



Mapping and classifying
wetlands and adjacent
upland habitat in the Indian
River valley, Yukon

Draft Report

Prepared for

Government of Yukon

May 23, 2017

May 23, 2017

Briar Young and Derek Fraser
Energy, Mines and Resources
and
Bruce McLean
Yukon Environment

Dear Messrs. Young, Fraser and McLean,

Re: [Mapping and classifying wetlands and adjacent upland habitat in the Indian River valley, Yukon](#)

CryoGeographic Consulting, in association with Palmer Environmental Consulting Group Inc., is pleased to provide Yukon Energy, Mines and Resources and Yukon Environment with the results of the mapping and classification of wetlands and adjacent upland habitat in the Indian River valley and its major tributaries.

Five classes of wetlands are distinguished – bogs, fens, swamps, marshes and shallow water – based on field investigations and interpretation of high-resolution aerial photography and satellite imagery.

Should you have any questions, please do not hesitate to contact Karen McKenna at 867-335-0191 or kmckenna@northwestel.net.

We appreciate the opportunity to work on this interesting and important project.

Yours truly,

CryoGeographic Consulting



Karen McKenna

Distribution List

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Revision Log

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Table of Contents

Letter
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1	Introduction	1
1.1	Geological setting.....	1
1.2	Wetlands Overview	2
2	Methods	3
2.1	Desktop Methods	3
2.1.1	Polygon Classification.....	4
2.2	Map Legend	7
2.3	Field Work.....	7
2.4	Final mapping.....	8
2.4.1	Limitations of the mapping.....	8
3	Description of Wetland Classes	9
3.1	Bogs	9
3.2	Fens	9
3.3	Swamps	10
3.4	Marshes	10
3.5	Shallow Water	10
4	References.....	11

List of Figures

Figure 1.	Original (blue) and Expanded (pink) Mapping Study Areas and Placer Claims (orange) within the Indian River Valley.....	2
Figure 2.	Systematic Procedure for Mapping and Classifying Wetlands and Adjacent Upland Habitat in the Indian River Valley	4

List of Tables

Table 1.	Key Factors Distinguishing Different Wetland Classes	6
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List of Appendices

Appendix A.	Field Form Sample
Appendix B.	Imagery Data Sources Consulted

1 Introduction

This report accompanies and explains the mapping of wetlands and adjacent upland habitat in the Indian River valley. The principal objective of the Indian River wetland mapping is to delineate, classify and describe existing wetland areas (and adjacent upland habitat) within the Indian River valley and its major tributaries (Figure 1). The description of the wetlands includes their distribution within the map area, associated landforms, soils, permafrost conditions, vegetation and (where possible) hydrological conditions. This mapping will provide technical support for decision bodies, regulators, project proponents, industry, environmental assessors and First Nations. The mapping will also assist with assessment of cumulative effects.

The mapping establishes the distribution of different classes of wetlands within undisturbed parts of the Indian River valley study area. The mapped wetlands consist of bogs, fens, swamps, marshes and shallow water¹. There are also wetlands in the disturbed and mined areas – mostly swamps, marshes and shallow water – which were not mapped. Wetlands are also common in the unmapped areas and adjacent valleys throughout the region. Although similar wetlands are found throughout the Klondike Plateau, the Indian River valley is broader than many other valleys and thus contains more extensive wetlands.

The initial mapping study area focused on the mainstem of the upper Indian River valley, but was doubled in area early in late 2017 to include more tributary valleys and the lower Indian River valley (Figure 1).

1.1 Geological setting

The Indian River is a meandering river in a broad valley within the unglaciated Klondike Plateau. Old fluvial and glaciofluvial terraces, more widespread on the south side of the valley, mark the channels of former Pleistocene and/or Pliocene rivers draining glaciers from the east (Froese and Jackson 2005). The active river channel follows the right (northeast) margin of the valley, commonly cutting into the Klondike muscovite-chlorite-quartz-feldspar schist, quartzite, gneiss or amphibolite bedrock (Gordey and Ryan 2005). The fluvial and glaciofluvial sands and gravels are overlain in most places by extensive reworked and resedimented loess (wind-blown silt and fine sand) known by placer miners as “muck”, and a surface organic layer of variable thickness.

Permafrost is discontinuous but extensive throughout most of the study area (Bonnaventure and Lewkowicz 2012) except beneath and immediately adjacent to the active river channel, which maintains a localized ‘talik’ of unfrozen ground. Permafrost, at least near-surface, has disappeared from some of the areas most severely altered by anthropogenic activities. It is found close to the surface, within 1.2 metres, in most wetlands and many of the uplands investigated as part of this project. At several locations on the old fluvial terraces, thermokarst has outlined ice-wedge polygons visible in high-resolution imagery. It is expected that the distribution of these ice wedges extends throughout most of the fine textured loess overlying the old floodplain and glaciofluvial terraces, which are slightly higher than the active river and creek floodplains.

¹ The simpler term ‘shallow water’ is used throughout this report, in accordance with nomenclature in *Boreal Low Zone of Yukon: A Field Guide to Ecosite Identification* (Environment Yukon, in press), but it is synonymous with the original term ‘shallow open water’, established in *The Canadian Wetland Classification System* by the National Wetlands Working Group (1997).

