousie Lake was reconstructed using historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Corbett Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Corbett Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Corbett Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Corbett Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Corbett Lake was reconstructed using historic air photos (1945).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.13 ROSEWAY HYDRO SYSTEM - COSTING

The Roseway Hydro System is situated within Shelburne County, flowing south and exiting at the community of Shelburne. The system drains 524 square kilometres of the Roseway watershed. NSPI system assets associated with the Roseway Hydro System, which represents two generating units with an operating capacity of 0.7 MW, include the Roseway Dam, Saddle Dam and Spillway.

The following costings represent the possible range of costs associated with the removal of assets associated with the Roseway Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 13. Summary of costings for individual asset locations – Roseway Hydro System

Asset Location	Reconnaissance Cost	Shovel Testing Cost	Excavation Cost	Total Asset Cost
Roseway Hydro	[redacted]			
Total Cost				

Asset Location: **Roseway Dam, Saddle Dam, Spillway and Reservoir**

Type: Small Dam (Roseway Dam)
Freeboard Dam (Saddle Dam)
Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Roseway Dams, Plant and Intake** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS069, however, and the area was considered to exhibit **Low Potential** for archaeological resources (MacIntyre et al 2012b). As a result, the recommended course of action is archaeological reconnaissance of the asset location as well as archaeological reconnaissance of the exposed shoreline if the reservoir is dewatered.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

3.14 SHEET HARBOUR HYDRO SYSTEM - COSTING

The Sheet Harbour Hydro System is situated within Halifax Regional Municipality, beginning approximately 3.5 kilometres east of the town of Sheet Harbour. The system drains 570.6 square kilometres of the Sheet Harbour watershed, with water storage provided by Governor Lake, Ten Mile Lake, Seloam Lake, and the Anti Dam Flowage. NSPI system assets associated with the Sheet Harbour Hydro System, which represents six generating units with an operating capacity of 10 MW, including Governor Lake Dam, Seloam Lake Dam, Anti Dam, Marshall Falls Dam and Spillway, Malay Falls Dam and Plant, Ruth Falls Dam, Plant and Spillway, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Sheet Harbour Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 14. Summary of costings for individual asset locations – Sheet Harbour Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Governor Lake Dam	[redacted]				
Governor Lake Reservoir Drawdown					
Seloam Lake Dam					
Seloam Lake Reservoir Drawdown					
Anti Dam					
Anti Dam Reservoir Drawdown					
Marshall Falls Dam and Spillway					
Marshall Falls Reservoir Drawdown					
Malay Falls Dam					
Malay Falls Plant					
Malay Falls Reservoir Drawdown					
Ruth Falls Dam and Spillway					
Ruth Falls Plant					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Ruth Falls Reservoir Drawdown	[redacted]				
Total System Cost					

Asset Location: **Governor Lake Dam**

Type: Small Dam; Earthfill embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Governor Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Governor Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Governor Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Governor Lake was reconstructed using Garmin bathymetry data.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Seloam Lake Dam**

Type: Small Dam; Earthfill timbercore embankment

Based on previous background research and archaeological potential modelling, the area surrounding the **Seloam Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Seloam Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Seloam Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Seloam Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Anti Dam**

Type: Medium Dam; Rockfill embankment; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Anti Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Anti Dam**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Anti Dam** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Anti Dam Lake was reconstructed using bathymetry data provided by NSPI.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Marshall Falls Main Dam and Spillway**

Type: Small Dam; Earthfill embankment; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Marshall Falls Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2010NS098 A2012NS053 and A2016NS081. In 2010, an archaeological screening and reconnaissance was carried out for a proposed generation unit at the Marshall Falls Dam with negative results (Beanlands & Kelman 2011). Subsequent subsurface testing of high archaeological potential in 2012 also proved negative (Garcin 2013a). In 2016, further screening and reconnaissance survey (A2016NS081) was conducted in the area below the Marshall Falls Dam and spillway. Two areas of high archaeological potential and one area of moderate archaeological potential were identified. It is unclear whether these areas have been tested to date. As it is unclear whether the previous assessments will apply to potential impacts from removal of assets, and the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Marshall Falls Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Marshall Falls Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. In 2013, a screening and reconnaissance survey (A2013NS70), for Marshall Flowage was conducted during a headpond drawdown. This shoreline survey resulted in the identification of six newly registered archaeological sites (Kelman 2013a). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Marshall Falls was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Malay Falls Dam**

Type: Small Dam; Earthfill embankment; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Malay Falls Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Malay Falls Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Malay Falls Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Malay Falls Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Malay Falls Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. In 2013, an archaeological screening and reconnaissance survey (A2013NS70), was conducted during headpond drawdown conditions (Kelman 2013a). During the course of the survey, three previously unregistered archaeological sites were identified. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Malay Falls was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Ruth Falls Dam and Spillway**

Type: Small Dam; Earthfill embankment; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Ruth Falls Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2017NS060 and A2018NS075. In 2017, Boreas Heritage (Garcin & Beanlands 2017b), conducted an archaeological reconnaissance and screening of the Ruth Falls Dam area, with three areas of high archaeological potential being identified. Subsequently, in 2018, two of the three high potential areas were subjected to archaeological shovel testing (A2018NS075), which yielded negative results for archaeological resources. Assuming that potential ground disturbance associated with removal of assets stays within the previously assessed study area, and avoids the remaining area of high potential, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Ruth Falls Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Ruth Falls Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Ruth Falls Reservoir**

Type: Dewatering

Based on previous background research and archaeological potential modelling, the **Ruth Falls Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Ruth Falls was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.15 SISSIBOO HYDRO SYSTEM - COSTING

The Sissiboo Hydro System is situated within Digby County, beginning approximately .5 kilometres north of the town of Weymouth Falls and 4.3 kilometers east of the town of Weymouth. The system drains 568 square kilometres of the Sissiboo watershed, with water storage provided by Big Tom Wallace Lake, Big Uniacke Lake, Sissiboo Grand Lake, Fifth Lake, and Fourth Lake. NSPI system assets associated with the Sissiboo Hydro System, which represents four generating units with an operating capacity of 28 MW, including Weymouth Plant and Penstock, Weymouth Falls Dam and Spillway, Sissiboo Main Dam, Grand Lake Spillway and Wing Dam, Fourth and Fifth Lake Main Dam, Fourth and Fifth Lake Wing Dams, Musquash Dam, Big Tom Wallace Earthen Dam, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Sissiboo Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 15. Summary of costings for individual asset locations – Sissiboo Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Weymouth Plant and Penstock	[redacted]				
Weymouth Falls Dam and Spillway					
Weynouth Falls Drawdown					
Sissiboo Main Dam					
Sissiboo Main Dam Drawdown					
Grand Lake Spillway					
Grand Lake Wing Dam					
Grand Lake Drawdown					
Fourth and Fifth Lake Main Dam					
Fourth and Fifth Lake Wing Dam 1					
Fourth and Fifth Lake Wing Dam 2					

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Fourth and Fifth Lake Wing Dam 3	[redacted]				
Musquash Dam					
Fourth Lake Drawdown					
Big Tom Wallace Earthen Dam					
Big Tom Wallace Drawdown					
Total System Cost					

Asset Location: **Weymouth Plant and Penstock**

Based on previous background research and archaeological potential modelling, the area surrounding the **Weymouth Plant and Penstock** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant and penstock.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Weymouth Falls Dam and Spillway**

Type: Large Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Weymouth Falls Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Weymouth Falls**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Weymouth Falls** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Weymouth Falls was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Sissiboo Main Dam and Plant**

Based on previous background research and archaeological potential modelling, the area surrounding the **Sissiboo Main Dam and Plant** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2017NS062, with four areas of high archaeological potential identified adjacent to the Sissiboo Falls Main Dam (Hicks et al. 2017). Archaeological shovel testing of these areas has yet to take place. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of previously identified areas of high potential within the vicinity of the assumed impact area.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Sissiboo Falls**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Sissiboo Falls** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Sissiboo Falls was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Grand Lake Spillways**

Type: Spillway; Rockfill
Spillway; Timber

Based on previous background research and archaeological potential modelling, the area surrounding the **Grand Lake Spillways** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the spillways.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Grand Lake Wing Dam**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Grand Lake Wing Dam** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Grand Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Grand Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. Analysis of bathymetry data provided by NSPI, as well as historic mapping and air photos (1945) could not detect a significant change in shoreline.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Fourth and Fifth Lake Main Dam**

Type: Large Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Fourth and Fifth Lake Main Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam, as well as archaeological monitoring of the earthfill portion of the Dam, assuming ground impacts are confined to the existing dam footprint

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Fourth and Fifth Lake Wing Dam 1**

Type: Medium Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Fourth and Fifth Lake Wing Dam 1** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Fourth and Fifth Lake Wing Dam 2**

Type: Medium Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Fourth and Fifth Lake Wing Dam 2** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Fourth and Fifth Lake Wing Dam 3**

Type: Small Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Fourth and Fifth Lake Wing Dam 3** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Musquash Dam**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Musquash Dam** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Fourth Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Fourth Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Fourth Lake was reconstructed using property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Big Tom Wallace Earthen Dam**

Type: Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Big Tom Wallace Earthen Dam** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Big Tom Wallace Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Big Tom Wallace Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Big Tom Wallace Lake could not be reconstructed using available datasets.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.16 ST MARGARETS BAY HYDRO SYSTEM - COSTING

