Our File #: 2451-06280-11

TECHNICAL MEMO

To	From
Crescent Beach Community Group	Adeola Oyefiade, Hydrogeologist Scott Green, Senior Hydrogeologist Remi Allard, Senior Hydrogeologist 2121 / Water Resources
Re	**Date**
Groundwater Impact Assessment Spearhead Industrial Expansion	March 12, 2025

1. Introduction

Crescent Beach Community Group (CBCG) retained McElhanney Ltd (McElhanney) to prepare this groundwater impact assessment for 3 lots located at 4612 and 4614-4616 Starlight Road, and 4643 Highway 3A, in the Crescent Bay area of the Regional District of Central Kootenay (RDCK), approximately 15 km northeast of Nelson, BC (***Figure 1***). The legal lot descriptions are presented in ***Table 1*** and together are hereafter referenced as the “Property”.

Legal Description	Size
4612 Starlight Road, LOT 5 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-282-228)	0.53 ha
4614-4616 Starlight Road, LOT 4 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-289-567)	0.68 ha
4643 Highway 3A, LOT 3 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-289-559)	0.81 ha

Note: ha hectare = 10 000 m^2

Table 1: Component Lot Legal Descriptions and Areas of the Property

Beyond the Property, this report considers water wells completed within a 300 m radius of the Property, and regional features such as Kokanee Peak (15 km north of the Property), Kokanee Creek (between 320 m and 530 m east of the Property) and the Kootenay River (between 195 m and 205 m southwest to south of the Property).

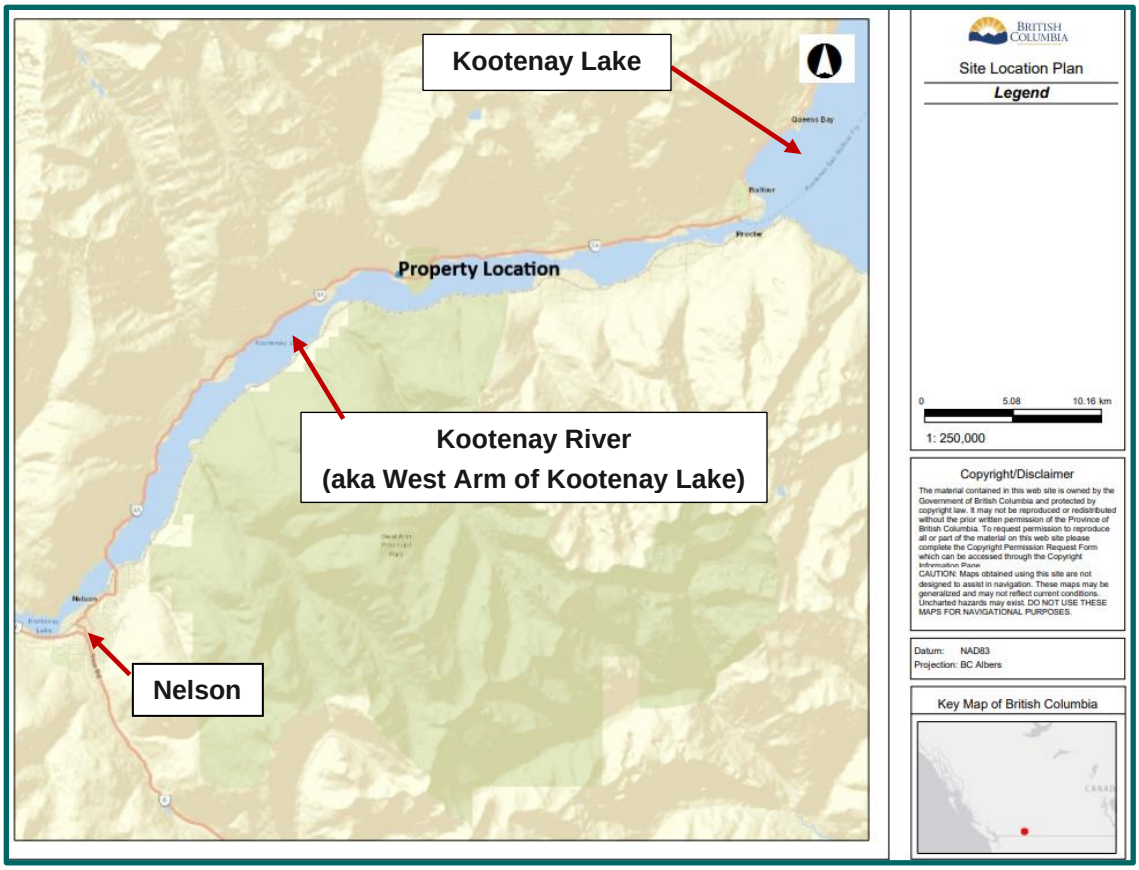

Figure 1: Property Location Map (BC Water Resources Atlas).

2. Background

Spearhead, a wood product manufacturer company and occupant of the lot immediately east of the Property, plans to expand onto the Property by building a new facility (***Figure 2***). It is assumed following expansion to the Property, Spearhead will continue to operate on the lot immediately east of the Property. The new facility is to be serviced by two septic fields and a currently unlicensed on-site water well. The Property is currently zoned Country Residential (R2). For the development to be approved, the following must occur under the Regional District of Central Kootenay (RDCK) regulatory framework (RDCK File Z2410F):

- Zoning must be changed to Comprehensive Development (CD3); and
- Land use designation in the Area F Official Community Plan (OCP) must be revised from Country Residential (CR) to Industrial (M).

A December 11, 2024 meeting of the RDCK Rural Affairs Committee required that an application by the Proponent to change the zoning on the Property be subject to a public meeting and required that a groundwater impact assessment (Active Earth, 2025) and an on-site wastewater assessment (Highland, 2025) be performed (among other studies and assessments) to support the application. Two public hearings were held on January 09 and January 28, 2025, where the proposed development was presented, and

local area residents were consulted and allowed an opportunity to comment. Following the public hearings, amid concern the proposed development would affect the groundwater quality in their private water wells, the Crescent Beach Community Group (CBCG) retained McElhanney to complete an independent groundwater impact assessment.

Figure 2: Property Location bounded by red polygon (Imagery from Regional District of Central Kootenay).

3. Objective and Scope of Work

The objectives of this groundwater impact assessment were to:

- Provide a professional opinion regarding potential impacts on groundwater quality and quantity resulting from the proposed development activity, and
- Provide preliminary level recommendations to prevent, reduce, mitigate, or monitor the anticipated effects to aquifers in the area of the proposed development.

To achieve the stated objectives, McElhanney has performed the following scope of work:

- Reviewed the public hearing information package distributed by the RDCK;
- Reviewed the Active Earth January 29, 2025 report entitled Groundwater Impact Assessment, 4612, 4614-4616 Starlight Road and 4643 Highway 3A, Nelson, BC prepared for Spearhead (Active Earth, 2025). Reviewed the Active Earth January 17, 2025 report. Hereafter, both the January 17 and January 29 Active Earth reports are collectively referenced as Active Earth (2025);
- Reviewed the Highland Consulting Ltd. January 17, 2025 report entitled Spearhead – SPHD Expansion On-Site Wastewater Review (Highland, 2025);
- Reviewed the BC Sewerage System Standard Practice Manual, Version 3;
- Reviewed the Geological Survey of Canada Surficial Geology Kootenay Lake Map (Fulton et. al. 1984);
- Reviewed the BC Groundwater Protection Regulation and BC Water Sustainability Act (BCGOV, 2025);
- Downloaded and reviewed aquifer mapping reports and factsheets for mapped aquifers in the area including AQ 1018 and AQ 994 (Appendix A) from the BC Water Resources Atlas (BCWRA, 2025), and,
- Downloaded and reviewed well logs for several wells adjacent the Property from the BC Water Resources Atlas (BCWRA, 2025).

All of the information presented in this report is publicly available.

4. Overview of Existing and Proposed Developments

4.1. OVERVIEW OF EXISTING DEVELOPMENT

Existing development on each lot is described below moving from west to east across the Study Area.

4612 Starlight Road, LOT 5 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-282-228)

There is a clearing at the north end of Lot 5, adjacent to Starlight Road. It is not clear from the imagery viewed if there is a single-family residence on this property. For purposes of this report, it is assumed that there is simply a clearing with no residence on this property. The clearing occupies approximately 25% of the area on the property. The southern 75% of the property remains undeveloped and is covered primarily with coniferous trees.

4614-4616 Starlight Road, LOT 4 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-289-567)

There are two buildings located on the north end of this property, adjacent to Starlight Road. One of these buildings is a single-family residence, while the other is an out-building servicing the single-family home. The reason that this single-family home has two civic addresses is uncertain, however it's noted on BC Assessment as a 1 Story Duplex. The residence is assumed to be serviced with an in-ground effluent disposal system. The Active Earth report (2025) shows this residence to be serviced with water from unregistered Well C (***Figure 3***). This well is taken to be unregistered since it is not referenced on the BCWRA and as such, there is no publicly available log for Well C.

The residential development occupies approximately 33% of the property, with 67% of the property surfaced with a mixture of coniferous and deciduous growth. The deciduous growth is primarily located in the central portion of the property where a clearing had previously been cut.

4643 Highway 3A, LOT 3 DISTRICT LOT 790 KOOTENAY DISTRICT PLAN 2449 (015-289-559)

There is a single-family residence and a garage at the south end of this lot, adjacent to Highway 3A. This residence is assumed to be serviced with an in-ground effluent disposal system. The Active Earth report (2025) shows this residence to be serviced with water from unregistered Well B (***Figure 3***). This well is taken to be unregistered since it is not referenced on the BCWRA and as such, there is no publicly available log for Well B.

The residential development occupies approximately 33% of the property. Approximately 15% of the property area is occupied by bedrock outcropping at ground surface on the slope immediately northwest of the existing Spearhead buildings on the adjacent lot.