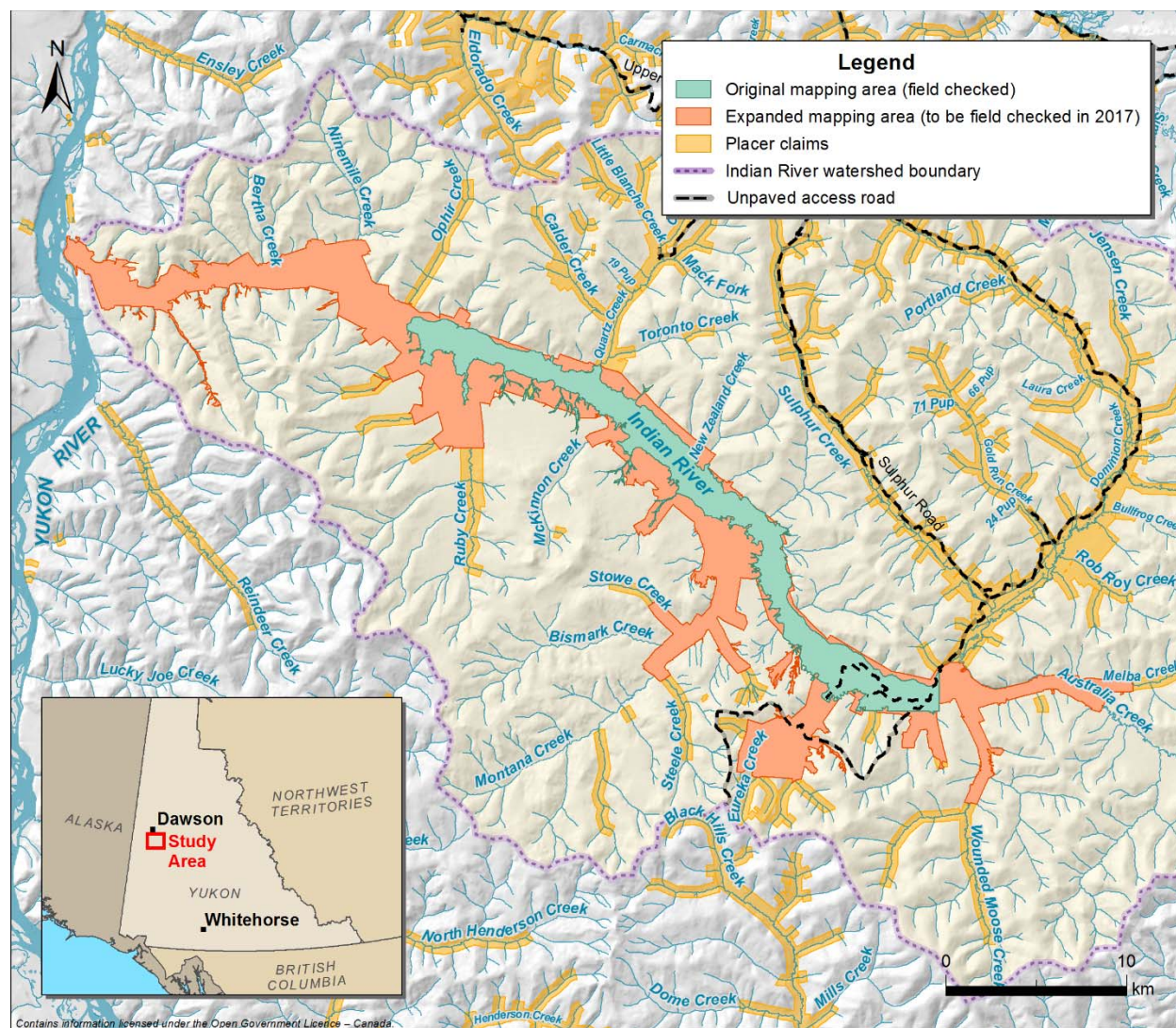


Figure 1. Original (blue) and Expanded (pink) Mapping Study Areas and Placer Claims (orange) within the Indian River Valley

1.2 Wetlands Overview

Wetlands are lands that are saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity that are adapted to a wet environment (Canadian Wetland Working Group 1998).

Wetlands, fens, swamps, bogs, marshes and shallow water are common throughout much of the undisturbed portions of the Indian River valley. These wetlands are the focus of this mapping project. Shallow water, marsh and swamp wetlands found in the disturbed and mined portions of the valley (Chevreux and Clarkson 2015) have not been mapped as part of this project. Ducks Unlimited is currently mapping these wetlands.

Wetlands are found on the fluvial and glaciofluvial terraces above the river, as well as in the drainages and fans that drain the surrounding uplands. They are also found on the current floodplain of the Indian River, which is incised into the older fluvial sediments. Based on the distribution of old meander scars and abandoned oxbows, the modern river channel appears to be gradually migrating towards the north side of the valley (Bond, pers. com.) leaving broad areas of fen, swamp and bog wetlands south of the current river. There are also wetlands found on the north side through the central part of the map area. Peat ranges from about 0.2 to more than 1.3 meters deep, based on representative, hand-dug soil pits or hand-auger holes excavated in association with this project. The deepest peat appears to be located on the old floodplain south of the Indian River. Where the peat fills old oxbows, the peat is likely even deeper. Wetlands extend along most of the tributary valleys draining the uplands south and east of the Indian River valley.