The St. Margaret's Bay Hydro System is situated within both Lunenburg County and the Halifax Regional Municipality, beginning approximately 2.25 kilometres east of the Head of Saint Margarets Bay and approximately 10 kilometres southwest of Hammonds Plain. The system is part of the East Indian River watershed and drains 271 square kilometres, with water storage provided in Lunenburg County by Mill Lake, Coon Pond, Sandy Lake, Wrights Lake, Big Indian Lake, Five Mile Lake and Pockwock Lake in the Halifax Regional Municipality. NSPI system assets associated with the St. Margaret's Bay Hydro System, which represents six generating units with an operating capacity of 10 MW, including Beeswanger Dam, Five Mile Dam and Wing Dam 4, Mack Lake Main Dam, Five Mile Wing Dams 1,2 and 3, Big Indian Dam, Wright's Lake Dam, Coon Pond Dam, Sandy Lake Dam, Sandy Lake and Coon Pond Pipeline, Mill Lake Plant and Surge Tank, Little Indian Crossover, Mill Lake Dam, Tidewater Plant and Surge Tank, Tidewater Pipeline, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the St. Margarets Bay Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 16. Summary of costings for individual asset locations – St Margarets Bay Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation Cost	Total Cost
Beeswanger Dam	[redacted]			
Five Mile Dam and Wing Dam 4				
Five Mile Lake Drawdown				
Mack Lake Main Dam				
Five Mile Wing Dams 1, 2, and 3				
Mack Lake Drawdown				
Big Indian Dam				
Big Indian Drawdown				
Wright's Lake Dam				
Wright's Lake Drawdown				
Coon Pond Dam				

Asset Location	Reconnaissance	Shovel Testing	Excavation Cost	Total Cost
Coon Pond Drawdown	[redacted]			
Sandy Lake Dam				
Sandy Lake/Coon Pond Pipeline				
Sandy Lake Drawdown				
Mill Lake Plant and Surge Tank				
Little Indian Crossover				
Little Indian Drawdown				
Mill Lake Dam				
Mill Lake Drawdown				
Tidewater Plant and Surge Tank				
Tidewater Pipeline				
Total System Cost				

Asset Location: **Beeswanger Dam**

Type: Small Dam; Earthfill; Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Beeswanger Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS071. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Five Mile Dam and Wing Dam 4**

Type: Small Dam; Concrete; Main Dam constructed on bedrock
Freeboard Dam (Wing Dam 4)

Based on previous background research and archaeological potential modelling, the area surrounding the **Five Mile Dam and Wing Dam 4** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS070. During the course of the study one previously unregistered archaeological site was identified in the vicinity of the Five Mile Dam. The area immediately surrounding the dam, however, was considered to be of low archaeological potential (de Boer et al. 2012g). Assuming that potential ground disturbance associated with removal of assets stays within the area previously assessed under A2012N070 and avoids the registered archaeological site, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Five Mile Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Five Mile Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Five Mile Lake was reconstructed using bathymetry data provided by NSPI, property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Mack Lake Main Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Mack Lake Main Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS063, however, and it was determined that the area surrounding the dam was determined to be **Low Potential** for archaeological resources (de Boer et al. 2012h:15). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Five Mile Wing Dams 1, 2 and 3**

Type: Small Dam; Earthfill; Freeboard Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **Five Mile Wing Dams 1, 2 and 3** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS063. As this location is a Freeboard dam, no further work is recommended.

Asset Location: **Mack Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Mack Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Mack Lake was reconstructed using property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Big Indian Dam**

Type: Small Dam; Earthfill and concrete; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Big Indian Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2008NS084, A2009NS056, A2010NS094 and A2010NS107. Archaeological work associated with the refurbishment of the Big Indian Dam included archaeological reconnaissance, shovel testing as well as test excavation. In October (A2010NS94) and December 2010 (A2010NS107), NSPI modified plans for new construction footprints relating to refurbishment plans for the Big Indian River Main Dam (Kelman 2013b:3).

The 2010 fieldwork associated with site BeCx-01 (A2010NS94), involved geotechnical monitoring of areas to avoid impact to archaeological high potential areas, further intensified testing (2.5 m grid) to investigate the extent, complexity and integrity of site BeCx-01, and excavation of thirteen 1 x 1 m evaluative test units. These excavated units were “focused on the proposed impact area rather than the total site area", which "extends south beyond the southern limit of the proposed NSPI impacts" (Kelman 2013b:16). The 2010 combined shovel testing and excavations resulted in the recovery of 2,335 artifacts, and established there are intact archaeological resources and deposits at the Indian Lake Dam Site (BeCx-01) and that the site represents a long period of repeated seasonal occupation, from the Middle Archaic Period / Mu Awsami Kejikawek L'nuk (ca. 7,500-5,000 BP), through to the historic period (Kelman 2013b:44).

As these studies were not exhaustive mitigative measures, significant intact archaeological resources remain in the immediate vicinity of the dam. As the dam has since been refurbished, however, it is assumed that the area immediately adjacent to the dam is free of archaeological concerns. If potential impacts from removal of assets stays within the previous work areas, the recommended course of action is archaeological reconnaissance.

Beyond site BeCx-01, intact and disturbed portions of the original shoreline around the Big Indian Lake Dam, and throughout the St Margarets Bay Hydro System, may still contain additional archaeological evidence of precontact and historic period occupation and land-use. The irregular patterns of erosion and siltation of headponds and reservoirs causes archaeological sites to be exposed and obscured in different ways and under various conditions. It is for CCH to determine if additional archaeological work is required or if any previously cleared archaeological assessment work remains valid.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Big Indian Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Big Indian Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. The area was previously assessed under Heritage Research Permit A1996NS031. During the course of this study, 19 archaeological sites were identified along the historic shoreline of the lake (Sanders 1996; Stewart & Sanders 1997). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Big Indian Lake was reconstructed using bathymetry data provided by NSPI, property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Wrights Lake Dam**

Type: Small Dam; Concrete and earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Wrights Lake Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2006NS068, A2012NS057, A2015NS029 and A2015NS030. The first systematic survey of the shoreline of Wrights Lake took place in 2006 when, along with the Coon Pond Reservoir, a total of 31 previously unregistered archaeological sites were identified, with all 22 precontact sites located on the shoreline of Wrights Lake (Stewart & Sanders 2007:120-121). Further work associated with the refurbishment of the Wrights Lake Dam focused on the area immediately adjacent to the dam and including survey, testing and mitigation of archaeological site BeCx-33 (MacIntyre & Davis 2012a; Glen & Davis 2015). In 2015, a risk assessment for the 10 closest sites to the Wright's Lake Dam included recommendations that if Wright's Lake is permanently dewatered at any point, that an archaeological assessment be conducted to determine suitable mitigation strategies (Glen & Crowell 2015:90).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Wrights Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Wrights Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. Previous assessments along the shoreline have identified 23 precontact archaeological sites (Stewart & Sanders 2007; Glen & Crowell 2015). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Wrights Lake was reconstructed using bathymetry data provided by NSPI, property data (Property Online) and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Coon Pond Dam**

Type: Small Dam; Concrete and earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Coon Pond Dam and Pipeline** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2011NS086 and A2012NS036, related to the proposed refurbishment of the Coon Pond Dam. During the course of the survey, one area of high archaeological potential was identified (Kelman 2011). Subsequently, a small portion of the identified area of high potential was subjected to archaeological shovel testing. While no significant archaeological resources were identified during the testing, it was recommended that the remainder of the area ascribed high potential during the 2011 screening and reconnaissance be subjected to a program of shovel testing should construction plans be modified beyond the area tested (Kelman 2012a:11). As the dam has since been refurbished, however, it is assumed that the area immediately adjacent to the dam is free of archaeological concerns. If potential impacts from removal of assets stays within the previous work areas, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Coon Pond**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Coon Pond** exhibits **High Potential** for archaeological resources when water levels are lowered. The area was previously assessed under Heritage Research Permits A2006NS068 and A2012N074. The first systematic survey of the shoreline of Coon Poon took place in 2006 when 4 historic archaeological sites were identified within the reservoir (Stewart & Sanders 2007). A subsequent survey in 2012 did not identify any additional archaeological resources (Garcin 2012). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Coon Pond was reconstructed using bathymetry data provided by NSPI, property data (Property Online) and historic mapping. Additional mitigation measures may be required for exposed historic structures present in the reservoir.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Sandy Lake Dam**

Type: Small Dam; Concrete; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Sandy Lake Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2008NS085, A2009NS055, A2010NS093, A2010NS106 and A2011NS040. Archaeological work associated with the refurbishment of the Sandy Lake Dam included archaeological reconnaissance, shovel testing as well as archaeological excavation. As the dam has since been refurbished, however, it is assumed that the area immediately adjacent to the dam is free of archaeological concerns. If potential impacts from removal of assets stays within the previous work areas, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Sandy Lake / Coon Pond Pipeline (St. Margaret's Bay Pipeline)**

Type: Pipeline

Based on previous background research and archaeological potential modelling, portions of the area surrounding the **Sandy Lake / Coon Pond Pipeline** exhibit **High Potential** for impacting archaeological resources. Portions of this location were previously assessed under A2011NS109 and A2011NS127 which included the identification of four areas of high archaeological potential and the subsequent archaeological shovel testing of these areas. No archaeological resources were encountered during the course of these studies (Kelman 2012b, 2012c). As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area for portions of the pipeline that have not previously been assessed and that exhibit high archaeological potential.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Sandy Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Sandy Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. This area was previously assessed under Heritage Research Permits A1996NS029, A1999NS036, A1999NS46, A2012NS073, A2014NS038, and A2015NS057. Starting in 1977 after reports of a fisherman finding artifacts in the vicinity of the Big Indian Lake Dam, Stephen Davis of St. Mary's University conducted a survey of Rafter Lake, accompanied by his students, which would result in the identification and recording of five Precontact archaeological sites (BeCx-01 through BeCx-05).

As part of a series of controlled water releases on the reservoir, five individual surveys were conducted in 1996, 1999, 2012, 2014 and 2015 to coincide with the low water events. These surveys, designed to assess known archaeological sites and evaluate the lakeshore for unidentified resources, identified four new Precontact sites (BeCx-10 through BeCx-13) and five historic sites (BeCx-14 through BeCx-18) in 1996, three new Precontact sites (BeCx-64 through BeCx-66) in 1999, five new Precontact sites (BeCx-70 through BeCx-74) in 2012 and one new Precontact site (BeCx-76) in 2014 (Sanders 1996; Stewart & Sanders 2000; Garcin 2013b; Garcin & Beanlands 2014b). Water levels during the 2015 survey were not low enough to expose all registered archaeological sites (Garcin & Beanlands 2016f).

