

Bulletin

Groundwater Management Bulletin

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By-law and Policy References

For a full list of by-law and policy references, see Appendix B.

- *Building By-law No. 12511*
- *Sewer and Watercourse By-law No. 8093*
- *Zoning and Development By-law No. 3575*
- *Rezoning Policy for Sustainable Large Developments*

Definitions

The following definitions apply in this bulletin:

- **Aquifer:** A layer of permeable material below ground where groundwater can be transmitted and stored.
- **Groundwater:** Water occurring below the surface of the ground within voids in a rock or soil matrix¹.
- **Groundwater management plan:** A written plan that sets out a comprehensive approach to the planning, design, implementation and operation of on-site groundwater management techniques to meet the requirements imposed on the development.
- **Hydrogeological study:** A written report, certified by a professional engineer or geoscientist, of the occurrence, distribution and effect of groundwater on a proposed development site. It may include a groundwater management plan and/or an impact assessment.
- **Impact Assessment:** A written report that sets out any potential or realized environmental impacts which may or will result from infiltration or extraction of groundwater at the development site.
- **Sewer:** A pipe or conduit that carries wastewater, stormwater or clear-water waste.
- **Static water level:** The elevation or depth of a water table (including within perched lenses) or potentiometric surface of a confined aquifer when the level is undisturbed by pumping or other activities.

Background and Context

The purpose of this bulletin is to provide rezoning and development permit applicants with information on the process and submission requirements related to groundwater management at development sites throughout the City of Vancouver (the “City”). The goal of groundwater management is to reduce groundwater-related risks, including impacts to the environment and to the sewer and drainage network. These requirements are applied to certain types of projects, including when they are located within the Groundwater Areas of Concern (see Section 2.1 for additional information).

¹ “Groundwater” includes water within any saturated, permeable geologic unit, such as a perched lens or aquifer.

1 Key Concerns

The City recognizes that groundwater has historically been pumped or drained during and after construction, and then discharged to the sewer system as waste. However, there are a number of concerns with both construction-related and permanent (i.e. post-construction) extraction/diversion of groundwater, including those listed below.

Table 1: Summary of Key Concerns Related to Groundwater Extraction/Diversion

Key Concern	Summary
Aquifer Depletion	The extraction/diversion of groundwater (e.g. via construction-related dewatering or permanent foundation drainage) diverts water to the sewer from aquifers. Rather than treating groundwater as waste, the City is making efforts to ensure that aquifers (including perched aquifers) are managed in a sustainable manner.
Contaminant Introduction and/or Migration	The introduction and/or migration of contaminants (including saltwater intrusion, chemicals from contaminated sites, etc.) can be initiated or exacerbated by the extraction/diversion (e.g. pumping, draining) of groundwater, as well as through artificial recharge (e.g. reinjection). These activities can reduce water quality at nearby wells.
Fish and Wildlife	Groundwater extraction can lower the water table and reduce base flow to streams or water levels in connected ponds or wetlands, thereby negatively impacting fish, wildlife, and ecosystems. A lowered water table can also impact trees and other vegetation that rely on accessing shallow groundwater. Groundwater from construction sites (which can contain suspended sediments and other pollutants) discharged to storm or combined sewers can end up in receiving water bodies, where it can impact aquatic ecosystems.
Flooding	Flooding may occur due to unintended groundwater ingress into buildings. This is of particular concern during wet seasons, and can be exacerbated by climate change (as a rising sea level will induce a rising water table – also known as groundwater rise).
Flowing Artesian Conditions	A portion of the City of Vancouver falls within the Province of BC's Well Drilling Advisory area for potential flowing artesian conditions. Developments and well construction, including for geoexchange systems, in this area should consider the potential hazards associated with uncontrolled artesian flow. Consideration should also be made for the potential for basal heave in excavations that advance sufficiently deep in an area with an artesian aquifer.
Ground Subsidence	Groundwater extraction in areas with underlying peat and/or other soft organic materials can cause ground subsidence, which may damage City property and infrastructure as well as other neighbouring properties. Excessive

Key Concern	Summary
	extraction/diversion of groundwater can also remove material from the subsurface and lead to subsidence or even sinkhole formation.
Sewer Capacity	The existing sewer system in Vancouver was designed for stormwater flow, sanitary flow, or a combination of both. Sewer capacity limitations are therefore a concern for the City, as the system was not designed to accommodate groundwater. For example, the sewer system within the Cambie Corridor is approaching capacity; as a result, the City is taking steps to limit discharges of groundwater in this and other areas.

2 Hydrogeological Study

The City may require a hydrogeological study in order to demonstrate that a proposed development can be feasibly constructed without significant groundwater-related risks or negative impacts (see Table 1 above), either on site or off site. This includes limiting groundwater discharges to the City’s sewer system, and also to Metro Vancouver’s wastewater infrastructure.

By gaining a greater understanding of the subsurface regime, the City will also be better able to protect local aquifers and develop and implement a holistic framework for groundwater management that may enable the sustainable utilization of aquifer resources in the future, particularly as other water supplies become more constrained.

