CP Process - Building Review

Engineers & Geoscientists British Columbia Updated Guidelines for Geotechnical Engineering Services for Building Projects

And Introduction to BC Housing's program,

MBAR

MOBILIZING
BUILDING ADAPTATION
AND RESILIENCE

October 29, 2020

Speaker

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- Member, Engineers Canada Qualifications Board, 2018 - present
- Professional Practice Committee, EGBC, 2012-present (chair 2016-2019)
- EGBC Councillor, 2012-2014
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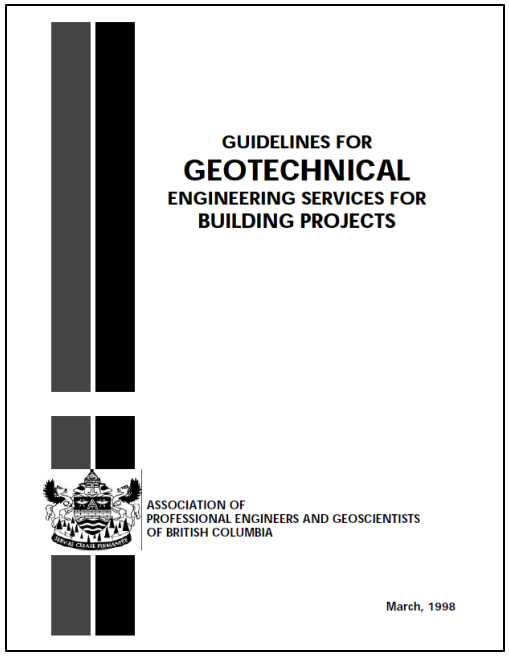
Outline

1. Summary of Updates to the EGBC Guidelines for Geotechnical Engineering Services for Building Projects
2. Introduction to MBAR and Project Design Philosophy Statement

Summary of Updates

Guidelines for Geotechnical Engineering Services for Building Projects



March 1998 Guidelines

Vs.

September 2020 Guidelines

Summary of Updates

Generally, guideline changes address offsite impacts, more prescriptive investigation requirements (including piezometers), alignment to CFEM , reconcile investigation results with published information and consideration of climate change

Subsurface Investigation

Vancouver Building By-law, 2019 Section 4.2.2.1:

1) A *subsurface investigation*, including *groundwater* conditions, shall be carried out by or under the direction of a professional engineer having knowledge and experience in planning and executing such investigations to a degree appropriate for the *building* and its use, the ground and the surrounding site conditions. (See Note A-4.2.2.1.(1).)

Canadian Foundation Engineering Manual, 2006, Section 4.4.3:

The determination of the number of boreholes and spacing for larger, more complex, and critical projects forms a very important part of the geotechnical design process, and cannot be covered by simple rules which apply across the entire country. Establishing the scope of a geotechnical investigation and subsequent supervision requires the direction of an experienced geotechnical engineer.

For buildings smaller than about 1000 m^2 in plan area but larger than about 250 m^2, a minimum of four boreholes where the ground surface is level, and the first two boreholes indicate regular stratification, may be adequate. Five boreholes are generally preferable (at building corners and centre), and especially if the site is not level. For buildings smaller than about 250 m^2, a minimum of three boreholes may be adequate. A single borehole may be sufficient for a concentrated foundation such as an industrial process tower base in a fixed location with the hole made at that location, and where the general stratigraphy is known from nearby boreholes.

A commonly used rule of thumb for minimum depth of boreholes is to extend the boreholes to such a depth that the net increase in soil stress under the weight of the structure is less than 10% of the applied load, or less than 5 % of the effective stress in the soil at that depth, whichever is less. A reduction in the depth can be considered if bedrock or dense soil is encountered within the minimum depth. In the case of very compressible normally consolidated clay soils located at depth, it may be necessary to extend boreholes deeper than determined by the 10 % and 5 % rules.

Subsurface Investigation - *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

Prior to beginning subsurface investigation, confirm with the Owner and/or CRP that the site is not within a defined archeological sensitive area or area of significance.

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3:

Ensure the subsurface investigation meets the requirements of the Canadian Foundation Engineering Manual (Canadian Geotechnical Society 2006) in terms of depth and quantity of test holes, unless a rationale for deviation is provided and documented in the geotechnical report.

Subsurface Investigation - *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

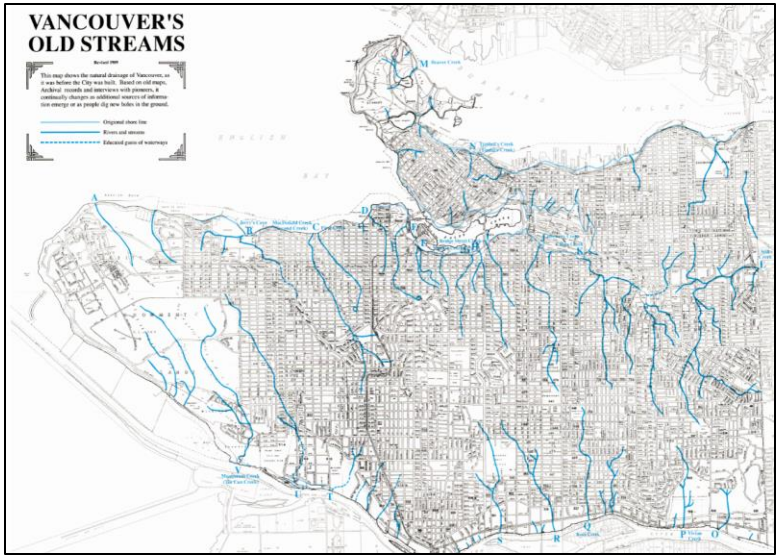
Installation and monitoring of groundwater observation piezometers should be carried out for all projects, unless it can be proven to be unnecessary.

Conduct physical testing of recovered samples to assist in determining soil and rock parameters that inform design recommendations pertaining to foundations, excavation (shoring), and management of groundwater and interflow, and reconcile qualitative and quantitative results of subsurface investigations with published geologic information.