The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Sandy Lake was reconstructed using bathymetry data provided by NSPI and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Mill Lake Plant (Ridge Powerhouse)**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Mill Lake Plant (Ridge Powerhouse)** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Little Indian Crossover**

Type: Small Dam; Concrete and earthfill; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Little Indian Crossover** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2012NS056, A2013NS045 and A2014NS057. In 2012, DMA conducted archaeological reconnaissance of the area surrounding the control structure, control bridge, as well as the outlet of Little Indian River. At the time, it was determined that the area surrounding the control structure and bridge at the southeast end of the lake was **Low Potential** for archaeological resources (MacIntyre & Davis 2012b:13). Subsequent surveys of the area also determined the area surrounding the Little Indian Crossover to be of low archaeological potential (MacIntyre & Davis 2013; MacIntyre et al. 2014). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Little Indian Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Little Indian Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. The shoreline of Little Indian Lake was previously assessed under Heritage Research Permits A2012NS056, A2013NS045 and A2014NS057. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Little Indian Lake could not be reconstructed with available datasets.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Mill Lake Dam (Tidewater)**

Type: Small Dam; Concrete and earthfill; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Mill Lake Dam and Pipeline** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS056, A2012NS082.

In the summer of 2012, NSPI conducted repairs to its intake structure on Mill Lake, which included a reservoir drawdown that temporarily lowered the water level beyond the minimal operating level. At this time archaeological reconnaissance was conducted on the Mill Lake Reservoir under Heritage Research Permit A2012NS082. Although an area of high archaeological potential was identified, no archaeological resources were encountered at this time (Garcin 2013c).

In the fall of 2012, DMA undertook archaeological reconnaissance on the southern side of Mill Lake. Although they identified the historic features initially recorded by CRM Group, including the remains of a raceway or channel associated with the mill site, DMA also noted that the stone footing had been impacted during excavation of a drainage ditch. In December 2012, archaeological testing was conducted in an effort to provide cultural material for dating and to assess site impact, and monitoring was undertaken when the drainage ditch was refilled. Based on an analysis of associated material cultural, DM&A determined the stone footing to date from the late nineteenth or early twentieth century. As a result of their assessments, DMA recommended that archaeological reconnaissance of the entire shoreline be conducted should lake levels drop to the extent that a submerged shoreline is exposed (Garcin 2013c:6).

As the dam has since been refurbished, however, it is assumed that the area immediately adjacent to the dam is free of archaeological concerns. If potential impacts from removal of assets stays within the previous work areas, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Mill Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Mill Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. The area has been previously assessed under Heritage Research Permits A2012NS082 and A2015NS064. Archaeological reconnaissance conducted on the Mill Lake Reservoir under Heritage Research Permit A2012NS082 identified an area of high archaeological potential, but no archaeological resources were encountered at this time (Garcin 2013c). A subsequent survey in 2015 also failed to identify any archaeological resources (Garcin & Beanlands 2015d). The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Mill Lake was reconstructed using bathymetry data provided by NSPI and historic mapping.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Tidewater Powerhouse**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Tidewater Plant and Surge Tank** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Tidewater Pipeline**

Type: Pipeline

Based on previous background research and archaeological potential modelling, the area surrounding the **Tidewater Pipeline** exhibits **Low Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2011NS110 and A2011NS128, which included the identification of three areas of high archaeological potential and the subsequent archaeological shovel testing of these areas. No archaeological resources were encountered during the course of these studies (Kelman 2012d, 2012e). Assuming that potential ground disturbance associated with removal of assets stays within the area previously assessed, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

3.17 TUSKET HYDRO SYSTEM - COSTING

The Tusket Hydro System is situated within Yarmouth County and the southern extent of Digby County. The Tusket River flows south from it's highpoint in Digby county, through a glacially modified landscape, where it exits into the Atlantic Ocean near the community of Tusket. The system drains 1456.7 square kilometres of the Tusket watershed. NSPI system assets associated with the Tusket Hydro System, which represents three generating units with an operating capacity of 2.7 MW, include the Great Barren Dam, Tusket Powerhouse Dam, Tusket Western Wing Dam, Tusket Canal Embankments, Tusket Main Dam and Spillway, Carleton Dam, Mink Lake Dam, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Tusket Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 17. Summary of costings for individual asset locations – Tusket Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
Great Barren Dam	[redacted]				
Great Barren Lake Drawdown					
Tusket Powerhouse Dam					
Tusket Western Wing Dam					
Tusket Canal Embankments					
Tusket Main Dam and Spillway					
Lake Vaughan Drawdown					
Carleton Dam					
Carleton Lake Drawdown					
Mink Lake Dam					
Mink Lake Drawdown					
Total System Cost					

Asset Location: **Great Barren Dam**

Type: Small Dam; Concrete/earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Great Barren Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2007NS087, A2008NS058 and A2008NS064. Due to the presence of potentially significant archaeological resources, it was recommended that any future work in the vicinity be subjected to additional archaeological assessment (Sanders et al. 2008:11). As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Great Barren Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Great Barren Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Great Barren Lake was reconstructed using historic air photos (1927).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Tusket Powerhouse Dam**

Type: Small Dam; Concrete Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Tusket Powerhouse Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Tusket Western Wing Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **Tusket Western Wing Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Tusket Canal Embankments**

Type: Earthfill; Leave in Place

Based on previous background research and archaeological potential modelling, the area surrounding the **Tusket Canal Embankments** exhibits **High Potential** for impacting archaeological resources. As this location is classified as Leave in Place, no further work is recommended.

Asset Location: **Tusket Main Dam and Spillway**

Type: Small Dam; Concrete and Earthfill; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Tusket Main Dam and Spillway** exhibits **High Potential** for impacting archaeological resources. This area has been previously assessed under Heritage Research Permits A2012NS060, A2012NS144, A2013NS042 and A2017NS024. Archaeological work associated with the refurbishment of the Tusket Main Dam and Spillway included archaeological reconnaissance, shovel testing as well as monitoring. Archaeological monitoring in 2017 identified a buried A-horizon 2.7 metres below the roadbed of Lake Vaughan Road on the eastern approach. Given that buried natural soil may exist east of the bridge, this area was recommended for additional shovel-testing during replacement (Glen 2017:21). Deposits on the west side of the bridge appeared heavily disturbed, but as bedrock was not reached, there is potential for buried soils here as well. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Lake Vaughan**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Great Barren Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Lake Vaughan was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Carleton Dam**

Type: Small Dam; Concrete and Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Carleton Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed by Jacques Whitford in 2008 and under Heritage Research Permit A2010NS117. As a result of these studies, further archaeological assessment was recommended for any future impacts in the vicinity of the dam (Sanders 2011:9). As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Carleton Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Carleton Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Carleton Lake was reconstructed using bathymetry data provided by NSPI and property data (Property Online).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **Mink Lake Dam**

Type: Small Dam; Rockfill Timber crib; Constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **Mink Lake Dam** exhibits **High Potential** for impacting archaeological resources. A portion of this area was previously assessed under Heritage Research Permits A2014NS020 and A2014NS040. During the course of these surveys, one area of high archaeological potential was identified and subsequently tested. No archaeological resources were encountered (Garcin & Beanlands 2014c, 2014d). These studies, however, were confined to the east side of the dam. As a result, the recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area on the west side of the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **Mink Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Mink Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. Analysis of bathymetry data provided by NSPI, as well as historic mapping and air photos (1928) could not detect a significant change in shoreline.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

3.18 WRECK COVE HYDRO SYSTEM - COSTING

The Wreck Cove Hydro System is situated within Victoria County, and drains 222 square kilometers of the Wreck Cove Watershed. NSPI system assets associated with the Wreck Cove Hydro System, which represents three generating units with an operating capacity of 230 MW, include the D1 Dam, D2 Dam, D3 Dam, D4 Dam, D5 & D6 Dams, D7 Dam, Gisborne Plant, D81-D87 Wing Dams, D9 & D10 Dams, South Lake Dam, D11-1 and D11-3 Dams, as well as associated headponds.

The following costings represent the possible range of costs associated with the removal of assets associated with the Wreck Cove Hydro System. Actual costs for archaeological assessment will vary and will likely fall within the range of costs presented.

Table 18. Summary of costings for individual asset locations –Wreck Cove Hydro System

Asset Location	Reconnaissance	Shovel Testing	Excavation	Monitoring	Total Cost
D1	[redacted]				
D1 Drawdown	[redacted]				
D2	[redacted]				
D2 Drawdown	[redacted]				
D3	[redacted]				
D3 Drawdown	[redacted]				
D4	[redacted]				
D4 Drawdown	[redacted]				
D7	[redacted]				
Gisborne Drawdown	[redacted]				
D5, D6	[redacted]				
Gisborne Plant	[redacted]				
D81-D87 Wing Dams	[redacted]				
D9, D10	[redacted]				
Wreck Cove Drawdown	[redacted]				
South Lake Dam	[redacted]				
South Lake Drawdown	[redacted]				
D11-1	[redacted]				
D11-3	[redacted]				

D11-1 & D11-3 Drawdown	[redacted]				
Total System Cost					

Asset Location: **D1 Dam – Cheticamp Flowage**

Type: Medium Dam; Rockfill; Spillway on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **D1 Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2012NS057, however, and it was determined that the area surrounding the dam and spillway was **Low Potential** for archaeological resources (de Boer & Davis 2012). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **D1 – Cheticamp Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Cheticamp Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Cheticamp Flowage was reconstructed using property data (Property Online) and historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **D2 Dam – Ingonish 1**

Type: Medium Dam; Earthfill; Spillway on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **D2 Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **D2 – Ingonish 1**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Ingonish 1** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Ingonish 1 was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **D3 Dam – Ingonish 2**

Type: Medium Dam; Earthfill

Comments:

Based on previous background research and archaeological potential modelling, the area surrounding the **D3 Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway. Archaeological monitoring is recommended for removal of the earthfill portions within the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **D3 – Ingonish 2**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Ingonish 2** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Ingonish 2 was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] plus applicable taxes.

