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GEOLOGICAL SURVEY OF CANADA
OPEN FILE 9246

Stream water geochemical data from central Nova Scotia (NTS 11-D, E, 21-A and H)

J. Zhang, P. Pelchat, G.E.M. Hall, M.B. McClenaghan, and J.A. Kidder

2025

Canada

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ABSTRACT

This Open File (OF) presents the analytical results from stream water samples collected during a reconnaissance-scale biogeochemical and hydrogeochemical survey in central Nova Scotia, Canada, in 1994. Led by C.E. Dunn and G.E.M. Hall of the Geological Survey of Canada (GSC), the water survey resulted in approximately 846 stream water samples collected from approximately 732 locations within a 5,600 km^2 area of central Nova Scotia. Simultaneous with the primary survey, a time study was conducted to determine the region's temporal variation in stream water chemistry. The samples underwent analysis for 48 trace and major elements, seven major anions, total organic carbon, pH, conductivity, and alkalinity (as $CaCO_3$). This report provides complementary data to C.E. Dunn's biogeochemical data published in GSC Open File 3221. This data release includes two versions of the dataset: a 'clean' version, which did not contain the data for quality assurance/quality control reference materials for user convenience and a 'restored' version that closely resembles the original raw data, reporting the control and reference materials in the sequence they were analysed. Furthermore, this report includes comprehensive documentation of the data recovery methodology to promote data transparency. This level of detail is intended to highlight the significance of data rescue initiatives, thereby contributing to the broader efforts to restore, preserve and promote scientific data quality essential for future research.

INTRODUCTION

This OF reports the hydrogeochemical data for stream water collected from central Nova Scotia in May 1994 by GSC–Ottawa under the supervision of G.E.M. Hall. The survey was part of a reconnaissance-scale biogeochemical and hydrogeochemical survey led by C.E. Dunn and G.E.M. Hall in four weeks, starting mid-May 1994 as part of the Canada–Nova Scotia Co-operation Agreement on Mineral Development (1992 – 1995). Previously, this dataset was taken to an advanced processing stage but has never been formally published by the GSC. The survey resulted in approximately 846 water samples, collected in 250 mL High-density polyethylene (HDPE) Nalgene bottles (two bottles per site) from approximately 732 locations within a 5600 km^2 area of central Nova Scotia, Canada, shown in Figures 1 and 2.

In addition to the main survey, a time study was conducted to determine the hydrogeochemical variation in the area over the sampling time. The time study resulted in 27 samples denoted by "TS" in the "sam_type" column. Unfortunately, the exact coordinates for these samples could not be recovered.

The entire water (main study + time study) dataset was initially taken to an advanced processing stage internally at the GSC but has never been formally published. This report will provide hydrogeochemical information in two versions, complementary to the biogeochemical dataset released in the GSC OF 3221 published by C.E. Dunn. The first, the 'clean' version, reports the dataset without the quality assurance/quality controls (QA/QC) and reference materials for ease of use for end users. The second version, 'restored', is the dataset that has been restored to resemble the original raw data as closely as possible, reporting routine QA/QC materials in the sequence they were analysed. This report contains the QA/QC data for the inductively coupled plasma mass spectrometry (ICP–MS), ICP-MS-hydride generation, inductively coupled plasma atomic emission spectrometry (ICP–AES), atomic

absorption spectroscopy (AAS), total organic carbon (TOC), ion chromatography (IC), pH, and conductivity. The current version of this report does not include the QA/QC data for alkalinity measurements.

In addition to publishing these scientific data for the first time, this report addresses critical challenges in data recovery, curation and archival practices (Chamberlain et al., 2021; Fallas et al., 2015; Griffin, 2015; Mayernik et al., 2020; Wyborn et al., 2015) as part of the GSC's ongoing geochemical data management practices (Adcock et al., 2013; Adcock and Spirito, 2024; Tremblay and Basso, 2021, 2022). Despite growing recognition of the importance of data recovery and curation, these practices have not been widely shared or systematically documented (Mayernik et al., 2020; Sorensen et al., 2023). This report serves as a starting effort to improve data recovery and archival practices, with the expectation that these practices will continue to evolve and progress with technological advancement and broader dissemination of methodologies. Furthermore, it serves as an example of how detailed documentation within the data recovery and curation process can enhance the reliability and reusability of scientific data, particularly in addressing challenges related to data quality that have been extensively discussed in the scientific literature (Lawrence et al., 2011; Pilowsky et al., 2024).

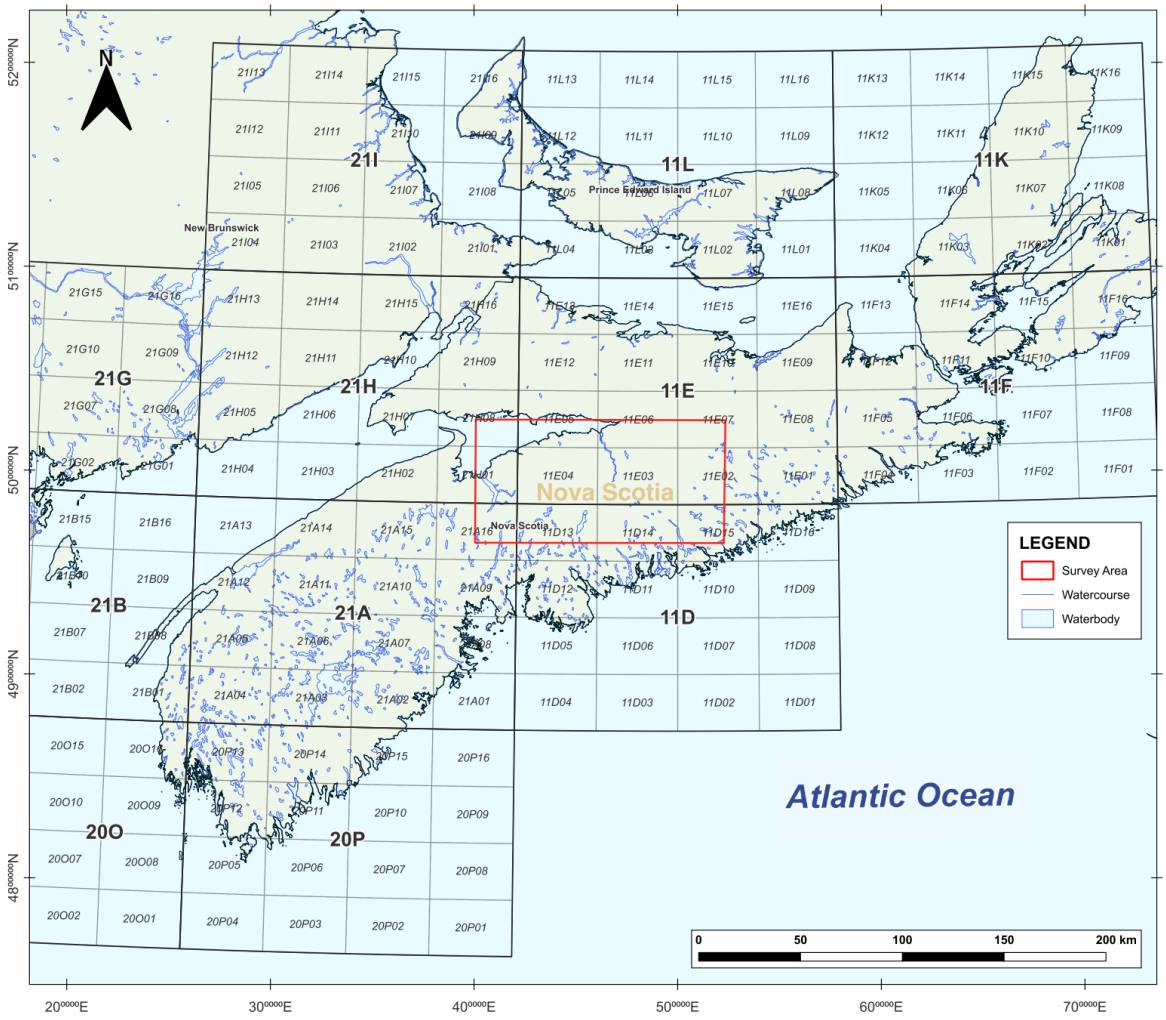

Figure 1: The survey area with respect to National Topographic System (NTS) map sheets. NTS map sheet and provincial boundary data were obtained from the Government of Canada's Open Government Portal.

CREDITS

Original 1994 GSC Field and Analytical Team

Survey design, direction and sampling methodology: G.E.M. Hall
Field party leader: G.E.M. Hall
Field party: P. James, K. Slough, assisted by T. Hearty, L. Young, W. Spirito, R.G. Balma, and P. Pelchat
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Sample preparation: P. Pelchat
ICP-MS analysis: J-C. Pelchat
ICP-AES analysis: P. Pelchat
ICP-MS – hydride generation analysis: J-C.Pelchat
AAS analysis: J. Vaive
IC analysis: C. Veys
TOC, alkalinity (as $CaCO_3$) measurements: G. Gauthier
Statistical analysis: R.G. Balma and W. Spirito

2025 Publication Team

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Reviewer: A. Voinot and G.E.M. Hall

SURVEY DESCRIPTION

LOCATION AND ACCESS

The four-week survey commenced mid-May in 1994 and covered approximately 5,600 km^2 of central Nova Scotia, Canada. The surveyed regions included parts of NTS map sheets 11D (Halifax), E (Truro), 21A (Annapolis Royal), and H (Amherst) in central Nova Scotia, consisting of approximately 735 sites shown in Figure 2. The survey area was accessed via roads and trails, with some helicopter support for remote areas.

BEDROCK GEOLOGY

The oldest rocks in the survey area are from the Late Neoproterozoic to Early Ordovician and are part of the Meguma Terrane. The Meguma Terrane, formed during the northern Appalachian orogeny, consists of the Goldenville and Halifax formations (Jackson et al., 2024). The Goldenville Group extends from the northern to the eastern parts of Halifax and is characterised by thickly embedded metasandstone (Horne and Macdonald, 1998; White et al., 2008). Detrital zircon and trace fossils suggest that this formation dates to the Early Cambrian, approximately 544 ± 18 Ma. (Jackson et al., 2024; Waldron et al., 2009; White et al., 2008). In contrast, the Halifax Group is subdivided into Beaverbank, Cunard and Bluestone formations, with varying proportions of metasiltstone and slate (White, 2010; White et al., 2008). The late syntectonic, granitic South Mountain Batholith in the southwest of the survey area gave rise to the deformation and metamorphism (regional greenschist to hornblende-hornfels facies) of the Meguma Terraneduring the Neoacadian Orogeny (ca. 406-388 Ma) (Jackson et al., 2024; White, 2010; White et al., 2008). After these regional metamorphism and deformation events, the central part of the Meguma Terrane was intruded by late Devonian peraluminous felsic to intermediate plutons from various sources (Jackson et al., 2024; Moran et al., 2007; White et al., 2008).

Following the formation of the Meguma Terrane, the late Devonian to early Carboniferous Horton Group was deposited. This group is notable for anomalous levels of uranium, radium and radon, characterised by clastic sedimentary rocks. Numerous uranium occurrences have been previously documented (Ryan and O'Beirne-Ryan, 2007, 2009). After the formation of the Horton Group, the carbonates and evaporites of the early Carboniferous Windsor Group, evaporites of the Canso Group and finally, the sandstones and shales of the Pictou Group (Scotch Village Formation) were deposited. Triassic sediments of the Fundy

Group can be seen in the north along the shores of the Bay of Fundy.

Central Nova Scotia, as illustrated in Figure 3, showcases a complex geological history marked by multiple phases of orogeny, sedimentation, and plutonism. Each distinct formation within the geological sequence contributes to understanding the region's evolution from the ancient Meguma Terrane to the more modern sedimentary deposits of the Carboniferous and Triassic periods. The complex interplay of these geological processes highlights the dynamic nature of the Earth's crust in this region.

MINERAL OCCURRENCES

Common mineral deposits and occurrences in the area include: massive barite (Felderhof, 1978); barite with sulphide mineralisation (Walton/ Magnet Cove barite–Pb–Zn–Cu–Ag deposit, Figure 3; Boyle, 1972; Boyle and Jambor, 1966; Boyle et al., 1976; Sangster et al., 1998); manganese occurrences in manganite-pyrolusite; iron occurrences in hematite-limonite; copper occurrences in sandstone, chalcopyrite–pyrite-malachite–atacamite; gypsum–anhydrite (Adams, 1991); and gold. In addition, Meguma rocks host numerous lode gold deposits with high-grade, narrow quartz veins (Sangster, 1990).

Table 1 summarises several metallic mineral occurrences reported in the survey area, and Figure 3 illustrates these occurrences and their associated stratigraphic unit (MacRae et al., 2024). Some of the gold occurrences reported in the area include Benvie Brook, Birch Bark Lake, Captain McPhee Brook, Gore, Little Nine Mile River, Middle Musquodoboit, and Roulston Corner. However, according to the Nova Scotia Mineral Occurrence Database (MODB), there is little or almost no information on these gold occurrences.

