



Geological Survey of Canada Open File 3889

New Brunswick Department of Natural Resources and Energy Open File 2000-6

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NEW BRUNSWICK DEPARTMENT OF
NATURAL RESOURCES AND ENERGY OPEN FILE 2000-6

GEOLOGICAL SURVEY OF CANADA OPEN FILE 3889

NATIONAL GEOCHEMICAL RECONNAISSANCE
Regional Stream Sediment and Water Data, Northwestern
New Brunswick

NTS 21J/12 and 21J/13



Collecting stream sediments in northwestern New Brunswick.

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TABLE OF CONTENTS

	Page
INTRODUCTION.....	1
BACKGROUND AND RELATED GEOSCIENCE STUDIES	1
CREDITS	4
DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT	4
ANALYTICAL PROCEDURES.....	4
COMPARISON OF DATA PRODUCED BY TWO METHODS.....	5
PRESENTATION AND INTERPRETATION OF GOLD DATA.....	5
REFERENCES.....	7
DATA LISTINGS	A-1 to A-33
SUMMARY STATISTICS	B-1 to B-42
SAMPLE LOCATION MAP (1:250 000 SCALE).....	in pocket
ELEMENT SYMBOL - TREND MAPS.....	in pocket
TABLE	
1. GSC Rating Categories for Mineral and Hydrocarbon Potential	2
2. Summary of Analytical Data and Methods.....	6
3. Field Data Legend	9
FIGURE	
1. Areas in the Northwest Territories covered by geochemical surveys, with current GSC open file numbers	1
2. Bathurst Island, showing GSC study areas and related areas of interest	3
FRONT COVER	DeHavilland Twin Otter landing with supplies at Dundee Bight camp.
FRONTISPIECE	Bell 206L (Long Ranger) refuelling at Dundee Bight camp.

**NB DNRE OFR 2000-6
GSC OPEN FILE 3889
REGIONAL STREAM SEDIMENT AND WATER DATA, NORTHWEST NEW BRUNSWICK
NTS 210/12 and 210/13**

INTRODUCTION

This open file presents analytical and statistical data for 35 elements in stream sediments from 767 sites collected in 1999 from northwest New Brunswick. Loss-on-ignition in sediments, and uranium, fluoride, and pH values in waters from these sites are included in this report. The Geological Surveys Branch of the New Brunswick Department of Natural Resources and Energy (NB DNRE) funded this reconnaissance survey.

Analytical results and field observations contribute to building a national geochemical database for resource assessment, mineral exploration, geological mapping, and environmental studies. Sample collection, preparation procedures and analytical methods are strictly specified and carefully monitored to ensure consistent and reliable results regardless of the area, the year of collection or the analytical laboratory undertaking the analyses.

Regional geochemical surveys have been carried out since 1985 in New Brunswick under the National Geochemical Reconnaissance (NGR) program. A total of 14 open files (Fig. 1) have been published or are in publication, covering approximately 26,500 km². Data for all open files are available on 3.5-inch diskettes, and in the original published form, from:

Geological Survey of Canada Bookstore
601 Booth Street
Ottawa, Ontario K1A 0E8

Tel: (613) 995-4342
Toll-Free: 1-888-252-4301
Fax: (613) 943-0646

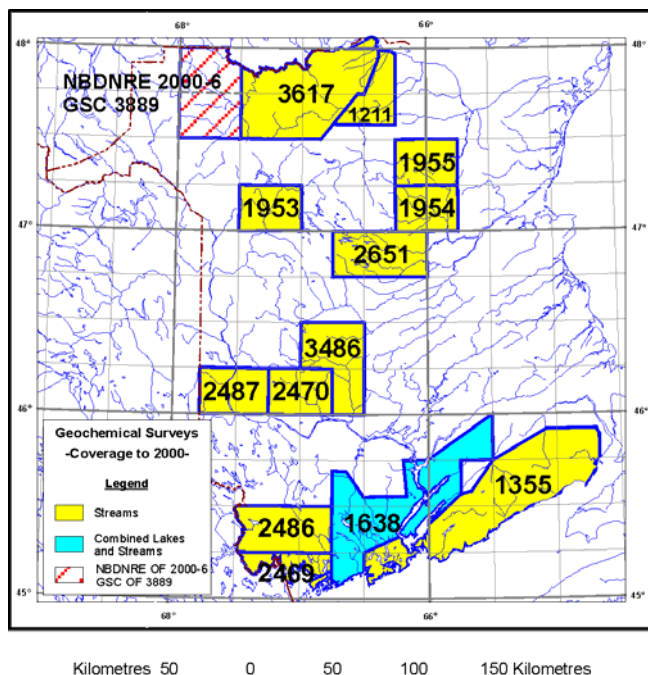


Figure 1. NGR coverage in New Brunswick.