2.1 Applicability

While the City may require a hydrogeological study for any development in Vancouver², typically these assessments are required for larger projects (e.g. multiple dwelling buildings) that are located partly or wholly within any of the areas of concern for groundwater. In some instances, a hydrogeological study may be required for developments located outside of the areas of concern for groundwater where specific risks exist (e.g. if nearby infrastructure could be impacted by dewatering).

Keeping in mind that other less common situations exist, as a general guideline, a hydrogeological study should be submitted and approved by the City *any time one or more of the following triggers apply*:

1. Rezoning and development permit applications (for developments with 1 or more levels of below-ground structure³ and excluding lower density residential buildings⁴) located partly or wholly within any of the areas of concern for groundwater (review [Groundwater Areas of Concern map](#)):
 - Potential soil sensitivity to water table changes

² See Section 4 of the *Zoning and Development By-law No. 3575*

³ “Below-ground structure” includes basements, underground parking, etc.

⁴ Single detached homes, laneway homes, duplexes, and other multiple dwelling developments with eight or fewer units (including secondary suites and lock-off units) are excluded from the requirement for a hydrogeological study.

- Designated Floodplain
 - Sewershed within the Cambie Corridor
 - Broadway Plan area⁵
 - Potential flowing artesian conditions ([Province of BC's Well Drilling Advisory](#))
2. Applications anywhere in the city that include open-loop geoexchange systems.
 3. Sites subject to the [Rezoning Policy for Sustainable Large Developments](#).

Note that the City's requirement for a hydrogeological study is independent of the requirements for a geotechnical study, or other document; as such, a separate hydrogeological study should be submitted. An overview of hydrogeological study requirements can be found in Section 2.3 below, while a more detailed submission checklist can be found in Appendix A.

The requirements outlined in this bulletin are also not intended to supersede those for contaminated sites or the [wastewater discharge permit](#) process. Management of contaminated groundwater requires review by the City's Environmental Services branch⁶. An Erosion and Sediment Control (ESC) Plan may also be required as part of the building permit application⁷.

Refer to the City's online [Groundwater Areas of Concern map](#) to determine if a project is located partly or wholly within any of the areas of concern for groundwater. If you are still uncertain whether a hydrogeological study is required for your development, contact your Project Coordinator or Project Facilitator at the City.

2.2 Conditions

Per the regulatory framework found in Appendix B of this bulletin, applicants for rezoning and development permits may be required to produce a hydrogeological study (or series of successive studies) that meets the following two conditions:

1. No Permanent Groundwater Discharge to the Sewer System

Any plans for dewatering/drainage of the site must ensure that permanent discharge of groundwater (including from perched aquifers) to the City's sewer system is avoided. Each proposed development is assessed based on details of the project and the site hydrogeology; however, the following guidance generally applies:

- a. Construction-related dewatering/drainage (i.e. of groundwater or precipitation) *is permitted* to be discharged to the City's sewer system, subject to available capacity and other conditions (e.g. minimum standards for water quality⁸). Applicants may be required to monitor and

⁵ The Broadway Plan area extends from Vine St. to Clark Dr., and from 1st Ave. to 16th Ave. For a more detailed map, see p. 6 of the [Broadway Plan](#), or the [Groundwater Areas of Concern map](#).

⁶ See [Groundwater Discharges from Contaminated Sites Bulletin](#).

⁷ See [Bulletin 2002-003-EV](#) for Large Lot Developments (1000 m² or more), and [Bulletin 2002-002-EV](#) for Small Lot Developments (less than 1000 m²).

⁸ Minimum water quality standards for discharges to the City's sewer system can be found in [Bulletin 2002-003-EV](#) for Large Lot Developments (1000 m² or more) as well as Section 3 of the [Sewer and Watercourse By-law No. 8093](#). Note that a

report discharge flow rates to the sewer during excavation and construction. See checklist in Appendix A for details.

- b. Permanent (i.e. post-construction) dewatering/drainage of water from saturated soils is *not permitted* to be discharged to the City's sewer system. This includes water from permanent on-site drainage infrastructure such as perimeter and foundation drains. Drainage systems may be installed in order to collect rainwater, surface runoff, and water in the unsaturated zone. However, these systems should be constructed in a way that prevents naturally saturated soils (such as perched lenses) up to the annual high water mark from being dewatered, unless this water is being infiltrated elsewhere on site. See checklist in Appendix A for details.

2. No Significant Risks or Negative Impacts from Groundwater Extraction/Diversion

If any groundwater extraction/diversion is required, it must be demonstrated that there will be no significant risks or negative impacts either on site or off site, including with respect to human health, property, infrastructure, the environment, or groundwater resources.

The final hydrogeological study should include a groundwater management plan for both construction-related and permanent dewatering/drainage, as well as an impact assessment addressing all of the key concerns listed in Table 1 as well as any others that may apply to the site. Discharge monitoring and reporting may also be required at the discretion of the City.

2.3 Submission Requirements

This section outlines the minimum requirements for hydrogeological study submissions at various project stages.