The most common mapped wetland classes are fens and swamps. Wetlands are dynamic ecosystems, however, and natural transitions from one wetland class to another commonly occur over decades to centuries. Disturbances, both natural (fire, succession, flooding, climate change) and human-generated (trenching, regrading, drainage alteration, vegetation disturbance, vehicle travel), can alter natural conditions, and the succession within and adjacent to the disturbance.

2 Methods

2.1 Desktop Methods

The wetland mapping project began by compiling and reviewing the available data including surficial geology mapping, preliminary draft wetland mapping by Jeff Bond (Yukon Geological Survey (YGS)), permafrost probability mapping (Bonnaventure and Lewkowicz 2012), and geological reports. Mapping commenced once the available data, imagery and digital aerial photography were acquired.

High- (2009, 2010) and medium-resolution (2013, 2016) colour satellite imagery available from Geomatics Yukon covered the whole area with good correlation to the base map data (list of consulted imagery data sources included in Appendix A). This imagery was used in ArcMap to interpret, delineate and classify wetland polygons and adjacent upland habitats. The 2016 SPOT imagery, first available in February 2017, was used to interpret the additional map areas completed after that date and to delineate the extent of the highly disturbed mined areas throughout the whole study area. Aerial photograph stereo-imagery (1989, 1995) was reviewed, mainly in association with QA/QC checks of the draft mapping, but poor georeferencing of the photos (± 25 m) relative to the satellite imagery and base mapping data precluded its direct use in polygon delineation. Interpretations were completed at a view scale larger than 1:10,000 (e.g., up to 1:5,000) to allow map production at a scale of 1:10,000.

2.1.1 Polygon Classification

A flow chart outlining the stepwise procedure used to interpret and map wetlands and adjacent upland habitat is provided in Figure 2. Polygons were classified according to cover type class according to the Yukon Vegetation Inventory Manual (Energy, Mines and Resources, 2014). If polygons represented disturbed anthropogenic landforms where major landform alteration had occurred, no further classification was completed.

The undisturbed portion of the landscape was further classified. Wetland polygons were distinguished by wetland class. Upland areas were classified according to the tree species present or, in the case of non-forested polygons, by physiognomic class (Yukon Vegetation Inventory 2014). Figure 2 illustrates the general work flow and, when viewed in conjunction with the information presented below, codifies the mapping procedure.

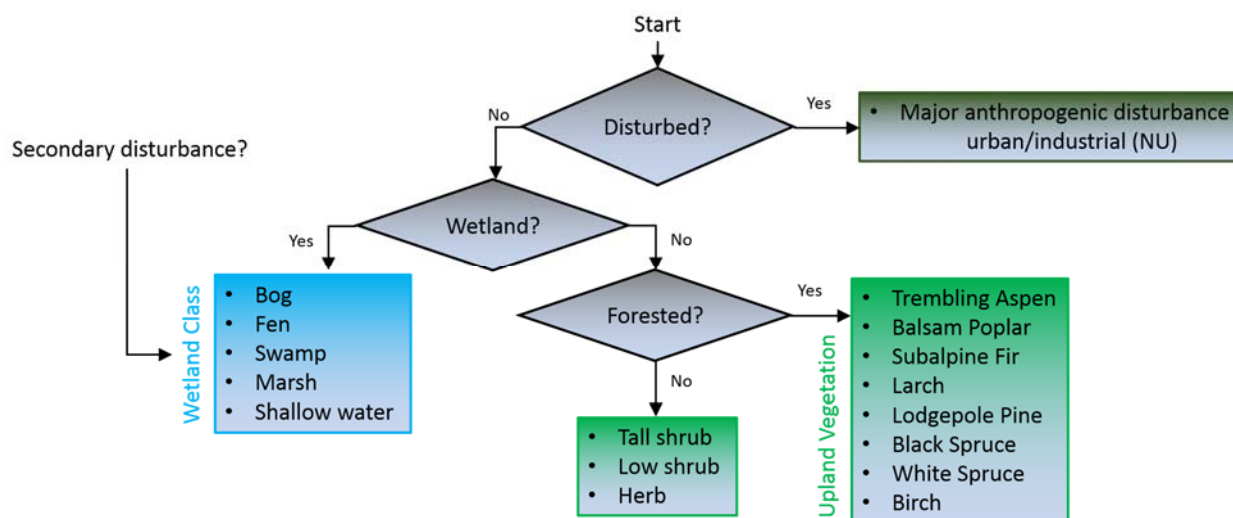


Figure 2. Systematic Procedure for Mapping and Classifying Wetlands and Adjacent Upland Habitat in the Indian River Valley

The following fields are characterized for each polygon, where applicable.