Asset Location: **D4 Dam – Gisborne Flowage**

Type: Large Dam; Earthfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **D4 Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permits A2015NS103 and A2016NS043, however, and both studies determined that the area surrounding the dam was **Low Potential** for archaeological resources (MacIntyre & de Boer 2015; Redden et al. 2016b).As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **D4 – Gisborne Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **D4** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Gisborne Flowage was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **D7 Dam – McMillan Flowage**

Type: Large Dam; Rockfill; Spillway constructed on bedrock

Based on previous background research and archaeological potential modelling, the area surrounding the **D4 Dam** exhibits **High Potential** for impacting archaeological resources. This area was previously assessed under Heritage Research Permit A2013NS057, however, and it was determined that the area surrounding the dam was **Low Potential** for archaeological resources (Kelman 2013c:16). As a result, the recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] plus applicable taxes. If it is determined that the previous study was not sufficient with respect to removal of assets, additional assessment may be required, which would increase estimated costs.

Asset Location: **D7 – McMillan Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **McMillan Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of McMillan Flowage was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **D5, D6**

Type: Medium Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **D5, D6 Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway. Archaeological monitoring is recommended for removal of the earthfill portions within the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Gisborne Plant**

Type: Plant/Powerhouse

Based on previous background research and archaeological potential modelling, the area surrounding the **Gisborne Plant** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the plant.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **D8-1-D8-7 and Wing Dams**

Type: Small Dam; Earthfill (DB1-DB7)
Wing Dam

Based on previous background research and archaeological potential modelling, the area surrounding the **D8-1-D8-7 and Wing Dams** exhibits **Low Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **D9, D10**

Type: Medium Dam; Earthfill; Spillway constructed on bedrock (D9)
Medium Dam; Earthfill (D10)

Based on previous background research and archaeological potential modelling, the area surrounding the **D9 and D10 dams** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam and spillway. Archaeological monitoring is recommended for removal of the earthfill portions within the dam footprint.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **Wreck Cove Flowage**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Wreck Cove Flowage** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Wreck Cove Flowage was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted] plus applicable taxes.

Asset Location: **South Lake Dam**

Type: Small Dam; Earthfill

Based on previous background research and archaeological potential modelling, the area surrounding the **South Lake Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, earthfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and **$27,442.00** plus applicable taxes.

Asset Location: **South Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **South Lake Reservoir** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. Analysis of historic mapping and air photos (1936) could not detect a significant change in shoreline.

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted]**0** plus applicable taxes.

Asset Location: **D11-1 Dam**

Type: Medium Dam; Rockfill

Based on previous background research and archaeological potential modelling, the area surrounding the **D11-1 Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance with archaeological shovel testing and archaeological excavation of the assumed impact area surrounding the dam.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **D11-3 Dam**

Type: Small Dam; Rockfill

Based on previous background research and archaeological potential modelling, the area surrounding the **D11-3 Dam** exhibits **High Potential** for impacting archaeological resources. No previous archaeological assessments were conducted for this area. As the location is classified as a small, rockfill dam, the recommended course of action is archaeological reconnaissance followed by archaeological monitoring of the asset removal.

It is estimated that the archaeological assessment can be undertaken at a cost between [redacted] and [redacted] plus applicable taxes.

Asset Location: **D11-1 and D11-3 – Surge Lake**

Type: Dewatering

Based on previous background research and archaeological potential modelling, **Surge Lake** exhibits **High Potential** for archaeological resources when water levels are lowered. No previous archaeological assessments were conducted for this area. The recommended course of action is archaeological reconnaissance of the lakeshore. The shoreline of Surge Lake was reconstructed using historic air photos (1936).

It is estimated that the archaeological assessment can be undertaken at a cost of [redacted]**0** plus applicable taxes.

4.0 REFERENCES CITED

Beanlands, Sara.
2010 "Donahue Lake. Archaeological Screening and Reconnaissance". Unpublished report for Heritage Research Permit A2010NS111. Report on file. Nova Scotia Museum, Halifax.

2012 "Donahue Lake. Archaeological Reconnaissance & Shovel Testing 2012". Unpublished report for Heritage Research Permit A2012NS100. Report on file. Nova Scotia Museum, Halifax.

Beanlands, Sara & Darryl Kelman.
2011 "Marshall Falls Dam. Archaeological Screening and Reconnaissance". Unpublished report for Heritage Research Permit A2010NS098. Report on file. Nova Scotia Museum, Halifax.

Beanlands, Sara & W. Bruce Stewart.
2008 "Great Barren Dam Safety Remedial Works. Archaeological Screening & Reconnaissance. Yarmouth County, Nova Scotia". Unpublished report for Heritage Research Permit A2007NS087. Report on file. Nova Scotia Museum, Halifax.

Christianson, David
1985 "Searching for Nova Scotia's Past: Archaeology and Lake Rossignol," *Mersey Quarterly* (Winter 1985) 8-9.

Crowell, Travis, & April MacIntyre.
2013 "NSPI Curl Hole Lake Dam Testing. Archaeological Resource Impact Assessment". Unpublished report for Heritage Research Permit A2013NS025. Report on file. Nova Scotia Museum, Halifax.

de Boer, Laura & Stephen Davis.
2012 "NSPI Cheticamp Flowage Dam (Wreck Cove Dam D-1). Archaeological Resource Impact Assessment" Unpublished report for Heritage Research Permit A2012NS057. Report on file. Nova Scotia Museum, Halifax.

de Boer, Laura, MacIntyre, April & Stephen Davis.
2012a "NSPI Methals Intake. Archaeological Resource Impact Assessment" Unpublished report for Heritage Research Permit A2012NS061. Report on file. Nova Scotia Museum, Halifax.

2012b "NSPI Hamony Dam Testing. Archaeological Resource Impact Assessment" Unpublished report for Heritage Research Permit A2012NS143. Report on file. Nova Scotia Museum, Halifax.

2012f “NSPI Neive’s Lake Dam Testing. Archaeological Resource Impact Assessment” Unpublished report for Heritage Research Permit A2012NS171. Report on file. Nova Scotia Museum, Halifax.

2012g “NSPI Five Mile Lake Dam. Archaeological Resource Impact Assessment” Unpublished report for Heritage Research Permit A2012NS070. Report on file. Nova Scotia Museum, Halifax.

2012h “NSPI Mack Lake Dams. Archaeological Resource Impact Assessment” Unpublished report for Heritage Research Permit A2012NS063. Report on file. Nova Scotia Museum, Halifax.

de Boer, Laura, MacIntyre, April, Niven, Laird & Stephen Davis.

2012c “NSPI Nictaux Main Dam. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS075. Report on file. Nova Scotia Museum, Halifax.

2012d “NSPI McGill Lake Dam. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS078. Report on file. Nova Scotia Museum, Halifax.

2012e “NSPI Curl Hole Lake Dam & Spillways. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS080. Report on file. Nova Scotia Museum, Halifax.

Garcin, Stephen.

2012 “Coon Pond Drawdown. Archaeological Reconnaissance. Halifax Regional Municipality, Nova Scotia”. Unpublished report for Heritage Research Permit A2012NS074. Report on file. Nova Scotia Museum, Halifax.

2013a “Marshall Falls Dam. Archaeological Shovel Testing”. Unpublished report for Heritage Research Permit A2012NS053. Report on file. Nova Scotia Museum, Halifax.

2013b “Sandy Lake Reservoir Drawdown. Archaeological Reconnaissance 2012”. Unpublished report for Heritage Research Permit A2012NS073. Report on file. Nova Scotia Museum, Halifax.

2013c “Mill Lake Reservoir Drawdown. Archaeological Reconnaissance 2012”. Unpublished report for Heritage Research Permit A2012NS082. Report on file. Nova Scotia Museum, Halifax.

Garcin, Stephen & Sara Beanlands.

2014a "Lower Lake Falls Reservoir. Archaeological Screening and Reconnaissance. Region of Queens Municipality". Unpublished report for Heritage Research Permit A2014NS105. Report on file. Nova Scotia Museum, Halifax.

2014b "Sandy Lake Reservoir Drawdown. Archaeological Reconnaissance 2014". Unpublished report for Heritage Research Permit A2014NS038. Report on file. Nova Scotia Museum, Halifax.

2014c "Mink Lake Refurbishment. Archaeological Screening and Reconnaissance. Yarmouth County, Nova Scotia". Unpublished report for Heritage Research Permit A2014NS020. Report on file. Nova Scotia Museum, Halifax.

2014d "Mink Lake Refurbishment. Archaeological Shovel Testing. Yarmouth County, Nova Scotia". Unpublished report for Heritage Research Permit A2014NS040. Report on file. Nova Scotia Museum, Halifax.

2015a "Hollow Bridge Canal. Archaeological Screening and Reconnaissance. Municipality of the County of Kings". Unpublished report for Heritage Research Permit A2015NS109. Report on file. Nova Scotia Museum, Halifax.

2015b "Mersey Hydro System Redevelopment. Archaeological Screening and Reconnaissance. Region of Queens Municipality". Unpublished report for Heritage Research Permit A2015NS011. Report on file. Nova Scotia Museum, Halifax.

2015c "Lower Lake Falls Reservoir. Archaeological Shovel Testing. Region of Queens Municipality". Unpublished report for Heritage Research Permit A2015NS001. Report on file. Nova Scotia Museum, Halifax.

2015d "Mill Lake Drawdown. Archaeological Reconnaissance. Halifax Regional Municipality". Unpublished report for Heritage Research Permit A2015NS064. Report on file. Nova Scotia Museum, Halifax.

2016a "White Rock Development – Canal Repair Project. Archaeological Shovel Testing. Municipality of the County of Kings". Unpublished report for Heritage Research Permit A2016NS078. Report on file. Nova Scotia Museum, Halifax.

2016b "Hollow Bridge Canal. Archaeological Shovel Testing. Municipality of the County of Kings". Unpublished report for Heritage Research Permit A2016NS005. Report on file. Nova Scotia Museum, Halifax.