At the early stages of a project, it may be difficult to collect all of the information necessary to fully understand the site hydrogeology. Because of this, the City usually only requires a preliminary (or "desktop") hydrogeological study to start, typically as part of an application for rezoning. During its review of this initial study, the City will identify any outstanding information or other issues that need to be addressed in the next version of the study. If, under exceptional circumstances, an applicant has sufficiently demonstrated in the preliminary study that the project meets the two conditions in Section 2.2 above, the City may not require any additional versions of the hydrogeological study throughout the rest of the development process. However, the City may still impose conditions on the project – for example, to require flow monitoring during or even after construction, or to ensure that any significant risks or negative impacts are avoided or mitigated.

As the project advances through the development process and additional information is obtained, the preliminary hydrogeological study may undergo one or more revisions. Eventually, a final hydrogeological study will in most cases be required by the City (typically as part of a development permit application) that provides details of the proposed project and includes all of the necessary

qualified environmental consultant must be available to identify, characterize, and appropriately manage any environmental media of suspect quality which may be encountered during any subsurface work. All work on site must be conducted in compliance with all City and Metro Vancouver by-laws, as well as any applicable provincial or federal legislation, such as British Columbia's *Environmental Management Act* and *Contaminated Sites Regulation*.

hydrogeological data for the site. The final study should also incorporate a finalized impact assessment as well as a plan for groundwater management (for both during and after construction), and demonstrate that the two conditions listed in Section 2.2 will be met.

It should be noted that it can be advantageous for applicants to submit as much information as possible in their preliminary hydrogeological study, even when not actually required to do so. This allows for earlier decision-making about building and site plans, as well as additional time for any required revisions to the hydrogeological study. Providing information earlier in the process can also reduce the likelihood of project delays at the development permit review stage.

In addition to the different requirements at each development stage, hydrogeological studies may also vary in complexity depending on the local subsurface conditions as well as the identified risks and impacts. However, there are a number of basic requirements for every hydrogeological study submission, as outlined in the next sections.

For a detailed submission checklist of the information that needs to be included in a hydrogeological study, see Appendix A.

2.3.1 Preliminary Hydrogeological Study

Applicants for rezoning that meet one or more of the applicability criteria (see Section 2.1) are required to produce a preliminary hydrogeological study for City review.

This preliminary hydrogeological study should provide background information on the project and site, a summary of the proposed hydrogeological investigation, an anticipated approach to construction-related and permanent groundwater management, as well as discuss any significant groundwater-related risks or negative impacts.

Specifically, the preliminary hydrogeological study should include the following:

- A. Background and site information⁹
 - i. Site details, including a description of the property boundary, site, and surrounding topography
 - ii. Description of existing and proposed buildings, and their locations on site
 - iii. Current site grade
 - iv. Known or suspected contamination on or near site
 - v. Anticipated elevation and depth of foundation and excavation

⁹ Most items listed in bullet 'A' are typically available at the preliminary stage; however, depending on the development, it's possible that some (e.g. water level monitoring) won't be completed until the revised preliminary or even final hydrogeological study.

- vi. Number of levels of below-ground structure (e.g., parking)
 - vii. Description of soil conditions and properties of the underlying stratigraphy
 - viii. Existing wells, test pits, and boreholes on and within 500 metres of the site
 - ix. Elevation and depth of static water level(s) (measured or estimated), as well as an estimate of the seasonal high water level
 - x. Any watercourses (including potential historic streams) within 25 metres of the site
 - xi. Other relevant information, as appropriate
- B. Description of any proposed investigative works (e.g. planned test pits, boreholes, wells, proposed hydrostratigraphic unit(s) to target, water level monitoring, hydraulic testing, and analysis, etc.) required to support completion of the final hydrogeological study.
 - C. A preliminary plan for any *construction-related* groundwater management, including anticipated dewatering/drainage methods. See Appendix A for elements of the plan to consider.
 - D. A preliminary plan for any *permanent* groundwater management, including anticipated dewatering/drainage methods. This plan should outline how permanent discharge of groundwater to City's sewer infrastructure will be avoided. See Appendix A for elements of the plan to consider.
 - E. An impact assessment, which demonstrates to the City that any groundwater extraction/diversion will not result in significant risks or negative impacts to human health, property, infrastructure, the environment, or groundwater resources, either on site or off site.
 - F. Any other information needed to support the preliminary study.

See the submission checklist in Appendix A for additional details on the City's requirements for preliminary hydrogeological studies.

2.3.2 Revised Preliminary Hydrogeological Study

If the preliminary study does not contain sufficient information, the applicant may be required to produce a revised preliminary hydrogeological study, typically prior to rezoning enactment.

This study should include any new or confirmed details about the project, recent or proposed works required to complete the hydrogeological study, revisions to the groundwater management plan or impact assessment, or any other information needed to address the City's feedback on the preliminary study.

