
Stage 1 Preliminary Site Investigation

4295 Robertson Road, Glenora, BC

Prepared for:
BC Parks – West Coast Region
Ministry of Environment and Climate Change Strategy
2080-A Labieux Road
Nanaimo, BC V9T 6J9

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EXECUTIVE SUMMARY

Trillium Environmental Ltd. ("Trillium") was engaged by BC Parks to conduct a Stage 1 Preliminary Site Investigation (PSI 1) for the property referenced as 4295 Robertson Road, Glenora, BC, located in the Cowichan Valley Regional District (herein referred to as "the Site").

Prior to the mid 1960s, the Site had been logged with regrowth apparent in historical aerial photographs. Beginning in the mid 1960s, the central and eastern portions of the Site were used as a gun range. The 100- and 200-yard outdoor ranges, its firing line enclosure, and the clubhouse building were the first to be built. This was followed by the 50-yard range firing line enclosure and range, the indoor 20-yard gun range building, Founders Hall building, a washroom building, and the on-Site residential building and outbuildings, between circa 1970 and 1990. The aerial photographs indicate that the current trap range area was the first portion of the Site cleared of vegetation; however, it is understood that formal use of this area for trap shooting did not commence until the 1990s.

The areas occupying the outdoor gun ranges, including the areas between the firing lines and the target areas are considered areas of potential environmental concern (APECs) given the presence of spent bullets, bullet fragments and gunshot. Preliminary soil sampling confirmed the presence metals-contaminated soil at the 50-, 100-, and 200-yard target berms (Trillium, 2018). In addition, a soil sample obtained approximately 50m east (behind) of the 200-yard target area also contained bullet fragments and lead concentrations above the applicable soil standard. Therefore, the horizontal extent of impacts from the outdoor range use potentially includes 'overspray' areas beyond the target berms. The Site's outdoor target ranges are considered potential sources of soil and groundwater metals contamination.

The indoor 20-yard target range is designed to contain bullets fired inside the building; however, a certain amount of lead associated with the building's ventilation system appears to have been transported outside the building and impacted surficial soils to the south of the building (Trillium, 2018). However, given the anticipated low mass of metals via aerial deposition, this source is considered to have a low potential to cause groundwater contamination.

During the site reconnaissance and preliminary soil sampling conducted by Trillium, spent gunshot was observed across a relatively wide area including the trap range target area and an overspray area to the north and east of the target area. Fragments of spent clay pigeons were observed most densely in the trap range target area, and to lesser amounts in the remaining outdoor gun range target areas. Results of the preliminary soil sampling did not reveal soil metals contamination based on one sample taken from the soil berm adjoining the trap range target area. However, the overall area influenced by spent gunshot, including overspray, is large and requires additional soil characterization. The trap range and overspray areas are considered potential sources of soil and groundwater metals contamination at the Site. Pitch from clay pigeon fragments can contain polycyclic aromatic hydrocarbons (PAHs) with potential to impact soils; however, if present, the PAHs are tightly bound to a limestone-pitch matrix and are considered unlikely to leach and impact groundwater.

The area surrounding the Site has a limited history of development, other than forestry/logging, and more recently, park use. No off-Site potential sources of soil, groundwater, and/or soil vapour contamination were identified during this investigation.

It is concluded that there is a potential for constituents of concern to be present in the Site soil and groundwater at concentrations in excess of applicable standards provided in the British Columbia Contaminated Sites Regulation (CSR).

Further site investigation is warranted to determine whether potential contaminants of concern (PCOCs) associated with the areas of potential environmental concern (APECs) listed in Table E-1 below are present at the Site.

Table E-1: List of APECs and PCOCs

APEC ID.	Name	Activities of Concern	PCOCs
On-Site			
APEC 1	Area Surrounding the Indoor 20-yard Range	Indoor target shooting activities, with venting of contaminants (c. 1970 to present)	Soil: Metals Groundwater: none
APEC 2	Outdoor 50-yard Gun Range	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (c. 1975 to present)	Soil: Metals & PAHs Groundwater: Metals
APEC 3	Outdoor 100- and 200-yard Gun Ranges	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (mid-1960s to present)	Soil: Metals & PAHs Groundwater: Metals
APEC 4	Trap Range	Trap range and overspray area with evidence of gunshot and clay pigeon fragments (1990s to present)	Soil: Metals & PAHs Groundwater: Metals

Notes:

APEC: Area of Potential Environmental Concern

PCOC: Potential Contaminant of Concern

PAH: Polycyclic Aromatic Hydrocarbons

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1.0 INTRODUCTION

Trillium Environmental Ltd. ("Trillium") is pleased to present the findings and results of a Stage 1 Preliminary Site Investigation (PSI 1) conducted for the property referenced as 4295 Robertson Road, Glenora, BC (herein referred to as the "Site"). This report was prepared at the request of BC Parks ("the Client").

The purpose of this PSI 1 was to identify potential environmental concerns at the Site that may have resulted from existing and previous land uses or site development activities on and adjacent to the Site, and to identify any present conditions or practices that may represent significant environmental risks or liabilities. It is understood that this investigation was requested for due diligence purposes to evaluate known and potential environmental concerns at the Site.

1.1 Site Identification

The Site consists of three legally titled parcels within Cowichan River Provincial Park, as described in in **Table 1-1** below.

Table 1-1: Site Information

Descriptor	Details
Civic Address	4295 Robertson Road, Glenora, BC
Parcel 1	
Legal Description	Lot 1, Section 6, Range 10, Sahtam District, Plan 19268
PID	003-709-116
Registered Owner	Her Majesty the Queen in Right of the Province of British Columbia
Parcel 2	
Legal Description	Lot 1, Section 6, Range 10, Sahtam District, Plan 3112, Except part in Plan 23420
PID	006-229-387
Registered Owner	Arthur W. Jones (Legal notation: "Notice of tax sale DF 17619 received 13.10.27 reverted to Crown 203021 23.10.28.")
Parcel 3	
Legal Description	Lot 1, Section 6, Range 10, Sahtam District, Plan 23914
PID	002-927-047
Registered Owner	Her Majesty the Queen in Right of the Province of British Columbia
Site ID	20976
Current Zoning	River Corridor (RC-1)
Property Area	9.95 hectares (99,490 m ² , approx.)
Latitude / Longitude	48° 45' 32.4"N, 123° 47' 20.9"W

The approximate latitude and longitude entered for the Site was obtained from Site Registry entry for the Site (see Section 3.1.5).

The Site is located within Electoral Area 'E' of the Cowichan Valley Regional District (CVRD), southwest of Duncan, BC, as shown on the attached **Figure 1**. A site plan is provided on **Figure 2**.

A current title search was obtained online from the Land Title and Survey Authority of BC (<http://ltsa.ca>). Leases, covenants, title transfers or easements related to site contamination issues were not listed in the land title. A copy of the current title search is provided in **Appendix A**.

1.2 Scope of Work

The work included the following tasks:

- Conduct and document site reconnaissance;
- Research and document information available for the Site and surrounding area, including geology, hydrology, water wells, city directories, aerial photographs, BC Site Registry, land titles, available well test results, and interviews.
- Prepare Stage 1 PSI report stating conclusions and recommendations, supported with figures, Site photos, and appended research documentation.

Trillium conducted this work according to standard assessment procedures, in general accordance with the BC *Environmental Management Act* (EMA) and Contaminated Sites Regulation (CSR), which also reflects the CSA Z768-01 Phase I Environmental Site Assessment standards.

1.3 Regulatory Background

The legislation which dictates site investigation and remediation of site contamination in British Columbia is mandated by the BC Ministry of Environment and Climate Change Strategy (BC ENV) under the EMA. Specific environmental standards, protocols and practice guidance are provided in the CSR. The CSR provides concentration-based standards for soil, groundwater and soil vapour that, when warranted, are used to determine whether or not a site is contaminated. The purpose of the PSI 1 is to review historical records to determine the potential for the Site to be contaminated as per the CSR, and if warranted, to recommend further site investigation.

1.4 Study Limitations

Findings presented in this report are based upon (i) a limited visual review of accessible areas of the on-Site buildings and surrounding grounds, (ii) interviews with personnel familiar with Site activities, and (iii) a review of Site, environmental agency and historic archive records. Consequently, while findings and conclusions documented in this report have been prepared in a manner consistent with that level of care and skill normally exercised by other members of the environmental science and engineering profession practising under similar circumstances in the area at the time of the performance of the work, this report is not intended nor is it able to provide a totally comprehensive review of past or present Site environmental conditions. This report is intended to provide information to reduce, but not necessarily eliminate, uncertainty regarding the potential for contamination of a property.

This report has been prepared solely for the internal use of BC Parks pursuant to the agreement between Trillium Environmental Ltd. and BC Parks. By using the report, BC Parks agrees that they will review and use the report in its entirety. Any use which other parties make of this report, or any reliance on or decisions made based on it, are the responsibility of such parties. Trillium Environmental Ltd. accepts no responsibility for damages, if any, suffered by other parties as a result of decisions made or actions based on this report.

2.0 SITE DESCRIPTION

The Site is an irregular-shaped lot, occupied by a number of buildings primarily used by the Cowichan Fish and Game Association (CFGa) and one residential building. The Site is located within the eastern-most portion of the Cowichan River Provincial Park (CRPP), with the river located north of the Site. Forested areas of the CRPP surround the Site to the north, east, and west. The area to the south of the Site includes Robertson Road and the Glenora Trails Head Park. The Site and adjacent areas are shown on **Figure 2**.

2.1.1 Surficial Geology

Local surficial geology was determined by consulting the Surficial Geology of the Duncan Area (BCGS, 1992). The stratigraphy of the Site and surrounding area is characterized by a surface of hummocky morainal diamicton comprised of silt and boulders, with lesser amounts of plain glaciolacustrine silt, underlain by glaciofluvial sand and gravel.

2.1.2 Regional Geology and Hydrogeology

Bedrock in the area of the Site is of the Haslam Formation, comprised of argillite, siltstone, shale and minor sandstone formations (BCGS, 1991).

Groundwater at the Site includes a confined aquifer within the glaciofluvial sand and gravel deposits known as the Glenora Aquifer, and an aquifer within the underlying Haslam Formation bedrock known as the South Cowichan Aquifer (BC Water Resources Atlas, 1995 & 1996). There is the potential for shallow groundwater to remain perched within the morainal diamicton soils overlying the Glenora Aquifer sand and gravel.

The productivity of the Glenora Aquifer is moderately high, ranging in yield from 0.06 to 6.31 L/s. Vulnerability of the aquifer is considered low as the degree of confinement is moderately high. A confining layer consisting of clay, silty sand and gravel, till and hardpan layers is reported, with a mean thickness of 9.9 m with a median depth of 10.7 m.

The productivity of the South Cowichan (bedrock) Aquifer is low, reportedly with a range of reported yields from 0.02 to 0.63 L/S. Vulnerability of the aquifer is low as the degree of confinement is moderately high. The mean thickness of the confining layer is 8.0 m.

Regional groundwater flow direction has not been determined in either aquifer; however, probable direction of flow would be north and/or west towards the Cowichan River (see **Appendix B**).

2.1.3 Surface Water Bodies

On-Site Surface Water

Gazetted¹ surface water bodies were not identified within the boundaries of the Site. During the site reconnaissance, two on-Site seasonally wetted areas were observed: ponding water within an artificial depression located to the east (behind) the 50-yard target berm, and water seeping from the natural slope east (behind) the 200-yard target area. Based on the lack of paved surfaces at the Site and a lack of evidence indicating surface water runoff, stormwater at the Site is believed to infiltrate into the subsurface.

Off-Site Surface Water

The nearest gazetted surface water body is the Cowichan River. The river meanders and therefore varies in distance from the Site; it is located as near as 120 m northeast of the Site, but is generally located upwards of 400 m away to the north. The Cowichan River is located topographically down-gradient of the Site.

Holt Creek is located about 485 m to the west of the Site, and flows north before discharging into the Cowichan River upstream of the Site. Holt Creek is located topographically up- to cross-gradient of the Site.

During the site reconnaissance, a swampy area and small stream were observed in a topographically lower area, approximately 100m north of the Site. Surface water in this area is anticipated to be seasonal and originating from one or more shallow groundwater seeps. At least one groundwater seep was observed near the base of land sloping down to this wetted area.

¹ The legally registered name of the stream as obtained from Geographic Data B.C.

3.0 RECORDS REVIEW

Various documents were reviewed and interviews conducted for information concerning historical use and activities at the Site. A list of references is included at the end of this report. The documents requested and reviewed for information, depending on availability, concerning historic land use include historical maps, street directories, aerial photographs, fire insurance maps, the BC ENV on-line Site Registry, and the BC Water Resources Atlas.

3.1.1 Historical Records

A request for historical records was made to the Cowichan Valley Museum Archives. Historical records specific to the Site area were not available.

3.1.2 Street Directories

A review of the City of Duncan street directories, for years 1968 to 1993, confirmed that records were not made for the Site and surrounding area.

3.1.3 Aerial Photographs

Aerial photographs, dated 1946 to 2007 were reviewed for information concerning historic physical features on the Site and in the surrounding areas. A summary of observations made during the aerial photograph review is presented below in **Table 3-1** below. Copies of the aerial photographs that were reviewed are presented in **Appendix C**.

Table 3-1: Aerial Photograph Review Summary

Date	Site	Surrounding Properties
1946	Recently logged with evidence of early forest regrowth throughout most of the Site. Forest regrowth appeared more advanced in the southwest portion of the Site. No buildings or infrastructure was evident.	North: Young forest; East: Young forest and recent logging; South: Robertson Road right of way and forest beyond; West: A narrow road, possibly a forest spur, paralleled the western Site boundary. Recently logged area beyond.
1950	Generally unchanged from 1946 aerial photograph except that vegetation was more mature and a clearing was present where the present trap range is located.	Unchanged from 1946 aerial photograph except for increased vegetation.
1958 & 1962	Generally unchanged from 1950 aerial photograph except that vegetation continued to mature. The previous clearing was still present and was larger in size in the 1962 photograph.	Immediately adjacent areas remained unchanged from 1950 aerial photograph except for increased vegetation. A large road-side clearing was present south of the Site in the area of the present Glenora Trails

Date	Site	Surrounding Properties
		Head Park, key a sma grave quarry associated w th ogg ng act v ty.
1968	The previous y c eared area (trap range area) was st present and may have been a sma grave quarry. Structures associated w th the present 100/200 yard range f r ng ne enclosure and cub house rectangular bu d ng were present. C eared areas for the 100/200 yard outdoor ranges were v s b e. Some c eared areas, nc ud ng an access road, were present n the northwestern port on of the S te.	Immed ate y adjacent areas rema ned forested as n prev ous aer a photographs, except an access road was v s b e to the mmed ate west of the S te. Robertson Road appeared overgrown and unused south of the S te. The arge road-s de c ear ng south of the S te appeared to have been abandoned w th encroach ng vegetat on.
1972, 1975, and 1981	New S te features nc ude a second rectangular bu d ng associated w th the 20 yard ndoor range, and a new c ear ng n the centra -southern area associated w th the present access road, res dence, and park ng areas. The 1975 photograph showed that the 50 yard outdoor range area had been c eared of vegetat on. Other aspects of the S te were genera y unchanged from the 1968 aer a photograph.	The surround ng area s genera y unchanged from the prev ous aer a photograph, except for ev dence of recent ogg ng south of the S te across from Robertson Road. A so, a ong rectangular area had been c eared of vegetat on south of the above area and the S te, key associated w th a h stor ca y proposed a rstr p. The 1981 aer a photograph showed vegetat on beg nn ng to encroach th s area.
1986	More vegetat on had been c eared from the centra area associated w th the current s de berm between the 100/200 yard range and Founders Ha and park ng area. Other aspects of the S te were genera y unchanged from the 1981 aer a photograph.	The surround ng area rema ned forested and was genera y unchanged from the 1981 aer a photograph.
1992, 1998, and 2007	Severa new S te features were present, nc ud ng new berms separat ng the 50 and 100 yard ranges, and the 200 yard and trap ranges; new bu d ngs nc uded Founders Ha , the southern res dent a bu d ng and ts outbu d ngs. Other aspects of the S te were genera y unchanged from the 1981 aer a photograph.	The mmed ate y surround ng area rema ned forested and was genera y unchanged from the 1986 aer a photograph. In the 2007 aer a photograph, the present park ng ot, access roads, and day-use area of the G enora Tra Heads Park was v s b e south of the S te.

3.1.4 Fire Insurance Maps

Fire insurance maps were not available for the area of the Site.

3.1.5 Ministry of Environment & Climate Change Strategy Site Registry Search

An on-line search of the MOE Site Registry was conducted to determine if it contained information regarding soil, groundwater and/or soil vapour contamination for sites within a 0.5 km² area, centered on 48° 45' 33.0" North by 123° 47' 26.7" West, the approximate latitude and longitude entered for the area of the Site. The search returned one record listed as Site ID 20976, located at

4295 Robertson Road, Duncan (Cowichan River Provincial Park), which corresponded with the Site in question. A detailed report was obtained for this listing, within which the following was noted:

- Notations: "Complaint received regarding the authorization of shooting range within the Cowichan River Provincial Park boundaries and possible contamination associated with the operation of this facility," dated November 7, 2016;
- Site Participants: BC Parks, Property Owner; Kerri L. Skelly, Ministry Contact;
- Suspected Land Use: Rifle or pistol firing ranges; and
- Record status was not assigned, and no activities were reported for this site.

Copies of the Site Registry area-based and search result and detailed report are provided in Appendix D.

3.1.6 Water Well Search

The BC Water Resource Atlas, which displays water management information for the Province of BC, was accessed to search for registered water wells located within 500m of the Site. Three wells were identified within the Site boundaries and two wells were identified off-Site within 500m of the Site. The water well mapping search and detailed well records are presented in **Appendix B**.

The following wells were identified as on-Site:

- Well Tag No. 21437: western portion of Site, drill date May 1968, depth 44ft, yield 5 GPM;
- Well Tag No. 22269: western portion of Site, drill date April 1969, depth 48ft, yield 5GPM;
- Well Tag No. 63494: central Site, drill date December 1987, depth 73ft, yield 7 USGPM.

The two earlier on-Site wells are located in undeveloped and forested portions of the Site. It is not clear whether these wells still exist and it is likely they have been abandoned. The third well is associated with an existing on-Site well that presently supplies domestic and potable water.

The following were off-Site wells identified within 500m of the Site:

- Well Tag No. 47204: approximately 200m southwest of the Site, drill date February 1981, depth 33ft, yield 50 GPM;
- Well Tag No. 85107: approximately 175m south of the central portion of the Site, drill date February 2005, depth 55ft, yield 20 USGPM.

Based on the regional topography of the area, it is anticipated that the above off-Site wells are located up-gradient of the Site; however, this may require confirmation.

3.1.7 Surface Water Licence Search

The BC Water Resource Atlas was accessed to search for surface water intakes within 500 m of the Site utilized for drinking, irrigation, or livestock watering. The search identified two active licences for surface with points of diversion located to the north and northeast of the Site:

- Water Licence No. C027703: approximately 80m northeast of the Site, priority date August 1962, Stream name Trail Spring, domestic use, quantity 2.273 cubic meters per day (500 GPD);
- Water Licence No. C033954: approximately 70m north of western portion of Site, priority date March 1968, Stream name Skeet Spring, domestic use, quantity 4.546 cubic meters per day (1,000 GPD).

The water licence mapping search and water licence records are presented in **Appendix B**.

4.0 PREVIOUS INVESTIGATIONS

4.1.1 Tapwater Testing - Cowichan Fish & Game Association, 2017

Mr. Geoff Maxwell, President of the Cowichan Fish & Game Association obtained a tap water sample and submitted it for analysis in November 2017. Since potable water is sourced from an on-Site well, the tapwater was collected to provide an indication of Site groundwater quality given the concerns with metals contamination. Prior to collecting the sample, Mr. Maxwell ran the tap water for a few minutes; this is considered good practice when tapwater sampling as it provides an opportunity to flush stagnant water within the plumbing network. Results of the tap water laboratory report and tabulated data compared to the applicable CSR groundwater standards are presented in **Appendix F**.

Results of the tapwater analytical results for total metals indicated that no constituents exceeded the BC CSR drinking water standards (DW). The concentrations of copper and zinc in the tap water were greater than the BC CSR freshwater aquatic life standard (AWFW); however, it is possible that these parameters were introduced by corrosion from the inner walls of plumbing pipes.

4.1.2 Preliminary Soil Sampling - Trillium Environmental, 2018

As part of Trillium's work for BC Parks, a preliminary round of soil sampling was conducted at the Site and reported during January 2018 (Trillium, 2018). Shallow soil samples were collected by hand from six locations at the Site: the target soil berms at the 50-, 100-, and 200-yard ranges; the area adjacent to the ventilation exhaust vent of the indoor 20-yard range; and the target area of the trap range. Soil analytical results were compared to the CSR Observations were made during sampling of the presence and relative amounts of visible bullets, bullet fragments, and shot amongst the sampled soil.

The followings findings were made based on the preliminary soil sampling program:

- Target berm soils at the outdoor 50-, 100-, and 200-yard gun ranges contained visible bullet fragments and were contaminated with metals, primarily lead, and variable amounts of antimony, cadmium, copper, and tin.
- Forest soils behind (~50m east) of the 200 yard range target area contained visible bullet fragments and were contaminated with lead.

- Soils in the trap field target area contained visible shot, but soil was not contaminated with metals.
- Soils adjacent to the indoor 20 yard range building were contaminated with lead and zinc from an apparent surficial source: suspected deposits emitted by the building ventilation.

5.0 SITE RECONNAISSANCE

On January 12, 2018, Trillium visited the Site accompanied by Mr. Geoff Maxwell, President of Cowichan Fish and Game Association. The purpose of the visit was to observe operations and conditions at the Site as well as neighboring properties to determine the potential for contamination at the Site and to prepare photographic documentation. Representative photographs taken during the Site reconnaissance are included in **Appendix E**.

5.1 Grounds Survey

The following was observed during the Site reconnaissance:

- The Site is predominately forested (75%). Approximately 15% of the Site is occupied by the gun range and residence, including open areas and buildings. Buildings occupy less than 1% of the Site area. All other areas of the Site are unpaved, with open areas of the range surfaced with either soil or grass.
- The topography of the gun range area and developed portions of the Site is relatively flat or shallow-sloping, except for berms. The portions of the Site east and west of the gun range are generally higher topographically, characterized by undulating terrain. The area north of the Site slopes away steeply to the north down to a lower river bench. The area south of the Site is relatively flat to gently sloping away to the south towards Glenora Trails Head Park.
- Soil berms, or target butts, are present in the target areas of the 50-, 100-, and 200-yard ranges. The berm of the 200-yard range target area take advantage of the naturally sloping land immediately adjacent to the east. Soil berms are also present along the sides of the 50-yard range and along the sides of the 100/200-yard range.
- A target box constructed of creosote-treated timbers, used for securing targets, was present at the 50-yard range target area. The target frames at the 100- and 200-yard range target areas were constructed using a combination of pressure-treated lumber and creosote-treated timbers.
- Evidence of spent lead bullets, unjacketed and copper jacketed, lead slugs, and bullet fragments of various calibres were observed amongst the soils at each of the three outdoor gun range target berms.
- A soil berm was not present in the designated target area at the trap range; rather, a large black rubberized tarp was observed to be hoisted by two trees in the target area. A similar tarp was placed under the backstop tarp to capture gun shot. Spent gunshot and clay target

fragments were observed through all the outdoor ranges, but predominantly in the target area of the trap range. The side-berm of the 200-yard outdoor range is adjacent to the north side of the trap range, which approaches the trap range target area at its eastern limit. Spent gunshot was observed amongst the soil of this berm, and was observed beyond this berm as far away as 20-25m north and 50m east of the 200-yard range target area.

- No tanks were observed on-Site, with the exception of an old abandoned concrete cistern, located on an elevated piece of land a few meters west of the 20-yard indoor gun range building.

5.2 Building Survey

The following was observed during the Site reconnaissance:

- Site buildings associated with the gun range were, from north to south:
 - Indoor 20-yard range and adjacent 50-yard outdoor range enclosed firing line;
 - Enclosed 100/200-yard outdoor range firing line;
 - The Clubhouse;
 - Founders Hall; and
 - A washroom building.
- The buildings are of wood construction on concrete foundations and slab floors. Rooftops are of steel, except for the 100/200-yard firing line enclosure, which had an asphalt shingle roof.
- The buildings are heated electrically. A wood stove was also present within the Founders Hall.
- The northern wall behind the target area within 20-yard range building is comprised of a bullet trap. The bullet trap is comprised of thick rubber mat draping, behind which are downward angled ½" steel plates, backfilled with sand. The bullet trap captures or contains bullets to within the building.
- A ventilation system within the 20-yard range building was present, and is understood to remove gun smoke from the shooting line area. The air is exhausted from the building via a vent located on the south side of the building.
- An enclosed outdoor storage and recycling area was present at the southwest side of the 20-yard range building. The above-mentioned building vent is located on the wall of the building which serves as the north side of this enclosure. The storage area was used to

temporarily store used plywood and paper target backings, most of which were perforated with numerous bullet holes.

- The 50-yard range firing line structure was an open-air, covered structure, containing 14 shoot bays. A barrel was present into which spent bullet brass casings were deposited.
- The 100- and 200-yard range firing area share one firing line structure. Similar to the 50-yard, the structure was open-air, covered, and containing nine shoot bays. A barrel was present into which spent brass casings were deposited.
- The clubhouse building is a square-shaped building used for small gatherings and meetings. It has a kitchen area and an open area with tables. It has linoleum flooring.
- The Founders Hall building is a wood structure on a concrete slab used for social gatherings.
- The washroom building is a two-room wood structure building, located south of Founders Hall.
- Site buildings associated with the single-family residence were, from north to south:
 - Two wood-constructed outbuildings, used for storage and the larger one used as a workshop; and
 - A mobile home structure, with an attached outdoor wood deck to its east.
- The residence and outbuildings were not entered as requested by the tenants.
- The mobile home exterior and roof were of metal construction. An electric heat pump was observed on a pad to the south of the home. No evidence of an underground or aboveground heating oil tank was observed.
- It is understood that the larger (northern) outbuilding contained personal storage and had previously been used as a workshop. The contents of the smaller outbuilding (southern) were unknown. It is understood that the outbuilding had earthen, unpaved floors.

5.3 Special Attention Substances

Special attention substances, including asbestos, mercury, lead, polychlorinated biphenyls (PCBs), and urea formaldehyde foam insulation (UFFI), have the potential to be present at the Site, as part of building materials and/or equipment as follows:

- Asbestos – the presence of asbestos has not been confirmed in the Site buildings, but based on its ages, asbestos may be present in cement products, grouts, plaster, compressed paper boards, duct tapes, floor tiles, sealants and protective coatings. If demolition or renovation of the structures is undertaken, the identification and safe removal or containment of asbestos will be needed.

- Mercury – thermostats containing mercury were not observed in the Site buildings during the Site reconnaissance. If mercury-containing equipment is identified and removed during renovation or demolition and is not to be reused, it is recommended that it be disposed appropriately.
- Lead – prior to 1976, lead was a component of both interior and exterior paint in Canada. After 1976, regulations limited the amount of lead which could be used in the manufacture of interior paint. Given the age of the main Site building, lead may be present in interior and exterior painted surfaces. If demolition is considered it should be identified, removed or contained, and disposed of in an appropriate manner.
- Fluorescent lighting fixtures were observed in all Site buildings. Most fixture appeared newer electrically ballasted models; however, it is possible that older conventional ballasted models are present. Current-regulating ballasts, transformers and capacitors that were manufactured prior to 1980 potentially contain a small volume of polychlorinated biphenyls (PCBs). As long as older fluorescent equipment is being used for its intended purpose, and is in good operating condition, it is not considered to be a waste material. If older fluorescent fixtures are present on-Site, disposal of any PCBs during renovations or replacement should be conducted appropriately.
- Urea formaldehyde foam insulation (UFFI) was installed in new and existing structures in Canada between 1975 and 1978. Its presence is typically determined by evidence of patched up injection holes on siding: the holes were used to install UFFI in older buildings. No evidence of old injection holes was observed on the siding of Site buildings; therefore, UFFI is not anticipated to exist on-Site.

5.4 Current Use – Adjacent Properties

The following was observed on surrounding properties:

- Forested areas of the Cowichan River Provincial Park are located to the east, west, and north of the Site; and
- The Glenora Trails Head Regional Park, across Robertson Road.

