# The Bonsall Creek Watershed

## Map Atlas

March 2015

DELIVERED BY

Investment Agriculture Foundation of British Columbia

FUNDING PROVIDED BY

British Columbia

Canada

Municipality of North Cowichan

## About This Document

Prepared as part of the Bonsall Creek Watershed Plan project (2015), this Map Atlas graphically outlines information and knowledge about the current state of the watershed, and is divided into 5 thematic sections. It is intended to be used as both a reference document, and a tool to initiate discussion about the future management of the watershed.

## Acknowledgements

This map atlas was prepared for the Municipality of North Cowichan by Sustainability Solutions Group with collaboration from:

Northwest Hydraulics Consulting Ltd. (Hydrology)
Q'ul-lhanumutsun Aquatic Resources Society (First Nations)
GW Solutions (Ground Water)
David Clough (Biodiversity)
David Tattum (Agriculture)

Each collaborator created stand-alone documents that are also available for reference.

Community knowledge was compiled from public engagement data gathered from a workshop hosted by Sustainability Solutions Group.

First Nations knowledge was compiled from First Nations engagement data gathered from two workshops hosted by the Q'ul-lhanumutsun Aquatic Resources Society. This knowledge is collectively shown on the community experience maps.

Sustainability Solutions Group would like to sincerely thank all of the collaborators, community members and municipal staff for their excellent contributions to this contextual document for the Bonsall Creek watershed.

## Table of Contents



> A watershed is an area of land where all of the water that is under it or drains off of it goes into the same place.
>
> — US Environmental Protection Agency

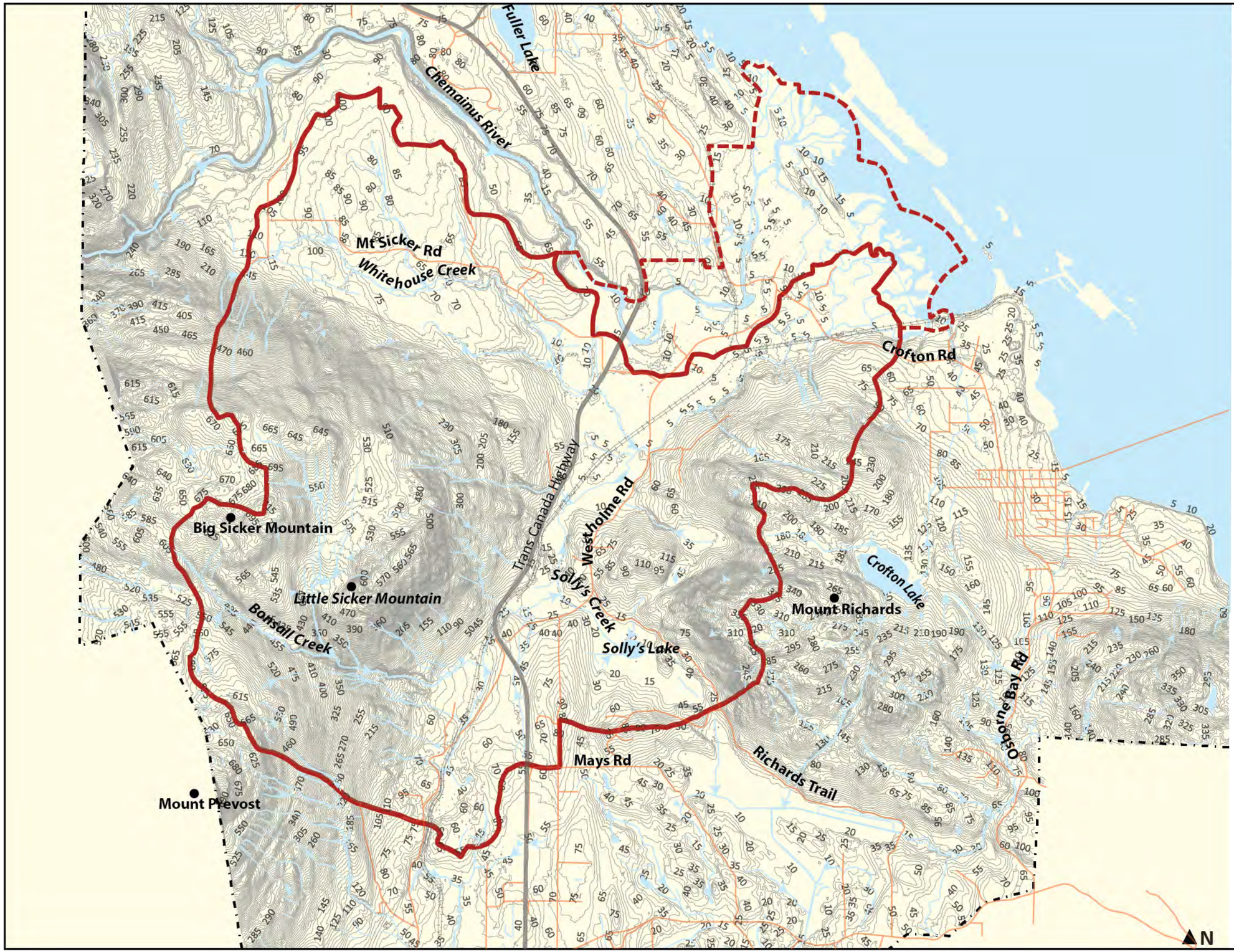
> An area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community.
>
> — John Wesley Powell
> American scientist geographer

# Bonsall Creek Watershed

## Context


Tyee Creek
Bush Creek
Holland Creek
South Holland Creek
Stocking Creek
Porter Creek
Chemainus
Banon Creek
Askew Creek
Mill Creek
Chipman Creek
Silver Creek
Holyoak Creek
Chemainus River
Humbird Creek
Nugget Creek
Whitehouse Creek
Crofton
BONSALL CREEK
Bonsall Creek
Sollys Creek
FLEET RIVER
Richards Creek
Averill Creek
Somenos Creek
MacIntyre Creek
Inwood Creek
Cowichan Valley Highway
Bings Creek
Somenos Lake
Quamichan Lake
Quamichan Creek
Currie Creek
Duncan
Trans Canada Highway
COWICHAN RIVER
Holt Creek
Glenora Creek
Koksilah River
Kelvin Creek
Neel Creek
Patrolas Creek
McFadden Creek
Duck Creek
Okano Creek
Ganges Creek
Maxwell Creek
Cusheon Creek
Fulford Creek
Salt Spring Island
Vancouver Island
Victoria
0 10 20 30 40
km
N
Legend
Bonsall Creek watershed boundary
additional study area
North Cowichan municipal boundary
Cowichan Valley Regional District
watershed area and name
major watershed area and NAME
land
water body
river or stream
major road
The Bonsall Creek watershed is a 36km² scenic area of North Cowichan. It is bound by the larger Chemainus River watershed to the north and the Cowichan River watershed to the south.
SOURCE: Data BC
Created by JMM
Sustainability Solutions Group
BCWMP_M01_01_v2
2015/02/26
0 2 4 6
km

# Topography




## Legend

- Bonsall Creek watershed boundary
- additional study area
- railway
- road
- highway
- land
- water
- water flow direciton
- 5 contour and elevation
- contour data extent

**Through Whitehouse Creek and Bonsall Creek, the watershed drains from the slopes of Mount Sicker and Mount Prevost in the west (over 700m elevation) and travels 12km eastward to the ocean. The gradient drops quickly and the majority of the Bonsall Creek channel is in low gradient, farmed reaches.**

**SOURCE:** District of North Cowichan; Data BC

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Sustainability Solutions Group
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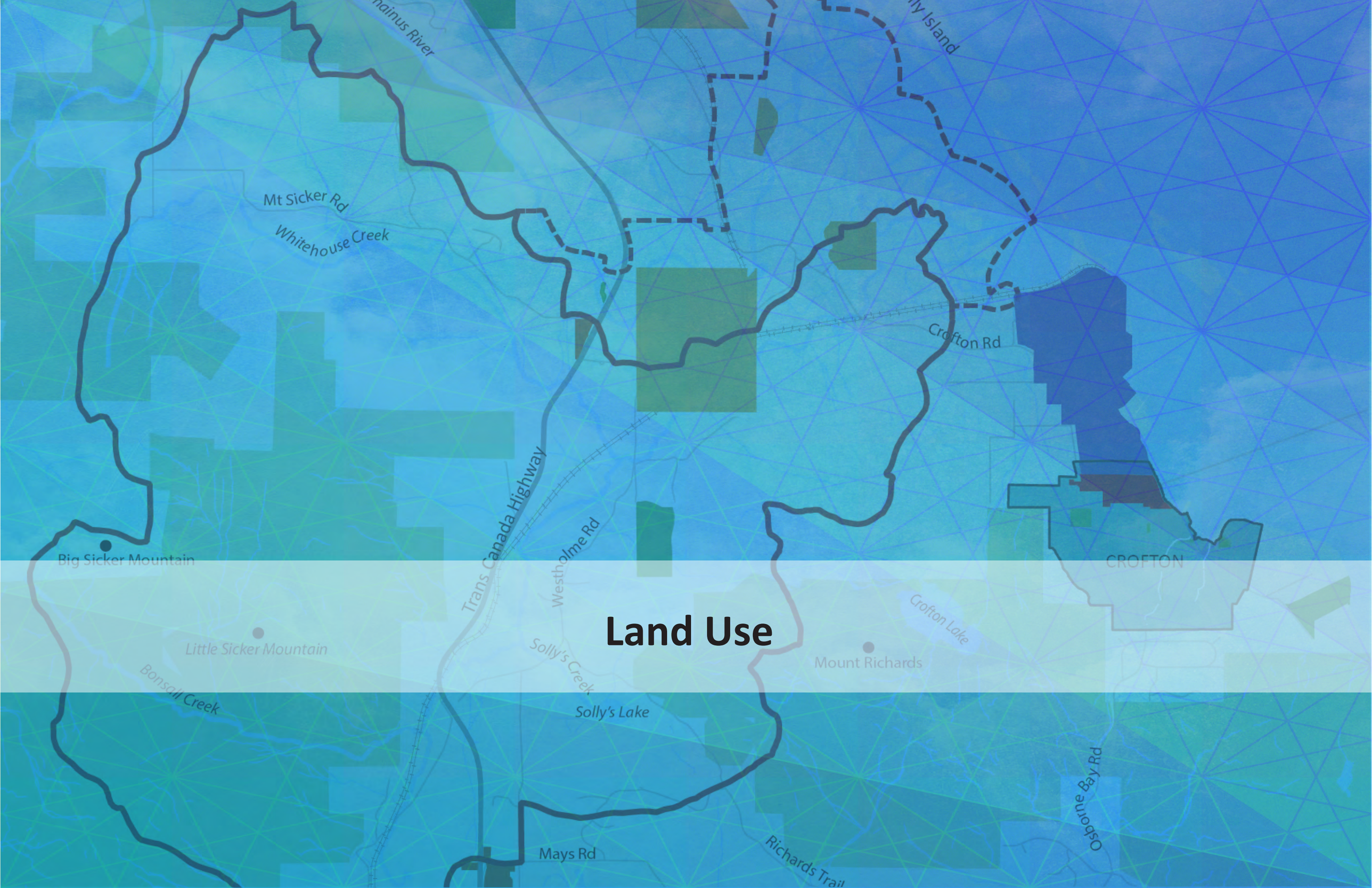
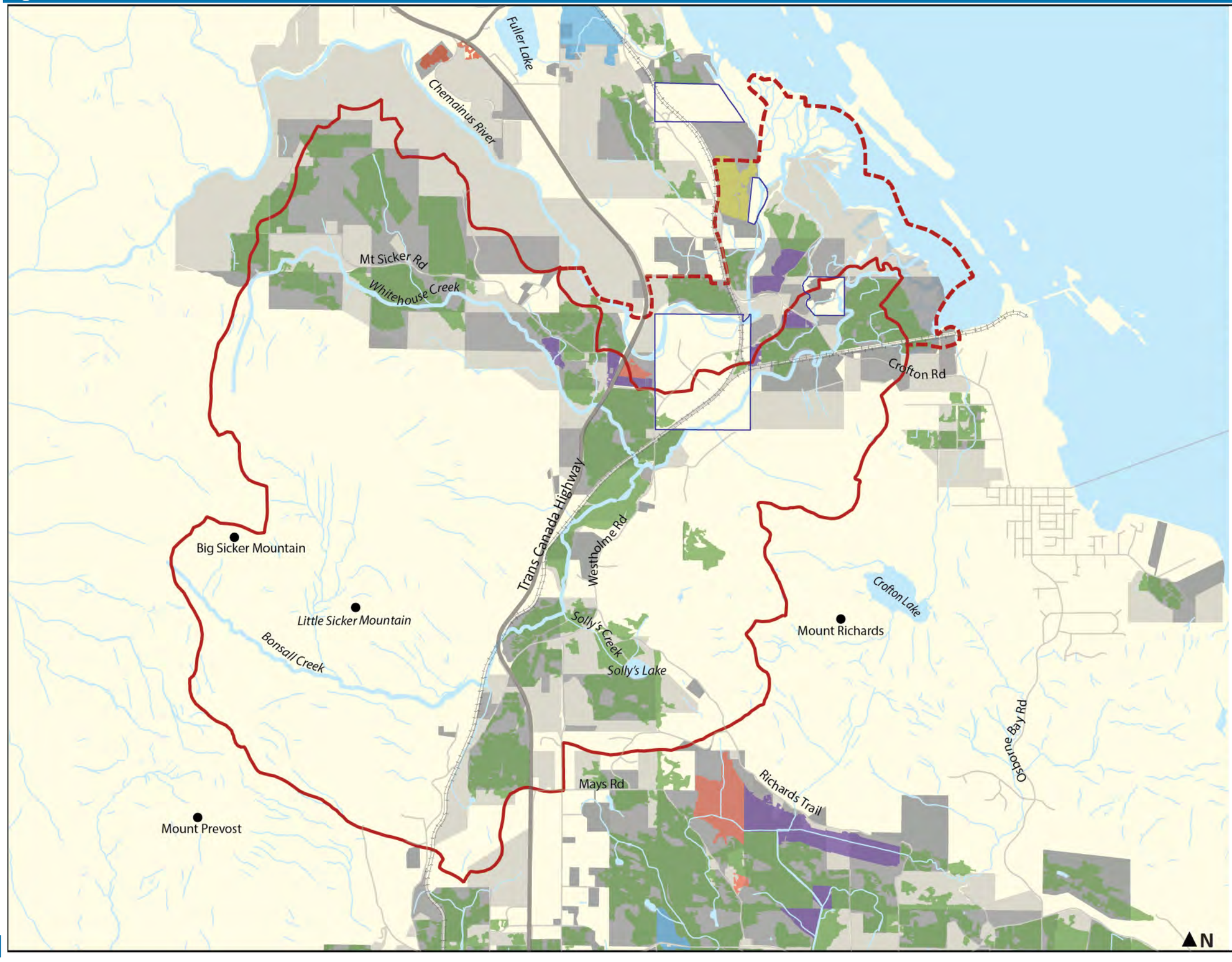
2015/02/26