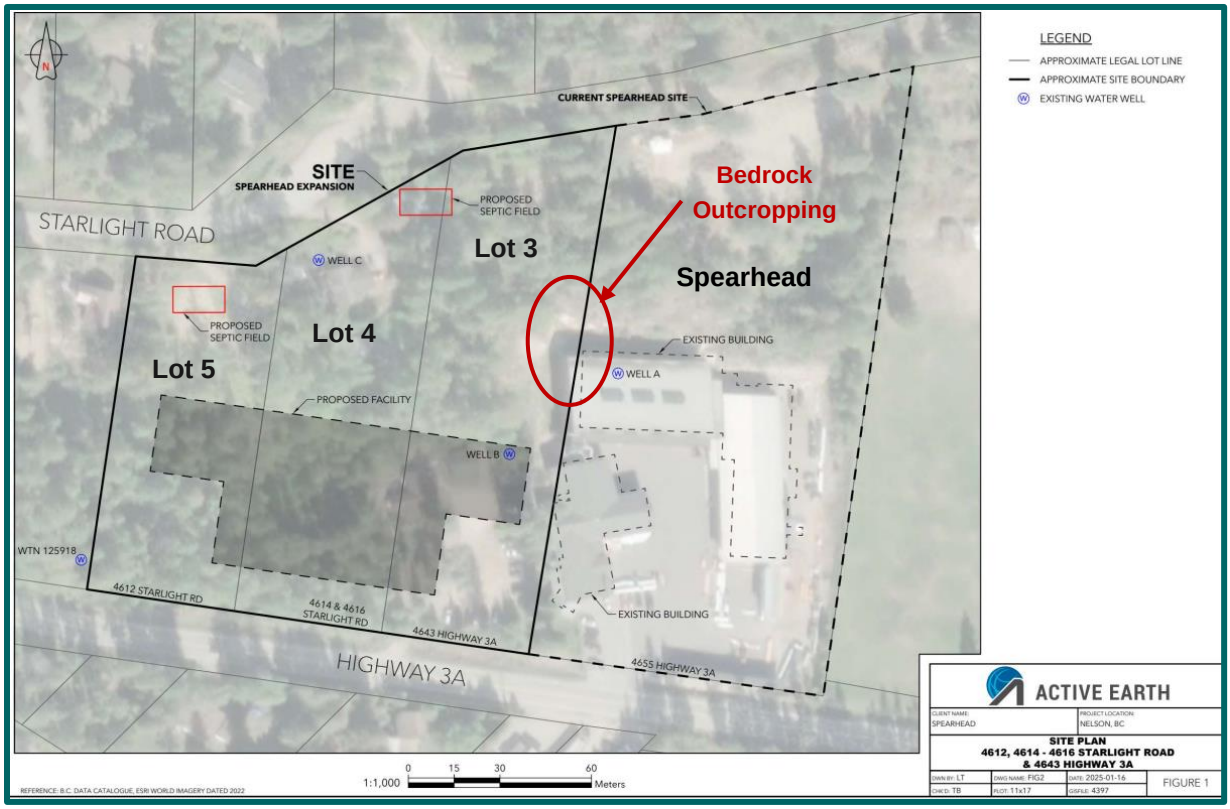

Figure 3: Property Layout with Proposed Facility Location (Active Earth, 2025)

The current operations by Spearhead are located on the neighbouring property to the east. The bedrock outcropping along the northern limit of the existing Spearhead buildings were photographed by Active Earth in their January 2025 site visit and presented as Photos 1 and 2 (***Figure 4***). Well A, which is assumed to be used for current operations, is located on this property. It is assumed that Well A will continue to be used for industrial water needs on the lot immediately east of the Property.

4.2. OVERVIEW OF PROPOSED DEVELOPMENT

McElhanney understands the proposed development calls for the following (in order of occurrence):

1. Consolidation of the 3 lots into a single lot having an area of 2.075 hectares (20,750 m^2);
2. Development of new production shop building (Phase I area: 4,885 m^2); and,
3. Development of Daycare and Office Tower (Phase II area: 1,243 m^2).

Figure 3 also presents the proposed development following completion of Phase I and does not show the Phase II development at full build-out. ***Figure 5*** (which is in the figures section appended to this report) shows the development following completion of Phase II. At full build-out the production shop building, daycare and office tower are expected to have a combined footprint of 6,128 m^2. Including the asphalted parking and access areas (2,150 m^2), the approximate developed area will be 8,278 m^2. This excludes the proposed landscaped area (944 m^2). Calculated areas are based on dimensions provided by Hemsworth (2024) as shown in ***Figure 5***.

Photo 1: View toward the east of bedrock slope located adjacent and north of site building

Photo 2: View toward the northeast of bedrock slope located north of site building

Figure 4: Photos of Bedrock Outcropping occupying approximately 15% of Lot 3 (Active Earth, 2025)

The building foundation design is reported to extend below the top of, and into, bedrock (Active Earth, 2025). The requirement for blasting of the bedrock, and the foundation depth for the new development, is unknown. It is expected that foundation perimeter drainage will be required.

The proposed development calls for two areas for subsurface effluent disposal (one primary field and one back-up field), adjacent the north boundary of the Property (***Figure 3***). The proposed development calls for Well C to be closed in accordance with the Groundwater Protection Regulation (BCGOV, 2025), as it is located within the 30 m setback from the proposed locations of effluent disposal areas. Unregistered Well B is proposed to service the development with potable water. Driller's logs for both Well B and Well C are either not provided or not available. ***Figure 3*** and ***Figure 6*** (Figure 6 is provided in the Figures section appended to this report) show the location of Well B within the footprint, at the northeast corner, of the proposed production shop building.

Three test pits were excavated to 1.5 m below existing grade (ground surface) at locations across the north end of the Property (***Figure 6***). Generally, the test pits intersected sand-silt mixtures overlying fine to coarse sand and gravel followed by silty sand having between 5 % and 50 % course fragments (Highland, 2025). At TP-1 (the northeast corner of the Property), a 15 cm thick sandy clay layer was reported at the base of the test pit (Highland, 2025). Since the clay layer was not intersected at any other test pits, its continuity across the Property has not been verified and the clay is considered a localized lens. Furthermore, the bottom of this clay layer has not been defined and as such, the thickness of this layer is unknown. Since each test pit was consistently terminated at 1.5 m depth below grade, the depth to the uppermost impermeable layer or saturated zone (restrictive or limiting layer, that defines the lower bound of vertical separation) is unknown (BC Health, 2014).

The stated purpose of Highland (2025) is to assess the Property's capacity for an on-site septic system with redundancy. At full build-out, the design effluent discharge rate is 5,780 L/day (5.78 m^3/day; Highland, 2025). Permeameter tests were performed at locations adjacent to each test pit location. Average percolation test results were reported to range between 2 and 4 minutes/inch (Highland, 2025). However, the depth at which percolation tests were performed and the number of trials performed at each test location were not reported. Further, there was no evidence in the report that adequate pre-saturation was performed or achieved prior to conducting the percolation tests. The proposed conceptual effluent disposal field design called for pressurized distribution laterals oriented parallel to the elevation contours at each location.

There is reference to a rock pit to be constructed at the southwest corner of the Property for purposes of water storage (Active Earth, 2025). Typically, rock pits are used to facilitate seepage into unconsolidated sediments as opposed to 'storage'. If the stated purpose of the rock pit is to store water, it is conceptualized that the rock pit will consist of a pit excavated, or blasted, into the low-permeability rock to store water. However, the more likely intent of the rock pit is to provide rapid infiltration of storm water collected from the building perimeter drain. Further detail of the design, location, and anticipated number of rock pits is required.

The proposed operation includes application, short-term storage, and handling of low volatile organic carbon (VOC) wood glue and stain (Active Earth, 2025). The RDCK public hearing information package included a Material Safety Data Sheet for an adhesive called 'Loctite' manufactured by Henkel Canada Corporation. The chemical constituents of Loctite are provided below (Henkel, 2020):

Hazardous Component(s)	CAS Number	Weight %*
Diphenylmethane diisocyanate, isomers and homologs	9016-87-9	30 - 60
Ethylene oxide-propylene oxide-polymeric MDI copolymer	67423-05-6	10 - 30
Methylenebis(phenylisocyanate)	101-68-8	10 - 30
Zinc compound	12767-90-7	1 - 5
o-(p-Isocyanatobenzyl)phenyl isocyanate	5873-54-1	1 - 5
2,2'-Methylenediphenyl diisocyanate	2536-05-2	0.1 - 1

* Exact percentages may vary or are trade secret. Concentration range is provided to assist users in providing appropriate protections.

No bulk storage of process chemicals is planned for the development (Active Earth, 2025). No information was provided regarding other chemicals that would potentially be used on the Property.

5. Climate

Climate normals for the period between 1991 to 2020 as recorded at the Nelson Climate Station (Elevation 534.9 m asl; 477892E; 5482128N Zone 11 NAD 83) operated by Environment Canada are summarized in ***Table 2***.

Table 2: Mean Monthly Temperature and Precipitation Recorded at Nelson Climate Station (Canadian Climate Normals, 2025)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Temp. (°C)	-0.7	0.6	4.4	8.6	13.3	16.4	20.7	20.4	15.4	8.5	2.9	-1.0	9.1
Precip. (mm)	nr	nr	nr	59.6	65.9	84.4	34.2	30.6	42.4	63.5	nr	nr	nr

Note: nr = not reported

Snow falls occasionally between November and March. However, representative precipitation measurements for these months are not reported at this climate station. In the absence of a complete annual precipitation record, a mean monthly precipitation rate of 54.4 mm/month is estimated. Peak runoff is likely to occur during spring freshet when rain-on-snow events could generate both significant overland flow and runoff from hard surfaces (bedrock, roof and park lot),

Climate change research in mountainous regions of BC predict that the intensity and frequency of fall and winter precipitation events will increase and, in contrast, persistent hot and dry conditions in summer with simultaneous periods of no precipitation will create prolonged periods without groundwater recharge to aquifers and prolonged periods of low water levels in creeks and streams during that season (Allen and Scibek, 2004).

6. Physiography

6.1. TOPOGRAPHY AND DRAINAGE

Regionally, the property is situated at the toe of the Selkirk Mountain Range defined to the west by Slocan Lake, to the east by Kootenay Lake and to the south by the Kootenay River (locally known as the West Arm of Kootenay Lake). Local area peaks include Mt. Yuill (2,150 m asl; 6 km north northeast of the Property), Grays Peak (2,740 m asl; 13.7 km north of the Property) and Kokanee Peak (2,780 m asl; 15.1 km north of the Property). Each of these peaks are adjacent to glaciers that drain into Kokanee Creek. Kokanee Creek is also fed by Kokanee Lake (~1,970 m asl) and Gibsons Lake (~ 1,560 m asl) at its headwaters (iMapBC, 2025). The Kootenay River is at an approximate elevation of 534 m asl.

At the closest proximity, Kokanee Creek is 320 m east of the northeast corner of the Property. At the most distal point, Kokanee Creek is 530 m east of the Property. ***Figure 7*** is an oblique image of the Property showing the layout relative to Kokanee Creek. The yellow lines on ***Figure 7*** highlight the crest and toe of the local area slope upon which the Property is situated. Using 5 m contours obtained from Lidar imagery across the Property, as shown in ***Figure 8*** (provided in the figures section appended to this report), the slope across the Property is roughly 23 %. The maximum elevation on the Property is 575 m asl at the northeast corner and 543 m asl at the southwest corner. The slope direction on the west side of the Property is south southwest (***Figure 8***), while on the east side of the Property it is south southeast and strongly influenced by the bedrock outcropping shown in ***Figure 4***.