This open file will also be available from:

Publications, Mineral Resources Division
New Brunswick Department of Natural Resources and Energy (NBDNRE)
P.O. Box 6000
Fredericton, New Brunswick E3B 5H1

Tel: (506) 453-2206

DESCRIPTION OF SURVEY AND SAMPLE MANAGEMENT

Stream sediments and waters were collected during the summer of 1999. Sample sites were distributed over a 2,020 km² survey area at an average of one sample per 2.7 km².

Sample site duplicate samples were routinely collected in each analytical block of twenty samples. Field observations were recorded on standard forms used by the Geological Survey of Canada (Garrett, 1974).

Site positions were marked on 1:50,000 scale NTS maps in the field and later digitized at the Geological Survey of Canada in Ottawa. Sample point coordinates were obtained from a Universal Transverse Mercator map projection (Zone 19), using the NAD83 datum. Distance units are in metres. The dominant rock types in the stream catchment basins were identified from appropriate geological maps used as the bedrock geological base on NGR maps.

Field-dried samples were air-dried and sieved through a minus 80-mesh (177 µm) screen. At that time, control reference and blind duplicate samples were inserted into each block of twenty sediment samples. For the water samples, only control reference samples were inserted into the block. There were no blind duplicate water samples.

Analytical data from analytical laboratories were monitored for reliability with standard methods used by the Applied Geochemistry and Mineralogy Subdivision at the Geological Survey of Canada.

ANALYTICAL PROCEDURES

Instrumental Neutron Activation Analysis (INAA)

Weighed and encapsulated samples are packaged for irradiation along with internal standards and international reference materials. Samples and standards are irradiated together with neutron flux monitors in a two-megawatt pool type reactor. After a seven-day decay period, samples are measured with a high-resolution germanium detector. Computer control is achieved with a Microvax II computer. Typical counting times are 500 seconds. Elements determined by INAA include: Ag, As, Au, Ba, Br, Cd, Ce, Co, Cr, Cs, Eu, Fe, Hf, Ir, La, Lu,

Mo, Na, Ni, Rb, Sb, Sc, Se, Sm, Sn, Ta, Tb, Te, Th, U, W, Yb, Zn, and Zr. The sample weights are also reported.

Data for Ag, Cd, Ir, Se, Sn, Te, Zn, and Zr are not published because of inadequate detection limits and/or precision.

To ascertain whether Au was finely divided or in 'nugget' form, samples returning values for Au greater than 3 ppb were split and the two portions reanalyzed separately.

Atomic Absorption Spectroscopy (AAS) and Other Analyses

For the determination of Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe, and Cd, a 1 gram sample is reacted with 3 ml concentrated HNO₃ in a test tube overnight at room temperature. After digestion, the test tube is immersed in a hot water bath at room temperature and brought up to 90° C and held at this temperature for 30 minutes with periodic shaking. One ml of concentrated HCl is added and heating continues for another 90 minutes. The sample solution is then diluted to 20 ml with metal-free water and mixed. Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe and Cd are determined by atomic absorption spectroscopy using an air-acetylene flame. Background corrections are made for Pb, Ni, Co, Ag, and Cd.

Molybdenum and vanadium are determined by atomic absorption spectroscopy using a nitrous oxide acetylene flame. A 0.5 gram sample is reacted with 1.5 ml concentrated HNO₃ at 90° C for 30 minutes. At this point, 0.5 ml concentrated HCl is added and the digestion continued at 90° C for an additional 90 minutes. After cooling, 8 ml of 1250 ppm Al solution are added and the sample solution diluted to 10 ml before aspiration.

