Canada

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada
Knowledge & Innovation Fund

Yukon Geological Survey

Yukon
Energy, Mines and Resources

PROJECT BACKGROUND

This map was produced as part of a biophysical mapping pilot study carried out in the Watson Lake (NTS 105A/2) area in 2004. Biophysical mapping (also known as ecological land classification) is an integrated system of mapping describing terrain conditions (surficial geology, slope, landscape position, drainage and permafrost conditions) as well as ecological values (vegetation community and structure, and soil moisture and nutrient regimes). At a local (1:50 000) scale, biophysical maps are an essential tool for facilitating stewardship and sustainable development of energy, mineral and land resources.

This map accompanies the report "Local scale biophysical mapping for integrated resource management, Watson Lake area (NTS 105A/2), Yukon" (Lipovsky and McKenna, 2005). Please refer to this report for more detailed background, methodology and descriptions of map units; GIS data is also included with the report on CD-ROM.

GLACIAL HISTORY

The Watson Lake map area has been glaciated at least six times since the Quaternary period (the last 2 million years; Jackson et. al. 1991). Aside from scattered section localities, evidence of the older glacial episodes are completely masked by deposits from the latest glaciation, which is known as the McConnell Glaciation. During this late Wisconsinan McConnell Glaciation, the Liard Lobe of the Cordilleran ice sheet flowed in an easterly direction out of the Cassiar Mountains and in a southeasterly direction out of the Pelly and Selwyn mountains, following the Tintina Trench/Liard Lowland.

At Tom Creek, just northwest of the map area, twig fragments in a silt unit underlying the McConnell till were found to be as young as 23 900 ± 1140 BP by radiocarbon dating (Klassen, 1987), implying that the onset of glaciation in the Watson Lake area occurred some time after that. The timing of deglaciation likely occurred after 10 700 years ago, according to radiocarbon dating on Marcella Lake cores in southwestern Yukon (Anderson et al., 2002). At the height of the McConnell Glaciation, ice in the Liard Lowland would have overtopped the highest uplands suggesting a minimum ice thickness of at least 500 m.

Northeast of the Liard River floodplain, a thick, gently undulating and rolling till plain is extensively streamlined with drumlins, flutings and grooves that provide clear indications of southeasterly to easterly ice flow directions. Till blankets and veneers are found on the slopes further to the northeast, while the higher ridge tops have been scoured to bedrock.

Prior to glacial retreat, damming of meltwater by the ice sheet produced extensive glacial lakes in the Liard valley floor. Fine-grained glaciolacustrine deposits underlying glaciofluvial outwash are exposed along the banks of the Liard River immediately south of the town of Watson Lake and just upstream of the mouth of Watson Creek.

As the ice sheet down-wasted and retreated to the northwest, vast amounts of meltwater deposited outwash plains of sand and gravel up to 30 m thick along the valley floor currently occupied by the Liard River. Extensive ice stagnation during deglaciation left behind blocks of ice that became buried by the outwash. The buried ice blocks have subsequently melted out leaving steep-sided depressions and the distinctive pitted, hummocky terrain around Upper Liard, Lucky Lake and the town of Watson Lake. The meltwater also carved deep meltwater channels through bedrock in various locations north and northeast of town.

KEY TO INTERPRETING SURFICIAL GEOLOGY MAP LABELS

Surficial geology polygons are labeled with a composite group of letters, which are arranged so that each letter position represents a particular characteristic of the terrain, including some or all of the following: texture, type of surficial material, surface expression, geomorphologic process, and activity state qualifiers. There may also be one or several surficial geology units incorporated in a polygon label. All labelling conventions are based on the British Columbia terrain classification system (Howes and Kenk, 1997).

In the sample label below, the characteristic that each letter represents is identified by the upper case type directly below each letter. For further details on each characteristic, refer to the appropriate sections of the legend.

This label indicates that the polygon is dominantly covered by muddy (m) sandy (s) pebbly (p) active (A) floodplain (FAp) with lesser amounts of flat-lying (p) and terraced (t) silty clay (zc) glaciolacustrine (LG) deposits, all of which is modified by thermokarst (e) permafrost (X) processes, gullying (V) and beaver damming (Q), and is underlain by gently dipping (j) phyllite (ph) bedrock (R).

QUALIFIERS

Qualifier symbols are used to indicate a glacial mode of surficial material formation, or the activity status of a surficial material or geomorphological process. Qualifier symbols are denoted by an upper case superscript that follows the surficial material symbol or the geomorphological process symbol. Up to two qualifiers may be used together.