2.3.3 Final Hydrogeological Study

Development permit applications that meet one or more of the applicability criteria (see Section 2.1) are required to produce a final hydrogeological study for City review. This final study should include:

- A. Updated content to reflect all material changes to the proposed development (e.g. confirmed number of levels of below-ground structure, confirmed excavation elevation and depth, etc.), as well as any new or refined supporting data, calculations, plans, reports, or other materials following submission of the preliminary hydrogeological study.
- B. A map of the site clearly showing the property boundary, surrounding sites, proposed building footprint(s), existing and proposed wells/test pits/boreholes, location(s) of groundwater extraction/diversion, and any other relevant information.
- C. Cross-section schematic(s) showing features such as: site stratigraphy; current site grade; location(s) and elevation(s)/depth(s) of planned excavation(s), foundation slab(s), test pits, boreholes, monitoring wells including screen intervals, static water level(s), seasonal range of water level(s) (measured or estimated, with dates shown); and any proposed groundwater management solutions. See Figure 1 in Appendix C for an example.
- D. All necessary hydrogeological information, including water level monitoring data and the results of any hydraulic testing. The City also requires the characterization (possibly including direct monitoring) of all hydrostratigraphic units above the proposed building foundation that would contribute to groundwater discharge from the site.
- E. Measured or estimated range in static water level(s) due to seasonal variation.
- F. Details about *construction-related* groundwater management
 - i. A final plan for any construction-related groundwater management, including details of the dewatering/drainage methods (e.g. cut-off walls, on-site storage, sump pumps, etc.), anticipated approximate duration of construction dewatering/drainage, discharge point(s), and any other relevant information. This plan should be included as part of the hydrogeological study.

Note: Groundwater includes water from perched aquifers.
 - ii. Estimated construction-related groundwater discharge rate or range of rates to the City's sewer system.

Note: This should be a calculated estimate based on site-specific data, as terms such as "negligible" are not sufficient. Include calculations and the methodology used.
 - iii. A statement from the applicant to confirm that any water (i.e. groundwater or precipitation) discharged to the City's sewer system during the construction dewatering period will be

measured, and that the daily average flow rate measurements (or as requested by the City) will be submitted monthly to groundwater@vancouver.ca.

G. Details about *permanent* groundwater management

- i. A final plan for permanent groundwater management, which should discuss any proposed dewatering/drainage methods such as low permeability boundaries (e.g. cut-off walls), waterproofed (e.g. tanked) foundations, reinjection or infiltration of groundwater, or other strategies to avoid groundwater discharge to the City's sewer system. This plan should be included as part of the hydrogeological study.

Note: Groundwater includes water from perched aquifers.

- ii. If permanent (i.e. post-construction) dewatering/drainage is expected, indicate where this water is to be discharged (e.g. infiltration trench), and provide an explanation of how the groundwater management plan will avoid permanent groundwater discharges to the City's sewer system.
- iii. If any permanent discharge to the City's sewer system is expected (e.g. from infrastructure such as foundation or perimeter drains), quantify the groundwater flow rate or range of flow rates (i.e. excluding precipitation). Include calculations and the methodology used.

Note: This should be a calculated estimate based on site-specific data, as terms such as "negligible" are not sufficient.

- H. A finalized impact assessment, which demonstrates to the City that any groundwater extraction/diversion will not result in significant risks or negative impacts to human health, property, infrastructure, the environment, or groundwater resources, either on site or off site. This impact assessment should be included as part of the hydrogeological study.
- I. Information to address the City's feedback on any previous version(s) of the hydrogeological study.
- J. Any other information that could support the application, such as design drawings related to the groundwater management plan.

See the submission checklist in Appendix A for additional details on the City's requirements for final hydrogeological studies.

2.3.4 Revised Final Hydrogeological Study

If any of the information outlined in Section 2.3.3 is missing in the final hydrogeological study, then a revised final hydrogeological study may be required, typically as a condition for development permit (DP) issuance.

2.3.5 Conditions After Approval of Hydrogeological Study

Even after the City has approved the hydrogeological study, follow-up monitoring and reporting on the performance of the proposed groundwater management strategies may still be required prior to City issuance of a building permit and/or occupancy permit.

The City understands that even a final hydrogeological study will only provide a best estimate of subsurface conditions, discharge rates, etc. Therefore, such monitoring and reporting requirements may be placed to ensure that the approved construction-related and permanent groundwater management methods are functioning as described in the hydrogeological study, and meeting the conditions in Section 2.2.

2.3.6 Groundwater Discharge Flow Monitoring Reports

For developments subject to this Bulletin, and located on properties greater than 1,000 square metres (m²) in area, the City requires monitoring and reporting of discharge flow rates to the sewer system during excavation and construction. Reporting requirements are as follows:

- A. Reports should be submitted once excavation activities have commenced
- B. Discharge data should be submitted using the report template found [here](#)¹⁰
- C. Reports should be submitted monthly, by the 15th day of the following month (e.g., the report with the January data should be submitted by February 15)
- D. Discharge reports are to be submitted to: groundwater@vancouver.ca
- E. Requests to discontinue discharge monitoring should be sent to the groundwater team at groundwater@vancouver.ca and *may* be considered if one of the following scenarios applies:
 - i. At least three consecutive months of zero discharge has occurred. Ensure that three consecutive months of discharge monitoring reports have been submitted prior to requesting the cessation of discharge monitoring. The City reserves the right to request additional monitoring even if three consecutive months of zero discharge has occurred.
 - ii. Permission has been granted by the City's Environmental Protection team to cease water quality monitoring and/or the site has been connected to the City's sewer system.