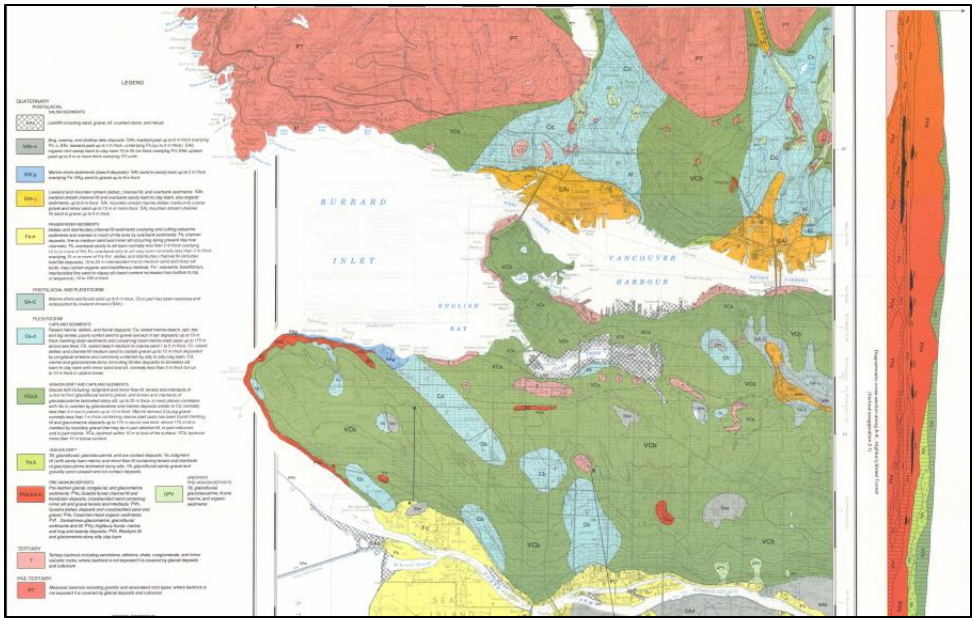
Subsurface Investigation - *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

The results of the investigation should be reconciled with the results of the literature review.