Mercury is determined by the Hatch and Ott procedure with some modifications. The method is described by Jonasson et al. (1973). A 0.5 gram sample is reacted with 20 ml concentrated HNO₃ and 1 ml concentrated HCl in a test tube for 10 minutes at room temperature prior to two hours of digestion with mixing at 90° C in a hot water bath. After digestion, the sample solutions are cooled and diluted to 100 ml with metal-free water. The Hg present is reduced to the elemental state by the addition of 10 ml 10% w/v SnSO₄ in M H₂SO₄. The Hg vapour is then flushed by a stream of air into an absorption cell mounted in the light path of an atomic absorption spectrophotometer. Absorption measurements are made at 253.7 nm.

Loss-on-ignition is determined using a 500 mg sample. The sample, weighed into a 30 ml beaker, is placed in a cold muffle furnace and brought up to 500° C over a period of two to three hours. The sample is held at this temperature for four hours, then allowed to cool to room temperature for weighing.

Tin in stream sediments is determined by heating a 200 mg sample with NH₄I: the sublimed SnI₄ is dissolved in acid and the tin determined by atomic absorption spectrometry after solvent extraction of the tin into methyl isobutyl ketone containing trioctylphosphine oxide (TOPO). E.P. Welsch and T.T. Chao (1976) describe the method.

Water Analyses

Fluoride in water samples is determined using a fluoride electrode. Prior to measurement, an aliquot of the ion sample is mixed with an equal volume of TISAB II buffer solution (total ionic strength adjustment buffer). The TISAB II buffer solution is prepared as follows: to 50 ml metal-free water add 57 ml glacial acetic acid, 58 g NaCl and 4 g CDTA (cyclohexylene dinitrilo tetraacetic acid). Stir to dissolve and cool to room temperature. Using a pH meter, adjust the pH between 5.0 and 5.5 by slowly adding 5 M NaOH solution. Cool and dilute to one liter in a volumetric flask. Detection limit = 20 ppb.

Hydrogen ion activity (pH) is measured with a combination glass-calomel electrode and a pH meter.

Uranium in waters is determined by a laser-induced fluorometric method using a Scintrex UA-3 uranium analyzer. A complexing agent, known commercially as Fluran and composed of sodium pyrophosphate and sodium monophosphate (Hall, 1979) is added to produce the uranyl pyrophosphate species which fluoresces when exposed to the laser. Since organic matter in the sample can cause unpredictable behaviour, a standard addition method is used. Further, the reaction of uranium with Fluran can be delayed or sluggish; for this reason an arbitrary 24 hour time delay between the addition of the Fluran and the actual reading is incorporated into this method. In practice, 500 microliters of Fluran solution are added to a 5 ml sample and allowed to stand for 24 hours. At the end of this period fluorescence readings are made with the addition of 0.0, 0.2 and 0.4 ppb U. For high samples, the additions are 0.0, 2.0 and 4.0 (20 microliter aliquots of either 55 or 550 ppb U are used). All readings are taken against a sample blank.

A summary of analytical methods and detection limits is provided in Table 1.

COMPARISON OF DATA PRODUCED BY TWO METHODS

The data listed allows users to make a comparison of data generated by two different analytical methods for two elements. Before attempting such a comparison some caution should be exercised.

The 'wet chemistry' data for Co and Fe were obtained by AAS using a partial extraction (HNO₃ and HCl). The data for these elements obtained by INAA are 'total' data. Hence, the 'wet chemistry' data will likely be somewhat lower than the INAA data.

PRESENTATION AND INTERPRETATION OF GOLD DATA

The following discussion reviews the format used to present the gold geochemical data and outlines some important points to consider when interpreting these data. This discussion is included in recognition of the special geochemical behaviour and mode of occurrence of gold in nature and the resultant difficulties in obtaining and analyzing samples which reflect the true concentration level at a given site.