6.0 INTERVIEWS

An interview was conducted on January 12, 2018 with Mr. Geoff Maxwell, President of the Cowichan Fish and Game Association. He reported the following:

- Mr. Maxwell has knowledge of the Site since becoming a member of CFGA in 1972.
- According to Mr. Maxwell, the gun range layout has remained unchanged since he has been a member of the club; however, the trap range along the southern portion of the Site came in use beginning during the 1990s.
- Presently, the CFGA has approximately 500 members, including around 80 regular users of the gun ranges.
- The Royal Canadian Mounted Police (RCMP) use the Site for firearms training approximately twice per year for a week at a time. RCMP training involves use of rifles (carbines), shotguns and pistols. According to the RCMP, some of the ammunition they use during training with 9mm bore pistols contains unleaded bullets.
- Spent brass casings are collected from the firing lines and placed in lined drums for disposal. Some range users collect the brass casings in order to re-charge them with gunpowder and bullets for reuse. Similarly, some range users collect lead from bullets that have been fired from the target area soils for casting new bullets.
- The target area berms are routinely maintained as they erode from repeated bullet impacts. The berm structure at each of the outdoor rifle ranges is reinstated using a machine backhoe; some new clean sand is brought in to amend the berms soils as needed. To Mr. Maxwell's knowledge, target berm soils from the outdoor ranges has not been moved to other parts of the Site.
- The old cistern located west of the indoor 20-yard target range was abandoned in place, but previously was used to store water for domestic use at the Site. It is believed that this cistern was associated with old water licence for a spring source located north of the Site (Section 3.1.7).
- Potable water is supplied by the on-Site well, located in the central portion of the Site, as shown on the attached **Figure 2**. Mr. Maxwell volunteered to supply Trillium with tap water analytical results that he initiated, on behalf of the CFGA. These results are presented and discussed in Section 4.1.1.

7.0 SUMMARY AND DISCUSSION

An historical summary of the Site and surrounding areas is provided below, with an emphasis on past or present activities deemed to be Area(s) of Potential Environmental Concern (APEC). APEC locations are summarized on the attached **Figure 3**.

7.1 Potential on-Site Sources of Contamination

Historical records indicate that the Site was used for forestry-related activities prior to the mid-1960s. Historical aerial photographs indicated that use of the Site as a gun range commenced sometime between 1962 and 1968; specifically, the structures and clearings associated with the existing 100- and 200-yard outdoor ranges and club house building were constructed circa mid-1960s. Other structures, including the indoor 20-yard gun range building and 50-yard range firing line enclosure, Founders Hall building, washroom building, southern residential building and its outbuildings, were erected at the Site between circa 1970 and circa 1990. The aerial photographs indicate that the current trap range area was the first portion of the Site cleared of vegetation; however, it is understood that formal use of this area for trap shooting did not commence until the 1990s. Furthermore, it is understood that on-Site soils impacted by metals from gun range activities have remained on-Site, within the general area of the outdoor ranges, particularly the target area soil berms.

The preliminary shallow soil sampling conducted by Trillium (2018) confirmed the presence of soil contaminated with metals, predominantly lead, at the 50-, 100-, and 200-yard outdoor target berms. A soil sample from the forested area located approximately 50m east of the 200-yard target area also contained bullet fragments and lead concentrations above the applicable standard. As such, the horizontal extent of soil contamination at the outdoor target ranges potentially includes the areas between the firing lines and target berms, in addition to the areas behind (east of) the target areas. The outdoor target ranges are considered potential sources of soil and groundwater contamination at the Site.

The preliminary soil sampling identified contamination adjacent to the 20-yard indoor target range. The analytical result identified lead and zinc at concentrations above CSR standards applicable at this location. The source was believed to originate from the ventilation exhausting air from within the indoor range building. The indoor 20-yard target range ventilation exhaust is considered the likely source of soil contamination at this location. However, given the anticipated low mass of aerial deposition, this source is considered to have a low potential to cause groundwater contamination.

The trap range area has been used since at least the 1990s for clay pigeon shooting with shotguns. During the site reconnaissance and preliminary soil sampling conducted by Trillium, spent gunshot was observed across a relatively wide area including the trap range target area and an overspray area to the north and east of the target area. Fragments of spent clay pigeons were observed most densely in the trap range target area, and to lesser amounts in the remaining outdoor gun range target areas. Results of the preliminary soil sampling did not reveal soil metals contamination at a single sample taken from the soil berm adjoining the trap range target area. However, the overall area influenced by spent gunshot, including overspray, is large and requires additional soil characterization. The trap range and overspray areas are considered potential sources of soil and groundwater contamination at the Site.

Clay pigeons are made of limestone, a pitch binder, and often they are painted. The pitch has historically been derived from coal tar or petroleum containing polycyclic aromatic hydrocarbons (PAHs), a potential soil contaminant. However, studies on new and aged clay pigeon targets suggest that PAH are tightly bound in the petroleum pitch and limestone matrix and are unlikely to be readily available in the environment (Baer et al., 1995). Therefore, any PAH from clay pigeons that may be identified in Site soils have a low potential to leach and impact groundwater.

Based on the findings of the historical records review, site reconnaissance, and interviews, no other areas were identified at the Site with potential to cause soil, groundwater, and/or soil vapour contamination.

7.2 Potential off-Site Sources of Contamination

The area surrounding the Site has a limited history of development, other than forestry/logging, and more recently, park use. Roadways associated with logging activities, and possibly a small-scale gravel quarry and a clearing for an airstrip, were observed south of the Site in historical aerial photographs. No commercial/industrial development, buildings, storage tanks, stockpiles, or other evidence of activities of concern were identified in the areas surrounding the Site. These areas have since become revegetated and are now occupied by the Glenora Trail Heads Park and Shawnigan (Glenora) Road, a logging access road. No off-Site potential sources of soil, groundwater, and/or soil vapour contamination were identified during this investigation.

8.0 CONCLUSION

It is concluded that there is a potential for constituents of concern to be present in the Site soil and groundwater at concentrations in excess of applicable standards provided in the British Columbia Contaminated Sites Regulation (CSR). No historical sources or activities were identified with potential to contribute to soil vapour contamination at the Site.

Further site investigation is warranted to determine whether potential contaminants of concern (PCOCs) associated with the areas of potential environmental concern (APECs) listed in Table 8-1 below are present at the Site.

Table 8-1: List of APECs and PCOCs

APEC ID.	Name	Activities of Concern	PCOCs
On-Site			
APEC 1	Area Surrounding the Indoor 20-yard Range	Indoor target shooting activities, with venting on to outside (circa 1970 to present)	Soil: Metals Groundwater: none
APEC 2	Outdoor 50-yard Gun Range	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (circa 1975 to present)	Soil: Metals & PAHs Groundwater: Metals
APEC 3	Outdoor 100- and 200-yard Gun Ranges	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (mid-1960s to present)	Soil: Metals & PAHs Groundwater: Metals
APEC 4	Trap Range	Trap range and overspray area with evidence of gunshot and clay pigeon fragments (1990s to present)	Soil: Metals & PAHs Groundwater: Metals

Notes:

APEC: Area of Potential Environmental Concern

PCOC: Potential Contaminant of Concern

PAH: Polycyclic Aromatic Hydrocarbons

I trust that the information presented in this report meets your current requirements. Should you have any questions, or concerns, please do not hesitate to contact the undersigned.

Prepared By:

TRILLIUM ENVIRONMENTAL LTD.



Stefan Quaglia, R.P.Bio., CSAP

9.0 REFERENCES

Historical aerial photographs (courtesy of UBC Geographic Information Centre) dated: 1946, 1950, 1958, 1962, 1968, 1972, 1975, 1981, 1986, 1992, 1998, and 2007.

BC Ministry of Environment & Climate Change Strategy (BC ENV) Site Registry:

<http://www.bconline.gov.bc.ca>

BC ENV Well Database: http://www.env.gov.bc.ca/wsd/data_searches/wrbc/

Current Title Search obtained online from the BC Land Title and Survey Authority of BC website:

<http://www.ltsa.ca>

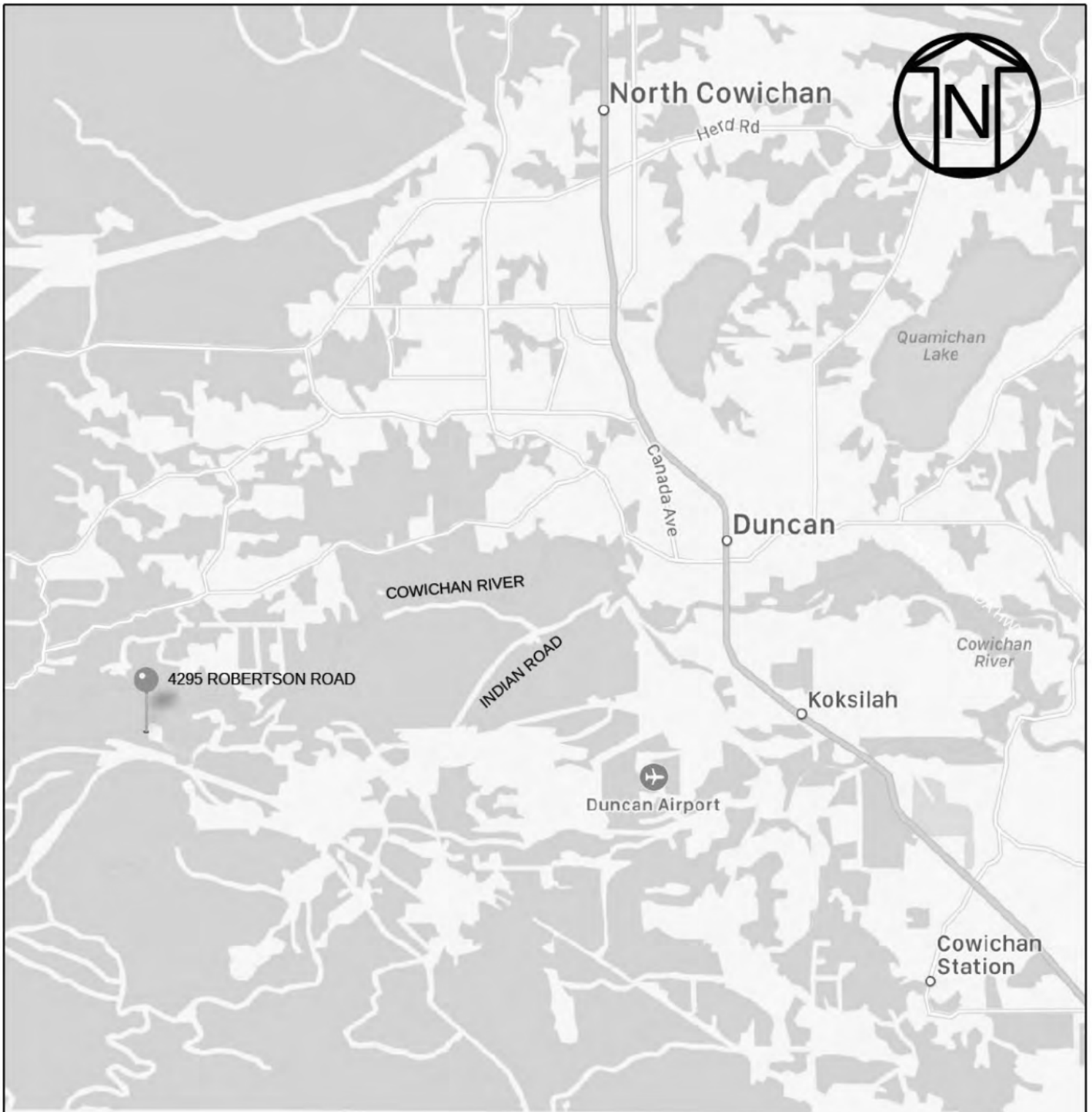
BC Geological Survey. 1992. Surficial Geology of the Duncan Area (92B/13), by H.E. Blyth and N.W. Rutter.

BC Geological Survey. 1991. Geology of the Duncan Area (92B/13), by N.W.D Massey, S.J. Friday, P.E. Tercier and T.E. Potter.

Preliminary Soil Sampling Report and Indoor Range Containment Testing, prepared for BC Parks, prepared by Trillium Environmental Ltd., January 25, 2018.

Baer, K.N., D.G. Hutton, R.L. Boeri, T.J. Ward and R.G. Stahl Jr. 1995. Toxicity evaluation of trap and skeet shooting targets to aquatic test species. *Ecotoxicology*, 4(6): 385-392.

Figures



4295 ROBERTSON ROAD

North Cowichan

Herd Rd



Quamichan Lake

Canada Ave

Duncan

COWICHAN RIVER

INDIAN ROAD

Cowichan River

Koksilah

Duncan Airport

Cowichan Station

SCALE in metres (approx.)

0 1,000 3,000

Legend



Subject Site

Note: All measurements are approximate.
No guarantee is made as to the accuracy.

DRAWING BASE SOURCES:
◆ Apple Map, 2017



CLIENT

BC PARKS

PRELIMINARY SITE INVESTIGATION, STAGE 1
4295 ROBERTSON ROAD, GLENORA, BC

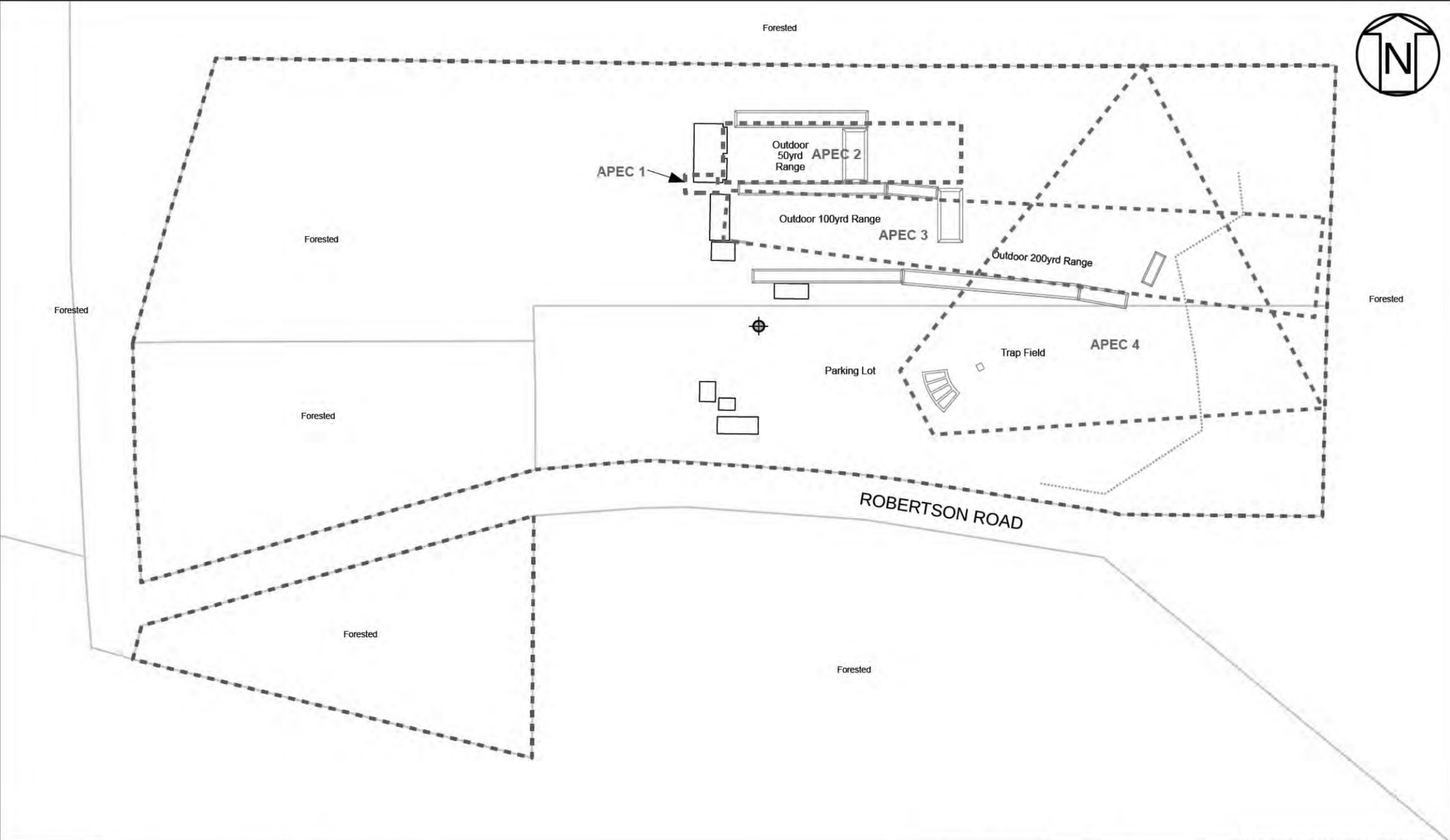
SITE LOCATION PLAN

PROJECT No.

128-001-02

MARCH 2018

FIGURE 1



LEGEND

--- Subject Site	--- Fence	⊕ Drinking Water Well
--- Property Lines	▭ Berm	
--- Buildings		

Note: All measurements are approximate.
No guarantee is made as to the accuracy.

SCALE 1:1,500 (approx.)
metres

10 0 40

trillium

CLIENT BC PARKS

PRELIMINARY SITE INVESTIGATION, STAGE 1
4295 ROBERTSON ROAD, GLENORA, BC

AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

PROJECT No. 128-001-02	MARCH 2018	FIGURE 3
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Appendix A

Current Legal Title

TITLE SEARCH PRINT

2018-01-08, 23:15:37

File Reference:

Requestor: Stefan Quaglia

CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN

Title Issued Under	SECTION 172 LAND TITLE ACT
Land Title District Land Title Office	VICTORIA VICTORIA
Title Number From Title Number	388667I 58240I
Application Received	1966-11-15
Application Entered	1966-11-21
Registered Owner in Fee Simple Registered Owner/Mailing Address:	HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA NO ADDRESS ON FILE FOR THIS OWNER
Taxation Authority	Nanaimo/Cowichan Assessment Area
Description of Land Parcel Identifier: Legal Description:	003-709-116 LOT 1, SECTION 6, RANGE 10, SAHTLAM DISTRICT, PLAN 19268
Legal Notations	NONE
Charges, Liens and Interests Nature: Registration Number: Registered Owner: Remarks:	EXCEPTIONS AND RESERVATIONS M76300 ESQUIMALT AND NANAIMO RAILWAY COMPANY INTER ALIA AFB 37.420.22076F AND AFB 9.693.7434A 53849G SECTION 172(3) FOR ACTUAL DATE AND TIME OF REGISTRATION SEE ORIGINAL GRANT FROM E & N RAILWAY COMPANY
Duplicate Indefeasible Title	NONE OUTSTANDING
Transfers	NONE

TITLE SEARCH PRINT

File Reference:

2018-01-08, 23:15:37
Requestor: Stefan Quaglia

Pending Applications

NONE

TITLE SEARCH PRINT

2018-01-08, 23:19:36

File Reference:

Requestor: Stefan Quaglia

CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN

Title Issued Under	SECTION 172 LAND TITLE ACT
Land Title District Land Title Office	VICTORIA VICTORIA
Title Number From Title Number	58336I 58240I
Application Received	1924-11-03
Application Entered	1924-11-14
Registered Owner in Fee Simple Registered Owner/Mailing Address:	s.22
Taxation Authority	Nanaimo/Cowichan Assessment Area
Description of Land Parcel Identifier: Legal Description:	006-229-387 LOT 1, SECTION 6, RANGE 10, SAHTLAM DISTRICT, PLAN 3112, EXCEPT PART IN PLAN 23420
Legal Notations	NOTICE OF TAX SALE DF 17619 RECEIVED 13.10.27 REVERTED TO CROWN 20302I 23.10.28
Charges, Liens and Interests Nature: Registration Number: Registered Owner: Remarks:	EXCEPTIONS AND RESERVATIONS 53849G ESQUIMALT AND NANAIMO RAILWAY COMPANY INTER ALIA SEE AFB 37.420.22076G; SECTION 172(3)
Duplicate Indefeasible Title	NONE OUTSTANDING
Transfers	NONE

TITLE SEARCH PRINT

File Reference:

2018-01-08, 23:19:36
Requestor: Stefan Quaglia

Pending Applications

NONE

TITLE SEARCH PRINT

2018-01-08, 23:21:36

File Reference:

Requestor: Stefan Quaglia

****CURRENT INFORMATION ONLY - NO CANCELLED INFORMATION SHOWN****

Title Issued Under	SECTION 172 LAND TITLE ACT
Land Title District Land Title Office	VICTORIA VICTORIA
Title Number From Title Number	64577W 58240I
Application Received	1970-11-09
Application Entered	1970-11-30
Registered Owner in Fee Simple Registered Owner/Mailing Address:	HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA NO ADDRESS ON FILE FOR THIS OWNER
Taxation Authority	Nanaimo/Cowichan Assessment Area
Description of Land Parcel Identifier: Legal Description:	002-927-047 LOT 1, SECTION 6, RANGE 10, SAHTLAM DISTRICT, PLAN 23914
Legal Notations	NONE
Charges, Liens and Interests Nature: Registration Number: Registered Owner: Remarks:	EXCEPTIONS AND RESERVATIONS M76300 ESQUIMALT AND NANAIMO RAILWAY COMPANY INTER ALIA A.F.B. 9.693.7434A 408235G SECTION 172(3) FOR ACTUAL DATE AND TIME OF REGISTRATION SEE ORIGINAL GRANT FROM E & N RAILWAY COMPANY
Duplicate Indefeasible Title	NONE OUTSTANDING
Transfers	NONE

TITLE SEARCH PRINT

File Reference:

2018-01-08, 23:21:36
Requestor: Stefan Quaglia

Pending Applications

NONE

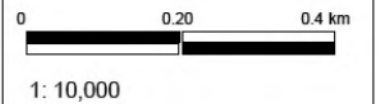
Appendix B

BC Water Resources Atlas Search



Water Resources Atlas
Wells Within 500m
Radius of 4295
Robertson Rd.

- Water Wells - All



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CAUTION: Maps obtained using this site are not designed to assist in navigation. These maps may be generalized and may not reflect current conditions. Uncharted hazards may exist. DO NOT USE THESE MAPS FOR NAVIGATIONAL PURPOSES.

Datum: NAD83
Projection: BC Albers

Key Map of British Columbia



Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 21437

Well Identification Plate Number:

Owner Name: J HULL

Licensed Status: Unlicensed

Well Status: New

Well Class:

Well Subclass:

Intended Water Use: Unknown Well Use

Observation Well Number:

Observation Well Status:

**Environmental Monitoring System (EMS)
ID:**

Aquifer Number: 185

Alternative specs submitted (if required):
No

Water Supply System Name:

Water Supply System Well Name:

Location Information

Street Address:

Town/City:

Legal Description:

Lot	
Plan	
District Lot	
Block	
Section	11
Township	
Range	1
Land District	45 QUAMICHAN
Property Identification Description (PID)	

Description of Well Location:

BCGS Mapsheet Number: 092B072311



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Geographic Coordinates - North American Datum of 1983 (NAD 83)

Latitude: 48.758528

Longitude: -123.792528

UTM Northing: 5400916

UTM Easting: 441753

Zone: 10

Location Accuracy Code: D

Well Activity

Construction Date (YYYY-MM-DD)	Alteration Date (YYYY-MM-DD)	Decommission Date (YYYY-MM-DD)	Drilling Company
1968-05-01			Drillwell Enterprises

Well Completion Data

Total Depth Drilled:

Finished Well Depth: 44 feet

Final Casing Stick Up:

Depth to Bedrock:

Ground Elevation:

Elevation Determined

By:

Static Water Level

28 feet

(BTOC):

Estimated Well Yield: 5 GPM

Artesian Flow:

Artesian Pressure:

Well Cap:

Well Disinfected: No

Drilling Method: UNK

Orientation of Well: vertical

Well Identification Plate Is Attached:

Lithology

From (feet)	To (feet)	Lithology Raw Data	Description	Material Description	Relative Hardness	Colour	Water-Bearing Estimated Flow
0	4	Brown clay					
4	11	Boulders					
11	17	Boulders					
17	25	Blue boulder clay					
25	35	Tight till					
35	38	Till					
38	44	Med. to coarse gravel with lenses of					
0	0	till					

Casing Details

From (feet)	To (feet)	Diameter (inches)	Casing Material	Wall Thickness (inches)	Drive Shoe
-------------	-----------	-------------------	-----------------	-------------------------	------------

Surface Seal and Backfill Details

Surface Seal Material:

Surface Seal Installation Method:

Surface Seal Thickness:

Surface Seal Length:

Backfill Material Above Surface Seal:

Backfill Depth:

Liner Details

Liner Material	Liner Diameter	Liner Thickness	Liner From	Liner To	Liner Perforated From	Liner Perforated To
----------------	----------------	-----------------	------------	----------	-----------------------	---------------------

Screen Details

Intake Method:

Type:

Material:

Opening:

Bottom:

From (feet)	To (feet)	Diameter (inches)	Screen Assembly Type	Slot Size
-------------	-----------	-------------------	----------------------	-----------

Well Development

Developed By:

Development Total Duration:

Well Yield

Well Decommissioning

Reason for Decommission:

Method of Decommission:

Decommission Details:

Sealant Material:

Backfill Material:

Comments

YIELD 5 GPM.

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Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 22269

Well Identification Plate Number:

Owner Name: HANSON

Licensed Status: Unlicensed

Well Status: New

Well Class:

Well Subclass:

Intended Water Use: Unknown Well Use

Observation Well Number:

Observation Well Status:

**Environmental Monitoring System (EMS)
ID:**

Aquifer Number: 185

Alternative specs submitted (if required):
No

Water Supply System Name:

Water Supply System Well Name:

Location Information

Street Address:

Town/City:

Legal Description:

Lot	
Plan	
District Lot	
Block	
Section	11
Township	
Range	1
Land District	45 QUAMICHAN
Property Identification Description (PID)	

Description of Well Location:

BCGS Mapsheet Number: 092B072311



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Geographic Coordinates - North American Datum of 1983 (NAD 83)

Latitude: 48.758758

Longitude: -123.791865

UTM Northing: 5400941

UTM Easting: 441802

Zone: 10

Location Accuracy Code: D

Well Activity

Construction Date (YYYY-MM-DD)	Alteration Date (YYYY-MM-DD)	Decommission Date (YYYY-MM-DD)	Drilling Company
1969-04-01			Drillwell Enterprises

Well Completion Data

Total Depth Drilled:

Finished Well Depth: 48 feet

Final Casing Stick Up:

Depth to Bedrock:

Ground Elevation:

Elevation Determined

By:

Static Water Level

24 feet

(BTOC):

Estimated Well Yield: 5 GPM

Artesian Flow:

Artesian Pressure:

Well Cap:

Well Disinfected: No

Drilling Method: UNK

Orientation of Well: vertical

Well Identification Plate Is Attached:

Lithology

From (feet)	To (feet)	Lithology Raw Data	Description	Material Description	Relative Hardness	Colour	Water-Bearing Estimated Flow
0	45	Gravel hardpan with cobbles, very hard					
45	48	Gravel					

Casing Details

From (feet)	To (feet)	Diameter (inches)	Casing Material	Wall Thickness (inches)	Drive Shoe
-------------	-----------	-------------------	-----------------	-------------------------	------------

Surface Seal and Backfill Details

Surface Seal Material:

Surface Seal Installation Method:

Surface Seal Thickness:

Surface Seal Length:

Backfill Material Above Surface Seal:

Backfill Depth:

Liner Details

Liner Material	Liner Diameter	Liner Thickness	Liner From	Liner To	Liner Perforated From	Liner Perforated To
----------------	----------------	-----------------	------------	----------	-----------------------	---------------------

Screen Details

Intake Method:

Type:

Material:

Opening:

Bottom:

From (feet)	To (feet)	Diameter (inches)	Screen Assembly Type	Slot Size
-------------	-----------	-------------------	----------------------	-----------

Well Development

Developed By:

Development Total Duration:

Well Yield

Well Decommissioning

Reason for Decommission:

Method of Decommission:

Decommission Details:

Sealant Material:

Backfill Material:

Comments

YIELD 5 GPM.