The earliest gold occurrence identified in the area is the Birth Bark Lark occurrence, first reported in an Open File in 1868 by H. How. The report indicated that a sample of gold was collected at Birth Bark Lake, Hants Country. However, the report did not specify the exact location of the gold-bearing sample. No further mineral exploration has been carried out since the first mention (O'Reilly, 1998).

The Gore Au Prospect, located in Hants County, was recorded next. It is about 400 m east of the road from Gore to Upper Rawdon, and about 800 m south of Gore. Although it has been recorded as an occurrence, no mineralisation was found at the site in 1941. Due to the pit that sunk before M. Goudge's visit following a field check-in in 1977 by NSDME, the area was deemed inaccessible (Feetham, 1996).

Next, the Benvie Brook occurrence was first identified on a geological map of Shubenacadie, Colchester, Halifax and Hants Counties produced by the GSC in 1959 (Stevenson, 1959a). Captain McPhee Brook and Roulston Corner occurrences were shown on a geological map of Kennetcook, Hants County, produced by I.M. Stevenson at the GSC (Stevenson, 1959b). Since their initial identification, no additional information has been available for these occurrences.

Finally, the most recent mentions of gold occurrences are the Little Nine Mile River and Middle Musquodoboit occurrences in Hants County. First noted in E.R. Faribault and H. Fletcher's geological map from 1993 (LeBlanc, 1993). No additional information has been found on the occurrence, according to the Nova Scotia MODB.

Additional details of these metallic mineral occurrences, along with non-metallic mineral occurrences, can be found on the Nova Scotia Mineral Occurrence Database website (https://gesner.novascotia.ca/modb/queryView/querysearch.aspx) or downloaded in various formats (KML, XLS, SHP and GDB) from the Provincial Nova Scotia Department of Resource and Renewable, Geoscience & Mines Branch website (https://novascotia.ca/natr/meb/download/gis-data-maps.asp).

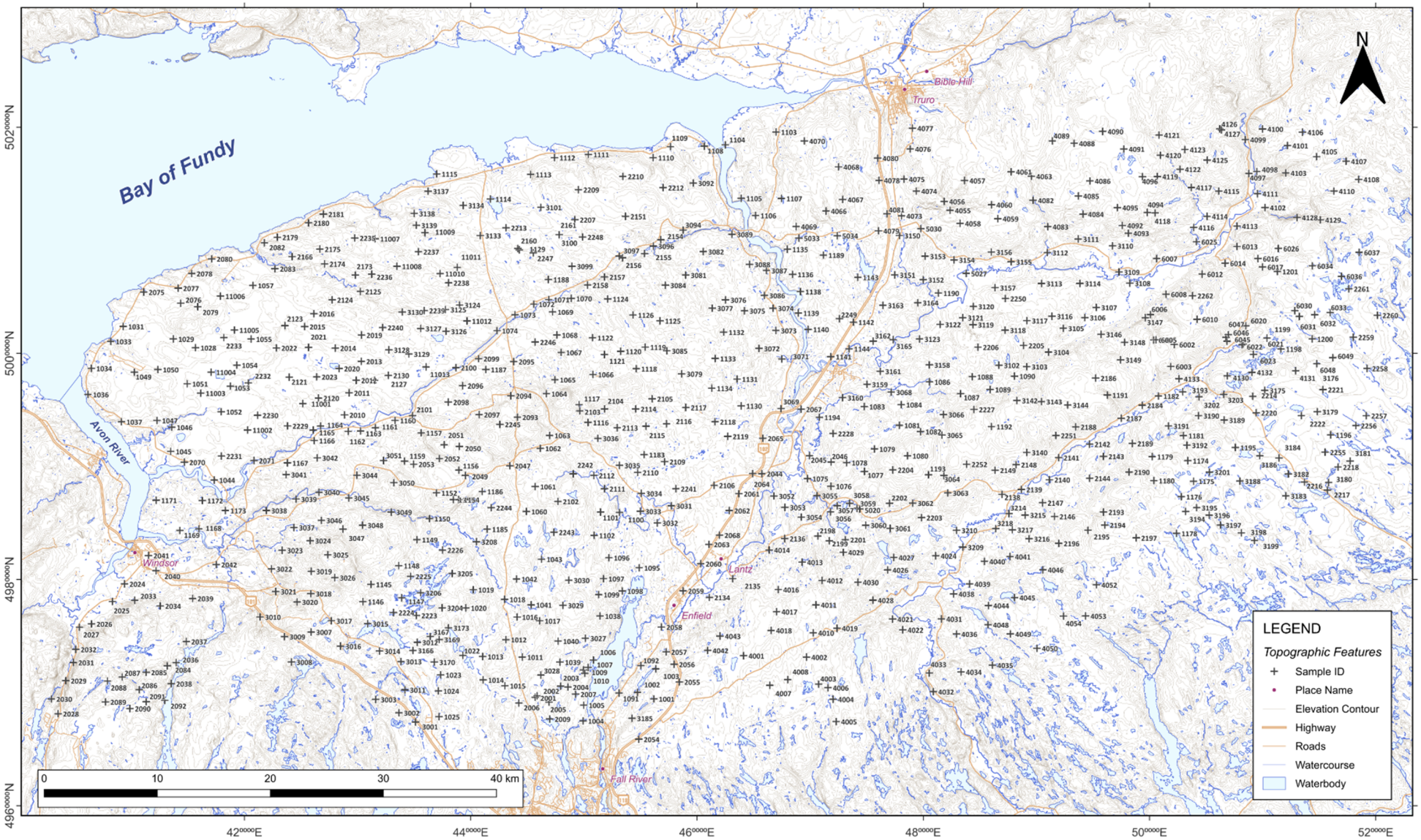
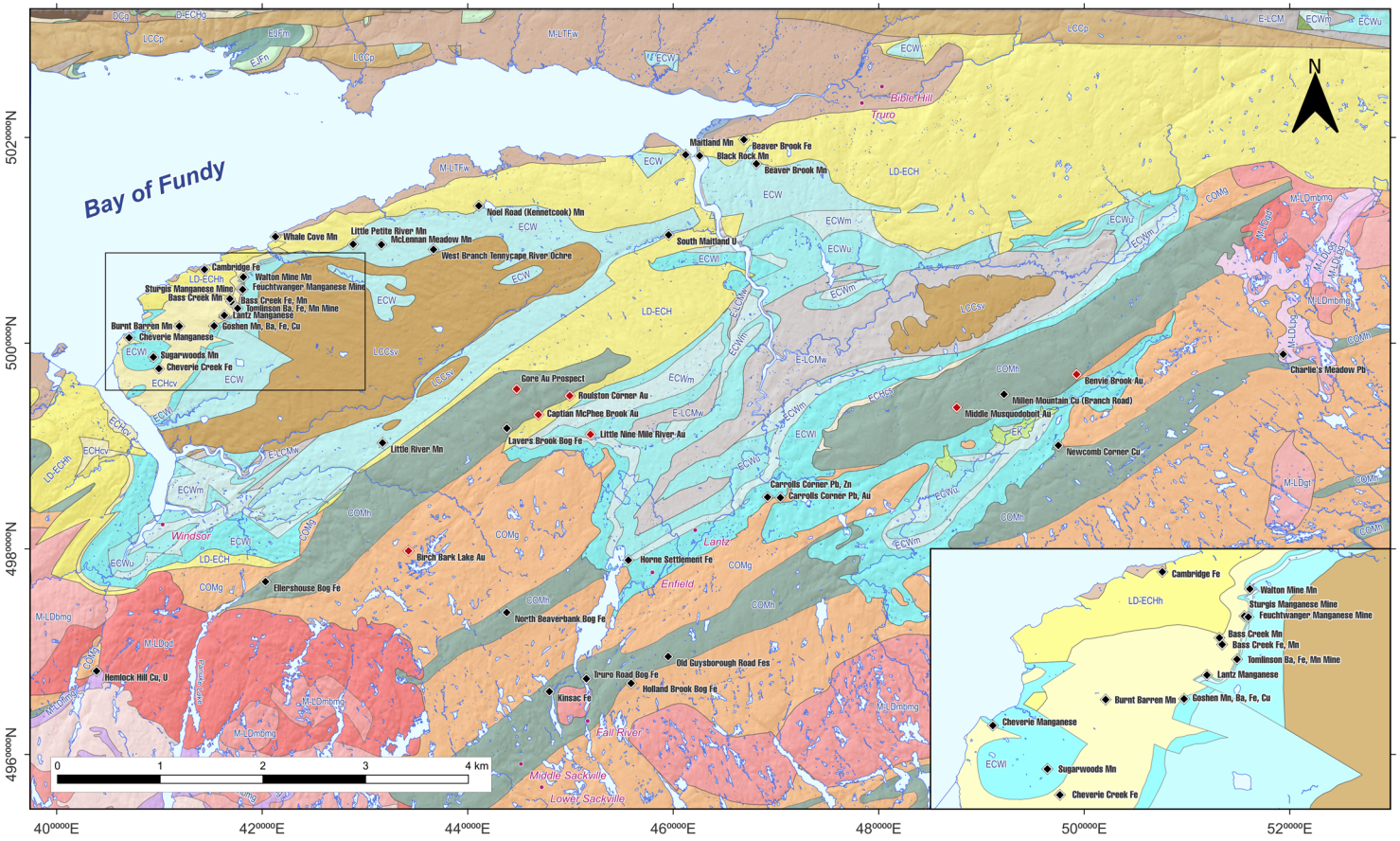


Figure 2: Sample locations and topography of the survey area. Topographic and hydrographic data is from the Government of Canada, Natural Resources Canada, Canvec (1:50,000 scale) and The Atlas of Canada, 2017 (1:1000,000 scale). The full resolution of this figure is included in Appendix C1.



LEGEND

Bedrock Geology

Early Cretaceous
- EK — Early Cretaceous units

Late Triassic - Early Jurassic
- LT-EJFb — Blomidon Formation

Early Jurassic
- EJFn — North Mountain Formation
- EJFm — McCoy Brook Formation

Middle - Late Triassic
- M-LTFw — Wolfville Formation

Early - Late Carboniferous
- E-LCM — Mabou Group
- E-LCMw — Watering Brook Formation

Late Carboniferous
- LCP — Pictou Group
- LCCp — Parrsboro Formation
- LCCsv — Scotch Village Formation

Early Carboniferous
- ECW — Windsor Group
- ECWu — Lime-Kiln Brook, Churchville and Hood Island Formations
- ECWm — Pugwash Mine, Forbes Lake,Addington, Wallace Brook and Lakevale Formations
- ECWi — Bridgeville, Holmes Brook, Hartshorn, Gays River and Macumber Formations
- ECHcs — Coldstream Formation
- ECHcv — Cheverie Formation

Late Devonian - Early Carboniferous
- LD-ECH — Horton Bluff Formation
- LD-ECHh — Horton Group

Devonian - Carboniferous
- DCg — Devonian - Carboniferous granite
- GKF — Fountain Lake Group

Devonian - Early Carboniferous
- D-ECHg — Greville River Formation

Middle - Late Devonian
- M-LDLog — Liscomb Complex: Orthogneiss
- M-LDLpg — Liscomb Complex: Paragneiss
- M-LDmbmg — Middle - Late Devonian muscovite biotite monzogranite
- M-LDlmg — Middle - Late Devonian leucomonzogranite
- M-LDgd — Middle - Late Devonian granodiorite
- M-LDgt — Middle - Late Devonian granitoid
- M-LDftmg — Middle - Late Devonian fine-grained leucomonzogranite
- M-LDdg — Middle - Late Devonian diorite - grabbro
- M-LDbmg — Middle - Late Devonian biotite monzogranite

Cambrian - Ordovician
- COMh — Halifax Formation
- COMg — Goldenville Formation

Neoproterozoic
- JJ — Cranberry Lake, Humming Brook and Gilbert Hills Formations
- 3GG — Georgeville Group

Topographic Features
- Gold Occurrence
- Metallic Mineral Occurrence
- Place Name
- Watercourse
- Waterbody

Basemap: ESRI Shaded Relief
Topographic and hydrological data: CanVec, 2023 and Atlas of Canada 1:1,000,000, 2017 - Natural Resources Canada
Projection: ESPG: 22620 - NAD83 (CSRS)v6 / UTM Zone 20

Figure 3. Bedrock geology of central Nova Scotia, Canada and known metallic mineral occurrences within the survey area. The inset map is a 1:120,000 representation of the mineral occurrences within the black box outlined on the main map. The full resolution of this figure is included in Appendix C2.

