## DESCRIPTIVE NOTES

### INTRODUCTION

This Surficial Geology Map of NTS 94-O/7 (Canadian Geoscience Map 127) is the product of collaboration between the Geological Survey of Canada and the British Columbia Ministry of Energy, Mines and Natural Gas as part of the Geo-mapping for Energy and Minerals Program (GEM-Energy Yukon Basins Project. The accompanying geodatabase includes field observation points and field photos, landform features as lines, and surficial geology unit polygons. The map and geodatabase are essential baseline geoscience information for a range of potential end-users including resource explorationists, geotechnical engineers, land-use managers, terrestrial ecologists, archaeologists, geoscientists and communities in northern British Columbia. By providing new insight into the distribution and origins of surficial earth materials, CGM 127 will help to reduce the economic costs and risks associated with the sustainable development of energy and mineral resources in NTS 94-O/7. Environmental impact assessments for new access roads, work camps, well pads, pipeline and power transmission line corridors, water storage and waste management systems and other infrastructure will benefit from the geoscience information presented here. By identifying areas prone to geological hazards (e.g., landslides, permafrost, flooding), CGM 105 will also help to protect natural resources, infrastructure and communities vulnerable to climate change in Canada's north.

### APPROACH TO SURFICIAL GEOLOGY MAPPING

Terrain mapping and field-based benchmarking studies have led to a better understanding of the regional distribution of surficial deposits, permafrost, landslides and other geomorphic processes in the NTS 94-O/7 map area (Huntley and Hickin, 2010; Huntley et al., 2011a-b). Surficial earth materials and landforms were classified using a combination of stereo-pair air photos (BCB97010, 15BCB97015, 15BCB97026, 15BCB97073 and 15BCB97088 series), LANDSAT 7 satellite imagery (http://glovis.usgs.gov/) [LRS, 2011]) and Shuttle Radar Topography Mission digital elevation models (http://dds.cr.usgs.gov/srtm/) [SRL 2011]). The base map was generated from CANVEC shape files (http://geogratis.cgdi.gc.ca/geogratis/ [LRL, 2011]). Surficial geology polygons and landform line symbols were digitized using commercially available computer software packages (Global Mapper, ArcMap and ArcGIS) and compared to published maps, reports and archived digital data (e.g., Stott and Taylor, 1968; Bednarski, 2003a-d; Clement et al., 2004; Bednarski, 2005a-b; Denchuk, 2010). The geodatabase accompanying this map conforms to the Science Language for the Data Management component of the GEM Geological Map Flow process (cf. Huntley and Sidwell, 2010; Huntley et al., 2011a; Dinkler and Kahl, 2012).

Fieldwork was undertaken in 2009 and 2010 to ground truth surficial geology polygons interpreted from air photos and satellite imagery, and to gather characteristics that could not be determined through remote predictive mapping. Earth materials were defined on the basis of facies and landform associations, texture, sorting, colour, sedimentary structures, degree of consolidation, and stratigraphic contact relationships at field stations and remote observations from helicopters. The distribution of glacial and non-glacial landforms is depicted on the surficial geology map. Map units in the Legend are presented chronostratigraphically and include organic deposits, alluvial, colluvial, eolian, glaciolacustrine and glaciofluvial sediments, tills and areas of bedrock.

### INFERRED GEOLOGICAL HISTORY

The distinctive landscape of NTS 94-O/7 is largely a product of the Late Wisconsinan Laurentide Ice Sheet. Topography and drainage patterns were greatly modified during the phase of maximum ice cover (>18 °C ka BP or >21.4 calendar ka BP). Unconsolidated sediment thicknesses in excess of 2-5 m are observed in major valleys and it is suspected that similar drift thicknesses blanket undifferentiated clastic bedrock (Lower Cretaceous Fort St. John Group, Stott and Taylor, 1968). Silt- and clay-rich Laurentide tills have low clast contents (<20%) of proximally derived Cretaceous siliciclastic sedimentary rocks and distal igneous and metamorphic clasts from the Canadian Shield; hundreds of kilometres to the northeast. Drumlin ridges up to several hundred metres in length suggest clay-rich tills (unit Ts) were deposited beneath active, rapidly flowing warm-based glacial ice (Huntley and Hickin, 2010; Huntley et al., 2011b). Multiple phases of streamlined ice flow and ice lobes are recognized in the map area. In the north, southwestward ice flow is interpreted as a glacial maximum palimpsest cross-cut by later westerly flow across the Elseho Plateau. In the south, the dominant ice flow direction is northwest, suggesting a separate ice lobe >50 kbsl the Fort Nelson Lowland.