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Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 47204

Well Identification Plate Number:

Owner Name: MACMILLAN BLOEDEL

Licensed Status: Unlicensed

Well Status: New

Well Class:

Well Subclass:

Intended Water Use: Commercial and
Industrial

Observation Well Number:

Observation Well Status:

**Environmental Monitoring System (EMS)
ID:**

Aquifer Number:

Alternative specs submitted (if required):
No

Water Supply System Name:

Water Supply System Well Name:

Location Information

Street Address: ROWE RD

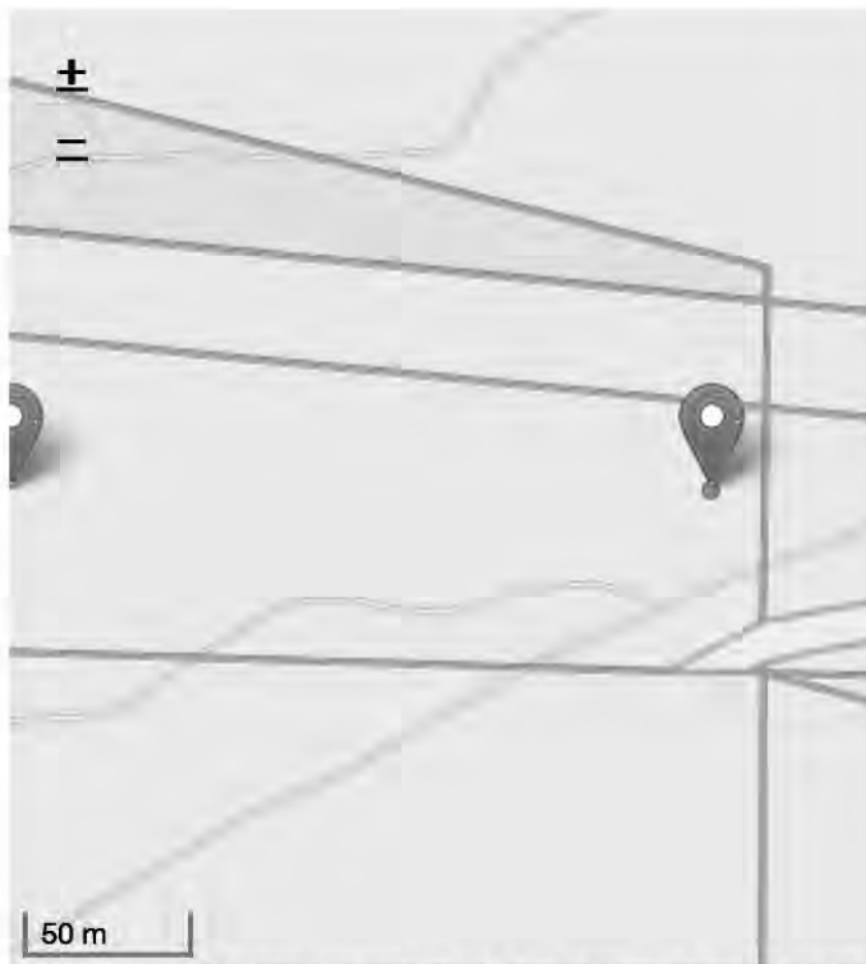
Town/City: GLENORA

Legal Description:

Lot	
Plan	
District Lot	
Block	
Section	6
Township	
Range	9
Land District	50 SAHTLAM
Property Identification Description (PID)	

Description of Well Location:

BCGS Mapsheet Number: 092B072311



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Geographic Coordinates - North American Datum of 1983 (NAD 83)

Latitude: 48.756176

Longitude: -123.794424

UTM Northing: 5400656

UTM Easting: 441611

Zone: 10

Location Accuracy Code: A

Well Activity

Construction Date (YYYY-MM-DD)	Alteration Date (YYYY-MM-DD)	Decommission Date (YYYY-MM-DD)	Drilling Company
1981-02-10			Drillwell Enterprises

Well Completion Data

Total Depth Drilled:

Finished Well Depth: 33 feet

Final Casing Stick Up:

Depth to Bedrock:

Ground Elevation:

Elevation Determined

By:

Static Water Level

6 feet

(BTOC):

Estimated Well Yield: 50 GPM

Artesian Flow:

Artesian Pressure:

Well Cap:

Well Disinfected: No

Drilling Method: UNK

Orientation of Well: vertical

Well Identification Plate Is Attached:

Lithology

From (feet)	To (feet)	Lithology Raw Data	Description	Material Description	Relative Hardness	Colour	Water-Bearing Estimated Flow
0	6.50	Coarse gravel					
6.50	19	Coarse gravel - water-bearing					
19	20	Blue till					
20	33	Coarse gravel (water-bearing 5-6")					

Casing Details

From (feet)	To (feet)	Diameter (inches)	Casing Material	Wall Thickness (inches)	Drive Shoe
-------------	-----------	-------------------	-----------------	-------------------------	------------

Surface Seal and Backfill Details

Surface Seal Material:

Surface Seal Installation Method:

Surface Seal Thickness:

Surface Seal Length:

Backfill Material Above Surface Seal:

Backfill Depth:

Liner Details

Liner Material	Liner Diameter	Liner Thickness	Liner From	Liner To	Liner Perforated From	Liner Perforated To
----------------	----------------	-----------------	------------	----------	-----------------------	---------------------

Screen Details

Intake Method:

Type:

Material:

Opening:

Bottom:

From (feet)	To (feet)	Diameter (inches)	Screen Assembly Type	Slot Size
-------------	-----------	-------------------	----------------------	-----------

Well Development

Developed By:

Development Total Duration:

Well Yield

Well Decommissioning

Reason for Decommission:	Sealant Material:
Method of Decommission:	Backfill Material:
Decommission Details:	

Comments

50 GPM. REC. PUMPING RATE: 25 GPM. REC. PUMP SETTING: 30'. WATER QUALITY, GOOD.

Disclaimer

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Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 63494

Well Identification Plate Number:

Owner Name: FISH & GAME CLUB

Licensed Status: Unlicensed

Well Status: New

Well Class:

Well Subclass:

Intended Water Use: Private Domestic

Observation Well Number:

Observation Well Status:

**Environmental Monitoring System (EMS)
ID:**

Aquifer Number:

Alternative specs submitted (if required):
No

Water Supply System Name:

Water Supply System Well Name:

Location Information

Street Address: NORTH RANGE

Town/City:

Legal Description:

Lot	
Plan	
District Lot	
Block	
Section	
Township	
Range	
Land District	16 COWICHAN
Property Identification Description (PID)	

Description of Well Location:

BCGS Mapsheet Number: 092B072311



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Geographic Coordinates - North American Datum of 1983 (NAD 83)

Latitude: 48.759532

Longitude: -123.790490

UTM Northing: 5401026

UTM Easting: 441904

Zone: 10

Location Accuracy Code: J

Well Activity

Construction Date (YYYY-MM-DD)	Alteration Date (YYYY-MM-DD)	Decommission Date (YYYY-MM-DD)	Drilling Company
1987-12-16			Drillwell Enterprises

Well Completion Data

Total Depth Drilled:

Finished Well Depth: 73 feet

Final Casing Stick Up:

Depth to Bedrock:

Ground Elevation:

Elevation Determined

By:

Static Water Level

60 feet

(BTOC):

Estimated Well Yield: 7 USGPM

Artesian Flow:

Artesian Pressure:

Well Cap:

Well Disinfected: No

Drilling Method:

Orientation of Well: vertical

Well Identification Plate Is Attached:

Lithology

From (feet)	To (feet)	Lithology Raw Data	Description	Material Description	Relative Hardness	Colour	Water-Bearing Estimated Flow
28	73	TIGHT BROWN GRAVEL					
11	15	BROWN GRAVEL					
15	18	GREY CLAY					
22	28	GREY CLAY					
18	22	BROWN SILT					
5	11	GREY SILTY SAND					
0	2	TILL					
2	5	TOPSOIL					

Casing Details

From (feet)	To (feet)	Diameter (inches)	Casing Material	Wall Thickness (inches)	Drive Shoe
-------------	-----------	-------------------	-----------------	-------------------------	------------

Surface Seal and Backfill Details

Surface Seal Material:

Surface Seal Installation Method:

Surface Seal Thickness:

Surface Seal Length:

Backfill Material Above Surface Seal:

Backfill Depth:

Liner Details

Liner Material	Liner Diameter	Liner Thickness	Liner From	Liner To	Liner Perforated From	Liner Perforated To
----------------	----------------	-----------------	------------	----------	-----------------------	---------------------

Screen Details

Intake Method:

Type:

Material:

Opening:

Bottom:

From (feet)	To (feet)	Diameter (inches)	Screen Assembly Type	Slot Size
-------------	-----------	-------------------	----------------------	-----------

Well Development

Developed By:

Development Total Duration:

Well Yield

Well Decommissioning

Reason for Decommission:	Sealant Material:
Method of Decommission:	Backfill Material:
Decommission Details:	

Comments

STEEL CASING,0.0 TO 73.0,,250 THICK,

Disclaimer

The information provided should not be used as a basis for making financial or any other commitments. The Government of British Columbia accepts no liability for the accuracy, availability, suitability, reliability, usability, completeness or timeliness of the data or graphical depictions rendered from the data.

Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 85107

Well Identification Plate Number:

Owner Name: TOURISM BRITISH COLUMBIA

Licensed Status: Unlicensed

Well Status: New

Well Class:

Well Subclass:

Intended Water Use: Private Domestic

Observation Well Number:

Observation Well Status:

**Environmental Monitoring System (EMS)
ID:**

Aquifer Number:

Alternative specs submitted (if required):
No

Water Supply System Name:

Water Supply System Well Name:

Location Information

Street Address: VAUX ROAD

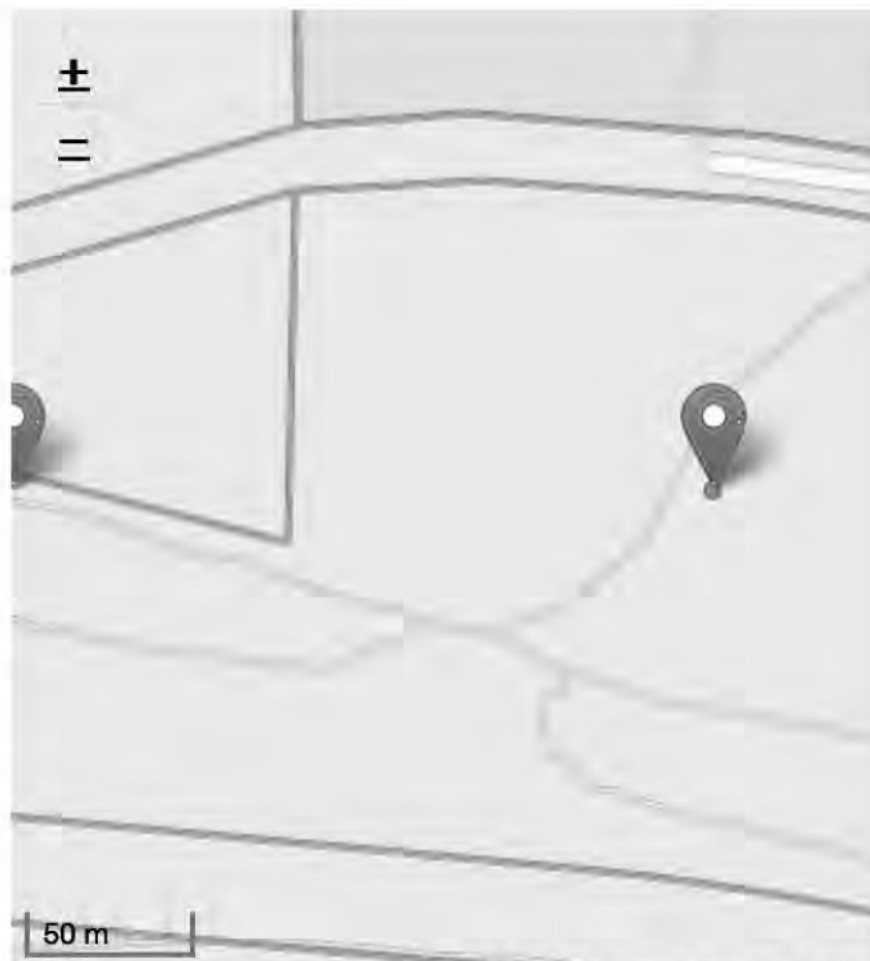
Town/City:

Legal Description:

Lot	1
Plan	23420
District Lot	
Block	
Section	6
Township	
Range	
Land District	48 RENFREW/COWICH, LAKE
Property Identification Description (PID)	

Description of Well Location: END OF VAUX RD ON S SIDE NR TRANS
CAN TR; RGE 9 & 10;

BCGS Mapsheet Number: 092B072311



[Leaflet](#) | Powered by [Esri](#) | Government of British Columbia, DataBC, GeoBC
[Leaflet](#) | Powered by [Esri](#)

**Geographic Coordinates - North American Datum of 1983
(NAD 83)**

Latitude: 48.757457

Longitude: -123.789981

UTM Northing: 5400795

UTM Easting: 441939

Zone: 10

Location Accuracy Code: J

Well Activity

Construction Date (YYYY-MM-DD)	Alteration Date (YYYY-MM-DD)	Decommission Date (YYYY-MM-DD)	Drilling Company
2005-02-16			Drillwell Enterprises

Well Completion Data

Total Depth Drilled: 55 feet

Finished Well Depth: 55 feet

Final Casing Stick Up:

Depth to Bedrock:

Ground Elevation:

Elevation Determined

By:

**Static Water Level
(BTOC):**

Estimated Well Yield: 20 USGPM

Artesian Flow:

Artesian Pressure:

Well Cap:

WELDED LID

Well Disinfected:

No

Drilling Method:

AIR_ROTARY

Orientation of Well:

vertical

Well Identification Plate Is Attached:

Lithology

From (feet)	To (feet)	Lithology Raw Data	Description	Material Description	Relative Hardness	Colour	Water-Bearing Estimated Flow
0	16	COARSE GRAVEL CLEAN BRN					
16	34	GRAVEL, SILTY BROWN WB					
34	55	GRAVEL, CLEANER BROWN WB					

Casing Details

From (feet)	To (feet)	Diameter (inches)	Casing Material	Wall Thickness (inches)	Drive Shoe
0	16	10.750	Steel		Yes
0	55	6.620	Steel		Yes

Surface Seal and Backfill Details

Surface Seal Material:

Surface Seal Installation Method:

Surface Seal Thickness:

Surface Seal Length:

Backfill Material Above Surface Seal:

Backfill Depth:

Liner Details

Liner Material	Liner Diameter	Liner Thickness	Liner From	Liner To	Liner Perforated From	Liner Perforated To
----------------	----------------	-----------------	------------	----------	-----------------------	---------------------

Screen Details

Intake Method: Open Bottom

Type:

Material:

Opening:

Bottom:

From (feet)	To (feet)	Diameter (inches)	Screen Assembly Type	Slot Size
-------------	-----------	-------------------	----------------------	-----------

Well Development

Developed By:

Development Total Duration:

Well Yield

Estimation Method: Air Lifting

Estimation Rate:

Estimation Duration:

Well Decommissioning

Reason for Decommission:	Sealant Material:
Method of Decommission:	Backfill Material:
Decommission Details:	

Comments

CHLORINATION.

Disclaimer

The information provided should not be used as a basis for making financial or any other commitments. The Government of British Columbia accepts no liability for the accuracy, availability, suitability, reliability, usability, completeness or timeliness of the data or graphical depictions rendered from the data.

Appendix C

Historical Aerial Photographs



Aerial taken: 1946

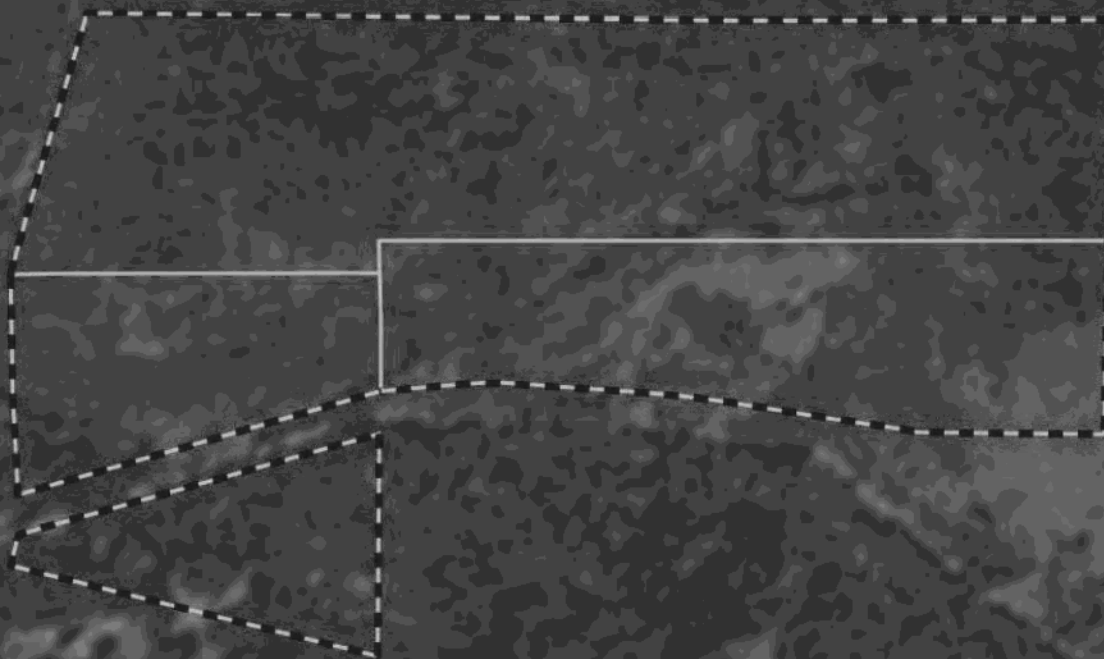
SCALE 1:3,500 (approx.)





Aerial taken: 1950

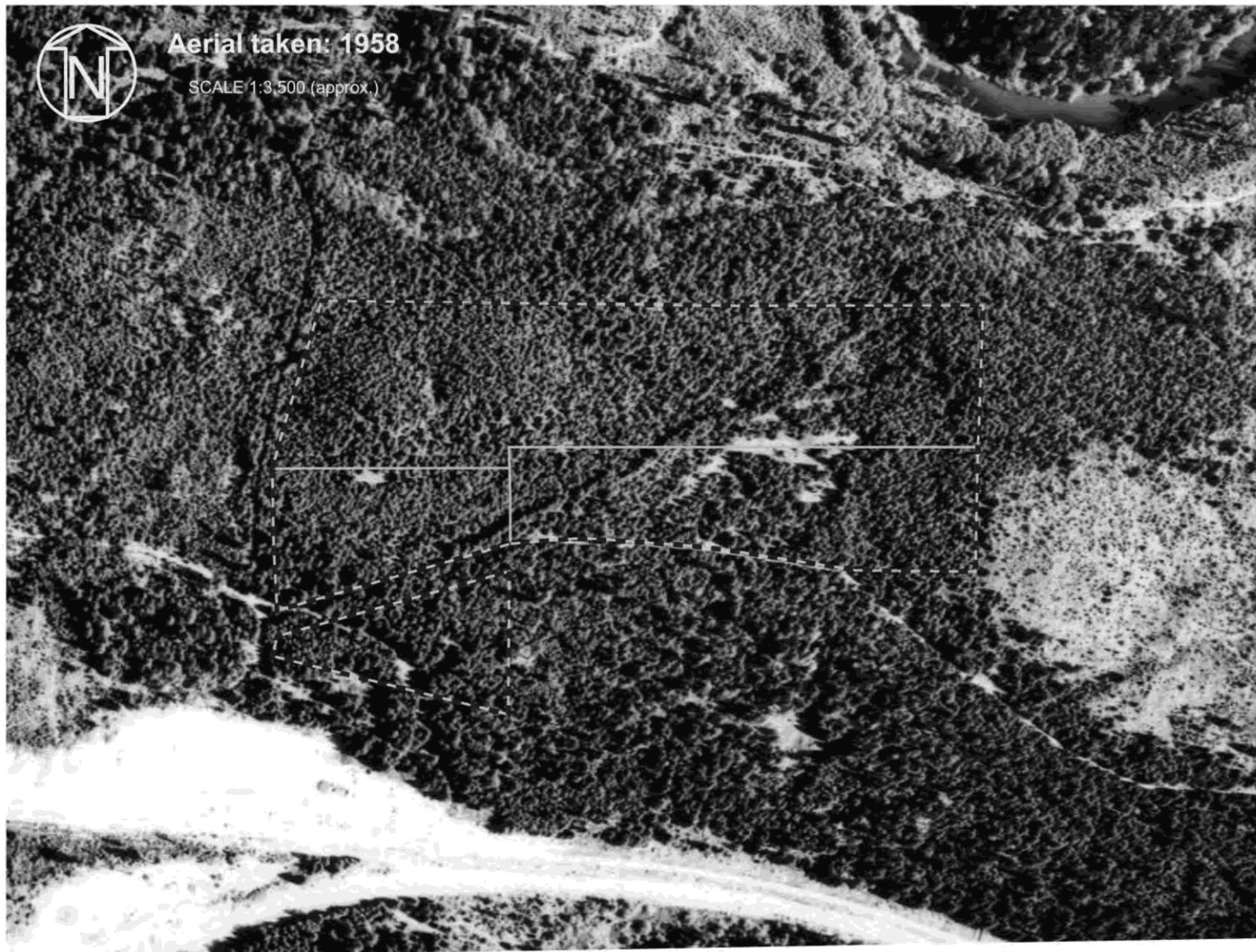
SCALE 1:3,500 (approx.)





Aerial taken: 1958

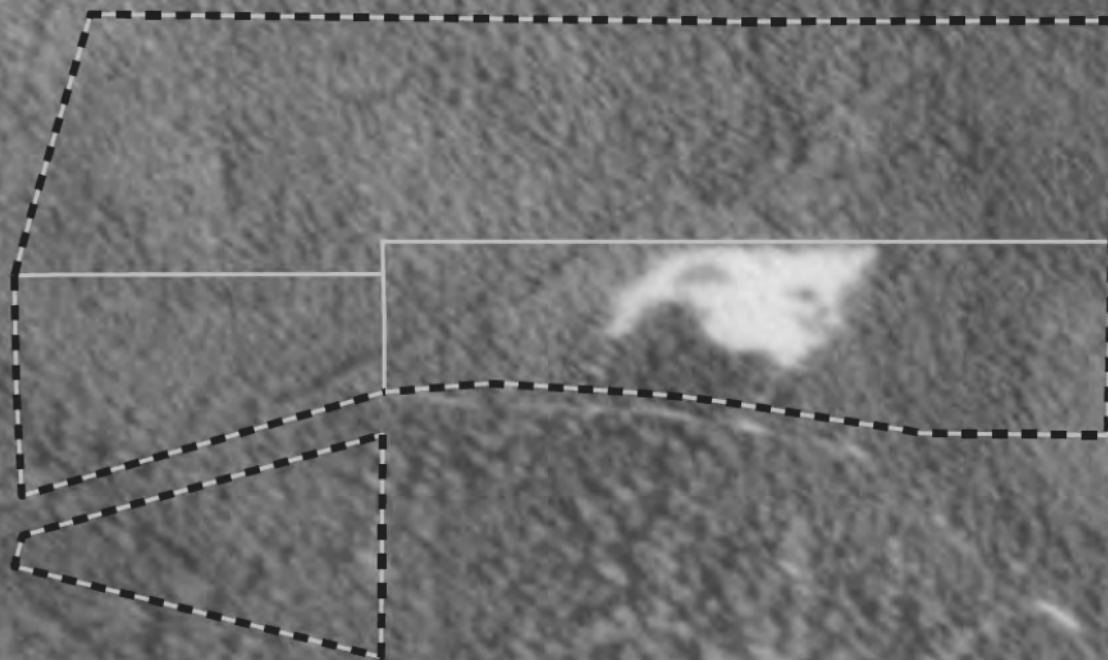
SCALE 1:3,500 (approx.)





Aerial taken: 1962

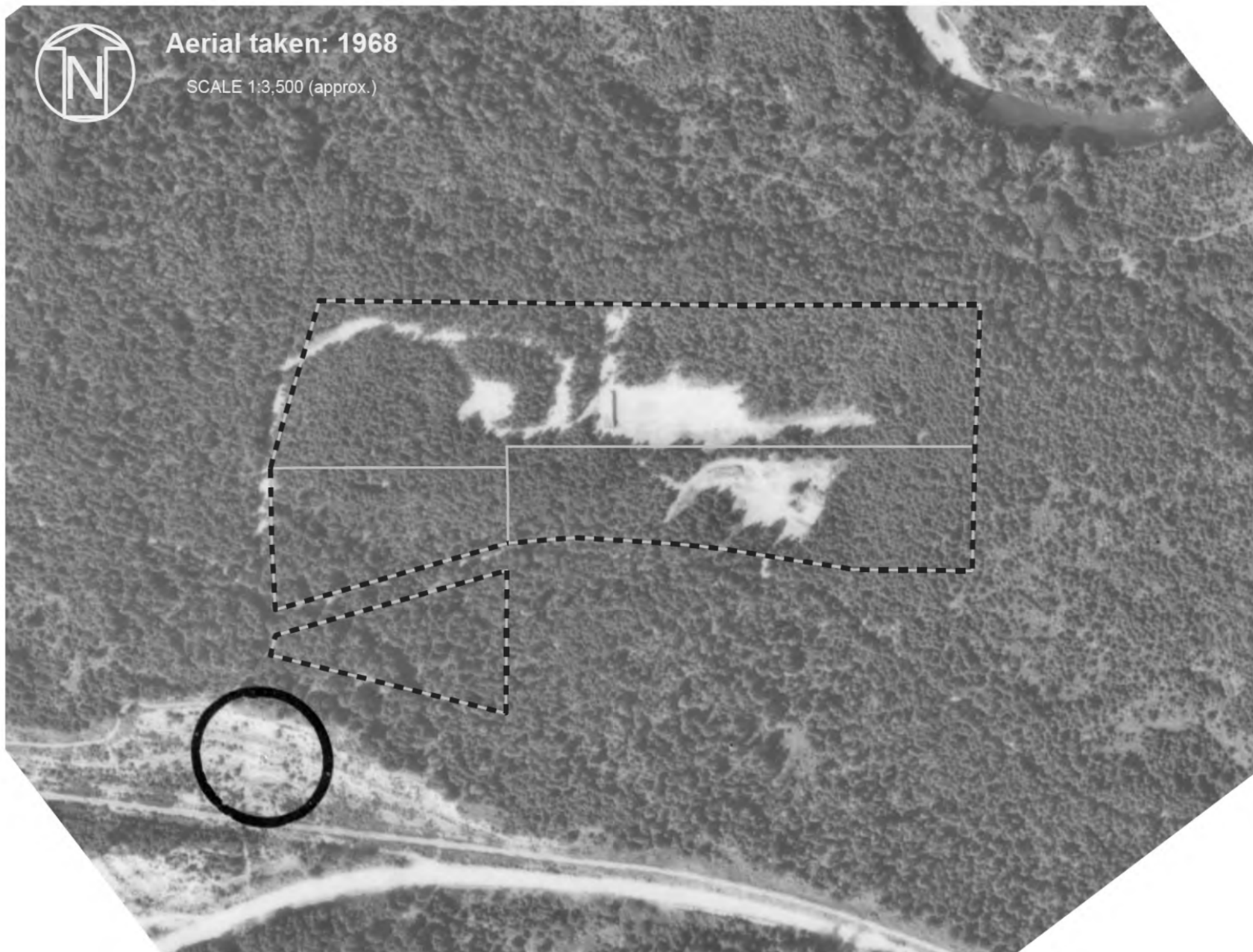
SCALE 1:3,500 (approx.)





Aerial taken: 1968

SCALE 1:3,500 (approx.)





Aerial taken: 1972

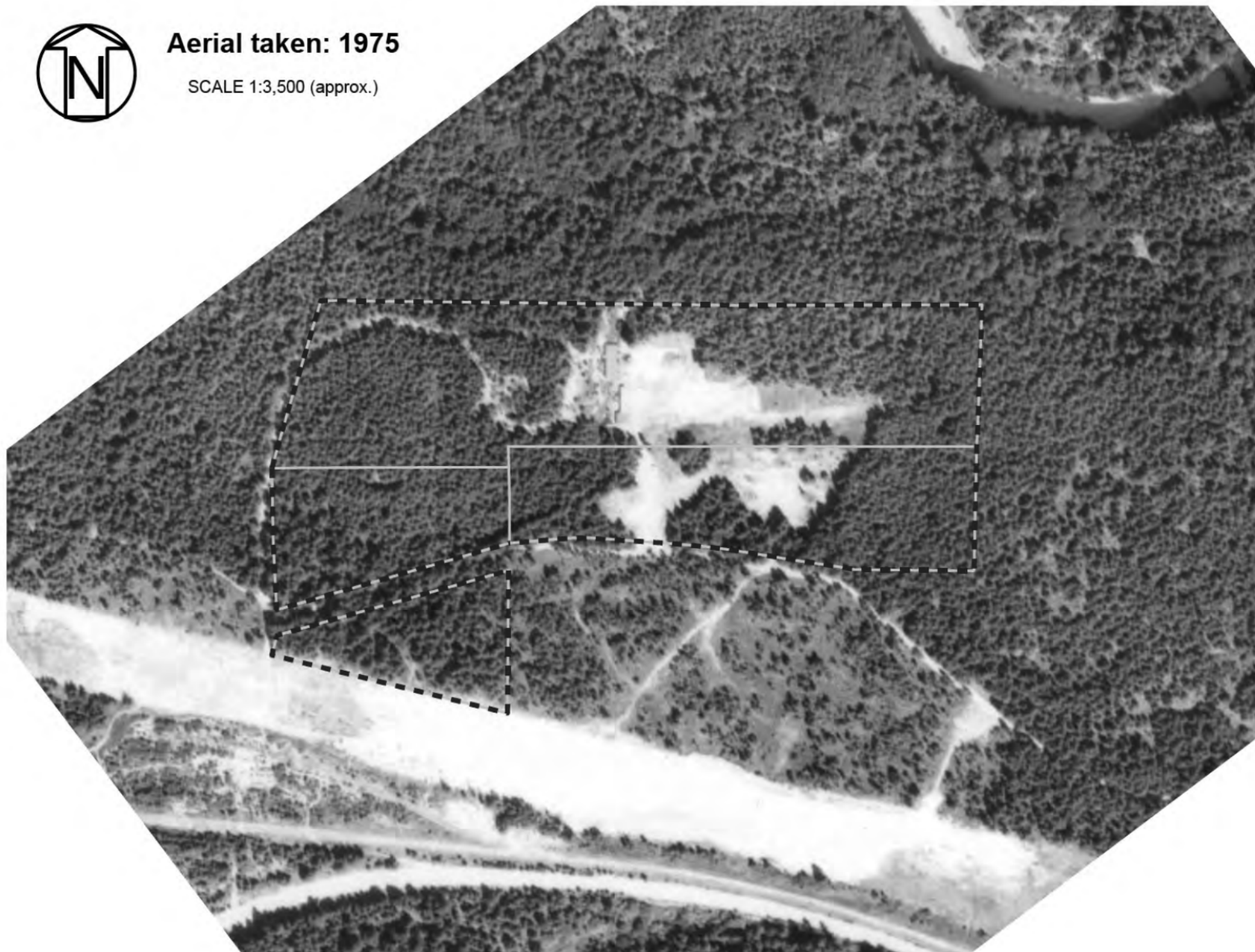
SCALE 1:3,500 (approx.)