Table 1: List of metallic minerals occurrences within the survey area

Occurrence Number	Mineral Occurrence Name and Primary Commodity	Mineralisation	Commodity List
H01-007	Bass Creek Fe, Mn	manganese oxide, Iron Oxide	Fe, Mn
H01-018	Bass Creek Mn	bog manganese	Mn
E06-009	Beaver Brook Fe	unknown	Fe
E06-019	Beaver Brook Mn	unknown	Mn
E03-001	Benvie Brook Au	gold	Au
D13-022	Birch Bark Lake Au	native gold	Au
E06-014	Black Rock Mn	manganite, limonite, hematite, hausmannite, pyrolusite, calcite	Mn, Fe
H01-020	Burnt Barren Mn	bog manganese	Mn
H01-006	Cambridge Fe	Iron Oxide	Fe
E04-003	Captain McPhee Brook Au	gold	Au
E03-019	Carrolls Corner Pb, Au	galena, pyrite, native gold	Pb, Fe, Au
E03-015	Carrolls Corner Pb, Zn	galena, sphalerite	Pb, Zn
E02-014	Charlie's Meadow (Moose Lake) Pb	galena, pyrite	Pb
H01-004	Cheverie Creek Fe	Iron Oxide	Fe
H01-026	Cheverie Manganese	manganite, pyrolusite, psilomelane, siderite, hematite	Mn, Fe
A16-005	Ellershouse Bog Iron	Iron Oxide, Bog iron	Fe
H01-016	Feuchtwanger Manganese Mine	limonite, manganite, pyrolusite, Gypsum, barite	Mn, Ba, Fe
E04-008	Gore Au Prospect	gold	Au
H01-002	Goshen Mn, Ba, Fe, Cu	barite, chalcopyrite, hematite, limonite, manganite, marcasite, pyrite, pyrolusite, siderite	Ba, Cu, Fe, Mn
A16-035	Hemlock Hill Cu, U	autunite, torbernite	Cu, U
D13-014	Holland Brook Bog Fe	Bog iron, limonite	Fe
D13-016	Horne Settlement Fe	Fe-oxide	Fe
D13-015	Kinsac Fe	pyrite	Fe
H01-019	Lantz Manganese	pyrolusite, siderite	Mn, Fe
E04-012	Lavers Brook Bog Iron	Bog iron	Fe
E04-010	Little Nine Mile River Au	native gold	Au
E04-021	Little Petite River Mn	manganese oxide	Mn
E04-022	Little River Mn	manganese oxide	Mn
E06-023	Maitland Mn	unknown	Mn
E04-018	McLennan Meadow Mn	bog manganese	Mn
E03-020	Middle Musquodoboit Au	native gold	Au
E03-092	Millen Mountain Cu (Branch Road)	chalcocite, malachite	Cu, Ag
E03-016	Newcomb Corner Cu	pyrite, chalcopyrite, bornite	Fe, Cu
E05-028	Noel Road (Kennetcook) Mn	pyrolusite	Mn

Occurrence Number	Mineral Occurrence Name and Primary Commodity	Mineralisation	Commodity List
D13-017	North Beaverbank Bog Fe	Bog iron	Fe
D13-012	Old Guysborough Road Fe	Bog iron, limonite, ochre	Fe
E04-004	Roulston Corner Au	native gold	Au
E04-023	South Maitland U	autunite	U
E05-025	South Maitland U	unknown	U
E06-025	South Maitland U	unknown	U
H01-017	Sturgis Manganese Mine	limonite, pyrolusite	Mn
H01-021	Sugarwoods Mn	bog manganese	Mn
H01-001	Tomlinson Ba, Fe, Mn Mine	barite, limonite, pyrolusite, siderite	Ba, Fe, Mn
D13-013	Truro Road Bog Fe	ochre, Bog iron, limonite	Fe
H01-015	Walton Mine Mn	pyrolusite, limonite, manganese oxide	Mn
E04-011	West Branch Tennycape River Ochre	ochre, iron oxide	Fe
H01-009	Whale Cove Mn	barite, manganese oxide	Mn, Ba

Mineral occurrence data was obtained from the Nova Scotia Mineral Occurrence Database (MacRae et al., 2024).

SURFICIAL GEOLOGY

The surficial geology of the study area is the product of extensive glaciations throughout late Wisconsin, with the varying thickness of the glacial cover ranging from less than 2 to more than 15 m. The current knowledge of the glacial history of north-central Nova Scotia is largely derived from previous regional-scale (1:100,000) surficial mapping and till sampling conducted by Stea and Fowler (1979, 1981), Stea and Finck (1988) and Stea and Kennedy (1998) in combination with stratigraphic studies (Stea et al., 1988, 1989, 2011). North-central Nova Scotia is in the Hants-Colchester Lowlands (Goldthwait, 1924). In the Shubenacadie area (the east part of the study area), topography is controlled by bedrock geology.

More resistant Meguma rocks underlie Northeast trending bedrock highlands and stand 150 m above the valleys of Stewiacke and Musquodoboit rivers. On the highlands, till is thin (<2 m) and locally derived (Stea and Kennedy, 1998). The intervening Musquodoboit, Shubenacadie and Stewiacke River valleys are underlain by softer Carboniferous rocks and, in places, Cretaceous sediments. Here, the terrain is flat; glacial sediments are thick (>15 m) and often consist of more than one till sheet (Stea and Kennedy, 1998). The west part of the study area (Walton-Cheverie area) is relatively flat terrain, generally 60 m above sea level. The area is bounded to the south by the Rawdon Hills, which rises 150 m above the Kennetcook River valley. Large areas of low-lying, poorly drained terrain occur along the north side of the Kennetcook River.

In most places, till is relatively thick (> 5m), the dominant surficial sediment across the region. Bedrock outcrops are scarce except in the southern parts of the area around Long Lake and Enfield. Sorted sands and gravel occur in narrow linear features such as eskers or alluvial deposits along river valleys (Stea et al., 1992).

Soils developed on till are commonly reddish-brown and sandy to clay-rich (MacDougall and Nowland, 1972), depending on the texture of the local till. The study area is within the Acadian Forest region of eastern Canada. The eco-district contains coniferous black and red spruce forests, white pine, pine and hemlock, and earlier successional white birch, red maple, and aspen species. On the better-drained hills, forests consist

of mixed Acadian Forest species of yellow birch, red spruce, hemlock, beech, and sugar maple (Nova Scotia Department of Natural Resources, 2015).

PREVIOUS GEOCHEMICAL SURVEYS

A wide range of geochemical surveys has been undertaken within the current study area in central Nova Scotia. These surveys include stream sediment, lake sediment, till, groundwater, vegetation, and soil, summarised in Table 2 and illustrated in Figure 4.

Stream Sediment Survey of Northern Mainland Nova Scotia 1957 - 1958

One of the earliest regional scale geochemical surveys for southwestern Nova Scotia began in 1956, conducted by the GSC and led by R.W. Boyle (Boyle et al., 1958). From 1957 to 1958, R.H.C. Holman took over the project and expanded the survey scope to the northern mainland of Nova Sco-

Table 2: Summary of previous geochemical surveys in central Nova Scotia, Canada

Year	Type	Name	Organisation	Reference
1957	Stream Sediment	Stream sediment survey, NTS 11D, E, F, 21H, northern mainland Nova Scotia, 1957-1958.	GSC	Holman, 1963a
1977-1978	Lake Sediment	Regional Lake Sediment Geochemical Survey over Southern Nova Scotia	NSGMB	Rogers and Lombard, 1990
1978	Till	Till sampling survey, NTS 21A, H and 11D, E in central Nova Scotia, 1978	NSGMB	Stea and Fowler, 1979
~1979	Till	Till sampling survey, NTS 11D, E, F, eastern Nova Scotia	NSGMB	Stea and Fowler, 1979
1982	Stream Sediment	Stream sediment and water survey, NTS 11, 21A, H, mainland Nova Scotia and Cape Breton Island, 1982-1983.	NSGMB	Rogers and Macdonald, 1984
1975	Well Water	Groundwater sampling survey, NTS 11E, L and 21H, I, eastern Canada, 1975.	GSC	Dyck et al., 1976a
1994	Vegetation	Reconnaissance biogeochemical survey central Nova Scotia (Parts of NTS 11D, E and 21A, H)	GSC	Dunn and Spirito, 1996
2007	Soil	NASGL soil survey, provinces of New Brunswick, Nova Scotia and Prince Edward Island, 2007.	GSC	Friske et al., 2014
2008	Soil	NASGL soil survey, provinces of NL, NB, NS, QC, ON, MB, SK, AB, BC, 2008-2009.	GSC	Friske et al., 2014

NSGMB − Nova Scotia Geoscience and Mines Branch
GSC − Geological Survey of Canada
NASGL − North American Soil Geochemical Landscapes

tia. The geochemical survey of copper, lead and zinc covered approximately 10,000 mi^2 within the mainland of Nova Scotia, northeast of a line drawn between Halifax and Windsor. It resulted in approximately 4,400 stream sediment samples. These samples were taken from streams intersecting with highways, secondary roads and rough tracks. To avoid contamination, the 340 g grab samples of silt-sand materials from stream beds were taken well upstream from roads. Samples were then placed in a paper envelope protected by a polyethene bag. Subsequently, some samples were sieved through an 80-mesh nylon screen after being dried at the base camp. The fine fraction was sent to the geochemical laboratory at GSC–Ottawa to determine the total metal concentration of all three metals by M.A. Gilbert using the technique described by Gilbert in 1959. For analysis of the readily-soluble

concentrations of Zn, Pb and Cu, the unsieved (whilst wet) portion of the samples were dissolved using a modified colourimetric dithizone technique (Holman, 1963b) adapted from Bloom (1955) for all three metals and a specific test for Cu developed by Holman, 1956. Finally, a coarser fraction was retained for reference materials. Geochemical maps for concentrations of Cu, Pb, Zn and total metals were published as a result of this survey (Holman, 1963a).

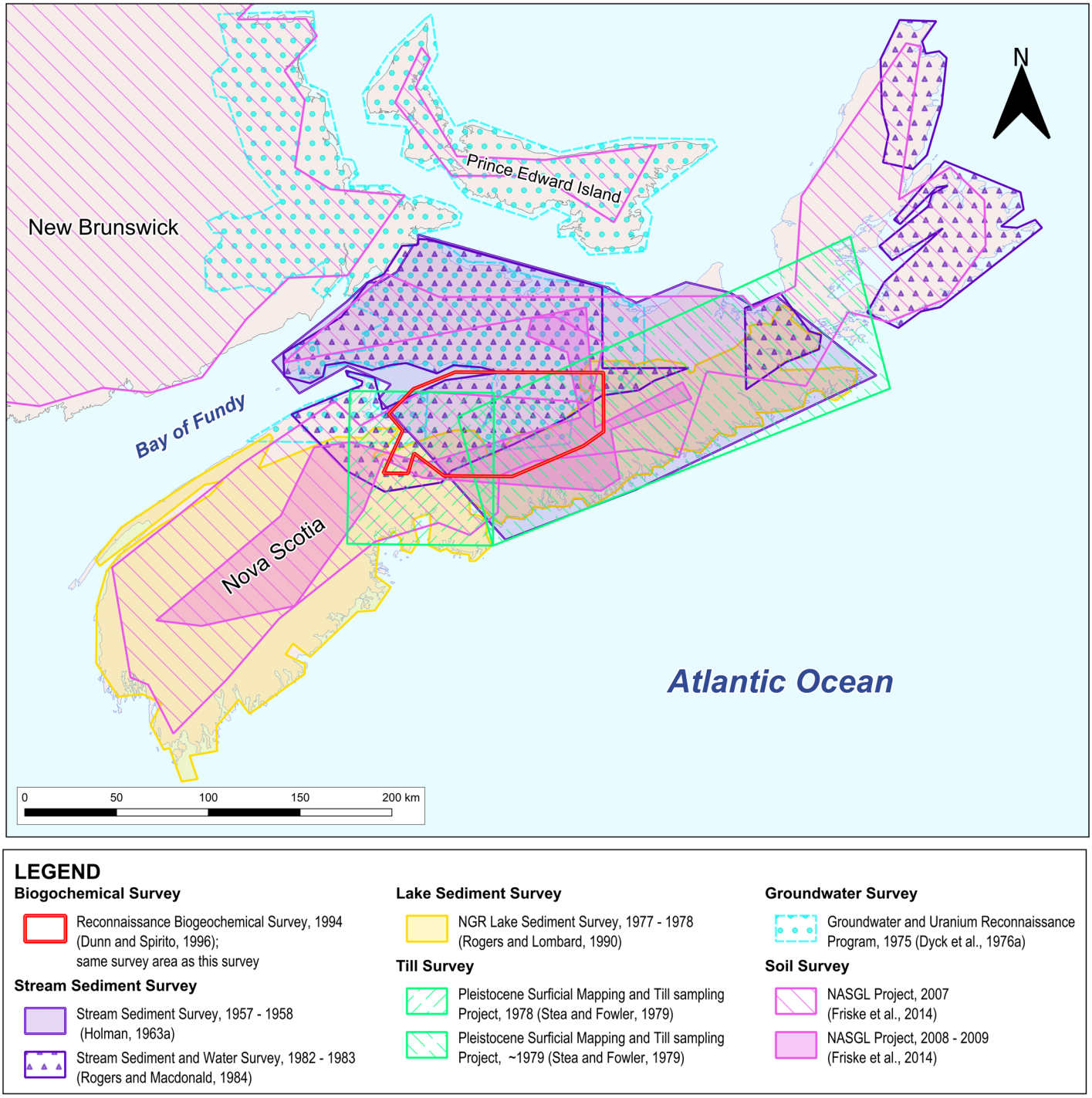


Figure 4: Previous geochemical surveys relative to the survey area. The biogeochemical and stream water survey area is outlined in red. Previous surveys are grouped by various media, sharing the same colour in symbology. The basemap is generated from the Atlas of Canada, 2017 (scale 1:1,000,0000), polygon shapefiles and sample location data are obtained

from the CDoGS database as a kml file, NGR Lake sediment data was obtained from the Nova Scotia Department of Natural Resources (DP ME 132, v2). Map projection in ESPG 22620: NAD83 (CSRS)v6 / UTM Zone 20.