Deglaciation began sometime after 18 °C ka BP (or >21.4 calendar ka BP) and ended before 10 °C ka BP (ca. 12 calendar ka BP), with the retreating active Laurentide Ice Sheet, stagnant ice masses in lowlands, glaciofluvial outwash and landslide debris blocking and reordering regional drainage. Over much of the map area, northwest-trending drumlins terminate at, or are draped by large recessional end moraines (unit Tm). Westward ice flow along the east margin of the map area suggests a re-organization of flow patterns as the Laurentide Ice Sheet margin retreated out of the Fort Nelson Lowland. Minor moraine ridges drape drumlins in cross-cutting patterns and are interpreted as crevasse fillings and squeeze moraines deposited shortly after drumlinization ended, or as ice retreated from the map area (Huntley et al., 2011b). Hummocky till (unit Th) is associated with short segments of subareal-subglacial meltwater channels and eskers. This landform association indicates that bodies of stagnant glacier ice remained in lowland areas west of the Mashamish Escarpment (Huntley et al., 2011a; Huntley et al., 2011b). As ice retreated from the map area, a proglacial lake system formed in the Fort Nelson Lowland. Proglacial lakes were linked by spillways that drained meltwater northward into the Liard River basin. In the map area, glaciolacustrine deposits (unit GLS), glaciofluvial terraces (unit GFt), and meltwater channels incised into till and bedrock indicate that glacial lake levels fell stepwise through deglaciation, with stable elevations at approximately 420 m and 380 m. Locally, fine-grained glacial earth materials have been re-worked by eolian activity and discontinuous loess covers glacial lake and till deposits in some areas.

Post-glaciation (10 °C ka BP, or ca. 12 calendar ka BP to present), changes in regional base-level led to episodes of channel incision and aggradation, resulting in the formation of erosional alluvial terraces along most stream and river valleys. In the early Holocene, pulses of fluvial terrace building followed initial valley incision by the Kwigana River. Most streams and rivers have alluvial fans (unit Af) and terraces (unit Af) <5 m above active floodplains (unit Ap) consisting of gravel overlain by silt and sand. Poorly drained clay-rich till on the plateaux and glaciolacustrine sediments in lowland areas are covered by extensive postglacial peat deposits (unit Owb), fens (unit Owf) and undifferentiated wetlands (unit O). Discontinuous permafrost is sporadically encountered in glaciolacustrine and some peat deposits. Charcoal, observed in dug pits on alluvial terraces, suggest forest fires may have contributed to periods of landslide activity on slopes and local fluvial aggradation. Landslides and colluvial deposits (units Cv, Cb) are common where bedrock outcrops form escarpments, and where shale or fine-grained glacial deposits are exposed along steep cutbanks. Stream networks and wetlands draining plateau watersheds are disrupted by beaver activity and, to a lesser extent, by roads and infrastructure where they cross streams, rivers and organic deposits (Huntley and Hickin, 2010; Huntley and Hickin, 2011a-b).

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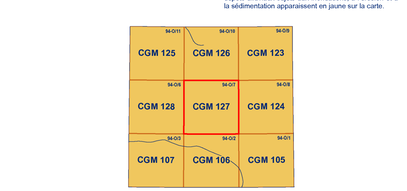
### Abstract

Canadian Geoscience Map 127 depicts the surficial geology over some 790 km² covered by the Kiwigana River map sheet (NTS 94-O/07), in northeastern British Columbia. The map area lies in the Fort Nelson Lowland, and is drained by the west-flowing Kiwigana River. Bedrock is mantled by unconsolidated earth materials dating to the Late Pleistocene (Late Wisconsinan Glaciation, > 25 ka to ca. 10 ka) and non-glacial Holocene (ca. 10 ka to present). Deposits of till, green on the map, are generally suitable for placement of infrastructure. Glaciofluvial deposits with mineral, aggregate, and groundwater potential are coloured orange. Slopes disturbed by landslides, rock slides, and debris flows appear brown. Glaciolacustrine and organic deposits with sporadically discontinuous permafrost are coloured purple and grey, respectively. Alluvial deposits prone to flooding, erosion, and sedimentation appear yellow on the map.