0 2 4 6
km

# Land Use


Mt Sicker Rd
Whitehouse Creek
Crofton Rd
Big Sicker Mountain
Trans Canada Highway
Westholme Rd
CROFTON
Little Sicker Mountain
Solly's Creek
Crofton Lake
Mount Richards
Bonsall Creek
Solly's Lake
Osborne Bay Rd
Mays Rd
Richards Trail

# Agriculture




## Legend

- Bonsall Creek watershed boundary
- additional study area
- land
- water
- 2009 Agricultural land reserve
- CVRD farms
- railway
- road
- highway
- First Nations Reserve land

**Agricultural land use (ALUI)**

- berry/small fruit
- grass/forage
- nursery crop
- orchard
- other agriculture
- uncultivated
- vegetable

**Agricultural land is predominantly located along Whitehouse Creek, Solly's Creek, and the Bonsall Creek mainstem. The majority of farmland is used for forage or grass production.**

SOURCES: Data BC, Agricultural Land Reserve, Agricultural Land Use Inventory, Cowichan Valley Regional District, District of North Cowichan

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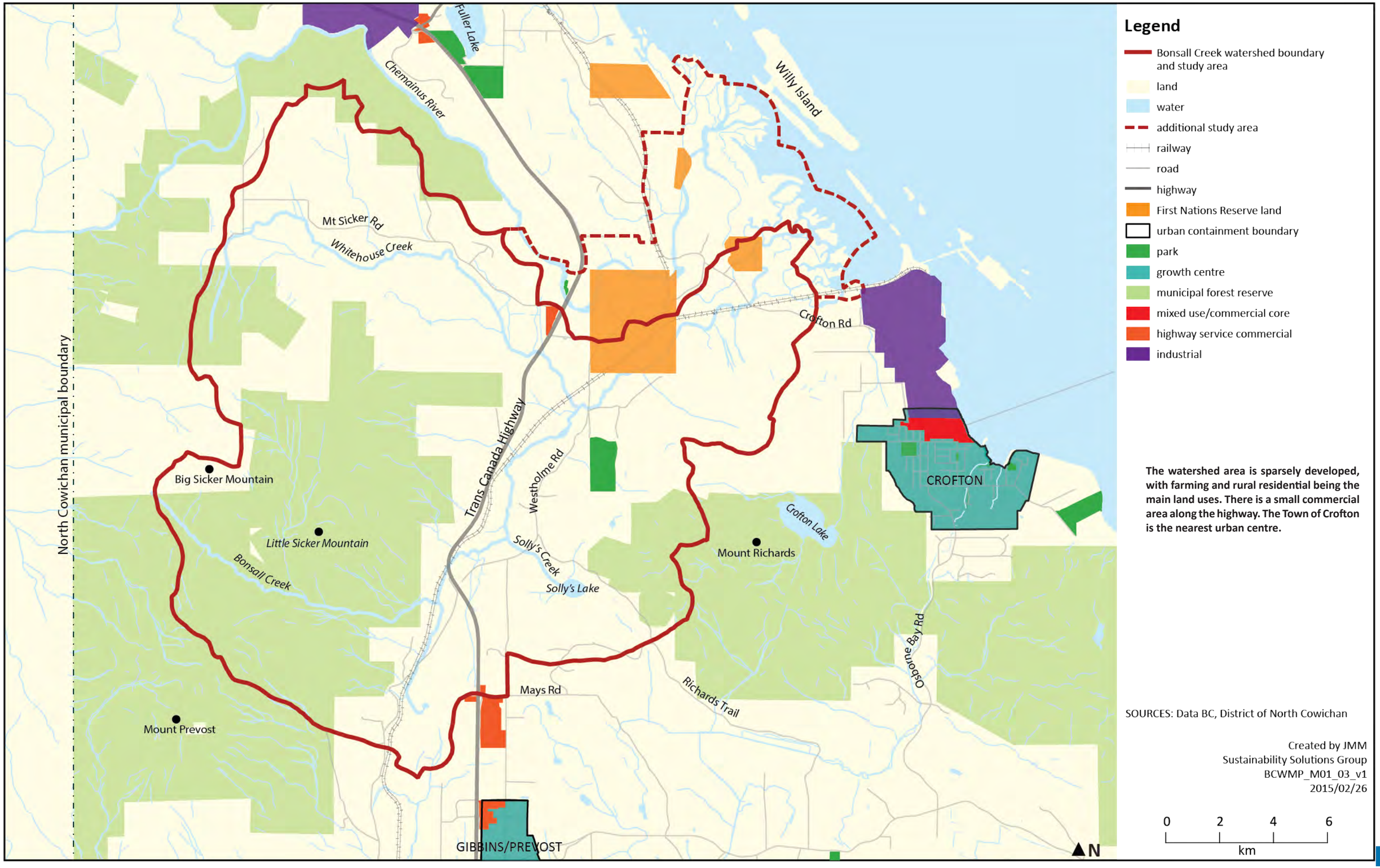
BCWMP_M02_01_v2
2015/02/26

0 2 4 6
km

# Land use




**The watershed area is sparsely developed, with farming and rural residential being the main land uses. There is a small commercial area along the highway. The Town of Crofton is the nearest urban centre.**

SOURCES: Data BC, District of North Cowichan

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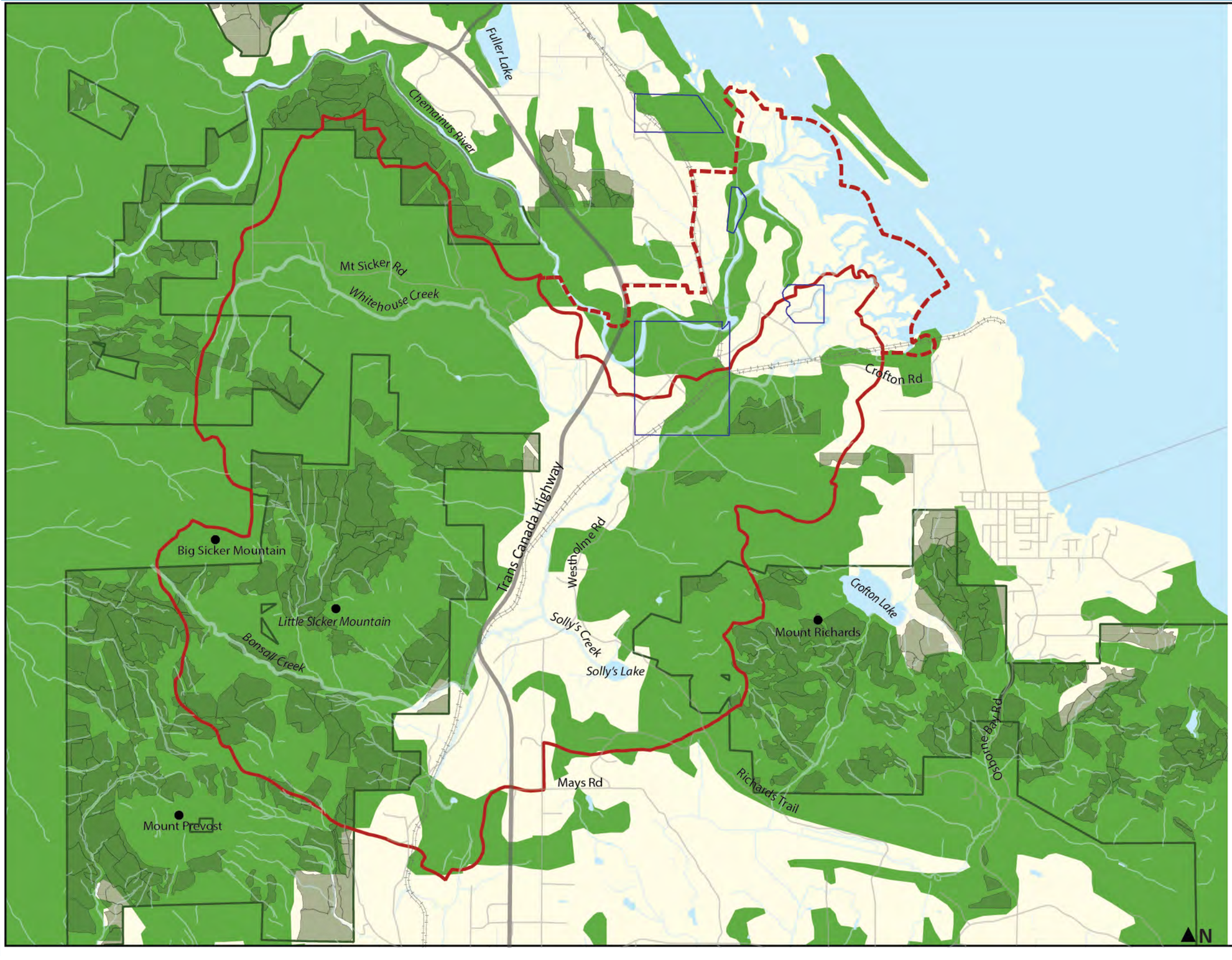
Sustainability Solutions Group
BCWMP_M01_03_v1
2015/02/26

0 2 4 6
km

# Forestry




## Legend

- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Reserve land
- CVRD 'young forest'
- municipal forest reserve
- municipal forest cutblock

**Forestry Lands comprise three different classes: Crown forests managed by the provincial Ministry of Forests, Lands and Natural Resource Operations under the Forest Practices Act; Municipal Forest Reserve owned and operated by the Municipality; and private forests subject to the Private Managed Forest Land Act and Regulation. 1,300ha of the Municipal Forest Reserve (5,000ha in Municipality) falls within the Bonsall Creek Watershed.**

**SOURCES:** District of North Cowichan (municipal forest), Cowichan Valley Regional District (young forest)

Created by JMM
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BCWMP_M02_02_v2
2015/02/26

0 2 4 6
km

# Zoning

There are 580 properties and 259 dwellings in the Bonsall Creek watershed area. Properties within the Bonsall Creek Watershed are predominantly zoned Agriculture (A), with the majority of properties zoned A1, A2 and others falling under A3 and A4.