SYMBOL	NAME	DESCRIPTION
G	glacial	used where there is direct evidence that glacier ice has controlled deposition
A	active	used where there is evidence that a surficial material is undergoing formation at the present time, or where a geomorphological process is occurring at present, unless activity is already inferred in the definition of surficial material or process
I	inactive	used where there is no evidence that a surficial material is undergoing formation at the present time, or where a geomorphological process is occurring at present, unless inactivity is already inferred in the definition of surficial material or process

DELIMITERS

Where multiple surficial materials are impossible to separate at map scale, up to three surficial materials can be listed, along with their textures and surface expressions, in order of decreasing importance. Each surficial material is separated by one of the following three delimiters:

SYMBOL	DESCRIPTION
,	components on either side of the symbol are of approximately equal proportion
/	the component in front of the symbol is more extensive than the one that follows
//	the component in front of the symbol is considerably more extensive than the one that follows

STRATIGRAPHIC SYMBOLS ("\" and "/")

Where one surficial material overlies another, the surficial materials are separated by a backward slash (\) symbol.

Where the overlying material is discontinous, but moderately extensive, a forward slash is included at the beginning of that unit (e.g., /tEvgFt).

TEXTURE

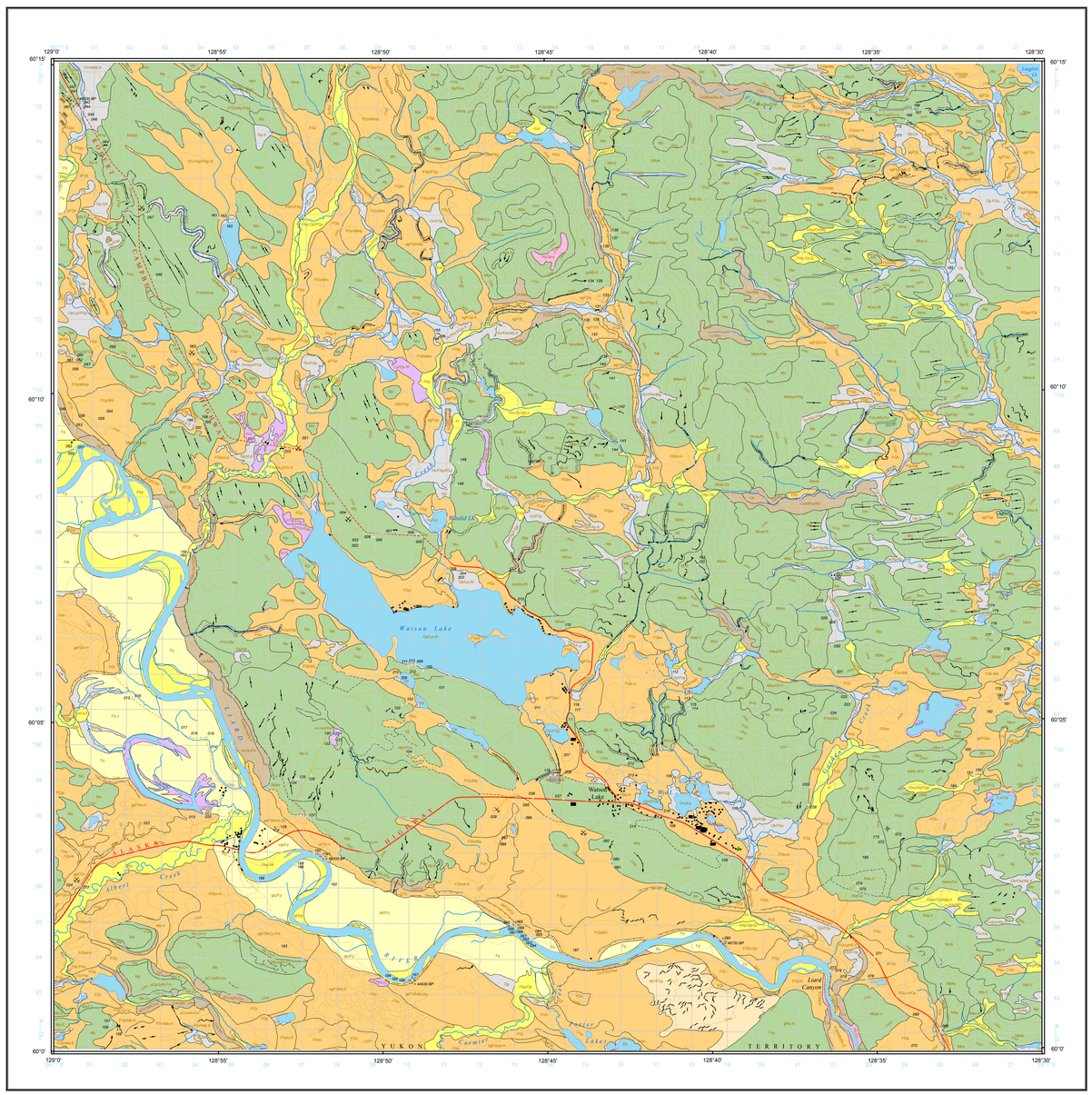
Texture refers to the size, shape (roundness) and sorting of particles in clastic sediments, and the proportion and degree of decomposition of plant fibre in organic sediments. Texture is indicated by up to three lower case letters that are listed before the surficial material designator in order of increasing importance. The use of two or three textural terms together indicates that either the various textures are intermixed or they are interstratified. Generalized textures are assigned based on representative field checking, but users should be aware that these textures can somewhat vary both laterally and vertically within a polygon.