3 Provincial Requirements

Applicants are hereby advised that the Province of British Columbia requires authorization for any groundwater that is diverted to the sewer system during construction, per the *Water Sustainability Act*.

¹⁰ See: <https://guidelines.vancouver.ca/bulletins/bulletin-groundwater-management-construction-related-discharge-flow-monitoring-template.xlsx>

Use Approval Applications can be [completed online](#), and questions should be directed to FrontCounter BC.

Note that the Use Approval should be available at the development site so that it may be shown to a government official upon request.

APPENDIX A: SUBMISSION CHECKLIST FOR HYDROGEOLOGICAL STUDIES

Below is a checklist for information that should be included in a submitted hydrogeological study (“the study”) ¹¹.

Bullets 1, 2, 3, 4, 5, 6, and 8 in this appendix apply to preliminary studies. Final (and revised final) studies also require the items listed in bullet 7. If a submitted study is incomplete or illegible, authored by an unqualified individual, or does not contain sufficient analysis, the application may be deemed incomplete and returned to the applicant.

This checklist is provided for convenience only and is not a substitute for applicable City by-laws or other regulations. It is the applicant’s responsibility to ensure that any existing or proposed construction or other works complies with all applicable regulations, and that an appropriate level of site investigation and assessment is undertaken prior to submission.

1 Submission Format

- The hydrogeological study should be submitted as a separate document, rather than being combined with a geotechnical report, ESC plan, etc.
- The groundwater management plan and the impact assessment should be included within the hydrogeological study document.
- In addition to any hard copies requested by City staff, the study should be submitted electronically in a searchable (not scanned) PDF format with digitally embedded images of signature(s) and stamp(s).
- All pages of the study, including those in any appendices, should be numbered for easy reference by City staff.
- All diagrams, logs, and photos should be of sufficient resolution to interpret (i.e. not grainy or distorted), and any boreholes, wells or other labelled map features should be legible.
- All estimates should include a statement of assumptions.
- All units should be metric.
- All elevation and depth values (for the foundation, excavation, borehole, and water levels) should be reported in both geodetic elevation and metres below ground surface. Due to the potential variation in depth below ground surface for foundations and excavations, these values should be provided as a range (e.g. “2.1 – 5.3 metres below ground surface”) as well as in metres geodetic.

2 Submission Details

- Name of consulting company, name(s) of author(s) and reviewer(s), and contact information
- Date of submission
- Title of submission

¹¹ Note that this “Submission Checklist for Hydrogeological Studies” does not need to be filled out and submitted. It is intended as a guide for use by applicants and/or consultants.

- Type of submission (indicate one of the options below):
 - Preliminary hydrogeological study
 - Revised preliminary hydrogeological study
 - Final hydrogeological study
 - Revised final hydrogeological study
- In a “Referenced Documents” section, list any separate supporting documents (e.g. geotechnical reports, shoring and excavation plans, architectural plans, environmental site assessments, etc.) that may contain relevant information and/or have been referred to in the hydrogeological study, and indicate whether these documents have already been submitted to the City (if known).

3 Site Information

- Primary civic address, as well as the addresses of any related secondary parcels
- Description of property boundary (i.e. bordering streets and properties)
- Description of proposed development (e.g. multiple dwelling building, office building, etc.)
- Description of existing and proposed buildings, and their locations on site
- Number of levels of below-ground structure (e.g. parking) in each building
- Current site grade and surrounding topography
- Known or suspected contamination on or near site
- Dimensions and area of entire property (metres and metres²)
- Dimensions and area of the excavation(s) (metres and metres²)
- Excavation elevation and depth (metres geodetic and metres below ground surface)
- Foundation elevation and depth (metres geodetic and metres below ground surface)

4 Preliminary Hydrogeological Information

- In the hydrogeological study, discuss (e.g. in the Impact Assessment section) all that apply:
 - The site is located partly or wholly within one or more areas of concern for groundwater (see [Groundwater Areas of Concern map](#)):
 - Potential soil sensitivity to water table changes
 - Designated Floodplain
 - Sewershed within the Cambie Corridor
 - Broadway Plan area
 - Potential flowing artesian conditions ([Province of BC's Well Drilling Advisory](#))
 - The proposed development is located anywhere in the city and includes an open-loop geoexchange system.
 - The site is subject to the [Rezoning Policy for Sustainable Large Developments](#).
- Any watercourses (including potential historic streams) within or near site (< 25 metres away)