2016c "Hollow Bridge Canal. Archaeological Monitoring. Municipality of the County of Kings". Unpublished report for Heritage Research Permit A2016NS063. Report on file. Nova Scotia Museum, Halifax.

2016d “Lequille Hydro System Developments. Archaeological Screening and Reconnaissance. Municipality of the County of Annapolis”. Unpublished report for Heritage Research Permit A2016NS052. Report on file. Nova Scotia Museum, Halifax.

2016e “Mersey Hydro System Redevelopment. Archaeological Shovel Testing. Region of Queens Municipality”. Unpublished report for Heritage Research Permit A2015NS069. Report on file. Nova Scotia Museum, Halifax.

2016f “Sandy Lake Reservoir Drawdown. Archaeological Reconnaissance. Halifax Regional Municipality”. Unpublished report for Heritage Research Permit A2015NS057. Report on file. Nova Scotia Museum, Halifax.

2017a “Lequille Hydro System Developments. Archaeological Screening and Reconnaissance. Municipality of the County of Annapolis”. Unpublished report for Heritage Research Permit A2016NS052. Report on file. Nova Scotia Museum, Halifax.

2017b “Ruth Falls Spillway Replacement. Archaeological Screening and Reconnaissance”. Unpublished report for Heritage Research Permit A2017NS060. Report on file. Nova Scotia Museum, Halifax.

Glen, Courtney.
2016 “Nictaux Powerhouse Dam Replacement Project Testing. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2016NS009. Report on file. Nova Scotia Museum, Halifax.

2017 “NSPI Tusket Falls Main Dam Replacement Project. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2017NS024. Report on file. Nova Scotia Museum, Halifax.

Glen, Courtney, & April MacIntyre.
2013 “NSPI McGill Lake Dam Testing”. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2013NS026. Report on file. Nova Scotia Museum, Halifax.

Glen, Courtney, & Courtney MacNeil.
2015 “Nictaux Powerhouse Dam Replacement Project. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2015NS107. Report on file. Nova Scotia Museum, Halifax.

Glen, Courtney, & Stephen Davis.
2015 “NSPI Wright’s Lake Mitigation of BeCx-33”. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2015NS029. Report on file. Nova Scotia Museum, Halifax.

Glen, Courtney, & Travis Crowell.
2015 "NSPI Wright's Lake 2015 Risk Assessment". Archaeological Resource Impact Assessment". Unpublished report for Heritage Research Permit A2015NS030. Report on file. Nova Scotia Museum, Halifax.

Hicks, Colin, Garcin, Stephen, & Sara Beanlands
2017 "Mersey Hydro System Redevelopment. Lower Great Brook. Archaeological Shovel Testing". Unpublished report for Heritage Research Permit A2017NS078. Report on file. Nova Scotia Museum, Halifax.

2018 "Sissiboo Dam Refurbishment. Archaeological Screening & Reconnaissance". Unpublished report for Heritage Research Permit A2017NS062. Report on file. Nova Scotia Museum, Halifax.

Jacques Whitford
2008 "Archaeological Screening & Reconnaissance Survey for the Dickie Brook Hydro System. Guysborough County". Unpublished report for Nova Scotia Power Inc.

Kelman, Darryl.
2008 "Soldier Reservoir Spillway Dam & Wing Dam 1 Refurbishment Works Archaeological Screening and Reconnaissance". Unpublished report for Heritage Research Permit A2008NS086. Report on file. Nova Scotia Museum, Halifax.

2009a "Bear River Ridge Dam, Spillway & Wing Dam 1 Refurbishment Works Archaeological Screening and Reconnaissance". Unpublished report for Heritage Research Permit A2009NS028. Report on file. Nova Scotia Museum, Halifax.

2009b "Soldier Reservoir Wing Dam 1 Refurbishment Works Archaeological Assessment". Unpublished report for Heritage Research Permit A2009NS053. Report on file. Nova Scotia Museum, Halifax.

2011 "Coon Pond Dam Refurbishment. 2011 Archaeological Screening & Reconnaissance". Unpublished report for Heritage Research Permit A2011NS086. Report on file. Nova Scotia Museum, Halifax.

2012a "Coon Pond Dam Refurbishment. Archaeological Assessment. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2012NS036. Report on file. Nova Scotia Museum, Halifax.

2012b "Sandy Pipeline Replacement Project. Archaeological Screening and Reconnaissance. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2011NS109. Report on file. Nova Scotia Museum, Halifax.

2012c "Sandy Pipeline Replacement Project. Archaeological Assessment. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2011NS127. Report on file. Nova Scotia Museum, Halifax.

2012d "Tidewater Pipeline Replacement Project. Archaeological Screening & Reconnaissance. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2011NS110. Report on file. Nova Scotia Museum, Halifax.

2012e "Tidewater Pipeline Replacement Project. Archaeological Assessment. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2011NS128. Report on file. Nova Scotia Museum, Halifax.

2013a "Malay Falls Flowage & Marshall Falls Flowage. Sheet Harbour Hydro System. Archaeological Screening & Reconnaissance. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2013NS070. Report on file. Nova Scotia Museum, Halifax.

2013b "Indian Lake Dam Site (BeCx-1). 2010 Archaeological Teting. Halifax Regional Municipality, Nova Scotia". Unpublished report for Heritage Research Permit A2010NS094. Report on file. Nova Scotia Museum, Halifax.

2013c "McMillan Reservoir D-7 Dam. Wreck Cove Hydro System. Archaeological Screening & Reconnaissance. Victoria County, Nova Scotia". Unpublished report for Heritage Research Permit A2013NS057. Report on file. Nova Scotia Museum, Halifax.

Kelman, Darryl & W. Bruce Stewart.

2007 "Gaspereau Dam Safety Remedial Works. Archaeological Screening & Reconnaissance. Kings County, Nova Scotia". Unpublished report for Heritage Research Permit A2007NS058. Report on file. Nova Scotia Museum, Halifax.

MacIntyre, April, de Boer, Laura, & Courtney Glen.

2014 "NSPI Little Indian Lake Dewatering. Archaeological Resource Impact Assessment". Unpublished report for Heritage Research Permit A2014NS057. Report on file. Nova Scotia Museum, Halifax.

MacIntyre, April, Niven, Laird & Stephen Davis.

2012a “NSPI Scragg Lake Dam. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS079. Report on file. Nova Scotia Museum, Halifax.

2012b “NSPI Roseway Dam. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS069. Report on file. Nova Scotia Museum, Halifax.

MacIntyre, April & Laura de Boer.

2015 “NSPI Gisborne Reservoir, D-4. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2015NS103. Report on file. Nova Scotia Museum, Halifax.

MacIntyre, April, & Stephen Davis.

2012a “NSPI Wright’s Lake Dam. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS057. Report on file. Nova Scotia Museum, Halifax.

2012b “NSPI Little Indian Lake. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2012NS056. Report on file. Nova Scotia Museum, Halifax.

2013 “NSPI Little Indian Lake/Indian River. Archaeological Resource Impact Assessment”. Unpublished report for Heritage Research Permit A2013NS045. Report on file. Nova Scotia Museum, Halifax.

Meade, Kenneth R.

2000 “Considering Fish Biology in Hydroelectric Operations: A Case Study of the Black River Hydro System in Nova Scotia”. Unpublished M.A. Thesis, Department of Environmental Studies, Dalhousie University. Halifax, NS.

Redden, Emily, MacIntyre, April, & Laura. de Boer.

2016a “Gulch Spillway Rehabilitation Project. Archaeological Resource Impact Assessment.” Unpublished report for Heritage Research Permit A2016NS083. Report on file. Nova Scotia Museum, Halifax.

2016b “Gisborne Reservoir D-4 Dam Emergency Spillway. Archaeological Resource Impact Assessment.” Unpublished report for Heritage Research Permit A2016NS043. Report on file. Nova Scotia Museum, Halifax.

Sanders, Mike.

1996 “St. Margarets Bay Lakes Archaeological Assessment”. Unpublished report for Heritage Research Permit A1996NS029. Report on file. Nova Scotia Museum, Halifax.

2011 “Carleton Dam Archaeological Monitoring, 2010 Carleton/Raynards Reservoir. Yarmouth County, Nova Scotia”. Unpublished report for Heritage Research Permit A2010NS117. Report on file. Nova Scotia Museum, Halifax.

Sanders, Mike, Stewart, W. Bruce, Beanlands, Sara and Kathryn Stewart.
2014a “Mersey Powerhouse Refurbishment (2004) Archaeological Reconnaissance & documentation. Mersey River, Queens Municipality”. Unpublished report for Heritage Research Permit A2004NS054. Report on file. Nova Scotia Museum, Halifax.

Sanders, Mike, Garcin, Stephen, Stewart, W. Bruce & Angela Finnie.
2014b “Big Falls (No. 3) Headpond: 2011 Archaeological Reconnaissance”. Unpublished report for Heritage Research Permit A2011NS042. Report on file. Nova Scotia Museum, Halifax.

Sanders, Mike, Stewart, W. Bruce, & Darryl Kelman.
2008 “Great Barren Dam Safety Remedial Works. Yarmouth County. 2008 Archaeological Screening and Assessment”. Unpublished report for Heritage Research Permit A2008NS058. Report on file. Nova Scotia Museum, Halifax.

Stewart, W. Bruce & Mike Sanders.
1997 “Big Indian Lake Archaeological Assessment”. Unpublished report for Heritage Research Permit A1997NS031. Report on file. Nova Scotia Museum, Halifax.

2000 “Archaeological Monitoring & Salvage – Sandy Lake Reservoir”. Draft report for Heritage Research Permits A1999NS036 & A1999NS046. On file with Cultural Resource Management Group Ltd.

2005 “MacDonald Headpond, Hants County. Archaeological Screening and Assessmend”. Unpublished report for Heritage Research Permit A2005NS095. Report on file. Nova Scotia Museum, Halifax.

