WELL DRILLING ADVISORY

Flowing artesian conditions
Surrey and Langley, BC

Flowing artesian conditions potentially exist in areas of the Serpentine and Nicomekl River watersheds in Surrey and Langley. Well drillers and property owners should be aware of potential complications and costs of flowing artesian wells.

Where do flowing artesian conditions occur?

The area under potential artesian pressure is located within the Township of Langley boundaries and extends westward into the City of Surrey (Figure 2). The area covers approximately 193 square kilometers and includes Aquifers 58, 33, and 51.

What is a flowing artesian well?

A flowing artesian well is one that has been drilled into an aquifer where the pressure within the aquifer forces the groundwater to rise above the land surface naturally without using a pump. A flowing artesian well may flow on an intermittent or a continuous basis (Figure 1).

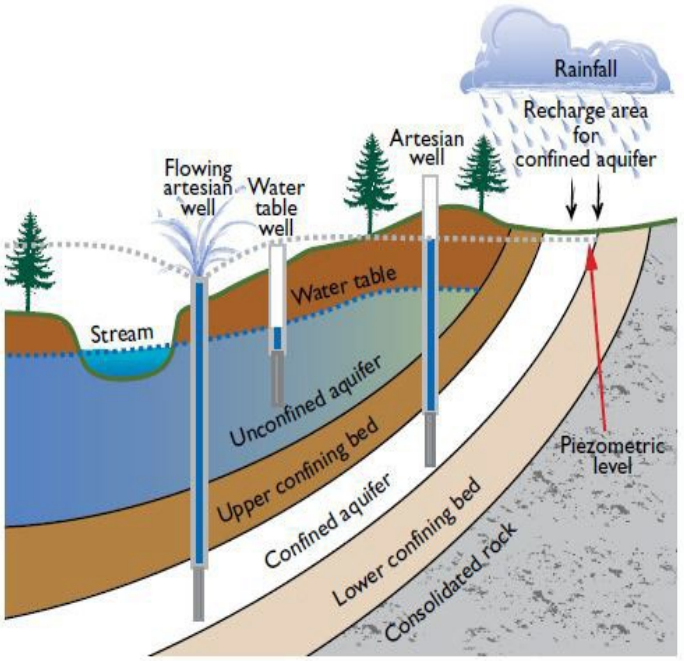

Figure 1: Geological and topographical controls affecting artesian and flowing artesian wells. The piezometric level is the imaginary height that the water level will rise in a well penetrating a confined aquifer.

It is important to properly construct the well to control this flow. Controlling artesian flow conserves groundwater resources, preserves the pressure within the aquifer, protects flow at critical natural discharge points such as streams or springs, and prevents damage to the natural environment (i.e., property damage, flooding, and erosion). A flowing artesian well can cause substantial damage and incur significant and unexpected costs if not carefully planned and constructed. Well drillers and well owners should be prepared in advance in case flowing artesian conditions are encountered.

Why are there flowing wells in Surrey and Langley (Aquifers 58, 33 and 51)?

Aquifers 58, 33 and 51 underlie much of the Township of Langley and the western portion of the City of Surrey (Figure 2). They are comprised of sands and gravels of glaciofluvial and glaciomarine outwash. Aquifer 58 is associated with the Semiahmoo and possibly pre-Semiahmoo glaciations; Aquifer 33 is associated with the Early Fort Langley Formation or intertill deposits of the Vashon Drift Formation; and Aquifer 51 is characterized as a series of interbedded glaciofluvial sand and gravel tentatively assigned as Vashon Drift. All three aquifers lie beneath thick intervals of silt, clay and till. The presence of these low permeability sediments overlying the aquifers acts as a confining layer. The confining layer creates a buildup of pressure by restricting flow of water out of the aquifer, resulting in artesian conditions.