Table 1. Summary of Analytical Data and Methods

ELEMENT		DETECTION LEVEL		METHOD
SEDIMENTS:				
Ag	Silver	0.2	ppm	AAS
As	Arsenic	0.5	ppm	INAA
Au	Gold	2	ppb	INAA
Au(R1)	Gold (first of two splits)	2	ppb	INAA
Au(R2)	Gold (second of two splits)	2	ppb	INAA
AuWt	Sample Weight	0.01	g	-
Ba	Barium	50	ppm	INAA
Br	Bromine	0.5	ppm	INAA
Cd	Cadmium	0.2	ppm	AAS
Ce	Cerium	5	ppm	INAA
Co	Cobalt	2	ppm	AAS
Co	Cobalt	5	ppm	INAA
Cr	Chromium	20	ppm	INAA
Cs	Cesium	0.5	ppm	INAA
Cu	Copper	2	ppm	AAS
Eu	Europium	1	ppm	INAA
Fe	Iron	0.02	pct	AAS
Fe	Iron	0.2	pct	INAA
Hf	Hafnium	1	ppm	INAA
Hg	Mercury	10	ppb	CV-AAS
La	Lanthanum	2	ppm	INAA
LOI	Loss-on-ignition	1.0	pct	grav
Lu	Lutetium	0.2	ppm	INAA
Mn	Manganese	5	ppm	AAS
Mo	Molybdenum	2	ppm	AAS
Na	Sodium	0.02	pct	INAA
Ni	Nickel	2	ppm	AAS
Pb	Lead	2	ppm	AAS
Rb	Rubidium	5	ppm	INAA
Sb	Antimony	0.1	ppm	INAA
Sc	Scandium	0.2	ppm	INAA
Sm	Samarium	0.1	ppm	INAA
Sn	Tin	1	ppm	NH4I
Ta	Tantalum	0.5	ppm	INAA
Tb	Terbium	0.5	ppm	INAA
Th	Thorium	0.2	ppm	INAA
U	Uranium	0.2	ppm	INAA
V	Vanadium	5	ppm	AAS
W	Tungsten	1	ppm	INAA
Yb	Ytterbium	1	ppm	INAA
Zn	Zinc	2	ppm	AAS
WATERS:				
F-W	Fluoride	20	ppb	ISE
pH	Hydrogen ion activity	-	-	GCM
U-W	Uranium	0.05	ppb	LIF

- AAS

CV-AAS

GCM

GRAV

INAA

ISE

LIF

NH4I
- atomic absorption spectrometry

- cold vapour / atomic absorption spectrometry

- glass Calomel electrode and pH meter

- gravimetry

- Instrumental Neutron Activation Analysis

- ion selective electrode

- laser-induced fluorescence

- heating with NH₄I/sublimation/atomic absorption spectrometry

An appropriate interpretation of geochemical gold data from regional stream sediment or lake sediment surveys requires an appreciation of the unique chemical and physical characteristics of gold and its mobility in the surficial environment. Key properties of gold that distinguish its geochemical behaviour from most other elements (Harris, 1982) include:

1. Gold occurs most commonly in the native form, which is chemically and physically resistant. A significant proportion of the metal is dispersed in a micron-sized particulate form, and the high specific gravity of gold results in a heterogeneous distribution, especially in stream sediment and clastic-rich (low LOI) lake sediment environments. Gold distribution appears to be more homogeneous in organic-rich fluvial and lake sediments.
2. Gold typically occurs at low concentrations in the ppb range. Whereas gold concentrations of only a few ppm may represent economic deposits, background levels in stream and centre-lake sediments seldom exceed 10 ppb, and commonly are near the detection limit of 2 ppb.

These factors result in a particle sparsity effect wherein very low concentrations of gold are heterogeneously enriched or depleted in the surficial environment. Hence, a major problem facing the geochemist is to obtain a representative sample. In general, areas where concentrations of gold in sediments are low, and/or grain sizes of the gold present are relatively high, require proportionally larger samples to reduce the variability between subsample analytical values. Conversely, as actual gold concentrations increase, or grain size decreases, the number of gold particles to be split between random subsamples increases and the variability of results decreases (Clifton et al., 1969; Harris, 1982). The limited amount of material collected during the rapid, reconnaissance-style regional surveys and the need to analyze for a broad spectrum of elements, precludes the use of a significantly large sample weight for the gold analyses. Therefore, to obtain representative samples, sieving of the dried sediments is employed to reduce grain size.

The following control methods are currently applied to evaluate and monitor the sampling and analytical variability, which are inherent in the analysis of gold in geochemical media.

For each block of 20 samples:

- a) Random insertion of a standard reference sample to control analytical accuracy and long-term precision;
- b) Collection of a field duplicate (two samples from one site) to measure sampling and analytical variance;
- c) Analysis of a second subsample (blind duplicate) from one sample to measure and control short-term precision or analytical variance.