## Legend

- Bonsall Creek watershed boundary
- additional study area
- land parcel
- zoning type division
- land
- water
- First Nations reserve and NAME
- park
- railway
- road
- highway

**Municipal zoning category**

- Agricultural (A1)
- Rural (A2, A3, A4, A5)
- Commercial (C1-C9, MA1-2, W2, W2a, W2b, W3a)
- Comprehensive Development (CD1, CD2, CD4, CD5, CD6, CD7)
- Industrial (I1, I2)
- Public/Institutional (PC, PI, PU)
- Residential (R1-R8, R2A, R3CH, R3MF, R3S, R7A, W1)

**SOURCES:** Data BC, District of North Cowichan
**NOTE:** Zoning codes were taken from the District of North Cowichan Zoning Bylaw 1997, No. 2950, at http://www.northcowichan.ca/documents/Cache/Zoning%20Bylaw.pdf. These were grouped thematically into general use categories, as indicated in the legend. The Bylaw should be consulted for further details on zoning/land use. At the time of map creation an updated Zoning Bylaw was scheduled to be completed in 2015.

Created by JMM
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0 2 4 6
km

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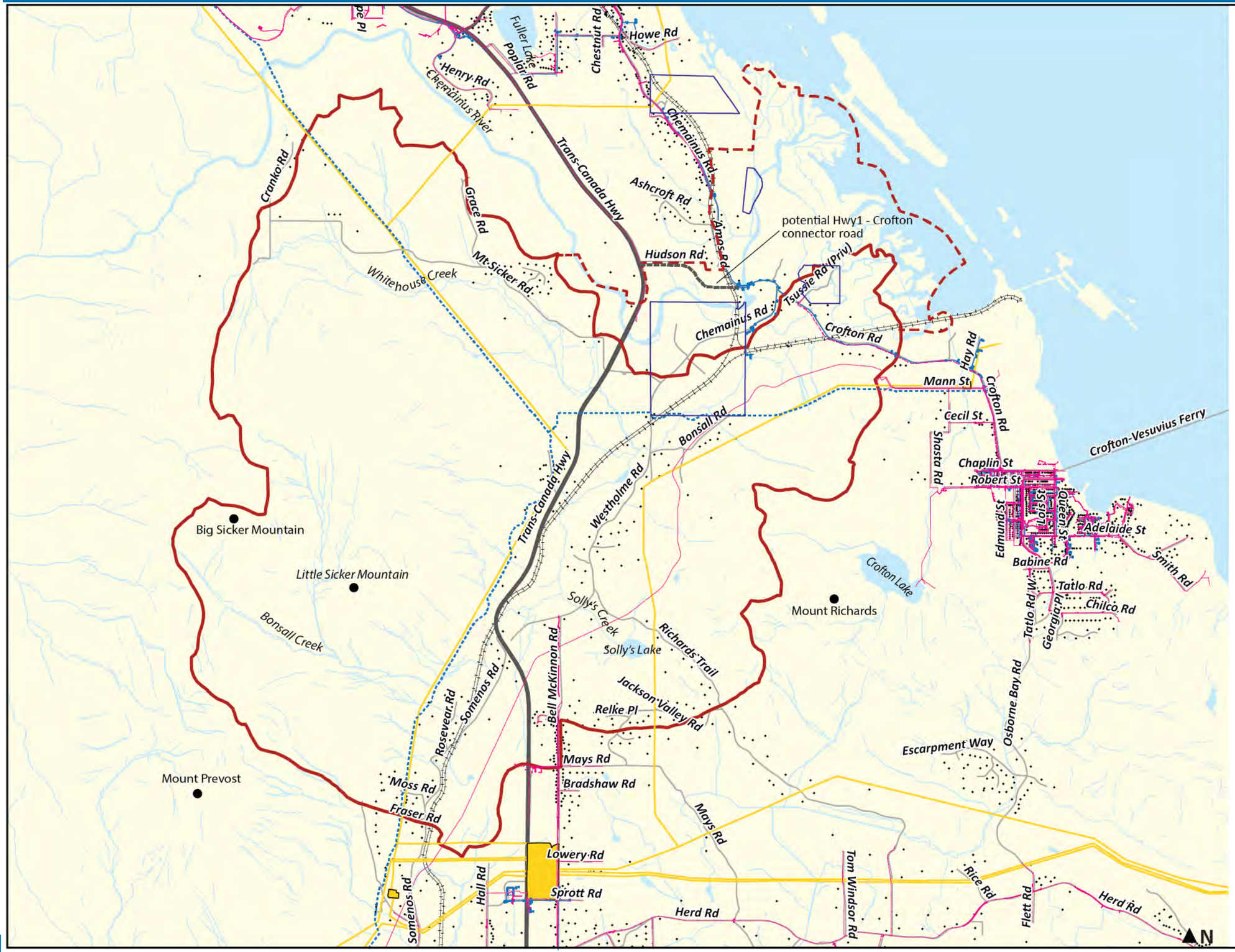


## Legend

- Bonsall Creek watershed boundary
- additional study area
- land
- water
- land parcel
- First Nations Reserve land
- highway
- road
- railway
- dwelling unit (2012)

**Electrical**
- power station
- electrical line

**Water**
- sanitary sewer mains
- water mains
- drainage mains

**Gas**
- gas transmission pipe
- gas line
- gas distribution pipe

**Municipal services are concentrated in Chemanius, Crofton, and the South End. Properties within the Bonsall Creek watershed are typically rural and serviced with on-site wells or surface water use and septic systems. The highway corridor is designated as Rural, and is dominated by agriculture and forestry uses.**

**SOURCES:** District of North Cowichan, Cowichan Valley Regional District, FortisBC

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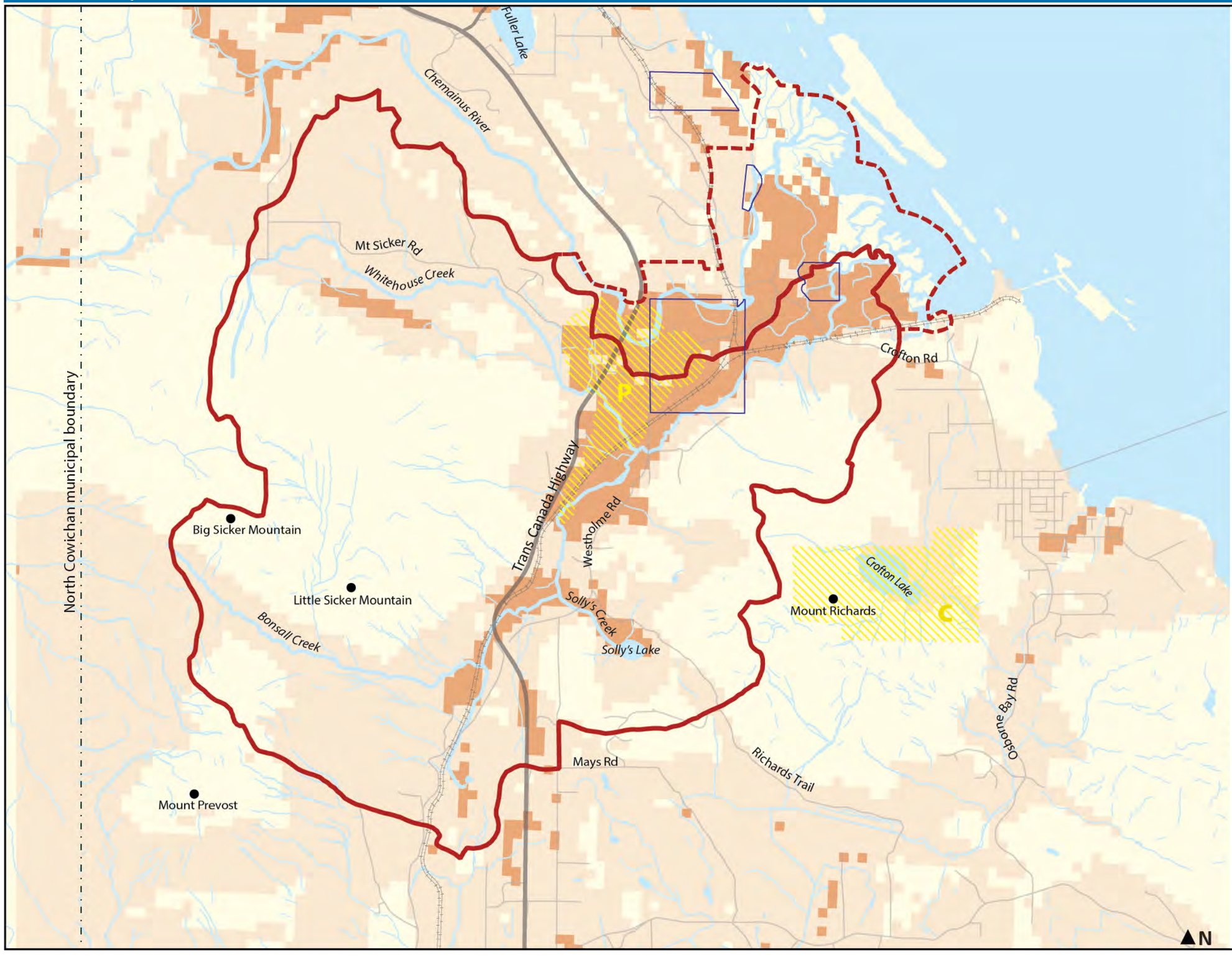
2015/02/26

0 2 4 6
km

# Water source protection




## Legend

- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Territory

Water Source Protection

- primary aquifer protection area
- Crofton Lake Protection Area

Aquifer vulnerability from VIU study

- moderate
- high

**Water source protection extends to highly vulnerable aquifers, typically in floodplains. These areas are subject to Development Permit Area 3 (Natural Environment). Use or disposal of substances or contaminants that may be harmful to area aquifers is prohibited.**

SOURCES: Data BC; District of North Cowichan; Province of BC; Vancouver Island University (VIU), Spring 2009, Vancouver Island Resources Vulnerability Mapping Project; Thurber Engineering, March 2001, Well Protection Plan Lower Cowichan River Aquifer Chemainus River Aquifer Primary Wells