- Number of existing test pits on site, as well as the number planned for site
- Number of existing boreholes and wells on site, as well as the number planned for site, including the proposed target hydrostratigraphic unit(s)
- Description of soil conditions and properties of the underlying stratigraphy
- The estimated proximity of the excavation to any known aquifers, including perched aquifers
- Number of existing wells on site, as well as the number planned for site
- Address, Well Tag Number, and distance (in metres) of any wells (active or inactive) located within 500 metres of site
- Any proposed works (e.g. additional well installation or monitoring) required to support completion of final hydrogeological study
- Any available hydrogeological data from nearby sites (e.g. from public well databases or previous projects completed by the applicant or consultant), such as lithology, water well record(s), date(s) of investigation, as well as proximity (in metres) to proposed development

5 Preliminary Groundwater Management

The plans for groundwater management should be included as part of the hydrogeological study, and include:

- A preliminary plan for any *construction-related* groundwater management, including details of the dewatering/drainage methods (e.g. cut-off walls, on-site storage, sump pumps, etc.), anticipated approximate duration of construction dewatering/drainage, pump location(s), discharge point(s), and any other relevant information. This plan should be included as part of the hydrogeological study. *Note: groundwater includes water from perched aquifers*
- A preliminary plan for *permanent* groundwater management, which should discuss any proposed dewatering/drainage methods such as low permeability boundaries (e.g. cut-off walls), waterproofed (e.g. tanked) foundations, reinjection or infiltration of groundwater, or other strategies to avoid groundwater discharge to the City's sewer system. This plan should be included as part of the hydrogeological study. *Note: groundwater includes water from perched aquifers*

6 Impact Assessment

The impact assessment should be included as part of the hydrogeological study, and discuss:

- Any significant risks or negative impacts (either on site or off site) that, based on the professional judgement of the study author, are reasonably likely to result from the development itself, or from the extraction/diversion of groundwater (including perched aquifers). These risks or impacts may include, but are not limited to:
 - The potential effects on known or suspected contamination (e.g. migration of existing plumes)
 - Reduction of base flow to streams or water levels in connected ponds or wetlands, negatively impacting fish, wildlife, or aquatic ecosystems.
 - Harm to trees and other vegetation that rely on accessing shallow groundwater.

- Encountering flowing artesian conditions, uncontrolled groundwater flow, and/or excavation basal heave.
- Flooding (e.g. due to construction in areas with a high water table, sewer system capacity exceedances caused in part by dewatering and/or perimeter drains, seasonal variation in static water levels, etc.)
- Erosion (e.g. from the discharge of groundwater)
- Ground subsidence, including potential damage to property or infrastructure on or off site, caused by dewatering or other means of inducing water level changes
- Other potential concerns listed in Table 1 above, and/or specific to the site
- Proposed avoidance or mitigation measures for any identified significant risks or negative impacts

7 Specific Requirements for Final (or Revised Final) Hydrogeological Study

In addition to the above, the final study should also include:

- Updated content to reflect all material changes to the proposed development (e.g. confirmed number of levels of below-ground structure, confirmed excavation elevation and depth, etc.), as well as any new or refined supporting data, calculations, plans, reports, or other materials obtained after submission of the preliminary study.
- An overview of the site investigation(s), including date(s), work completed, etc.
- Borehole and/or well logs, including elevation(s) and depth(s) of stratigraphic changes, screen intervals and other observations (metres geodetic and metres below ground surface).
- Borehole and/or test pit maximum depth and minimum elevation (metres below ground surface and metres geodetic).
- Water level monitoring data (automated and/or manual measurements), including minimum level, maximum level, and average level measured over the entire monitoring period (provide a table listing quantified values in metres geodetic and metres below ground surface). *Note: this data should include water levels for all hydrostratigraphic units that may contribute to groundwater diversions from site*
- Date(s) and time(s) of water level measurements.
- Measured or estimated range (in metres) in static water level(s) due to seasonal variation. *Note: a measured or estimated annual high water level must be included.*
- Hydraulic conductivity testing and analysis (e.g. slug tests).
- A map of the site clearly showing the property boundary, surrounding sites, proposed building footprint(s), existing and proposed wells/test pits/boreholes, location(s) of groundwater extraction/diversion, and any other relevant information.
- Cross-section schematic(s) showing features such as: site stratigraphy; current site grade; location(s) and elevation(s)/depth(s) of planned excavation(s), foundation slab(s), test pits, boreholes, monitoring wells including screen intervals, static water level(s), seasonal range of water level(s) (measured or estimated, with dates shown if available); and any proposed groundwater management solutions. See Figure 1 in Appendix C for an example.