In summary, geochemical follow-up investigations for gold should be based on a careful consideration of all geological and geochemical information, and especially a careful appraisal of gold geochemical data and its variability. In some instances, pathfinder element associations in favourable geology may indirectly identify prospective follow-up areas, although an anomalous gold response due to natural variability may be lacking.

Once an anomalous area has been identified, field investigations should be designed to include detailed geochemical follow-up surveys and collection of large representative samples. Subsequent repeat subsample analyses will increase the reliability of results and permit a better understanding of natural variability which can then be used to improve sampling methods and interpretation.

DATA PRESENTATION

For this report, relative concentrations of selected elements in sediments at sample sites are illustrated with two types of images: shaded contour plots and multi-element proportional spot plots ('beachball' plots).

Contour plots depict broad regional trends. From the irregular grid of sample sites, a regular grid is generated using the following parameters:

Inverse Distance Weighting (IDW) function
Exponent = 2
Cell size = 100 metres
Search radius = 5000 metres
Display Radius = 2500 metres

The resulting grid is then coloured based on percentiles. A hill-shading effect is also added to enhance the surface of the regular grid. Maps are generated using the Vertical Mapper® module in ©MapInfo.

'Beachball' plots, a variation of proportional spot plots, represent multi-element anomalies at specific sites. Individual analytical values of selected elements are reassigned with integer 'scores' of four, three, two, one or zero, depending on the relative position of each analytical result relative to the median value for each element. For example, values greater than 8.0 times the median value for an individual element might be assigned a score of four. Values greater than 5.0 times and less than or equal to 8.0 times the median value might be assigned a score of three, values greater than 3.0 times and less than or equal to 5.1 times the median value assigned a score of two. Values greater than 2.0 times the median value and less than or equal to 3.0 times the median value might be assigned a score of one, and values less than or equal to two times the median value assigned a score of zero. **Specific scores assigned to element ranges are found on individual maps.**

The total score is used to establish the size of the individual spot, with the maximum size of the spot equivalent to the composite score of the different elements represented. The proportion of the total value within individual spots represented by one element (elements are assigned different colours) is indicated by the size of the wedge within the

spot. Bedrock geology maps are used as a background to facilitate a visual evaluation of the relationship between geology and element distribution.

ACNKOWLEDGEMENTS

Toon Pronk directed the survey, coordinating the Branch field activities of New Brunswick Geological Surveys staff. P.W. Friske directed the open file preparation.

Contracts were let to the following companies for sample collection, preparation and analysis:

- Collection: Precise Surveys Ltd.
Lyttleton, N.B.
- Preparation: Overburden Drilling Management Ltd.
Nepean, Ontario
- Analysis: Becquerel Laboratories Ltd.
Streetsville, Ontario

CanTech Laboratories Inc.
Calgary, Alberta

S.W. Adcock provided software support for the preparation of data listings and statistical information.

R.G. Garrett reviewed this open file and provided many useful comments and suggestions.

FIELD DATA LEGEND

Table 2 describes the field and map information appearing on the following pages preceding the analytical data for each sample site.

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Table 2. Field Observations Legend

FIELD RECORD	DEFINITION	TEXT CODE
NTS MAP	National Topographic System (NTS); lettered quadrangle (1:250 000 or 1:50 000 scale)	21O/12, 21O/13
SAMPLE NUMBER	Remainder of sample number: Year of collection Field crew..... Sample sequence number	99 1,2,3,4 001-999
REP STAT	Replicate status; relationship of the sample to others within the survey: Routine sample site First of a site duplicate pair Second of a site duplicate pair	0 1 2
UTM	Universal Transverse Mercator UTM co-ordinate system; (Datum = NAD83) digitized sample location co-ordinates	
ZN	Zone (7 to 22)	19
EASTING	UTM Easting in metres	
NORTHING	UTM Northing in metres	
ROCK UNIT	Major rock type of stream catchment area: Devonian (Mainly) Shale, limestone, sandstone; minor greywacke, tuff and volcanic rocks..... Silurian Greywacke, slate, siltstone, sandstone, conglomerate and limestone; minor ferruginous and manganiferous chert and argillite; minor volcanic rocks Ordovician and/or Silurian Calcareous and argillaceous sedimentary rocks	D1 S OS1
ROCK AGE	Stratigraphic age of dominant rock type in catchment basin: Devonian Silurian Ordovician and/or Silurian.....	25 20 19
SAMPLE TYPE	Sample material collected: Stream bed sediment only Spring or sediment seep Heavy mineral concentrate Stream water only Natural groundwater, spring seep..... Simultaneous stream sediment and water..... Simultaneous spring or seep water and sediment.....	SedOnly SpgSedOnly HvMnCn Strm GrWat Sed/Water SpgSep/Sed
STREAM WIDTH	Stream width in metres	
STREAM DEPTH	Stream depth in metres	
SAMPLE CONTAM	Contamination, human or natural: None..... Possible..... Probable..... Definite Mining activity..... Industrial sources Agricultural Domestic or household Forestry activities Burned areas.....	- Possible Probable Definite Mining Industry Agricult Domestic Forestry Burn