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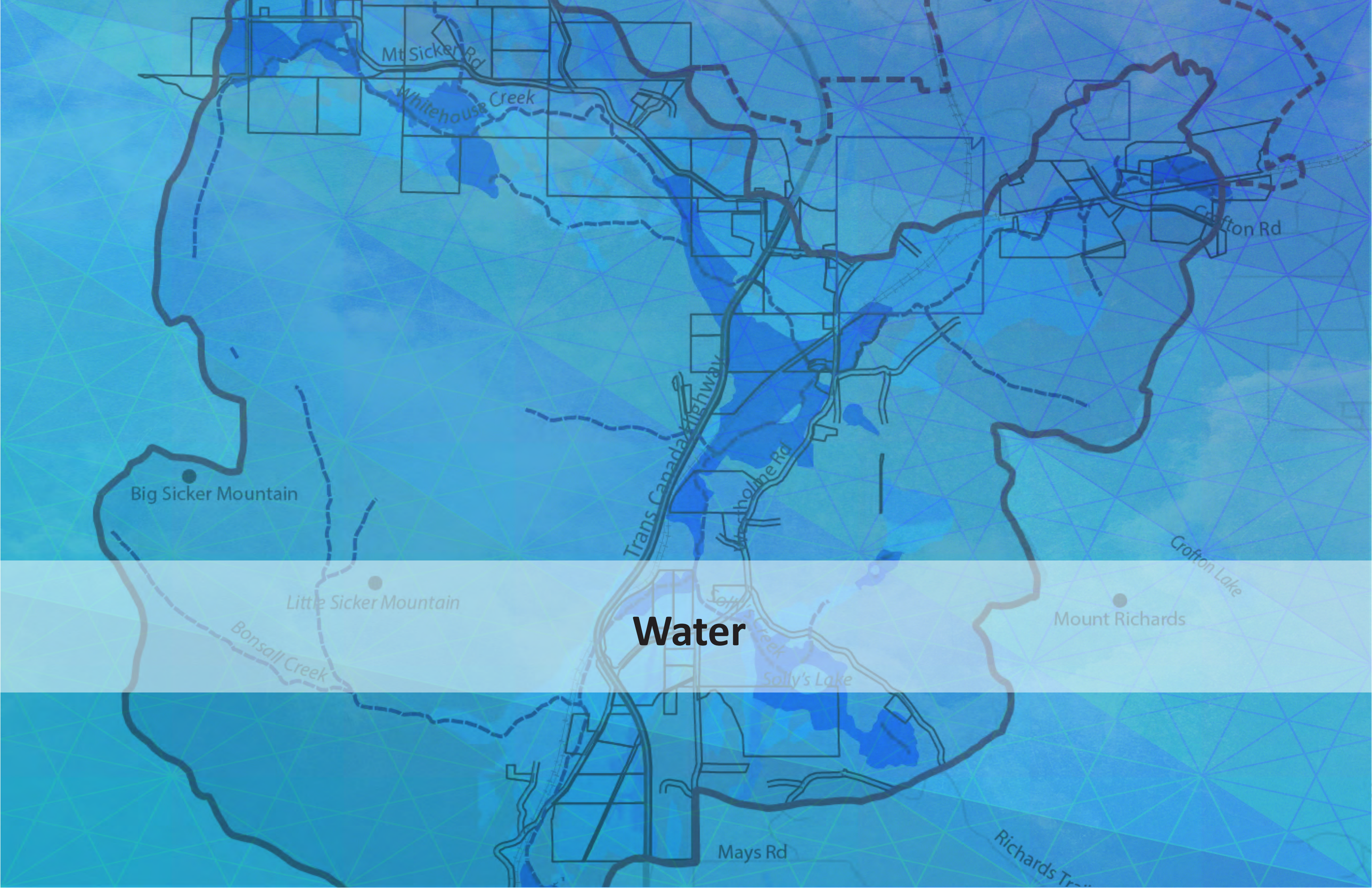
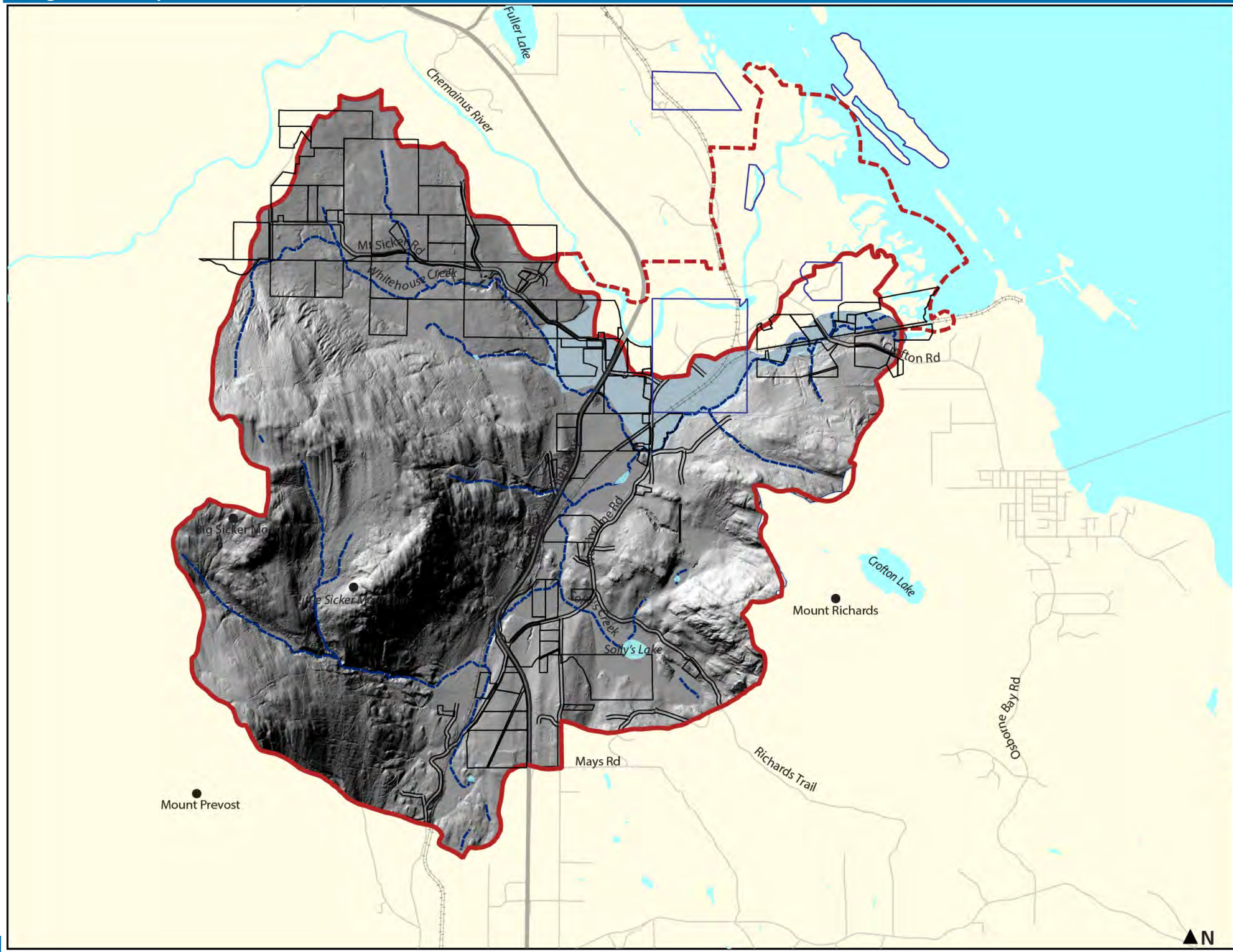
2015/02/26

0 2 4 6
km

# Water


Mt Sicker Rd
Whitehouse Creek
Clifton Rd
Big Sicker Mountain
Trans Canada Hwy
Whitehouse Rd
Crofton Lake
Little Sicker Mountain
Mount Richards
Bonsall Creek
Solly's Lake
Mays Rd
Richards Trail

# Designated floodplain




## Legend

- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Reserve land
- farm
- stream
- designated floodplain

**Bonsall Creek lies within the limits of the Chemainus River 1:20 year return period flood, though it is likely to receive Chemainus River inflows more frequently. Highway 1 lies above the Chemainus floodplain and acts as a dike when flow levels rise, resulting in the diversion of Chemainus flood water into Whitehouse Creek, which is then conveyed into Bonsall Creek. The Chemainus floodplain extends into the Bonsall Creek basin, covering an area of approximately 1.8km$^2$.**

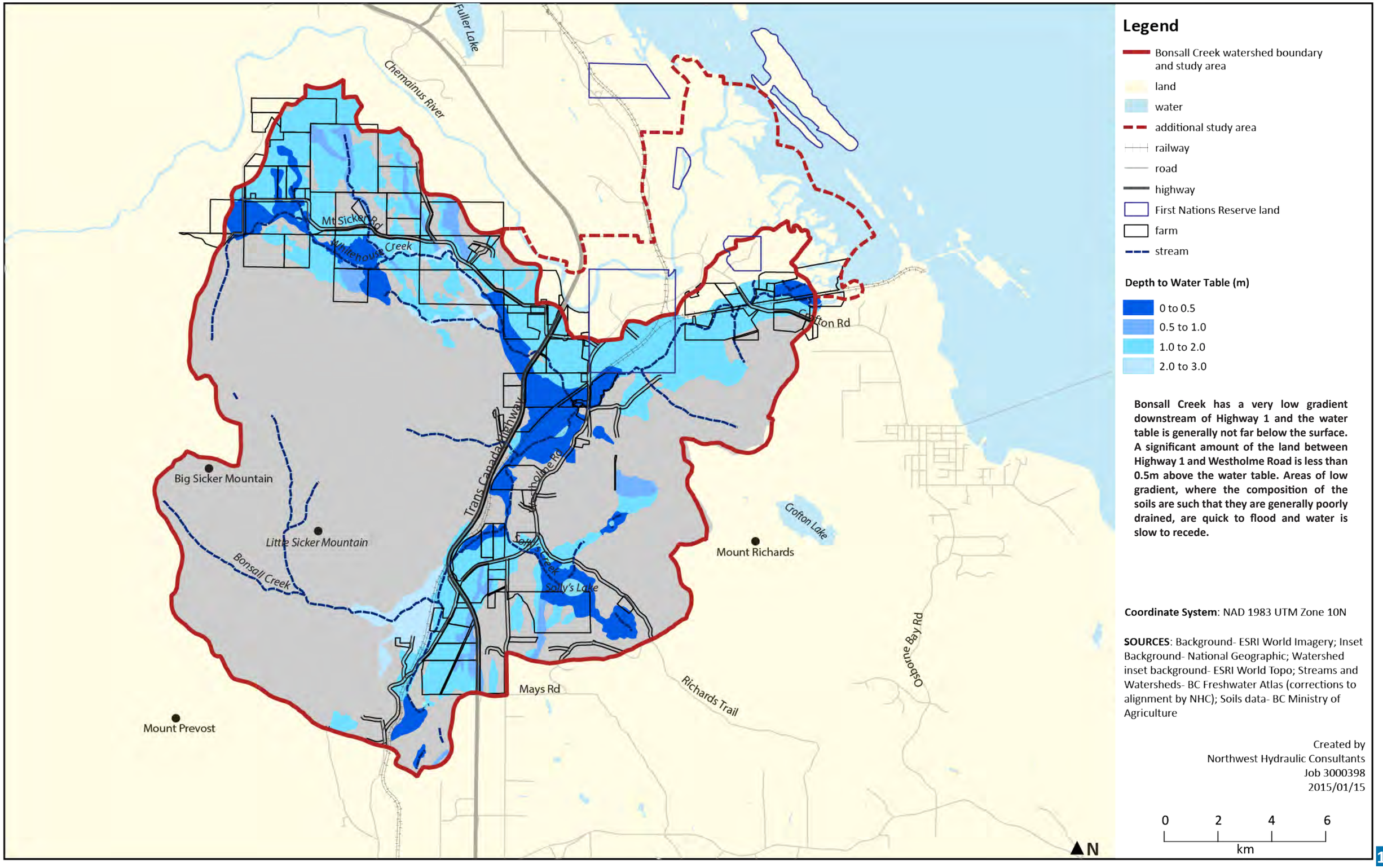
**Coordinate System**: NAD 1983 UTM Zone 10N

**SOURCES**: Background- ESRI World Imagery; Inset Background- National Geographic; Watershed inset background- ESRI World Topo; Streams and Watersheds- BC Freshwater Atlas (corrections to alignment by NHC); Floodplain data- BC Ministry of Environment

Created by
Northwest Hydraulic Consultants
Job 3000398
2015/01/15

0 2 4 6
km

# Water table




## Legend

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- railway
- road
- highway
- First Nations Reserve land
- farm
- stream

**Depth to Water Table (m)**

- 0 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 to 3.0

**Bonsall Creek has a very low gradient downstream of Highway 1 and the water table is generally not far below the surface. A significant amount of the land between Highway 1 and Westholme Road is less than 0.5m above the water table. Areas of low gradient, where the composition of the soils are such that they are generally poorly drained, are quick to flood and water is slow to recede.**

**Coordinate System**: NAD 1983 UTM Zone 10N

**SOURCES**: Background- ESRI World Imagery; Inset Background- National Geographic; Watershed inset background- ESRI World Topo; Streams and Watersheds- BC Freshwater Atlas (corrections to alignment by NHC); Soils data- BC Ministry of Agriculture

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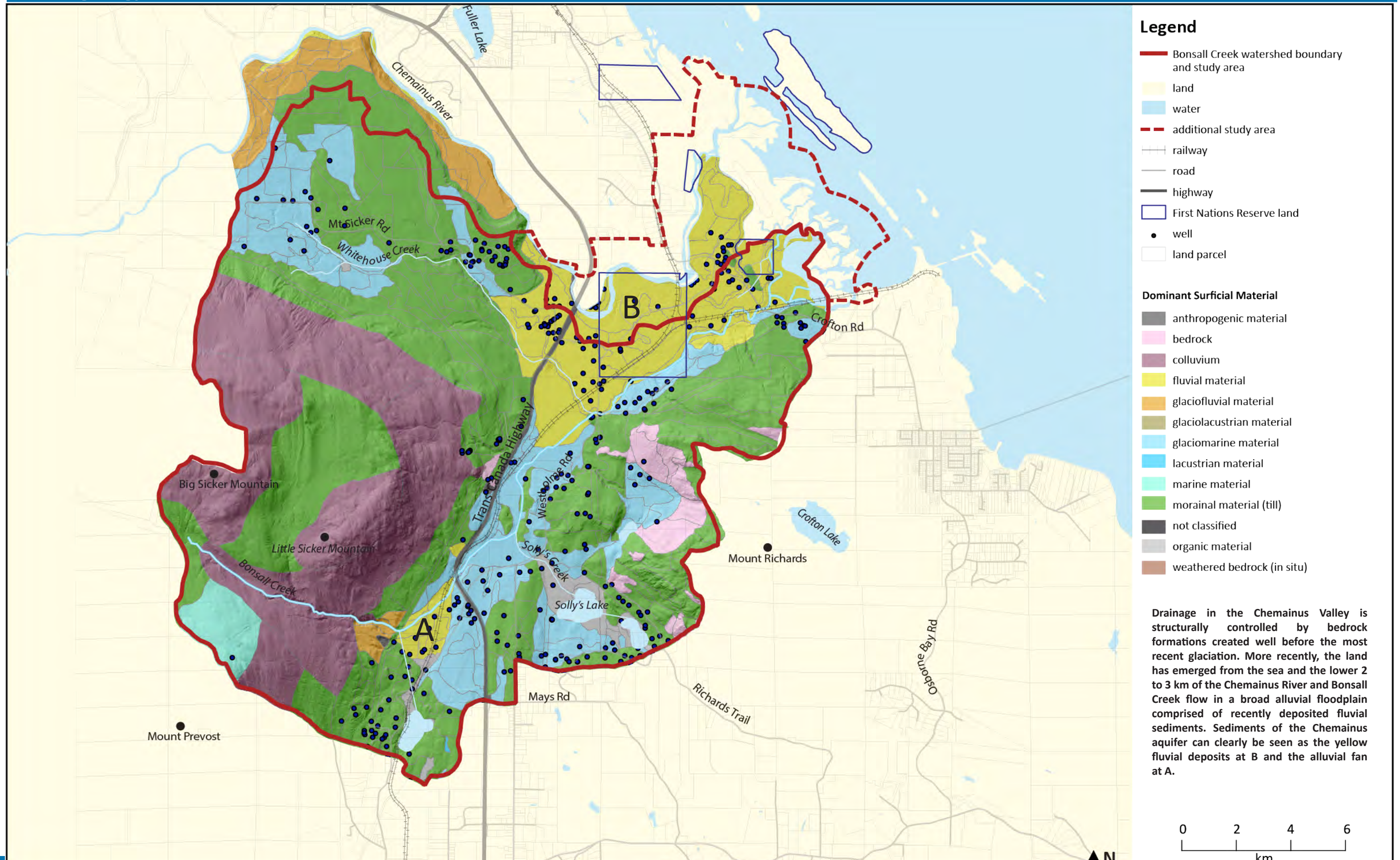
Job 3000398
2015/01/15