Regional Lake Sediment Geochemical Survey over Southern Nova Scotia, 1977 – 1978

From 1977 to 1978, the Provincial Nova Scotia Department of Mines and Energy (NSDME) conducted a regional lake sediment geochemical survey in the Meguma Terrane over southern Nova Scotia, Canada. The survey was conducted as part of the National Geochemical Reconnaissance (NGR) program of the GSC (Friske and Hornbrook, 1991), funded by the Canada Department of Regional Economic Expansion – Nova Scotia (DREE–NS) Mineral Development Agreement (1975 – 1980). The two-year survey collected approximately 4,000 samples over 27,000 km^2 with an average sampling density of one sample per 7.9 km^2 gathered from the Meguma terrain of southern Nova Scotia. Samples were located using a two-square-mile grid; the sediment samples were collected from the centre of the lakes using a float-equipped helicopter (Bell 206 Jet Ranger) to represent the total drainage system. Field cards by Garret (1974) were used during flight, recording details such as water depth, composition, colour, suspended matter and basin area (Richardson and Bingley, 1979). The samples were sent to the Technical University of Nova Scotia, Halifax, for sample preparation and analysis. Samples dried at 80 °C in an oven, disaggregated via a mortar and pestle or using a steel shatter box for 30 seconds. (Rogers and Lombard, 1990). Without sieving, the samples were analysed for Cu, Pb, Zn, Ni, Co, Fe, Mn, Ca, Mg, Mo, Ag, Cd, Hg, As, U and loss on ignition (LOI) (Bingley and Richardson, 1978; Richardson and Bingley, 1980). Elements including Cu, Pb, Zn, Ni, Co, Fe, Mn, Hg, Ag, and Cd were measured by AAS; Ca, Mg, and Mo were analysed as oxides by X-ray fluorescence (XRF). As was analysed using Colourimetric (Gitzeit), F was measured using ion selective electrode, and U was analysed using Fluorimetry with a turner fluorometer (Lund, 1987). The written record for the analytical method for U and F varied based on various documents from various sources (Lund, 1987; Rogers and Lombard, 1990; Nova Scotia Department of Natural Resources, 2006). All the elements were published as maps except Ag, Cd, and LOI, which yielded low values (Lund, 1987; Nova Scotia Department of Natural Resources, 2006).

In the following years, approximately 3,400 archived samples were re-analysed for As, Ag, Cu, Pb, Zn, Th, Ti, Sb, Sn, Zr, Nb, Au, W, Rb, Li and F in 1984 (Rogers et al., 1985; Rogers and Lombard, 1990). Cu, Pb, Zn, Ag, and Li were determined using AAS, while F concentrations were measured with a specific ion electrode. Both methods employed total dissolution using hydrofluoric, perchloric, and nitric acids. Nb, Rb, Sn, Zr, and Ti were analysed using XRF and Th, Sb, As, W, and Au were measured via instrumental neutron activation analysis (INAA) (Rogers and MacDonald, 1985; Rogers et al., 1985). Samples were submitted to Bondar-Clegg and Company Ltd. in Ottawa for analysis, and the project was funded by the Canada – Nova Scotia Mineral Development Agreement 1984 – 1989 (Rogers et al., 1985; Rogers, 1989).

Pleistocene Surficial Mapping and Till Sampling Project, 1978 – 1978

Between 1978 and 1979, R.R. Stea, from NSDME, carried out three surveys over Nova Scotia, Canada, for surficial mapping. The central Nova Scotia survey resulted in more than 480 till samples and one map, where the analytical data are published as part of the map. Three till types (Lawrencetown and East Milford till, granite till and quartzite and slate tills) were analysed for Cu, Ni, Pb, Zn, Co, Fe%, Mn, Ca, Mg, Mo, Hg, U, As, Sn and W. All the elements except for Sn and W were analysed using (< 2μm) clay fraction while, Sn and W were analysed from heavy mineral separates

(tetrabromoethane, specific gravity = 2.96) of fine to medium sand fractions (-50 + 230 mesh) from the till sample (Stea and Fowler 1981). The general analytical procedure follows Stea and Fowler (1979).

In 1979, a report containing three maps was published by NSDME containing data from over 1400 samples collected in the Eastern Shore region of Nova Scotia, Canada, as part of a joint project with the Canada DREE–NS; the exact survey year is unknown. Fifteen elements, including Cu, Pb, Zn, Ni, Co, Fe, Mn, Mg, Ca, Hg, As, Mo, Ag, Cd, and U. The tills within the survey area consist of two basic types: widespread, oligomictic, locally derived sandy till sheet and polymictic, red clay Lawrencetown till comprising the bulk of drumlins in the region and partly derived from the northern region. Most samples were collected from the weathered zone (<2 m) of the surface outcropping tills. Then, the clay size (<2μm) fraction was isolated and analysed at the Laboratory for the Investigation of Minerals, Nova Scotia Technical College, Halifax, Nova Scotia, using AAS (Jarrel Ash Model 810 A.A. unit) for measuring the concentration of Cu, Pb, Zn, Ni, Mo, Fe, Mn, Cd, Ag, Co, Ca and Mg in samples. Arsenic concentration was determined by electrophotometry (Fisher Electrophotometer II unit), U was detected by fluorometry (Model III Fluormeter), and Hg concentration was determined by the Cold Vapor Atomic Absorption Spectroscopy with a Perkin-Elmer Coleman 50 Analyses System (Stea and Fowler, 1979).

Stream Sediment and Water Survey of Mainland Nova Scotia and Cape Breton Island, 1982 – 1983

A regional stream sediment survey was conducted throughout northern mainland Nova Scotia and eastern Cape Breton Island from 1982 to 1983. This project aimed to complete the coverage of stream sediment sampling in the 1970s. This project also adopted two changes to the previous project. Sample spacing was increased to ~2 km intervals, and samples were preconcentrated by wet sieving 1 mm nylon screen during collection. This survey resulted in approximately 4,100 samples covering an area of 10,000 km^2. Samples were wet-sieved through a 1–mm nylon screen on site before being placed in a Kraft paper bag and air-dried. Each analytical batch of 20 contained one standard, one field duplicate pair and a blind duplicate pair (Garret et al., 1980). The sediment samples were dry-sieved to collect the -80 mesh materials and sent to the commercial laboratory for analysis via AAS using partial extraction by $HCl–HNO_3$ and ICP–AES using total extraction by $HF–HClO_4$ (Rogers and Macdonald, 1984).

Groundwater Sampling Survey and Provincial Uranium Reconnaissance Program, 1975 - 1976

Dyck, W. lead the groundwater geochemical survey from 1975 to 1976 over southeastern New Brunswick, western Nova Scotia and Prince Edward Island, Canada. The Uranium Reconnaissance Program sampled well waters to determine the effectiveness of geochemistry in uranium delineation and characterising the hydrogeochemistry of regions. Overall, 1,721 wells were sampled at a density of one sample per 13 km^2. More specifically, 115 wells over 1,560 km^2 were sampled in Wolfville. Three water bottles were collected at each well and sent to three analytical laboratories. Duplicate sets of samples were taken at approximately every 30 sites. Three sites were sampled twice a week throughout the sampling season to determine seasonal variations and analytical errors.

A 284 mL glass bottle containing an unacidified water sample was transported to the field laboratory at the Department of Geology, Mount Allison University, Sackville, New Brunswick. The sample underwent analysis using

the following methods: radon concentration was measured with an EDA Electronics radon counter (RD–200); conductivity with a Yellow Springs Instrument (YSI) conductivity meter (Model 33); dissolved oxygen with Beckman and YSI meters; Eh (redox potential) with an Orion specific ion analyser (Model 407) attached to electrodes; pH with a Beckman electrode connected to a GSC pH meter; and total alkalinity (as $CaCO_3$) via potentiometric titration. Uranium and fluoride concentrations were measured within one to three days using fluorometry (Galvanek-Morrison fluorometer) and an ion-selective electrode method with the Orion specific ion meter (Model 407) (Dyck et al., 1976a).

A second sample, also collected in a 284 mL glass bottle, was acidified in the field with 0.5 mL of 15 M HNO_3. This sample was sent to the GSC laboratories to analyse H_2, CH_4, He, Zn, Cu, Pb, Mn, and Fe. Gaseous components (H_2, CH_4, He) were analysed using a mass spectrometry technique developed by Dyck et al. (1976b), while the metals were analysed via AAS using a Perkin Elmer 306 equipped with an automated data acquisition system developed by Bristow (1975).

The last unacidified sample in a 500 mL polyethylene bottle was sent to the Inland Water Directorate in Moncton, New Brunswick, for K^+, Cl^-, Ca^{2+}, SO_4^{2-} and NO_3^- determination which are detailed in the Analytical Methods Manual (Lively, et al., 2974). Potassium is analysed using a flame photometer, chloride by titration, calcium by AAS, sulfate by titration, and nitrate (including nitrite) by a colourimetric method (Dyck et al., 1976a).

Reconnaissance Biogeochemical Survey for Central Nova Scotia, 1994 - 1995

Between 1994 and 1995, C.E. Dunn (GSC–Ottawa) led the biogeochemical sampling, while G.E.M. Hall conducted hydrogeochemical sampling in central Nova Scotia (this study). For four weeks, balsam fir (*Abies balsamea*) twigs were collected in a heavy-duty brown paper bag and secured with masking tape from 925 sites within a 5,600 km^2 area, with an average sampling density of one site per 7 km^2. The twig samples were dried, separated and ashed to be analysed by INAA to determine a total of 36 elements, including As, Au, Ba, Br, Ca, Co, Cr, Cs, Fe, Hf, K, Rb, Na, Sb, Sc, Se, Sr, Th, U, W, Zn, La, Ce, Nd, Sm, Eu, Yb, Lu, Ag, Hg, Ir, Sn, Ta, Tb, Mo and Ni by Activation Laboratories Ltd. (Actlabs). In addition, 15 elements (Ag, Al, B, Be, Cd, Cu, Li, Mg, Mn, Mo, Ni, P, Pb, Sr and V) were analysed by ICP–AES by Acme Analytical Laboratories Ltd. (Dunn and Spirito, 1996). The OF report resulted in 28 geochemical maps. During the survey, samples of spruce bark were also collected; however, the data has never been officially published in a GSC report.

North American Soil Geochemical Landscapes Project 2007 - 2009

The North American Soil Geochemical Landscapes Project (NASGLP) took place in 2007 as part of the tri-national initiative between the United States, Canada, and Mexico. The project was a joint program by Natural Resources Canada – Geological Survey of Canada, United States Geological Survey (USGS), and Servicio Gologico Mexicano (SGM). Fifty-four sites were selected for soil sampling across Nova Scotia to analyse the geochemistry of the soils, radon, permeability, and *in-situ* gamma-ray spectroscopy. Twenty-one samples per site were collected according to the comprehensive soil sampling protocol from the GSC (Friske et al., 2010), which includes sampling at 0 - 5 cm depth and A, B, and C horizons at each site. Specifically for soil geochemistry, two size fractions <2 mm and <63 mm were dissolved and analysed via ICP–MS/AES (Friske et al., 2014). Approximately three sites were located within the central Nova Scotia stream water survey area.

Canada continued soil sampling nationwide until 2009, following the NASGLP project in 2007. The sampling transects followed the Trans-Canada highway extending from British Columbia to the Island of Newfoundland, with 15 sites in Nova Scotia. The sampling method followed the exact systematic sampling and analytical protocols established in 2007 for the project. The 2009 field season marked the end of the NASGLP project in Canada due to a change in GSC priorities (Friske et al., 2014; Kettles et al., 2008).

METHODS

SAMPLE COLLECTION

Stream water samples were collected from approximately 732 sites with an approximate average sample density of one site per 7 km^2. Generally, samples were collected at 2 km intervals along roads and drivable tracks, with some helicopter support used for access to remote areas.