2006 “McGowan Headpond Main Dam. Harmony Mills, Region of Queens Municipality. Archaeological Screening and Assessment”. Unpublished report for Heritage Research Permit A2006NS050. Report on file. Nova Scotia Museum, Halifax.

2007 “Wrights Lake & Coon Pond Headponds. Halifax Regional Municipality. Archaeological Reconnaissance”. Unpublished report for Heritage Research Permit A2006NS050. Report on file. Nova Scotia Museum, Halifax.

APPENDIX A – MASTER LIST OF ASSETS

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Annapolis	Annapolis Plant					379.03765259800	2913.31758131000
Avon	Avon 1 Penstock					249.51164609100	805.94954333200
Avon	Avon 1 Powerhouse					85.94075639890	424.92432926100
Avon	Avon 2 Penstock					287.96982442300	1790.69948110000
Avon	Card Lake Main Dam	Small		Earthfill		368.73833490300	4615.50408775000
Avon	Card Lake Wing Dam	Small		Earthfill		719.83947517800	6798.40451022000
Avon	Falls Dam	Small	Concrete on bedrock	Earthfill		237.84904985200	1978.48897459000
Avon	MacDonald Dam	Medium	Concrete dam on bedrock	Earthfill dyke and concrete gravity	Yes	118.80708757400	419.40384547600
Avon	MacDonald Dam	Medium	Concrete dam on bedrock	Earthfill dyke and concrete gravity	Yes	378.41748067500	8202.81995650000
Avon	MacDonald Pond Dam Spillway					123.81720718700	418.41366437500
Avon	Pipeline					1614.39627717000	15743.95140880000
Avon	South Canoe Dam	Small		Earthfill		629.71291989100	5939.48733408000
Avon	Zwicker Lake Dam	Small		Earthen abutment		97.49667116690	582.53108709600
Bear River	Bear River Powerhouse					67.88608281650	279.96754808500
Bear River	Gulch Main Dam (Sam Harris Dam)	Medium		Earthfill with concrete core wall	Yes	766.79897072500	12667.92828930000
Bear River	Gulch Main Dam (Sam Harris Dam)	Medium		Earthfill with concrete core wall	Yes	381.61273434200	4348.33789450000
Bear River	Gulch Main Dam (Sam Harris Dam) Spillway	Medium	Spillway is on bedrock		Yes	117.72619811100	327.02023118300
Bear River	Gulch Pipeline					6201.97128098000	61619.39848720000
Bear River	Mulgrave Main Dam	Medium		Earthfill with concrete core wall		392.32814023700	5725.58292977000
Bear River	Mulgrave Wing Dam 1	Small		Earthfill with timber and concrete spillway		511.15853191000	8702.15288126000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Bear River	Mulgrave Wing Dam 2	Small		Earthfill with timber core wall		348.04136293200	3080.41571218000
Bear River	Mulgrave Wing Dam 3	Small		Earthfill with timber core wall		288.18649901700	2481.86545051000
Bear River	Ridge Main Dam	Medium		Earthfill with concrete core wall and spillway	Yes	935.84685002100	21186.08059190000
Bear River	Ridge Main Dam	Medium		Earthfill with concrete core wall and spillway	Yes	503.60991024200	4673.30756820000
Bear River	Ridge Main Dam (Spillway)	Medium	Spillway is on bedrock	Earthfill with concrete core wall and spillway	Yes	171.27224859800	790.79439360600
Bear River	Ridge Pipeline					2007.32434516000	19669.32051110000
Bear River	Ridge Powerhouse					71.20238564150	303.88016422700
Bear River	Ridge Wing Dam 1	Small		Earthfill with concrete core wall		367.70075587900	3277.00648438000
Bear River	Ridge Wing Dam 2	Small	Leave in place-mainly access rd to other dams	Earthfill with concrete core wall		602.88889421800	5733.46174957000
Black River	Aylesford Dam	Small		Earth / Rockfill		222.44431385000	1824.44035388000
Black River	Black Brook Dam	Small	Dyke constructed on bedrock	Earthfill / Concrete Earthfill	Yes	1442.77636712000	9703.55200498000
Black River	Black River Dam	Small		Earthfill		779.23755466100	7374.13832631000
Black River	Dean Chapter Dam	Small	Spillway is on bedrock	Earth / Rockfill		511.00901926900	4710.09051788000
Black River	Dyke L					98.81041168760	549.46028271200
Black River	Dyke M					182.76495701900	1002.50273196000
Black River	Dyke N					182.82733947500	1115.77513077000
Black River	Dyke P & Spillway					333.28497777500	2400.15568768000
Black River	Dyke P Spillway		Spillway on bedrock			116.84816078000	293.92757653600
Black River	Forest Home Dyke		Dyke constructed on bedrock		Yes	2773.16408124000	24857.74447590000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Black River	Forks Dam	Medium		Earthfill		739.80376155200	18428.30462590000
Black River	Forks Dam	Medium		Earthfill		423.86533816100	4324.43221013000
Black River	Forks Dam Spillway	Medium	Spillway is on bedrock			142.96703660200	541.03140949300
Black River	Hatchard Lake Dam (Salmontail wing dam)		Freeboard Dam			271.98142029200	1800.91568079000
Black River	Hells Gate Dam	Medium	Dam constructed on bedrock	Concrete		361.98445057800	6899.64894106000
Black River	Hells Gate Dam	Medium	Dam constructed on bedrock	Concrete		144.46121926200	792.32909766100
Black River	Hells Gate Plant					301.29452204200	5616.54959774000
Black River	Hollow Bridge Pipeline				Yes	869.39847270300	8330.83473913000
Black River	Hollow Bridge Powerhouse					73.86637341920	325.22970892000
Black River	Lane Mills Dam & Spillway	Small	Spillway is on bedrock	Earthfill / Concrete	Yes	332.18774777500	3031.47108032000
Black River	Little River Lake Main Dam	Small		Timber / Rockfill		368.99206565000	3308.52770669000
Black River	Little River Lake Wing Dam	Small		Timber / Rockfill		252.13122899900	2121.31178157000
Black River	Lumsden Dam	Medium		Earthfill		653.66533470500	17848.27396420000
Black River	Lumsden Dam	Medium		Earthfill		476.28092960800	7778.78782919000
Black River	Lumsden Dam Spillway	Medium	Spillway is on bedrock			139.08829210100	419.18268564500
Black River	Lunn Dam		Freeboard Dam			306.47826081300	5289.43662705000
Black River	MacMillian Dam (aka Diversion Dam)	Small		Earthfill		522.93012219300	4774.64764175000
Black River	Methals Dam	Medium		Earthfill	Yes	1049.27735071000	31088.22755110000
Black River	Methals Dam	Medium		Earthfill	Yes	560.16383147800	5562.73328759000
Black River	Methals Spillway and Powerhouse	Medium	Spillway and powerhouse are on bedrock		Yes	149.99586989100	1282.78060455000
Black River	Mid point spillway		Freeboard Dam			361.50086853400	3131.92218888000
Black River	Muskrat Cove Dam	Small		Earthfill / Concrete	Yes	237.50052031700	2095.17187496000
Black River	North Gaspereau Dam				Yes	475.98930174100	10755.13627820000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Black River	Salmontail Main Dam	Small		Earth / Rockfill		301.35000615500	2637.43547670000
Black River	White Rock Dam	Medium	Dam constructed on bedrock	Concrete		91.06760299420	473.67525083100
Black River	White Rock Dam and Fish Ladder	Medium	Dam constructed on bedrock	Concrete		545.94885185200	12972.57695920000
Black River	White Rock Plant					272.78408985200	4601.55586586000
Dickie Brook	Donahue Dam	Small		Earthfill embankment	Yes	179.22071558000	1429.38300825000
Dickie Brook	Pipeline					3094.49798829000	31145.68669140000
Dickie Brook	Spillway					391.19941771500	8669.44059730000
Dickie Brook	Spillway					526.61810665000	12265.54795740000
Dickie Brook	Tom Dam	Medium		Earthfill embankment	Yes	1507.41032698000	43357.99389949990
Dickie Brook	Tom Dam	Medium		Earthfill embankment	Yes	1323.04408642000	9737.38008545000
Fall River	Fall River Pipeline					318.84388352700	2788.43007347000
Fall River	Miller Lake Dam	Small		Concrete		98.54678741160	585.46691763100
Fall River	Soldier Lake Wing Dam 1	Small			Yes	281.54216305000	2404.95793278000
Fall River	Soldier Lake Wing Dam 2	Small	Freeboard Dam			202.77685935000	1627.76828388000
Fall River	Soldier Main Dam	Small	Spillway is on bedrock	Concrete	Yes	108.30286235000	683.02802916800
Harmony	Harmony Powerhouse					60.35002066510	215.56002328900
Harmony	Main Dam	Small	Dam built on bedrock	Earthfill embankment	Yes	420.57313689500	3815.54105110000
Harmony	Wing Dam	Small		Earthfill embankment	Yes	564.39801999600	5246.30338440000
Lequille	Canal Intake & Wing Dam 1					317.96413303200	5164.47170465000
Lequille	Dargie Dam	Small		Earthfill embankment		161.14271232700	1211.42766802000
Lequille	Grand Lake Dam	Small	Spillway is on bedrock	Earthfill embankment		181.43772764900	1414.37916000000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Lequille	Lequille Main Dam	Medium		Earthfill embankment	Yes	668.60128078700	19782.71494140000
Lequille	Lequille Main Dam	Medium		Earthfill embankment	Yes	509.74711365700	6736.65907848000
Lequille	Lequille Powerhouse					74.13032590150	333.86521264500
Lequille	Lequille Wing Dam 4					362.38615331800	7083.28633911000
Lequille	Spillway		Spillway is on bedrock			53.43621115940	145.94756922500
Lequille	Wing Dam 3					275.21095888300	1656.36689558000
Mersey	Big Falls Bulkhead Dam		Constructed on bedrock			122.73233642900	945.34467524300
Mersey	Big Falls Embankment 1 (Left Wing Dam)					766.18688612500	19593.42748830000
Mersey	Big Falls Embankment 2 (Main Dam)	Large		Earthfill with concrete core		783.49053658400	19620.09513220000
Mersey	Big Falls Embankment 2 (Main Dam)	Large		Earthfill with concrete core		2986.63555849000	83992.20527740000
Mersey	Big Falls Embankment 2 (Main Dam)	Large		Earthfill with concrete core		704.39170031900	6168.65376362000
Mersey	Big Falls Embankment 3					929.37845677900	23519.29731580000
Mersey	Big Falls Embankment 4 (Right Wing Dam)					440.44141310000	8895.66144410000
Mersey	Big Falls Sluiceway		Constructed on bedrock			62.04379206590	227.79809901600
Mersey	Big Falls Spillway		Constructed on bedrock			260.79643253600	1596.99611453000
Mersey	Canal Embankment					767.84361040000	3765.05580368000
Mersey	Cowie Falls Dam and Fish ladder	Medium		Earthfill with concrete core		700.09729851200	17193.79903700000
Mersey	Cowie Falls Wind Dam 3		Freeboard Dam			107.11450226700	617.01960190900
Mersey	Cowie Falls Wing Dam 1		Freeboard Dam			549.86175546900	9796.52780965000
Mersey	Cowie Falls Wing Dam 2		Freeboard Dam			102.48262053500	547.13611329100