- All final information related to groundwater management:
 - A finalized plan for *construction-related* groundwater management. See bullet 5 (Preliminary Groundwater Management) above.
 - Estimated *construction-related* dewatering/drainage rate, or range of rates (litres/minute). *Note: this should be a calculated estimate based on site-specific data, as terms such as “negligible” are not sufficient.* The characterization, possibly including direct monitoring, of all hydrostratigraphic units above the proposed building foundation that would contribute to groundwater discharge from the site will be required. Include calculations, as well as details of the methodology used and assumptions made. Where significant uncertainty exists due to a lack of data, a sensitivity analysis should be completed.
 - A finalized plan for *permanent* groundwater management. See bullet 5 (Preliminary Groundwater Management) above.
 - If permanent (i.e. post-construction) dewatering/drainage is expected, indicate where this water is to be discharged (e.g. infiltration trench), and provide an explanation of how the groundwater management plan will avoid permanent groundwater discharges to the City’s sewer system.
 - If any permanent discharge to the City’s sewer system is expected (e.g. from infrastructure such as foundation or perimeter drains), quantify the groundwater (i.e. excluding precipitation) flow rate in litres/minute. The study must characterize all hydrostratigraphic units above the proposed building foundation that would contribute to groundwater discharge from the site. Include calculations, as well as details of the methodology used and assumptions made. Where significant uncertainty exists due to a lack of data, a sensitivity analysis should be completed.
 - Any other information that could support the application, such as design drawings related to the groundwater management plan.
- A finalized impact assessment. See bullet 6 above.
- Any test results or other information that could support the application, such as grain size analysis, soil density tests, graph(s) showing groundwater monitoring levels, etc.
- Finalized details of information included in any previous version(s) of the study.
- Any other information needed to address the City’s feedback on previous version(s) of the study.

8 Other Requirements for All Hydrogeological Studies

- The hydrogeological study should be prepared, signed, and sealed by a qualified professional (P.Eng. or P.Geo.) with competency in hydrogeology and registered with Engineers and Geoscientists British Columbia (EGBC).
- For sites subject to the [Rezoning Policy for Sustainable Large Developments](#), applicants should refer to that policy for any additional requirements.
- If after submission of a final hydrogeological study, the applicant or consultant becomes aware of any changes that may be material to the City’s review of the study (e.g. if the proposed excavation depth increases), then the City should immediately be notified by emailing: groundwater@vancouver.ca.
- If any potentially serious issues related to groundwater are experienced at the site, such as excessive or uncontrolled flow, the applicant and/or consultant must immediately notify the City by calling 3-1-1.

APPENDIX B: REGULATORY FRAMEWORK

Table 2 below provides a summary of key regulations, policies, and plans, as well as their applicability to the management of groundwater in Vancouver.

Table 2: Summary of Key Regulations, Policies, and Plans

Reference	Applicability (Paraphrased)
City of Vancouver Building By-law No. 12511 (2019), Book II (Plumbing Systems), Division B	Per Article 2.2.11.5, no open-loop geexchange systems are permitted for buildings used for residential occupancy containing up to 8 principal dwelling units, and any open-loop geexchange systems shall not discharge to the sewer. Per Article 2.4.5.3, a subsoil drainage pipe shall be connected to a sump, and the sump shall be connected to a storm sewer or to a combined sewer, but not to a sanitary sewer.
City of Vancouver Building By-law No. 12511 (2019), Book I, Division B	Per Article 4.2.4.9, where proposed construction will result in a temporary or permanent change in the groundwater level, the effects of this change on adjacent buildings shall be fully investigated and provided for in the design. Per Article 4.2.5.5, surface water, all groundwater, perched groundwater, and in particular artesian groundwater shall be kept under control at all phases of excavation and construction.
City of Vancouver Rezoning Policy for Sustainable Large Developments (2018)	Per E.3.2, a hydrogeological study shall be undertaken for Sustainable Large Developments.
City of Vancouver Sewer and Watercourse By-law No. 8093 (2019)	Per 3.1(1), the City does not permit the discharge of uncontaminated ¹² water to sanitary sewers. Per 3.3(1), the City does not permit discharge of prohibited substances. Per 4.3(1), the City may set flow volume limits on uncontaminated water discharged to the storm drainage system. Per 6.2, the City may prevent a discharge into the sewer system that is hazardous or creates an immediate danger to any person, animal, or the environment, or endangers or interferes with the operation of the sewerage system, a storm drainage system, or a sewage treatment plant.
City of Vancouver Zoning and Development By-law 3575 (1956)	Per 4.3.4, the City may require applicants to submit a hydrogeological study and an impact assessment, and may consider drainage to be inadequate if the proposed development will result in any groundwater discharge from the site into the City collection system. Per 4.3.5, the City may impose conditions on a development requiring the applicant to limit or reduce environmental impacts.

¹² See page 2 of [Sewer and Watercourse By-law No. 8093](#) for definition of “contaminated water”.