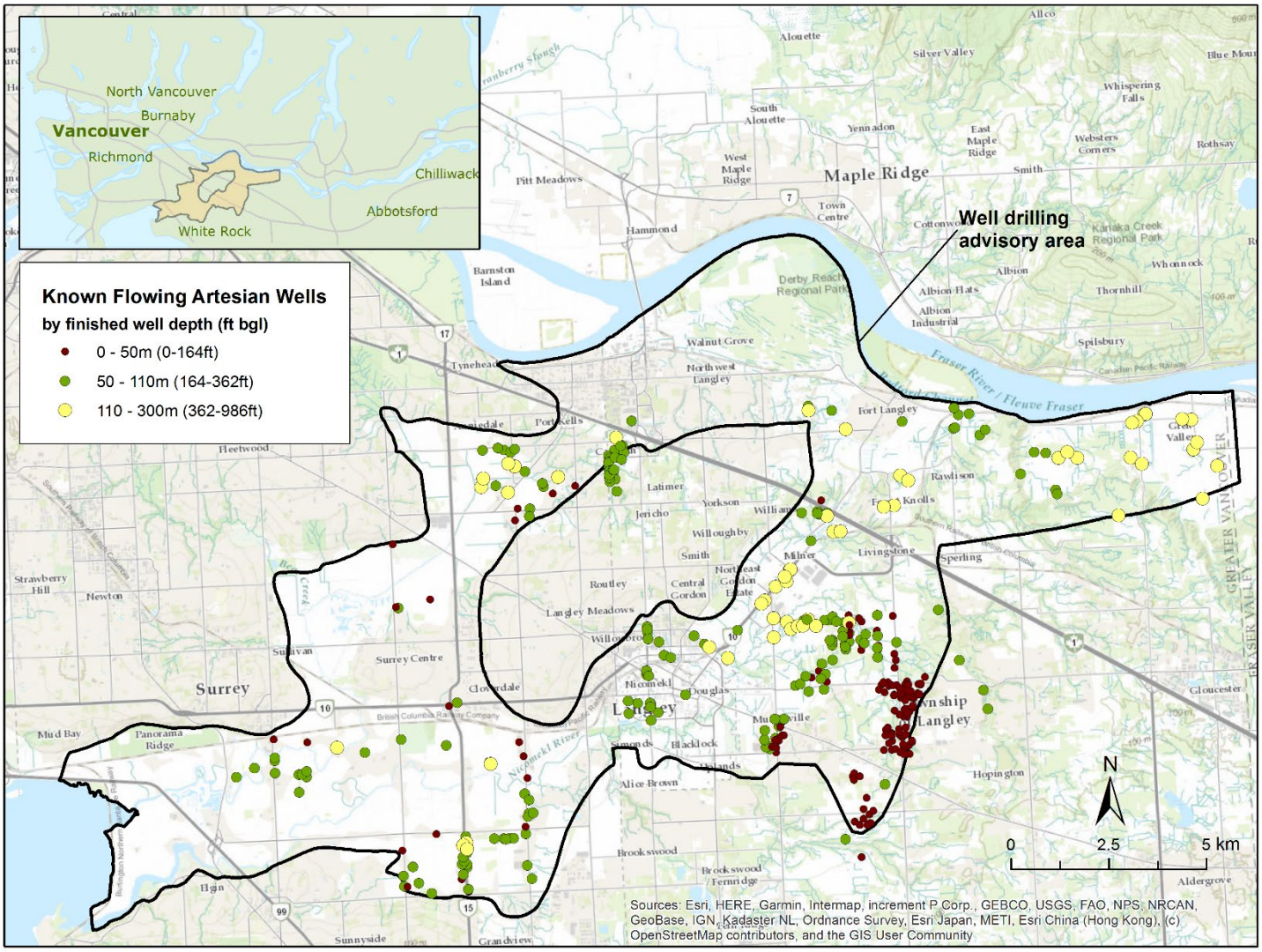

Figure 2: Map of the location of potential flowing artesian conditions (aquifers 58, 33, and 51) in Langley and Surrey, B.C.

Known flowing artesian wells in Surrey and Langley

A review of the BC GWELLS database indicates that over 350 wells in the area had reported flowing artesian conditions at the time of drilling. It is possible that there are additional flowing wells in the area, but these wells have not been registered in the BC GWELLS database (submission of well records for most types of wells became mandatory in 2016. Until this point, well records were submitted on a voluntary basis.) Of the known artesian wells, flow rates range up to 1090 m^3/day (200 US gallons per minute).

The depth to known artesian conditions ranges from 4 m to 186 m below ground.