Cover type – The cover type class was interpreted for each polygon (Energy Mines and Resources 2014). The classes mapped include:

Code	Cover type class	Description
NU	industrial/urban	Anthropogenic landform. Developed land such as municipalities, mines and gravel pits
NW	water	Lakes and rivers. Note: no lakes were presented within the study area, and the river itself was not digitized separately.
VF	vegetated forested	Polygons with greater than or equal to 10% tree cover
VN	vegetated non-forested	Polygons with less than 10% tree cover
BR	bedrock	Steep bedrock exposures

Wetland Class – Each polygon was also classified as a wetland or upland (National Wetlands Working Group 1997). The wetlands were classified as 1 of 5 classes, or in some cases as a complex of 2 wetland classes where they could not be differentiated due to the scale of mapping. If more than one class is indicated, the proportion of each class (decile) is also indicated:

Code	Wetland class
B	bog
F	fen
S	swamp
M	marsh
W	shallow water (<2 m deep)

Upland Vegetation – Uplands were classified by tree cover and the relative proportion (decile) of each species within a polygon, or by the non-forested class for non-forested polygons (codes are from Energy Mines and Resources 2014):

Code	Upland vegetation (tree species/non-forested class)
Sw	White spruce ¹
Sb	Black spruce ¹
A	Aspen
B	Balsam poplar
W	Alaska birch
TS	Tall shrub
LS	Low shrub
HE	Herbaceous

¹ Many areas on the floodplain of the Indian River and some lower slopes appear to consist of a mixed tree cover of black and white spruce and hybrids (similarly noted from other parts of central Yukon, Bennett, pers.com.). The tree cover in these locations has been noted as **SwSb** with no corresponding cover indicator.

Disturbance – Two degrees of disturbance are represented in the mapping. Highly disturbed polygons, where major land alteration has occurred, include features such as mined pits, overburden piles, tailings ponds, and recontoured landscapes. Such highly disturbed areas have been assigned a cover type class of NU, in addition to being identified as Disturbed (D) in the digital database. Disturbances also includes areas of more subtle changes such as clearing, extensive vehicle tracks, and changes to natural drainage patterns, which have resulted in changes to the wetland polygon. Such modestly disturbed areas are identified solely by a D in the Disturbed Field.

Code	Disturbed?
D	Minor disturbance by anthropogenic activities to vegetation and/or soils at surface, but with limited to no alteration to the underlying materials/landforms such as is the case for polygons classified as NU
	Polygon is largely undisturbed (no code assigned)

Table 1 summarizes the key factors that distinguish different wetland classes.





Table 1. Key Factors Distinguishing Different Wetland Classes

Wetland Class	Site/Terrain	Moisture	Soils	Overstorey Vegetation	Groundcover Vegetation
BOGS	Low terraces along river, surrounded by fen	SMR 6-7; may appear dry on surface	Poorly decomposed peat; permafrost; Fibric Organic Cryosols	Open to sparse stunted black spruce; low shrub cover of Labrador tea, shrub birch	Sphagnum moss and Cladina/Cladonia lichen
	Steep north facing slopes at edge of valley	SMR 6; may appear dry at surface	40-60 cm poorly decomposed peat; permafrost; Terric Fibric Organic Cryosols	Open to sparse stunted black spruce; low shrub cover of Labrador tea, shrub birch	Sphagnum moss and Cladina/Cladonia lichen
FENS	Gently sloping terraces along river and drainages	SMR 6-8	Variable depth of peat from 20 cm to greater than 1 metre	Extensive shrub cover willow, shrub birch, Chamaedaphne, Labrador tea; sparse black or white spruce	Sedge tussocks (<i>Eriophorum vaginatum</i> and <i>Carex lugens</i>)
	Old meander scars or channels along old trails	SMR 6-8; water table often at surface	Greater than 40 cm poorly decomposed peat; deep active layer often greater than 1 metre	Few trees or shrubs	Sedges dominated by <i>Carex aquatilis</i> , <i>C. utriculata</i>
SWAMPS	Adjacent to river or oxbows	SMR 6-7; signs of fluctuating water table within about 30 cm of surface	Mineral soils; Gleyed Regosol or Gleysol soils	Dominated by willow and alder and some balsam poplar	Horsetails, groundcover may be sparse
	Adjacent to river or oxbows	SMR 6-7; signs of fluctuating water table within about 30 cm of surface	Mineral soils, permafrost usually present; moderately well decomposed peaty surface horizon may be present	Decadent white and/or black spruce; willow, Labrador tea understory may be present	Moss, horsetails
	Gently sloping terraces often between fens and uplands	SMR 6-7; signs of fluctuating water table within about 30 cm of surface	Mineral soils, permafrost usually present; moderately well decomposed peaty surface horizon may be present	White or black spruce with willow, Labrador tea understory	Mixed groundcover of moss, ground shrubs, lichen, sparse tussocks, <i>Tomenhypnum nitens</i> , Sphagnum moss
MARSHES	In oxbows near rivers	SMR 7-8; frequently flooded	Mineral soils; Gleysols	Trees and tall shrub cover less than about 10%	Dominated by sedges, horsetails, wetland plants
SHALLOW WATER	In old oxbows or old test pits; may also be found adjacent to placer mining disturbance	SMR 9	Stable water regimes usually have limnic peat or limnic peat interspersed with mineral sediments	-	Emergent and submergent aquatic plants

2.2 Map Legend

Map symbolization was designed to highlight the distribution and classification of wetlands. Each of the five wetland classes was represented by a standardized colour. Non-vegetated urban/anthropogenic disturbance areas were shaded lightly (transparent white) and denoted using a stippled pattern; other uplands are only shaded lightly. Labels were used to differentiate cover types and distinguish different species codes. Complexes are indicated by the proportion of each component (decile). The final depiction of wetlands, cover types and species codes is included below.