Aerial taken: 1975

SCALE 1:3,500 (approx.)





Aerial taken: 1981

SCALE 1:3,500 (approx.)





Aerial taken: 1986

SCALE 1:3,500 (approx.)





Aerial taken: 1992

SCALE 1:3,500 (approx.)





Aerial taken: 1998

SCALE 1:3,500 (approx.)





Aerial taken: 2007

SCALE 1:3,500 (approx.)



Appendix D

Site Registry Search

As Of: JAN 07, 2018 BC Online: Site Registry 18/01/08
Folio: 128-001-02 For: PA41461 TRILLIUM ENVIRONMENTAL 21:59:31
Page 1

1 records selected for 0.5 km from latitude 48 deg, 45 min, 33 sec
and Longitude 123 deg, 47 min, 26.7 sec

Site Id	Lastupd	Address / City
0020976		4295 ROBERTSON ROAD DUNCAN

As of: JAN 07, 2018 BC Online: Site Registry 18-01-08
For: PA41461 TRILLIUM ENVIRONMENTAL 22:08:45
Folio: 128-001-02 Page 1

Detail Report

SITE LOCATION

Site ID: 20976 Latitude: 48d 45m 32.4s
Victoria File: 26250-20/20976 Longitude: 123d 47m 20.9s
Regional File:
Region: NANAIMO, VANCOUVER ISLAND

Site Address: 4295 ROBERTSON ROAD
(COWICHAN RIVER PROVINCIAL PARK)
City: DUNCAN Prov/State: BC
Postal Code: V9L 6S8

Registered: SEP 14, 2017 Updated: Detail Removed:

Notations: 1 Participants: 2 Associated Sites: 0
Documents: 0 Susp. Land Use: 1 Parcel Descriptions: 0

Location Description: LOCATION CONFIRMED USING GOOGLE MAPS

Record Status: NOT ASSIGNED
Fee category: NOT APPLICABLE

=====

NOTATIONS

Notation Type: COMPLAINT RECEIVED
Notation Class: ADMINISTRATIVE
Initiated: NOV 07, 2016 Approved: NOV 07, 2016

Ministry Contact: SKELLY, KERRI L

Notation Participants Notation Roles
BC PARKS RECEIVED BY

Note: COMPLAINT RECEIVED REGARDING THE AUTHORIZATION OF A SHOOTING RANGE
WITHIN THE COWICHAN RIVER PROVINCIAL PARK BOUNDARIES AND POSSIBLE
CONTAMINATION ASSOCIATED WITH THE OPERATION OF THIS FACILITY.

=====

SITE PARTICIPANTS

Participant: BC PARKS
Role(s): PROPERTY OWNER
Start Date: NOV 07, 2016 End Date:

Participant: SKELLY, KERRI L
Role(s): MINISTRY CONTACT
Start Date: NOV 07, 2016 End Date:

=====

SUSPECTED LAND USE

Description: RIFLE OR PISTOL FIRING RANGES
Notes:

As of: JAN 07, 2018 BC Online: Site Registry
Folio: 128-001-02 For: PA41461 TRILLIUM ENVIRONMENTAL
SUSPECTED LAND USE

18-01-08
22:08:45
Page 2

No activities were reported for this site

End of Detail Report

Appendix E

Photographs of Site Reconnaissance



Photo 1 – Outdoor 50-yard target range.



Photo 2 – Outdoor 50-yard firing line.



Photo 3 – Indoor 20-yard target range.



Photo 4 – South side of 20-yard target range building.



Photo 5 – Vent outside of 20-yard indoor range.



Photo 6 – 100-yard (near left) and 200-yard (distant right) range target areas.



Photo 7 – 100- and 200-yard target range firing line.



Photo 8 – Trap range firing lines (facing northwest).



Photo 9 – Trap range target area with backstop tarps.



Photo 10 – Clay pigeon fragments in trap range target area.

Appendix F

Previous Tapwater Analytical Results

Table F-1
Water Analytical Results
Total Metals
4295 Robertson Road, Glenora, BC
BC Parks
Project # 128-001-02

Sample ID	4295 Robertson Rd Kitchen Tap	BC CSR Sched. 3.2	BC CSR Sched. 3.2
Lab Sample ID	W136834		
Collected by:	Cowchan Fish & Game		
Date Sampled:	6 Nov 17		
Total Metals			
Aluminum	278	ns	9,500
Antimony	<0.5	90	6
Arsenic	<0.5	50	10
Barium	<0.009	10,000	1,000
Beryllium	<3	1.5	8
Boron	828	12,000	5,000
Cadmium	<0.1	0.5 4 (hardness dep)	5
Calcium	7,840	ns	ns
Chromium	<10	10 (CrVI)	50 (CrVI)
Cobalt	<20	40	1
Copper	52	20 - 90 (hardness dep)	1,500
Gold	<40	ns	ns
Iron	27	ns	6,500
Lead	2.03	40 160 (hardness dep)	10
Magnesium	4,080	ns	ns
Manganese	<4	ns	1,500
Molybdenum	<20	10,000	250
Nickel	<50	250 1,500 (hardness dep)	80
Phosphorus	<10	ns	ns
Potassium	390	ns	ns
Selenium	6,490	ns	ns
Silver	<10	0.5 15 (hardness dep)	20
Sodium	5,030	ns	200,000
Strontium	44	ns	2,500
Titanium	<10	1,000	ns
Tungsten	<50	ns	3
Vanadium	<10	ns	40
Zinc	100	75 - 2,400 (hardness dep)	3,000
Hardness (mg/L)	36.4	ns	ns
pH	6.32	ns	ns

NOTES:

Standards are concentration based and are presented in units of micrograms per litre (µg/L) or parts per billion (ppb) unless otherwise noted

BOLD	Greater than one or more applicable CSR water standards
<u>Value</u>	Detection limit for value is greater than one or more applicable CSR water standard
BOLD	Greater than the CSR Generic Numerical Water Standard for the Protection of Freshwater Aquatic Life (AW _{FW})
BOLD	Greater than the CSR Generic Numerical Water Standard for the Protection of Drinking Water (DW)
CSR	Contaminated Sites Regulation effective April 1 1997 including amendments up to November 1 2017
hardness dep	Standard for this constituent varies depending on hardness
ns	No standard for this constituent

Client/Code

Geoff Maxwell
6383 Wicks Rd
Duncan, BC
V9L 5V1

Date 06Nov17 12:27p
Source Well
Type of Sample water
No. of Samples 1

No. W136834

TEL: 250-746-7812
pacificquest@shaw.ca

Comments arrival temp.: 19.0C
PAID: Visa Batch 833

Sample: 4295 Robertson Rd - Kitchen Tap

03Nov17 11:20a

ELEMENTS		SAMPLE	UNITS	Maximum Limits Permissible In Drinking Water*
1) Aluminium	Al	0.278	mg/L	no limit listed
2) Antimony	Sb	<0.500	ug/L	6.00 ug/L
3) Arsenic	As	<0.500	ug/L	10.0 ug/L
4) Barium	Ba	<0.009	ug/L	1.00 mg/L
5) Beryllium	Be	<0.003	mg/L	no limit listed
6) Boron	B	0.828	mg/L	5.00 mg/L
7) Cadmium	Cd	<0.100	ug/L	5.00 ug/L
8) Calcium	Ca	7.84	mg/L	200 mg/L
9) Chromium	Cr	<0.010	mg/L	0.050 mg/L
10) Cobalt	Co	<0.020	mg/L	no limit listed
11) Copper	Cu	0.052	mg/L	1.00 mg/L
12) Gold	Au	<0.040	mg/L	no limit listed
13) Iron	Fe	0.027	mg/L	0.300 mg/L
14) Lanthanum	La	<0.020	mg/L	no limit listed
15) Lead	Pb	2.03	ug/L	10.0 ug/L
16) Magnesium	Mg	4.08	mg/L	50.0 mg/L
17) Manganese	Mn	<0.004	mg/L	0.050 mg/L
18) Molybdenum	Mo	<0.020	mg/L	no limit listed
19) Nickel	Ni	<0.050	mg/L	no limit listed
20) Phosphorus	P	<0.010	mg/L	no limit listed
21) Potassium	K	0.390	mg/L	no limit listed
22) Scandium	Sc	<0.050	mg/L	no limit listed
23) Silicon	Si	6.49	mg/L	no limit listed
24) Silver	Ag	<0.010	mg/L	0.050 mg/L
25) Sodium	Na	5.03	mg/L	200 mg/L
26) Strontium	Sr	0.044	mg/L	no limit listed
27) Titanium	Ti	<0.010	mg/L	no limit listed
28) Tungsten	W	<0.050	mg/L	no limit listed
29) Vanadium	V	<0.010	mg/L	no limit listed
30) Zinc	Zn	0.100	mg/L	5.00 mg/L
Hardness (mg/L CaCO ₃)		36.4	mg/L	0-75 mg/L = soft
pH		6.32	units	6.5 to 8.5

* As per Canadian or B.C. Health Act Safe Drinking Water Regulation BC Reg 230/92, & 390 Sch 120, 2001. Task Force of Canadian Council of Resource & Envir. Ministers Guidelines for Canadian Drinking Water Quality, 2014.

Comments:

pH: extremes in pH can lead to corrosion (too low) or incrustation (too high) of pipes & plumbing fixtures. Water with low pH allows metals to dissolve into water; water with high pH reduces disinfection efficacy, increases THM & scale formations.



R. Bilodeau
Analytical Chemist

H. Hartmann
Sr. Analytical Chemist

Stage 2 Preliminary Site Investigation 4295 Robertson Road, Glenora, BC

Prepared for:
BC Parks – West Coast Region
Ministry of Environment and Climate Change Strategy
2080-A Labieux Road
Nanaimo, BC V9T 6J9

Project #128-001-03
March 23, 2018



Trillium Environmental
126 Ingram Street, Unit 203
Duncan, BC

EXECUTIVE SUMMARY

Trillium Environmental Ltd. ("Trillium") was engaged by BC Parks to conduct environmental investigations at a property located at 4295 Robertson Road, Glenora, BC (herein referred to as the "Site"). This following presents the results of a Stage 2 Preliminary Site Investigation (PSI 2). The work involved soil and groundwater sampling based on previous preliminary sampling of shallow soil which identified soil metals contamination, and based on a PSI 1.

Trillium conducted the field component of the Stage 2 PSI on between February 8 and 20, 2018. A total of four boreholes were advanced across the Site, three of which were completed as monitoring wells. Soils observed in boreholes at the Site encountered similar conditions across the investigated area and consisted of variable thicknesses of a variable silty sand and/or gravel fill between from surface to depths of 0.6 to 1.4 m, underlain by a gravel till layer between 0.6 to over 7.3 m below ground. Below the gravel till was a soft, silty sand, between 4.4 to over 7.3 m below ground.

The results of three borehole soil samples submitted for analysis had concentrations of metals less than the applicable CSR PL standards. Three groundwater samples had concentrations of dissolved metals less than the applicable CSR DW and AW_{FW} standards.

It is concluded that constituents of concern (COCs) are present in Site soil at concentrations in excess of applicable standards provided in the British Columbia Contaminated Sites Regulation (CSR), based on the results of previous shallow soil sampling. The results of the current PSI 2 borehole sampling indicated that the soil contamination does not continue substantially at depth below the outdoor range target areas. In addition, there was no indication that the contaminants found in Site soil are impacting the groundwater below the Site.

Three of the four previously identified areas of potential environmental concern (APECs) were confirmed as areas of environmental concern (AECs 1, 2, and 3). Further investigations are recommended to determine the extent of metals contamination found in shallow soil at AECs 1, 2, and 3. It is also recommended that further investigations be conducted to investigate polycyclic aromatic hydrocarbons (PAH) possibly associated with clay pigeon fragments at AEC 2 and 3.

APEC 4, was retained as an APEC where it is recommended that further investigations be conducted to complete the investigation of metals and PAHs.

Determination and delineation of all COCs at the Site is a prerequisite for the development of a remedial action plan for the Site. A summary of remaining APECs/AECs and PCOCs/COCs for the Site is provided in **Table E-1** below.

Table E-1: List of APECs and PCOCs

APEC/ AEC ID.	Name	Activities of Concern	PCOCs	COCs
AEC 1	Area South of the Indoor 20 yard Pistol Range	Indoor target shooting activities, with vent at on to outside (circa 1970 to present)	Soil: Metals Groundwater: N/A	Soil: Lead, Zinc Groundwater: N/A
AEC 2	Outdoor 50 yard Gun Range	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (circa 1975 to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Cadmium, Copper, Lead, Tin Groundwater: None
AEC 3	Outdoor 100 and 200 yard Rifle Ranges	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (mid 1960s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Copper, Lead Groundwater: None
APEC 4	Trap Range	Trap range and overspray area with evidence of gunshot and clay pigeon fragments (1990s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: None identified to date Groundwater: No data yet

Notes:

APEC Area of Potential Environmental Concern

AEC Area of Environmental Concern

PCOC Potential Contaminant of Concern

COC Contaminant of Concern

PAH Polycyclic Aromatic Hydrocarbons

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Figure 3	Areas of Potential Environmental Concern
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Figure 6	Groundwater Dissolved Metals Results

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Appendix B	Borehole and Monitoring Well Logs
Appendix C	Well Purging and Sampling Forms
Appendix D	Laboratory Analytical Certificates

1.0 INTRODUCTION

Trillium Environmental Ltd. ("Trillium") was engaged by BC Parks to conduct environmental investigations at a portion of Cowichan River Provincial Park located at 4295 Robertson Road, Glenora, BC (herein referred to as the "Site"). This report presents the findings and results of a Stage 2 Preliminary Site Investigation (PSI 2) conducted for the Site.

The purpose of this PSI 2 was to investigate areas of potential environmental concern (APECs) identified by Trillium based on the completion of preliminary soil sampling (Trillium, 2018a) and a Stage 1 Preliminary Site Investigation (PSI 1; Trillium, 2018b). The work and findings presented herein include drilling, soil sampling, installation of monitoring wells, and groundwater sampling.

1.1 Objectives

BC Parks wishes to confirm whether or not the Site is contaminated and to determine whether any contamination can potentially migrate from the Site via groundwater.

1.2 Scope of Work

The scope of work for the PSI 2 included the following tasks:

- Conduct pre-drilling BC One Call. Prepare fieldwork health and safety plan; review with involved parties on-site.
- Mobilize to Site with drilling contractor and advance three (3) boreholes. Collect one (1) soil sample at depth per borehole. Install groundwater monitoring wells in each borehole.
- Mobilize to Site to develop each monitoring well.
- Mobilize to Site to purge and sample monitoring wells.
- Submit three samples and one duplicate (3+1), from each soil and water, to laboratory for analysis of total metals in soil and dissolved metals in groundwater.
- Prepare Stage 2 PSI report presenting analytical results compared to applicable regulatory standards, figures and borehole logs. The report will include an assessment of whether contamination is travelling to groundwater from known surface sources.

Trillium conducted this work according to standard assessment procedures, in accordance with the *BC Environmental Management Act (EMA)* and *Contaminated Sites Regulation (CSR)*.

Contracting for the PSI 2 was established prior to completion of preliminary soil sampling and the PSI 1. As a result, this PSI 2 has not exhaustively addressed all issues identified in the PSI 1.

2.0 SITE INFORMATION

Site information is provided in the following sections.

2.1 Location and Legal Description

The Site is located within the eastern-most portion of the Cowichan River Provincial Park, which is part of Electoral Area 'E', Cowichan Valley Regional District (CVRD), located southwest of the City of Duncan, BC, as shown on the attached **Figure 1**. A site plan is provided on **Figure 2**.

The Site consists of three legally titled parcels as described in **Table 2-1** below.

Table 2-1: Site Information

Descriptor	Details
Civic Address	4295 Robertson Road, Glenora, BC
Parcel 1	
Legal Description	Lot 1, Section 6, Range 10, Saht am D str ct, P an 19268
PID	003-709-116
Registered Owner	Her Majesty the Queen n R ght of the Prov nce of Br t sh Co umb a
Parcel 2	
Legal Description	Lot 1, Section 6, Range 10, Saht am D str ct, P an 3112, Except part n P an 23420
PID	006-229-387
Registered Owner	Arthur W ams Jones (ega notat on: "Not ce of tax sa e DF 17619 rece ved 13.10.27 reverted to Crown 20302l 23.10.28."
Parcel 3	
Legal Description	Lot 1, Section 6, Range 10, Saht am D str ct, P an 23914
PID	002-927-047
Registered Owner	Her Majesty the Queen n R ght of the Prov nce of Br t sh Co umb a
Site ID	20976
Current Zoning	River Corridor (RC-1)
Property Area	9.95 hectares (99,490 m ² , approx.)
Latitude / Longitude	48° 45' 32.4"N, 123° 47' 20.9"W

The approximate latitude and longitude entered for the Site was obtained from the Site Registry entry for the Site (see Trillium, 2018b).

2.2 Site Description

The Site is an irregular-shaped property, occupied by a number of buildings used by the Cowichan Fish and Game Association (CFGF), and one residential building. Much of the Site and surrounding areas remain forested and undeveloped; the area to the south of the Site includes Robertson Road and the Glenora Trails Head Park.

CFGF has occupied the Site for club activities and a firearms target range since the mid 1960s (Trillium, 2018b). In 1995 Cowichan River Provincial Park was created encompassing the CFGF, which maintains four shooting ranges at the Site. These include three outdoor ranges with sheltered firing lines: a combined 100/200-yard rifle range, a 50-yard handgun and small bore (.22 LR calibre) range, and a single station trap range. Additionally, there is a six-position indoor 20-yard range.

Site buildings, other than those associated with the above target ranges, include the CFGF club house with kitchen and meeting area, another building for social gatherings called "Founders Hall", and a stand-alone washroom building. A residential structure and its two outbuildings have been located at the southern portion of the Site since the late 1980s/early 1990s.

2.3 List of APECs and PCOCs

The findings of the previous PSI 1 identified four areas of potential environmental concern (APECs) at the Site. No off-Site APECs were identified. The preliminary soil sampling program confirmed the presence of metals contamination in shallow soil at APECs 1, 2, and 3; therefore, these are now considered 'areas of environmental concern' (or AECs). Although contamination was not identified at APEC 4 (trap range), the widespread nature of gunshot deposition associated with this activity requires additional soil sampling. Therefore, at this time the trap range is retained as APEC 4.

The potential contaminants of concern (PCOCs) associated with the APECs/AECs are listed in **Table 2-2** below. The location of the APECs are shown on attached **Figure 3**.

Table 2-2: List of APEC/AECs, PCOCs, and COCs

APEC ID.	Name	Activities of Concern	PCOCs	COCs
APEC 1/ AEC 1	Area South of the Indoor 20 yard Pistol Range	Indoor target shooting activities, with vent at on to outside (circa 1970 to present)	Soil: Metals Groundwater: N/A	Soil: Lead, Zinc Groundwater: N/A
APEC 2/ AEC 2	Outdoor 50 yard Gun Range	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (circa 1975 to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Cadmium, Copper, Lead, Tin Groundwater: No data
APEC 3/ AEC 3	Outdoor 100 and 200 yard Rifle Ranges	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (mid 1960s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Copper, Lead Groundwater: No data
APEC 4	Trap Range	Trap range and overspray area with evidence of gunshot and clay pigeon fragments (1990s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: None to date Groundwater: No data

Notes:

APEC Area of Potential Environmental Concern

PCOC Potential Contaminated of Concern

PAH Polycyclic Aromatic Hydrocarbons

2.4 Geology and Hydrogeology

The surficial geology map for the Duncan area (BCGS, 1992) indicates that the Site and surrounding area are underlain by hummocky morainal diamicton (unsorted to poorly sorted glacial deposits, a form of till) comprised of silt and boulders, with lesser amounts of plain glaciolacustrine silt, underlain by glaciofluvial sand and gravel. Conditions observed by Trillium at the Site are discussed in Section 5.1.

Bedrock in the area of the Site is of the Haslam Formation, comprised of argillite, siltstone, shale and minor sandstone formations (BCGS, 1991). Bedrock was not encountered by Trillium during this investigation.

Groundwater at the Site includes a confined aquifer within the glaciofluvial sand and gravel deposits known as the Glenora Aquifer, and an aquifer within the underlying Haslam Formation bedrock known as the South Cowichan Aquifer (BC Water Resources Atlas, 1995 & 1996). Groundwater encountered by Trillium at the Site was an unconfined shallow water table overlying and/or straddling the Glenora Aquifer.

Groundwater flow direction has not been determined at the Site; probable direction of flow would be north and/or west towards the Cowichan River.

3.0 REGULATORY FRAMEWORK

Environmental matters pertaining to contaminated sites in British Columbia fall under the jurisdiction of the BC Ministry of Environment and Climate Change Strategy (BC ENV), pursuant to the Environmental Management Act (EMA). Specific environmental standards, protocols and practice guidance are provided in the Contaminated Sites Regulation (CSR). The CSR provides concentration-based standards for soil, groundwater and soil vapour that, when warranted, are used to determine whether or not a site is contaminated. The purpose of the PSI 2 is to investigate the findings of the PSI 1 to confirm whether or not any of the Potential Contaminants of Concern (PCOCs) can be found in concentrations above an applicable numerical standard at each Area of Potential Environmental Concern (APEC). If a Stage 2 PSI confirms the presence of Contaminants of Concern (COCs), it is the expectation of BC ENV that a Detailed Site Investigation (DSI) be completed.

In accordance with Section 11 of the CSR, contamination exists where concentrations of substances exceed the applicable standards listed in Schedules 3.1, 3.2, 3.3, and 3.4 of the regulation.

For a given substance in soil, the CSR includes either a generic or matrix numerical standard. Matrix standards set out in Schedule 3.1, Part 1 apply to some other potential contaminants, and take into account site-specific factors. Generic standards are listed in Schedules 3.1, Parts 2 and 3 of the regulation, and consist of concentrations that apply regardless of site-specific factors. The applicable standard for a substance in soil at the Site was determined as the lowest of the applicable site-specific standards for urban park land (PL) that account for human exposure by intake of contaminated soil and groundwater used for drinking water, and other factors such as whether environmental receptors (e.g., soil invertebrates, livestock, and freshwater aquatic life) may be exposed, and whether the water will be used for irrigation. At the Site, generic soil standards are applicable, as well as matrix standards for the protection of human intake and drinking water (DW), protection against toxicity to plants and soil invertebrates, and fresh water aquatic life (AW_{FW}). Livestock watering and irrigation uses of groundwater were not identified in the area of the Site and those standards were not applied.

For substances in groundwater, the CSR includes Schedule 3.2 DW, AW, irrigation, and livestock watering standards. As for soil, the DW and AW_{FW} standards from were applied from Schedule 3.2. to Site groundwater, but irrigation and livestock watering standards were not applied.

4.0 DESCRIPTION OF INVESTIGATION

Methodologies for borehole drilling, monitoring well construction, sample collection, and measures to ensure sample integrity are described in **Appendix A**. Monitoring well construction and borehole drilling was completed in three mobilizations between February 8, 2018 and February 16, 2018.

The first mobilization involved the attempted advancement of BH18-01 (**Figure 4**) on February 8, 2018. Because of limited machine access in the area of the 50-yard target range (APEC 2), borehole drilling was initially attempted using a limited-access rig ("Mole Rat") with solid stem auger. However, dense gravel and sand glacial till was encountered through which auger drilling was not feasible. One soil sample was obtained at BH18-01 before complete drilling and monitoring well installment was postponed.

Based on the soils encountered, a second and third mobilizations involved the advancement of MW18-02 and MW18-03 on February 14, 2018, and MW18-04 on February 16, 2018. The drilling method was switched to ODEX, a down-hole air hammer system, attached to a Mole Rat at the 50-yard range (MW18-02, APEC 2) and to a truck-mounted rig at the 100- and 200-yard ranges (MW18-03 and MW18-04, APEC 3). This drilling program was to investigate metals in soils at depth and groundwater quality associated with APECs 2 and 3.

4.1 Borehole Drilling and Collection of Soil Samples

Soil samples were collected from boreholes that were drilled for monitoring well construction, except for just soil was sampled from the initial abandoned borehole. All work was completed under the direction of Trillium using methods described in **Appendix A**. The locations of boreholes, monitoring wells, and previous shallow soil samples are shown on **Figure 4**.

Soil conditions were logged throughout the soil profile, including observations of soil type, texture, colour, and moisture content. Soil conditions and monitoring well construction details are presented on logs provided in **Appendix B**.

Soil samples were shipped to the laboratory in an ice-packed cooler. One sample representing undisturbed soil at depth from each of three boreholes was analyzed for metals. Soil analyses results are discussed in Section 5.3.

4.2 Installation and Development of Monitoring Wells

The monitoring wells consisted of solid 50mm (2") diameter PVC pipes with slotted screens (0.25mm slot size) constructed for Trillium using the methodologies described in **Appendix A**. The well screen depth intervals were selected to target specific zones from where water samples were desired. The screens were installed in shallowest water-bearing zone, straddling or below the water table, in order to confirm groundwater quality immediately below the surface impacts at APECs 2 and 3. Details for each installation are indicated on the logs in **Appendix B**.

On February 16, 2018, each well was developed using a 5/8" diameter high-density polyethylene tubing with Waterra® foot valves. Groundwater was pumped from each monitoring wells until approximately nine well volumes were evacuated, field water quality measurements had stabilized, and discharged water was generally free of visible sediment. All purge water was dispersed on unpaved areas.

4.3 Collection of Groundwater Samples

The monitoring wells were sampled on February 20, 2018 using low-flow methods described in **Appendix A**. Dissolved oxygen, electrical conductivity, pH, salinity, and temperature were continuously measured while purging prior to sample collection. The wells were pumped and monitored until three well volumes were purged or field parameters achieved stabilization, whichever occurred first. Groundwater purging and sampling field data are included in **Appendix C**, which include the water levels measured prior to sample collection.

The groundwater samples were analyzed for PCOCs corresponding with the APECs, specifically metals.

The results of groundwater analyses are presented in Section 5.3.

4.4 Chemical Analyses

Soil and groundwater samples were analyzed by CARO Analytical Services at their Richmond laboratory. New, unused sample jars and bottles were supplied by the laboratory. All samples were submitted to the laboratory packed in ice on as soon as practically possible after collection. All samples were analyzed within the recommended holding time. Laboratory analytical certificates of analyses are provided as **Appendix D**.

5.0 INVESTIGATION FINDINGS

5.1 Stratigraphy

Site lithology, based on the borehole soil observations, consisted of 0.6 to 1.4 m reddish-brown/beige fill comprised of variable silty sand and/or gravel. Below the fill was a variable layer of brownish-grey sand and gravel grading into a very dense gravel till with sand and variable silt. The gravel till ranged in depth from 0.6 m to over 7.3 m. Below the gravel till was a soft, beige, silty sand with free water, ranging in depth from 4.4 to over 7.3 m below ground.

5.2 Groundwater Conditions

One main hydrostatic unit was observed at the Site, which is likely to be unconfined and continuous from the gravel till to the underlying silty sand. Given that the Site is unpaved, surface water infiltration is believed to be a significant contributor to the recharge of this shallow water table.

The well recharge rate was adequate during well development and purging, particularly in the silty sand stratum, suggesting that the hydraulic conductivity is relatively high. The recharge rate was somewhat slower but adequate at the well screened in the gravel till (MW18-02), suggesting a lower hydraulic conductivity, but it is unlikely to act as a natural confining barrier.

5.3 Analytical Results for Soil and Groundwater

Analytical results collected during this PSI 2 are presented in the attached **Table 1a** (soil) and **Table 2** (groundwater). Note that the soil results from a previous shallow soil sampling program (Trillium, 2018b) are included in **Table 1b** for ease of comparison.

The results of borehole soil samples submitted for analysis had concentrations of metals less than the applicable CSR PL standards.

The results of groundwater samples had concentrations of dissolved metals less than the applicable CSR DW and AW_{FW} standards.