0 2 4 6
km

## Surficial geology




### Legend

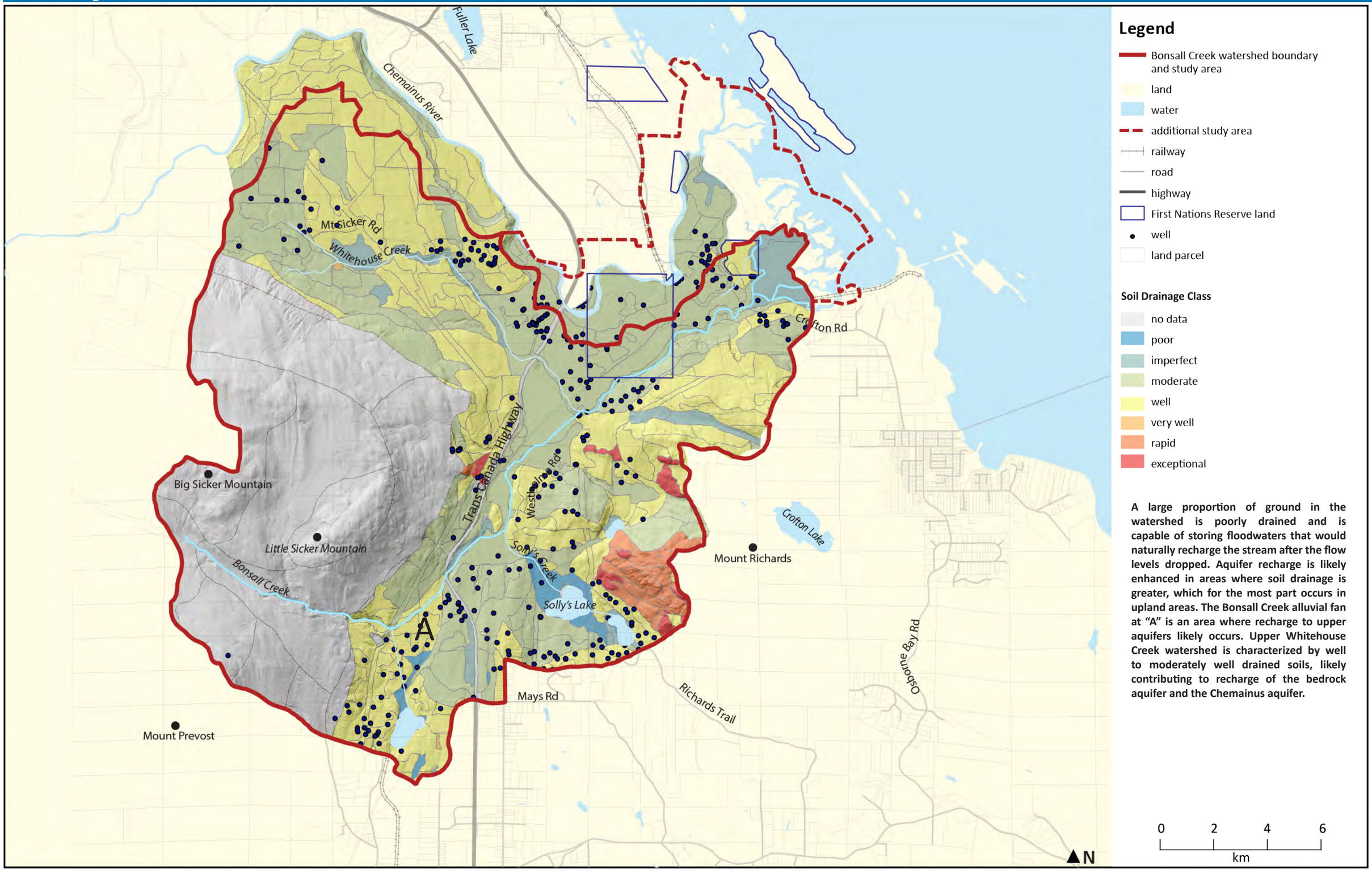
- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Reserve land
- well
- land parcel

**Dominant Surficial Material**

- anthropogenic material
- bedrock
- colluvium
- fluvial material
- glaciofluvial material
- glaciolacustrian material
- glaciomarine material
- lacustrian material
- marine material
- morainal material (till)
- not classified
- organic material
- weathered bedrock (in situ)

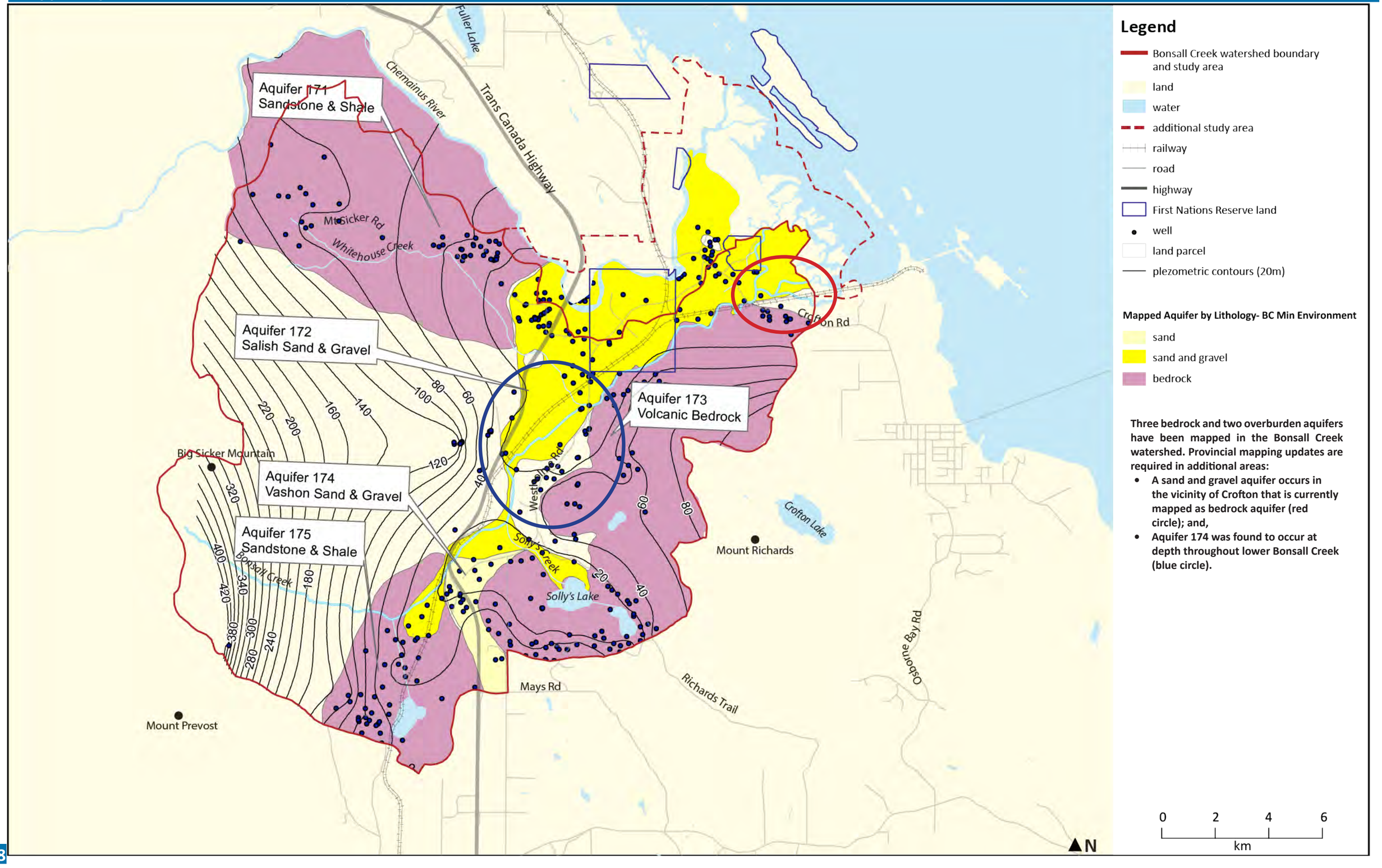
**Drainage in the Chemainus Valley is structurally controlled by bedrock formations created well before the most recent glaciation. More recently, the land has emerged from the sea and the lower 2 to 3 km of the Chemainus River and Bonsall Creek flow in a broad alluvial floodplain comprised of recently deposited fluvial sediments. Sediments of the Chemainus aquifer can clearly be seen as the yellow fluvial deposits at B and the alluvial fan at A.**

# Soil drainage class




**A large proportion of ground in the watershed is poorly drained and is capable of storing floodwaters that would naturally recharge the stream after the flow levels dropped. Aquifer recharge is likely enhanced in areas where soil drainage is greater, which for the most part occurs in upland areas. The Bonsall Creek alluvial fan at "A" is an area where recharge to upper aquifers likely occurs. Upper Whitehouse Creek watershed is characterized by well to moderately well drained soils, likely contributing to recharge of the bedrock aquifer and the Chemainus aquifer.**

## Mapped aquifers




### Legend

- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Reserve land
- well
- land parcel
- plezometric contours (20m)

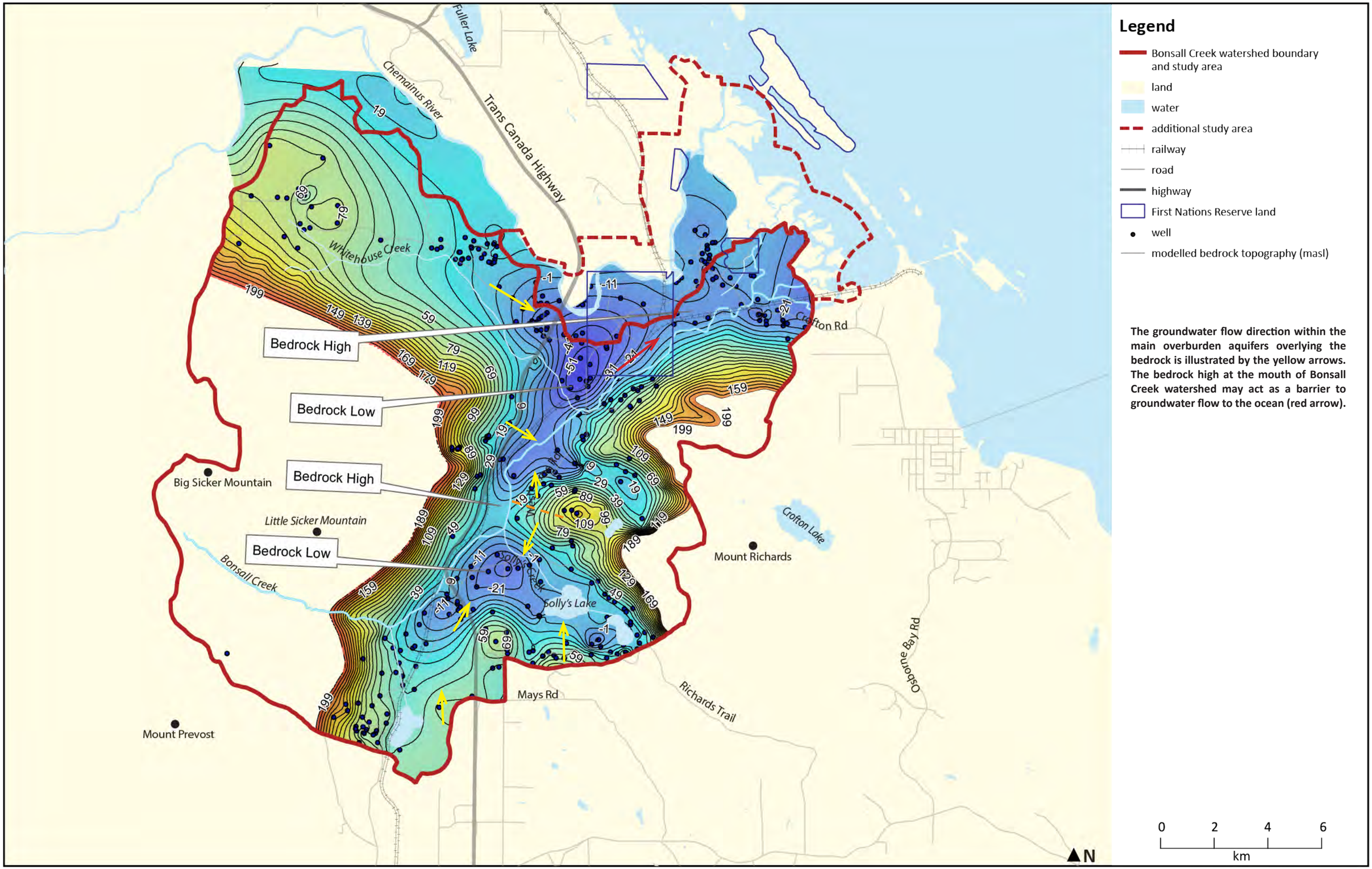
**Mapped Aquifer by Lithology- BC Min Environment**