The samples were located in the field using a combination of 1:50,000 NTS paper maps in the NAD27 datum and 1:10,000 LRIS (Land Registration Information Service) maps, which use the Nova Scotia modified transverse Mercator (MTM) projection in combination with the ATS77 datum, the precursor to NAD83. The NTS 1:50,000 maps use the NAD27 datum and Universal Transverse Mercator (UTM) projection. The UTM Eastings and Northings presented in the data are all in UTM Zone 20.

During the primary survey, multiple field collection teams participated in sample collection. C.E. Dunn led field teams that recorded field observations published as part of the GSC OF 3221 dataset (Dunn and Spirito, 1996). G.E.M. Hall led two field teams in collecting stream water samples. At each site, two bottles of stream water samples were collected by pre-rinsing the bottle twice and sampling approximately 1 m upstream. The samples were then taken by immersing 250 mL HDPE Nalgene bottles (Hall et al., 1996) near channel centres to ensure homogeneity. Two bottles were collected at every site, and field duplicates were taken at approximately every 10 sites (Hall et al., 1994) at selected sites and are denoted by "D2" within the sam_type column in the dataset. Within 24 hours of sample collection, the water samples were analysed for pH and filtered through a mixed cellulose ester (MCE) membrane (Millipore HAWP04700, 47 mm diameter, 0.45 µm pore size) with a vacuum pump attached to a dedicated glass filtering apparatus. One filtered sample was acidified with 2 mL of nano-pure HNO_3 to 0.4% HNO_3 (Finch et al., 1992). Both bottles were stored in a large opaque carrying case at room temperature to await further analysis at GSC Ottawa. A large aliquot of acidified reverse osmosis deionised water (RODI–H_2O) stored in multiple 10 L high-density polyethylene (HDPE) Carboy containers was brought to the field for the field blank. An aliquot was taken out and stored in a dedicated bottle for daily use, with any remaining amount disposed of at the end of the day. These blanks are denoted by "BK" in the sam_type column.

The time study was conducted over 27 days, with one sample being collected at similar times each day. A moderately fast-flowing stream of 2 – 3 m width was selected for the study (Hall et al., 1996). The original file (PH4015) noted that an unknown entity tempered with the site for TS-14. Thus, subsequent "TS" samples after TS-14 should be regarded with caution. The coordinates for the study could not be recovered.

SAMPLE ANALYSIS

The water samples were analysed for 48 elements by AAS, ICP–MS, ICP–AES, and ICP–MS–hydride generation at the GSC laboratories. Six anions were analysed using IC. Conductivity and pH were measured in the field and at the GSC Ottawa laboratories, along with total

organic carbon and alkalinity (as $CaCO_3$). The complete lists of elements and detection limits for both surveys are presented in Tables 3.1, 3.2, 3.3, 3.4 and 3.5 below. The analytical laboratories generally moved the control and reference materials to the end of the sequence during data processing.

Upon arrival at the GSC laboratory, unacidified samples were transferred to the fridge while the acidified samples were climatised to room temperature for analysis. The field blanks followed the same filtration and acidification protocol for processing stream water samples. The blanks (field and laboratory) and reference material standards (OTT-94, TAP-92, 1643c and SLRS-2) were inserted periodically throughout the analysis. Generally, a laboratory blank (RODI–H_2O) and OTT-94 standard were inserted at the end of every block of 50 samples, followed by several laboratory blanks (RODI−H_2O) and OTT-94 standards at the end of each batch of samples. The number and types of standard materials varied depending on the analytical method. The sequence was discovered based on the original printout from the analytical instruments. The official documentation for some of the standard reference materials was recovered and is provided in Appendix B1 and B2.

The following standard reference materials were deployed:

- **OTT-94**: An in-house reference standard consisting of filtered and acidified water from the Ottawa River collected on the north side of Bate Island Park, Ottawa, Ontario, Canada.

- **SLRS-2**: A standard reference material for riverine water containing trace metals developed by the National Research Council Canada (NRC) in 1991. The documentation is attached in Appendix B1.

- **1643c:** A standard reference material for trace elements in water by the National Institute of Standards & Technology (NIST).

- **TAP-92***:* An in-house reference standard of filtered and acidified City of Ottawa tap water collected at the GSC-Ottawa.

Concentrations of trace metals and metalloids were determined using ICP–MS analysis using a VG PlasmaQuad 2+ with Ni cones, a water-cooled Scott Double Pass Spray chamber and a concentric nebuliser. The protocol for correcting spectral interferences is detailed in previously published papers (Hall et al., 1995, 1996; Hall and Pelchat, 1997c). Hydride-forming elements and elemental Hg were analysed on the ICP−MS using an in-house

Table 3.1: Limit of detection for major elements analysed by ICP-AES, ICP-MS and AAS

Major Element	Analytical Method	Limit of Detection	Units
Magnesium (Mg)	AA	0.1	ppm
Aluminum (Al)	AES	40	ppb
	MS	2	ppb
Silicon (Si)	AES	20	ppb
Potassium (K)	AA	0.1	ppm
Calcium (Ca)	AA	0.1	ppm
Titanium (Ti)	MS	0.5	ppb
Iron (Fe)	AES	3.5	ppb
	MS	5	ppb

AES− Inductively coupled plasma−atomic emission spectroscopy
MS− Inductively coupled plasma−mass spectroscopy
AA− Atomic absorption spectroscopy

Table 3.2: Limit of detection for minor elements analysed by ICP-AES, ICP-MS and AAS`

Minor Element	Analytical Method	Limit of Detection	Units
Sodium (Na)	AA	0.1	ppm
Manganese (Mn)	AES	0.5	ppb
	MS	1	ppb
Chromium (Cr)	MS	0.1	ppb
Nickel (Ni)	MS	0.2	ppb
Copper (Cu)	MS	0.1	ppb
Zinc (Zn)	AES	5	ppb
	MS	0.5	ppb
Arsenic (As)	AA	0.1	ppb
	MS	0.1	ppb

AES− Inductively coupled plasma−atomic emission spectroscopy
MS− Inductively coupled plasma−mass spectroscopy
AAS− Atomic absorption spectroscopy

Table 3.3: Limit of detection for trace elements analysed by ICP-AES, ICP-MS, and ICP-MS-hydride generation

Trace Element	Analytical Method	Limit of Detection	Units
Lithium (Li)	MS	0.005	ppb
Beryllium (Be)	MS	0.005	ppb
Vanadium (V)	MS	0.1	ppb
Cobalt (Co)	MS	0.05	ppb
Selenium (Se)	HYD	0.006	ppb
	MS	1	ppb
Rubidium (Rb)	MS	0.05	ppb
Strontium (Sr)	MS	0.5	ppb
	AES	0.5	ppb
Yttrium (Y)	MS	0.01	ppb
Molybdenum (Mo)	MS	0.05	ppb
Silver (Ag)	MS	0.05	ppb
Cadmium (Cd)	MS	0.05	ppb
Indium (In)	MS	0.01	ppb
Antimony (Sb)	HYD	0.006	ppb
	MS	0.01	ppb
Tellurium (Te)	HYD	0.006	ppb
Barium (Ba)	AES	1	ppb
	MS	0.5	ppb
Lanthanum (La)	MS	0.01	ppb
Cerium (Ce)	MS	0.01	ppb
Praseodymium (Pr)	MS	0.005	ppb
Neodymium (Nd)	MS	0.005	ppb
Samarium (Sm)	MS	0.005	ppb
Europium (Eu)	MS	0.005	ppb
Gadolinium (Gd)	MS	0.005	ppb
Terbium (Tb)	MS	0.005	ppb
Dysprosium (Dy)	MS	0.005	ppb
Holmium (Ho)	MS	0.005	ppb
Erbium (Er)	MS	0.005	ppb
Thulium (Tm)	MS	0.005	ppb
Ytterbium (Yb)	MS	0.005	ppb
Lutetium (Lu)	MS	0.005	ppb
Mercury (Hg)	HYD	0.006	ppb
Thallium (Tl)	MS	0.005	ppb
Lead (Pb)	MS	0.1	ppb
Bismuth (Bi)	HYD	0.006	ppb
Uranium (U)	MS	0.005	ppb

AES– Inductively coupled plasma–atomic emission spectroscopy
MS– Inductively coupled plasma–mass spectroscopy
HYD– Inductively coupled plasma mass spectroscopy via hydride generation

Table 3.4: Limit of detection for anions analysed by Ion Chromatography

Anion	Analytical Method	Limit of Detection	Units
Nitrite (NO_2^-)	IC	50	ppm
Nitrate (NO_3^-)	IC	50	ppm
Fluorine (F^-)	IC	50	ppm
Phosphate (PO_4^{3-})	IC	50	ppm
Bromine (Br^-)	IC	50	ppm
Sulfate (SO_4^{2-})	IC	0.05	ppm
Chlorine (Cl^-)	IC	0.05	ppm

IC– Ion chromatography

Table 3.5: Limit of detection for water quality parameters

Water Parameter	Limit of Detection	Units
$pH_{(field)}$	0.01	-
$pH_{(lab)}$	0.01	-
TOC	1	ppm
Conductivity$_{(field)}$	2	µs/cm
Alkalinity$_{(calculated)}$	1	ppm $CaCO_3$
Alkalinity$_{(found)}$	1	ppm $CaCO_3$

TOC – Total organic carbon

hydride generator described in previously published reports (Hall and Pelchat, 1997a, 1997b).

The ICP–AES analysis used a Jobin-Yvon sequential Model 38 spectrometer with a Scott Double Pass Spray chamber and a concentric nebuliser. Background correction on one or both sides of the analyte peak was employed. Blank and the in-house reference standard OTT-94 were generally inserted within a block of fifty water samples. The AAS analysis of major and minor elements was carried out on a Perkin-Elmer Model 3030 spectrometer, using control and reference materials, including laboratory blanks and standards OTT-94 and SLRS-2 (National Research Council, 1990). A blank and OTT-94 standard was inserted at the end of every block of 50 samples.

The concentrations of anions were determined using ion chromatography for filtered,

non-acidified water (Cameron et al., 1995), and it was carried out on a Dionex 600 Chromatograph. A blank and four calibration standards were run at the beginning of the sequence. An in-house standard was inserted at approximately one every ten samples to monitor the instrument's drift using blanks, the OTT-94, and SLRS-2 standards according to the standard operating procedure for the Dionex 600, attached in Appendix B3. The Shimadzu TOC Model 5000 total organic carbon (TOC) instrument, based on combustion at 680 ºC and non-dispersive infrared detection, was used to determine total organic carbon content. Blank and OTT-94 standards were employed in the analysis. Alkalinity analysis was performed using a Man-Tech PC-Titrate™ system. Titration of the sample with 0.2 N Sulfuric acid to a pH endpoint of 4.5, giving Total Alkalinity expressed as mg $CaCO_3$/L.

Multiple field members determined stream water's physical conductivity and pH using a Corning portable pH meter. Laboratory conductivity and pH analyses were determined within 24 hours at the field camp using an Accumet AR50 dual-channel pH/ion/conductivity meter without temperature compensation because the samples acclimated at room temperature during storage.

DATA PROCESSING

Data Source and History

The stream water geochemical analyses were conducted in 1994, but the data were never published in a GSC report. The analysis was conducted by J.-C. Pelchat, P. Pelchat, G. Gauthier and J. Vaive in the Analytical Method Development Laboratory and C. Veys in the Analytical Chemistry Laboratory, both at GSC-Ottawa. Using two different GSC labs led to the dataset being fragmented across multiple sources. Thus, the dataset could not be compiled into a single table. Around 20 years ago, upon request, a version of the Nova Scotia stream water dataset containing the 1994 and 1995 data was available on the Canadian Database of Geochemical Surveys (CDoGS) website. The dataset published on the CDoGS website originated from the files provided by R.G. Balma.

Approximately 75+ files were discovered and examined during the data restoration project. These files and their sources are summarised in Table 4. The final version of the files selected for this compilation are highlighted in bold. The Quattro Pro files (WQ1) were converted to Microsoft® Excel format using Libre Office v.24.2.2. However, some database files were also found but could not be opened due to the versioning of Microsoft® Access not being backwards compatible.

Data Cleaning and Restoration

The nature of legacy datasets requires additional steps to ensure accuracy, validity, integrity, and completeness before the cleaning process. The initial phase of the restoration focused on assessing the dataset's completeness by cross-referencing multiple data sources and carefully examining any user-induced inconsistencies and errors. The detailed notes on each file discovered during this phase are summarised in Table 4. The number of samples, controls, reference material, and UTM coordinates were recorded to ensure data consistency across all files.

The second phase involves taking the most “complete” and “original” version of the file (primary dataset) and comparing it to another version of the same dataset to determine the original sequence of data. Before starting this process, it is vital to understand the original scientist's sample naming convention used during the analytical process to assign various sample types in the “sam_type” column summarised in Table 5.