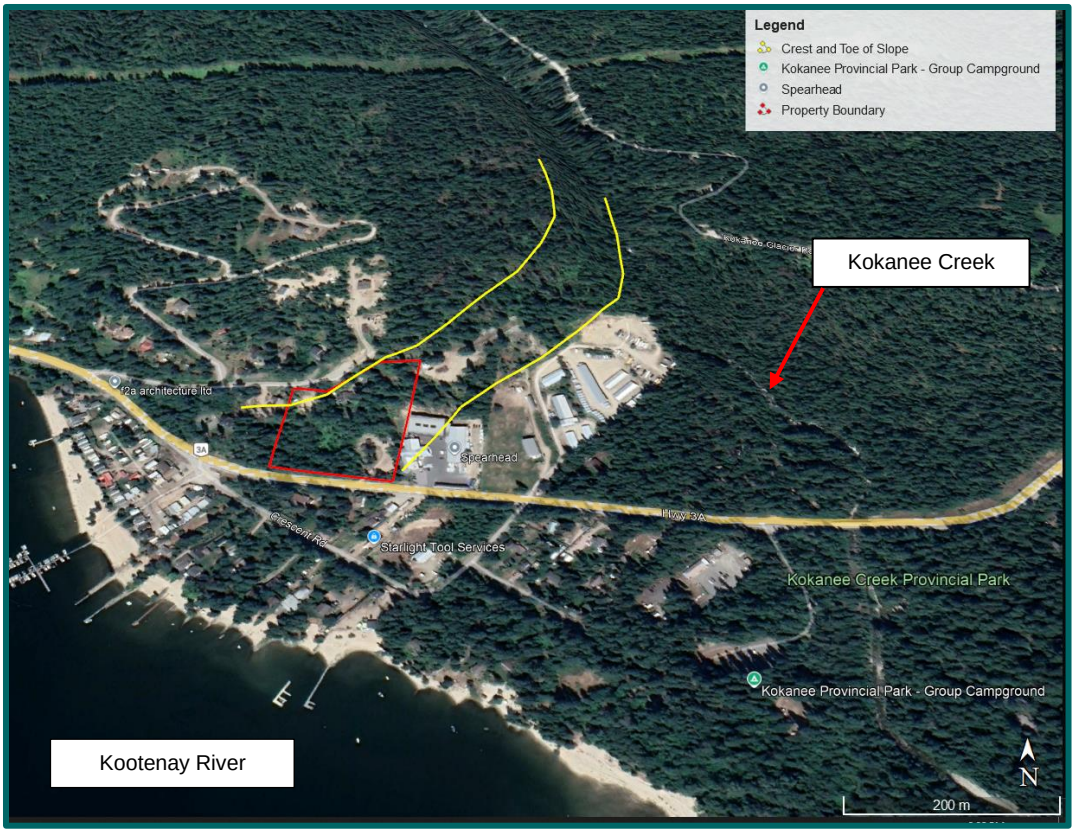

Figure 7: Oblique Image of the Property Showing Toe and Crest of Local Slope (Google Earth, 2025)

6.2. BEDROCK GEOLOGY

Bedrock geology at the Property has been mapped as the Nelson Batholith comprised of porphyritic granite, granodiorite, and granite gneiss (iMapBC, 2025). The batholith is regional in scale and has been mapped across the area extending from Slocan Lake (in the west), a series of north-south trending faults adjacent the north arm of Kootenay Lake (in the east), Nelson (in the southwest), but extending to a point approximately 10 km north of Salmo, BC (iMapBC, 2025). There are no faults in the area of the Property (iMapBC, 2025).

6.3. SURFICIAL GEOLOGY

Regional scale mapping of surficial geology published by the Geological Survey of Canada has determined the Property is underlain by “bedrock with steep slopes exposed by a modern stream” (Fulton et. al., 1984). Generally, this includes rock outcropping at surface with a thin veneer or blanket of colluvium, rubble aprons and rubbly till.

The Property is situated upon the west slope (lateral distal portion) of a delta associated with Kokanee Creek. The depositional history of area including the Property is interpreted to be as follows:

1. The west slope, which is dominated by bedrock, was initially formed by scouring during glacial advance and retreat; and,
2. The fast-moving waters of Kokanee Creek have discharged into the slow-moving waters of the Kootenay River forming a complex of fan and delta deposits. Deltaic deposits are typically comprised of sand and gravels, as deposited sediment-laden water in Kokanee Creek, interbedded with lacustrine silts and clays as deposited during periods of high water in the slower moving Kootenay River.

7. Groundwater Occurrence and Flow

7.1. PROVINCIAL AQUIFERS IN THE AREA

Figure 9 shows the local extent of the two provincial aquifers that exist in the area of the Property. A summary of aquifer characteristics is provided in ***Table 3***.

Table 3: Summary of Aquifer Characteristics for Provincial Aquifers in the Area

Aquifer Name	Aquifer Number	Aquifer Type	Current Delineated Extent (km^2)	Vulnerability	Productivity	Demand
Crescent Bay	1018	Bedrock	8.36	Moderate	Moderate	Low
Kokanee Point	994	Sand and Gravel	1.18	High	Moderate	Moderate

The Property is located at the southeast extent of fractured bedrock Aquifer AQ 1018 (***Appendix A***). The aquifer extent has been delineated based on recorded stratigraphy, well location and occurrence, bedrock geology and drainage area. Generally, the hydraulic conductivity of the aquifer is reported as low, having a median well yield of 34 m^3/day (BCWRA, 2025). Based on low hydraulic conductivity clay and silt units reported by drillers as overlying the bedrock, the aquifer is characterized as being partially confined. Based on the reported thickness of these low hydraulic conductivity layers, the aquifer is interpreted to have a moderate vulnerability to contamination from infiltration of potential contaminants. The mean depth to water is reported as 14.2 m below grade. A note on the Aquifer Classification Worksheet (***Appendix A***) suggests that discharge from this aquifer is into the surficial aquifer (AQ 994) and Kootenay River to the south (BCWRA, 2025).

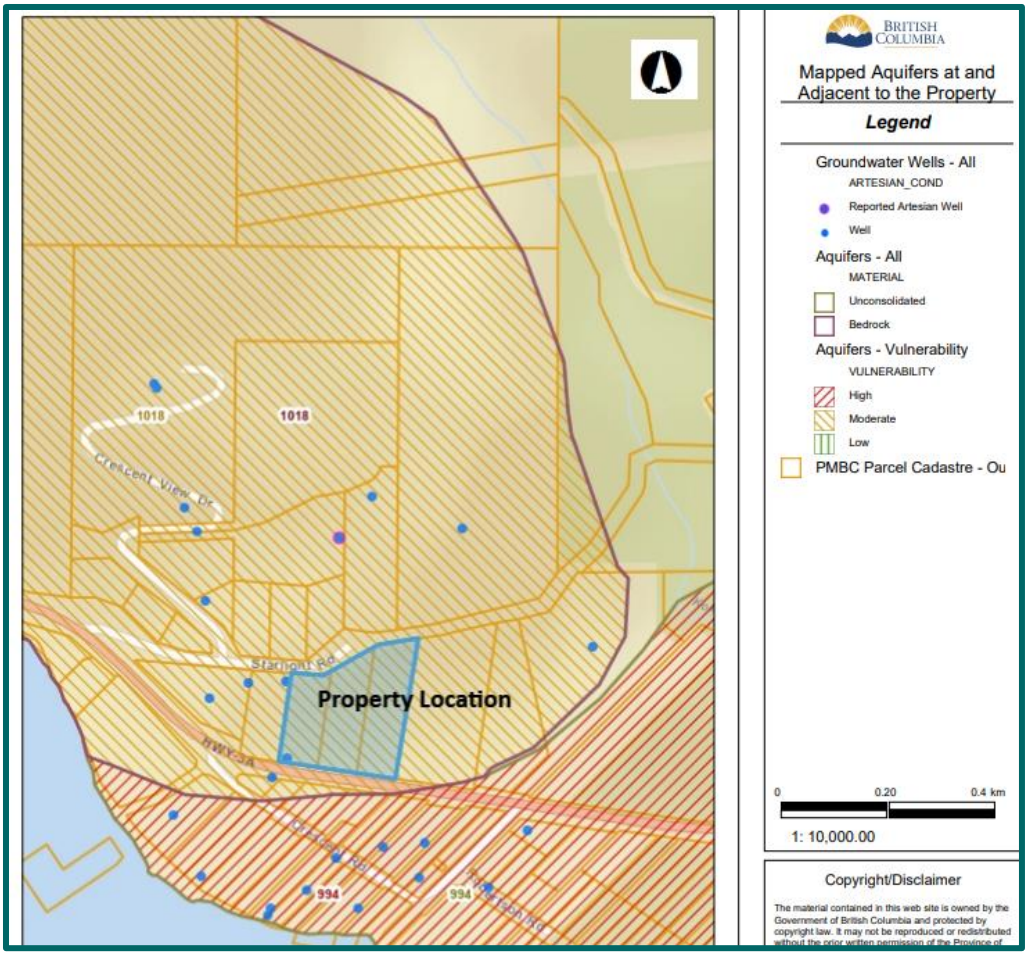

Figure 9: Provincial Aquifers in the area of the Property (BC Water Resources Atlas, 2025)

The northern extent of sand and gravel Aquifer AQ 994 has been mapped between 20 m and 45 m south of the Property (***Appendix A***). The aquifer extent has been delineated based on recorded stratigraphy, well location and occurrence, surficial geology mapping and topography (BCWRA, 2025). The southern extent of the aquifer is defined by the Kootenay River. In addition to the sand and gravel aquifer materials, the Aquifer Classification Worksheet (***Appendix A***) also indicates that dirty sand and gravel, silt, clay and some till and boulders are present (BCWRA, 2025). Of the wells drilled up to and including 2012 (when the Aquifer Classification worksheet was published), the worksheet indicates low permeability confining units in 38 % of the wells, and an unconfined sand and gravel aquifer in 53% of the wells drilled (BCWRA, 2025). The low hydraulic conductivity units are discontinuous lenses and as such, the vulnerability of Aquifer AQ 994 is more likely high as opposed to moderate as described in the Aquifer Classification Worksheet (***Appendix A***). The median well yield is 124.8 m^3/day (22.9 USgpm), inferring the aquifer is moderately productive. The average depth to groundwater is reported to be 6.2 m below grade (BCWRA, 2025). A note on the Aquifer Classification Worksheet (***Appendix A***) suggests that recharge to Aquifer AQ 994 originates laterally from Aquifer 1018 (BCWRA, 2025). Copies of the Aquifer Classification Worksheets for AQ 994 and AQ 1018 are included in ***Appendix A***.

7.2. WATER WELLS

Figure 10 shows the locations of 24 water wells registered in the BCWRA within a 300 m radius of the Property. On the assumption that all properties in the area that have buildings must also have a water well, there are many wells in the area that have not been registered. Submission of water well logs prior to 2016 was discretionary and therefore wells completed prior to this date may not appear in the well registry. There are at least twenty-four lots south of the property and only eleven registered wells in the area. This suggests that, in addition to the 11 registered wells, there are inferred to be approximately 25 unregistered wells located south of the property (for an estimated total of 36 wells). Available details garnered from well logs are summarized in ***Table 4***.

Individual well records can be accessed on the BCWRA at https://maps.gov.bc.ca/ess/hm/wrbc/.

Relative Location or Civic Address	Well Tag Number	Drillers Reported Yield (m^3/day)	Well Depth (m bgs)	Depth to Water (m below reference)	Aquifer No.	Distance from Property (m)	Notes
4647 Cresent Rd	131010	8.18	170	nr	1018	106	
4608 Starlight Rd	125918	19.1	224	nr	1018	on property	
4598 Highway 3A	124093	nr	9.14	nr	994	144	
4622 Crescent Rd	120935	nr	>9	nr	994	171	
4711 Robertson Rd	117710	109	28.3	8.23	994	175	
4608 Crescent View	166151	16.4	182	13.72	1018	139	
4676 Crescent Rd	108916	109	14.0	6.71	994	216	
Starlight Rd	105588	2.73	183	91.44	1018	5	
Crescent View Dr	92891	16.4	165	4.27	1018	241	
Crescent View Dr	92889	38.2	116	0	1018	140	Artesian
Crescent View Dr	92888	10.9	122	3.05	1018	182	
Crescent View Dr	91664	21.8	123	1.22	1018	96	
4646 Crescent Rd	85983	245	13.1	4.88	994	180	
4646 Crescent Rd	85981	nr	5.94	5.49	994	189	
4604 Starlight Rd	85957	27.3	219	0	1018	52	Artesian
12 Mile-Storage	79334	109	152	23.77	1018	221	
4652 Crescent Rd	66287	109	10.7	1.83	994	151	
Crescent Beach	51893	60.0	116	nr	1018	209	
Nelson	39860	81.8	143	30.48	1018	146	
North Shore	35593	81.8	18.6	10.67	994	86	
North Shore	34912	54.5	15.2	7.31	994	85	
Kokanee	26477	nr	4.57	nr	994	22	dry
Kokanee	26469	218	10.7	nr	994	164	
Provincial Park	16615	191	15.2	6.71	994	175	

Note: nr = not reported

Table 4: Registered Well Locations within a 300 m Radius of the Property (BCWRA, 2025)

Figure 10: Registered Well Locations within 300 m of the Property (BCWRA, 2025)

Of the 24 registered wells within a 300 m radius of the Property, 12 source water from bedrock aquifer AQ 1018 and 11 wells source water from the sand and gravel aquifer AQ 994 (BCWRA, 2025). One of the wells (WTN 26477) intersecting AQ 994 is reported as dry.