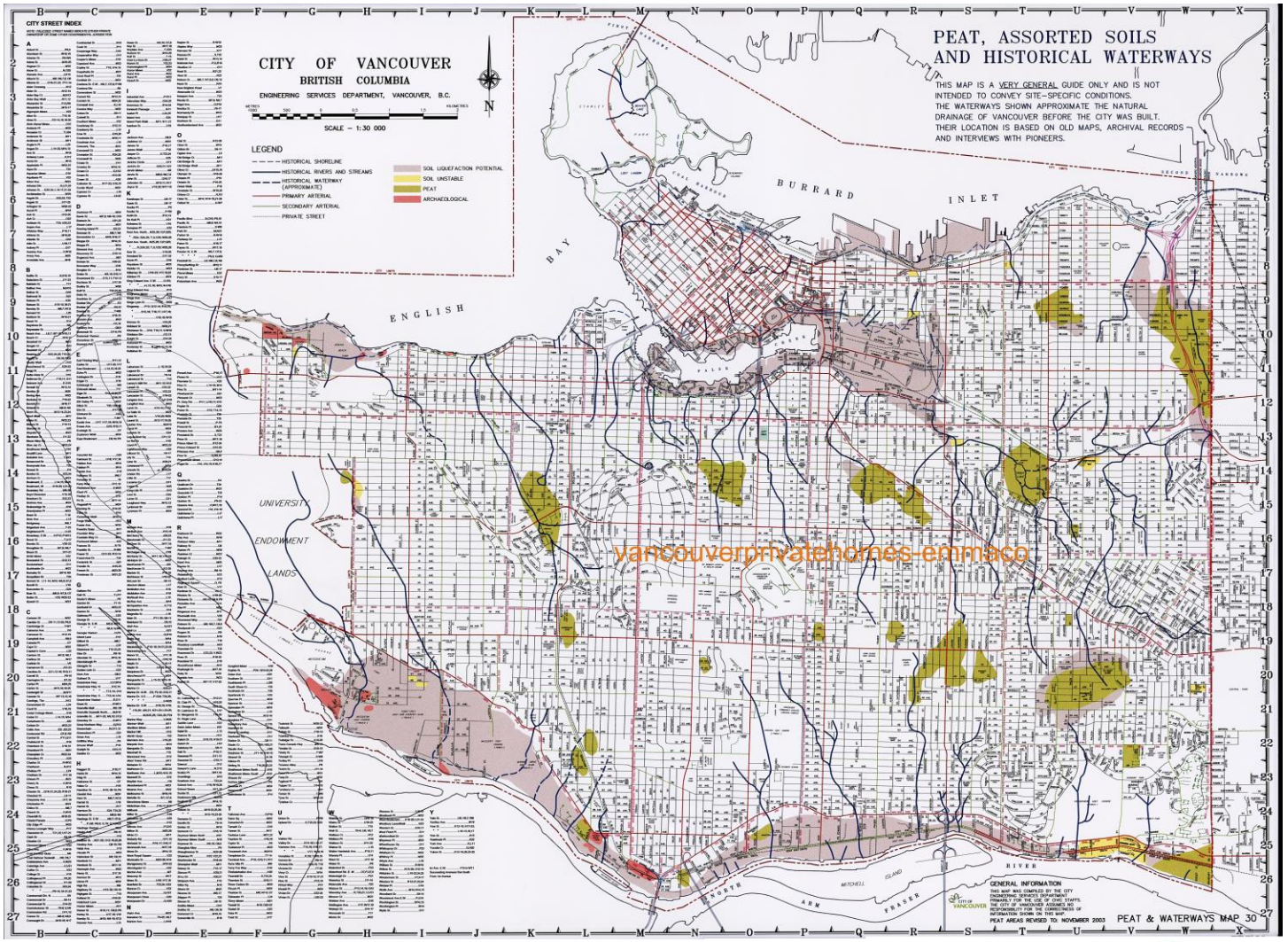


Ref: Vancouver Public Aquarium Association, 1989



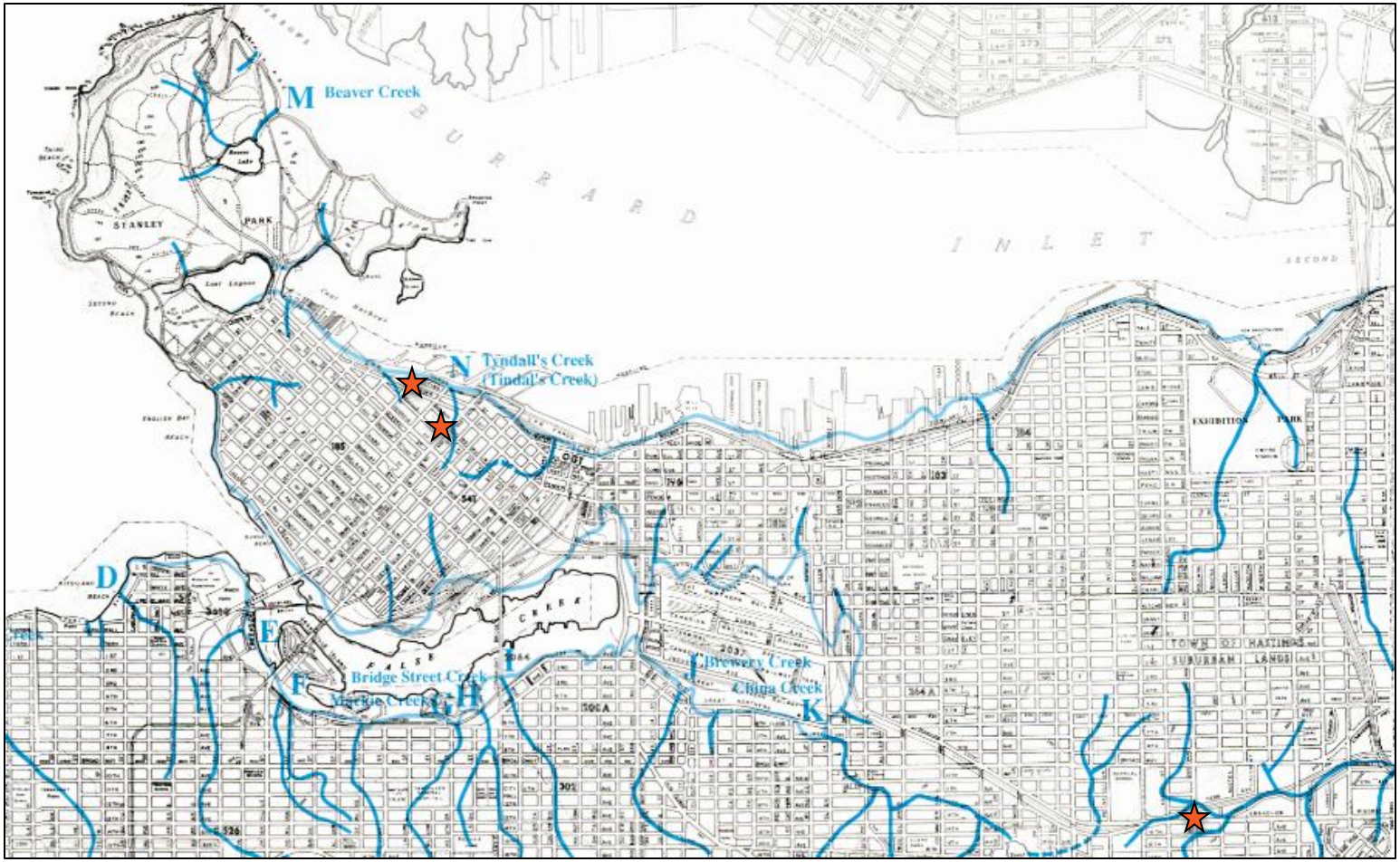
Ref: Geological Survey of Canada, Map 1486A

Subsurface Investigation - *Cont'd*



Ref: City of Vancouver, Engineering Services Department, Peat & Waterways Map 30

Subsurface Investigation - *Cont'd*



Ref: Vancouver Public Aquarium Association, 1989

Identification

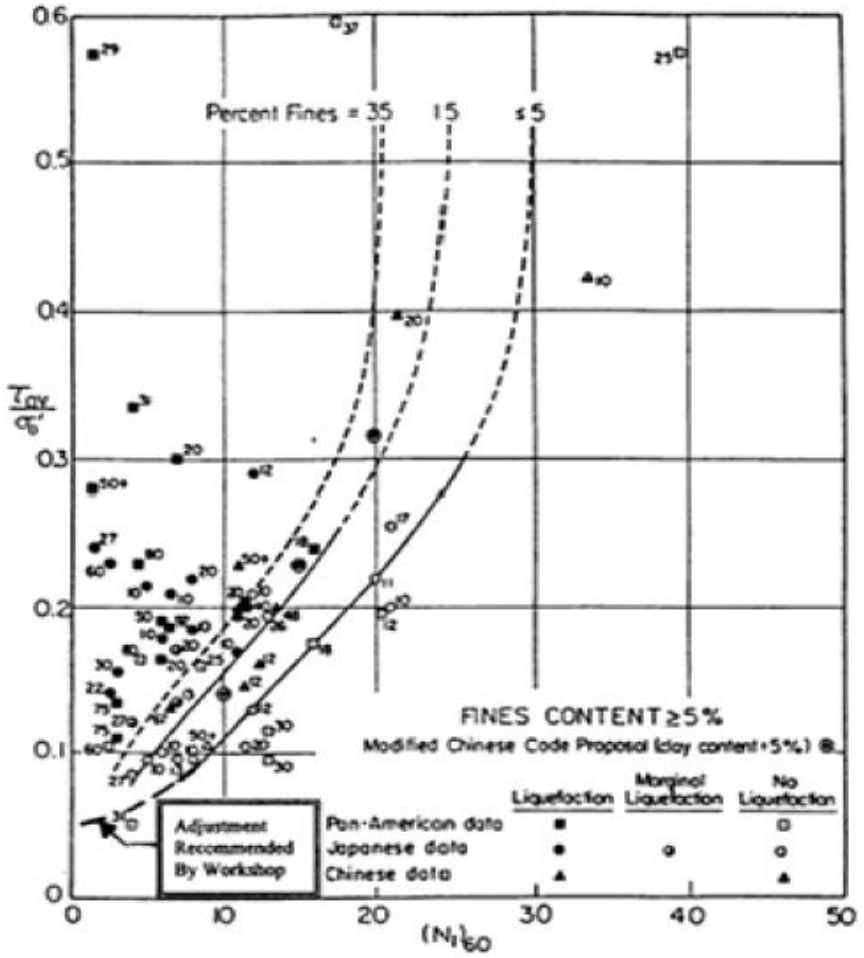
Vancouver Building By-law, 2019 Section 4.2.4.3:

1) The identification and classification of *soil*, *rock* and *groundwater* and descriptions of their engineering and physical properties shall be in accordance with a widely accepted system.