The attached **Figure 5** summarizes the combined soil results from the preliminary shallow soil sampling and this PSI 2. **Figure 6** summarizes the groundwater results. Both graphical summaries indicate the sample locations with exceedances of the CSR standards.

5.4 Quality Assurance and Quality Control

Quality assurance/quality control (QA/QC) measures implemented for the soil and groundwater analytical program included measures by both the laboratory and by field personnel collecting the soil and groundwater samples. Routine analysis of laboratory replicates and standard reference materials were conducted by the laboratory to define precision and accuracy, and to demonstrate contamination control for the type of samples and parameters under investigation.

QA/QC measures taken by Trillium included collection of sample-duplicate pairs for concurrent analysis by the laboratory. A measure of sampling reproducibility or precision was evaluated by calculating the relative percent difference (RPD) between each parameter of the sample-duplicate pairings, as follows:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where,

RPD = relative percent difference;

C_1 = the larger of the two observed values; and

C_2 = the smaller of the two observed values.

Generally, RPDs less than 35% are considered desirable, and values up to 65% are considered acceptable when based on results measured greater than 5 times the reported detection limit (RDL). The RPDs for the soil sample-duplicate pair were predominantly less than 35%, except the RPD for lead of 62.7% which was less than 65% (see attached **Table 3**). The RPDs for the groundwater sample-duplicate pair were less than 35% (see attached **Table 4**). Overall, the RPDs indicate that the precision of the data was acceptable.

Measures were taken during sampling to prevent cross-contamination during collection of soil and groundwater samples, as described in the detailed field methodologies (**Appendix A**).

6.0 DISCUSSION

6.1 AEC 1 – Area South of Indoor 20-yard Pistol Range

AEC 1 was not further investigated as part of the PSI 2; however, soil contamination was identified during the preliminary soil sampling program (Trillium, 2018a). Soil contaminants identified were lead and zinc. The presence of these COCs were attributed to the use of the building ventilation system, which ventilates indoor air from the 20-yard range firing line to the outside via the southern wall of the indoor range building. Given that soil contaminants were from aerial deposition and soil impacts appear to be limited to near surface soils, the total contaminant mass and impacted soil volume at this AEC is anticipated to be relatively small. Therefore, the potential for groundwater to be impacted is considered low. Groundwater investigation at AEC 1 is not warranted.

6.2 AEC 2 – Outdoor 50-yard Range

Soil analysis results from the preliminary sampling program confirmed the presence of five metal COCs in the target area backstop soils: antimony, cadmium, copper, lead, and tin. The soil analysis results of the PSI 2 borehole sampling showed that these metals were not found at concentrations above CSR standards at depth. PAHs were also identified as PCOCs due to the presence of clay pigeon fragments and have yet to be investigated in soil. The lateral extent of shallow soil contamination would be required in advance of preparing a remediation plan.

Groundwater analysis results from one monitoring well installed near the backstop berm at AEC 2 indicated concentrations for metal PCOCs that were less than the applicable standards.

6.3 AEC 3 – Outdoor 100- and 200-yard Rifle Ranges

Soil analysis results from the preliminary sampling program confirmed the presence of three metal COCs in the target area backstop soils of AEC 3: antimony, copper, and lead. The soil analysis results of the PSI 2 borehole sampling showed that these metals were not found at concentrations above CSR standards at depth. PAHs were also identified as PCOCs due to the presence of clay pigeon fragments and have yet to be investigated in soil. The lateral extent of shallow soil contamination would be required in advance of preparing a remediation plan.

Groundwater analysis results from two monitoring wells, installed near each of the 100-yard and 200-yard backstop berms of AEC 3, indicated concentrations for metal PCOCs that were less than the applicable standards.

6.4 APEC 4 – Trap Range

APEC 4 was not further investigated as part of the PSI 2. Soil analysis results from the preliminary soil sampling program included one sample which did not identify soil COCs (Trillium, 2018a). PAHs were also identified as PCOCs due to the presence of clay pigeon fragments and have yet to be investigated in soil. Given the widespread nature of gunshot deposition associated with this activity, additional soil sampling is warranted for metals PCOCs. As speculated by Trillium during the preliminary soil sampling, it is possible that shot gun munitions become less pulverized than bullets from pistols and rifles, producing less fine metal fragments in soil. While gunshot is conventionally made of lead, some steel gunshot may also be used at the trap range, which do not contain lead and may not readily leach metals.

Groundwater has not been investigated, but may be warranted in the case that soil metals COCs are identified at APEC 4.

Additional investigation is warranted at APEC 4 as described above.

7.0 CONCLUSIONS AND RECOMMENDATIONS

It is concluded that constituents of concern (COCs) are present in Site soil at concentrations in excess of applicable standards provided in the British Columbia Contaminated Sites Regulation (CSR), based on the results of previous shallow soil sampling. The results of the current PSI 2 borehole sampling indicated that the soil contamination does not continue substantially at depth below the outdoor range target areas.

Concentrations of PCOCs were not found to exceed BC CSR standards in groundwater at the Site. Therefore, there was no indication that the contaminants found in Site soil are impacting the groundwater below the three outdoor target berms at AECs 2 and 3. As a result, there is presently no evidence that Site contaminants are migrating from the Site via groundwater.

It is recommended that further investigations be conducted to complete the investigation of PAHs at AEC 2 and 3, and metals and PAHs at APEC 4. Detailed investigation is recommended to delineate shallow soil metals contamination found at AECs 1, 2, and 3. Determination and delineation of all COCs at the Site is a prerequisite for the development of a remedial action plan for the Site. A summary of remaining APECs/AECs and PCOCs/COCs for the Site is provided in Table 7-1 below.

Table 7-1: Summary of Remaining APECs/AECs and PCOCs/COCs

APEC/ AEC ID.	Name	Activities of Concern	PCOCs	COCs
AEC 1	Area South of the Indoor 20 yard Pistol Range	Indoor target shooting activities, with venting on to outside (circa 1970 to present)	Soil: Metals Groundwater: N/A	Soil: Lead, Zinc Groundwater: N/A
AEC 2	Outdoor 50 yard Gun Range	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (circa 1975 to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Cadmium, Copper, Lead, Tin Groundwater: None
AEC 3	Outdoor 100 and 200 yard Rifle Ranges	Outdoor target shooting, with evidence of bullet fragments, gunshot, and clay pigeon fragments (mid 1960s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: Antimony, Copper, Lead Groundwater: None
APEC 4	Trap Range	Trap range and overspray area with evidence of gunshot and clay pigeon fragments (1990s to present)	Soil: Metals & PAHs Groundwater: Metals	Soil: None identified to date Groundwater: No data yet

Notes:

APEC Area of Potential Environmental Concern

AEC Area of Environmental Concern

PCOC Potential Contaminant of Concern

COC Contaminant of Concern

PAH Polycyclic Aromatic Hydrocarbons

8.0 STATEMENT OF LIMITATIONS

Findings presented in this reports are based upon: (i) a review of the available site records and (ii) the results of a field investigation including the collection and analysis of soil and water samples. Geologic observation and analytical results reflect conditions encountered at a specific test location. Site conditions (geologic, hydrogeologic, and chemical characterization) may vary from that extrapolated from the data collected during this investigation. Consequently, while findings and conclusion documented in this report have been prepared in a manner consistent with that level of care and skill normally exercised by other members of the environmental science and engineering profession practicing under similar circumstances in the area at the time of the performance of the work, this report is not intended, nor is it able to provide a totally comprehensive review of present or past site environmental conditions.

This report has been prepared solely for the internal use of BC Parks pursuant to the agreement between Trillium Environmental and BC Parks. Any use which other parties make of this report, or any reliance on, or decisions made based on it, are the responsibility of such parties. By using the report, the above parties agree that they will review and use the report in its entirety. Trillium Environmental accepts no responsibility for damages, if any, suffered by other parties as a result of decisions made or actions based on this report.

I trust that the information presented in this report meets your current requirements. Should you have any questions, or concerns, please do not hesitate to contact the undersigned.

Prepared By:

TRILLIUM ENVIRONMENTAL LTD.



Stefan Quaglia, R.P.Bio., CSAP

9.0 REFERENCES

BC Geological Survey. 1992. Surficial Geology of the Duncan Area (92B/13), by H.E. Blyth and N.W. Rutter.

BC Geological Survey. 1991. Geology of the Duncan Area (92B/13), by N.W.D Massey, S.J. Friday, P.E. Tercier and T.E. Potter.

Preliminary Soil Sampling Report and Indoor Range Containment Testing, prepared for BC Parks, prepared by Trillium Environmental Ltd., January 25, 2018a.

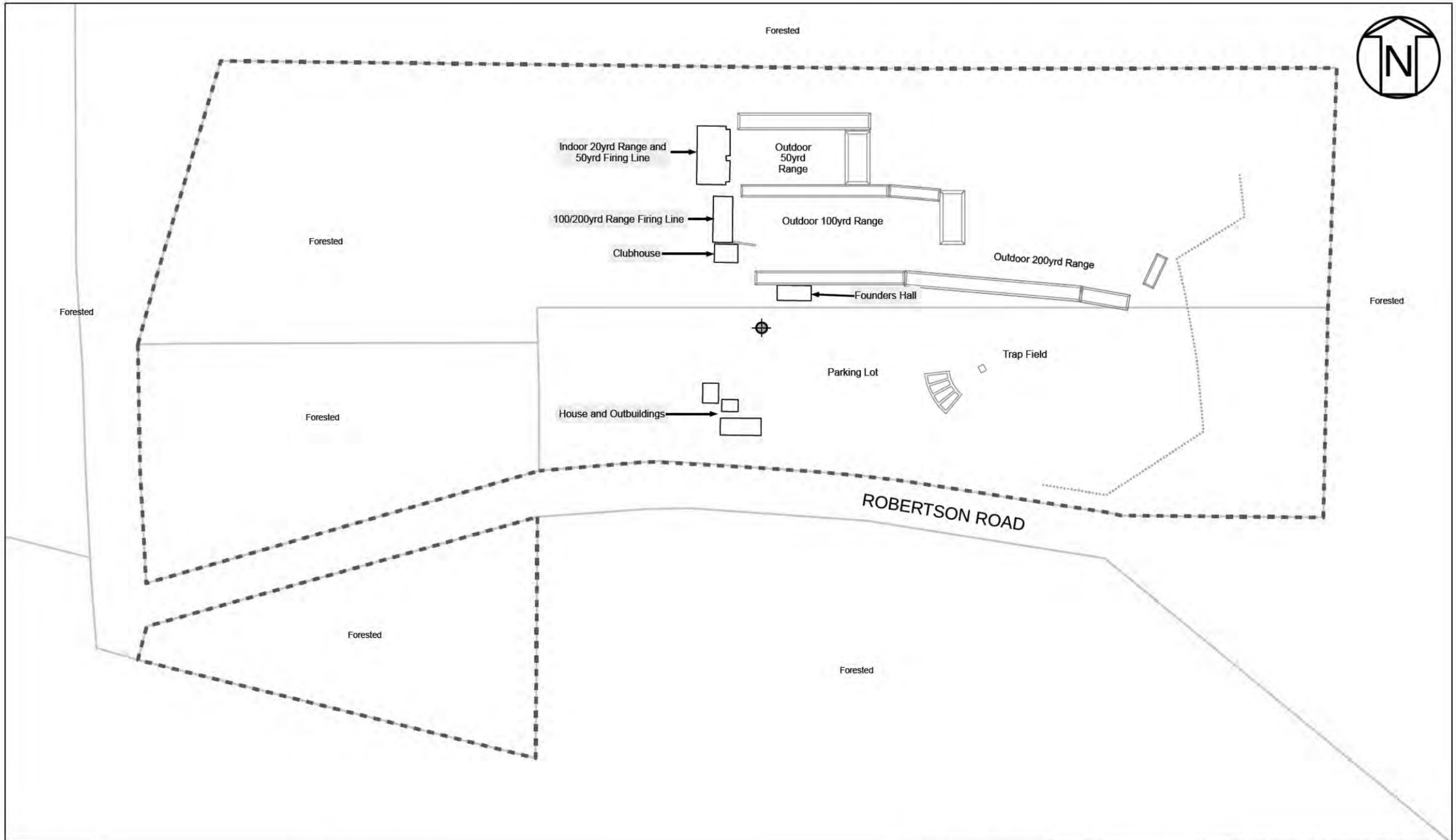
Stage 1 Preliminary Site Investigation, 4295 Robertson Road, Glenora, BC, prepared for BC Parks, prepared by Trillium Environmental Ltd., March 16, 2018b.

Figures

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Copyright



LEGEND			
--- Subject Site	- - - - - Fence	⊕ Drinking Water Well	
— Property Lines	▭ Berm		
— Buildings			

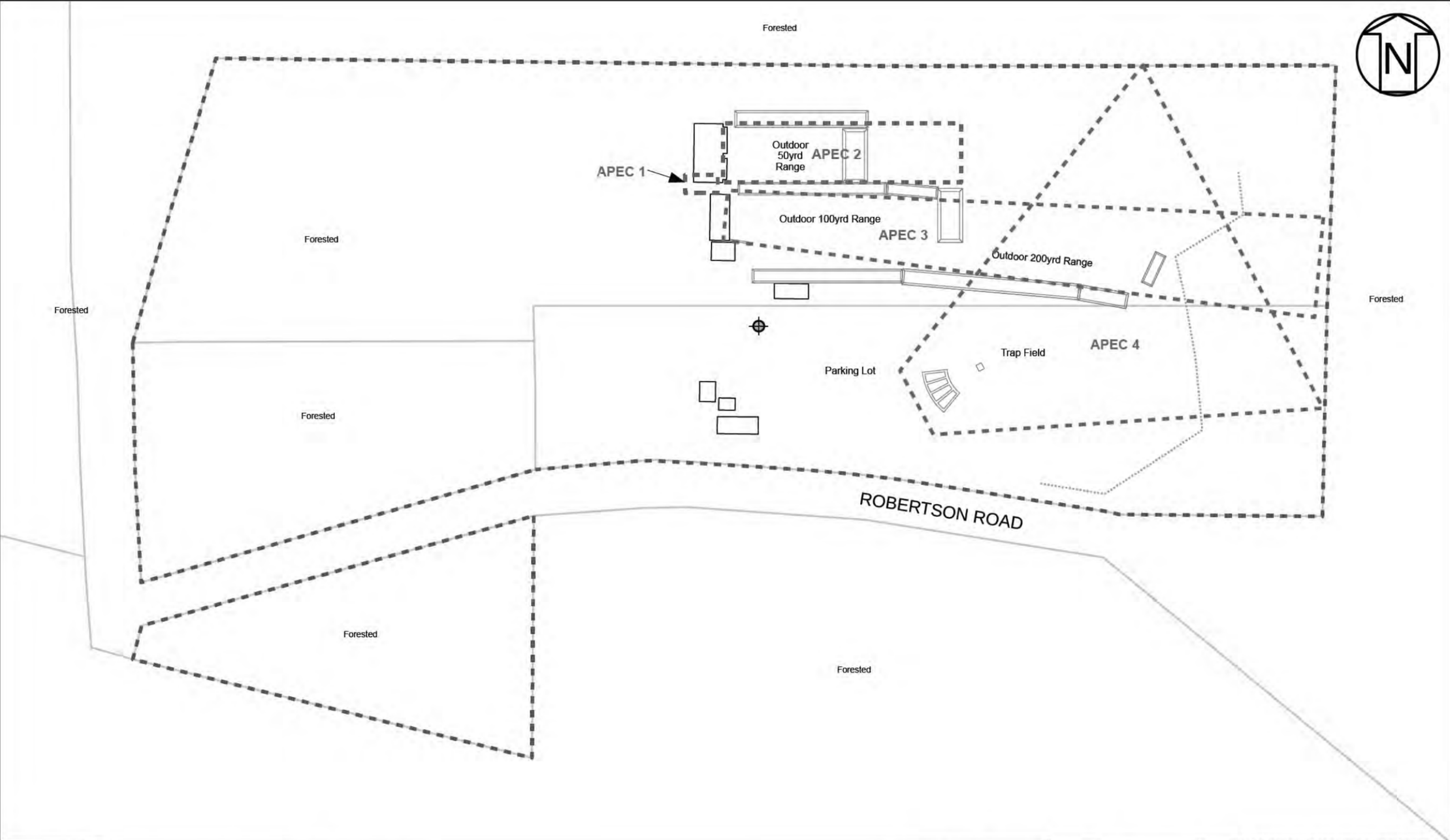
Note: All measurements are approximate.
No guarantee is made as to the accuracy.

SCALE 1:1,500 (approx.)
metres

10 0 40

CLIENT BC PARKS

PRELIMINARY SITE INVESTIGATION, STAGE 2 4295 ROBERTSON ROAD, GLENORA, BC		
SITE PLAN		
PROJECT No. 128-001-03	MARCH 2018	FIGURE 2



LEGEND

--- Subject Site	--- Fence	⊕ Drinking Water Well
--- Property Lines	▭ Berm	
--- Buildings		

Note: All measurements are approximate.
No guarantee is made as to the accuracy.

SCALE 1:1,500 (approx.)
metres

10 0 40

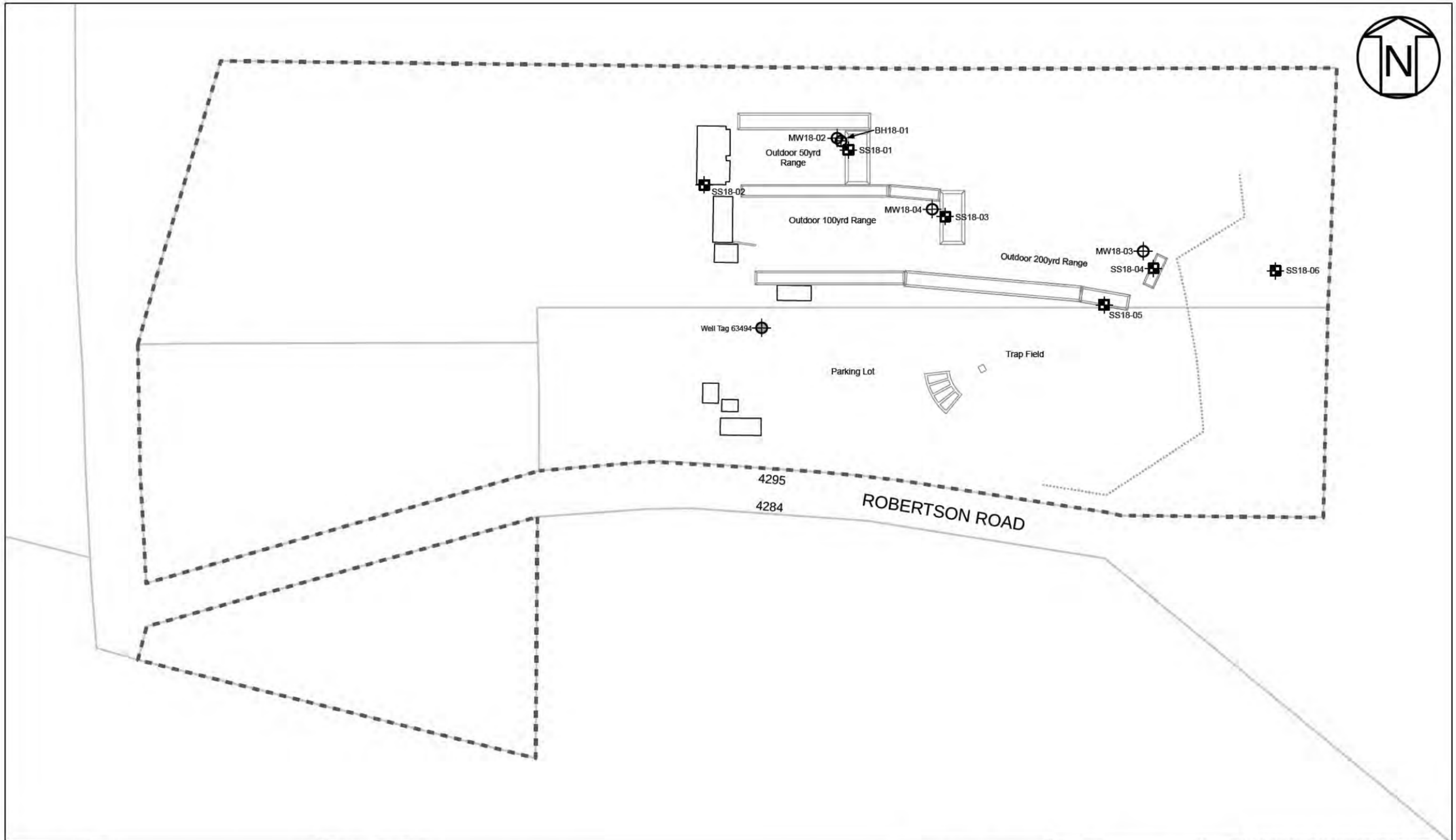
trillium

CLIENT BC PARKS

PRELIMINARY SITE INVESTIGATION, STAGE 2
4295 ROBERTSON ROAD, GLENORA, BC

AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

PROJECT No. 128-001-03	MARCH 2018	FIGURE 3
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LEGEND		Drinking Water Well	
Subject Site	Fence	Previous Shallow Soil Sample (Trillium, Jan. 2018)	
Property Lines	Berm	Borehole (Trillium, PSI 2)	
Buildings		Monitoring Well (Trillium, PSI 2)	

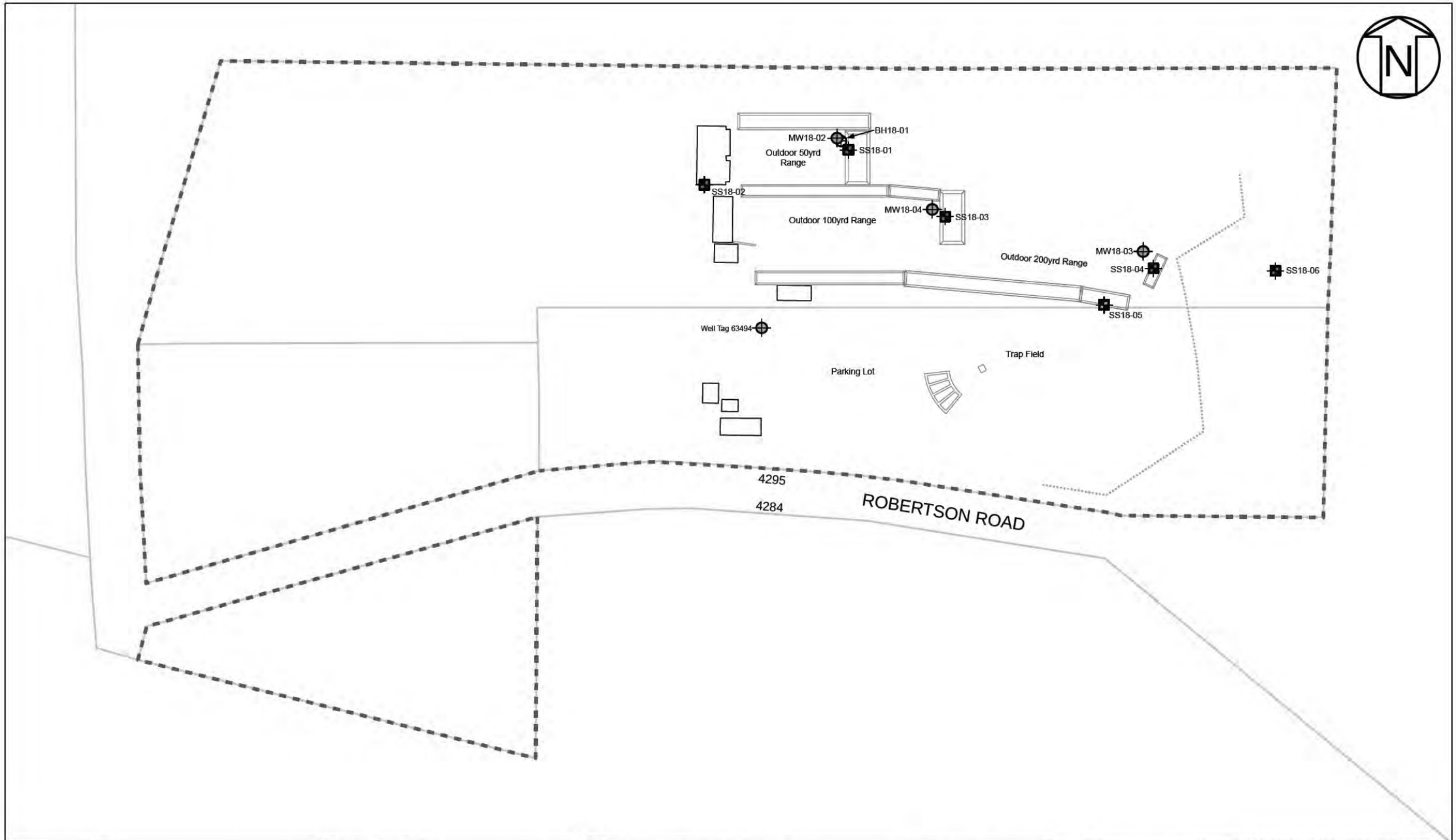
Note: All measurements are approximate.
No guarantee is made as to the accuracy.

SCALE 1:1,500 (approx.)
metres

10 0 40

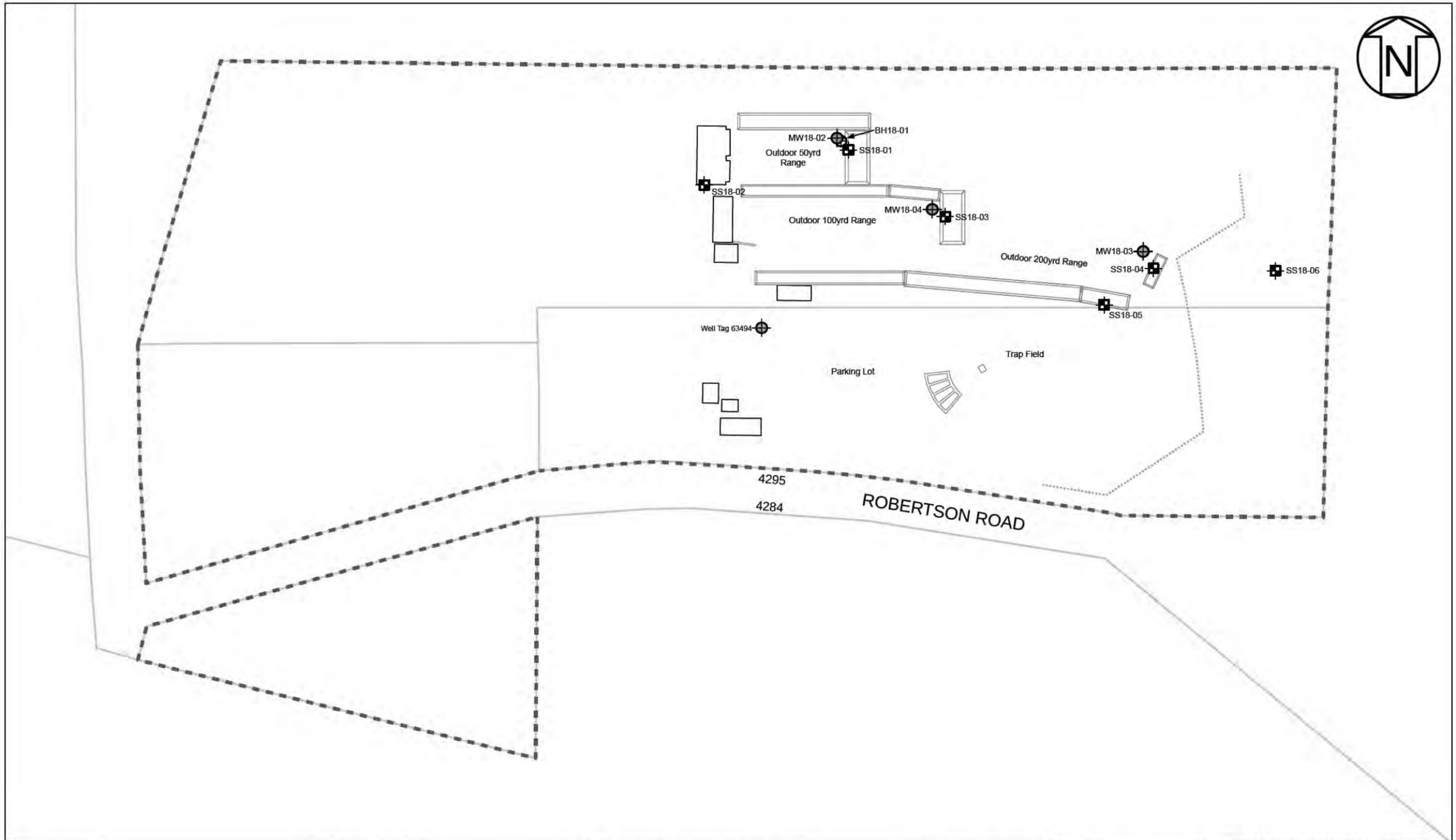
CLIENT: BC PARKS

PRELIMINARY SITE INVESTIGATION, STAGE 2 4295 ROBERTSON ROAD, GLENORA, BC		
SAMPLE LOCATION PLAN		
PROJECT No. 128-001-03	MARCH 2018	FIGURE 4



LEGEND		Drinking Water Well		Soil Concentrations < CSR Standards		SCALE 1:1,500 (approx.) metres 10 0 40			PRELIMINARY SITE INVESTIGATION, STAGE 2 4295 ROBERTSON ROAD, GLENORA, BC			
Subject Site	Fence	Previous Shallow Soil Sample (Trillium, Jan. 2018)	Soil Concentrations > CSR Standards	Borehole (Trillium, PSI 2)	Monitoring Well (Trillium, PSI 2)				SOIL METALS RESULTS			
Property Lines	Berm							CLIENT	BC PARKS	PROJECT No. 128-001-03	MARCH 2018	FIGURE 5
Buildings												

Note: All measurements are approximate. No guarantee is made as to the accuracy.