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Mersey	Cowie Lake Falls Earthfill Dam	Medium		Earthfill		473.16642495800	3815.43515228000
Mersey	Cowie Lake Falls Sluiceway	Medium	Constructed on bedrock			114.42547679200	624.77710419200
Mersey	Cowie Lake Falls Spillway	Medium	Constructed on bedrock			107.85090679600	548.41552441100
Mersey	Deep Brook Canal Embankment Dam					1019.29565266000	4730.52156722000
Mersey	Deep Brook Dam & Powerhouse	Medium		Earthfill with impervious fill		1927.76054658000	54552.51509650000
Mersey	Deep Brook Dam & Powerhouse	Medium		Earthfill with impervious fill		1584.09433913000	17404.66500730000
Mersey	Deep Brook Diversion Dam					453.21764887700	9833.95707999000
Mersey	Deep Brook Diversion Dam (Sluiceway/Spillway)		Spillway and Sluiceway constructed on bedrock			260.02738858200	915.65835390600
Mersey	Deep Brook Road Wing Dam					758.83640954100	4393.72995832000
Mersey	Eight Lake Dam					360.91102150700	7628.69432415000
Mersey	Jordan Lake Dyke 5					154.74270595400	1147.20213927000
Mersey	Jordan Lake Dyke 6					160.64002498300	1074.60352833000
Mersey	Jordan Lake Dyke 7					242.28963456700	1656.87173861000
Mersey	Jordan Main Dam	Small		Earthfill		501.88529882800	4608.38574100000
Mersey	Left wing dam					463.32990722400	4646.92338740000
Mersey	Lower Great Brook Dam	Medium		Earthfill with concrete core		472.86328106000	10637.12328350000
Mersey	Lower Great Brook Dam	Medium		Earthfill with concrete core		280.70066908300	2020.39959568000
Mersey	Lower Great Brook Earthfill Dam	Medium		Earthfill with concrete core		496.62243394700	3941.82447916000
Mersey	Lower Great Brook Spillway		Freeboard Dam			638.95841356900	13730.99082380000
Mersey	Lower Great Brook Wing Dam					202.77269774400	1476.47387319000