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3:

Classify soil and rock materials, groundwater levels, and other conditions (including subsurface), including at adjacent off-site areas that could affect or be affected by the project. The geotechnical description of the soil conditions should conform with the intent of relevant standards

Subsurface Investigation – Cont'd



CRR Vs $(N_1)_{60}$ for M7.5 earthquake

Ref: 2007 Task Force Report Guidelines for Buildings on Liquefiable Site NBC 2005

Compactness Condition	SPT N-INDEX (blows per 0.3 m)
Very loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very dense	Over 50

Subsurface Investigation – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

Conduct additional investigation beyond the initially defined investigation program, if significantly varied subsurface conditions are encountered or the design requirements of the development must be refined; the GER's Agreement for Geotechnical Services should be amended accordingly to reflect these additional services (see Section 3.4.2 Extraordinary Additional Services).

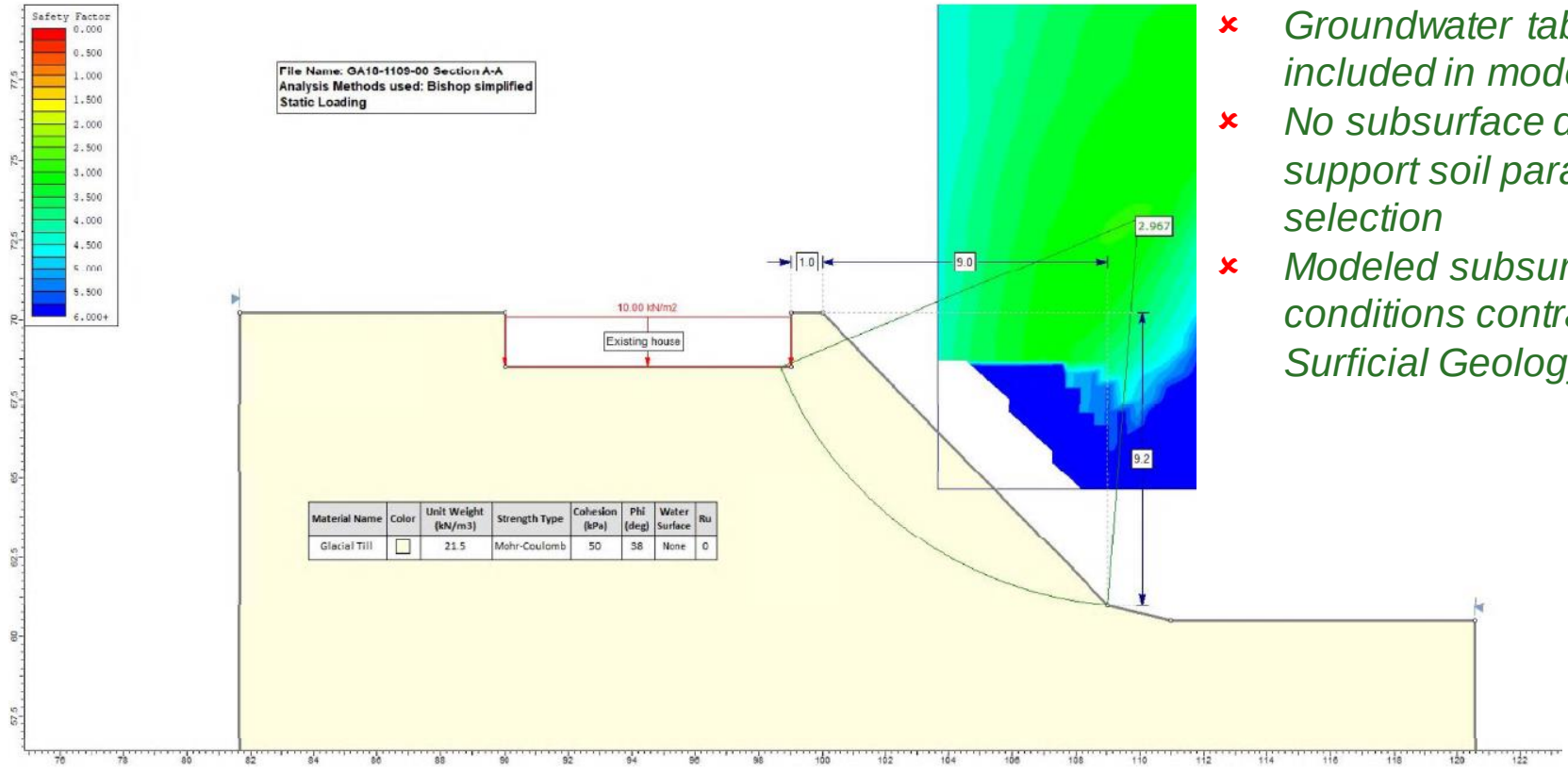
Subsurface Investigation – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

Perform necessary engineering analyses in order to determine geotechnical parameters that are relevant to the project, which may include the following:

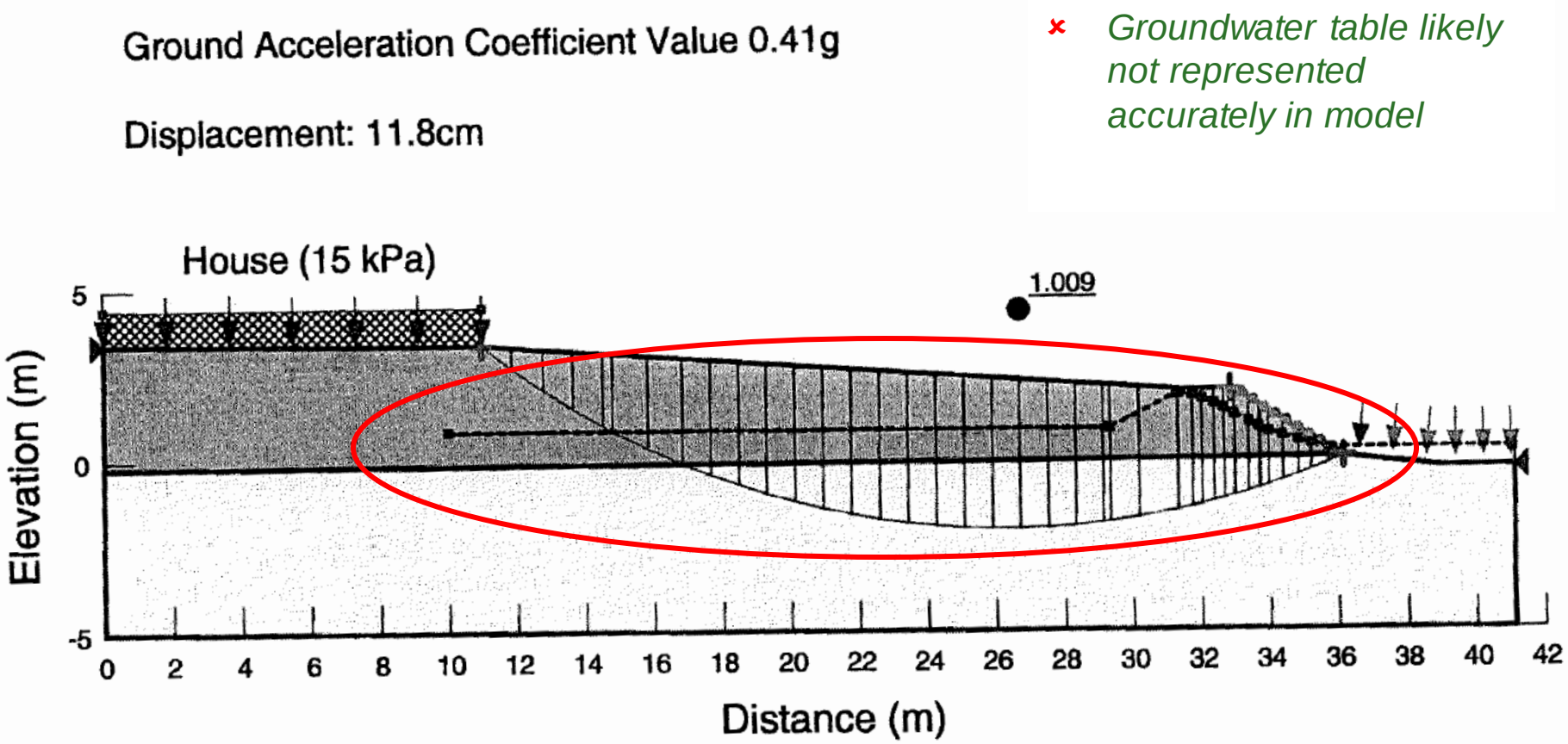
- Perform analyses to determine expected material strength parameters and groundwater elevations.
- Specify methodologies and software to be used for analysis of soil response to static, seismic, and other (as appropriate) loading conditions, and note the limitations of prescribed boundary conditions and other input parameter assumptions.
- Determine factors of safety.
- Conduct design sensitivity analyses and obtain optimization results.
- Estimate vertical and horizontal displacement for the building.

Slope Stability Analysis – Coquitlam, BC



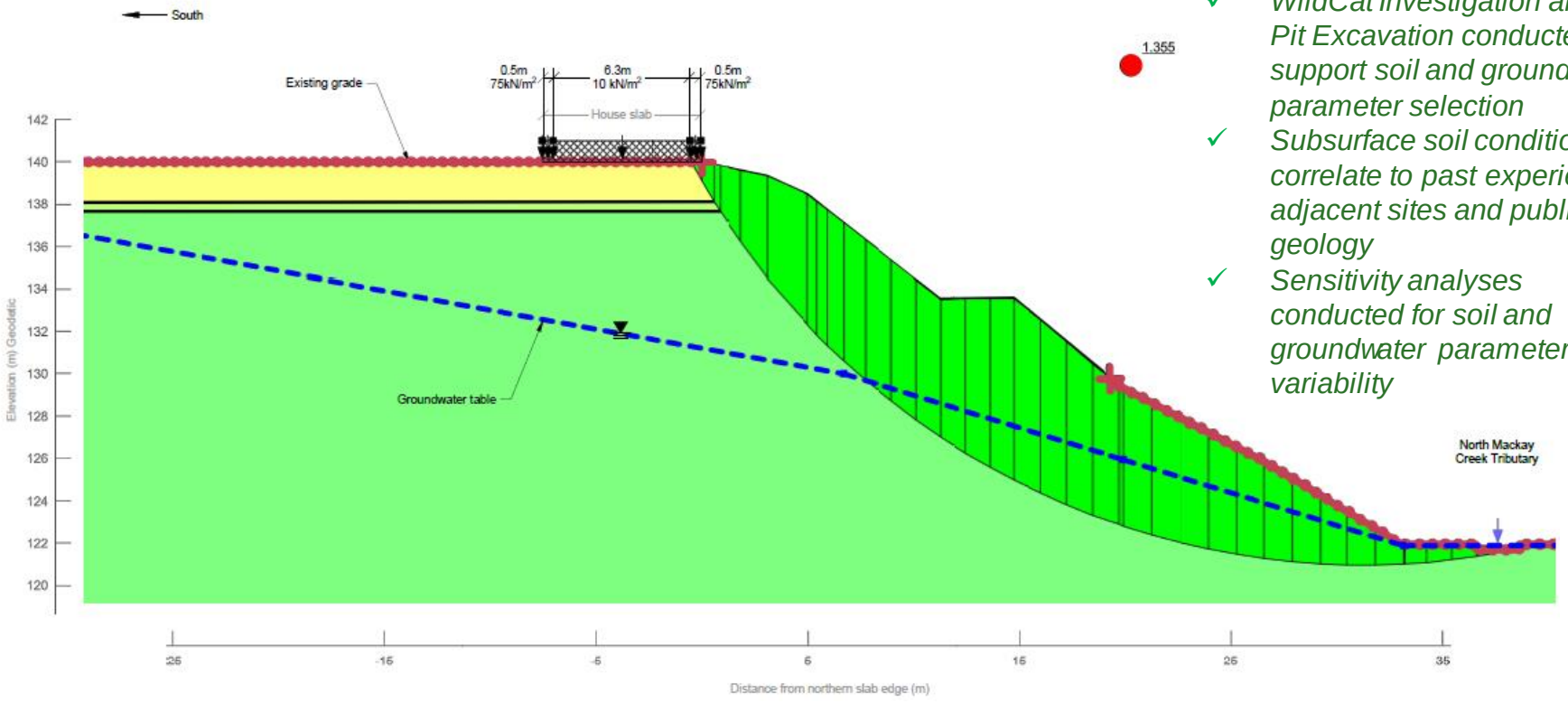
- *Groundwater table not included in model*
- *No subsurface data to support soil parameter selection*
- *Modeled subsurface soil conditions contradict Surficial Geology Map*