LEGEND		 Drinking Water Well	 Previous Shallow Soil Sample (Trillium, Jan. 2018)	 Borehole (Trillium, PSI 2)	 Monitoring Well (Trillium, PSI 2)	 Groundwater Concentrations < CSR Standards	 Groundwater Concentrations > CSR Standards	SCALE 1:1,500 (approx.) metres 10 0 40		PRELIMINARY SITE INVESTIGATION, STAGE 2 4295 ROBERTSON ROAD, GLENORA, BC		
 Subject Site	 Property Lines									 Fence	 Berm	 Buildings
									CLIENT BC PARKS	PROJECT No. 128-001-03	MARCH 2018	FIGURE 6

Note: All measurements are approximate. No guarantee is made as to the accuracy.

Tables

Table 1a

Soil Analytical Results
Metals
 4295 Robertson Road, Glenora, BC
 BC Parks
 Project # 128-001-03

Sample ID	MW18-02b	MW18-02x Dup. of MW18-02b	MW18-03a	MW18-04a
Lab Sample ID	802 609 03	802 609 3	802 609 08	802 609 09
Sample Depth (mbgs)	2.45-3.0	2.45-3.0	1.8-2.15	1.05-1.40
Date Sampled	14-Feb-18	14-Feb-18	14-Feb-18	16-Feb-18
pH (lab measured)	5.8	6.63	7.45	6.77
Metals in Soil				
Aluminum	17600	16800	18500	23700
Antimony	0.18	0.24	0.15	0.2
Arsenic	3.4	3.45	3.22	3.06
Barium	102.0	99.2	51.4	90.4
Beryllium	0.23	0.22	0.23	0.26
Boron	2.2	<2.0	<2.0	<2.0
Cadmium	0.055	0.059	0.053	0.048
Chromium	30.2	27.3	27.4	33.7
Cobalt	11.5	11.3	12	12.1
Copper	48.3	48.7	55.7	65.4
Iron	26300.0	26100	26500	26600
Lead	4.23	8.09	2.18	6.45
Lithium	10.4	10.8	11.1	10.4
Manganese*	491.0	483	404	441
Mercury	<0.040	<0.040	<0.040	<0.040
Molybdenum	2.7	2.86	1.06	1.46
Nickel	22.8	22.6	23.3	24.7
Selenium	<0.20	<0.20	<0.20	<0.20
Silver	<0.10	<0.10	<0.10	<0.10
Strontium	31.3	25.6	22.3	35.9
Thallium	<0.10	<0.10	<0.10	<0.10
Tin	0.34	0.35	0.31	0.35
Tungsten	0.7	0.64	0.27	0.64
Uranium	0.2	0.231	0.329	0.185
Vanadium	72.0	68	72	74.6
Zinc	38.9	38.1	39.4	41.4

NOTES:

Standards are concentration based and are presented in units of micrograms per gram (µg/g) or parts per million (ppm), unless otherwise noted

CSR Contaminated Sites Regulation, effective April , 1997, including amendments up to November , 20 7

mbgs Meters below ground surface

ns No standard for this constituent

* CSR Schedule 3 Parts and 2, Matrix and Generic numerical soil standards

BOLD CSR soil standards for manganese apply at site with specific uses and activities, not including rifle ranges**RED** Greater than one or more applicable CSR soil standards

Greater than the CSR Matrix standard for the Protection of Human Health due to Soil Intake (Intake)

Greater than the CSR Matrix standard for the Protection of Groundwater used for Drinking Water (DW)

Greater than the CSR Matrix standard for the Protection against Toxicity to Soil Invertebrates and Plants (TOX)

Greater than the CSR Matrix standard for the Protection of Groundwater flow to Surface Water used by Freshwater Aquatic Life (AW_{FW})Greater than the CSR Matrix standards for the Protection of DW and AW_{FW}Underline Greater than the CSR Generic standard for the Protection of Human and/or Ecological Health

BC CSR Stage 11 - Urban Park Land (PL)†				
Protection of Human Soil Intake (Intake)	Protection of Groundwater used for Drinking Water (DW)	Protection of Soil Invertebrates and Plants (TOX)	Protection of Aquatic Life, Freshwater (AW _{FW})	Generic Numerical Standards
ns	ns	ns	ns	ns
ns	ns	ns	ns	40000 ^a , ns ^b
ns	ns	ns	ns	500 ^a , 20 ^b
40	10	25	10	ns
15000	350	700	3500	ns
150	1 @ pH < 5.5 1.5 @ pH 5.5 - < 6.0 4 @ pH 6.0 - < 6.5 20 @ pH 6.5 - < 7.0 150 @ pH 7.0 - < 7.5 1000 @ pH 7.5 - < 8.0 2500 @ pH ≥ 8.0	150	1 @ pH < 6.5 4 @ pH 6.5 - < 7.0 30 @ pH 7.0 - < 7.5 250 @ pH 7.5 - < 8.0 500 @ pH ≥ 8.0	ns
ns	ns	ns	ns	15000, ns ^b
40	1 @ pH < 7.0 4.5 @ pH 7.0 - < 7.5 30 @ pH 7.5 - < 8.0 70 @ pH ≥ 8.0	35	1 @ pH < 7.0 3 @ pH 7.0 - < 7.5 20 @ pH 7.5 - < 8.0 50 @ pH ≥ 8.0	ns
250	60 ^c , >1000 mg/g ^d	200	60 ^c , 300,000 ^e	ns
25	25	45	25	ns
7500	250 @ pH < 5.0 500 @ pH 5.0 - < 5.5 2000 @ pH 5.5 - < 6.0 10000 @ pH 6.0 - < 6.5 50000 @ pH 6.5 - < 7.0 100000 @ pH ≥ 7.0	150	70 @ pH < 5.5 100 @ pH 5.5 - < 6.0 650 @ pH 6.0 - < 6.5 2500 @ pH 6.5 - < 7.0 6000 @ pH 7.0 - < 7.5 6500 @ pH ≥ 7.5	ns
ns	ns	ns	ns	35000
120	120 @ pH < 5.5 150 @ pH 5.5 - < 6.0 800 @ pH 6.0 - < 6.5 3500 @ pH 6.5 - < 7.0 7500 @ pH 7.0 - < 7.5 8500 @ pH ≥ 7.5	550	120 @ pH < 5.0 200 @ pH 5.0 - < 5.5 850 @ pH 5.5 - < 6.0 5000 @ pH 6.0 - < 6.5 20000 @ pH 6.5 - < 7.0 45000 @ pH 7.0 - < 7.5 50000 @ pH ≥ 7.5	ns
ns	ns	ns	ns	65 ^a
10000	2000	2000	ns	ns
25	ns	40	25	ns
400	15	80	650	ns
900	70 @ pH < 7.5 250 @ pH 7.5 - < 8.0 500 @ pH ≥ 8.0	150	90 @ pH < 5.0 100 @ pH 5.0 - < 5.5 150 @ pH 5.5 - < 6.0 200 @ pH 6.0 - < 6.5 300 @ pH 6.5 - < 7.0 900 @ pH 7.0 - < 7.5 5000 @ pH 7.5 - < 8.0 9500 @ pH ≥ 8.0	ns
400	1	1.5	1	ns
ns	ns	ns	ns	400 ^a , 20 ^b
ns	ns	ns	ns	20000 ^a
2	2	9	2	ns
ns	ns	ns	ns	50000 ^a , 50 ^b
ns	ns	ns	ns	25 ^a , ns ^b
250	30	500	150	ns
400	100	150	ns	ns
25000	200 @ pH < 5.0 250 @ pH 5.0 - < 5.5 300 @ pH 5.5 - < 6.0 450 @ pH 6.0 - < 6.5 600 @ pH 6.5 - < 7.0 1000 @ pH 7.0 - < 7.5 3000 @ pH 7.5 - < 8.0 5500 @ pH ≥ 8.0	450	150 @ pH < 6.5 200 @ pH 6.5 - < 7.0 350 @ pH 7.0 - < 7.5 900 @ pH 7.5 - < 8.0 1500 @ pH ≥ 8.0	ns

Table 1b (1 of 2)
Previous Soil Analytical Results
Metals
 4295 Robertson Road Glenora BC
 BC Parks
 Project # 128-001-03

Sample ID	SS18-01	SS18-02a	SS18-02b	SS18-03	SS18-04	SS18-07 Dup of SS18-04	SS18-05	SS18-06
Lab Sample ID	8011002-01	8011002-08	8011002-09	8011002-03	8011002-04	8011002-07	8011002-05	8011002-06
Sample Depth (mbgs)	0-0 15	0-0 05	0 15-0 20	0-0 15	0-0 15	0-0 15	0-0 15	0-0 15
Date Sampled	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18
pH (lab measured)								
pH	6.86	6.94	6.19	7.37	7.13	7.03	5.6	4.68
Metals in Soil								
Aluminum	23700	23400	23200	17800	20800	18000	25000	8490
Antimony	183	17.2	7.58	66.1	137	152	0.64	2.26
Arsenic	7.4	4.59	3.72	5.04	6.67	6.2	3.59	3.29
Barium	60.6	96.2	88.7	33.4	45.2	38.5	47.8	157
Beryllium	0.4	0.34	0.36	0.31	0.35	0.3	0.39	0.17
Boron	<2.0	3.4	2.4	<2.0	<2.0	<2.0	<2.0	<2.0
Cadmium	1.63	0.335	0.186	0.179	0.511	0.619	0.076	0.17
Chromium	28.7	31.9	28.9	28.6	30	29.3	35.9	10.3
Cobalt	11.8	12.2	11.2	12.3	13.6	11.8	13.5	5.48
Copper	274	105	47.7	63.8	176	139	40.9	40.7
Iron	30300.0	33000	31300	30100	32300	28500	33700	10900
Lead	11800	1230	571	3140	6580	7320	25.9	511
Lithium	11.6	12.2	11.5	12.5	13.3	11.7	12.1	4.15
Manganese*	728.0	587	669	498	594	525	551	2430
Mercury	0.044	0.10	0.054	<0.040	0.044	0.045	<0.040	0.125
Molybdenum	0.3	0.5	0.45	0.2	0.21	0.21	0.23	0.19
Nickel	20.2	22.7	21.5	21.5	23	22.1	23.1	8.29

BC CSR Stage 11 - Urban Park Land (PL)†				
Protection of Human Soil Intake (Intake)	Protection of Groundwater used for Drinking Water (DW)	Protection of Soil Invertebrates and Plants (TOX)	Protection of Aquatic Life, Freshwater (AW _{FW})	Generic Numerical Standards
ns	ns	ns	ns	ns
ns	ns	ns	ns	40000 ^a ns ^b
ns	ns	ns	ns	500 ^a 20^b
40	10	25	10	ns
15000	350	700	3500	ns
150	1 @ pH < 5.5 15 @ pH 5.5 - < 6.0 4 @ pH 6.0 - < 6.5 20 @ pH 6.5 - < 7.0 150 @ pH 7.0 - < 7.5 1000 @ pH 7.5 - < 8.0 2500 @ pH ≥ 8.0	150	1 @ pH < 6.5 4 @ pH 6.5 - < 7.0 30 @ pH 7.0 - < 7.5 250 @ pH 7.5 - < 8.0 500 @ pH ≥ 8.0	ns
ns	ns	ns	ns	15000 ^a ns ^b
40	1 @ pH < 7.0 4.5 @ pH 7.0 - < 7.5 30 @ pH 7.5 - < 8.0 70 @ pH ≥ 8.0	35	1 @ pH < 7.0 3 @ pH 7.0 - < 7.5 20 @ pH 7.5 - < 8.0 50 @ pH ≥ 8.0	ns
250	60 ^c >1000 mg/g ^d	200	60 ^c 300 000 ^d	ns
25	25	45	25	ns
7500	250 @ pH < 5.0 500 @ pH 5.0 - 5.5 2000 @ pH 5.5 - < 6.0 10000 @ pH 6.0 - < 6.5 50000 @ pH 6.5 - < 7.0 100000 @ pH ≥ 7.0	150	70 @ pH < 5.5 100 @ pH 5.5 - < 6.0 650 @ pH 6.0 - < 6.5 2500 @ pH 6.5 - < 7.0 6000 @ pH 7.0 - < 7.5 6500 @ pH ≥ 7.5	ns
ns	ns	ns	ns	35000
120	120 @ pH < 5.5 150 @ pH 5.5 - < 6.0 800 @ pH 6.0 - < 6.5 3500 @ pH 6.5 - < 7.0 7500 @ pH 7.0 - < 7.5 8500 @ pH ≥ 7.5	550	120 @ pH < 5.0 200 @ pH 5.0 - 5.5 850 @ pH 5.5 - < 6.0 5000 @ pH 6.0 - < 6.5 20000 @ pH 6.5 - < 7.0 45000 @ pH 7.0 - < 7.5 50000 @ pH ≥ 7.5	ns
ns	ns	ns	ns	65 ^a
10000	2000	2000	ns	ns
25	ns	40	25	ns
400	15	80	650	ns
900	70 @ pH < 7.5 250 @ pH 7.5 - < 8.0 500 @ pH ≥ 8.0	150	90 @ pH < 5.0 100 @ pH 5.0 - < 5.5 150 @ pH 5.5 - < 6.0 200 @ pH 6.0 - < 6.5 300 @ pH 6.5 - < 7.0 900 @ pH 7.0 - < 7.5 5000 @ pH 7.5 - < 8.0 9500 @ pH ≥ 8.0	ns

Table 1b (2 of 2)
Previous Soil Analytical Results
Metals
4295 Robertson Road Glenora BC
BC Parks
Project # 128-001-03

Sample ID	SS18-01	SS18-02a	SS18-02b	SS18-03	SS18-04	SS18-07 Dup o SS18-04	SS18-05	SS18-06
Lab Sample ID	8011002-01	8011002-08	8011002-09	8011002-03	8011002-04	8011002-07	8011002-05	8011002-06
Sample Depth (mbgs)	0-0 15	0-0 05	0 15-0 20	0-0 15	0-0 15	0-0 15	0-0 15	0-0 15
Date Sampled	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18	12-Jan-18
Selenium	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20
Silver	0 4	<0 10	<0 10	0 18	0 29	0 31	<0 10	<0 10
Strontium	23 6	24 9	23 7	29 7	30 5	25 8	21 5	38 8
hassium	<0 10	<0 10	<0 10	<0 10	<0 10	<0 10	<0 10	<0 10
in	80.9	4 53	1 54	7 43	24 7	30 3	0 71	0 87
ungsten	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20	<0 20
Uranium	0 3	0 283	0 253	0 237	0 248	0 218	0 302	0 08
Vanadium	80 2	84 2	80 5	78 5	83 4	73	91 8	28 7
Zinc	95 2	227	97 4	47 5	61	52 4	49 5	60 4

BC CSR Stage 11 - Urban Park Land (PL)†				
Protection of Human Soil Intake (Intake)	Protection of Groundwater used for Drinking Water (DW)	Protection of Soil Invertebrates and Plants (TOX)	Protection of Aquatic Life, Freshwater (AW _{FW})	Generic Numerical Standards
400	1	1 5	1	ns
ns	ns	ns	ns	400 ^a 20 ^b
ns	ns	ns	ns	20000 ^a
2	2	9	2	ns
ns	ns	ns	ns	50000 ^a 50 ^b
ns	ns	ns	ns	25 ^a ns ^b
250	30	500	150	ns
400	100	150	ns	ns
25000	200 @ pH < 5 0 250 @ pH 5 0 - < 5 5 300 @ pH 5 5 - < 6 0 450 @ pH 6 0 - < 6 5 600 @ pH 6 5 - < 7 0 1000 @ pH 7 0 - < 7 5 3000 @ pH 7 5 - < 8 0 5500 @ pH ≥ 8 0	450	150 @ pH < 6 5 200 @ pH 6 5 - < 7 0 350 @ pH 7 0 - < 7 5 900 @ pH 7 5 - < 8 0 1500 @ pH ≥ 8 0	ns

NOTES

Standards are concentration based and are presented in units of micrograms per gram (µg/g) or parts per million (ppm) unless otherwise noted

CSR Contaminated Sites Regulation effective April 1997 including amendments up to November 20 7

mbgs Meters below ground surface

ns No standard for this constituent

† CSR Schedule 3 - Parts and 2 Matrix and Generic numerical soil standards

* CSR soil standards for manganese apply at site with specific uses and activities not including rifle ranges

BOLD Greater than one or more applicable CSR soil standards

RED Greater than the CSR Matrix standard for the Protection of Human Health due to Soil Intake (Intake)

Greater than the CSR Matrix standard for the Protection of Groundwater used for Drinking Water (DW)

Greater than the CSR Matrix standard for the Protection against Toxicity to Soil Invertebrates and Plants (TOX)

Greater than the CSR Matrix standard for the Protection of Groundwater flow to Surface Water used by Freshwater Aquatic Life (AW_{FW})

Greater than the CSR Matrix standards for the Protection of DW and AW_{FW}

Underline Greater than the CSR Generic standard for the Protection of Human and/or Ecological Health

Table 2
Groundwater Analytical Results
Dissolved Metals
4295 Robertson Road, Genora, BC
BC Parks
Project # 128-001-03

Sample ID	MW18-02	MW18-03	MW18-a dup. of MW18 03	MW18-04	BC CSR Sched. 3.2	BC CSR Sched. 3.2
Lab Sample ID	8021609-14	8021609-15	8021609-17	8021609-16	Aquatic Life (AW)	Drinking Water (DW)
Date Sampled:	20 Feb 18	20 Feb 18	20 Feb 18	20 Feb 18		
Total Metals						
Aluminum	7.9	5.3	6.1	< 5	ns	9,500
Antimony	< 0.2	< 0.2	0.2	< 0.2	90	6
Arsenic	< 0.5	< 0.5	< 0.5	< 0.5	50	10
Barium	< 5	< 5	< 5	< 5	10,000	1,000
Beryllium	< 0.1	< 0.1	< 0.1	< 0.1	1.5	8
Boron	6	< 5	< 5	6.9	12,000	5,000
Cadmium	< 0.01	< 0.01	< 0.01	< 0.01	0.5 4 (hardness dep)	5
Calcium	7,830	2070	2150	10900	ns	ns
Chromium	< 0.5	< 0.5	< 0.5	< 0.5	10 (CrVI)	50 (CrVI)
Cobalt	0.17	0.25	0.17	0.27	40	1
Copper	< 0.4	< 0.4	< 0.4	< 0.4	20 90 (hardness dep)	1,500
Iron	11	< 10	< 10	< 10	ns	6,500
Lead	< 0.2	< 0.2	< 0.2	< 0.2	40 160 (hardness dep)	10
Lithium	0.30	< 0.1	< 0.1	0.52	ns	8
Magnesium	1,880	602	615	1560	ns	ns
Manganese	27.1	22.7	22.9	46.2	ns	1,500
Mercury	< 0.01	< 0.01	< 0.01	< 0.01	0.25	1
Molybdenum	0.1	< 0.1	< 0.1	0.17	10,000	250
Nickel	< 0.4	< 0.4	< 0.4	0.43	250 1,500 (hardness dep)	80
Selenium	< 0.5	< 0.5	< 0.5	< 0.5	20	10
Silver	< 0.05	< 0.05	< 0.05	< 0.05	0.5 15 (hardness dep)	20
Sodium	2380	1730	1770	2390	ns	200,000
Strontium	23.4	11	11.3	30.1	ns	2,500
Thallium	< 0.02	< 0.02	< 0.02	< 0.02	3	ns
Tin	< 0.2	< 0.2	< 0.2	< 0.2	ns	2,500
Titanium	< 5	< 5	< 5	< 5	1,000	ns
Tungsten	< 1	< 1	< 1	< 1	ns	3
Uranium	< 0.02	< 0.02	< 0.02	< 0.02	85	20
Vanadium	< 1	< 1	< 1	< 1	ns	20
Zinc	< 4	< 4	< 4	< 4	75 2,400 (hardness dep)	3,000
Hardness (mg/L)	7.90	5.30	6.10	< 5	ns	ns

NOTES:

Standards are concentration based and are presented in units of micrograms per litre (µg/L) or parts per billion (ppb) unless otherwise noted

BOLD	Greater than one or more applicable CSR water standards
<u>Value</u>	Decision limit or value is greater than one or more applicable CSR water standard
BOLD	Greater than the CSR Generic Numerical Water Standard or the Protection of Freshwater Aquatic Life (AW _{FW})
BOLD	Greater than the CSR Generic Numerical Water Standard or the Protection of Drinking Water (DW)
CSR	Comminuted Slies Regulation effective April 1 1997 including amendments up to November 1 2017
hardness dependent	Standard or this condition varies depending on hardness
ns	No standard or this condition

Table 3
Soil Sample-Duplicate Pairing QA/QC
Metals
4295 Robertson Road, G enora, BC
BC Parks
Project # 128-001-01

Sample ID	RDL	MW18-02b	MW18-02x Dup. of MW18 02b	RPD
Lab Sample ID		8021609-03	8021609-13	(%)
Sample Depth (mbgs)		2.45 3.0	2.45 3.0	
Date Sampled		14 Feb 18	14 Feb 18	
pH (lab measured)				
pH	0.1	5.8	6.63	13.4%
Metals in Soil				
Aluminum	40	17600	16800	4.7%
Antimony	0.1	0.18	0.24	(28.6%)
Arsenic	0.3	3.4	3.45	2.3%
Barium	1	102.0	99.2	2.8%
Beryllium	0.1	0.23	0.22	(4.4%)
Boron	2	2.2	<2.0	
Cadmium	0.04	0.055	0.059	(7.0%)
Chromium	1	30.2	27.3	10.1%
Cobalt	0.1	11.5	11.3	1.8%
Copper	0.4	48.3	48.7	0.8%
Iron	20	26300.0	26100	0.8%
Lead	0.2	4.23	8.09	62.7%
Lithium	0.1	10.4	10.8	3.8%
Manganese	0.4	491.0	483	1.6%
Mercury	0.04	<0.040	<0.040	
Molybdenum	0.1	2.7	2.86	6.5%
Nickel	0.6	22.8	22.6	0.9%
Selenium	0.2	<0.20	<0.20	
Silver	0.1	<0.10	<0.10	
Strontium	0.2	31.3	25.6	20.0%
Thallium	0.1	<0.10	<0.10	
Tin	0.2	0.34	0.35	(2.9%)
Tungsten	0.2	0.7	0.64	(10.4%)
Uranium	0.05	0.2	0.231	(4.7%)
Vanadium	1	72.0	68	5.7%
Zinc	2	38.9	38.1	2.1%

NOTES

Standards are concentration based and are presented in units of micrograms per gram (µg/g) or parts per million (ppm) unless otherwise noted

RPD Relative percent difference Calculated as (sample value - duplicate value) X 100% / ((sample + duplicate value)/2)

RDL Reported detection limit

BOLD RPD exceeds 35% for sample value greater than 5 times the RDL

(value) One or both analytes less than 5 X RDL RPD calculated for reference purposes

- RPD calculations not performed if analytical result in one or both samples is less than RDL

Table 4
Groundwater Sample-Duplicate Pairing QA/QC
Dissolved Metals
4295 Robertson Road, Glenora, BC
BC Parks
Project # 128-001-03

Sample ID	RDL	MW18-03	MW18-a dup. of MW18-03	RPD
Lab Sample ID:		8021609 15	8021609 17	(%)
Date Sampled:		20-Feb-18	20-Feb-18	
Total Metals				
Aluminum	5	5.3	6.1	(14.0%)
Antimony	0.2	< 0.2	0.2	-
Arsenic	0.5	< 0.5	< 0.5	-
Barium	5	< 5	< 5	-
Beryllium	0.1	< 0.1	< 0.1	-
Boron	5	< 5	< 5	-
Cadmium	0.01	< 0.01	< 0.01	-
Calcium	200	2070	2150	3.8%
Chromium	0.5	< 0.5	< 0.5	-
Cobalt	0.1	0.25	0.17	(38.1%)
Copper	0.4	< 0.4	< 0.4	-
Iron	10	< 10	< 10	-
Lead	0.2	< 0.2	< 0.2	-
Lithium	0.1	< 0.1	< 0.1	-
Magnesium	10	602	615	2.1%
Manganese	0.2	22.7	22.9	0.9%
Mercury	0.01	< 0.01	< 0.01	-
Molybdenum	0.1	< 0.1	< 0.1	-
Nickel	0.4	< 0.4	< 0.4	-
Selenium	0.5	< 0.5	< 0.5	-
Silver	0.05	< 0.05	< 0.05	-
Sodium	100	1730	1770	2.3%
Strontium	1	11	11.3	2.7%
Thallium	0.02	< 0.02	< 0.02	-
Tin	0.2	< 0.2	< 0.2	-
Titanium	5	< 5	< 5	-
Tungsten	1	< 1	< 1	-
Uranium	0.02	< 0.02	< 0.02	-
Vanadium	1	< 1	< 1	-
Zinc	4	< 4	< 4	-
Hardness (mg/L)	0.5	5.30	6.10	14.0%

NOTES:

Concentrations are presented in units of micrograms per litre (µg/L) or parts per billion (ppb) unless otherwise noted

RPD Relative percent difference Calculated as (sample value - duplicate value) X 100% / ((sample + duplicate value)/2)

RDL Reported detection limit

BOLD RPD exceeds 35% for sample value greater than 5 times the RDL

(value) One or both analytes less than 5 X RDL RPD calculated for reference purposes

- RPD calculations not performed if analytical result in one or both samples is less than RDL

Appendix A

Field Methodologies

Field Methodologies

The following section details the methodology of the field work performed during the PSI 2 investigation.

Intrusive Investigation

All work was carried out in accordance with Trillium Environmental's Standard Field Procedures and general environmental standards of practice. A project-specific health and safety plan was prepared prior to the field activities, with a health and safety meeting held immediately prior to initiating the subsurface investigation.

Drilling Investigation and Soil Sampling

The drilling investigation was directed by Trillium utilizing drill rigs mounted on a limited-access "Mole Rat" or on a truck-mounted drill rig. Following an attempt using solid stem auger method, a down-hole ODEX air hammer was used supplied and operated by Grassroots Drilling Inc.

Soil cutting were collected for sampling from the top of the drill casing as each borehole progressed. Samples were collected in 20L plastic pails. The pails were cleaned and rinsed between each borehole using a mixture of Alconox and water, and one additional clear water rinse between soil samples. Soil samples were classified according to type, structure, colour, and moisture.

Selected soil samples were placed in sealed laboratory prepared 125 ml glass jars for laboratory analysis of metals. Nitrile gloves were changed prior to each soil sample collection. The soil samples were then labelled and placed in an ice-filled cooler at approximately 4°C. Select soil samples and an accompanying chain-of-custody form were submitted to CARO Analytical Services of Richmond, BC (CARO) for analysis of metals.

Monitoring Well Installation

In order to permit the characterization of groundwater quality and measure groundwater depths, 50 mm diameter, 0.25 mm slot, PVC monitoring wells were installed in three boreholes. The annuli of the monitoring wells were backfilled with a silica sand pack and a bentonite seal was installed above the sand pack in order to isolate the hydrogeological unit and mitigate surface water infiltration. The native silty sand encountered below the gravel till at MW18-03 rose up and filled the annulus when the drill rod and casing were being extracted. Therefore, the well casing was tamped down directly into the native silty sand, rather than backfilling with silica sand, and sealed as typical with bentonite above. Flush-mount steel road boxes, set in concrete, were installed to protect the wells.

Groundwater Monitoring and Sampling

A complete set of static groundwater level measurements was obtained prior to well development and sampling activities. All monitoring wells were measured for depth to well bottom and depth to groundwater utilizing a Testwell Instruments water level meter. The water probe was washed with a mixture of water and Alconox between wells.

Soon after well installation, the monitoring wells were developed by removing approximately 9-10 well volumes or until the wells when dry. Well development was completed in order to prepare the wells for



sampling by removing loose soil/sediment from the well and screen, to maximize the hydraulic conductivity and sample representativeness. The wells were developed using a dedicated Waterra foot valve and tubing. Surge blocks were not used; instead a relatively high rate of pumping was successful at removing sediment and maintaining an adequate recharge rate.