The column “sample_ID” was created to assign a persistent identifier to each sample, including the QA/QC materials for each dataset.

Each analytical method is considered a separate dataset because the original data lacks unique identifiers, and varying types and quantities of QA/QC standards were used depending on the dataset. The column "site_ID_2" was created during the process to standardise the naming of site IDs. The original site IDs used by the scientist are preserved in the column "site_ID".

The original "raw" data sequence was uncovered from the files 4012ALL, 4013ALL, 4014ALL, and 4015ALL from G. Gauthier's archive. These files contained two important columns, list# and ICP#, which initially hinted that the standards and controls were inserted into a block of 50. Another hint came from the ICP-MS file from R.G. Balma, which contained a column "sam_type," indicating whether a sample was routine, duplicate, repeat, blank, or standard, as summarised in Table 5.

An outline of the raw data sequence is established by taking the files from R.G. Balma and G. Gauthier and importing them into a single Microsoft® Excel spreadsheet. The data was cross-referenced with multiple sources and colour-coded to visually define and verify the data sequence before initiating the data cleaning and restoration in Microsoft® Access. This step was repeated whenever a new dataset was recovered to verify the data sequence before processing.

The final phase of the data restoration involves data transformation in Microsoft® Access

Table 4: Summary of data files and sources discovered during the initial phase

Source	Files	Notes
C. Dunn's digital archive	• AA.XLS • ALL_SITE.XLS • CARBON.XLS • DIONEX.XLS • DUPREP.XLS • GEOLMAT.XLS • HYDRID.XLS • ICPES.XLS • ICPMS.XLS • PH.XLS	Contained QA/QC standards were presented at the end of the sequence, as well as statistical analysis.
R.G. Balma's digital archive	• AA.XLS • ALL_SITE.XLS • CARBON.XLS • **DIONEX.XLS** • DUPREP.XLS • GEOLMAT.XLS • HYDRID.XLS • **ICPES.XLS** • ICPMS.XLS • **PH.XLS**	The same files and folders are found on a CD ROM, C.E. Dunn's digital archive, and W. Spirito's digital archive. These files only contained the end of the batch blanks.
G. Gauthier's digital archive	• **4011ALL.WQ1** • **4012ALL.WQ1** • **4013ALL.WQ1** • **4014ALL.WQ1** • **4015ALL.WQ1** • 4011DIR.WQ1 • 4012DIR.WQ1 • 4013DIR.WQ1 • 4014DIR.WQ1 • 4015DIR.WQ1 • ES4011.WQ1 • ES4012.WQ1 • ES4013.WQ1 • ES4014.WQ1 • ES4015.WQ1 • **NS4011.WQ1** • **NS4012.WQ1** • **NS4013.WQ1** • **NS4014.WQ1** • **NS4015.WQ1** • OTT94ES.WQ1 • PH4011.WQ1 • PH4012.WQ1 • PH4013.WQ1 • PH4014.WQ1 • PH4015.WQ1 • 943ALL.xlsx • AA.XLS • CARBON.XLS • HYDRID.XLS • ICPES.csv • ICPES.XLS • **NS94.csv** • NS94.MDB • PH.XLS	• Discovered by P. Pelchat • QA/QC standards were present for ICP-MS, ICP-MS-hyd and ICP-AES datasets • Alkalinity data was found in the file named NS94.csv
Zip disk archive	• AA_data_from_zipdrive.zip • **NS94 Data with repeats and controls_Rev 12-2024.xlsx**	• A series of 400+ files were found on a zip disk discovered by P. Pelchat. These files were exported from G. Gauthier's database and then compiled by P. Pelchat into the file named "NS94 Data with repeats and controls_Rev 12-2024.xlsx"
G.E.M. Hall's digital files	• NS94WAT.DBF • NS94.xlsx	• A compilation of all the analytical methods. • No QA/QC standards in this version of the dataset.
W. Spirito's digital archive	• NS94-95_Water.xls • NS94WAT.DBF • Ns94wat.dbf	• Found in a folder named Dunn_Hall_NS_1994. • This was the version of the dataset published on CDoGS without QA/QC.
CDoGS	• NS94-95_Water.xls	• A compilation of all the analytical methods • No QA/QC standards.

The files used for the compilation of this dataset are highlighted in bold.

after verifying the sequence with another set of data (e.g., the ICP–AES dataset). Microsoft® Access was used due to its ability to enforce referential integrity, which is crucial for data validation and assigning persistent identifiers when working with large datasets. Additionally, the software provides a systematic and documentable approach to data cleaning while minimising the risk of user-introduced errors commonly associated with data sorting, copying and pasting in Microsoft® Excel.

The original files used to compile the dataset in this report will be included in Appendix D1, along with the notes and rough SQL scripts and notes used during the data cleaning process in Appendix D2.

The nature of Legacy data is that it inherently contains gaps that cannot be resolved due to missing information. Some of the missing or inconsistent data points encountered in this data set include:

- Within the 4014ALL dataset, the sample *4:OR:4* was missing its value in all dataset sources for ICP–MS.
- The ICP–MS values for the standard 6:TP:3 appear higher than the other TP samples. This could be likely due to contamination of the sample.
- The site_IDs 5008 and 5035 did not have corresponding UTM coordinates in the file ALLSITES.XLS from R.G. Balma's archive.
- The units for NO_2, NO_3, P, PO_4 and Br concentrations were originally expressed as ppb in all the versions of the data from different sources. However, after J.A. Kidder had performed the charge balance and determined that units should be corrected to ppm, P. Pelchat also confirmed this.

In the final versions of the stream water dataset, two versions of the dataset have been published in this OF report. The first version is the 'clean' version, which contains the analytical data for all the samples without the control and standard reference materials for ease of use for the end user. The second version is the 'restored' version, where the controls and standard reference materials are included in the analytical sequence. This version of the dataset represents, as closely as possible, the

Table 5: Abbreviations of sample types in the dataset in Appendix A2 and A3

Abbreviation	Full Term	Description
R	Routine Sample	A routine sample
D1 & D2	Field Duplicate Sample pairs	D1 is the first of the duplicate pair, and D2 is the second of the duplicate pair. The field duplicate is denoted by "d" in the site_ID column.
D3	Lab Duplicate Sample	Repeat analysis of routine samples. These can be field samples, blank, standard, etc.
DD3	Lab Duplicate of Field Duplicate Sample	Repeat analysis of field duplicate.
OR	OTT-94 Routine	Routine Ottawa River standard
OT	OTT-94	End of batch Ottawa River standard
3c	1643c	NIST standard reference materials
SL	SLRS-2	NRC Canada standard reference material
BR	Routine Blank	Routine lab blank
BK	Field Blank	Field blank that was brought to the field
TS	Time Study Sample	Water samples were taken during the time study, one sample per day.
TP	TAP-92	In-house tap water standard

raw data that would have been passed onto the G.E.M. Hall after the analytical chemists processed the raw readings from the analytical instruments. The end user can perform statistical analysis with this dataset for data validation.

MAP PRODUCTION

The original coordinates were extracted from the ALLSITES file, which included site IDs and coordinates in UTM projection (NAD27 datum) with a central meridian of 63° (Zone 20). Using the National Transformation version 2 (NTv2) transformation, the original coordinates were transformed into NAD83 datum, and locations were plotted on a map using QGIS v.3.38.1.

The basemap "ESRI Shaded Relief" used for Figure 3 was obtained via the QuickMapServices plugin in QGIS. Additional basemap elements used in Figures 1, 2, and 4, such as topographic features, hydrographic features, roads, boundary lines, etc., were retrieved from the CanVec (Natural Resources Canada, 2019), the Atlas of Canada (Natural Resources Canada, 2017) and NTS of Canada (Natural Resources Canada, 2015) from the Open Canada, the Government of Canada website.

In QGIS, the Select Feature tool filters the various data layers to simplify map features. Limiting to only major highways and municipal roads to simplify the road segment layer, selecting major cities and townships based on the point of interest. The style and symbology of topographic features were based on the standards illustrated by Topographic Map Symbols (USGS, 2005).

For Figure 3, the map of mineral occurrences within the survey area was produced using mineral occurrence data retrieved from the government of Nova Scotia's website (MacRae et al., 2024). Metallic mineral occurrences were in the mineral occurrence dataset using the Select Features tool to filter the data. The bedrock geology layer was extracted from the data obtained from the Government of Nova Scotia website (Fisher and Poole, 2006). A bounding polygon was used to clip both the bedrock and mineral occurrence layer with the Clip tool to isolate the relevant bedrock formations for the map. The Dissolve tool was then used on the clipped bedrock layer to aggregate the distinct geological units for workflow purposes. The colour and abbreviation for each geological unit adhere to the provincial bedrock map published by the Government of Nova Scotia (Keppie, 2000).

For Figure 4, the bounding polygons for previous surveys were downloaded from the Canadian Database of Geochemical Surveys (https://geochem.nrcan.gc.ca/cdogs/content/main/home_en.htm) as KML files. These files were imported into QGIS for initial visualisation. The shape of some of the bounding polygons was further refined by downloading sample location data from either CDoGS (either as raw data files in RGG format or Microsoft® Excel spreadsheet) or the Nova Scotia Department of Natural Resources website (DP ME 132, 2006). To read and convert the raw RGG file, it was first opened in Notepad. The data was then extracted into a .txt file and imported into Microsoft® Access to extract sample_ID, UTM Zone, Easting and Northing from the string of text from the raw RGG file based on the metadata included in the file. Once the sample locations were imported into QGIS, new bounding polygons for the surveys were generated by manually tracing the outline of the data points using the Add Polygon Feature Tool.

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REFERENCES

Adams, A.C. 1991. Gypsum and anhydrite resources in Nova Scotia; Nova Scotia Dept. of Natural Resources; Economic Geology Series 91-1, 293 p.

Adcock, S.W., and Spirito, W.A., The Canadian Database of Geochemical Surveys: Historical Overview and Current Challenges; Geological Survey of Canada, Current Research, 2024-1. https://doi.org/10.4095/332490.

Adcock, S.W., Spirito, W.A., and Garrett, R.G., 2013. Geochemical data management - issues and solutions; Geochemistry: Exploration, Environment, Analysis, 13, 4, 337-348p. https://doi.org/10.1144/geochem2011-084.

Bingley, J.M., and Richardson, G.G., 1978. Regional lake sediment geochemical survey for eastern mainland Nova Scotia; Nova Scotia Department of Mines and Energy, Open File Report ME 371, scale 1:100,000, 39 maps.

Bloom, H., 1955. A field method for the determination of ammonium citrate-soluble heavy metals in soils and alluvium; Economic Geology, 50-5, 533–541p. https://doi.org/10.2113/gsecongeo.50.5.533.

Boyle, R.W. 1972. The geology, geochemistry, and origin of the barite, manganese, and lead-copper-silver deposits of the Walton-Cheverie area, Nova Scotia; Geological Survey of Canada, Bulletin 166, 181 p.

Boyle, R.W. and Jambor, J.I. 1966. Mineralogy, geochemistry, and origin of the Magnet Cove barite-sulphide deposit, Walton, N.S.; CIM Bulletin, v. 59, p. 1209-1228.

Boyle, R.W., Koehler, G.F., Moxham, R.L., and Palmer, H. C., 1958. Heavy metal, Zn, Cu, Pb, content of water and sediments in streams, rivers and lakes, southwestern Nova Scotia; Geological Survey of Canada, Paper, 58-1, 37p. https://doi.org/10.4095/101217.

Boyle, R.W., Wanless, R.K., and Stevens, R.D. 1976. Sulfur isotope investigation of the barite, manganese, and lead-zinc-copper-silver deposits of the Walton-Cheverie area, Nova Scotia, Canada; *Economic Geology*, v. 71 (4), p. 749–762.

Bristow, Q., 1975. A computer-controlled geochemical analysis system for use with existing Perkin Elmer double-beam atomic absorption spectrophotometers; Journal of Geochemical Exploration, v. 4, p. 371-383. https://doi.org/10.1016/0375-6742(75)90017-5.

Cameron, E.M., Hall, G.E.M., Veizer, J., and Krouse, H.R., 1995. Isotopic and elemental hydrogeochemistry of a major river system: Fraser River, British Columbia, Canada; Chemical Geology, 122(1–4), 149–169. https://doi.org/10.1016/0009-2541(95)00007-9.

Canadian Database of Geochemical Surveys, 2024. Groundwater sampling survey, NTS 11E, L and 21H, I, eastern Canada, 1975; Raw data for RGG Open Files; Natural Resources Canada, Geological Survey of Canada, digital DAT files, 64 files. https://geochem.nrcan.gc.ca/cdogs/content/svy/svy210053_e.htm <date accessed 2025-01-06>.

Chamberlain, K.J., Lehnert, K.A., McIntosh, I.M., Morgan, D.J., and Wörner, G., 2021. Time to change the data culture in geochemistry; Nature Reviews Earth & Environment, v. 2 (11), p. 737–739. https://doi.org/10.1038/s43017-021-00237-w.