Wetland Class

	Bog (B)
	Fen (F)
	Marsh (M)
	Swamp (S)
	Shallow water (W)
	Non-vegetated urban/anthropogenic (NU)

Cover Type

VF	Vegetated forested
VN	Vegetated non-forested
/D	Minor disturbance by anthropogenic activities to vegetation and/or soils at surface, but with limited to no alteration to the underlying materials/landforms such as is the case for polygons classified as NU.

Species Code

Sw	White spruce	W	Alaska birch
Sb	Black spruce	TS	Tall shrub
A	Aspen	LS	Low shrub
B	Balsam poplar	HE	Herbaceous

2.3 Field Work

Ground truthing (field checking) of the preliminary desktop interpretations was undertaken within the original mapping area in September 2016 (Figure 1). Expansion of the mapping area following the field program has not yet been followed by any field checks. The limits of the representative field checking are depicted on the accompanying final map set. Early fall is a good time of year to study soils in permafrost regions, to determine the depth of the peat and active layer, and to examine as much of the soil as possible with a hand auger at the time of maximum thaw. The vegetation is slightly more challenging to identify in September as many plants have gone to seed at this time of year. However, because the focus of the project was to map wetland class and not to identify rare species occurrences or to provide detailed vegetation lists, September field work was appropriate.

Thanks to Schmidt Mining, the field crew consisting of Karen McKenna (project lead and wetland mapper) and Dirk Janas (vegetation ecologist) had excellent accommodation and food at the Schmidt placer mining camp on Quartz Creek. The camp also provided easy access to the Indian River valley. Most areas were accessed by truck along placer mining roads and foot traverses. Seven days were spent checking as many polygons and wetlands as possible.

Much of the field data were compiled on Yukon Environment's draft site visit and vegetation forms, including GPS location, terrain factors, important soil characteristics, wetland class and detailed vegetation lists and cover (sample form in Appendix B). It was decided that the forms provided a good summary of the data required to distinguish different wetland classes and assist with understanding and describing the wetland

classes. Data collected included tree, shrub and graminoid cover, depth of peat, depth to water table and depth to permafrost. pH was also measured at numerous locations to help classify the wetlands. The forms also provided a good way to standardize the data collection. Notes, photographs and quick checks were made at additional sites, recorded by waypoint locations.

YGS' Jeff Bond and Syd Van Loon provided the opportunity for a helicopter overview flight to access parts of the valley inaccessible by road, take photographs of the valley from oblique aerial perspectives, identify limits of the most recent placer development (since acquisition of the 2013 satellite imagery) and check wetland delineations from the air.

Numerous stakeholders were interested in accompanying the field crew to gain an introduction to the wetlands and the methods used for the mapping. Interested parties were invited to visit the wetlands on two separate days following the originally planned field work. Randy Clarkson (KPMA), Adam Thom (THFN), Jeff Schuyler, Johnny Nunan, Tyson Bourgard (Compliance Monitoring and Inspections EMR, Dawson City), Bruce McLean, John Ryder, (Environment Yukon - Whitehorse), Mike Suitor (Environment Yukon - Dawson City) and Katie Fraser (YESAB - Dawson City) all spent a day assisting with additional data collection and becoming more familiar with the wetlands in the Indian River valley and the mapping process.

2.4 Final mapping

Following the field work, the mapped polygons were reinterpreted and refined based on the data and knowledge gained from the field work. Mapping was also extended to the lower Indian River, as well as southern tributaries including Ruby, McKinnon, Montana, Eureka, Wounded Moose and Australia Creeks, where field checks have yet to be completed. Wetland polygons were extended to the boundaries of the placer claims along each creek throughout the complete area. A final update to the mapping was completed in late March 2017 to include the recent placer mining activity based on the new imagery from 2016.

2.4.1 Limitations of the mapping

The wetland map of the Indian River valley reflects the best interpretation possible based on the available imagery and aerial photographs, and the experience of the interpreter. However, even at a mapping scale of 1:10,000, inclusions of non-wetland may be included in a wetland polygon and vice versa due to inherent landscape heterogeneity at that scale. Inclusions of different wetland classes may also be found within polygons mapped as another class.

Mapping is dependent on how the vegetation cover is reflected in the imagery. Areas that were burned in a 2004 forest fire show significant shrub cover in wetlands and in uplands, complicating the distinction between wetlands and uplands. Distinguishing some swamps from moist upland polygons can be difficult even with the good quality available imagery. Field visits may be required to confirm site-specific classifications.