Slope Stability Analysis – Surrey, BC



- *Groundwater table likely not represented accurately in model*

Slope Stability Analysis – North Vancouver, BC



- ✓ *Groundwater table included in model*
- ✓ *WildCat Investigation and Test Pit Excavation conducted to support soil and groundwater parameter selection*
- ✓ *Subsurface soil conditions correlate to past experience at adjacent sites and published geology*
- ✓ *Sensitivity analyses conducted for soil and groundwater parameter variability*

Offsite Impacts

Vancouver Building By-law, 2019 Section 4.2.4.9:

Groundwater Level Change

1) 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.

Vancouver Building By-law, 2019 Section 4.2.5.2:

1) Every *excavation* shall be undertaken in such a manner as to

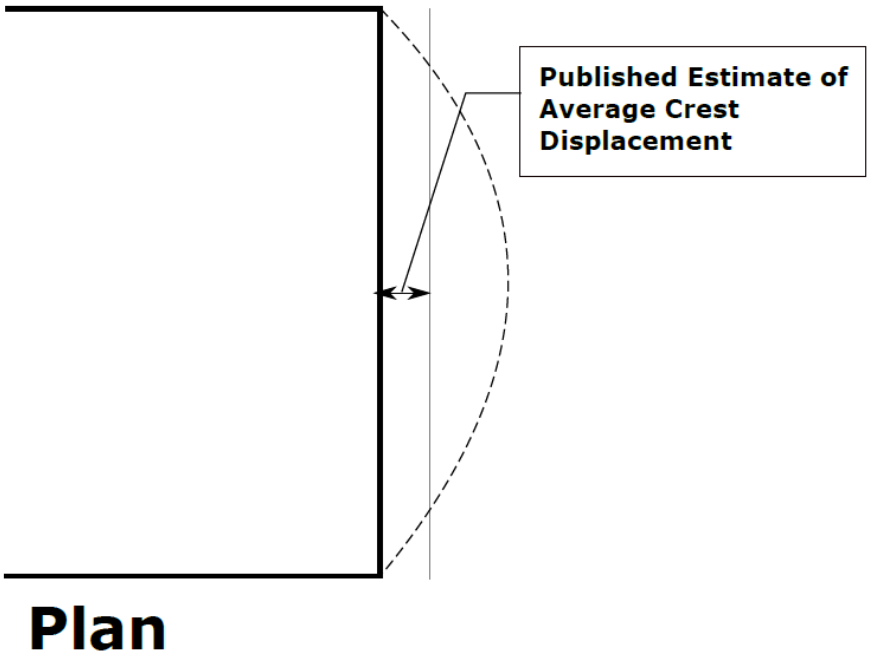
a) prevent movement that would cause damage to adjacent *buildings* at all phases of construction, and

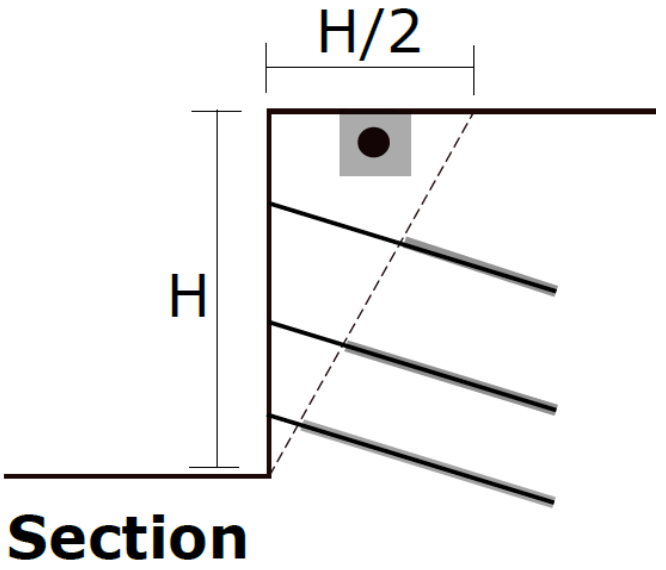
b) comply with the appropriate requirements of Part 8.

2) Material shall not be placed nor shall equipment be operated or placed in or adjacent to an *excavation* in a manner that may endanger the integrity of the *excavation* or its supports.

Offsite Impacts – *Cont'd*

Check vulnerability of existing adjacent infrastructure, especially within these zones:





Offsite Impacts – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

Estimates of probable (foundation) movement or differential movement and, depending on the engaged scope of services, recommendations for matters such as:

- stability of slopes;
- design of retention systems;
- utility support;
- pavement;
- stormwater facilities;
- off-site impacts, including in consideration of the *BCBC* or VBBL, Clause 4.2.4.9 (relating to changes in groundwater) and Clause 4.2.5.2 (relating to excavation);
- temporary support options and their impact on building design and construction; and
- permanent dewatering, among other subsurface-related matters.