SYMBOL	NAME	SIZE (mm)	DESCRIPTION
a	blocks	> 256	angular
b	boulders	>256	rounded
c	clay	<0.002	
d	mixed fragments	>2	rounded and angular
e	fibric		poorly decomposed organic material
g	gravel	>2	rounded, mixture of two or more size ranges
h	humic		organic material, advanced decomposition
k	cobbles	64 - 256	rounded
m	mud	<0.0625	mixture of silt and clay
p	pebbles	2-64	rounded
r	rubble	2-256	angular
s	sand	0.0625 - 2	
u	mesic		organic material, intermediate decomposition
x	angular fragments	>2	mixture of angular blocks and rubble
y	shells		consists of shells and/or shell fragments
z	silt	0.002 - 0.0625	

BEDROCK SUBCLASSES

When describing bedrock, a subclass precedes the surficial material descriptor (R), instead of using a textural term as above. Bedrock subclasses used on this map include:

LABEL	NAME
bs	basalt
ph	phyllite
ss	sandstone



1:50 000-scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION NATURAL RESOURCES CANADA

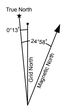
ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 9

CONTOUR INTERVAL 100 FEET
elevations in feet above mean sea level

SURFICIAL GEOLOGY
WATSON LAKE
YUKON

SCALE 1:50 000

0 1 2 3 4 5
kilometres



Use diagram to obtain numerical values
APPROXIMATE MEAN DECLINATION 2005
FOR CENTRE OF MAP: 24° 58' E
Annual change decreasing 18.4'

105A/6 MIDDLE CANYON	105A/7 TOM LAKE	105A/8 SUNRISE CREEK
105A/3 DODO LAKES	105A/2 **THIS MAP**	105A/1 BLIND LAKE
104P/14 OLD FADDY LAKE	104P/15 LUTZ CREEK	104P/16 LOWER POST

SURFICIAL MATERIALS

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. On the map, surficial materials form the core of the polygon label. They are symbolized with a single upper case letter, with texture written to the left, and surface expression to the right. If actual activity state is different than the assumed activity state (indicated in brackets next to the surficial material name below), a qualifier A (active) or I (inactive) must be used as a superscript following the surficial material designator. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that unit.

A — Anthropogenic (A): surficial materials so modified by human activities that their original physical properties (e.g., structure, cohesion, compaction) have been drastically altered. These materials commonly have a wide range of textures. They are typically formed by the removal of material from an original site followed by redeposition elsewhere. Includes landfills and tailings.

C — Colluvium(A): materials that have reached their present positions as a result of direct, gravity-induced mass movement involving no agent of transportation such as water or ice, although the moving material may have contained water and/or ice. Generally consists of massive to moderately well stratified, non-sorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks. Includes landslide debris, talus slopes and weathered mantles of till or bedrock.

E — Eolian (I): materials transported and deposited by wind action. Generally consists of medium to fine sand and coarse silt that is well sorted, non-compacted, and may contain internal structures such as cross-bedding or ripple laminae, or may be massive.
A thin veneer of silty loess (zEvw) between 5 and 30 cm thick is widespread throughout the map area over till and glaciofluvial deposits, especially in hollows and depressions. Inactive sand dune fields (sEr) are found immediately north and south of the Liard River, just east of Porter Lakes.