### Résumé

La Carte géoscientifique du Canada 127 illustre la géologie des matériaux superficiels d'un territoire d'environ 790 km² couvert par le feuillet cartographique de Kiwigana River (SNRC 94-O/07), dans le nord-est de la Colombie-Britannique. La région cartographique se situe dans les basses terres de Fort Nelson et est drainée par la rivière Kiwigana qui coule vers l'ouest. Le socle rocheux est couvert de matériaux terrestres non consolidés remontant au Pléistocène supérieur (Glaciation du Wisconsinien supérieur, de > 25 ka à env. 10 ka) ainsi que de matériaux non glaciaires de l'Holocène (d'env. 10 ka jusqu'à nos jours). Les dépôts de till, de couleur verte sur la carte, sont généralement propices à l'établissement de l'infrastructure. Les dépôts fluvioglaciaires, qui recèlent un potentiel en minéraux, en agrégats et en eau souterraine, sont figurés par la couleur orange. Les versants dérangés par des glissements de terrain, des chutes de blocs et des coulés de débris sont représentés en brun. Les dépôts glaciolacustres et organiques, qui renferment sporadiquement du pergélisol discontinu, sont représentés en violet et en gris, respectivement. Les dépôts alluviaux sujets aux inondations, à l'érosion et à la sédimentation apparaissent en jaune sur la carte.




National Topographic System reference and index to adjoining published Geological Survey of Canada maps

**Cover illustration**
Hummocky moraines and glacial outwash deposits incised by meltwater channels and Klenteh Creek in northeast British Columbia, view to the northeast. Photograph by D.H. Huntley. 2013-105

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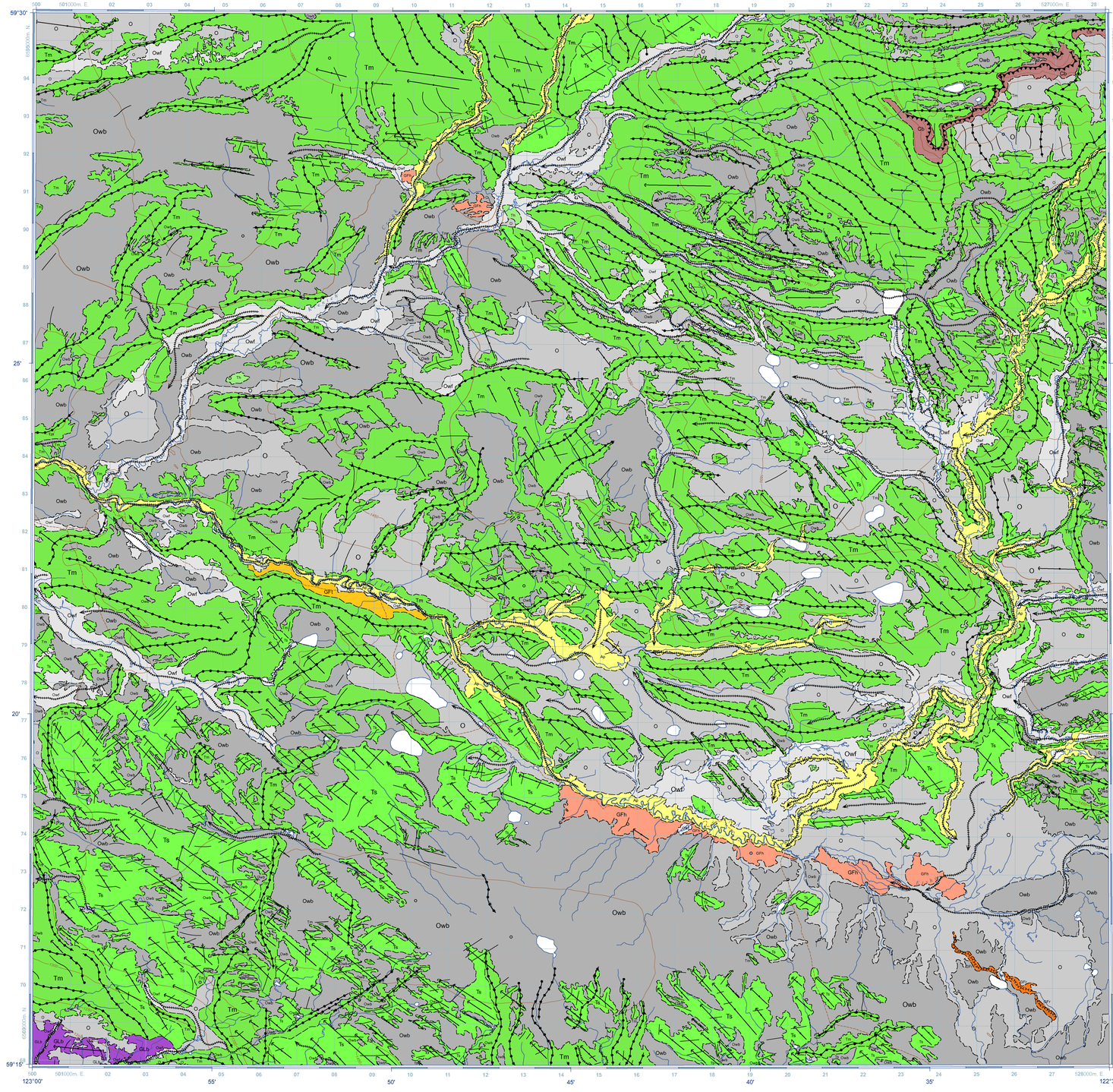
# CANADIAN GEOSCIENCE MAP 127
## SURFICIAL GEOLOGY
# KIWIGANA RIVER
British Columbia
**1:50 000**