The mapping represents a snap-shot in time of wetland type and distribution in the valley, in this case in 2013 with refinements based on 2016 field observations and a review of available 2016 imagery coverage.

3 Description of Wetland Classes

The definitions of wetland classes in the following paragraphs are simplified from those provided in *The Canadian Wetland Classification System* (National Wetlands Working Group, 1997). The descriptions and discussion of distribution are based on CryoGeographic's field work in September 2016.

3.1 Bogs

Bogs are peat landforms characterized by a surface raised above the surrounding terrain, receiving water from precipitation but virtually unaffected by any groundwater flow. The pH of the soil and soil water is low, usually less than pH 4.8. The surface of the bogs is usually fairly dry (usually providing much easier walking than other wetland classes).

Bogs are sparsely mapped in the study area. Typically, Yukon bog soils are frozen close to the surface, though the bogs investigated in September 2016 were generally found to be unfrozen to 60 to 100 cm. Many of the bogs investigated had wetter parts within them. Bogs in the Indian River valley are usually characterized by stunted black spruce vegetation, *Sphagnum fuscum* moss and, on the driest undisturbed sites, a high *Cladina* lichen cover. Other species such as Labrador tea, bog cranberry, cloudberry, low bush cranberry and crowberry are also typical. Lower pockets may consist of *Sphagnum capillifolium*, *S. girgensohnii*, brown mosses and various sedges.

Bogs are found in two different landscape positions in the Indian River valley. They are associated with deep peats on old river deposits, usually surrounded by fens. They are also found on steep, northerly facing slopes on the valley sides, where the cooler temperatures are associated with permafrost, slow decomposition of organic material and accumulation of peat under *Sphagnum* moss. The peat on these slopes is usually more than 30 cm thick but generally thinner than in the bogs on the valley floor.

3.2 Fens

Fens are peatlands influenced by minerotrophic groundwater, rich in dissolved minerals, and therefore have a higher pH and are more productive than bogs. Slow groundwater and sometimes surface water flow are characteristic. The water table is usually at or just below the surface, and peat is composed of moderately decomposed sedge or brown moss peat. Fens can range from rich fens, dominated by herbaceous vegetation, to poor fens, with lower pH and nutrients and with many vegetation species in common with bogs.

Fens are very common in the Indian River valley. The depth of peat in fens within the study area varies from about 20 cm to more than 2 m. The pH is typically in the range of 5.5 to 7. The ground vegetation of fens is typically dominated by sedge and moss communities. In the Indian River valley, the most extensive fens are characterized by sedge tussocks, which may be of two different species: Tussock cottongrass (*Eriophorum vaginatum*) and muskeg sedge (*Carex lugens*). There tends to be a transition between the driest fens, which may have black, white and hybrid spruce trees (Bennett pers. com.); to shrub fens with shrub birch, leatherleaf (*Chamaedaphne calyculata*), willow (*Salix* spp.) and sedge tussocks; to wetter fens

dominated by sedge tussocks and fewer shrubs. The wettest fens occur in channels with more water flow and are usually dominated by *Carex utriculata*. The deeper peat (difficult to assess where the soils are frozen) appears to be found on the old floodplain of the Indian River in old meander scars.

3.3 Swamps

A swamp is a tall shrub or tree dominated wetland (usually >25% cover of woody species) that is influenced by minerotrophic groundwater. Swamps are characterized by well decomposed woody peat and can be either peatlands or non-peatlands. They typically have a fluctuating water table.

Swamps are one of the most common wetland classes in the study area. On the Indian River floodplain, there are willow and alder shrub swamps adjacent to the river that are frequently inundated by flood water. There are also coniferous treed swamps affected by a shallow water table and a shallow depth to permafrost. These may also be subject to flooding. The swamps are interspersed with white and black spruce riparian forest. The spruce trees in the swamps are usually slightly smaller and leaning (“drunken”), or with numerous dead branches, and the ground cover includes species indicating a shallow water table. Similar but narrow bands of coniferous treed floodplain forest and shrub swamps are also found along smaller tributary creeks.

Another type of swamp is found along the margins of the fens on the higher terraces where the black spruce coniferous swamps transition to adjacent uplands. These swamps generally have taller trees and a denser tree canopy than the fens, however growth is severely limited by excess water and underlying permafrost. These swamps are also slightly drier than fens, with more shrubs and lichen, but still show a significant cover of sedge tussocks.

3.4 Marshes

A marsh is a minerotrophic wetland with a near-surface water table that fluctuates daily, seasonally, or annually. Water levels may vary from year to year. Marshes are characterized by herbaceous sedge, grass or forb vegetation.

Marshes are not widespread in the study area but are common in recently abandoned meander channels of the Indian River. Grasses dominated by *Calamagrostis canadensis*, diverse sedges including *Carex utriculata*, *C. aquatilis*, and *Scirpus* sp., *Juncus* sp., and *Equisetum fluviatile* are typical dominant species in these marshes.