F / **F^A** — Fluvial (I): materials transported and deposited by streams and rivers. Deposits generally consist of gravel and/or sand and/or silt (and rarely, clay). Gravel is typically rounded and contains interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification. Includes floodplain, delta, fluvial terrace and fan deposits.

F^G — Glaciofluvial (I): materials that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice. Materials typically range from non-sorted and non-bedded gravel made up of a wide range of particle sizes, to moderately to well sorted, stratified gravel; flow tills may occur in some deposits. Hummocky or irregular terrain may be present and is indicative of collapse of the material due to melting of supporting ice. Kettles may occur on the surface of these deposits as a result of buried or partially buried ice melting out. Includes pitted outwash plains, kames and eskers.

M — Till (I): morainal material deposited directly by glacier ice without modification by any other agent of transportation. Morainal material can be transported beneath, beside, on, within and in front of a glacier. The physical characteristics of till deposits are highly variable and depend upon both the source of material incorporated by the glacier and the mode of deposition. In general, till consists of well compacted to non-compacted material that is non-stratified and contains a heterogeneous mixture of particle sizes, commonly in a matrix of sand, silt and clay.

L — Lacustrine (I): sediments that have settled in bodies of standing fresh water either from suspension or from underwater gravity flows, such as turbidity currents. Lacustrine sediments can also accumulate along lake margins through the action of waves. Sediments commonly consist of stratified fine sand, silt and/or clay deposited on the lake bed from suspension, or moderately to well sorted, stratified sand and coarser materials that are beach and other littoral sediments transported and deposited by wave action.

L^G — Glaciolacustrine (I): lacustrine materials deposited in or along the margins of glacial (ice-dammed) lakes, including sediments that were released by the melting of floating ice. Glaciolacustrine sediments include lake bed sediments consisting of stratified fine sand, silt and/or clay, they commonly contain ice-rafted stones and lenses of till and/or glaciofluvial material. Slump structures and/or their topographic expression, such as hummocky or irregular terrain, may be present and are indicative of collapse of the material due to melting of supporting ice. Kettles may occur on the surface of lake bed sediments as a result of the melting of buried or partially buried ice. A second type of glaciolacustrine deposite occurs as moderately sorted to well sorted, stratified sand and coarser beach sediments transported and deposited by wave action along the margins of glacial lakes.

O — Organic (A): sediments composed largely of organic materials resulting from the accumulation of vegetative matter; they contain at least 30% organic matter by weight (17% or more organic carbon). Organic materials are commonly saturated with water and consist mainly of the accumulated remains of mosses, sedges, or other hydrophytic vegetation in wetland settings.

R — Bedrock: Areas with bedrock outcrops, which may or may not be covered by a thin mantle (< 10 cm) of unconsolidated till, colluvium or organic materials.

SURFACE EXPRESSION

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the land surface. This three-dimensional shape of the material is equivalent to 'landform' used in a non-genetic sense (e.g., ridges, plain). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (e.g., veneer). Surface expression is indicated by up to three lower case letters, placed immediately following the surficial material designator, listed in order of decreasing extent.

a - Moderate slope: unidirectional (planar) surface; 16-26° (27-50%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m.

b - Blanket: a layer of unconsolidated material thick enough (>1 m) to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography; outcrops of the underlying unit are rare.

c - Cone: a cone or sector of a cone, mostly steeper than 15° (26%); longitudinal profile is smooth and straight, or slightly concave/convex; typically applied to talus cones.

d - Depression: circular or irregular area of lower elevation (hollow) than the surrounding terrain, >2 m deep, delimited by an abrupt break in slope steeper than the surrounding terrain; commonly applied to kettle holes and pitted outwash plains in glaciofluvial materials.

f - Fan: sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longitudinal profile is smooth and straight, or slightly concave/convex.

h - Hummock: steep sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15-35° (26-70%) if composed of unconsolidated materials, whereas bedrock slopes may be steeper; local relief >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to knob-and-kettle glaciofluvial terrain.

j - Gentle slope: unidirectional (planar) surface; 4-15° (7-26%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m.

k - Moderately steep slope: unidirectional (planar) surface; 27-35° (50-70%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m.

m - Rolling: elongate hillock(s); slopes dominantly between 3-15° (5-26%); local relief >1 m; in plan, an assemblage of parallel or sub-parallel linear forms with subdued relief (commonly applied to bedrock ridges and fluted or streamlined till plains).