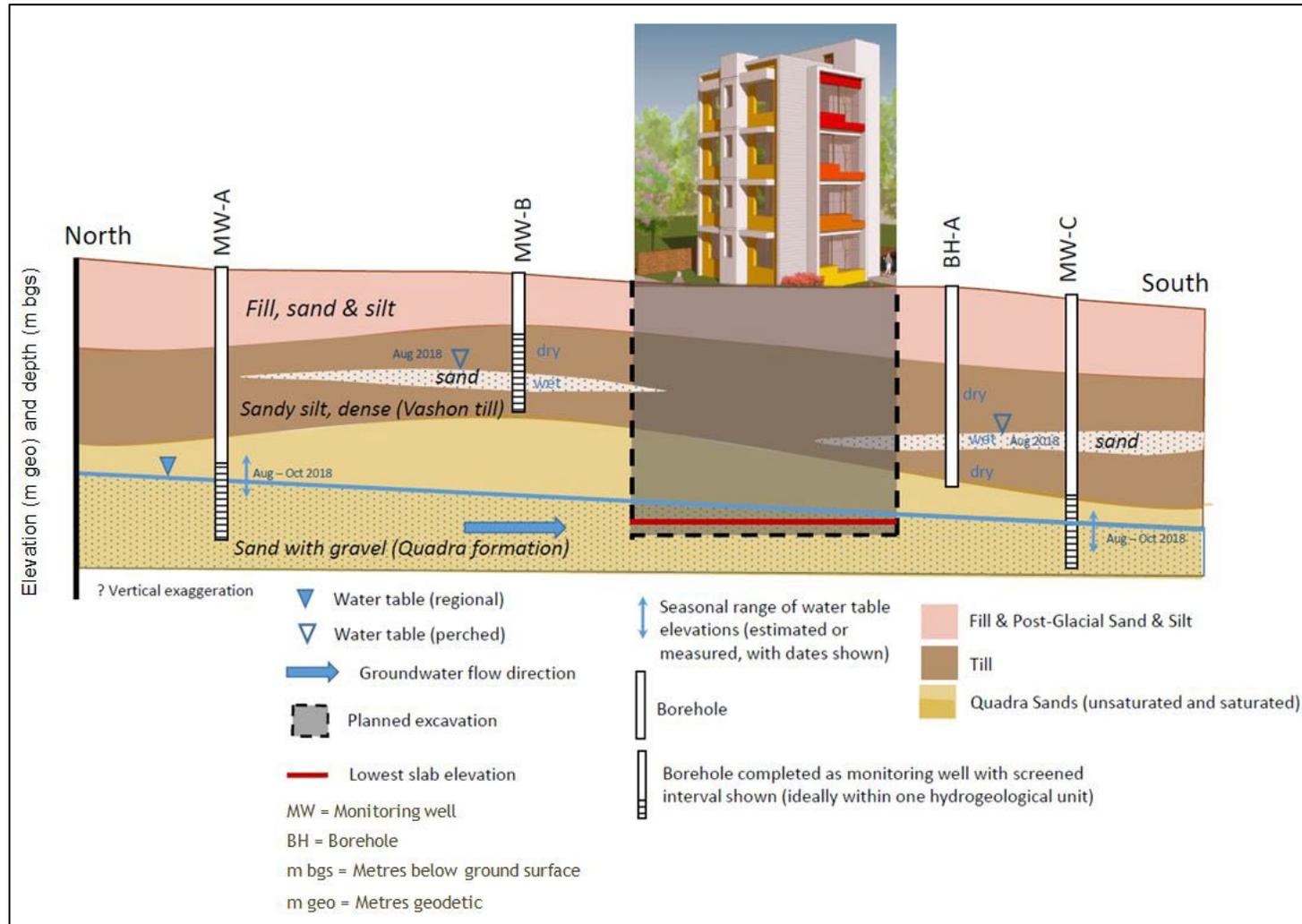
Reference	Applicability (Paraphrased)
Metro Vancouver Greater Vancouver Sewerage and Drainage District Sewer Use Bylaw No. 299 (2007)	No person shall discharge or allow or cause the discharge of groundwater into a Sewer or a Sewage Facility.
Metro Vancouver Integrated Liquid Waste and Resource Management Plan (2010)	Per 1.1 and 1.2, the City aims to keep groundwater inflow and infiltration out of sewers in order to reduce the risk of sewer overflows and help maintain sewer capacity and treatment effectiveness.
Province of British Columbia Water Sustainability Act (2016)	Groundwater extraction and use is regulated by BC's <i>Water Sustainability Act</i> (WSA). The WSA states that a person must not divert or use water from a stream or an aquifer unless authorized by the Province. A Use Approval is required to divert groundwater for construction-related dewatering ¹³ . Under the WSA, the <i>Groundwater Protection Regulation</i> defines minimum standards for the installation, use, maintenance and decommissioning of wells, including those used for monitoring.

Note: This table is current as of Groundwater Management Bulletin publication. Additional regulations, policies, and strategies may also apply.

¹³ See Section 3 above for details on provincial requirements.

APPENDIX C: ADDITIONAL RESOURCES

Figure 1: Example of Cross-Section Schematic for Final Hydrogeological Study



APPENDIX D: NOTIFICATIONS

Notification Regarding Water Levels in the Oakridge Area

Groundwater has been extracted from the site of Oakridge Mall (41st and Cambie St.) since 1958. During this time, groundwater levels are estimated to have been lowered by up to 6 metres at Oakridge, with a generally reduced impact the farther you are from the site. This artificially lowered water level is to be roughly maintained by Oakridge, in accordance with their Groundwater Management Strategy, but that may change over time.

For additional information, the Groundwater Management Strategy is available through the Land Title Office (<https://ltsa.ca/>). The City of Vancouver is providing this information for general purposes only, and makes no warranties or representations as to the completeness, accuracy or reliability of this information. Development applicants should retain their own geotechnical and/or hydrogeological expertise in order to determine their best course of conduct, and should not simply rely on this information.