BANK TYPE	Bank type; the general nature of the bank material adjacent to the sample site: Alluvial Colluvial (bare rock, residual or mountain soils) Glacial till Glacial outwash sediments Bare rock Talus scree..... Organic predominant (debris, peat, muskeg, swamp)	Alluv Colluv Till Outwash BareRock TalScr Organic
WATER COLOUR	Water colour; the general colour and suspended load of the sampled water: Clear..... Brown transparent..... White cloudy..... Brown cloudy.....	Clear BnTrans WhCldy BnCldy
STREAM FLOW	Water flow rate: Stagnant..... Slow..... Moderate Fast Torrential	Stagnt Slow Modert Fast Torrrnt
SAMPLE COLOUR	Predominant sediment colour: Red-brown..... White-buff..... Black..... Yellow..... Green Grey, blue grey..... Pink Buff to brown Brown Dark Brown	Rd-Bn Wh-Bf Black Yellow Green Gy-Blu Pink Bf-Bn Brown DkBrown
SAMPLE COMP	Sediment composition; description of the bulk mechanical composition of the collected sample on a scale of 1 to 3, the total of the column must add up to 3 or 4 or 5: Size fractions are divided as follows: Column 1 >0.125 mm (sand) Column 2 <0.125 mm (fines - organic silt, clay) Column 3 organic material Amount of size fraction: sum of amounts = 3 4 5 Absent 0 0 0 Minor <33% 25% 20% Medium 33-67% 50% 40% Major >67% 75% 60%	0 1 2 3
BOTTOM PCPT	Precipitate or stain; the presence of any coatings on pebbles, boulders or stream bottoms: None..... Red-brown..... White or buff..... Black..... Yellow..... Green Grey..... Pink Buff to brown	None Rd-Bn Wh-Bf Black Yellow Green Grey Pink Bf-Bn

BANK PCPT	Distinctive precipitate, stains or weathering on rocks in immediate area of catchment basin or stream bank: None Red, brown (eg., Fe) White, buff (eg., CO ₃ , Zn)..... Black (e.g., Fe, Mn, sulphides) Yellow (e.g., Pb, U, Fe, Mo, REE) Green (Cu, Ni, U, Mo, As, Fe)..... Bluish (Zn, P) Pink (Co, As)	None Rd-Bn Wh-Bf Black Yellow Green Blue Pink
STREAM PHYSIOG	General physiography of the drainage basin: Plain Muskeg, swampland Peneplain, plateau Hilly, undulating Mountainous, mature Mountainous, youthful (precipitous)	Plain Swamp Penpln Hilly Moun/M Moun/Y
DRAINAGE PATTERN	Drainage pattern: Poorly defined, haphazard Dendritic Herringbone Rectangular Trellis..... Discontinuous shield type (chains of lakes)..... Basinal Others	Poor Dendrc Herrbn Rectln Trellis Discnt Closed Other
STREAM TYPE	Stream type: Undefined Permanent, continuous Intermittent, seasonal Re-emergent, discontinuous	Undfnd Permnt Intermitt Re-emerg
STREAM CLASS	Classification based on proximity to source: Undefined Primary Secondary Tertiary Quaternary	Undefined Primary Secondary Tertiary Quaternary
STREAM SOURCE	Source of water: Unknown Groundwater Snow melt or spring run-off Recent precipitation Ice-cap or glacier meltwater	Unknown Ground Sp'gMelt RecRain Glacier
Miscellaneous	Missing data in any field no sample material for analysis parts per million parts per billion percent weight (of sample)..... gram	- ns ppm ppb pct Wt g