p - Plain: a level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities generally <1 m; applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains.

r - Ridge: elongate hillock(s) with slopes dominantly 15-35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper; local relief is >1 m; in plan, an assemblage of parallel or sub-parallel linear forms; commonly applied to drumlinized till plains, eskers, morainal ridges, crevasse fillings and ridged bedrock.

s - Steep slope: unidirectional (planar) surface; >35° (70%) slope; longitudinal profile smooth and straight, or slightly concave/convex; relief of local surface irregularities generally <1 m; bedrock slopes may be more irregular; commonly applied to terrace scarps, gully side walls and bedrock cliffs.

t - Terrace: a single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface above it; applied to fluvial and lacustrine terraces and stepped bedrock topography.

u - Undulating: gently sloping hillock(s) and hollow(s) with multidirectional slopes up to 15° (26%); local relief >1 m; in plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile; commonly applied to till plains, sand dunes and kame topography.

v - Veneer: a layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material; 10 cm - 1m in thick; commonly applied to eolian/loess veneers and colluvial veneers.

w - Mantle of variable thickness: a layer or discontinuous layer of surficial material of variable thickness (0-3 m) that fills or partly fills depressions in an irregular substrate.

x - Thin veneer: a very thin layer of unconsolidated material, 2-20 cm thick.

GEOMORPHOLOGICAL PROCESSES

Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth's surface. Unless a qualifier (A (active) or I (inactive)) is used, all processes are assumed to be active, except for deglacial processes. Process is indicated by up to three upper case letters, listed in order of decreasing importance, placed after the surface expression symbol, and separated from the surface expression by a dash (-).

Subclasses can be used to provide more specific information about a general geomorphological process, and are represented by lower case letter(s) placed after the related process designator. Up to three subclasses can be attached to each process. Process subclasses used on this map are defined with the related process below.

EROSIONAL PROCESSES

V - Gully erosion: running water, mass movement and/or snow avalanching, resulting in the formation of parallel and sub-parallel long, narrow ravines.

FLUVIAL PROCESSES

I - Irregularly sinuous channel: a clearly defined main channel displaying irregular turns and bends without repetition of similar features; backchannels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent.

J - Anastomosing channel: a channel zone where channels diverge and converge around many islands. The islands are vegetated and have surfaces that are relatively far above mean maximum discharge levels. Some channels are dry at moderate or low flows.

M - Meandering channel: a clearly defined channel characterized by a regular and repeated pattern of bends with relatively uniform amplitude and wave length.

Q - Beaver damming: interruption of regular fluvial transport by beaver dams leading to widespread and repeated ponding.

MASS MOVEMENT PROCESSES

F - Slow mass movements: slow downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding.

Subclasses: (k) tension cracks - fissures commonly near the crest of a slope; (u) slump: sliding of internally cohesive mass of surficial material along a slip plane that is concave upward or planar.

R - Rapid mass movements: rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris derived from surficial material and/or bedrock.

Subclasses: (') initiation zone - headscarps of debris slides or earthflows and source areas for rockfall and debris flows; (d) debris flow - rapid flow of saturated debris; (m, u) slump - sliding of internally cohesive masses of bedrock (m) or surficial material (u) along a slip plane that is concave upward or planar; (r) rockslide - sliding mass of disintegrating bedrock; (s) debris slide - sliding mass of disintegrating surficial material.

PERIGLACIAL PROCESSES

C - Cryoturbation: movement of surficial materials by heaving and/or churning due to frost action (repeated freezing and thawing).

X - Permafrost processes: processes controlled by the presence of permafrost, and permafrost aggradation or degradation.

Subclasses (e) - thermokarst: depressions created by melting of ice-rich permafrost due to heat transfer from water bodies; (t) - surface depressions created by the thaw of ice-rich permafrost and resulting soil subsidence.

DEGLACIAL PROCESSES

E - Channeled by meltwater: erosion and channel formation by meltwater alongside, beneath, or in front of a glacier.

H - Kettled: depressions in surficial materials resulting from the melting of buried glacier ice.

SELECTED REFERENCES

Anderson, L., Abbott, M.B., Finney, B. and Edwards, M.E., 2002. The Holocene lake-level history of Marcella Lake, southern Yukon Territory, Canada. Geological Society of America, Northeastern Section, 37th annual meeting, Springfield, MA, Session No. 19 Program Abstract.

Gabrielse, H., 1967. Geology, Watson Lake, Yukon Territory. Geological Survey of Canada Map 19-1966, 1:250 000 scale.