The following notable observations were made from the well logs:

- Generally, wells on the Property and areas to the north are completed in bedrock aquifer AQ 1018 and wells to the south of the Property are in sand and gravel aquifer AQ994. The mean well yield in bedrock aquifer AQ 1018 is 27.3 m^3/day (5 USgpm). The mean well yield in the sand and gravel aquifer AQ 994 is 124.8 m^3/day (22.9 USgpm);
- Two wells intersecting the bedrock aquifer AQ 1018 (WTN 92889 and WTN 85957), were reported to have water levels at grade or slightly above and are noted as artesian in ***Table 3***. Artesian means water pressure in the fractures intersected by the well is higher than the ground surface;
- Wells completed in bedrock aquifer AQ 1018 have depths ranging from 116 m (WTN 92889 and WTN 51893) to 224 m (WTN 125918);

- The average depth from ground surface to the top of bedrock in the area is 4.7 m, with the maximum depth of 16.7 m noted in WTN 51893 located 190 m NW of the Property. The depth to bedrock is greatest generally to the north of the Property. However, as inferred by bedrock outcropping on the Property, the depth to bedrock on the Property is inferred to be relatively shallow. The depth to bedrock increases from between 5 and 15 m below ground surface to the south and downslope of the Property;
- Although located within the footprint of aquifer AQ 994, WTN 131010 was drilled through sand and gravel AQ 994 and into the underlying bedrock Aquifer AQ 1018;
- WTN 125918 was drilled adjacent the southwest corner of the Property and the stratigraphy reported at this location was sand and gravel to 3.0 m below grade, followed by clay to 6.1 m below grade overlying bedrock; and,
- WTN 105588 was drilled 5 m west of the Property and approximately 15 m west of the proposed westernmost effluent disposal area, with bedrock encountered at 1.2 m below ground surface.
- The mean depth to groundwater (the water table or static water level) in the sand and gravel aquifer AQ 1018 is 5.8 m below ground surface. The closest well to the Property and in aquifer AQ 994 is WTN 26477 located 30 m downslope of the southern limit of the Property. This well is completed to 4.6 m depth where it intersected bedrock. This well was not completed with a well screen.

7.3. GROUNDWATER RECHARGE AND AQUIFER FLOW

Generally, groundwater travels from groundwater recharge zones (typically found at high elevations) towards groundwater discharge zones (typically found at lower elevations). Groundwater recharge to bedrock aquifer AQ 1018 is conceptualized as precipitation and glacial meltwater infiltrating fractures in bedrock at the higher elevations of the Selkirk Mountains adjacent Kokanee Peak, Grays Peak and Mount Yuill. If glacial or snow meltwater and precipitation do not encounter fractured bedrock, infiltration will be limited resulting in runoff and infiltration into the overburden material above the bedrock and shallow groundwater flow along the top of the bedrock. The flow along bedrock follows topography, some of which will report as runoff to local creek channels. Where the creeks flow over fractured bedrock, there may be some loss of creek flow via infiltration into bedrock.

Flow within bedrock is not within the primary porosity of the bedrock itself but via the fractures in the bedrock following pressure gradients. Where a well has been drilled into the bedrock, the groundwater flow rate of that well is dependent upon the number of continuous fractures intersected by that well. Granodiorite rock which predominates in the area, is notoriously massive with relatively few fractures. The paucity of fractures is consistent with the absence of mapped faults in the area and the depth of the wells drilled in the bedrock aquifer AQ 1018.

The quantity of flow above bedrock is a function of the type and thickness of overburden material above the rock and the size of the catchment area that provides recharge of precipitation and snowmelt. The local catchment area of aquifer AQ 994 that collects and infiltrates precipitation to the overburden extends 1 km upslope to the north of the Property.

The regional groundwater discharge zone is the Kootenay River (West Arm of Kootenay Lake). As such, groundwater in the bedrock is conceptualized as following pressure gradients that converge upon the Kootenay River. Where the bedrock surface is exposed at the base of the Kootenay River, groundwater in the bedrock is expected to discharge directly into the Kootenay River. However, where sand and gravel is deposited directly upon the fractured bedrock, groundwater discharging from the fractured bedrock is conceptualized as discharging laterally and directly into the sand and gravel aquifer AQ 994. Where isolated clay lenses are present directly on the bedrock, discharge from the bedrock into the sand and gravel aquifer will be minimal or absent. However, as clay mantled on bedrock has been reported at WTN 125918 only and not in other well logs in the area, it is inferred the clay layer is discontinuous and therefore that groundwater discharge from the bedrock to the sand and gravel aquifer predominates. Since aquifer AQ 994 abuts directly against the Kootenay River, it is also expected that seasonal groundwater recharge occurs from the river into the aquifer during freshet when water levels in the river may rise marginally higher than water levels in the aquifer.

In summary, groundwater flow in the area is from the north to the south towards the River. To the north of the Property flow is predominantly in fractured bedrock (AQ 1018) that is recharged over a larger area that extends to 2,700 m asl. Flow in this aquifer provides some recharge to the sand and gravel overburden aquifer (AQ 994) that is at lower elevation and adjacent to the River. Recharge to AQ 994 is also provided by lateral flow along the top of bedrock that is derived from infiltration within a smaller catchment area that extends to 1 km north of the Property. The overburden aquifer AQ 994 is also recharged via infiltration of precipitation over the footprint of the aquifer and lateral recharge from the River when the elevation of the River is higher than the level in the aquifer which may occur during peak freshet runoff.

7.4. GROUNDWATER USE

Wells in sand and gravel aquifer AQ 994 are inferred to be primarily domestic wells, except perhaps WTN 124093 which based on its location, is inferred to service the Crescent Beach Resort.

Similarly, wells completed in the bedrock aquifer AQ 1018 are inferred to be primarily domestic wells, with the exception of WTN 79334 servicing the 12-Mile Storage facility.

8. Potential Impacts

8.1. AQUIFER WATER BALANCE

A groundwater budget or aquifer water balance is simply an accounting of water inputs or “recharge” to an aquifer (or system of aquifers) offset against water outputs including pumping from wells, losses to surface water and lateral flow to down-gradient aquifers (Fetter,1994; Domenico & Schwartz, 1990). The completion of a detailed water balance is beyond the scope of this assessment; however, a discussion of the how the proposed development may impact the water balance in the area is presented.

Our understanding is that most of the effluent infiltrating into the disposal fields on the property will be sourced via pumping from one of the water wells on the Property (likely Well B). The existing disposal fields servicing the existing homes will be decommissioned. At full buildout on the Property, the effluent disposal

rate will be 5,780 L/day (1,500 USgals/day). This equates to a water demand on site of 5.8 m^3/day (1 USgpm), which is much less than the average 27.3 m^3/day (5 USgpm) yield for a well in bedrock aquifer AQ 1018.

The volume of water withdrawn from wells on the property is likely to be higher considering shop floor and parking lot washdown plus irrigation water requirements. It is assumed that shop washdown water will report to the perimeter drain, with appropriate attention afforded to preventing any shop chemicals or cleaners being included in the waste stream. The volume used for exterior washdown and irrigation demands is also assumed to be 5.8 m^3/day (1 USgpm). Exterior washdown water is expected to report to the on-site stormwater retention/disposal system. The net of applied irrigation water used, defined as irrigation return flow, will equate to about 30% of the volume of irrigation applied. Irrigation return flow will infiltrate into the subsurface and recharge shallow groundwater above bedrock in the same way as effluent from the disposal fields. The total water use on the Property is therefore assumed to be 17.4 m^3/day (3 USgpm), which is still less than the mean well yield for aquifer AQ 1018.

There will be an increase in the volume of recharge reporting to the overburden materials above bedrock on the Property due to a substantial increase in impervious surface area, represented by roofing atop the production shop building and paved parking areas. Less impervious surfaces cause water to run off quickly and increase the volume of stormwater to be accommodated by a stormwater system. Our understanding is the stormwater on the Property will be collected and infiltrated to ground at a location downslope of the main production shop building.

In summary, the volume of water that will accumulate on top of the shallow bedrock on the Property will increase and this water will flow laterally downslope ultimately contributing to the recharge of aquifer AQ 994. The extent to which the water table may rise in the aquifer due to increased recharge is beyond the scope of this assessment, but practically it is unlikely to be more than 1m and expected to occur in the summer when rainfall and irrigation return flow will have the most influence. Given the mean depth to water (water table) in aquifer AQ 994 is 5.8 m, a 1 m increase is not expected to represent a significant impact. However, a reconnaissance of wells located downslope of the Property including static water level measurements, combined with a survey of basement slab elevations relative to groundwater levels is warranted. Ultimately an assessment of the impact of increased recharge and groundwater level rise should be completed.

The increase in flow above bedrock will be the result of:

- Water pumped from bedrock aquifer AQ 1018 that ultimately reports to the effluent disposal fields upslope of the production shop building. This is effectively a transfer of water from aquifer AQ 1018 to aquifer AQ 994; and,
- Disposal of stormwater collected on the Property via infiltration to ground, noting the volume will be higher than historical due to increased impervious area.

8.2. POTENTIAL FOR GROUNDWATER CONTAMINATION

The depth to bedrock is 1.2 m below grade at WTN 105588 (20 m west of the western-most septic field), which is relatively shallow. Bedrock outcropping at ground surface is also noted on the Property. The clay that sits on top of the bedrock has been identified in test pit TP3 at the north end of the property and in WTN 125918 at the south end of the Property underlying 3 m of sand and gravel inferred to be the northern extent of sand and gravel aquifer AQ 944. There is insufficient subsurface data to suggest that clay is continuous over the Property. Lastly, the slope across the Property is roughly 23% and the percolation rate is less than 4 min/inch in the proposed disposal field areas.

Effluent discharged at the proposed effluent disposal field locations is therefore expected to infiltrate and migrate vertically downward through the coarse sand and gravel at a rapid rate prior to intersecting the underlying bedrock surface. At the bedrock surface, the effluent flow direction is expected to follow the topography of the bedrock surface, which is generally from north to south across the property, towards the production shop building and ultimately the Kootenay River. As such, there is significant potential for the effluent to be collected by the perimeter drain surrounding the production shop building and subsequently discharged to ground on the south side of the building. The effluent is expected to mix and dilute with any other runoff captured in the perimeter drain.

In summary, this information raises a concern that substantial renovation of effluent may not be achieved, leading to partially treated effluent flowing along the top of the bedrock on the Property being captured by the stormwater system and subsequently infiltrated to ground at the south end of the property. Disposal of partially renovated effluent at the south end of the Property has the potential to impact groundwater quality in aquifer AQ 994 and represents a health hazard for groundwater users (domestic water wells) in the residential area downslope of the Property.