- sand
- sand and gravel
- bedrock

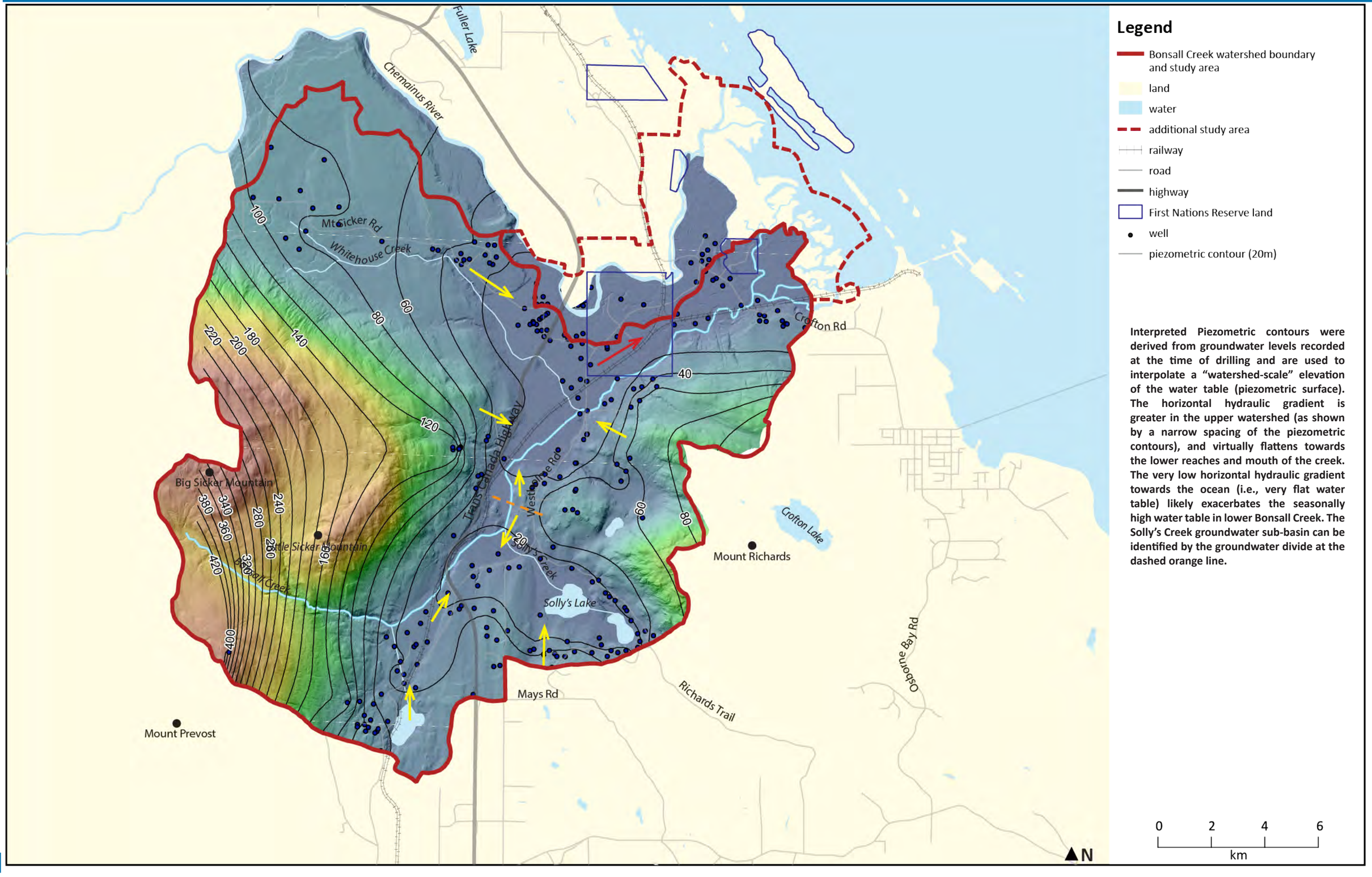
**Three bedrock and two overburden aquifers have been mapped in the Bonsall Creek watershed. Provincial mapping updates are required in additional areas:**

- **A sand and gravel aquifer occurs in the vicinity of Crofton that is currently mapped as bedrock aquifer (red circle); and,**
- **Aquifer 174 was found to occur at depth throughout lower Bonsall Creek (blue circle).**

## Interpreted bedrock



## Piezometric contours



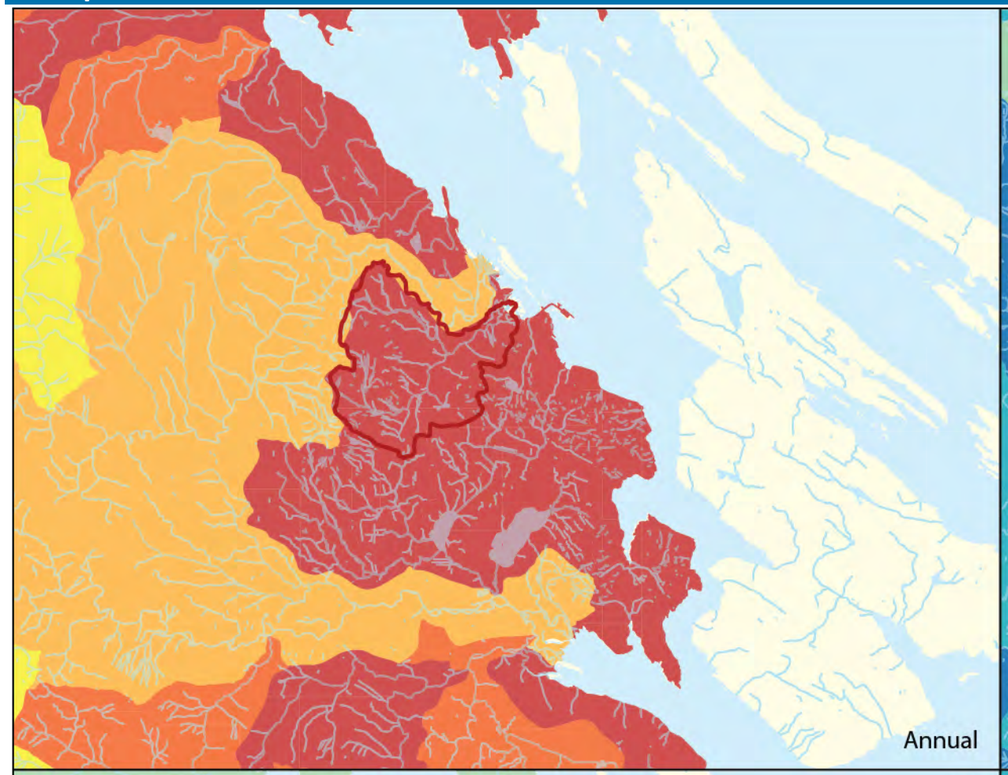

### Legend

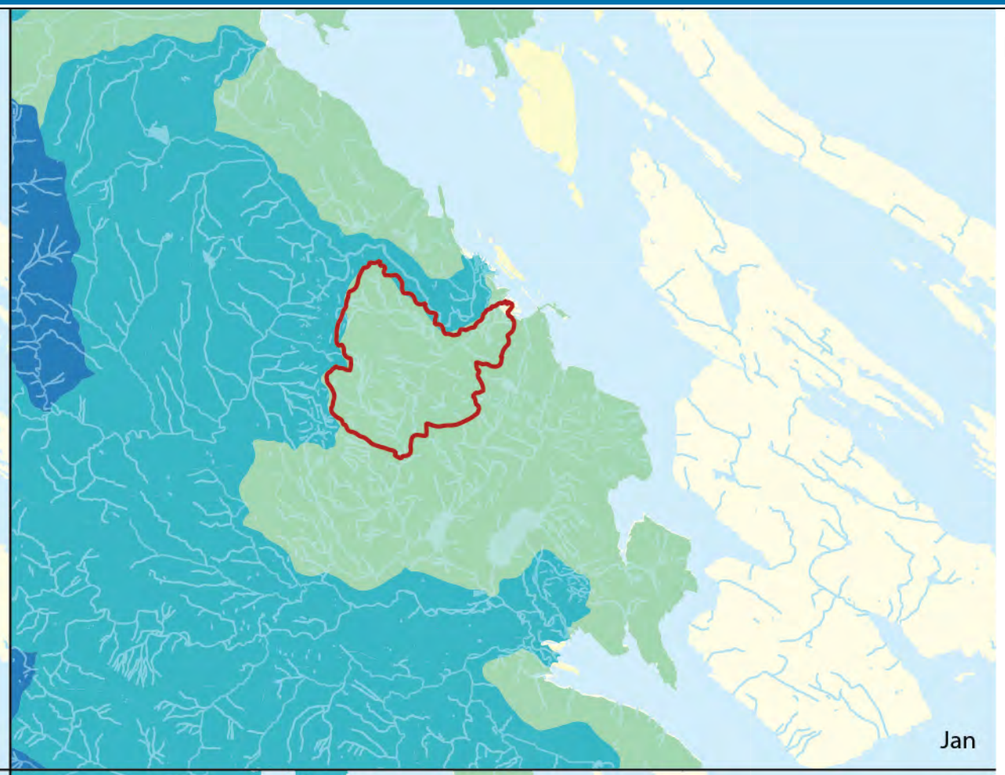
- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- railway
- road
- highway
- First Nations Reserve land
- well
- piezometric contour (20m)

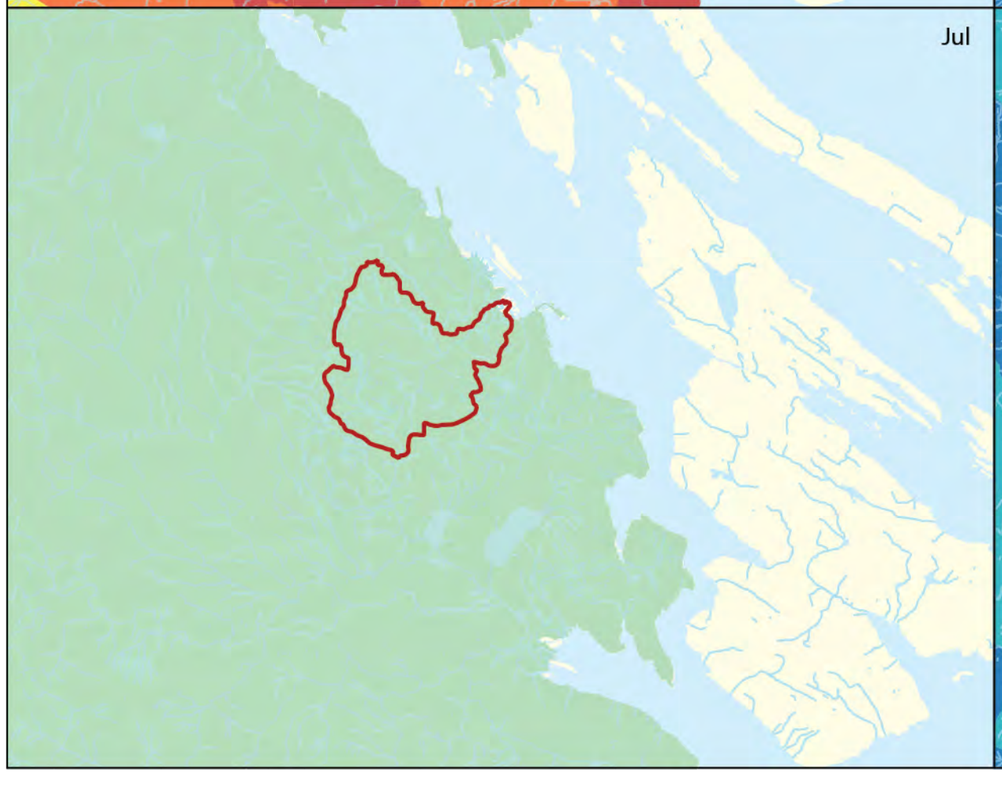
**Interpreted Piezometric contours were derived from groundwater levels recorded at the time of drilling and are used to interpolate a "watershed-scale" elevation of the water table (piezometric surface). The horizontal hydraulic gradient is greater in the upper watershed (as shown by a narrow spacing of the piezometric contours), and virtually flattens towards the lower reaches and mouth of the creek. The very low horizontal hydraulic gradient towards the ocean (i.e., very flat water table) likely exacerbates the seasonally high water table in lower Bonsall Creek. The Solly's Creek groundwater sub-basin can be identified by the groundwater divide at the dashed orange line.**