## Holocene earth materials and landforms

### Organic Deposits

**Owb**

**Peat bogs**: fibric to humic organic matter; massive to stratified accumulations; generally greater than 2 m thick, confined to topographic depressions or level areas; underlain by poorly drained till, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; bogs with sporadically discontinuous permafrost and thermokarst depressions potentially unstable if organic material is disturbed or removed.

**Owf**

**Fens**: fibric organic matter; massive to stratified; generally greater than 2 m thick; confined to topographic depressions, level areas and meltwater channels; underlain by poorly drained till, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; fens are prone to flooding following drainage damming by beaver activity.

**O**

**Undifferentiated peat bogs and fens**: humic to fibric organic matter; massive to stratified accumulations; generally greater than 2 m thick; confined to topographic depressions, level areas or channels; underlain by poorly drained till, glaciolacustrine and other unconsolidated sediments; formed by decomposition of plant material in wetland areas; may contain sporadically discontinuous permafrost and thermokarst depressions; potentially unstable if disturbed or removed during development.

### Alluvial deposits

**Ap**

**Alluvial floodplain sediments**: gravel, sand and silt; massive, trough crossbedded, rippled-bedded, planar stratified; well to rapidly drained; greater than 2 m thick; underlain by till or bedrock; transported and deposited by modern rivers, streams and creeks; subject to seasonal flooding; land use activities may adversely affect stream courses and conditions, and impact fish and wildlife resources.

### Colluvial deposits

**Cb**

**Colluvial blanket**: clast-supported diamictons and rubble; massive to stratified, poorly-sorted; well to rapidly drained; deposits greater than 2 m thick; landslide blankets range from 300 m to 10.5 km; formed by the weathering and down-slope movement of earth materials by gravitational processes; bedrock and unconsolidated debris on slopes above 15-19° with greater than 5 m relief prone to mass-wasting; rock falls, topples, rock slides and debris flows occur where shale, sandstone and carbonate strata is exposed close to the surface; retrogressive rotational debris slides, debris flows and slumps occur in glaciolacustrine sediments and outwash containing sporadically discontinuous permafrost; where ground ice is exposed, the failure can occur on surfaces less than 5°; slope instability could present major problems for construction events - areas.

## Late Pleistocene earth materials and landforms

### Glaciolacustrine deposits

**GLb**

**Glaciolacustrine blanket**: silt and clay with subordinate sand, gravel and diamicton; massive or rhythmically interbedded; slump structures and dropstones locally present; poor to moderately drained; generally greater than 2 m thick; kettle lakes and irregular topography underlain by bedrock, tills and outwash; transported by and deposited from sediment-laden meltwater, subaqueous gravity flows and thermal melting of ice in proglacial lakes; where sporadically discontinuous permafrost is present, ice wedge pseudomorphs in glaciolacustrine sediments may be subject to thermokarst processes; slopes less than 5° are potentially unstable and prone to landslides and debris flows.

### Glaciofluvial deposits

**GFh**

**Kames and hummocky outwash**: boulders, cobbles, pebble-gravel, sand, silt and diamicton; generally massive to stratified, some slump structures; moderately to well-drained; greater than 2 m thick; irregular hummocks and kettled topography; in contact with, and overlying till units, outwash and glaciolacustrine sediments; deposited by rivers and streams flowing from, or in contact with glacial ice; potential source of groundwater and granular aggregate when material is gravel rich.