Therefore, the stormwater collection and disposal system on the Property must carefully consider the following:

- If stormwater will be collected and conveyed solely via gravity to the lowest elevation area (southern portion) of the Property;
- The locations, intended function and number of rock pits should be clarified. Are rock pits for storage and subsequent infiltration of stormwater directly to bedrock, or are rock pits only for storage with overflow of storage directed via gravity to infiltration points in the overburden above bedrock;
- Partially treated effluent can still contain significant levels of contaminants such as organic matter, nutrients (like nitrogen and phosphorus), and pathogens. Effluent that accumulates in rock pits designed to convey overflow only, represents a stagnant volume of effluent which can lead to higher concentrations of biological pathogens over time;
- Perimeter drain design, including sections of pipe that are perforated or not perforated to optimize collection and delivery of water to disposal areas, points of connection with roof leader and parking area runoff and design of rock pits for optimal storage;

- How will the concrete floor slab in the shop building be washed or will it be washed at all; and,
- Assuming the concrete floor slab will be washed, how will that wash water be managed.

Based on the very limited information provided on the proposed stormwater system for the Property, our understanding is that disposal of stormwater to ground may be planned at the south side of the production shop building in which case partially renovated effluent and stormwater would be discharged directly into the unsaturated sand and gravel (as noted in WTN 125918) either directly from the perimeter drain or from the rock pit(s), and infiltrate vertically downward until it intersects the clay noted in WTN 125918 or intersects the water table in AQ 994. Where the effluent and stormwater intersects the water table in aquifer AQ 994, the mixture will travel following the direction of flow in the aquifer towards the Kootenay River.

Stormwater discharge to ground on the Property will mix with ambient groundwater flow in aquifer AQ 994, with water quality expected to improve as distance increases downslope from the Property along the direction of groundwater flow towards the River. However, pumping from domestic water wells located along the groundwater flow path has the potential to “capture” a portion of the infiltrated stormwater prior to substantial mixing occurring with the ambient groundwater flow in aquifer AQ 994. The area surrounding a well where groundwater is influenced by pumping is defined as a well head capture zone. It includes all the water that will eventually flow into the well. The extent and orientation of a capture zone is a function of the rate the well is pumped and the hydraulic gradient in the aquifer. Where the pumping rate is small and the hydraulic gradient is relatively flat, the capture zone is small and symmetric (circular). Where the pumping rate is higher and the gradient is not flat, the capture zone increases in size and becomes elongated extending further upslope (up-gradient) along the dominant direction of groundwater flow. In summary, the time for potentially contaminated groundwater to be intercepted by domestic wells located downslope (down-gradient) of the Property may be less than expected and represents a health hazard.

There is no proposed secondary containment proposed for the low-VOC wood glues and stains that will be used on site (Active Earth, 2025). The viscosity and maximum on-site storage quantities of these products is not reported. The primary containment for these products is reported to be the concrete floor slab of the production shop building. The same concerns exist for the transport and fate of these chemicals within the effluent disposal and stormwater management systems on the Property.

9. CONCLUSIONS

The unconfined sand and gravel aquifer located down slope and down-gradient with respect to groundwater flow, designated by the Province as aquifer AQ 994, has been characterized as highly vulnerable to impacts from potential contaminants at ground surface. The northern limit of aquifer AQ 994 is between 20 m and 45 m of the southern limits of the Property.

Based on a review of the available information, potential impacts to down-gradient receptors (water wells and the Kootenay River) from the proposed development are as follows:

- Partially renovated wastewater effluent may be directed, or eventually report, to aquifer AQ 994 via the rock pits and/or perimeter drains on the Property.
- Recharge of stormwater to the subsurface at the south limit of the Property will increase via the rock pit and/or the perimeter drain;
- If Well B is not completed with a surface annular casing seal, there is a risk that insufficiently treated effluent from upslope effluent disposal fields could migrate into Well B;
- Wash water from the concrete floor slab (residual wood stain and glue water quality) and from asphalt surfacing (residual hydrocarbon concentration) may report to the perimeter drain system and/or rock pit(s) on the Property and impact groundwater that will recharge aquifer AQ 1018;
- It is understood that Well B is proposed to service Spearhead with potable water. The location of Well B is within the footprint of the proposed production shop building. There are no details regarding this well, specifically when the well is drilled, what geology was encountered, the depth to water-bearing fractures and if the well is compliant with the requirements under the Groundwater Protection Regulation. As defined in the BC Water Act, if the well is used for industrial/commercial purposes, it will be become a public water supply well

Generally, in our professional opinion, based on the information provided to date, the proposal has the following deficiencies:

- There is currently no clear stormwater management plan for the Property;
- It is unlikely that there will be adequate effluent renovation prior to discharge at the south property boundary;
- There is no consideration of the high consequence, low likelihood event of a release of low VOC or petroleum hydrocarbon chemicals at the Property;
- Since Well B is planned to become a public water supply, well completion details at Well B are unknown;

- There is no consideration of the fact that the proposed development on the Property is between 20 m and 45 m up-gradient of a highly vulnerable aquifer that is the sole-source of potable drinking water for several homeowners;
- Time for potentially contaminated groundwater to be intercepted by domestic wells located downslope (down-gradient) of the Property may be less than expected and could represent a health hazard.
- There has been no consideration of effluent pre-treatment to a higher standard than Type 1;
- There has been no consideration of installation of groundwater monitoring wells along the south Property boundary;
- There has been no consideration of baseline and post operation groundwater monitoring along the south property boundary or in the highly vulnerable aquifer;

10. CLOSING

We trust the information provided meets your current requirements. If you have any questions or concerns, please contact the undersigned at your convenience.

Sincerely,

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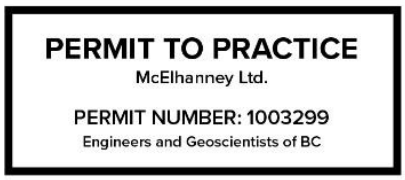

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FIGURES NOT INCLUDED IN TEXT

Figure 5: Architect's Rendering of Proposed Development at Full Build out (Hemsworth, 2024)

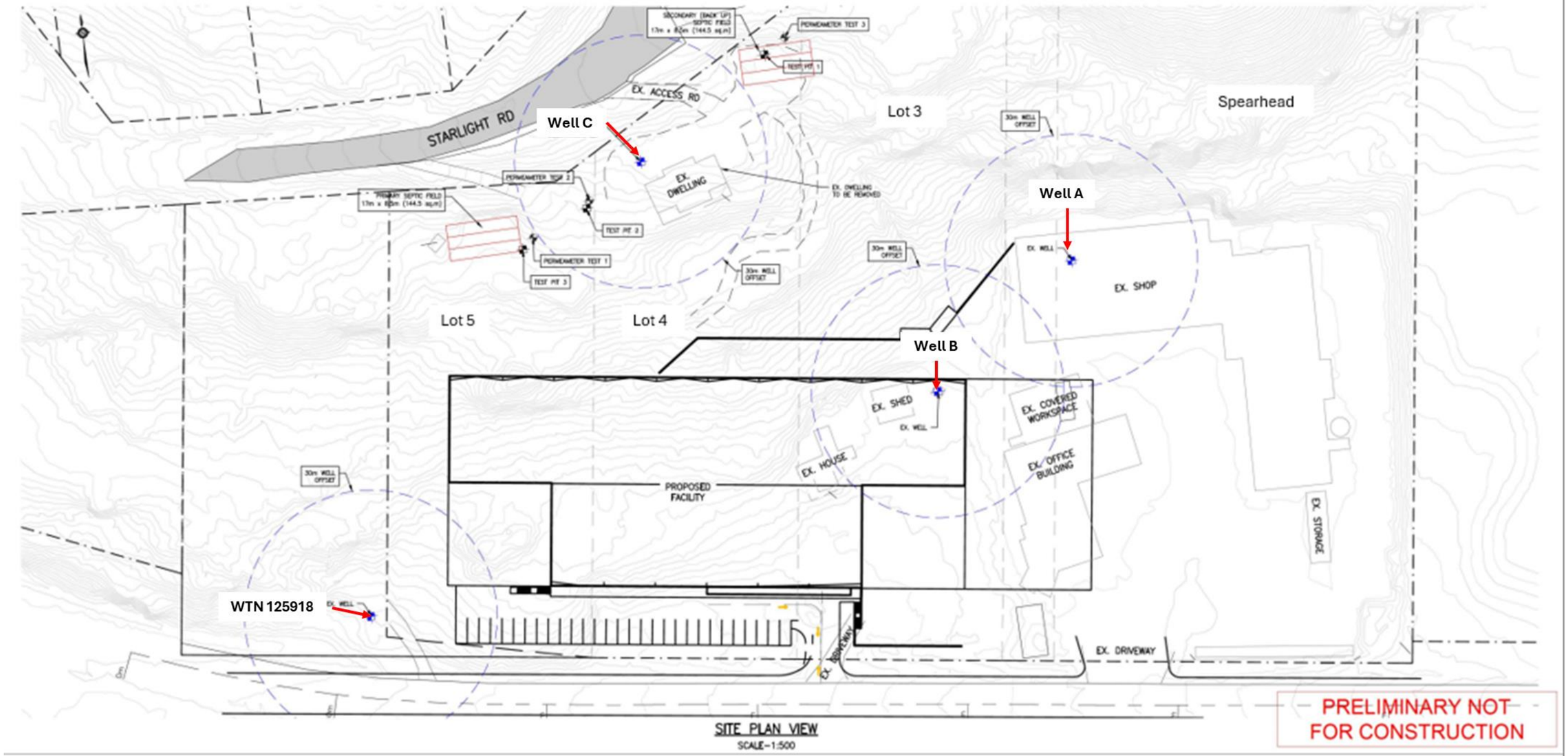


Figure 6: Test Pit and Well Location Plan (after Highland, 2025)