If methodologies (e.g., subsurface investigation program, factors of safety for excavation shoring design) deviate from the best practices described in the Canadian Foundation Engineering Manual (Canadian Geotechnical Society 2006), provide a rationale for the deviations, and a discussion of the associated risks.

For adjoining properties, carry out an appropriate level of analysis to support the GER's technical recommendations, and maintain proper documentation to demonstrate appropriate protection of the geologically proximate structures, properties, and infrastructure.

- Documentation should include parameters and groundwater level used in analysis, and a rationale for their selection.

The GER should advise the Owner to notify adjacent landowners of potential impacts to geologically proximate properties from the development and its construction, including:

- associated vibration, excavation, filling, and ground improvement;
- altering of the ambient groundwater regime, such as lowering groundwater elevation or changing its flow path; and

Offsite Impacts – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 2.2.4 & 3.3.1:

The GER is normally responsible for planning and executing the exploration program to characterize the subsurface conditions at the project site, including assessing soil, rock, and groundwater conditions relevant to the Subgrade Support of the Building and investigating the potential for off-site impacts from earthworks activities or changes to groundwater elevation.

Before carrying out the design for an excavation, fill, or ground improvement works, an appropriate level of due diligence must be followed when considering and documenting the:

- geological setting;
- vulnerability or sensitivity-to-movement of adjacent structures, elements, and/or infrastructure;
- selection of soil parameters and stability calculations including proximate surcharge loads; and
- sources of water which may reasonably influence performance.

Offsite Impacts – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1 & 3.3.2:

Collaborate with the design team, including the environmental engineer, regarding management of groundwater removal from site (such as strategies to limit flows and volumes), so potential off-site impacts are fully investigated and addressed in the design.

When addressing item 8.4 (Structural considerations of soil, including slope stability and seismic loading) of Schedule B, consider the associated geologic history and geologic model of the subject stratigraphy.

Offsite Impacts – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Appendix A:

- The name of a designated person on the site who is authorized to determine changes in soil conditions, where applicable, along with a description of change thresholds that should trigger:
  - review by the Geotechnical Engineer of Record (GER), and;
  - evacuation of the excavation.

The following additional documents may be provided to supplement those listed above:

- Site plan, to scale, including:
  - property lines;
  - proposed subsurface development, accounting for footing depths, elevator pits, and pull pits sumps; and
  - existing structures within the 1 vertical to 1 horizontal line rising from the toe of the excavation, including related buried utilities and excavations and trenches.
- Sections, to scale, including the elements above, as well as assumed subsurface soil conditions and shoring elements; variations in subsurface soil should be indicated that account for weathering and previous proximate excavation and backfilling work.
- Specifications that include:
  - reference documents (including the results of a BC One Call);
  - testing results or proximate experience yielding information on subsurface soil conditions;
  - modelling software and soil strength parameters yielding design results associated with design slope cuts steeper than 4 vertical to 3 horizontal;
  - specifications for drainage, filter, fill, and protection materials;
  - specifications for shoring materials;
  - procedure for staged or sequenced installation;
  - description of proposed encroaching elements; and
  - requirements for decommissioning.

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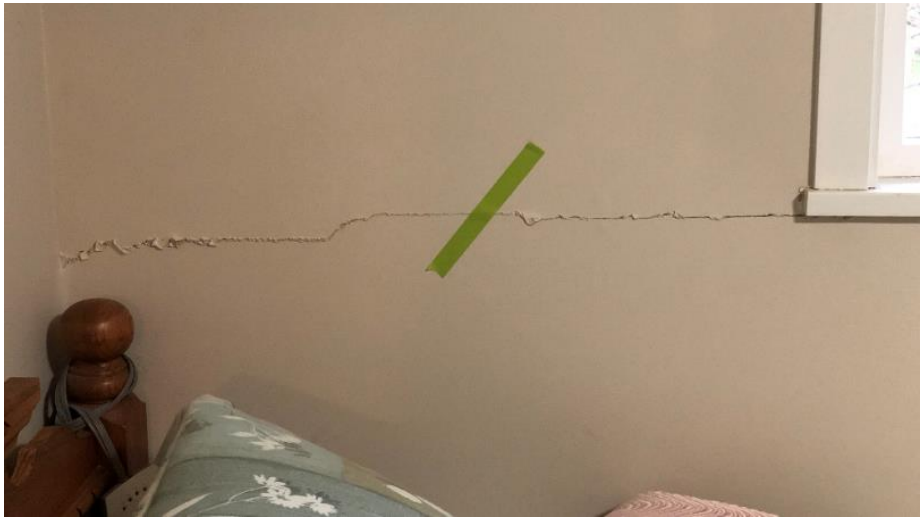
Offsite Impacts – *Cont'd*



Role of An Authority Having Jurisdiction

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 2.2.7:

An Authority Having Jurisdiction will typically consider the regional ramifications of the implementation of solutions, such as groundwater cut-off structures, slope management systems, geothermal wells, groundwater wells, and municipal infrastructure, and may develop management policies for such items.

In situations where an Authority Having Jurisdiction has significant concerns regarding the technical nature of the permit submissions, it may require that an independent review be carried out, the costs of which

Documented Checks of Engineering and Field Reviews During Construction

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 4.1.5 :

4.1.5 DOCUMENTED CHECKS OF ENGINEERING AND GEOSCIENCE WORK

In accordance with Bylaw 14(b)(2), Engineering Professionals are required to perform a documented quality checking process of engineering work, appropriate to the risk associated with that work.

Regardless of sector, Engineering Professionals must meet this quality management requirement.

In this context, "checking" means all professional deliverables must undergo a documented quality checking process before being finalized and delivered. This process would normally involve an internal check by another Engineering Professional within the same organization. Where an appropriate internal checker is not available, an external checker (i.e., one outside the organization) must be engaged. Where an internal or external check has been carried out, this must be documented.