Dunn, C.E., and Spirito, W.A., 1996. Reconnaissance biogeochemical survey, central Nova Scotia (parts of NTS 11D, E, and 21A, H): Part I - balsam fir twigs; Geological Survey of Canada, Open File 3221, 173p. https://doi.org/10.4095/207616.

Dyck, W., Garrison, E.W., Godoi, H.O., and Wells, G.S., 1976a. Minor and trace element contents of well waters, carboniferous basin, eastern Canada; Geological Survey of Canada, Open File 340, 38p. https://doi.org/10.4095/129451.

Dyck, W., Pelchat, J.C., and Meilleur, G.A., 1976b. Equipment and procedures for the collection and

determination of dissolved gases in natural waters; Geological Survey of Canada, Paper 75-34, 12 p. https://doi.org/10.4095/102606

Fallas, K.M., MacNaughton, R.B., and Sommers, M.J., 2015. Maximizing the value of historical bedrock field observations: An example from northwest Canada; GeoResJ, v. 6, p. 30-34. https://doi.org/10.1016/j.grj.2015.01.004.

Feetham, M., 1996. MINERAL OCCURRENCE DATABASE: E04-008; Nova Scotia Department of Natural Resources and Renewables, Geoscience and Mines Branch, Mineral Occurrence Database (MPDBv12). https://gesner.novascotia.ca/modb/queryView/singlereport.aspx?Occ_number=E04-008.

Felderhof, G.W. 1978. Barite, celestite and fluorite in Nova Scotia; Nova Scotia Department of Mines and Energy, Bulletin No. 4, 463 p.

Finch, C., Hall, G.E.M., and McConnell, J., 1992. The development and application of geochemical analysis of water; Newfoundland Department of Mines and Energy, Current Research 92-1, p. 297-307. https://www.gov.nl.ca/iet/files/mines-geoscience-publications-currentresearch-1992-finch.pdf

Fisher, B.E., and Poole, J.C., 2006. DP ME 43, Version 2, 2006. Digital Version of Nova Scotia Department of Natural Resources Map ME 2000-1, Geological Map of the Province of Nova Scotia, Scale 1:500,000, compiled by J.D. Keppie, 2000 (Version 2); Nova Scotia Department of Natural Resources, Mineral Resources Branch, Vector digital data. https://novascotia.ca/natr/meb/download/dp043.asp.

Friske, P.W.B., Ford, K.L., Kettles, I.M., McCurdy, M.W., McNeil, R.J., and Harvey, B.A., 2010. North American soil geochemical landscapes project: Canadian field protocols for collecting mineral soils and measuring soil gas radon and natural radioactivity; Geological Survey of Canada, Open File 6282, 177p. https://doi.org/10.4095/261633.

Friske, P.W.B., Ford, R. J., McNeil, R. J., Amor, S. D., Goodwin, T. A., Groom, H. D., Matile, J. E., Campbell, J.E., and Weiss, J.A., 2014. Soil geochemical, radon and gamma ray spectrometric data from the 2008 and 2009 North American Soil Geochemical Landscapes Project field surveys. rev.; Geological Survey of Canada, Open File 7334, 35p. https://doi.org/10.4095/293019.

Friske, P.W.B., and Hornbrook, E.H.W., 1991. Canada's National Geochemical Reconnaissance programme; Institution of Mining and Metallurgy, Transactions, Section B: Applied Earth Sciences, 100, B47-B56 p. https://ostrnrcan-dostrncan.canada.ca/handle/1845/252774.

Garret, R.G., Kane, V.E. and Zeigler, R.K., 1980. The management, analysis and display of regional geochemical data; Journal of Geochemical Exploration, v.13, p. 115-152.

Gilbert, M.A., 1959. Field and laboratory methods used by the Geological Survey of Canada in geochemical surveys No 1 laboratory methods for determining copper, zinc and lead; Geological Survey of Canada, Paper 59-3, 24 p. https://doi.org/10.4095/104036.

Griffin, R.E.M., 2015. When are Old Data New Data?; GeoResJ, v. 6, p. 92-97. https://doi.org/10.1016/j.grj.2015.02.004.

Goldthwait, J.W. 1924. Physiography of Nova Scotia; Geological Survey of Canada, Memoir 140, 179 p.

Hall, G.E.M., and Pelchat, J.-C., 1997a. Analysis of Geological Materials for Bismuth, Antimony, Selenium and Tellurium by Continuous Flow Hydride Generation Inductively Coupled Plasma Mass Spectrometry; Journal of Analytical Atomic Spectrometry, v.12(1), p. 97–102. https://doi.org/10.1039/A605398J.

Hall, G.E.M., and Pelchat, P., 1997b. Comparison of two Reagents, Sodium Pyrophosphate and Sodium Hydroxide, in the Extraction of Labile Metal Organic Complexes; Water, Air, and Soil

Pollution, v. 99(1), p, 217–223. https://doi.org/10.1023/A:1018317407840.

Hall, G.E.M., and Pelchat, P., 1997c. Evaluation of a Direct Solid Sampling Atomic Absorption Spectrometer for the Trace Determination of Mercury in Geological Samples; Analyst, v. 122(9), p. 921–924. https://doi.org/10.1039/A700194K.

Hall, G.E.M., Pelchat, P. and Balma, R.G. 1994. Hydrogeochemical exploration in central Nova Scotia: in Program and Summaries, Eighteenth Annual Review of Activities, Nova Scotia Department of Natural Resources, Mines and Energy Branch Report 94-2, p. 40.

Hall, G.E.M., Vaive, J.E., and McConnell, J.W., 1995. Development and application of a sensitive and rapid analytical method to determine the rare-earth elements in surface waters; Chemical Geology, v. 120 (1-2), p. 91–109. https://doi.org/10.1016/0009-2541(94)00110-T.

Hall, G.E.M., Vaive, J.E., and Pelchat, J.-C., 1996. Performance of inductively coupled plasma mass spectrometric methods used in the determination of trace elements in surface waters in hydrogeochemical surveys; Journal of Analytical Atomic Spectrometry, v. 11(9), p. 779-786. https://doi.org/10.1039/ja9961100779.

Holman, R.H.C., 1956. A method of determining readily-soluble copper in soil and alluvium-Introducing White Spirit as a Solvent for Dithizone; Transactions of the Canadian Institute of Mining and Metallurgy, v. 66 (1), p. 7-16.

Holman, R.H.C., 1963a. A regional geochemical reconnaissance of stream sediments in the northern mainland of Nova Scotia, Canada, Eight papers on regional geochemistry in Canada; Geological Survey of Canada, Paper 63-23, 46 p. https://ostrnrcan-dostrncan.canada.ca/handle/1845/136159.

Holman, R.H.C., 1963b. Field and laboratory methods used by the Geological Survey of Canada in Geochemical Surveys, No 2: a method for determining readily-soluble Copper in Soil and Alluvium; Geological Survey of Canada, Paper 63-7, 5 p. https://doi.org/10.4095/104033.

Horne, R., and Macdonald, L., 1998. Geology of the Meguma Group, Kennetcook (NTS Sheet 11E/04); Atlantic Geology, v. 34(1), 64 p. https://archives.datapages.com/data/atlantic-geology-journal/data/034/034001/pdfs/64.html.

Jackson, H.R., Chian, D., Funck, T., Barr, S. M., Shimeld, J., White, C.E., and Salisbury, M., 2024. Geological interpretation of wide-angle seismic reflection/refraction profiles along the Scotian margin and across Nova Scotia, Canada; Tectonophysics, v. 879, 230315, p. 1-19. https://doi.org/10.1016/j.tecto.2024.230315.

Keppie, J.D., 2000. Geological Map of the Province of Nova Scotia; Nova Scotia Department of Natural Resources, Minerals and Energy Branch, Map ME 2000-001, scale 1:500,000, 1 sheet. https://novascotia.ca/natr/meb/download/mg/map/htm/map_2000-001.asp.

Kettles, I.M., Rencz, A.N., and Friske, P.W.B., 2008. The North American soil geochemical landscapes project – a Canadian perspective; EXPLORE Newsletter for the Association of Applied Geochemists, no. 141, p. 12–22.

Lawrence, B., Jones, C., Matthews, B., Pepler, S., and Callaghan, S., 2011. Citation and Peer Review of Data: Moving Towards Formal Data Publication; International Journal of Digital Curation, v. 6 (2), p. 4-37. https://doi.org/10.2218/ijdc.v6i2.205.

LeBlanc, P., 1993. Index Map to Geological Survey of Canada Faribault-Fletcher Series Bedrock Geological Maps of Nova Scotia, Nova Scotia Department of Natural Resources, Map OFM ME 1993-010, scale 1:1,000,000, 1 sheet.

Lively, et al., 1974. Analytical Methods manual; Inland Waters Directorate, Water Quality Branch, Thron Press Ltd., Contract No. 02KXKL327-3-8061.

Lund, N.G., 1987. Index to national geochemical reconnaissance surveys, 1973-1986; Geological Survey of Canada, “A” Series Map 1661A, scale

1: 10,000,000, 1 map. https://doi.org/10.4095/133926.

MacDougall, J.I. and Nowland, J.L., 1972. Soils of Nova Scotia; Canada Department of Agriculture, Research Branch, map, scale 1:450,000, 1 sheet.

MacRae, K.D., Neyedley, K., Baldwin, G. J., and Poole, J. C., 2024. DP ME 002, Version 12, 2024. Nova Scotia Mineral Occurrence Database (Version 12); Nova Scotia Department of Natural Resources and Renewables, Geoscience and Mines Branch, vector digital database DP ME 002. http://novascotia.ca/natr/meb/geoscience-online/about-database-modb.asp.

Mayernik, M.S., Breseman, K, Downs, R.R., Duerr, R., Garretson, A., Hou, C-Y, EDGI and ESIP Data Stewardship Committee, 2020. Risk Assessment for Scientific Data; Data Science Journal, v. 19, p. 1-15. https://doi.org/10.5334/dsj-2020-010.

Moran, P.C., Barr, S. M., White, C.E., and Hamilton, M.A., 2007. Petrology, age, and tectonic setting of the Seal Island Pluton, offshore southwestern Nova Scotia; Canadian Journal of Earth Sciences, v. 44(10), p. 1467–1478. https://doi.org/10.1139/e07-023.

National Research Council, 1990. SLRS-2: RIVERINE WATER REFERENCE MATERIAL FOR TRACE METALS; National Research Council Canada, Division of Chemistry, 3 p.

Natural Resources Canada, 2015. Indexes of the National Topographic System of Canada; Natural Resources Canada, Strategic Policy and Results Sector, Open Government Portal, vector dataset. https://open.canada.ca/data/en/dataset/055919c2-101e-4329-bfd7-1d0c333c0e62.

Natural Resources Canada., 2017. Atlas of Canada National Scale Data 1:1,000,000—Roads; Government of Canada, Open Government Portal, shapefile dataset. https://open.canada.ca/data/en/dataset/a53b65d8-f12e-52ba-b890-af12dfa6075a.

Natural Resources Canada, 2019. CanVec (Version 17); Natural Resources Canada, digital topographic dataset, scale 1:50,000. https://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/doc/.

Nova Scotia Department of Natural Resources, 2006. DP ME 132, Version 2, 2006. Regional Lake Sediment Geochemical Survey by the Nova Scotia Department of Natural Resources over Southern Nova Scotia, 1977-1978; Nova Scotia Department of Natural Resources, Mineral Resources Branch, vector digital data with metadata. https://novascotia.ca/natr/meb/download/dp132md.asp. <date accessed 2025-01-06>

Nova Scotia Department of Natural Resources, 2015. Ecological Landscape Analysis, Ecodistrict Profile 630: Central Lowlands. https://novascotia.ca/natr/ELA/pdf/600/630CentralLowlandsProfile.pdf <accessed October 30, 2024>

O'Reilly, G.A., 1998. MINERAL OCCURRENCE DATABASE: D13-022; Nova Scotia Department of Natural Resources and Renewables, Geoscience and Mines Branch, Mineral Occurrence Database (MPDBv12). https://gesner.novascotia.ca/modb/queryView/singlereport.aspx?Occ_number=D13-022.

Pilowsky, J.K., Elliot, R., and Roche, M.A.,2024. Data cleaning for clinician researchers: Application and explanation of a data-quality framework; Australian Critical Care, v. 37(5), p. 827-833. https://doi.org/10.1016/j.aucc.2024.03.004.

Richardson, G.G., and Bingley, J.M., 1979. The lake sediment geochemistry survey; Nova Scotia Department of Mines; In Mineral Resources Division, Report of Activities 1978, Report 79-1, p. 51-56.

Richardson, G.G., and Bingley, J.M., 1980. Regional lake sediment survey, southwestern mainland Nova Scotia. Nova Scotia Department

of Mines and Energy, Open File Report ME 453, scale 1:100000, 65 maps.