3.5 Shallow Water

Shallow water wetlands have standing or flowing water less than 2 m deep in mid-summer. Shallow water wetlands are transitional between seasonally wet (i.e. bog, fen, marsh or swamp) and permanent, deep water bodies. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods. Shallow waters are subject to aquatic processes typical of upper limnetic or infralittoral lake zones, such as nutrient and gaseous exchange, oxidation and decomposition.

The shallow water wetland class excludes artificial water bodies (reservoirs, impoundments and dugouts), where water regimes have been manipulated. As such, *active* tailings ponds, with controlled inputs and outputs, have not been mapped as shallow water wetlands. *Abandoned* tailings ponds that appear less than 2 m deep and are subject to natural aquatic processes typical of upper limnetic or infralittoral lake zones have been included.

Shallow waters are variously called ponds, pools, shallow lakes, oxbows, sloughs, reaches or channels. They may occupy portions of larger wetlands or bays and margins of profundal lakes. In the Indian River valley, these wetlands may be surrounded by fens, marshes, swamps and/or riparian forest. Aquatic submergents, such as pondweeds and bladderworts, and emergent, including cattails and rushes (*Juncaceae*), usually characterize the vegetation.

4 References

Bennett, Bruce, pers. com. Bruce Bennet has identified hybrid spruce in other parts of central Yukon similar in appearance to those recorded in the Indian River valley.

Bonnaventure P.P. and A.G. Lewkowicz. 2012. Yukon Permafrost Probability map. http://permafrost.gov.yk.ca/data/permafrost_probability_map/

Chevreux A. and Clarkson R. 2015. Best Management Practices for Placer Mining in Yukon Wetlands, Recommendations and Guidelines. Prepared for Klondike Placer Miners Association, draft for Review. Whitehorse Yukon.

Energy, Mines and Resources Yukon. 2014. Yukon Vegetation Inventory Manual. Version 3.1. Department of Energy Mines and Resources, Forest Management Branch, Government of Yukon, Whitehorse, Yukon, iii + 46 pp.

Environment Yukon. 2016. Yukon Ecological and Landscape Classification and Mapping Guidelines. Flynn, N. and Francis. S. (eds). Version 1.0. Department of Environment, Policy, Planning & Aboriginal Relations Branch, ELC Program, Government of Yukon, Whitehorse, Yukon.

Froese, D.G. and Jackson L.E. 2005. Surficial Geology Grand Forks, Granville, Reindeer Mountain, Yukon Territory; GSC Open Files 4587, 4588, 4591.

Gordey, S.P. and Ryan J.J. 2005. Geology of Stewart River area (115N, 115O and part of 115J) Yukon Territory. GSC Open File 4970.

National Wetlands Working Group. 1997. The Canadian Wetland Classification System 2nd edition. Wetlands Research Centre, Univ. of Waterloo, Waterloo, Ontario

Appendix A

Imagery Data Sources Consulted

HIGH RESOLUTION SATELLITES:

Acquisition Date: 14-Jul-2009
File Name: GeoEye_Klondike_88_1_0-4_50cm_14July2009_NAD_1983_UTM_Zone_7N
Sensor: GeoEye-1
Project Area: Klondike Region
Pixel Resolution (m): 0.5
Cloud Cover (%): 40
Horizontal Accuracy (m): 1.5
Licensee: Yukon government

Acquisition Date: 25-Jul-2009
File Name: GeoEye_Klondike_88_0_1-6_50cm_25July2009_NAD_1983_UTM_Zone_7N
Sensor: GeoEye-1
Project Area: Klondike Region
Pixel Resolution (m): 0.5
Cloud Cover (%): 35
Horizontal Accuracy (m): 1.5
Licensee: Yukon government

Acquisition Date: 03-Aug-2010
File Name: GeoEye_Klondike_97_0_0-3_50cm_03Aug2010_NAD_1983_UTM_Zone_7N
Sensor: GeoEye-1
Project Area: Klondike Region
Pixel Resolution (m): 0.5
Cloud Cover (%): 55
Horizontal Accuracy (m): 1.5
Licensee: Yukon government

MEDIUM/LOW RESOLUTION SATELLITES:

Acquisition Date: 07-Oct-2016
File Name: SPOT6_IndianR_RGB_1500cm_07Oct2016_NAD_1983_UTM_7N
Sensor: SPOT-6
Project Area: Indian River Disturbance Updates (2016)
Pixel Resolution (m): 1.5
Cloud Cover (%): 0
Horizontal Accuracy (m): 3
Licensee: Yukon government

Acquisition Date: 08-Oct-2016
File Name: SPOT6_IndianR_RGB_1500cm_08Sep2016_NAD_1983_UTM_7N
Sensor: SPOT-6
Project Area: Indian River Disturbance Updates (2016)
Pixel Resolution (m): 1.5
Cloud Cover (%): 0
Horizontal Accuracy (m): 3
Licensee: Yukon government

Acquisition Date: 09-Oct-2016
File Name: SPOT6_IndianRiver_RGB_1500cm_09Oct2016_NAD_1983_UTM_Zone_7N
Sensor: SPOT-6
Project Area: Indian River Disturbance Updates (2016)
Pixel Resolution (m): 1.5
Cloud Cover (%): 0
Horizontal Accuracy (m): 3
Licensee: Yukon government