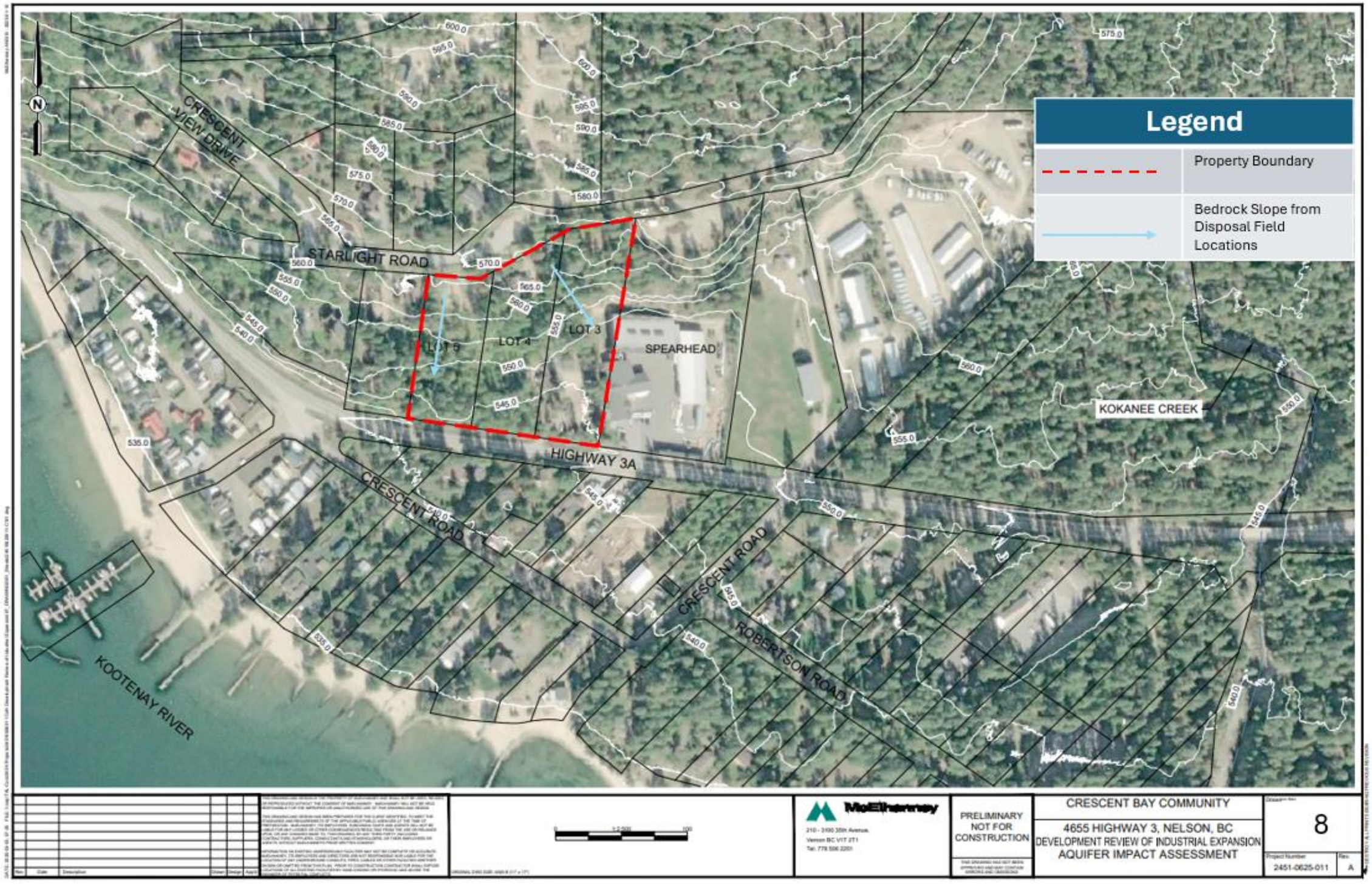
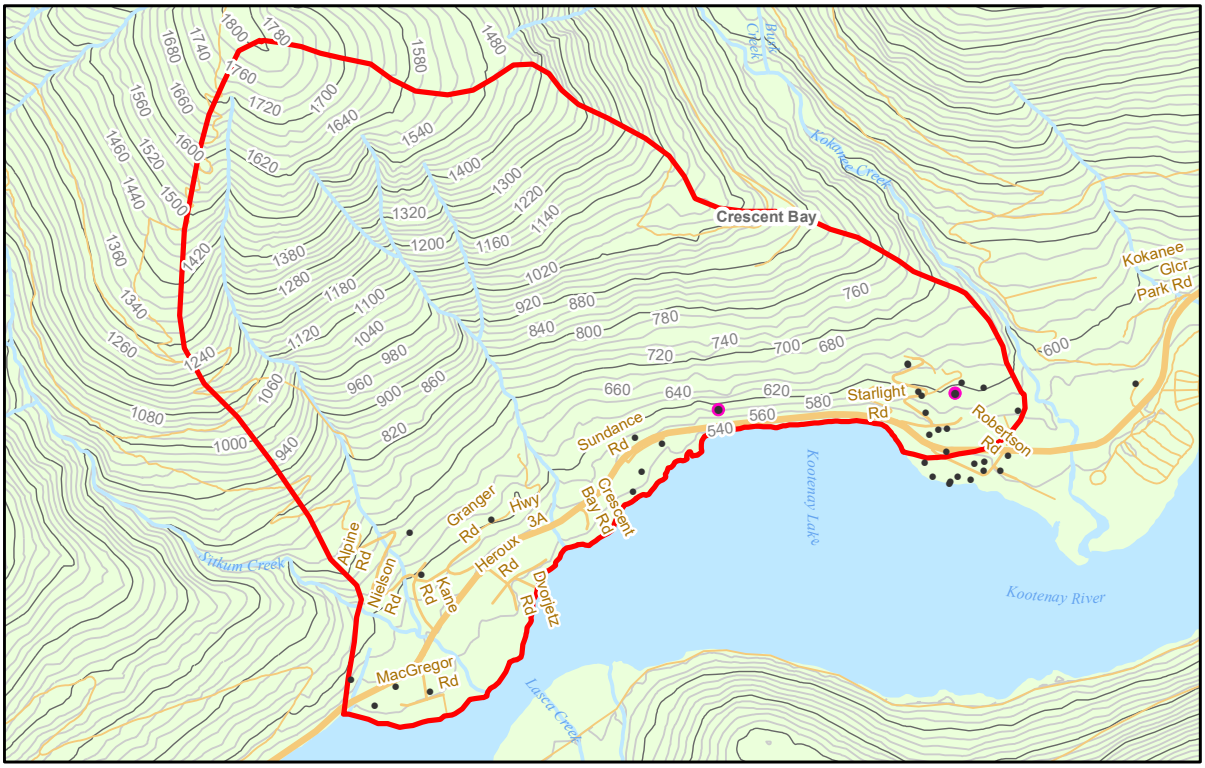


Figure 8: 5 m contours obtained from Lidar imagery across the Property

APPENDIX A

Aquifer Mapping and Factsheet Reports for AQ 994 and AQ 1018

Aquifer #1018



Legend

- Registered Water Well - Artesian
- Registered Water Well
- Aquifer Boundary

0 0.45 0.9 km

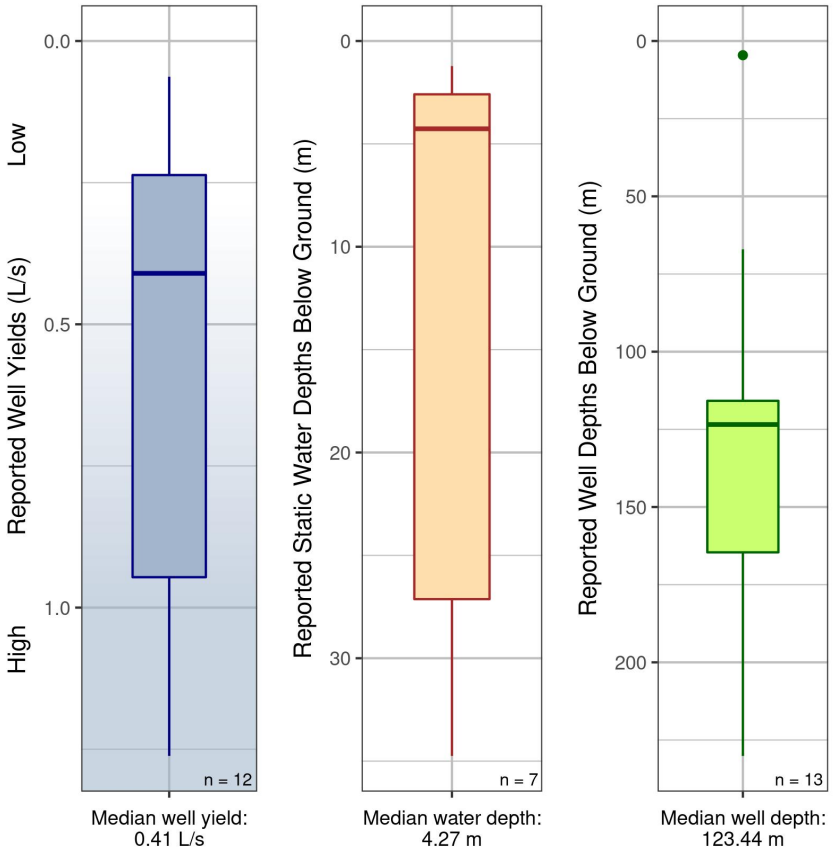
N

Aquifer Description (Mapping Report - 2012): Fractured crystalline (igneous intrusive or metamorphic, meta-sedimentary, meta-volcanic, volcanic) rock aquifer (subtype = 6b).

Aquifer Details	
Region	Kootenay
Water District	Nelson
Aquifer Area	8.4 km^2
No. Wells Correlated	13
Vulnerability to Contamination	Moderate
Productivity	Moderate
Aquifer Classification	IIIB
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	Unknown
Observation Wells (**Active**, Inactive)	None

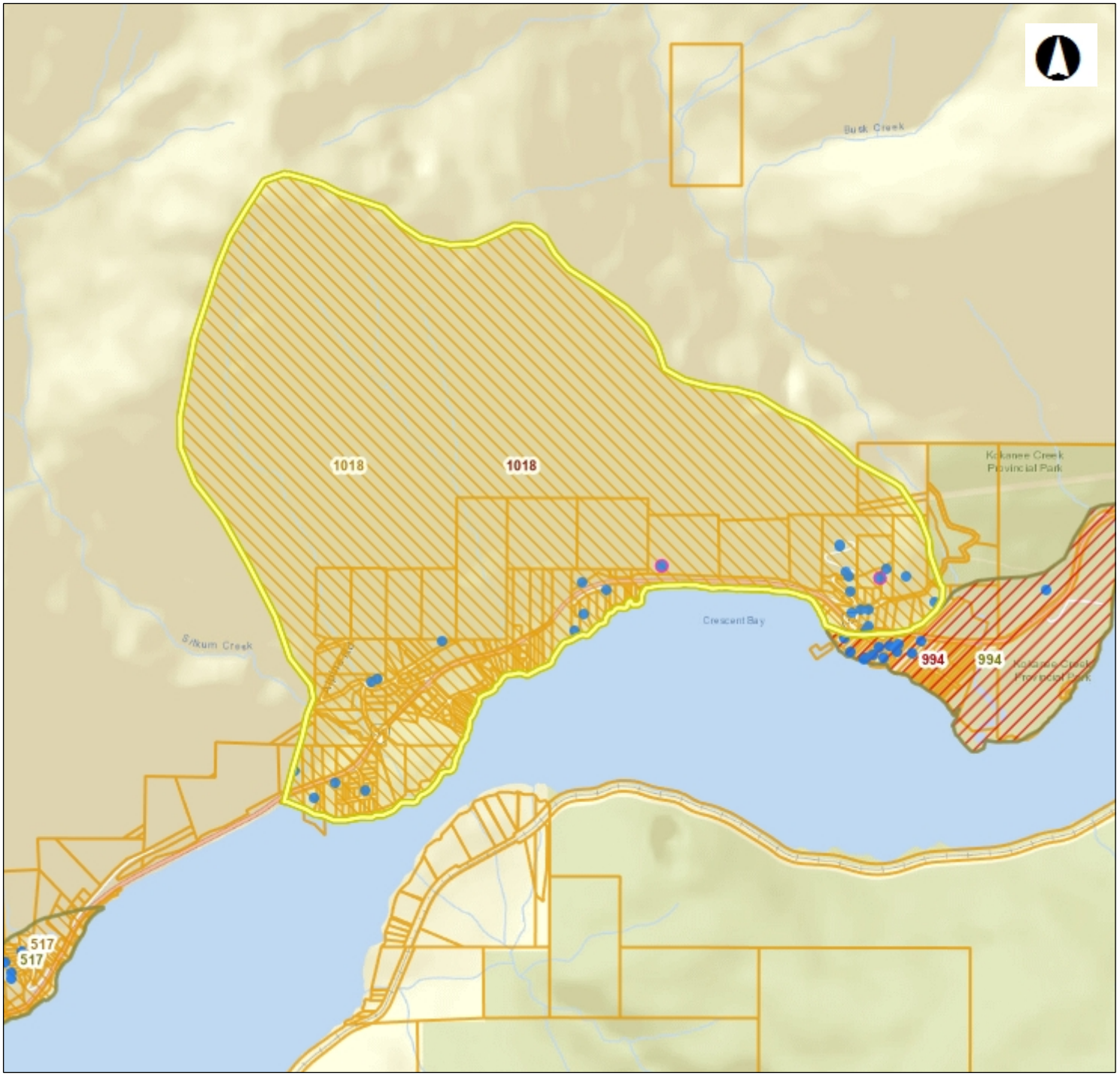
* min - max

For Hydraulic Connection see guidance document



Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2022-07-27. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.