Howes, D.E. and Kenk, E. (ed.), 1997. Terrain classification system for British Columbia (version 2). Province of British Columbia: Resource Inventory Branch, Ministry of Environment, Lands and Parks; Recreational Fisheries Branch, Ministry of Environment, and Surveys and Mapping Branch, Ministry of Crown Lands. (Available online at http://srmwww.gov.bc.ca/risc/pubs/teecolo/terclass/).

Jackson, L.E., Jr., Ward, B., Duk-Rodkin, A. and Hughes, O.L., 1991. The Last Cordilleran Ice Sheet in Southern Yukon Territory. Géographie physique et Quaternaire, vol. 45, no. 3, p. 341-354.

Klassen, R.W. and Morison, S.R., 1981. Surficial geology, Watson Lake, Yukon Territory. Geological Survey of Canada Map 21-1981, 1:250 000 scale.

Klassen, R.W., 1987. The Tertiary Pleistocene stratigraphy of the Liard Plain, southeastern Yukon Territory. Geological Survey of Canada Paper 86-17, p. 16.

Lavkulich, L.M., Walmsley, M.E. and Beale, R.L., 1973. Physical environmental studies, Watson Lake area, Yukon Territory. Indian and Northern Affairs Canada, Arctic Land Use Research Program (ALUR) Final Report 72-73-01.

Lipovsky, P.S. and McKenna, K., 2005. Local-scale biophysical mapping for integrated resource management, Watson Lake area (NTS 105A/2), Yukon. Yukon Geological Survey, Energy, Mines and Resources, Yukon Government, Open File 2005-6, report and CD-ROM, 74 p.

McKenna, K. and Lipovsky, P.S., 2005. Biophysical map of Watson Lake area (NTS 105A/2), Yukon (1: 50 000 scale). Yukon Geological Survey, Energy, Mines and Resources, Yukon Government, Open File 2005-8.

Ryder, J.M. and Howes, D.E., 1986. Terrain information: a user's guide to terrain maps in British Columbia. Government of British Columbia. (Available online at http://srmwww.gov.bc.ca/terrain/inventory/guide/index.html).

ACKNOWLEDGEMENTS

This work was funded in part by the Knowledge and Innovation Fund of the Department of Indian and Northern Affairs Canada. Mapping would not have been possible without the invaluable assistance of Rob Legare at the Forest Management Branch (Yukon Energy, Mines and Resources), as well as Jan Adamczewski and Riley Brodhagen at the Watson Lake Fish and Wildlife Branch (Yukon Environment).

RECOMMENDED CITATION

Lipovsky, P.S., McKenna, K. and Huscroft, C.A., 2005. Surficial geology of Watson Lake (NTS 105A/2), Yukon (1: 50 000 scale), Yukon Geological Survey, Energy, Mines and Resources, Yukon Government, Open File 2005-7.

Digital cartography and drafting by P.S. Lipovsky using ArcGIS 9.0. Mapping based on hard-copy and soft-copy (using MicroStation Diap Viewer) air photo interpretation using 1:40 000-scale 1998/1999 photos. Field checking was performed in summer 2004.

Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey.

Paper copies of this map, the accompanying report and Yukon MINFILE may be purchased from Geoscience Information and Sales, c/o Whitehorse Mining Recorder, Energy, Mines and Resources, Yukon Government, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5. Ph. 867-667-5200, Fx. 867-667-5150, Email geosales@gov.yk.ca.

A digital PDF (Portable Document File) file of this map may be downloaded free of charge from the Yukon Geological Survey website: http://www.geology.gov.yk.ca.

SYMBOL LEGEND

building
campground
airstrip
seaplane base
tank
tower
lake
stream
topographical contour
trail
highway, paved
main road, loose surface
secondary road (paved, loose surface)
street (paved, loose surface)

field observation site
observation of frozen ground
C14 radiocarbon dated wood sample
stratigraphic section site
gravel pit
kettle hole
landslide headwall and track
sand dunes
streamlined landform (drumlins, flutings, grooves)
terrain boundary (defined, approximate)
meltwater channel
scarp
esker
tension crack

site number (04WLXXX)
years

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2005-7

Surficial Geology of Watson Lake Area (NTS 105A/2), Yukon (1:50 000 scale)

by

P.S. Lipovsky[1], K. McKenna[2], and C.A. Huscroft[1]

[1] Yukon Geological Survey
[2] Cryogeographic Consulting