**GFr**

**Esker ridges**: boulders, cobbles, pebble-gravel, sand, silt and matrix-supported diamicton; generally massive to stratified, some slump structures; moderately to well-drained; greater than 2 m thick; range from 100 m to 8.8 km in length; in contact with, and overlying till units, outwash and glaciolacustrine sediments; deposited by subglacial meltwater in contact with glacial ice; potential source of groundwater and granular aggregate when material is gravel rich.

**GFt**

**Outwash terraces**: boulders, cobbles, pebble-gravel, sand, silt and matrix-supported diamicton; generally massive to stratified, some slump structures; moderately to well-drained; greater than 2 m thick; terrace scarps range from 100 m to 8 km in length; in contact with, and overlying other till units, outwash and glaciolacustrine sediments; deposited by meltwater confined to proglacial channels and spillways, potential source of groundwater and granular aggregate when material is gravel rich.

### Till deposits

**Tb**

**Till blanket**: sand, silt and clay-rich diamictons; massive, matrix-supported and compact; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to well-drained; greater than 2 m thick mantling bedrock and older glacial deposits; transported and deposited by the Laurentide Ice Sheet directly through lodgement, basal meltout, glacigenic deformation of sediment beneath active, warm-based ice and in situ melting from stagnant cold-based ice; stable terrain, generally suitable for infrastructure placement.

**Th**

**Hummocky till**: sand and silt-rich diamictons; massive to stratified, matrix- and clast-supported; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to well-drained; greater than 2 m thick; drapes till and other glacial deposits; deposited by in situ melting from stagnant cold-based ice and modified by meltwater; evidence for ice collapse includes slump structures, kettle lakes and irregular topography; potential source of aggregate when material is gravel rich; generally suitable for infrastructure placement.

**Tm**

**Moraine ridges**: sand, silt and clay-rich diamictons; massive, matrix-supported; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately to well-drained; greater than 2 m thick; minor moraines less than 1 km long and 5 m high; major moraines up to 12.5 km in length and 10 m high; ridges drape bedrock and older glacial deposits; minor moraines include crevasse-fill ridges and small recessional push moraines; major ridges features are large recessional end moraines and ice-thrust ridges; generally suitable for infrastructure placement.

**Ts**

**Streamlined till**: silt and clay-rich diamictons; massive, matrix-supported and compact; clast contents less than 20% and contain sub-rounded granitic erratic boulders with sources on the Canadian Shield; moderately well-drained; greater than 2 m thick mantling bedrock and older glacial deposits; drumlins and fluted till ridges typically under 1 km long but can exceed 9 km in length; generally less than 50 m wide and 20 m high; formed beneath the Laurentide Ice Sheet directly through lodgement, basal meltout, glacigenic deformation of sediment beneath rapidly-flowing warm-based ice; generally suitable for infrastructure placement.

- Geological boundary (Confidence: approximate)
- Bedrock scarp
- Major moraine ridge (end, interlobate, or unspecified)
- Other moraine ridge (DeGeer, minor lateral, recessional, rogen, washboard, other transverse or unspecified)
- Esker ridge (sense: unknown or unspecified)
- Drumlin ridge
- Major meltwater channel scarp
- Minor meltwater channel central axis (marginal, overflow, subglacial or unspecified; sense: known)
- Terrace scarp (environment: unspecified)
- Station location (ground observation or stratigraphic section)

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Canadian Geoscience Maps

Canada

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Geology by D.H. Huntley and A.S. Hickin (2009–2010)

Geological compilation by D.H. Huntley (2009–2011)

Geomatics by D.H. Huntley, W. Chow, and M. Mirmohammadi

Cartography by W. Chow

Initiative of the Geological Survey of Canada, conducted under the auspices of the Yukon Basin Project as part of Natural Resources Canada's Geo-mapping for Energy and Minerals (GEM) program

CANADIAN GEOSCIENCE MAP 127
SURFICIAL GEOLOGY
KIWIGANA RIVER
British Columbia
1:50 000

1 0 1 2 3 4 km

Map projection Universal Transverse Mercator, zone 10. North American Datum 1983

Base map at the scale of 1:50 000 from Natural Resources Canada, with modifications. Elevations in feet above mean sea level

Magnetic declination 2013, 20°20'E, decreasing 21' annually.

The Geological Survey of Canada welcomes corrections or additional information from users.

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**Preliminary publications in this series have not been scientifically edited.**

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