Rogers, P.J., 1989. Multi-element Rating Maps for Meguma Zone Lake Sediments; Nova Scotia Department of Mines and Energy, Open File Report ME 1988-055, 63 p., 6 maps.

Rogers, P.J., and Lombard, P.A., 1990. Regional geochemical surveys conducted by the Nova Scotia Department of Mines and Energy from 1957 to 1989; Nova Scotia Department of Mines and Energy, Open File Report ME 1990-017, 68 p.

Rogers, P.J., and Macdonald, M.A., 1984. Stream sediment sampling, orientation studies and geochemical associations from selected deposits on Cape Breton Island, Nova Scotia; Geological Survey of Canada, Current Research Paper 84-1B, p. 65-74. https://doi.org/10.4095/119563.

Rogers, P.J., and Macdonald, M.A., 1985. Regional geochemical surveys; Nova Scotia Department of Mines and Energy, In Mines and Minerals Branch, Report of Activities 1984, Report 85-1, p. 55-67.

Rogers, P.J., Macdonald, M.A., and Rigby, D.W., 1985. Regional Lake Sediment Survey of the Meguma Zone, Southern Nova Scotia: New Analytical Data; Nova Scotia Department of Mines and Energy, Open File Report ME 603, 65 p.

Ryan, R., and O'Beirne-Ryan, A.M., 2007. Preliminary Report on the Origin of Uranium Occurrences in the Horton Group of the Windsor Area, Nova Scotia; Nova Scotia Department of Natural Resources, Report of Activities ME 2007-001, p. 137-157.

Ryan, R., and O'Beirne-Ryan, A.M., 2009. Uranium occurrences in the Horton Group of the Windsor area, Nova Scotia and the environmental implications for the Maritimes Basin; Atlantic Geology, v. 45, p. 171-190. https://doi.org/10.4138/atlgeol.2009.008.

Sangster, A.L., 1990. Metallogeny of the Meguma Terrane, Nova Scotia; in Mineral Deposit Studies in Nova Scotia, v. 1, ed. A.L. Sangster; Geological Survey of Canada, Paper 90-8, p. 115-162.

Sangster, D.F., Burtt, M.D., Kontak, D.J., 1998. Geology of the B baseline zone, Walton Cu-Pb-Zn-Ag-Ba deposit, Nova Scotia, Canada; Economic Geology, v. 93 (6), p. 869-882.

Sorensen, A. H., Escobar-Vredevoogd, C., Wagner, T.L., and Fenlon, K., 2023. Recovering and Reusing Historical Data for Science: Retrospective Curation Practices Across Disciplines; Information for a Better World: Normality, Virtuality, Physicality, Inclusivity, iConference 2023, Conference paper, p. 14–28. https://doi.org/10.1007/978-3-031-28035-1_2.

Stea, R.R., Conley, H. and Brown, Y., 1992. Surficial geology of the Province of Nova Scotia; Nova Scotia Department of Natural Resources, Map 92-3.

Stea, R.R. and Finck, P.W., 1988. Quaternary geology of northern mainland Nova Scotia (sheets 10 and 11); Nova Scotia Department of Mines and Energy, Map 88-13 and 88-14, scale 1:100 000.

Stea, R.R. and Fowler, J. H., 1979. Minor and Trace Element Variations in Wisconsinan Tills, Eastern Shore Region, Nova Scotia; Nova Scotia Department of Mines and Energy, Paper ME 1979-004, p. 1-41, 4 maps. https://novascotia.ca/natr/meb/pdf/79pap04.asp

Stea, R.R. and Fowler, J.H., 1981. Pleistocene geology and till geochemistry of central Nova Scotia (sheet 4); Nova Scotia Department of Mines and Energy, Map 81-1, scale 1:100,000.

Stea, R.R. and Kennedy, C.M., 1998. Surficial geology of the Shubenacadie area (NTS 11E/03), Colchester, Halifax and Hants counties, Nova Scotia; Nova Scotia Department of Natural Resources, OFM ME 1998-3, scale 1:50,000.

Stea, R.R., Piper, D.J., Fader, G.B., Boyd, R., 1998. Wisconsinan glacial and sea-level history of Maritime Canada and the adjacent continental shelf: a correlation of land and sea events;

Geological Society of America Bulletin, v. 110, p. 821-845.

Stea, R.R., Turner, R.G., Finck, P.W., and Graves, R.M., 1989. Glacial dispersal in Nova Scotia: a zonal concept; in Drift Prospecting, ed. R.N.W. DiLabio and W.B. Coker; Geological Survey of Canada, Paper 89-20, p. 155-169.

Stea, R.R., Seaman, A.A., Pronk, T., Parkhill, M.A., Allard, S., and Utting, D., 2011. The Appalachian Glacier Complex in Maritime Canada; in Developments in Quaternary Sciences, v. 15, p. 631–659.

Stevenson, I.M., 1959a. Geology, Shubenacadie, Colchester, Halifax and Hants Counties, Nova Scotia (1076A ed.) [Map]. Geological Survey of Canada. https://doi.org/10.4095/107920.

Stevenson, I.M., 1959b. Kennetcook, Hants County, Nova Scotia (1075A ed.); Geological Survey of Canada, "A" Series Map 1076A, scale 1:63,360 mi. https://doi.org/10.4095/107877.

Tremblay, T., and Basso, S., 2021. Compiling data from the analysis of surficial materials in Nunavut into a database at the Canada-Nunavut Geoscience Office; Canada-Nunavut Geoscience Office, Summary of Activities 2020, p. 93-99.

Tremblay, T., and Basso, S., 2022. Database of the locations of surficial material sample station in Nunavut; Canada-Nunavut Geoscience Office, Summary of Activities 2021, p. 15–20.

USGS., 2005. Topographic Map Symbols; United States Geological Survey, USGS Unnumbered Series Report, https://doi.org/10.3133/70039164.

Waldron, J.W.F., White, C.E., Barr, S.M., Simonetti, A., and Heaman, L.M., 2009. Provenance of the Meguma terrane, Nova Scotia: Rifted margin of early Paleozoic Gondwana; Canadian Journal of Earth Sciences, v. 46(1), p. 1–8. https://doi.org/10.1139/E09-004

White, C.E., 2010. Stratigraphy of the Lower Paleozoic Goldenville and Halifax groups in southwestern Nova Scotia; Atlantic Geology, v.46, p. 136–154. https://doi.org/10.4138/atlgeol.2010.008

White, C.E., Bell, J.A., McLeish, D.F., Macdonald, M.A., Goodwin, T.A., and MacNeil, J.D., 2008. Geology of the Halifax Regional Municipality, Central Nova Scotia; Nova Scotia Department of Natural Resources, Report of Activities 2007, Report ME 2008-1, p. 125–139.

Wyborn, L.A.I., Hsu, L., Lehnert, K., and Parsons, M., 2015. Guest Editorial: Special Issue Rescuing Legacy data for Future Science; GeoResJ, v. 6, p.106-107. https://doi.org/10.1016/j.grj.2015.02.017.

APPENDIX A

Appendix A1 Metadata

Table A1: Project and Sample Metadata

Metadata Category	OF 9246
Project Lead Name	G.E.M. Hall
Province/Territory	Nova Scotia, Canada
Project or Activity Name	Nova Scotia biogeochemical and hydrogeochemical surveys 1993-1995
Funding Source	Canada—Nova Scotia Co-operation Agreement on Mineral Development (1992 – 1995)
Geodetic Datum	NAD27
Sample Collection Date Range	Approx. 1994-05-10 to 1994-06-10
Context of Current Project	New stream water data were collected simultaneously with the biogeochemical data in OF 3221. This legacy dataset has never been previously published.
Supporting Publications (if applicable)	The reconnaissance biogeochemical survey—Open File 3221—has the same site IDs and occurred at the same time as the one in OF 3221 with the same field team. 1995: OF 3344 reports on the biogeochemical survey in Cape Breton Island, while OF 9246 reports the stream water data that occurred at the same time as OF 3344.
Sampling Access Method	Road access and some helicopter support
Sampling Design/Pattern	Samples were collected at 2 km intervals along drivable roads where a stream was present
Sampling Method	250 mL Nalgene bottle sampling
Total # of Samples Collected, # of Each Sample Media and Mass of Sample	Approx. 846 stream water in a 250 mL HDPE bottle
Average Sampling Density (if applicable)	1 site per 7 km^2

Table A2: Sample Preparation Metadata

Lab Name and Address	Work Order #/ Certificate Name	Sample Submission Date	Sample Process Date	# of Samples Prepared	Sample Medium	Screening – mesh size	Screening – grain size (Wentworth)	Methodology	Published Reference(s) for the Preparation Method Used	Commercial Lab Preparation Package Code
GSC field lab (set up close to the sampling area)	N/A	N/A	1994-05-10 to 1994-06-10	846	stream water	N/A	N/A	water samples are filtered through a 0.45 µm pore size Millipore (MCE) membrane filter and acidified with 2 mL of nano-pure HNO_3 after collection	Finch et al., 1992	N/A

Table A3: Geochemical Analysis Metadata

Part 1/2

Lab Name & Address	Work Order #/Certificate Name	Sample Submission Date	Sample Analysis Date	Date Sample Data Reported to GSC	# of Samples per Media	Sample Medium	Size Fraction Analysed	Description of Analytical Digestion (if applicable)	Analytical Method/ Aliquot Mass	Name and Abbreviation of Laboratory's Analytical Package	# of Elements Analysed in the Analytical Package
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	937	stream water	N/A	N/A	ICP-MS	N/A	40
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	936	stream water	N/A	N/A	ICPMS-HYD	N/A	5
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	933	stream water	N/A	N/A	ICP-AES	N/A	7
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	936	stream water	N/A	N/A	AA	N/A	5
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	888	stream water	N/A	N/A	Total Organic Carbon (TOC)	N/A	1
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	846	stream water	N/A	N/A	pH, Cond	N/A	1
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	846	stream water	N/A	N/A	Cond	N/A	1
GSC-Ottawa Analytical Method Development Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	729	stream water	N/A	N/A	Alkalinity	N/A	1
GSC-Ottawa Analytical Chemistry Laboratory - 601 Booth Street, Ottawa, ON	N/A	N/A	N/A	N/A	808	stream water	N/A	N/A	DIONEX	N/A	6

Part 2/2

Name and Abbreviation of Laboratory's Analytical Package	Location of Table of Detection Limits	PDF of Price Brochure & Analytical Methods from the Commercial lab	Deviation from Standard Methods in Lab Brochure (if applicable)	List Different Types of Controls and Standard Reference Materials
ICPMS	Table 3.1- 3.5 in the Report	not available	N/A	• OTT-94- GSC-Analytical Method Development Laboratory- routine std -1 with a block of 50 end-of-batch samples • TAP-92- GSC-Analytical Method Development Laboratory- end of batch std – approx. 3 every batch of samples • BLANK-GSC-Analytical Method Development Laboratory- routine blank – 1 within a block of 50, and at the end of batch samples
ICPMS-HYD	Table 3.1- 3.5 in the Report	not available	N/A	• OTT-94- GSC-Analytical Method Development Laboratory- routine std -1 with a block of 50 end-of-batch samples • BLANK-GSC-Analytical Method Development Laboratory- routine blank – 1 within a block of 50, and at the end of batch samples
ICPAES	Table 3.1- 3.5 in the Report	not available	N/A	• OTT-94- GSC-Analytical Method Development Laboratory- routine std -1 with a block of 50 end-of-batch samples • BLANK-GSC-Analytical Method Development Laboratory- routine blank – 1 within a block of 50, and at the end of batch samples • SLRS-2-GSC-National Institute of Standards & Technology - standard for trace water elements – present at the end of the first batch of samples
AA	Table 3.1- 3.5 in the Report	not available	N/A	• OTT-94- GSC-Analytical Method Development Laboratory- routine std -1 with a block of 50 end-of-batch samples • BLANK-GSC-Analytical Method Development Laboratory- routine blank – 1 within a block of 50, and at the end of batch samples
TOC	Table 3.1- 3.5 in the Report	not available	N/A	• OTT-94- GSC-Analytical Method Development Laboratory- routine std -1 with a block of 50 end-of-batch samples • BLANK-GSC-Analytical Method Development Laboratory- routine blank – 1 within a block of 50, end of batch samples
pH	Table 3.1- 3.5 in the Report	not available	N/A	• BLANK-GSC-Analytical Method Development Laboratory- routine blank – ran at the end of the project
Cond	Table 3.1- 3.5 in the Report	not available	N/A	• BLANK-GSC-Analytical Method Development Laboratory- routine blank – ran at the end of the project
Alk	Table 3.1- 3.5 in the Report	not available	N/A	• Missing QA/QC data
DIONEX	Table 3.1- 3.5 in the Report	Appendix B3	N/A	• BLANK-GSC-Analytical Method Development Laboratory- end of the batch blank – ran at the end of the project