To obtain representative groundwater samples, wells were purged using a low-flow Geotech Geopump™ peristaltic pump, dedicated ¼" plastic tubing, and silicone tubing. Low-flow methods were used in order to minimize the turbidity of the samples. Generally, a minimum of three well volumes were purged, dictated primarily by the stabilization of field measurements of pH, temperature, conductivity, total dissolved solids, salinity, and dissolved oxygen parameters. Field water measurements were continuously monitored using a YSI Quattro handheld multiparameter instrument and a flow-through cell. The well recharge rate was adequate at the pumping rates applied (0.3-0.6 L/min), maintaining static water level conditions. Once purging was complete, groundwater samples were collected for laboratory analysis from the ¼" tubing with an in-line 0.45 µm field filter attached.

Nitrile gloves were changed prior to collection of each groundwater sample. Groundwater samples were then placed in laboratory prepared sample bottles. All groundwater samples were clearly labelled and stored in an ice-filled cooler at approximately 4°C. The samples and a completed chain-of-custody form were submitted to CARO for analysis of dissolved metals.

Lateral distances were measured to confirm the monitoring well locations. A level survey has not been completed to date to determine well head elevations.



Appendix B

Borehole and Monitoring Well Logs



BOREHOLE LOG BH18-01

PROJECT NUMBER 128-001-03 **DRILLER/METHOD** Grassroots Drilling / SS Auger **SURFACE ELEVATION** 98 m as (approx)
PROJECT NAME Cowichan Fish & Game **DRILLING DATE** February 8, 2018 **BOREHOLE LOCATION** 50-yd outdoor range
CLIENT BC Parks **TOTAL DEPTH** 2.13 m
ADDRESS 4295 Robertson Rd, Glenora, BC **BOREHOLE DIAMETER** 15 cm

COMMENTS 50-yd outdoor target range; 6m northeast of wood target box

LOGGED BY Stefan Quaglia

Page 1 of 1

Depth (m)	Graphic Log	Soil Description	Samples	Analysed	PID	Additional Observations
0.5		FILL: silty GRAVEL and sand; radish-brown; soft; ooze; some mottling; wet	BH18-01a	N		
1		Increasing mottling; beige; saturated				
1.5		SAND and rounded gravel; brownish-grey; ooze; saturated				Abandoned drilling method upon encountering dense gravel stratum
2		GRAVEL with sand and minor silt; brownish-grey; v. dense; moist				
2.13		Refusa				
2.5						
3						
3.5						
4						
4.5						
5						
5.5						
6						
6.5						
7						
7.5						
8						
8.5						
9						
9.5						



GROUNDWATER LOG MW18-02

PROJECT NUMBER 128-001-03	DRILLING DATE February 14 2018	WATER LEVEL (TOC) 4.83 m
PROJECT NAME Cowichan Fish & Game	TOTAL DEPTH 7.32 m	DEPTH OF WELL (TOC) 6.51 m
CLIENT BC Parks	BOREHOLE DIAMETER 11.5 cm	COMPLETION Flush mount
ADDRESS 4295 Robertson Rd. Glenora BC	CASING Schedule 40 PVC 5 cm diam	SURFACE ELEVATION 98 m as (approx)
DRILLER/METHOD Grassroots Drilling / ODEX	SCREEN 0.25 mm	WELL LOCATION 50-yd outdoor target range

COMMENTS 50-yd outdoor target range; 6m northeast of wood target box	LOGGED BY Stefan Quaglia
	Page 1 of 1

Depth (m)	Graphic Log	Soil Description	Samples	Analysed	PID	Well Diagram	Additional Observations
0.5		FILL: silty GRAVEL and sand, reddish-brown, soft, loose, some mottling, wet					
1		Increasing mottling, beige, saturated					
1.5		SAND and rounded gravel, brownish-grey, loose, saturated					
2			MW18-02a	N			
2.5		GRAVEL with sand and minor silt, brownish-grey, very dense, moist					
2.5			MW18-02b (+dup)	Y			
3							
3.5							Saturated
4							Changing to grey
4.5							
5			MW18-02c	N			
5.5							
6							
6.5							
7			MW18-02d	N			
7.5		End of borehole					
8							
8.5							
9							
9.5							



GROUNDWATER LOG MW18-03

PROJECT NUMBER 128-001-03	DRILLING DATE February 14 2018	WATER LEVEL (TOC) 2.78 m
PROJECT NAME Cowichan Fish & Game	TOTAL DEPTH 7.32 m	DEPTH OF WELL (TOC) 6.49 m
CLIENT BC Parks	BOREHOLE DIAMETER 11.5 cm	COMPLETION Flush mount
ADDRESS 4295 Robertson Rd. Glenora BC	CASING Schedule 40 PVC 5 cm diam	SURFACE ELEVATION 98 m as (approx)
DRILLER/METHOD Grassroots Drilling / ODEX	SCREEN 0.25 mm	WELL LOCATION 200-yd outdoor target range

COMMENTS 200-yd outdoor target range; 3.7m northeast target frame

LOGGED BY Stefan Quaglia

Page 1 of 1

Depth (m)	Graphic Log	Soil Description	Samples	Analysed	PID	Well Diagram	Additional Observations
0.5		FILL silty sand reddish-brown soft loose damp					
1		GRAVEL and sand with some silt grey v dense wet					
2			MW18-03a	Y			
2.5							
3							
3.5							
4			MW18-03b	N			
4.5							
5							
5.5							
6		SAND some silt beige soft loose free water changing to grey					
6.5							
7			MW18-03c	N			
7.5		End of borehole					
8							
8.5							
9							
9.5							

Native sand slurry below gravel pushed up into borehole while retracting drill bit and casing. Installed well casing into soft sand.



GROUNDWATER LOG MW18-04

PROJECT NUMBER 128-001-03	DRILLING DATE February 16 2018	WATER LEVEL (TOC) 4.01 m
PROJECT NAME Cowichan Fish & Game	TOTAL DEPTH 4.57 m	DEPTH OF WELL (TOC) 4.45 m
CLIENT BC Parks	BOREHOLE DIAMETER 11.5 cm	COMPLETION Flush mount
ADDRESS 4295 Robertson Rd. Glenora BC	CASING Schedule 40 PVC 5 cm diam	SURFACE ELEVATION 98 m as (approx)
DRILLER/METHOD Grassroots Drilling / ODEX	SCREEN 0.25 mm	WELL LOCATION 100-yd outdoor target range

COMMENTS 100-yd outdoor target range; 3.0m southwest of north target frame post

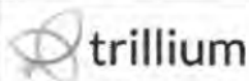
LOGGED BY Stefan Quaglia

Page 1 of 1

Depth (m)	Graphic Log	Soil Description	Samples	Analysed	PID	Well Diagram	Additional Observations
0.5		FILL sand and gravel some silt beige loose					
1.0		GRAVEL and sand some cobble grey v dense moist	MW18-04a	Y			
1.5							
2.0		wet					
2.5		saturated	MW18-04b	N			
3.0							
3.5							
4.0			MW18-04c	N			
4.5		Silty SAND beige medium soft loose free water	MW18-04d	N			Water level measured 20-Feb-2018
5.0		End of borehole					
5.5							
6.0							
6.5							
7.0							
7.5							
8.0							
8.5							
9.0							
9.5							

Appendix C

Well Purging and Sampling Forms



Groundwater Development and Purging/Sampling Data Sheet

☐ Development
☒ Purging/Sampling

Well ID: MWR-02 (50-yd range)
Date (dd-mm-yy): 20-Feb-2018

Project No.: 128-001-03
Time (hh:mm): 09:50

MONITORING WELL INFORMATION

Depth to water Below Top of Casing (btoc): A 4.825 metres
Depth to bottom (btoc): B 6.505 metres
Depth to product (btoc): C _____ metres
Product thickness: dr. column (C-A) 1.68 metres
Headspace - peak (ppm): _____ Headspace - equilibrium (ppm): _____ (OVA or PID)

One purge volume:
7.0 L / metre 19.76 litres - for sandpack of a 15 cm borehole and 5 cm well
12.0 L / metre = _____ litres - for sandpack of a 20 cm borehole and 5 cm well
2.0 L / metre = _____ litres - for a 5 cm solid stem well

EQUIPMENT LIST - Fill in once only at the first well of the day.

Model: Geopump Serial No. H06001177 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: VSI Quattro Serial No. 17K100370-T For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☒ No Cal. Required ☐
Model: Testwell Instr. Serial No. 110116 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐

WELL DEVELOPMENT / PURGING

Purge Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailer ☒ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Purge Volume (L): 11.76 Purge Vol. X 3 = 35.28 litres (guideline only) Sample Intake Depth (m): ~6.5 G.I.

Flow Rate: 0.32 L/min. Start Time: 10:22 Finish Time: 10:39

Time	Removed (L)	Temp (°C)	pH (Units)	Cond. (uS/cm)	Redox: <u>SAL</u>	Diss. O ₂ : <u>mg/L</u>	DTW (btoc)	Remarks
10:24	1	9.5	8.94	53.2	0.03	12.98	4.83	slightly cloudy, beige
10:29	2	9.4	7.97	52.9	0.03	12.02		slug of silt, then clear, yellow
10:38	5	9.4	7.23	49.8	0.03	12.49		
10:50	8	9.5	6.69	49.6	0.03	13.92		v. clear
10:56	10	9.5	6.54	47.3	0.03	13.98		v. clear
11:19	18	9.5	6.35	46.1	0.03	13.50		v. clear
11:31	22	9.5	6.33	45.9	0.03	12.55		v. clear
11:36	24	9.5	6.31	46.3	0.03	11.77		v. clear

DESCRIPTION - AT END OF PURGE

Odour: ☐ Yes ☒ No If yes, describe: _____ Sediment: at start bit, then clear Purge Water disposal: _____
Sheen: ☐ Yes ☒ No If yes, describe: _____ Colour: beige Drum ☐ on-site ☒
Clarity (relative scale, indicate start and end of purge) Other: _____

SAMPLE COLLECTION AND ANALYSES

Sample Collection Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailer ☐ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Analysis	Time	Container			Preservative	Filter (0.45 µ)
		Type	Size	Quantity		
<u>Metals, diss</u>	<u>10:39</u>	<input checked="" type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear	<u>100 mL</u>	<u>1</u>	<u>HNO₃</u>	<u>Y</u>
<u>Hg, diss</u>	<u>10:39</u>	<input type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input checked="" type="checkbox"/> Clear	<u>40 mL</u>	<u>1</u>	<u>HCl</u>	<u>Y</u>
		<input type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear				
		<input type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear				
		<input type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear				
		<input type="checkbox"/> Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear				

NOTES

CONSUMABLES

Quantity	Item	Quantity	Item	Quantity	Item
	5/8" Tubing (m/ft) (teflon)		Surge block		Footvalves
	3/8" tubing (m/ft) (teflon)		VOC Tip	<u>1</u>	Metals Filter
<u>7</u>	1/4" Tubing (m/ft) (teflon)		Bailer		J-plug

Sampled By (print): S. Vaglia

Signature: S. Vaglia

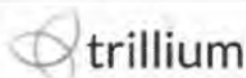
Page 1 of 1

LOW-FLOW PURGE/SAMPLE INFORMATION:

Wetted Screen Interval: _____
Static Water Level: _____
Maximum Drawdown Depth = 10% of Wetted Screen Interval + Static Water Level: _____

STABILIZATION CRITERIA:

pH +/- 0.2 pH units Conductivity +/- 3% of reading D.O. +/- 10% of reading or 0.2 mg/L ORP +/- 20mV



Groundwater Development and Purging/Sampling Data Sheet

☐ Development
☒ Purging/Sampling

Well ID.: MW18-03 (200-yd range)

Project No.: 128-001-03

Date (dd-mm-yy): 20-Feb-18

Time (hh:mm): 13:36

MONITORING WELL INFORMATION

Depth to water Below Top of Casing (btoc): A 2.775 metres
Depth to bottom (btoc): B 6.485 metres
Depth to product (btoc): C _____ metres
Product thickness: u column (C-A) 3.71 metres
Headspace - peak (ppm): _____ Headspace - equilibrium (ppm): _____ (OVA or PID)

One purge volume: *
7.0 L / metre = 25.97 litres - for sandpack of a 15 cm borehole and 5 cm well
12.0 L / metre = _____ litres - for sandpack of a 20 cm borehole and 5 cm well
2.0 L / metre = _____ litres - for a 5 cm solid stem well

* no filter sand pack so much less purging needed

EQUIPMENT LIST - Fill in once only at the first well of the day.

Model: GeoPump Serial No. AD600177 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: YSI Quatro Serial No. PK100370-T For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☒ No Cal. Required ☐
Model: Testwell Intro Serial No. 110116 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐

WELL DEVELOPMENT / PURGING

Purge Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailor ☒ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Purge Volume (L): 26 Purge Vol. X 3 = 78 litres (guideline only) Sample Intake Depth (m): 25.0m

Flow Rate: 0.63 L/min. Start Time: 13:49 Finish Time: 14:40

Time	Removed (L)	Temp (°C)	pH (Units)	Cond. (uS/cm)	Redox: <u>SAL</u>	Diss. O ₂ <u>mg/L</u>	DTW (btoc)	Remarks
13:51	1	7.6	6.46	17.6	0.01	15.75	2.86	silty but clearing
13:58	5	7.6	6.03	17.1	0.01	15.12	2.84	clear
14:05	9	7.6	5.93	17.4	0.01	14.10	2.84	clear
14:17	14	7.6	5.88	17.6	0.01	14.78	2.845	clear
14:24	18	7.6	5.83	17.1	0.01	14.94	2.84	clear
14:32	27	7.6	5.83	17.2	0.01	14.30	2.835	clear → sample
14:40							2.80	no pumping

DESCRIPTION - AT END OF PURGE

Odour: ☐ Yes ☒ No If yes, describe: _____ Sediment: no
Sheen: ☐ Yes ☒ No If yes, describe: _____ Colour: clear
Clarity (relative scale, indicate start and end of purge): Other: _____
Purge Water disposal: Drum ☐ on-site ☒

SAMPLE COLLECTION AND ANALYSES

Sample Collection Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailor ☒ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Analysis	Time	Container			Preservative	Filter (0.45 µ)
		Type	Size	Quantity		
Metals, diss + dup	14:37	Plastic <input checked="" type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>	100 mL	2	HNO ₃	Y
H ₂ , diss + dup	14:40	Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input checked="" type="checkbox"/>	40 mL	2	HCl	Y
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				

NOTES

Dup = MW18-a

CONSUMABLES

Quantity	Item	Quantity	Item	Quantity	Item	Quantity	Item
	5/8" Tubing (m/ft) (teflon)		Surge block		Footvalves	0.5	Silicon Tubing (m/ft)
	3/8" tubing (m/ft) (teflon)		VOC Tip	1	Metals Filter		
8	1/4" Tubing (m/ft) (teflon)		Bailor		J-plug		

Sampled By (print): Stefan Quaglia

Signature: Stefan Quaglia

Page 1 of 1

LOW-FLOW PURGE/SAMPLE INFORMATION:

Wetted Screen Interval: _____

Static Water Level: _____

Maximum Drawdown Depth = 10% of Wetted Screen Interval + Static Water Level: _____

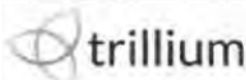
STABILIZATION CRITERIA:

pH +/- 0.2 pH units

Conductivity +/- 3% of reading

D.O. +/- 10% of reading or 0.2 mg/L

ORP +/- 20mV



Groundwater Development and Purging/Sampling Data Sheet

☐ Development
☒ Purging/Sampling

Well ID: MW18-04 (100 yd range)
Date (dd-mm-yy): 20-Feb-2018

Project No.: 128-001-03
Time (hh:mm): 12:03

MONITORING WELL INFORMATION

Depth to water Below Top of Casing (btoc): A 4.005 metres
Depth to bottom (btoc): B 4.443 metres
Depth to product (btoc): C 0 metres
Product thickness: in Column (C-A) 0.44 metres
Headspace - peak (ppm): _____ Headspace - equilibrium (ppm): _____ (OVA or PID)

One purge volume:
7.0 L / metre = 3.08 litres - for sandpack of a 15 cm borehole and 5 cm well
12.0 L / metre = _____ litres - for sandpack of a 20 cm borehole and 5 cm well
2.0 L / metre = _____ litres - for a 5 cm solid stem well

EQUIPMENT LIST - Fill in once only at the first well of the day.

Model: GeoPump Serial No. AD6001177 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: YSI Quattro Serial No. 17K100370-T For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☒ No Cal. Required ☐
Model: Testwell Instru Serial No. 110116 For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☒
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐
Model: _____ Serial No. _____ For calibration refer to: Calibration Book #: _____ Rental Calibration Sheet ☐ No Cal. Required ☐

WELL DEVELOPMENT / PURGING

Purge Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailer ☒ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Purge Volume (L): 3.08 Purge Vol. X 3 = 9.24 litres (guideline only)

Sample Intake Depth (m): _____

Flow Rate: 0.37 L/min.

Start Time: 12:25

Finish Time: _____

Time	Removed (L)	Temp (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O ₂ (mg/L)	DTW (btoc)	Remarks
12:28	1	9.4	6.49	65.8	0.04	11.71	3.995	some silt, beige
12:31	3	9.2	6.64	61.4	0.04	11.85	4.000	clear
12:41	6	9.3	6.60	57.3	0.04	12.00	4.000	clear
12:46	8	9.2	6.56	55.4	0.04	11.82	4.000	clear
12:51	10	9.2	6.52	54.6	0.04	11.64	3.995	
12:55	11	9.3	6.51	54.0	0.04	11.52		

DESCRIPTION - AT END OF PURGE

Odour: ☐ Yes ☒ No If yes, describe: _____

Sediment: NO

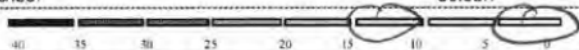
Purge Water disposal:

Sheen: ☐ Yes ☒ No If yes, describe: _____

Colour: _____

Drum ☐ on-site ☒

Clarity (relative scale, indicate start and end of purge)



Other: _____

SAMPLE COLLECTION AND ANALYSES

Sample Collection Method: ☐ Bladder Pump ☐ Hydrolift ☐ Bailer ☒ Peristaltic ☐ Submersible ☐ Manual tubing ☐ No-purge

Analysis	Time	Container			Preservative	Filter (0.45 µ)
		Type	Size	Quantity		
Metals, digc	12:55	Plastic <input checked="" type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>	100mL	1	HNO ₃	Yes
Hg, digc	12:55	Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input checked="" type="checkbox"/>	40mL	1	HCL	Yes
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				
		Plastic <input type="checkbox"/> Glass: Amber <input type="checkbox"/> Clear <input type="checkbox"/>				

NOTES

CONSUMABLES

Quantity	Item	Quantity	Item	Quantity	Item	Quantity	Item
	5/8" Tubing (m / ft) (teflon)		Surge block		Footvalves	0.6	Silicon Tubing (m (ft))
	3/8" tubing (m / ft) (teflon)		VOC Tip	1	Metals Filter		
5	1/4" Tubing (m) (ft) (teflon)		Bailer		J-plug		

Sampled By (print): S. Maglia

Signature: SKL

Page 1 of 1

LOW-FLOW PURGE/SAMPLE INFORMATION:

Wetted Screen Interval: _____

Static Water Level: _____

Maximum Drawdown Depth = 10% of Wetted Screen Interval + Static Water Level: _____

STABILIZATION CRITERIA:

pH +/- 0.2 pH units

Conductivity +/- 3% of reading

D.O. +/- 10% of reading or 0.2 mg/L

ORP +/- 20mV

Appendix D

Laboratory Analytical Certificates

CERTIFICATE OF ANALYSIS

REPORTED TO Trillium Environmental
#203 - 126 Ingram Street
Duncan, BC V9L 1P1

ATTENTION Stefan Quaglia

PO NUMBER 128-001-01

PROJECT 128-001-01

PROJECT INFO Cowichan Fish & Game

WORK ORDER 8021609

RECEIVED / TEMP REPORTED 2018-02-22 11:00 / 6°C
2018-03-01 11:07

COC NUMBER 12800103

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

If you have any questions or concerns, please contact me at bshaw@caro.ca

Authorized By:

Bryan Shaw, Ph.D., P.Chem.
Client Service Coordinator

1-888-311-8846 | www.caro.ca

#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7

TEST RESULTS

REPORTED TO PROJECT Trillium Environmental
128-001-01

WORK ORDER REPORTED 8021609
2018-03-01 11:07

Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-02b (8021609-03) Matrix: Soil Sampled: 2018-02-14					
General Parameters					
pH (1:2 H2O Solution)	5.80	0.10	pH units	2018-02-26	
Strong Acid Leachable Metals					
Aluminum	17600	40	mg/kg dry	2018-02-26	
Antimony	0.18	0.10	mg/kg dry	2018-02-26	
Arsenic	3.37	0.30	mg/kg dry	2018-02-26	
Barium	102	1.0	mg/kg dry	2018-02-26	
Beryllium	0.23	0.10	mg/kg dry	2018-02-26	
Boron	2.2	2.0	mg/kg dry	2018-02-26	
Cadmium	0.055	0.040	mg/kg dry	2018-02-26	
Chromium	30.2	1.0	mg/kg dry	2018-02-26	
Cobalt	11.5	0.10	mg/kg dry	2018-02-26	
Copper	48.3	0.40	mg/kg dry	2018-02-26	
Iron	26300	20	mg/kg dry	2018-02-26	
Lead	4.23	0.20	mg/kg dry	2018-02-26	
Lithium	10.4	0.10	mg/kg dry	2018-02-26	
Manganese	491	0.40	mg/kg dry	2018-02-26	
Mercury	< 0.040	0.040	mg/kg dry	2018-02-26	
Molybdenum	2.68	0.10	mg/kg dry	2018-02-26	
Nickel	22.8	0.60	mg/kg dry	2018-02-26	
Selenium	< 0.20	0.20	mg/kg dry	2018-02-26	
Silver	< 0.10	0.10	mg/kg dry	2018-02-26	
Strontium	31.3	0.20	mg/kg dry	2018-02-26	
Thallium	< 0.10	0.10	mg/kg dry	2018-02-26	
Tin	0.34	0.20	mg/kg dry	2018-02-26	
Tungsten	0.71	0.20	mg/kg dry	2018-02-26	
Uranium	0.242	0.050	mg/kg dry	2018-02-26	
Vanadium	72.0	1.0	mg/kg dry	2018-02-26	
Zinc	38.9	2.0	mg/kg dry	2018-02-26	

MW18-03a (8021609-06) | Matrix: Soil | Sampled: 2018-02-14

General Parameters					
pH (1:2 H2O Solution)	7.45	0.10	pH units	2018-02-26	
Strong Acid Leachable Metals					
Aluminum	18500	40	mg/kg dry	2018-02-26	
Antimony	0.15	0.10	mg/kg dry	2018-02-26	
Arsenic	3.22	0.30	mg/kg dry	2018-02-26	
Barium	51.4	1.0	mg/kg dry	2018-02-26	
Beryllium	0.23	0.10	mg/kg dry	2018-02-26	
Boron	< 2.0	2.0	mg/kg dry	2018-02-26	
Cadmium	0.053	0.040	mg/kg dry	2018-02-26	

TEST RESULTS

REPORTED TO PROJECT Trillium Environmental
128-001-01

WORK ORDER REPORTED 8021609
2018-03-01 11:07

Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-03a (8021609-06) Matrix: Soil Sampled: 2018-02-14, Continued					
Strong Acid Leachable Metals, Continued					
Chromium	27.4	1.0	mg/kg dry	2018-02-26	
Cobalt	12.0	0.10	mg/kg dry	2018-02-26	
Copper	55.7	0.40	mg/kg dry	2018-02-26	
Iron	26500	20	mg/kg dry	2018-02-26	
Lead	2.18	0.20	mg/kg dry	2018-02-26	
Lithium	11.1	0.10	mg/kg dry	2018-02-26	
Manganese	404	0.40	mg/kg dry	2018-02-26	
Mercury	< 0.040	0.040	mg/kg dry	2018-02-26	
Molybdenum	1.06	0.10	mg/kg dry	2018-02-26	
Nickel	23.3	0.60	mg/kg dry	2018-02-26	
Selenium	< 0.20	0.20	mg/kg dry	2018-02-26	
Silver	< 0.10	0.10	mg/kg dry	2018-02-26	
Strontium	22.3	0.20	mg/kg dry	2018-02-26	
Thallium	< 0.10	0.10	mg/kg dry	2018-02-26	
Tin	0.31	0.20	mg/kg dry	2018-02-26	
Tungsten	0.27	0.20	mg/kg dry	2018-02-26	
Uranium	0.329	0.050	mg/kg dry	2018-02-26	
Vanadium	72.0	1.0	mg/kg dry	2018-02-26	
Zinc	39.4	2.0	mg/kg dry	2018-02-26	

MW18-04a (8021609-09) | Matrix: Soil | Sampled: 2018-02-16

General Parameters

pH (1:2 H2O Solution)	6.77	0.10	pH units	2018-02-26	
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Strong Acid Leachable Metals

Aluminum	23700	40	mg/kg dry	2018-02-26	
Antimony	0.20	0.10	mg/kg dry	2018-02-26	
Arsenic	3.06	0.30	mg/kg dry	2018-02-26	
Barium	90.4	1.0	mg/kg dry	2018-02-26	
Beryllium	0.26	0.10	mg/kg dry	2018-02-26	
Boron	< 2.0	2.0	mg/kg dry	2018-02-26	
Cadmium	0.048	0.040	mg/kg dry	2018-02-26	
Chromium	33.7	1.0	mg/kg dry	2018-02-26	
Cobalt	12.1	0.10	mg/kg dry	2018-02-26	
Copper	65.4	0.40	mg/kg dry	2018-02-26	
Iron	26600	20	mg/kg dry	2018-02-26	
Lead	6.45	0.20	mg/kg dry	2018-02-26	
Lithium	10.4	0.10	mg/kg dry	2018-02-26	
Manganese	441	0.40	mg/kg dry	2018-02-26	
Mercury	< 0.040	0.040	mg/kg dry	2018-02-26	
Molybdenum	1.46	0.10	mg/kg dry	2018-02-26	

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Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-04a (8021609-09) Matrix: Soil Sampled: 2018-02-16, Continued					
<i>Strong Acid Leachable Metals, Continued</i>					
Nickel	24.7	0.60	mg/kg dry	2018-02-26	
Selenium	< 0.20	0.20	mg/kg dry	2018-02-26	
Silver	< 0.10	0.10	mg/kg dry	2018-02-26	
Strontium	35.9	0.20	mg/kg dry	2018-02-26	
Thallium	< 0.10	0.10	mg/kg dry	2018-02-26	
Tin	0.35	0.20	mg/kg dry	2018-02-26	
Tungsten	0.64	0.20	mg/kg dry	2018-02-26	
Uranium	0.185	0.050	mg/kg dry	2018-02-26	
Vanadium	74.6	1.0	mg/kg dry	2018-02-26	
Zinc	41.4	2.0	mg/kg dry	2018-02-26	

MW18-02x (8021609-13) | Matrix: Soil | Sampled: 2018-02-14

General Parameters

pH (1:2 H2O Solution)	6.63	0.10	pH units	2018-02-26	
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Strong Acid Leachable Metals

Aluminum	16800	40	mg/kg dry	2018-02-26	
Antimony	0.24	0.10	mg/kg dry	2018-02-26	
Arsenic	3.45	0.30	mg/kg dry	2018-02-26	
Barium	99.2	1.0	mg/kg dry	2018-02-26	
Beryllium	0.22	0.10	mg/kg dry	2018-02-26	
Boron	< 2.0	2.0	mg/kg dry	2018-02-26	
Cadmium	0.059	0.040	mg/kg dry	2018-02-26	
Chromium	27.3	1.0	mg/kg dry	2018-02-26	
Cobalt	11.3	0.10	mg/kg dry	2018-02-26	
Copper	48.7	0.40	mg/kg dry	2018-02-26	
Iron	26100	20	mg/kg dry	2018-02-26	
Lead	8.09	0.20	mg/kg dry	2018-02-26	
Lithium	10.8	0.10	mg/kg dry	2018-02-26	
Manganese	483	0.40	mg/kg dry	2018-02-26	
Mercury	< 0.040	0.040	mg/kg dry	2018-02-26	
Molybdenum	2.86	0.10	mg/kg dry	2018-02-26	
Nickel	22.6	0.60	mg/kg dry	2018-02-26	
Selenium	< 0.20	0.20	mg/kg dry	2018-02-26	
Silver	< 0.10	0.10	mg/kg dry	2018-02-26	
Strontium	25.6	0.20	mg/kg dry	2018-02-26	
Thallium	< 0.10	0.10	mg/kg dry	2018-02-26	
Tin	0.35	0.20	mg/kg dry	2018-02-26	
Tungsten	0.64	0.20	mg/kg dry	2018-02-26	
Uranium	0.231	0.050	mg/kg dry	2018-02-26	
Vanadium	68.0	1.0	mg/kg dry	2018-02-26	

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Analyte	Result	RL	Units	Analyzed	Qualifier
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MW18-02x (8021609-13) | Matrix: Soil | Sampled: 2018-02-14, Continued