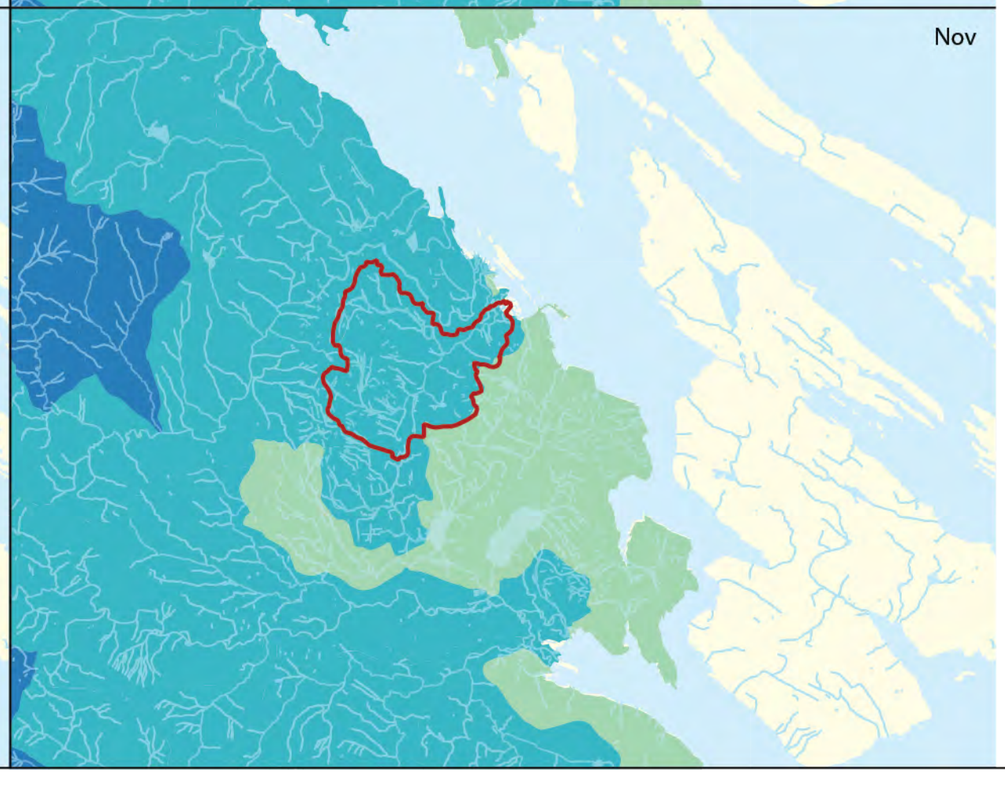
# Climate, Hazards, and Ecosystems

# Precipitation




## Legend

- Bonsall Creek watershed boundary
- land
- water body
- river or stream

**Mean annual precipitation (mm)**

- 1,004 - 1,365
- 1,366 - 1,937
- 1,938 - 2,410
- 2,411 - 2,971

**Monthly precipitation (mm)**

- 0 - 200
- 200 - 400
- 400 - 600
- 600 - 800

**The historical mean precipitation for annual (top left), January (top right), July (bottom left) and November (bottom right) for the watershed and surrounding region are shown. On average, BC has been experiencing more days out of the year with precipitation, and fewer consecutive dry days. For the coming decades, projections show North Cowichan's annual precipitation continuing to increase slightly, but with notable decreases in the summer—decreases larger than the provincial average.**

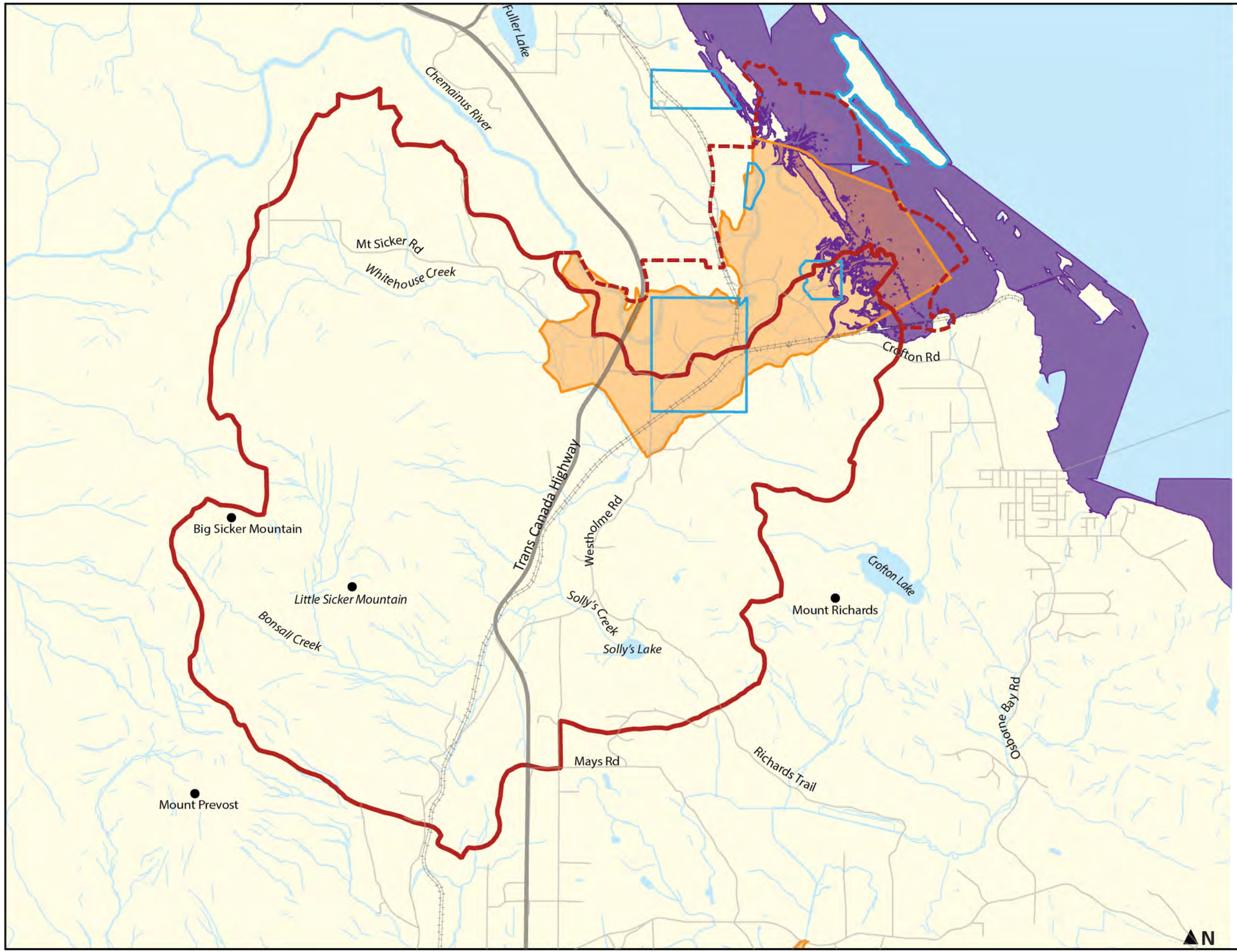
**SOURCES:** Cowichan Valley Regional District, District of North Cowichan

Created by JMM
Sustainability Solutions Group
BCWMP_M04_03_v2
2015/02/26

0 2 4 6 km

N

# Floodplains and sea level rise




## Legend

- Bonsall Creek watershed
- additional study area
- land
- water
- railway
- road
- highway
- First Nations Reserve land

**Flood risk**

- designated floodplain area
- 1m sea level rise

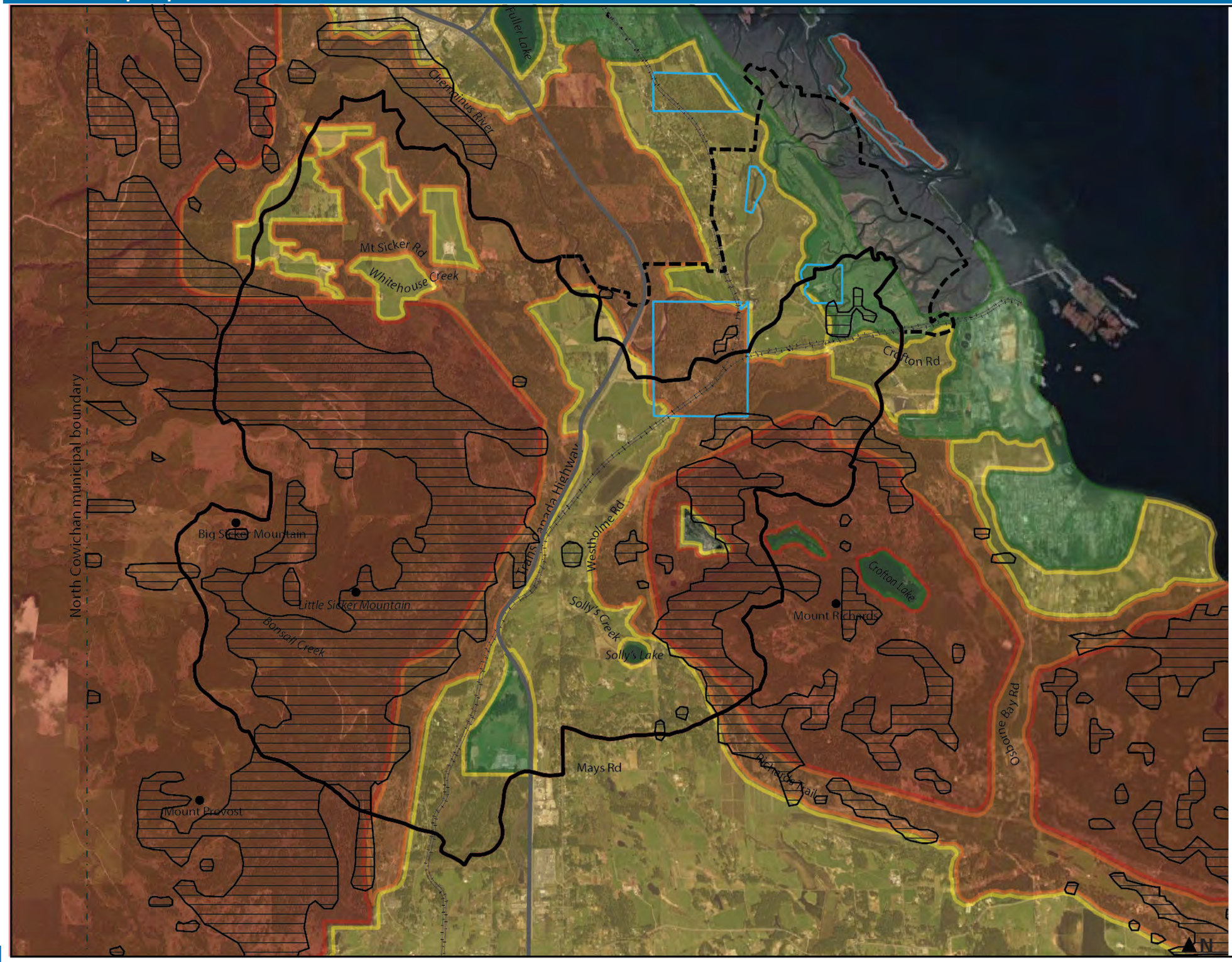
**A projection for 1 metre sea level rise by the year 2100 is shown. The BC Parks Shoreline Sensitivity Model identifies coastline in the watershed as a zone highly sensitive to sea level rise and erosion. Currently, a combination of a severe storm event at high tide could overwhelm coastal flood protection infrastructure, even without additional sea level rise.**