In Aquifer 58, the depths that wells have encountered artesian conditions range from 4 m to 186 m (12 to 612 feet) below ground level, with an average of 92 m below ground level. In Aquifers 33 and 51, the depths that wells have encountered artesian conditions range from 12 m to 97 m (41 to 320 feet) below ground level, with an average of 45 m below ground level. Locations of known artesian wells can be accessed through iMapBC.

Do all wells in the area encounter flowing artesian conditions?

Artesian conditions generally occur within the outer perimeter of aquifer 58, within the Serpentine Valley (Northwest) and the Nicomekl Valley (South). Flowing artesian wells generally do not occur in the highlands of Cloverdale and Langley Meadows, within the center of aquifer 58. Generally, flowing artesian wells occur within areas of low topographic elevation and low angle slopes.

Most areas of Aquifers 33 and 51 do not have a high likelihood of artesian conditions, as flowing wells are limited to the western extents of the aquifers. The artesian conditions are understood to be topographically controlled, as the flowing artesian conditions correspond to a change in ground elevation from the surrounding highlands. The confining unit is continuous over the aquifer and maintains the hydraulic head at a relatively constant level, however where the ground elevation drops, it results in the hydraulic head being above the ground surface.

The glacial deposits of the Fraser Valley are complex, with multiple stacked layers of sands and gravels between clays, silts, and tills. There are more than 20 mapped aquifers which overlap with the extents of Aquifers 58, 51 and 33. Most of these aquifers are not known to experience flowing artesian conditions, however, there are five other aquifers where flowing artesian wells have been recorded: Aquifers 55, 59, 35, 1144, and 1194. Therefore, drillers and property owners should be aware of the potential for flowing artesian conditions when drilling into or through aquifers within the area of this advisory. If you drill through any of the listed aquifers into an underlying deeper confined aquifer, there is an increased likelihood of encountering flowing artesian conditions.

Preparing for drilling in the Surrey and Langley area

Qualifications and experience

In B.C., anyone constructing a well[1] (with some exceptions for shallow excavated wells) must be registered as a well driller or be working under the supervision of a registered well driller or a professional (engineer or geoscientist, with competency in hydrogeology or geotechnical engineering). Registered well drillers must also be classified and have the qualifications required to work on the particular class of well that they are working on (e.g., water supply wells, geoexchange wells, dewatering wells, etc.)

Water well drillers in BC must be registered and must be qualified to work on the particular class of well that they are working on.

Regardless of the class of well being drilled, if artesian conditions are encountered and the well has the likelihood to flow, a well driller or a professional who is qualified in respect of the activity must be engaged to stop or control the flow. To be qualified, a well driller or professional must have competency in stopping or controlling artesian flow (as a result of training, experience, knowledge and skills) and have the equipment required to deal with flowing artesian conditions. A well driller may also undertake that activity if supervised by another registered well driller or a professional, who has competency in stopping or controlling artesian flow.

If a person constructing a well (other than a qualified well driller or professional) encounters flowing artesian conditions that person, and the property owner, must engage a well driller who is qualified, or a professional, to ensure that any artesian flow is stopped or brought under control. Controlling artesian flow is defined under Sec. 52 of the *Water Sustainability Act* and described below.

Controlling artesian flow means that the entire flow:

- Must be conveyed through the well's production casing;
- Can be stopped indefinitely without leakage outside of the production casing;
- Is clear of sediment;
- Must not pose a threat to property, public safety, or the environment.

Flow is not considered controlled if:

- Water is surfacing outside the well casing or in another location nearby;
- The flow cannot be stopped (e.g., with a valve shut-off or packer assembly);
- There is subsurface erosion (i.e., evident if flowing water is muddy or murky).

[1] A well is defined in the *Water Sustainability Act* as: an artificial opening in the ground made for the purpose of (a) exploring for or diverting groundwater, (b) testing or measuring groundwater, (c) recharging or dewatering an aquifer, (d) groundwater remediation, (e) use as a monitoring well, (f) use as a closed-loop geoexchange well, or (g) use as a geotechnical well.