BRITISH COLUMBIA

Mapped Extent of Aquifer 1018

Legend

Groundwater Wells - All

ARTESIAN_COND

Reported Artesian Well

Well

Aquifers - All

MATERIAL

Unconsolidated

Bedrock

Aquifers - Vulnerability

VULNERABILITY

High

Moderate

Low

PMBC Parcel Cadastre - Ou

0 1.02 2.03 km

1: 50,000

Datum: NAD83

Projection: BC Albers

Key Map of British Columbia

AQUIFER CLASSIFICATION WORKSHEET

DATE:	31-Mar-12
AQUIFER REFERENCE NUMBER:	1018
DESCRIPTIVE LOCATION OF AQUIFER:	Crescent Bay, BC
NTS MAP SHEET:	082F11
BCGS MAP SHEET:	082F065

CLASSIFICATION: IIB **RANKING: 9**

Aquifer Size: 8.35 km^2

Aquifer Boundaries:

The aquifer boundaries were delineated based on well lithology, the extent of groundwater development, bedrock geology, and the drainage area encompassing the extent of development (topography). The southern boundary is shown with a solid line along the west arm of Kootenay Lake between Longbeach and Fraser. The northern boundary is shown as a dashed line along the approximate drainage basin for the bedrock aquifer. This aquifer may be hydraulically connected (discharging to) aquifer 9939.

Aquifer Sub-type: 6b

Aquifer Priority Rating for Observation Wells: 24.64

Geologic Formation (overlying materials): clay & till

From surficial soils maps, the overlying deposits are mostly sandy tills (Fulton et. al, 1984). The thickness of the overlying deposits vary between 2.44 and 25.91 m and are described as clay, gravel, boulders, and till.

Geologic Formation (aquifer): bedrock

Fractured bedrock. Bedrock is made up of granodioritic intrusive rocks of the Nelson Batholith Group from the Mesozoic Era (Massy et. at., 2005). Within the well logs, bedrock was characterized as granite or simply referred to as ‘bedrock’.

Confined/Partially Confined/Unconfined: Partially Confined

Five of the 13 wells report low permeable confining deposits above the bedrock. These five wells are distributed across the southern extents of the aquifer. The eight wells that do not report low permeable confining deposits above the bedrock are within the south-eastern extents of the aquifer. Therefore, although only a few wells report the presence of confining deposits, the deposits are expected to be aerially extensive with localized windows of vulnerability in the southeast. The confining deposits are described as clay and till. Where present, the confining thickness varies between 3.05 m and 22.86 m. The average and median thicknesses of the confining deposits are 10.18 m and 9.14 m, respectively.

In the southeast where confining deposits are not reported, high permeable materials (gravel, cobbles, and boulders) were reported above the bedrock. In this region, there are localized windows of vulnerability to the aquifer.

Vulnerability: B - Moderate

The depth to water is shallow. The permeability of the aquifer materials is low (fractured bedrock). The aquifer is partially confined with localized windows of vulnerability in the southeast. The average thickness of the confining deposits is 10.18 m.

Productivity: Moderate – 0.4 L/s (geomean)

Well yields were reported for 12 of the 13 wells within the aquifer with values ranging between 0.06 L/s and 1.26 L/s. The geometric mean of the yield values is shown above and was used to calculate the aquifer rank. The median yield value is 0.38 L/s.

Depth to Water: 14.24 m (average)

Depth to water was reported for ten of the seven wells with values ranging between 1.22 m and 34.75 m. The average depth to water is shown above. The median depth to water is 4.27 m.

Direction of Groundwater Flow:

This has not been determined. It is estimated that groundwater flow is from areas of high elevation in the north towards Kootenay Lake in the south.

Recharge:

This has not been determined. It is estimated that recharge to this aquifer is from the infiltration of precipitation and discharge is to the surficial aquifer and Kootenay Lake in the south.

Domestic Well Density: Low – 1.4 domestic wells/km^2

The domestic well density was calculated based on ten private domestic wells and two unknown wells with a yield of less than 1 L/s. An unknown well with a yield of less than 1 L/s was assumed to be representative of a domestic well.

Type of Water Use: Drinking Water

None of the wells are listed as commericial/industrial or irrigation wells. Therefore, they are assumed to be for drinking water purposes.

Reliance on Source:

Conjunctive. There are natural springs and surface water licenses within this aquifer.

Conflicts between Users:

None documented.

Quantity Concerns:

None documented.

Quality Concerns:

None documented.

Comments:

Well depth ranges between 4.57 m and 230.12 m. The average and median well depths are 132.45 m and 123.44 m, respectively.

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AQUIFER CLASSIFICATION AND RANKING

AQUIFER LOCATION: Crescent Bay, BC

AQUIFER REFERENCE NUMBER: 1018

AQUIFER SUB-TYPE: 6b

AQUIFER PRIORITY RATING FOR OBSERVATION WELLS: 24.64

CLASSIFICATION: IIB **RANKING: 9**

Classification Component:

Level of Development – Low level of development and moderate productivity.

Level of Vulnerability – Depth to water is moderately shallow, permeability of the aquifer material is low, the aquifer is partially confined but there are windows of vulnerability within the southeast.

Ranking Component:	*Ranking Value:*
Productivity:	2
Vulnerability:	2
Size:	2
Demand*:	1
Type Of Use:	2
Quality:	
Quantity:	
Total:	**9**

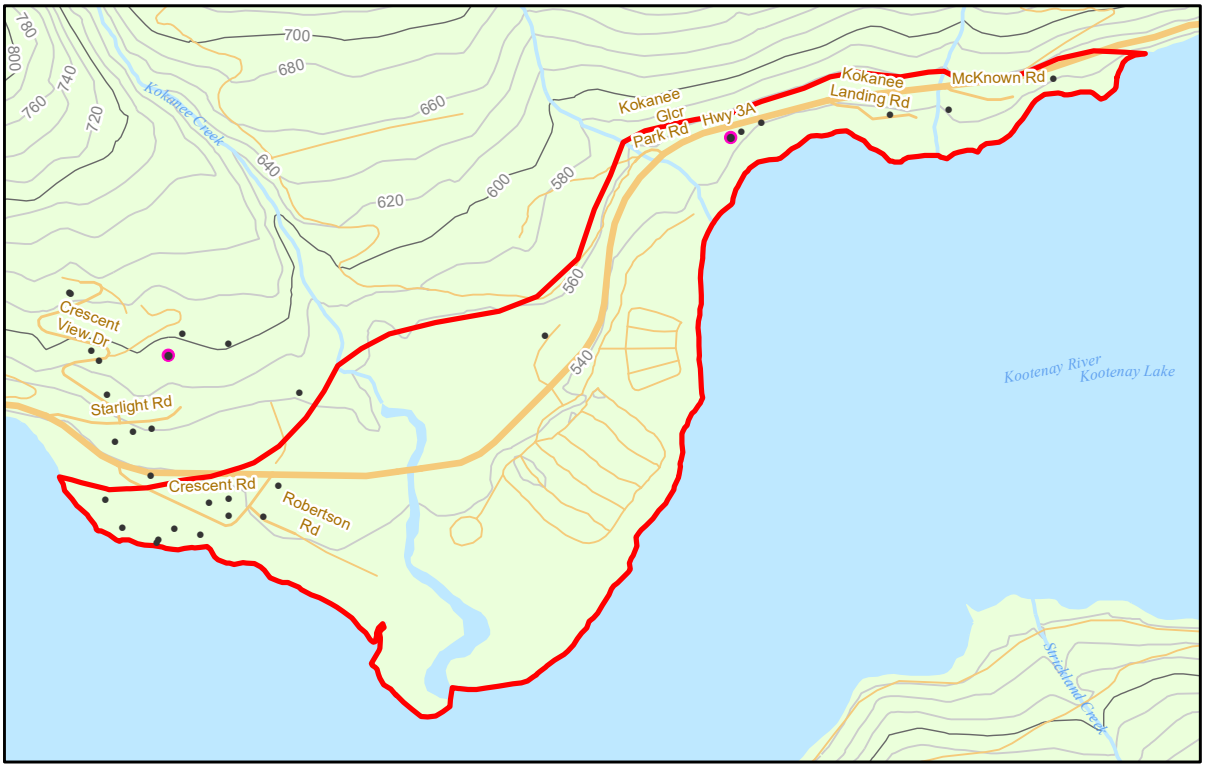
* Demand has been assessed subjectively. Demand is based on domestic well density, the presence of several water supply system wells, and general knowledge of well use and land use in the area. Demand assumes that the reported well capacity is the amount of water used, which can be misleading. The reported well capacity is often higher than actual use.

Statistical Summary of Well Data for Aquifer # 1018

Total number of wells available for statistical 13

	Depth to Bedrock (m bgs)	Well Depth (m bgs)	Depth to Water (m bgs)	Reported Est. Well Yield (L/s)	Est. Thickness of Confining Materials (m)
Number of Wells	9	13	7	12	5
Maximum	25.91	230.12	34.75	1.26	22.86
Minimum	2.44	4.57	1.22	0.06	3.05
Average	9.99	132.45	14.24	0.57	10.18
Median	4.57	123.44	4.27	0.38	9.14
Geometric Mean	7.08	104.28	7.03	0.40	7.78

Aquifer #994



Legend

- Registered Water Well - Artesian
- Registered Water Well
- Aquifer Boundary

N

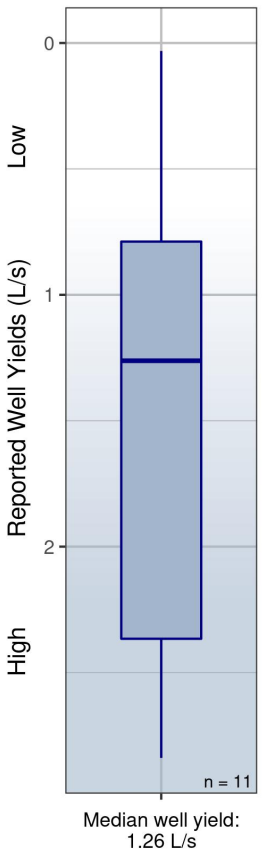
0 0.2 0.4 km

Aquifer Description (Mapping Report - 2012): Predominantly unconfined deltaic sand and gravel aquifers are commonly found in deltas where a stream or smaller river flows into a standing body of water (subtype = 2).