**SOURCES:** District of North Cowichan, Cowichan Valley Regional District

Created by JMM
Sustainability Solutions Group
BCWMP_M04_02_v2
2015/02/26

0 2 4 6
km

# Hazards: steep slopes and wildfire




## Legend

- Bonsall Creek watershed boundary
- additional study area
- highway
- railway
- First Nations Reserve land

**Fire risk**

- extreme
- high
- medium
- low
- Slopes > 20%

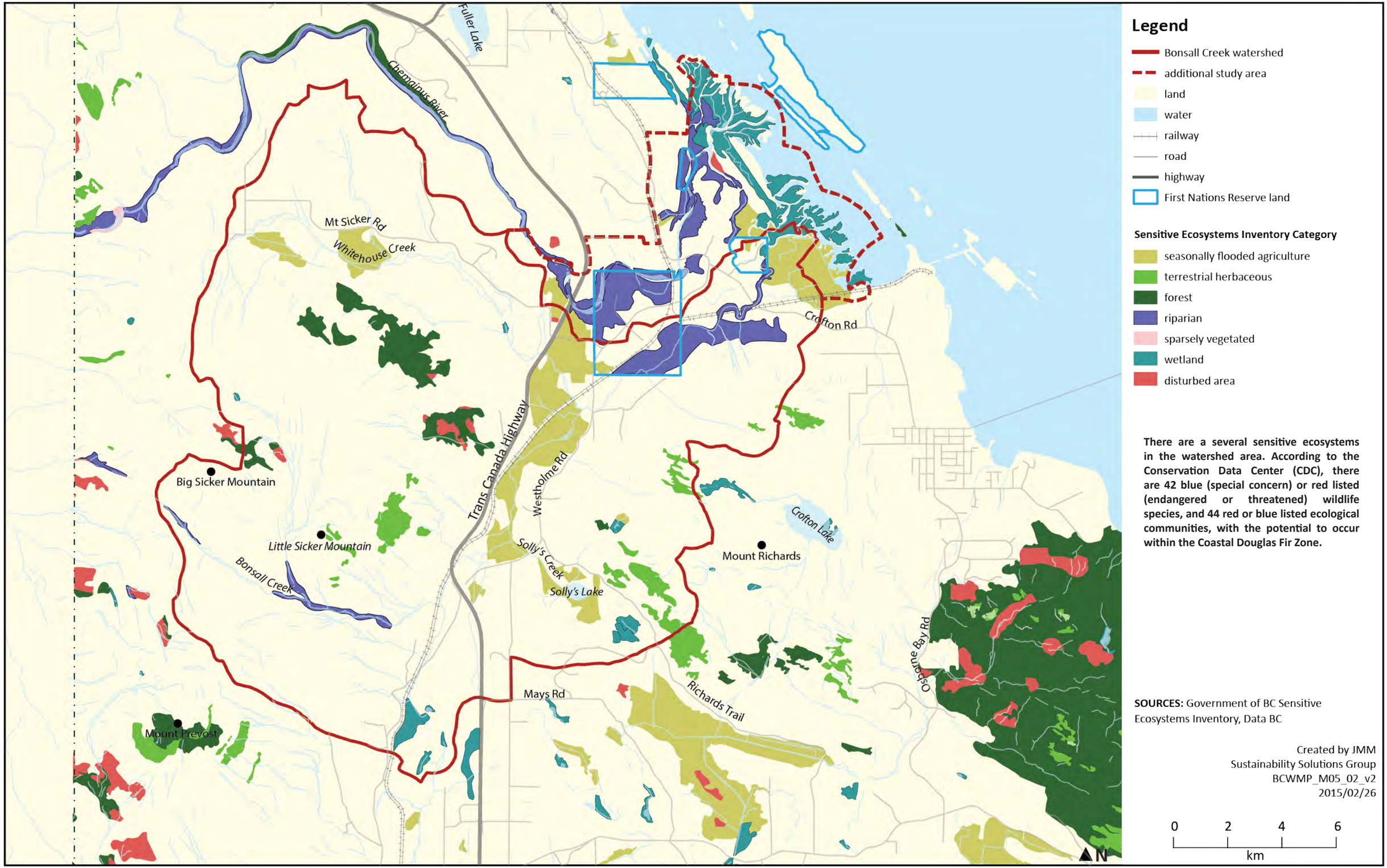
**Warming, water flow decrease and increased drought hazard will increase the risk of wildfire hazard. As the presence of different tree species change due to changes in climate, fire risk may be elevated. Projections indicate British Columbia will have five or six times as many fires in the near future. Although some fires can be beneficial for forest rejuvenation, the types of fires projected to occur in the future will do more damage than good.**

SOURCE: District of North Cowichan

Created by JMM
Sustainability Solutions Group
BCWMP_M08_01_v2
2015/02/26

0 2 4 6
km

# Sensitive ecosystems




**There are a several sensitive ecosystems in the watershed area. According to the Conservation Data Center (CDC), there are 42 blue (special concern) or red listed (endangered or threatened) wildlife species, and 44 red or blue listed ecological communities, with the potential to occur within the Coastal Douglas Fir Zone.**

**SOURCES:** Government of BC Sensitive Ecosystems Inventory, Data BC

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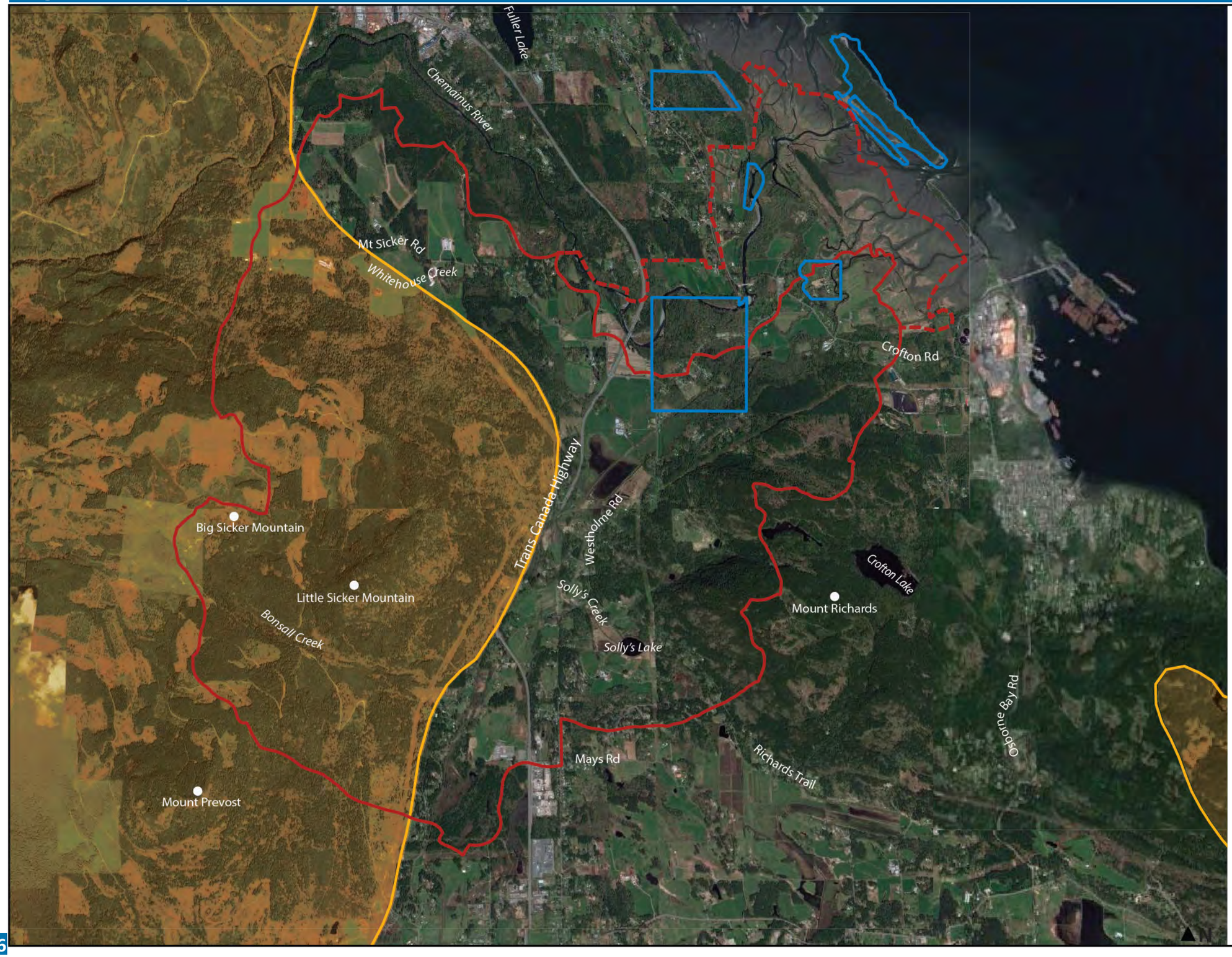
Sustainability Solutions Group
BCWMP_M05_02_v2
2015/02/26

0 2 4 6
km

## Biogeoclimatic ecosystem classification




### Legend

- Bonsall Creek watershed boundary and study area
- land
- water
- additional study area
- First Nations Reserve land

**Biogeoclimatic Ecosystem Classification**

- Coastal Douglas fir
- Coastal Western Hemlock

**The watershed is located in the Coastal Douglas Fir (CDF) Biogeoclimatic Zone, one of the smallest zones in B.C., covering approximately 0.3% of the province. The CDF is located at low elevations (between 0 and 260m) on areas of the mainland coast, the Gulf Islands and the southeastern coast of Vancouver Island. Common vegetative species in the CDF are Douglas Fir, Western Red Cedar, Western Hemlock, Big Leaf Maple, Red Alder, Pacific Crab Apple, Pacific Dogwood, Gary Oak and Arbutus.**

**SOURCES:** Data BC; Government of British Columbia Forest Analysis and Inventory Branch; Google Earth

Created by JMM
Sustainability Solutions Group
BCWMP_M05_03_v2
2015/02/26

0 2 4 6
km

# Community Experience

# Community mapping: water


## Legend

- Bonsall Creek watershed boundary
- highway
- road
- railway
- land parcel boundary
- water
- land
- First Nations Reserve land
- water feature

**This map was developed via community watershed mapping exercises completed at open houses for the Bonsall Creeek Watershed Management Plan. Participants located important or notable elements for water, including streams, ponds, blockages, marshes, and other. There appears to be a high degree of awareness of water elements in the watershed.**

**SOURCE:** Nov 2014 SSG community consultations with North Cowichan; Data BC

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Sustainability Solutions Group
14BCWMP M_C1_v2
2015/02/26

0 1 2
km

# Community mapping: ecology and habitat


## Legend

- Bonsall Creek watershed boundary
- highway
- road
- railway
- land parcel boundary
- water
- land
- First Nations Reserve land
- ecological feature
- habitat feature

**This map was developed via community watershed mapping exercises completed at open houses for the Bonsall Creeek Watershed Management Plan. Participants located important or notable elements for ecology (eg: forest type, plant species concentration) and habitat (eg: beaver dam, animal home, habitat area for a specific species). There appears to be a high degree of public awareness of natural elements in the watershed.**

**SOURCE:** Nov 2014 SSG community consultations with North Cowichan; Data BC

Created by JMM
Sustainability Solutions Group
14BCWMP M_C2_v2
2015/02/26

0 1 2
km

# Community mapping: physical and economic


## Legend

- Bonsall Creek watershed boundary
- highway
- road
- railway
- land parcel boundary
- water
- land
- First Nations Reserve land
- physical feature
- economic feature
- other feature

**This map was developed via community watershed mapping exercises completed at open houses for the Bonsall Creeek Watershed Management Plan. Participants located important or notable physical features (eg: viewpoints, steep slopes, natural landmarks) and economic features (eg: business, farm, resource extraction activity). There appears to be a high degree awareness of physical and economic elements in the watershed.**

**SOURCE:** Nov 2014 SSG community consultations with North Cowichan; Data BC

Created by JMM
Sustainability Solutions Group
14BCWMP M_C4_v2
2015/02/26
Scale 1:40,000

0 1 2
km

# Community mapping: historical and spiritual


## Legend

- Bonsall Creek watershed boundary
- highway
- road
- railway
- land parcel boundary
- water
- land
- First Nations Reserve land
- historical feature
- spiritual feature

**This map was developed via community watershed mapping exercises completed at open houses for the Bonsall Creeek Watershed Management Plan. Participants located important or notable historical and spiritual (eg: sacred place, visiting place, tourist spot) elements. There appears to be moderate awareness of historical and cultural uses in the area.**

**SOURCE:** Nov 2014 SSG community consultations with North Cowichan; Data BC

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Sustainability Solutions Group
14BCWMP M_C3_v2
2015/02/26

0 1 2
km

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