Strong Acid Leachable Metals, Continued

Zinc	38.1	2.0	mg/kg dry	2018-02-26	
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MW18-02 (8021609-14) | Matrix: Water | Sampled: 2018-02-20

Calculated Parameters

Hardness, Total (as CaCO3)	27.3	0.500	mg/L	N/A	
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Dissolved Metals

Aluminum, dissolved	0.0079	0.0050	mg/L	2018-02-28	
Antimony, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Arsenic, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Barium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Boron, dissolved	0.0055	0.0050	mg/L	2018-02-28	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2018-02-28	
Calcium, dissolved	7.83	0.20	mg/L	2018-02-28	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Cobalt, dissolved	0.00017	0.00010	mg/L	2018-02-28	
Copper, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Iron, dissolved	0.011	0.010	mg/L	2018-02-28	
Lead, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Lithium, dissolved	0.00030	0.00010	mg/L	2018-02-28	
Magnesium, dissolved	1.88	0.010	mg/L	2018-02-28	
Manganese, dissolved	0.0271	0.00020	mg/L	2018-02-28	
Mercury, dissolved	< 0.000010	0.000010	mg/L	2018-02-27	
Molybdenum, dissolved	0.00010	0.00010	mg/L	2018-02-28	
Nickel, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Silver, dissolved	< 0.000050	0.000050	mg/L	2018-02-28	
Sodium, dissolved	2.38	0.10	mg/L	2018-02-28	
Strontium, dissolved	0.0234	0.0010	mg/L	2018-02-28	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Tin, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Uranium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Vanadium, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Zinc, dissolved	< 0.0040	0.0040	mg/L	2018-02-28	

MW18-03 (8021609-15) | Matrix: Water | Sampled: 2018-02-20

Calculated Parameters

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Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-03 (8021609-15) Matrix: Water Sampled: 2018-02-20, Continued					
Calculated Parameters, Continued					
Hardness, Total (as CaCO ₃)	7.66	0.500	mg/L	N/A	
Dissolved Metals					
Aluminum, dissolved	0.0053	0.0050	mg/L	2018-02-28	
Antimony, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Arsenic, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Barium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Boron, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2018-02-28	
Calcium, dissolved	2.07	0.20	mg/L	2018-02-28	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Cobalt, dissolved	0.00025	0.00010	mg/L	2018-02-28	
Copper, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Iron, dissolved	< 0.010	0.010	mg/L	2018-02-28	
Lead, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Lithium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Magnesium, dissolved	0.602	0.010	mg/L	2018-02-28	
Manganese, dissolved	0.0227	0.00020	mg/L	2018-02-28	
Mercury, dissolved	< 0.000010	0.000010	mg/L	2018-02-27	
Molybdenum, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Nickel, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Silver, dissolved	< 0.000050	0.000050	mg/L	2018-02-28	
Sodium, dissolved	1.73	0.10	mg/L	2018-02-28	
Strontium, dissolved	0.0110	0.0010	mg/L	2018-02-28	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Tin, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Uranium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Vanadium, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Zinc, dissolved	< 0.0040	0.0040	mg/L	2018-02-28	

MW18-04 (8021609-16) | Matrix: Water | Sampled: 2018-02-20

Calculated Parameters					
Hardness, Total (as CaCO ₃)	33.7	0.500	mg/L	N/A	
Dissolved Metals					
Aluminum, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Antimony, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Arsenic, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	

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Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-04 (8021609-16) Matrix: Water Sampled: 2018-02-20, Continued					
<i>Dissolved Metals, Continued</i>					
Barium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Boron, dissolved	0.0069	0.0050	mg/L	2018-02-28	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2018-02-28	
Calcium, dissolved	10.9	0.20	mg/L	2018-02-28	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Cobalt, dissolved	0.00027	0.00010	mg/L	2018-02-28	
Copper, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Iron, dissolved	< 0.010	0.010	mg/L	2018-02-28	
Lead, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Lithium, dissolved	0.00052	0.00010	mg/L	2018-02-28	
Magnesium, dissolved	1.56	0.010	mg/L	2018-02-28	
Manganese, dissolved	0.0462	0.00020	mg/L	2018-02-28	
Mercury, dissolved	< 0.000010	0.000010	mg/L	2018-02-27	
Molybdenum, dissolved	0.00017	0.00010	mg/L	2018-02-28	
Nickel, dissolved	0.00043	0.00040	mg/L	2018-02-28	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Silver, dissolved	< 0.000050	0.000050	mg/L	2018-02-28	
Sodium, dissolved	2.39	0.10	mg/L	2018-02-28	
Strontium, dissolved	0.0301	0.0010	mg/L	2018-02-28	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Tin, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Uranium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Vanadium, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Zinc, dissolved	< 0.0040	0.0040	mg/L	2018-02-28	

MW18-a (8021609-17) | Matrix: Water | Sampled: 2018-02-20

Calculated Parameters

Hardness, Total (as CaCO ₃)	7.90	0.500	mg/L	N/A	
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Dissolved Metals

Aluminum, dissolved	0.0061	0.0050	mg/L	2018-02-28	
Antimony, dissolved	0.00020	0.00020	mg/L	2018-02-28	
Arsenic, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Barium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Boron, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2018-02-28	
Calcium, dissolved	2.15	0.20	mg/L	2018-02-28	

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Analyte	Result	RL	Units	Analyzed	Qualifier
MW18-a (8021609-17) Matrix: Water Sampled: 2018-02-20, Continued					
<i>Dissolved Metals, Continued</i>					
Chromium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Cobalt, dissolved	0.00017	0.00010	mg/L	2018-02-28	
Copper, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Iron, dissolved	< 0.010	0.010	mg/L	2018-02-28	
Lead, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Lithium, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Magnesium, dissolved	0.615	0.010	mg/L	2018-02-28	
Manganese, dissolved	0.0229	0.00020	mg/L	2018-02-28	
Mercury, dissolved	< 0.000010	0.000010	mg/L	2018-02-27	
Molybdenum, dissolved	< 0.00010	0.00010	mg/L	2018-02-28	
Nickel, dissolved	< 0.00040	0.00040	mg/L	2018-02-28	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2018-02-28	
Silver, dissolved	< 0.000050	0.000050	mg/L	2018-02-28	
Sodium, dissolved	1.77	0.10	mg/L	2018-02-28	
Strontium, dissolved	0.0113	0.0010	mg/L	2018-02-28	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Tin, dissolved	< 0.00020	0.00020	mg/L	2018-02-28	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2018-02-28	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Uranium, dissolved	< 0.000020	0.000020	mg/L	2018-02-28	
Vanadium, dissolved	< 0.0010	0.0010	mg/L	2018-02-28	
Zinc, dissolved	< 0.0040	0.0040	mg/L	2018-02-28	

APPENDIX 1: SUPPORTING INFORMATION

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Analysis Description	Method Ref.	Technique	Location
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Hardness in Water	SM 2340 B (2011)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl ₂ Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
pH in Soil	Carter 16.2 / SM 4500-H+ B (2011)	1:2 Soil/Water Slurry / Electrometry	Richmond
SALM in Soil	BCMOE SALM V.2 / EPA 6020B	HNO ₃ +HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
mg/kg dry	Milligrams per kilogram (dry weight basis)
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, pH > 7 = basic
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

APPENDIX 2: QUALITY CONTROL RESULTS

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B8B1561

Blank (B8B1561-BLK1)			Prepared: 2018-02-26, Analyzed: 2018-02-27					
Mercury, dissolved	< 0.000010	0.000010 mg/L						
Reference (B8B1561-SRM1)			Prepared: 2018-02-26, Analyzed: 2018-02-27					
Mercury, dissolved	0.00428	0.000010 mg/L	0.00489		88	80-120		

Dissolved Metals, Batch B8B1665

Blank (B8B1665-BLK1)			Prepared: 2018-02-28, Analyzed: 2018-02-28					
Aluminum, dissolved	< 0.0050	0.0050 mg/L						
Antimony, dissolved	< 0.00020	0.00020 mg/L						
Arsenic, dissolved	< 0.00050	0.00050 mg/L						
Barium, dissolved	< 0.0050	0.0050 mg/L						
Beryllium, dissolved	< 0.00010	0.00010 mg/L						
Boron, dissolved	< 0.0050	0.0050 mg/L						
Cadmium, dissolved	< 0.000010	0.000010 mg/L						
Calcium, dissolved	< 0.20	0.20 mg/L						
Chromium, dissolved	< 0.00050	0.00050 mg/L						
Cobalt, dissolved	< 0.00010	0.00010 mg/L						
Copper, dissolved	< 0.00040	0.00040 mg/L						
Iron, dissolved	< 0.010	0.010 mg/L						
Lead, dissolved	< 0.00020	0.00020 mg/L						
Lithium, dissolved	< 0.00010	0.00010 mg/L						
Magnesium, dissolved	< 0.010	0.010 mg/L						
Manganese, dissolved	< 0.00020	0.00020 mg/L						
Molybdenum, dissolved	< 0.00010	0.00010 mg/L						
Nickel, dissolved	< 0.00040	0.00040 mg/L						
Selenium, dissolved	< 0.00050	0.00050 mg/L						
Silver, dissolved	< 0.000050	0.000050 mg/L						
Sodium, dissolved	< 0.10	0.10 mg/L						
Strontium, dissolved	< 0.0010	0.0010 mg/L						
Thallium, dissolved	< 0.000020	0.000020 mg/L						
Tin, dissolved	< 0.00020	0.00020 mg/L						
Titanium, dissolved	< 0.0050	0.0050 mg/L						
Tungsten, dissolved	< 0.0010	0.0010 mg/L						
Uranium, dissolved	< 0.000020	0.000020 mg/L						

APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8B1665, Continued									
Blank (B8B1665-BLK1), Continued					Prepared: 2018-02-28, Analyzed: 2018-02-28				
Vanadium, dissolved	< 0.0010	0.0010 mg/L							
Zinc, dissolved	< 0.0040	0.0040 mg/L							
LCS (B8B1665-BS1)					Prepared: 2018-02-28, Analyzed: 2018-02-28				
Aluminum, dissolved	0.0207	0.0050 mg/L	0.0200		104	80-120			
Antimony, dissolved	0.0188	0.00020 mg/L	0.0200		94	80-120			
Arsenic, dissolved	0.0185	0.00050 mg/L	0.0200		93	80-120			
Barium, dissolved	0.0190	0.0050 mg/L	0.0200		95	80-120			
Beryllium, dissolved	0.0210	0.00010 mg/L	0.0200		105	80-120			
Boron, dissolved	0.0206	0.0050 mg/L	0.0200		103	80-120			
Cadmium, dissolved	0.0191	0.000010 mg/L	0.0200		95	80-120			
Calcium, dissolved	1.99	0.20 mg/L	2.00		99	80-120			
Chromium, dissolved	0.0183	0.00050 mg/L	0.0200		91	80-120			
Cobalt, dissolved	0.0187	0.00010 mg/L	0.0200		94	80-120			
Copper, dissolved	0.0195	0.00040 mg/L	0.0200		97	80-120			
Iron, dissolved	1.89	0.010 mg/L	2.00		95	80-120			
Lead, dissolved	0.0196	0.00020 mg/L	0.0200		98	80-120			
Lithium, dissolved	0.0220	0.00010 mg/L	0.0200		110	80-120			
Magnesium, dissolved	2.00	0.010 mg/L	2.00		100	80-120			
Manganese, dissolved	0.0184	0.00020 mg/L	0.0200		92	80-120			
Molybdenum, dissolved	0.0190	0.00010 mg/L	0.0200		95	80-120			
Nickel, dissolved	0.0189	0.00040 mg/L	0.0200		95	80-120			
Selenium, dissolved	0.0189	0.00050 mg/L	0.0200		94	80-120			
Silver, dissolved	0.0171	0.000050 mg/L	0.0200		85	80-120			
Sodium, dissolved	2.02	0.10 mg/L	2.00		101	80-120			
Strontium, dissolved	0.0189	0.0010 mg/L	0.0200		95	80-120			
Thallium, dissolved	0.0197	0.000020 mg/L	0.0200		98	80-120			
Tin, dissolved	0.0200	0.00020 mg/L	0.0200		100	80-120			
Titanium, dissolved	0.0198	0.0050 mg/L	0.0200		99	80-120			
Tungsten, dissolved	0.0176	0.0010 mg/L	0.0200		88	80-120			
Uranium, dissolved	0.0214	0.000020 mg/L	0.0200		107	80-120			
Vanadium, dissolved	0.0179	0.0010 mg/L	0.0200		89	80-120			
Zinc, dissolved	0.0204	0.0040 mg/L	0.0200		102	80-120			
Reference (B8B1665-SRM1)					Prepared: 2018-02-28, Analyzed: 2018-02-28				
Aluminum, dissolved	0.232	0.0050 mg/L	0.233		99	79-114			
Antimony, dissolved	0.0456	0.00020 mg/L	0.0430		106	89-123			
Arsenic, dissolved	0.429	0.00050 mg/L	0.438		98	87-113			
Barium, dissolved	3.27	0.0050 mg/L	3.35		97	85-114			
Beryllium, dissolved	0.235	0.00010 mg/L	0.213		110	79-122			
Boron, dissolved	1.70	0.0050 mg/L	1.74		98	79-117			
Cadmium, dissolved	0.220	0.000010 mg/L	0.224		98	89-112			
Calcium, dissolved	7.69	0.20 mg/L	7.69		100	85-120			
Chromium, dissolved	0.418	0.00050 mg/L	0.437		96	87-113			
Cobalt, dissolved	0.126	0.00010 mg/L	0.128		98	90-117			
Copper, dissolved	0.826	0.00040 mg/L	0.844		98	90-115			
Iron, dissolved	1.24	0.010 mg/L	1.29		96	86-112			
Lead, dissolved	0.112	0.00020 mg/L	0.112		100	90-113			
Lithium, dissolved	0.120	0.00010 mg/L	0.104		115	77-127			
Magnesium, dissolved	6.93	0.010 mg/L	6.92		100	84-116			
Manganese, dissolved	0.333	0.00020 mg/L	0.345		96	85-113			
Molybdenum, dissolved	0.423	0.00010 mg/L	0.426		99	87-112			
Nickel, dissolved	0.809	0.00040 mg/L	0.840		96	90-114			
Selenium, dissolved	0.0325	0.00050 mg/L	0.0331		98	89-123			
Sodium, dissolved	18.8	0.10 mg/L	19.1		99	81-117			
Strontium, dissolved	0.878	0.0010 mg/L	0.916		96	82-111			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Trillium Environmental
128-001-01

WORK ORDER REPORTED 8021609
2018-03-01 11:07

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B8B1665, Continued

Reference (B8B1665-SRM1), Continued

Prepared: 2018-02-28, Analyzed: 2018-02-28

Thallium, dissolved	0.0395	0.000020 mg/L	0.0393		101	90-113			
Uranium, dissolved	0.255	0.000020 mg/L	0.266		96	87-113			
Vanadium, dissolved	0.813	0.0010 mg/L	0.869		94	85-110			
Zinc, dissolved	0.869	0.0040 mg/L	0.881		99	88-114			

General Parameters, Batch B8B1466

Reference (B8B1466-SRM1)

Prepared: 2018-02-26, Analyzed: 2018-02-26

pH (1:2 H2O Solution)	7.13	0.10 pH units	7.27		98	95-105			
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Reference (B8B1466-SRM2)

Prepared: 2018-02-26, Analyzed: 2018-02-26

pH (1:2 H2O Solution)	7.21	0.10 pH units	7.27		99	95-105			
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Strong Acid Leachable Metals, Batch B8B1505

Blank (B8B1505-BLK1)

Prepared: 2018-02-26, Analyzed: 2018-02-26

Aluminum	< 40	40 mg/kg dry							
Antimony	< 0.10	0.10 mg/kg dry							
Arsenic	< 0.30	0.30 mg/kg dry							
Barium	< 1.0	1.0 mg/kg dry							
Beryllium	< 0.10	0.10 mg/kg dry							
Boron	< 2.0	2.0 mg/kg dry							
Cadmium	< 0.040	0.040 mg/kg dry							
Chromium	< 1.0	1.0 mg/kg dry							
Cobalt	< 0.10	0.10 mg/kg dry							
Copper	< 0.40	0.40 mg/kg dry							
Iron	< 20	20 mg/kg dry							
Lead	< 0.20	0.20 mg/kg dry							
Lithium	< 0.10	0.10 mg/kg dry							
Manganese	< 0.40	0.40 mg/kg dry							
Mercury	< 0.040	0.040 mg/kg dry							
Molybdenum	< 0.10	0.10 mg/kg dry							
Nickel	< 0.60	0.60 mg/kg dry							
Selenium	< 0.20	0.20 mg/kg dry							
Silver	< 0.10	0.10 mg/kg dry							
Strontium	< 0.20	0.20 mg/kg dry							
Thallium	< 0.10	0.10 mg/kg dry							
Tin	< 0.20	0.20 mg/kg dry							
Tungsten	< 0.20	0.20 mg/kg dry							
Uranium	< 0.050	0.050 mg/kg dry							
Vanadium	< 1.0	1.0 mg/kg dry							
Zinc	< 2.0	2.0 mg/kg dry							

LCS (B8B1505-BS1)

Prepared: 2018-02-26, Analyzed: 2018-02-26

Antimony	1.81	0.10 mg/kg dry	2.00		90	80-120			
Arsenic	1.73	0.30 mg/kg dry	2.00		86	80-120			
Barium	1.7	1.0 mg/kg dry	2.00		87	80-120			
Beryllium	1.69	0.10 mg/kg dry	2.00		84	80-120			
Boron	2.0	2.0 mg/kg dry	2.00		100	80-120			
Cadmium	1.80	0.040 mg/kg dry	2.00		90	80-120			
Chromium	1.8	1.0 mg/kg dry	2.00		91	80-120			
Cobalt	1.84	0.10 mg/kg dry	2.00		92	80-120			
Copper	1.93	0.40 mg/kg dry	2.00		96	80-120			
Iron	188	20 mg/kg dry	200		94	80-120			
Lead	1.84	0.20 mg/kg dry	2.00		92	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Trillium Environmental
128-001-01

WORK ORDER REPORTED 8021609
2018-03-01 11:07

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Strong Acid Leachable Metals, Batch B8B1505, Continued

LCS (B8B1505-BS1), Continued

Prepared: 2018-02-26, Analyzed: 2018-02-26

Lithium	1.84	0.10 mg/kg dry	2.00		92	80-120			
Manganese	1.82	0.40 mg/kg dry	2.00		91	80-120			
Mercury	0.083	0.040 mg/kg dry	0.100		83	80-120			
Molybdenum	1.81	0.10 mg/kg dry	2.00		90	80-120			
Nickel	1.87	0.60 mg/kg dry	2.00		93	80-120			
Selenium	1.80	0.20 mg/kg dry	2.00		90	80-120			
Silver	1.87	0.10 mg/kg dry	2.00		94	80-120			
Strontium	1.72	0.20 mg/kg dry	2.00		86	80-120			
Thallium	1.68	0.10 mg/kg dry	2.00		84	80-120			
Tin	1.81	0.20 mg/kg dry	2.00		90	80-120			
Tungsten	1.62	0.20 mg/kg dry	2.00		81	80-120			
Uranium	1.75	0.050 mg/kg dry	2.00		88	80-120			
Vanadium	1.8	1.0 mg/kg dry	2.00		88	80-120			
Zinc	2.0	2.0 mg/kg dry	2.00		100	80-120			

Reference (B8B1505-SRM1)

Prepared: 2018-02-26, Analyzed: 2018-02-26

Aluminum	16100	40 mg/kg dry	17500		92	70-130			
Antimony	5.35	0.10 mg/kg dry	6.46		83	70-130			
Arsenic	13.4	0.30 mg/kg dry	15.1		89	70-130			
Barium	67.1	1.0 mg/kg dry	80.6		83	70-130			
Beryllium	0.43	0.10 mg/kg dry	0.522		82	70-130			
Boron	2.9	2.0 mg/kg dry	3.00		95	70-130			
Cadmium	0.196	0.040 mg/kg dry	0.216		91	70-130			
Chromium	24.4	1.0 mg/kg dry	27.5		89	70-130			
Cobalt	11.0	0.10 mg/kg dry	12.4		89	70-130			
Copper	38.1	0.40 mg/kg dry	45.3		84	70-130			
Iron	28300	20 mg/kg dry	32600		87	70-130			
Lead	11.6	0.20 mg/kg dry	13.8		84	70-130			
Lithium	9.45	0.10 mg/kg dry	9.91		95	70-130			
Manganese	928	0.40 mg/kg dry	1090		85	70-130			
Mercury	0.074	0.040 mg/kg dry	0.103		72	70-130			
Molybdenum	0.60	0.10 mg/kg dry	0.731		82	70-130			
Nickel	15.1	0.60 mg/kg dry	17.4		87	70-130			
Strontium	10.7	0.20 mg/kg dry	11.5		93	70-130			
Tin	0.90	0.20 mg/kg dry	1.03		88	70-130			
Uranium	0.686	0.050 mg/kg dry	0.837		82	70-130			
Vanadium	48.0	1.0 mg/kg dry	54.9		87	70-130			
Zinc	56.7	2.0 mg/kg dry	66.8		85	70-130			

Fortin, Patricia ENV:EX

From: Lines, Jessica ENV:EX
Sent: Monday, March 26, 2018 2:24 PM
To: Cadden, Don ENV:EX
Cc: McClaren, Erica L ENV:EX; Macdonald, Andy M ENV:EX
Subject: FW: CFGA, Stage 2 PSI report

Hi Don,
Here is Trillium's response to your question. Lots of detail.
Jess

From: Stefan Quaglia [mailto:squaglia@trilliumenviro.com]
Sent: Monday, March 26, 2018 12:31 PM
To: Lines, Jessica ENV:EX
Subject: Re: CFGA, Stage 2 PSI report

Hi Jessica,

These are good and valid questions. After discussing with you late Friday, I understand better that BC Parks is interested to know what, if any, immediate actions are needed given that contamination is present. The quick answer is that I don't think there's a need to immediately cease activities at the gun range; this is a process that is completed step-by-step and usually lasts a number of months, but often a few years. It is a question that deserves some explanation of the contaminated sites process, so apologies for the length of this email.

The typical process for contaminated sites is:

1. identify which are potentially contaminated (Stage 1 PSI);
2. confirm whether contamination is present or not (Stage 2 PSI);
3. determine the extents of contamination (Detailed Site Investigation, or 'DSI');
4. identify remedial options and prepare a remediation plan (RAP); and
5. complete remediation and obtain a Ministry legal instrument, as needed (e.g., Certificate of Compliance).

Most of the mandatory triggers to notify the Ministry happen once the DSI is complete and the early stages of the RAP are in motion. Note that presently, we have a mostly complete PSI 2, and we learned that shallow soil is impacted at the target berms, but that the groundwater below it does not appear impacted. Another important factor to consider is the type and timing of any proposed redevelopment of a site; I understand that there is talk that the CFGA may seek to upgrade to an indoor facility.

If BC Parks wishes to manage the site as is, it is important to note that there are presently no firm triggers to move forward with remediation, yet. This changes once one or more things happen as I explain below.

The findings of the soil sampling near the eastern edge of the site property indicates that contamination may continue off-site, further to the east. Typically, when there is 'known or likely' contaminants affecting a neighbouring property, then the affected property owner and the Ministry must be notified in writing. This can trigger things to move forward. But as far as I can tell, the provincial park continues to the east, so even if soil contamination continues off property, it would not be a different (or private) land owner that is additionally impacted. I believe this is just part of the same provincial park. This may be a point worth confirming with the Ministry, which I can do if you like. At this point, it doesn't look like this issue is an imminent trigger of the process.

Another issue which can force landowners to expedite remediation is if a site is considered 'high risk' per the CSR. The identification of high risk sites is done when consultants complete and submit the Site Risk Classification Report (SRCR) form, which in the case of the CFGA property would lead to a 'high risk' site because lead concentrations are greater than 10X their standards and because exposure to contaminants is likely because they are present in shallow soils (If the SRCR were completed today, please note that I believe the site would be classified as high risk. I've worked on more than a handful of high risk sites. Typically what happens is the Ministry asks for more information to narrow down if the exposure scenarios driving the 'high risk' designation actually do present real on-going risks to human health or the environment. Even with the high risk designation, site operators are usually able to continue operations, but may need to modify certain aspects to mitigate the exposure(s) that may cause exposures to the highest contaminant concentrations.

At this site, I foresee the following possibilities, based on two future scenarios:

- **No redevelopment/status quo** – Investigation proceeds at a pace convenient to BC Parks, toward DSI and eventually to a RAP. Overall, any additional work going forward in this direction would largely be an exercise in due diligence by BC Parks. The site could be remediated under what is known as 'Independent Remediation', meaning that the Ministry does not need to be directly involved – this is available for non high risk sites. However, as I described above, I believe the site will have a 'high risk' designation, which the Ministry may at their discretion choose to be involved directly. The risk classification generally takes place once the DSI is nearing completion and the planning stages of the RAP are underway. At this point a notification of independent remediation or 'NOIR' is submitted, along with the SRCR. The full list of SRCR reporting triggers are listed in Part 2 of the SRCR form. It is at this point that the Ministry responds with their decision on any next steps to address the high risk conditions. Without future plans, the RAP must achieve remediation that protects human health and the environment under the current site use and configuration.
- **Plans for future redevelopment** – future redevelopment are considered changes in activities or major upgrades (requiring permits) that are proposed within the next five years. The five year period may be extended with a request and rationale provided to the Ministry. The DSI and RAP would proceed as above, but the objective would be to support the acquisition of any needed development permits (typically from local municipality, i.e., CVRD). The NOIR and SRCR would be submitted, similarly to the above scenario; however, this is completed based on both the current site status and the future development scenario. The site may be designated high risk presently, but the Ministry provides a bit more flexibility given the movement towards a future scenario that would likely be non high risk, depending on the DSI results and how the RAP plans to address known areas of contamination. Of course, there would be several details needed in order to confirm this trajectory, particularly a completed DSI.

The first scenario would make it difficult to predict and control whether contamination levels could increase over time with continued use, but it's safe to assume that soil concentrations would continue to rise slowly over time. As I mentioned to you, for the status quo scenario, the site would already be designated 'high risk' so increasing concentrations would not change the severity of this designation. However, increasing soil concentrations and the extent of impacts could possibly increase remediation costs over time (i.e., more to clean up and over a larger area). Also, because there would not be any future development plans to work towards, BC Parks will be forced to address all high risk conditions ASAP, rather than within a five year period as is typically the case when development is on the horizon (see below).

The second scenario would require higher costs in the near to medium-term, but would provide more certainty about the impact and costs of contamination going forward. Keep in mind that remedial options available to BC Parks are not just limited to digging up and off-site disposal of impacted soils, as this alone would be extremely expensive. There are suitable and acceptable ways to manage contamination on-site or in-situ (i.e., in place), particularly when future development is in the works. These may include conducting a human health and ecological risk assessment (HHERA), which is my expertise, and/or an engineered solution such as on-site consolidation and stabilization of lead contamination. A number of years ago, I worked on a gun range in the City of Burnaby, which you can read about on the Ministry's website here.

Given the above, I think you can see why I've recommended that a DSI be completed as a next step. This leaves the exact future plans for the site in the hands of BC Parks and CFGA. I hope this helps, but I'm happy to discuss in more detail.

Stefan



Stefan Quaglia, RPBio, PBIOL, CSAP
President, Senior Risk Assessor

Trillium Environmental Ltd.
126 Ingram Street, Suite 203
Duncan, BC V9L 1P1
m: (250) 466-9990

From: "Lines, Jessica ENV:EX"
Date: Friday, March 23, 2018 at 4:17 PM
To: Stefan Quaglia
Subject: RE: CFGA, Stage 2 PSI report

Hi Stefan,

Thanks for the report, and I just received the invoice as well. I have passed on the report and one question as come up, which I'm not sure you can answer or not.

Given that the shallow soils are contaminated, does that mean that activities that will continue to increase the level of contamination? (ie. continued use of the gun range) are not allowed? Or is that something that would be addressed with the Contaminated Site Regulations?

Thanks,
Jessica

From: Stefan Quaglia [mailto:squaglia@trilliumenviro.com]
Sent: Friday, March 23, 2018 3:11 PM
To: Lines, Jessica ENV:EX
Subject: CFGA, Stage 2 PSI report

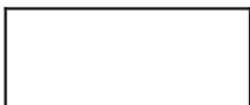
Hello Jessica,

Please find attached the third and final report with the findings of the drilling and well sampling program at the Cowichan Fish and Game site.

I believe the overall scope of work has been achieve for this contract.

The services do include, "...the contractor will be responsible for completing or assist BC Parks with the completion of any submittals required for the Ministry of Environment and Climate Change Strategy [BC ENV] under the CSR as a result of this investigation." I have determined that no submittals are required to BC ENV at this time; however, once a detailed site investigation (DSI) has been completed and steps are taken to commence site remediation, then a Notification of Independent Remediation form would need to be completed and submitted.

Regards,
Stefan



Stefan Quaglia, RPBio, PBiol, CSAP
President, Senior Risk Assessor

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