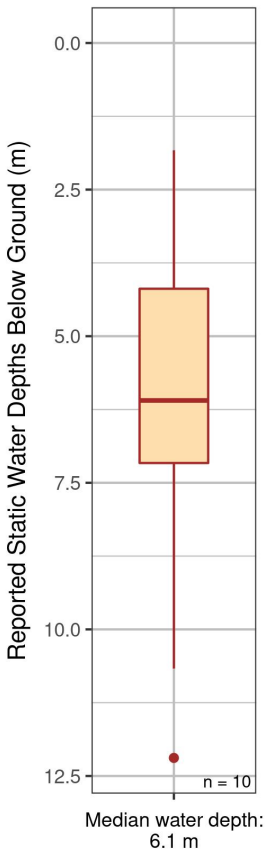
Aquifer Details

Region	Kootenay
Water District	Nelson
Aquifer Area	1.2 km^2
No. Wells Correlated	13
Vulnerability to Contamination	High
Productivity	Moderate
Aquifer Classification	IIA
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	Unknown
Observation Wells (**Active**, Inactive)	None

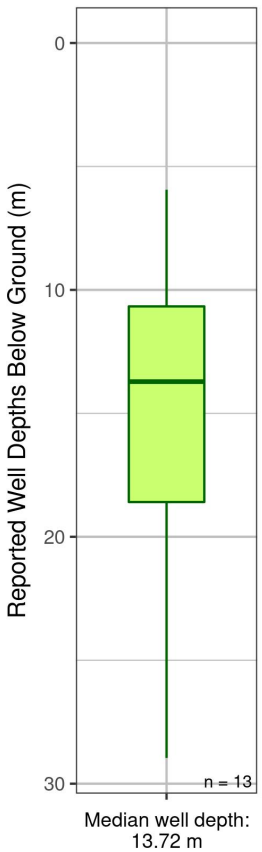
* min - max
For Hydraulic Connection see guidance document



Median well yield: 1.26 L/s

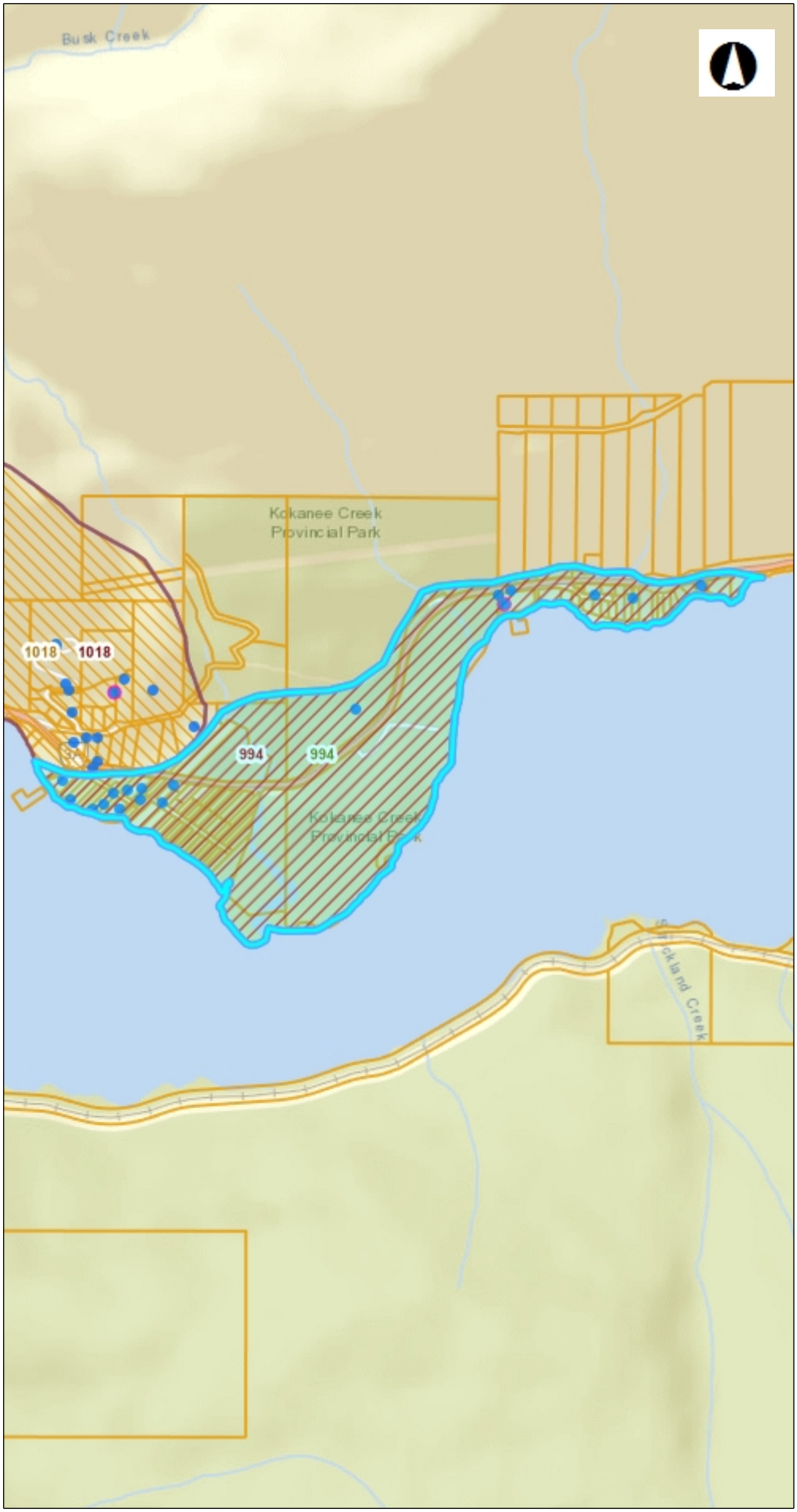


Median water depth: 6.1 m



Median well depth: 13.72 m

Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).
Factsheet generated: 2022-07-27. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.



BRITISH COLUMBIA

Water Resources Atlas

Legend

Groundwater Wells - All

ARTESIAN_COND

Reported Artesian Well

Well

Aquifers - All

MATERIAL

Unconsolidated

Bedrock

Aquifers - Vulnerability

VULNERABILITY

High

Moderate

Low

PMBC Parcel Cadastre - Ou

0 0.73 1.5 km

1: 36,111.91

Copyright/Disclaimer

Datum: NAD83

Projection: BC Albers

Key Map of British Columbia

AQUIFER CLASSIFICATION WORKSHEET

DATE:	31-Mar-12
AQUIFER REFERENCE NUMBER:	994
DESCRIPTIVE LOCATION OF AQUIFER:	Kokanee Point, BC
NTS MAP SHEET:	082F11
BCGS MAP SHEET:	082F065

CLASSIFICATION: IIA **RANKING: 10**

Aquifer Size: 1.18 km^2

Aquifer Boundaries:

The aquifer boundaries were delineated based on well lithology, the extent of groundwater development, surficial soils mapping, and topography. The southern boundary is shown with a solid line along the west arm of Kootenay Lake between Crescent Bay and east of the Kokanee Narrows where the aquifer is believed to discharge. The northern boundary is shown as a dashed line where the valley bottom meets the valley wall at the base of Mount Yuill.

Aquifer Sub-type: 2

Aquifer Priority Rating for Observation Wells: 32.38

Geologic Formation (overlying materials): clay, sand & fines, and boulders

Fifty-three percent of the wells log the aquifer material to surface. Where the aquifer material is not at surface, fluvial deposits of sand & fines, dirty sand & gravel, silt, clay, and some till and boulders are reported.

Geologic Formation (aquifer): sand & gravel

Fluvial gravel, sand, and sand & gravel deposits. Aquifer materials are present at surface in 53% of the wells.

Confined/Partially Confined/Unconfined: Partially Confined

Low permeable confining deposits of sand & fines, silt, till, and clay were reported in five of the thirteen wells within the aquifer. Where reported, the thickness of these deposits varies from

1.83 to 16.15 m. The average thickness of the low permeable deposits is 7.98 m. The median thickness is 8.23 m. These deposits are not aerially extensive. As well, 53 percent of the wells have logged the aquifer material to surface. This aquifer is considered partially confined with windows of vulnerability.

Vulnerability: A - High

The depth to water is shallow. The permeability of the aquifer materials is high. The aquifer is partially confined with windows of vulnerability. The confining sediments are not aerially extensive and are comprised of some moderately permeable materials (sand & fines). Fifty-three percent of the wells log the aquifer material at surface. Therefore, although the aquifer is partially confined, majority of this aquifer is highly vulnerable to contamination from surface activities.

Productivity: Moderate – 0.89 L/s (geomean)

Well yields were reported for 11 of the 13 wells within the aquifer with values ranging between 0.03 to 2.84 L/s. The geometric mean of the yield values is shown above and was used to calculate the aquifer rank. The median yield value is 1.26 L/s.

Depth to Water: 6.16 m (average)

Depth to water was reported for ten of the 13 wells with values ranging between 1.83 m and 12.19 m. The average depth to water is shown above. The median depth to water is 6.1 m.

Direction of Groundwater Flow:

This has not been determined. It is estimated that groundwater flow is from areas of high elevation in the north towards Kootenay Lake in the south and perhaps locally towards Kokanee Creek.

Recharge:

This has not been determined. It is estimated that recharge to this aquifer is from the infiltration of precipitation and discharge from bedrock aquifers to the north.

Domestic Well Density: Moderate – 6.77 domestic wells/km^2

The domestic well density was calculated based on four private domestic wells and four unknown wells with a yield of less than 1 L/s. An unknown well with a yield of less than 1 L/s was assumed to be representative of a domestic well.

Type of Water Use: Drinking Water

Reliance on Source:

Conjunctive. There are natural springs and surface water licenses within this aquifer.

Conflicts between Users:

None documented.

Quantity Concerns:

One well has gone dry.

Quality Concerns:

None documented.

Comments:

Well depth ranges between 5.94 m and 28.96 m. The average and median well depths are 15.46 m and 14.28 m, respectively.

References:

Berardinucci J. and K. Ronneseth, 2002. Guide to Using the BC Aquifer Classification Maps For the Protection and Management of Groundwater. BC Ministry of Water, Land and Air Protection, Water Management Branch, Groundwater Section.

Fulton, R.J., I. Shetsen, and N.W. Rutter. 1984. Surficial Geology, Kootenay Lake, British Columbia – Alberta. Geological Survey of Canada, Open File 1084.

AQUIFER CLASSIFICATION AND RANKING

AQUIFER LOCATION: Kokanee Point, BC

AQUIFER REFERENCE NUMBER: 994

AQUIFER SUB-TYPE: 2

AQUIFER PRIORITY RATING FOR OBSERVATION WELLS: 32.38

CLASSIFICATION: IIA **RANKING: 10**

Classification Component:

Level of Development – Moderate level of development and moderate productivity.

Level of Vulnerability – Depth to water is shallow, permeability of the aquifer material is high, the aquifer is partially confined but majority of the aquifer is vulnerable due to a lack of confining deposits present.

Ranking Component:	*Ranking Value:*
Productivity:	2
Vulnerability:	3
Size:	1
Demand*:	2
Type Of Use:	2
Quality:	
Quantity:	
Total:	**10**

* Demand has been assessed subjectively. Demand is based on domestic well density, the presence of several water supply system wells, and general knowledge of well use and land use in the area. Demand assumes that the reported well capacity is the amount of water used, which can be misleading. The reported well capacity is often higher than actual use.

Statistical Summary of Well Data for Aquifer # 994

Total number of wells available for statistical 13

	Depth to Bedrock (m bgs)	Well Depth (m bgs)	Depth to Water (m bgs)	Reported Est. Well Yield (L/s)	Est. Thickness of Confining Materials (m)
Number of Wells	0	13	10	11	5
Maximum	0.00	28.96	12.19	2.84	16.15
Minimum		5.94	1.83	0.03	1.83
Average		15.46	6.16	1.40	7.98
Median	0.00	13.72	6.10	1.26	8.23
Geometric Mean	0.00	14.28	5.23	0.89	6.10

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