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Mersey	Lower Lake Falls Dam	Medium		Earthfill with concrete core		824.14379943400	19648.50172930000
Mersey	Lower Lake Falls Dam	Medium		Earthfill with concrete core		707.43864853400	3329.71268903000
Mersey	Lower Lake Falls Powerhouse					106.29552311000	703.30455198700
Mersey	Lower Lake Falls Powerhouse Bulkhead Dam		Constructed on bedrock			31.91727846300	62.59852165650
Mersey	Lower Lake Falls Sluiceway					57.46886696330	179.49953427300
Mersey	Lower Lake Falls Sluiceway Bulkhead Dam		Constructed on bedrock			71.30342304750	177.33305564500
Mersey	Lower Lake Falls Spillway		Constructed on bedrock			161.18112581300	767.34844960000
Mersey	Lower Lake Falls Wing Dam		Freeboard Dam			497.26141817600	3852.59382327000
Mersey	Lower Lake Falls Wing Dam		Freeboard Dam			296.80063246800	2256.25802446000
Mersey	Sixth Lake Dam					506.80195818700	11866.95902030000
Mersey	Upper Lake Falls Bulkhead		Constructed on bedrock			110.20502651600	763.01086148400
Mersey	Upper Lake Falls Dam	Large	Constructed on bedrock	Earthfill with concrete core		330.19841284500	3973.91103258000
Mersey	Upper Lake Falls Dam & Spillway	Large		Earthfill with concrete core		785.38019987700	18700.14890110000
Mersey	Upper Lake Falls Right Wing Dam		Constructed on bedrock			69.98676788940	286.91214529100
Mersey	Upper Lake Falls Sluiceway		Constructed on bedrock			73.29354756340	277.68045604200
Mersey	Upper Lake Falls Spillway		Constructed on bedrock			189.49776159800	1150.87430858000
Nictaux	Big Molly Upsim Earth/Rockfill Dykes and Overflows		Freeboard Dykes	Earth/Rockfill		548.64075203400	10513.73847780000
Nictaux	Curl Hole Dam	Small		Earthfill	Yes	413.84130353400	8499.07537791000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Nictaux	Curl Hole Spillway #1 and 2				Yes	566.38507218500	10136.41083030000
Nictaux	McGill Lake Dam	Small		Earthfill	Yes	451.75378775600	10372.60335800000
Nictaux	Nictaux Canal		Leave in place			10586.23105780000	################
Nictaux	Nictaux Main Dam	Large		Earthfill	Yes	1552.34530373000	45276.52541360000
Nictaux	Nictaux Main Dam	Large		Earthfill	Yes	792.53401497400	7676.52549031000
Nictaux	Nictaux Main Dam Spillway	Large	Spillway build on bedrock		Yes	503.80759122100	2658.68112873000
Nictaux	Nictaux Powerhouse		Constructed on bedrock		Yes	65.99029907070	270.78295753500
Nictaux	Scrag Lake Dam	Small		Earthfill & Concrete	Yes	850.06463558700	8301.71456088000
Nictaux	Scrag Lake Dam Discharge structure	Small	Discharge structure build on bedrock		Yes	46.69496903260	123.22433346300
Nictaux	Trout Lake Spillway					271.92652107100	4511.26095289000
Nictaux						323.81627117900	5954.50762060000
Paradise	Corbett Lake Dam	Small		Earthfill		311.93161115000	2719.31600657000
Paradise	Neives Lake Dam	Small	Spillway build on bedrock	Earthfill	Yes	270.22778645300	4372.84392817000
Paradise	Neives Pump Station					231.73009635800	3342.71687264000
Paradise	Paradise Lake Dam	Small		Earthfill		481.93964953300	4419.39307725000
Paradise	Paradise Pipeline					7350.42732166000	73114.17296580000
Paradise	Roxbury Main Dam	Small		Earthfill		175.37558234200	1350.94778846000
Paradise	Saunders Pond Dam	Small		Earthfill		261.92393069300	2219.24026908000
Paradise	Saunders Pond Dam Spillway	Small	Spillway build on bedrock	Earthfill		579.54442136900	5326.21827177000
Paradise	Wing Dam #1 and 2	Small		Earthfill		503.99052932900	4639.90451037000
Roseway	Roseway Dam, Saddle Dam & Spillway	Small	Spillway: const. on bedrock. Saddle dam: freeboard		YesNo	544.71062576800	5066.21749829000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Sheet Harbour	Anti Dam	Medium	Constructed on bedrock	Rockfill embankment		561.31728597900	16229.57622650000
Sheet Harbour	Anti Dam	Medium	Constructed on bedrock	Rockfill embankment		283.76500838100	2491.72998826000
Sheet Harbour	Governor Dam	Small		Earthfill embankment		827.38551641800	7793.77541065000
Sheet Harbour	Malay Falls Dam	Small	Constructed on bedrock	Earthfill embankment	Yes	422.70011570800	3788.97204096000
Sheet Harbour	Malay Falls Powerhouse					100.32143943500	536.57430814800
Sheet Harbour	Marshall Falls Main Dam	Small	Spillway constructed on bedrock	Earthfill embankment	Yes	958.69226500700	9190.32703461000
Sheet Harbour	Power Canal					4746.77243520000	27103.66744610000
Sheet Harbour	Ruth Falls Dam & Spillway	Small	Constructed on bedrock	Earthfill embankment		480.58779477900	4405.52465002000
Sheet Harbour	Ruth Falls Powerhouse					102.67370360400	606.21798698800
Sheet Harbour	Sloane Dam	Small		Earthfill timbercore embankment		925.85317889900	8932.82518810000
Sheet Harbour	Ten Mile Lake Dam		Decommissioned			335.38422787100	6364.05797749000
Sissiboo	Big Tom Wallace Earthen Dam	Small	Freeboard Dam	Earthfill & rock masonry		172.62235306300	1318.13241400000
Sissiboo	Big Uniacke Dam	Small	Decommishioned			314.99964466700	2717.33070444000
Sissiboo	Forth and Fifth Lake Main Dam	Large		Earthfill		968.38314162400	32810.60857580000
Sissiboo	Forth and Fifth Lake Main Dam	Large		Earthfill		685.01137032400	10732.40746360000
Sissiboo	Fourth and Fifth Lake Wing Dam 1	Medium		Earthfill		1287.67857504000	42324.08401690000
Sissiboo	Fourth and Fifth Lake Wing Dam 1	Medium		Earthfill		1178.18715311000	17503.41436180000
Sissiboo	Fourth and Fifth Lake Wing Dam 2	Medium		Earthfill		1096.92244476000	36729.15597980000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Sissiboo	Fourth and Fifth Lake Wing Dam 2	Medium		Earthfill		989.20863055400	12188.93257770000
Sissiboo	Fourth and Fifth Lake Wing Dam 3	Small	Spillway built on bedrock	Earthfill		112.67922727700	725.21952663900
Sissiboo	Musquash Dam	Small	Freeboard Dam	Earthfill		274.31534293900	2342.68815878000
Sissiboo	Sissiboo Embankement Dam					223.29821785200	2199.54608121000
Sissiboo	Sissiboo Embankement Dam					233.49313064200	2459.99954963000
Sissiboo	Sissiboo Falls Main Dam	Large	Constructed on bedrock	Concrete gravity	Yes	889.85958351900	27203.37084920000
Sissiboo	Sissiboo Falls Main Dam	Large	Constructed on bedrock		Yes	331.23557122400	1544.20109960000
Sissiboo	Sissiboo Grand Lake Rock Spillway	Small		Rockfill		379.18943028800	3381.36420430000
Sissiboo	Sissiboo Grand Lake Timber Spillway	Small		Timber		211.15810104900	1711.58417114000
Sissiboo	Sissiboo Grand Lake Wing Dam	Small	Freeboard Dam	Earthfill		393.34145672600	3533.41513879000
Sissiboo	Weymouth Falls Main Dam and Wing Dam	Large		Earthfill		1526.47815049000	- 55009.29779400000
Sissiboo	Weymouth Falls Main Dam and Wing Dam	Large		Earthfill		1117.70423448000	22776.79471100000
Sissiboo	Weymouth Falls Spillway	Large	Spillway built on bedrock			203.93616558600	1011.99207380000
Sissiboo	Weymouth Plant and Penstock				Yes	565.34750214100	6619.84912763000
St. Margaret's Bay	Beeswanger Dam	Small	Freeboard dam	Earthfill	Yes	235.44197832200	1853.46244478000
St. Margaret's Bay	Big Indian Main Dam (Earth)	Small	Constructed on bedrock	Concrete & Earthfill	Yes	337.11306673900	2970.10956446000
St. Margaret's Bay	Big Indian Spillway	Small	Constructed on bedrock	Concrete	Yes	287.06972582400	1528.50428269000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
St. Margaret's Bay	Coon Pond Dam	Small	Constructed on bedrock	Concrete & Earthfill	Yes	289.01492006200	3486.42312579000
St. Margaret's Bay	EarthFill Main Dam				Yes	98.60630732940	460.51190971300
St. Margaret's Bay	Five Mile Dam and Wing Dam 4	Small	Main dam-const. on bedrock wing dam 4-freeboard	Concrete	Yes	945.31678767200	8948.34823525000
St. Margaret's Bay	Five Mile Lake Wing Dam 1-3		Freeboard Dam	Earthfill		363.92338953700	7160.80307215000
St. Margaret's Bay	Little Indian Crossover Structure	Small	Constructed on bedrock	Concrete & Earthfill	Yes	86.70783301710	466.45122471400
St. Margaret's Bay	Mack Lake Dam	Small		Earthfill	Yes	448.44578930000	4084.45932309000
St. Margaret's Bay	Mill Lake Dam (Tidewater)	Small	Constructed on bedrock	Concrete & Earthfill	Yes	176.72344786100	1550.86294557000
St. Margaret's Bay	Ridge Powerhouse					110.02102919800	719.14545615500
St. Margaret's Bay	Sandy Lake Dam	Small	Concrete dam built on bedrock	Concrete Concrete	Yes	608.78436545500	10504.25552120000
St. Margaret's Bay	Sluiceway				Yes	39.85229255680	93.42052018990
St. Margaret's Bay	St. Margaret's Bay Pipeline					2197.24372095000	21572.32076940000
St. Margaret's Bay	St. Margaret's Bay Pipeline					3587.90700469000	35836.70019640000
St. Margaret's Bay	St. Margaret's Bay Tidewater Piepline					2173.55948966000	21335.70362710000
St. Margaret's Bay	Tidewater Powerhouse					100.29778158100	547.05079392000
St. Margaret's Bay	Wrights Dam	Small		Concrete & Earthfill	Yes	240.15571297100	1997.52761867000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Tusket	Canal Embankment	Small	Leave in place	Earthfill		353.44606657600	3133.68617378000
Tusket	Canal Embankment	Small	Leave in place	Earthfill		610.47111913900	5891.39311153000
Tusket	Carleton Dam	Small	Spillway constructed on bedrock	Concrete/Earthfill		830.83860218400	7681.02800053000
Tusket	Great Barren Dam	Small	Spillway constructed on bedrock	Concrete/Earthfill		214.80733758900	1745.10246458000
Tusket	Kempt Back Dam		Decommissioned			243.35294248500	3375.35150248000
Tusket	Main Dam	Small	Constructed on bedrock	Concrete/Earthfill		276.19527403700	2361.95709209000
Tusket	Mink Dam	Small	Constructed on bedrock	Rockfill/Timber Crib		174.39810392300	1351.91943352000
Tusket	Powerhouse Dam	Small		Concrete/Earthfill		231.25414767600	1919.32025432000
Tusket	Western Wing Dam	Small		Earthfill		156.26755772400	1160.79183348000
Wreck Cove	D1	Medium		Rockfill	Yes	1941.62761881000	81749.48008450000
Wreck Cove	D1 Spillway	Medium	Spillway on bedrock	Rockfill	Yes	1677.94434791000	28802.63475560000
Wreck Cove	D10	Medium		Earthfill		590.01352902500	16820.32620140000
Wreck Cove	D10	Medium		Earthfill		416.24878579700	5025.28419592000
Wreck Cove	D11-1	Medium		Rockfill		596.01528737400	16214.46325320000
Wreck Cove	D11-3	Small		Rockfill		1073.05819499000	10340.50343150000
Wreck Cove	D2	Medium	Spillway on bedrock	Earthfill		889.95358082900	28136.62753640000
Wreck Cove	D2 Spillway	Medium	Spillway on bedrock	Earthfill		600.59021065500	5718.15454477000
Wreck Cove	D3	Medium		Earthfill		1207.06203002000	39167.07418000000
Wreck Cove	D3	Medium		Earthfill		909.32185726300	11834.93439420000
Wreck Cove	D4	Large		Earthfill	Yes	1731.84465063000	69848.50827090000
Wreck Cove	D4 Spillway	Large	Spillway on bedrock	Earthfill	Yes	1522.78720210000	25458.79115100000
Wreck Cove	D5, D6	Medium		Earthfill		2698.08905543000	92348.44330210000
Wreck Cove	D5, D6	Medium		Earthfill		2458.63373929000	27768.16374110000

System	Name	Classification	Foundation	Type	Cleared	Shape_Leng	Shape_Area
Wreck Cove	D7	Large		Rockfill	Yes	1109.88522898000	39824.39351470000
Wreck Cove	D7 Spillway	Large	Spillway on bedrock	Rockfill	Yes	891.87296410400	11616.39553490000
Wreck Cove	D8-1	Small		Earthfill		1250.52987188000	12105.27193650000
Wreck Cove	D8-2	Small		Earthfill		457.26083446400	4181.16793942000
Wreck Cove	D8-3	Small		Earthfill		442.83301890200	4028.33213134000
Wreck Cove	D8-4	Small		Earthfill		609.18584920800	5691.86053762000
Wreck Cove	D8-5	Small		Earthfill		921.04360424200	8828.85964479000
Wreck Cove	D8-6	Small		Earthfill		361.95485576900	3219.54924223000
Wreck Cove	D8-7	Small		Earthfill		258.82836385300	2188.27919773000
Wreck Cove	D9	Medium	Spillway on bedrock	Earthfill		673.30754827200	20033.70749930000
Wreck Cove	D9	Medium	Spillway on bedrock	Earthfill		484.03264399000	5918.94613114000
Wreck Cove	Gisborne Powerhouse					92.96372350870	503.55301375700
Wreck Cove	South Lake Dam	Small		Earthfill		191.29783572200	1529.65707687000
Wreck Cove	Wing Dam					363.94806662700	6960.89268214000

APPENDIX B – ARCHAEOLOGICAL EXPERIENCE

Stephen G. Garcin, MA, RPA, Principal and Senior Archaeologist

Stephen Garcin is a founding partner and senior manager at Boreas Heritage with over 15 years of experience as a consulting archaeologist. Stephen holds a Bachelor of Arts degree in Anthropology from the University of Waterloo (2002) and a Master of Arts degree in anthropology from the University of Alberta (2006). His research interests include indigenous archaeology and the application of GIS, geophysics, and unmanned aerial vehicle operation (drones) in archaeological investigations. Stephen is keen to keep us on the cutting edge of geoscience technological advances and their application within consulting archaeology.

Stephen has held permits for archaeological assessments in urban and remote contexts throughout Atlantic Canada, Alberta and Saskatchewan. He has worked for a range of clients including residential developers, government (First Nation, federal, provincial and municipal), and industry (forestry, mining, petroleum, transportation, utilities and wind power). Stephen's professional experience includes designing heritage management plans for forestry operations in northern Alberta, and supervising archaeological assessments for multi-year hydro-power infrastructure renewal projects in southwest Nova Scotia.

Sara J. Beanlands, MA, Principal and Senior Archaeologist

Sara Beanlands is a founding partner of Boreas Heritage Consulting Inc. Over the past 25 years, Sara has undertaken a wide range of historical research and held archaeological assessment permits throughout Atlantic Canada. Before becoming a principal and senior archaeologist with Boreas Heritage in 2013, she completed a bachelor's degree (honours) in history and anthropology at Dalhousie University (1998) and a master's degree in history at Saint Mary's University (2010). Having twice served as President of the Nova Scotia Archaeology Society, she is currently an adjunct professor in the Department of Anthropology at Saint Mary's University, and President of the Royal Nova Scotia Historical Society.