Assuming artesian flow

It is important to understand that geologic conditions are highly variable and information may not be available near the proposed drilling location(s); therefore, neither the presence nor absence of flowing artesian conditions can be known with certainty prior to drilling. Therefore, when drilling into aquifers within the area of this advisory (see Figure 2) in Surrey and Langley, it should always be assumed that flowing artesian conditions will be present and assume a precautionary approach (e.g., installing and sealing a surface casing of sufficient length). The well driller and property owner must be prepared for the resulting costs, planning time, materials, expertise and equipment needed to construct the well to control or stop any artesian flow.

To manage the uncertainty, well drillers should always conduct a pre-drilling assessment. This could include:

- Assessing the physical setting of the proposed well (e.g., in a valley or area where nearby water is at a higher elevation),
- Consulting with local groundwater professionals, experienced well drillers, or residents to learn of other flowing wells or springs in the area,
- Examining well records from the BC GWELLS database (available at apps.nrs.gov.bc.ca/gwells/) and the Groundwater Wells layer using mapping tools (e.g., BC Water Resources Atlas or iMapBC).
- Reviewing professional hydrogeologic reports in the Ecological Reports Catalogue (EcoCat) that may identify artesian aquifers (www.env.gov.bc.ca/ecocat/).

Considerations for Property Owners

- Ensure the driller or professional you hire is registered with the Province, qualified and experienced with flowing artesian conditions. Obtain multiple quotes.
- Have an agreement in place with the driller to deal with flowing artesian conditions.
- Recognize the real risks and your liability to neighbours and others if uncontrolled flows cause damage.

Considerations for Well Drillers

- Ensure you have experience and equipment to deal with flowing artesian conditions.
- Assume flowing artesian conditions will be encountered in the subject area (Figure 2).
- Inform property owners of potential risks and associated costs of flowing artesian wells prior to drilling.

Preparing and budgeting

It is the responsibility of the well driller to advise the property owner of potential hazards associated with uncontrolled artesian flow (e.g., potential for erosion, flooding, subsidence) and the associated costs. The property owner and well driller should always have an agreement in place ahead of time to minimize any misunderstandings in the event that flowing artesian conditions are encountered. Although preparing and constructing a well for flowing artesian conditions costs more than one in non-flowing conditions, it is substantially less than the ensuing costs to repair damages or to decommission an uncontrolled flowing

well. In B.C., the cost to decommission a high pressure, high flow well that was not constructed to handle flowing artesian conditions can easily reach hundreds of thousands of dollars and possibly millions of dollars; in comparison, installing a permanent surface casing of sufficient length to control the flow before drilling into the flowing artesian aquifer can costs tens of thousands of dollars.

Constructing a well for flowing conditions

Assessing the geological and hydrogeological environment will help determine the best construction process for wells that may encounter flowing artesian conditions:

- For bedrock aquifers, the bottom of the casing should be sealed securely into the bedrock to ensure the flowing water can not rise up through the annular space of the well.
- For sand and gravel aquifers, a permanent outer casing should be grouted into the lowest confining layer before the inner production casing is drilled into the aquifer. A seal should be installed between the two casings to ensure flowing water can not rise up between the casings.

Drilling methods such as digging, boring, driving, augering and jetting are not typically sufficient where flowing conditions may be encountered; cable tool, air rotary, or mud rotary methods have been used more successfully. Plastic casings are not recommended for use in flowing artesian conditions.

For additional information on assessing, controlling, or decommissioning flowing artesian wells refer to:

- Province of BC's Flowing Artesian Well Brief for The Well Owner: www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-wells/flowing_artesian_wells.pdf
- Mapping the Likelihood of Flowing Artesian Conditions in the Okanagan Basin and Fraser Valley, British Columbia (Johnson, Allen, and Wei, 2022): a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=59470
- Government of Ontario, Water Supply Wells – Requirements and Best Management Practices Handbook (Chapter 12): www.ontario.ca/page/water-supply-wells-requirements-and-best-practices
- Michigan Department of Environmental Quality's Flowing Well Handbook: www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf

Legislation and regulatory information

To learn more about the applicable regulations, please see:

- *Water Sustainability Act*, Sections 52 and 53: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/14015
- Ground Water Protection Regulation Guidance Manual (June 2019): www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/gwpr_guidance_manual_signed.pdf

Contact

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