Acquisition Date: 13-Jul-2013
File Name: SPOT6_Klondike_13July2013_utm7
Sensor: SPOT-6
Project Area: Klondike Region
Pixel Resolution (m): 1.5
Cloud Cover (%): 0
Horizontal Accuracy (m): 1
Licensee: Yukon Government

Acquisition Date: 16-Aug-2007
File Name: SPOT5_GY_KlondikeRiverValley_16Aug2007_pan_UTM7
Sensor: IRS
Project Area: Klondike River Valley
Pixel Resolution (m): 5
Cloud Cover (%): 0
Horizontal Accuracy (m): 1
Licensee: Yukon Government

Acquisition Date: 10-Sep-2000
File Name: IRS_IndianRiver_Klondike_pan_20000910_albers
Sensor: IRS
Project Area: Indian River
Pixel Resolution (m): 5
Cloud Cover (%): 0
Horizontal Accuracy (m): 5
Licensee: Yukon Government

AERIAL PHOTOGRAPHS:

Acquisition Date: 01-Jul-1989
Name: ocPan_ortho_115O11_1989_albers
Sensor: Unknown
Project: Yukon - Central Region
LowPS: 1.5
Cloud Cover (%): 0
Horizontal Accuracy (m): 3
Licensee: Public

Appendix B

Field Form Sample



SITE VISIT FORM

Project		Plot No.		Plot Level: <input type="checkbox"/> G <input type="checkbox"/> V	
Date: YYYY-MM-DD		Plot Type: <input type="checkbox"/> Standard <input type="checkbox"/> Novveg <input type="checkbox"/> Irreg		Field No.	
NTS map		Location			
Northing		Easting		UTM Zone	YBEC
Lat N		Long W		Accur (m) WGS84 <input type="checkbox"/>	Polygon No.
Site Features	Elev (m)	Aspect (°)	Slope %	Surface Shape <input type="checkbox"/> CV <input type="checkbox"/> CX <input type="checkbox"/> ST <input type="checkbox"/> UN	
	<input type="checkbox"/> Crest <input type="checkbox"/> Toe	<input type="checkbox"/> Upper <input type="checkbox"/> Level	<input type="checkbox"/> Mid <input type="checkbox"/> Dep.	<input type="checkbox"/> Lower <input type="checkbox"/> Gully	Flood plain? <input type="checkbox"/>
Site Disturb.	<input type="checkbox"/> None <input type="checkbox"/> Fire <input type="checkbox"/> Other	<input type="checkbox"/> Veg. Removal <input type="checkbox"/> Biotic	<input type="checkbox"/> Soil Dist. <input type="checkbox"/> Terrain	<input type="checkbox"/> Plant Gather <input type="checkbox"/> Water	
	Expose. Type	<input type="checkbox"/> None <input type="checkbox"/> Frost <input type="checkbox"/> Other	<input type="checkbox"/> Insolation <input type="checkbox"/> Cold Air	<input type="checkbox"/> Wind <input type="checkbox"/> Aufeis	<input type="checkbox"/> Snow <input type="checkbox"/> Rain Shadow
Stand Attributes	Stand Age _____ <input type="checkbox"/> Est. <input type="checkbox"/> Mea.		Canopy Composition		
	Stand Ht. _____ <input type="checkbox"/> Est. <input type="checkbox"/> Mea.		Structure <input type="checkbox"/> 1 <input type="checkbox"/> 2a <input type="checkbox"/> 2b <input type="checkbox"/> 2c <input type="checkbox"/> 2d <input type="checkbox"/> 3a <input type="checkbox"/> 3b <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7a <input type="checkbox"/> 7b <input type="checkbox"/> 8		
Plot Representing					
Wetland Class			Veg Assoc.		
Ecosite			Map Label		
Terrain	Texture	Surficial Material	Surface Expression	Geo. Process	Rock Types
	1.				1.
2.					2.
Rooting Zone	Drainage <input type="checkbox"/> VR <input type="checkbox"/> R <input type="checkbox"/> W <input type="checkbox"/> MW <input type="checkbox"/> I <input type="checkbox"/> P <input type="checkbox"/> VP				
	Humus/Organic Form <input type="checkbox"/> Mor <input type="checkbox"/> Moder <input type="checkbox"/> Mull <input type="checkbox"/> Fibric <input type="checkbox"/> Mesic <input type="checkbox"/> Humic				
	Humus thickness _____ cm <input type="checkbox"/> Ah? <input type="checkbox"/> Ae? _____ cm Est. soil depth _____ cm				
	Depth to: Min Soil (cm)	Wat. table	Seepage	Mottle/gley	Restrict. <input type="checkbox"/> None
	Rest. Type <input type="checkbox"/> Cement <input type="checkbox"/> Pan <input type="checkbox"/> Kompact <input type="checkbox"/> Water <input type="checkbox"/> Lithic <input type="checkbox"/> CaCO3 <input type="checkbox"/> Frost				
R.Z. Soil Texture		R.Z. Coarse Fragment %		Estimated Rooting Depth _____ cm	
Comments					

YG(6329E)F2 06/2016