Engineering Professionals are responsible for ensuring that the checks being performed are appropriate to the level of risk.

Documented Independent Review

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 4.1.7:

4.1.7 DOCUMENTED INDEPENDENT REVIEW

Bylaw 14(b)(4) refers to an independent review in the context of structural engineering. An independent review is a documented evaluation of the structural design concept, details, and documentation based on a qualitative examination of the substantially complete structural design documents, which occurs before those documents are issued for construction. It is carried out by an experienced Engineering Professional qualified to practice structural engineering, who has not been involved in preparing the design.

Geotechnical engineering projects can pose great risk to public safety and the environment. Therefore, the GER must consider the risk related to the project and determine whether an independent review of the GER's design by a qualified professional is warranted. To maintain independence, the independent reviewer must not have been involved in preparing the design. The independent reviewer may, however, be a member of the same organization.

As per the *Professional Practice Guidelines – Retaining Wall Design* (Engineers and Geoscientists BC 2020), an independent review is required for retaining walls over 3.0 metres high.

Field Reviews

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 2.2.4:

The GER's responsibilities during construction include conducting Field Reviews of geotechnical aspects of construction being installed by the prime contractor or subcontractors. The GER is primarily responsible for evaluating whether the geotechnical aspects of construction are generally being performed according to the project plans, specifications, and geotechnical design recommendations of the GER, and for confirming that subsurface conditions encountered during construction are consistent with the design assumptions. The GER should review the Field Review

Field Reviews – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 3.3.4:

The GER may rely on the Owner, the CRP, or the contractor to inform the GER of construction progress and advise the GER when excavation shoring, foundation, and earthwork elements of the project are ready for Field Review.

During construction, the CRP or other appropriate person should notify the GER in a timely fashion when Field Reviews (and evaluation) can be conducted to confirm site conditions are as anticipated or, if site conditions are materially different, to modify design recommendations.

Issue timely reports to inform the appropriate parties of geotechnical-related construction observations, defective work, and/or unanticipated conditions requiring interpretation and direction.

It should be noted that engaging a GER to conduct Field Reviews does not relieve the prime contractor of responsibility for construction of the project,

Furthermore, Field Reviews by the GER do not constitute approval of the contractor's safety measures

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Specialty Geotechnical Engineer or Supporting Registered Professional

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 2.2.5:

When engaging an SRP, it should be confirmed that the SRP carries liability insurance and is registered to engage in the practice of professional engineering in BC.

The SRP may take responsibility for some geotechnical elements of the project, including aspects of the Subgrade Support of the Building, as agreed with the GER and CRP. Therefore, the SRP must provide the GER with all relevant information on the loadings, deflections, and other performance criteria to permit the GER to carry out a review of the impact of the specialty work on the comprehensive geotechnical design, including the Subgrade Support of Buildings and other features both on and off site.

While such information may not include the specific means or methods of analyses and design of the specialty work, the SRP must identify conditions or characteristics that differ materially from conventional design methods and from the critical or limiting design assumptions associated with these conventional methods.

Safety, Health and Welfare of the Public
EGBC Code of Ethics

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 3.3.1:

To satisfy WorkSafeBC requirements, when taking responsibility under Schedule B for Geotechnical – Temporary, item 7.1, Excavation, prepare a design and supporting documents for building permit applications that include excavations and/or shoring designs for excavations with one or more of the following attributes:

- Over 1.2 metres (4 feet) deep with sides sloped at an angle steeper than 3/4 horizontal to 1 vertical.
- More than 6.1 metres (20 feet) deep.
- Adjacent to structures that apply loads to the soil in the excavated area.
- In soil subject to vibration (including from construction traffic) or hydrostatic pressure likely to result in ground movement hazardous to workers.
- Along natural or human-made side slopes that are steeper than 3 horizontal to 1 vertical.
- Shored in a different fashion from those shown in the tables of the *Occupational Health and Safety Regulation*.

This design should specifically address:

- the indication of the intended design life for the temporary works;
- the topography, geology, and existing structures and/or improvements of the area encompassing the subject site; and
- anticipated soil and groundwater conditions, including natural geology and groundwater, that may have been or could be affected by previous or existing utility and basement excavations, buildings, retaining walls, and stormwater infiltration facilities, especially those that are sensitive to movement.

This design should specifically address:

- the indication of the intended design life for the temporary works;
- the topography, geology, and existing structures and/or improvements of the area encompassing the subject site; and
- anticipated soil and groundwater conditions, including natural geology and groundwater, that may have been or could be affected by previous or existing utility and basement excavations, buildings, retaining walls, and stormwater infiltration facilities, especially those that are sensitive to movement.

If shoring or underpinning is to be constructed, a sequence to allow safe installation should be provided. The design drawings should limit construction loading (magnitude and/or offset). Routine monitoring of excavations, as required by the *Occupational Health and Safety Regulation*, should be carried out.

Safety, Health and Welfare of the Public
EGBC Code of Ethics – *Cont'd*

Guidelines for Geotechnical Engineering Services for Building Projects, 2020 Section 2.2.4 & 3.3.4:

In all circumstances, the GER is obligated to comply with the intent of these guidelines and take any additional steps necessary to protect the safety, health, and welfare of the public (i.e., such as notifying the Authority Having Jurisdiction or WorkSafeBC of unsafe or substantially unforeseen conditions).

However, if the GER has concerns about the safety, health, and welfare of the public that cannot be addressed satisfactorily amongst the project team (including the Owner, CRP, and contractor) and adjacent landowners, the GER should notify the Authority Having Jurisdiction and/or WorkSafeBC in a timely manner and in accordance with the GER's professional responsibility under the Association's Code of Ethics.

Temporary Works

1998 Guidelines

- Where temporary systems are in place longer than the period assumed in the design, the design should be reviewed **and remedial work may be required**

2020 Guidelines

- Seismic design of the works is **not** normally required, but the design should consider weather
- If temporary systems are to be in place longer than the period assumed in the design, the design should be **reviewed by the GER and/or others, and supplementary assessment, design, and / or remedial construction work may be required**

Schedule B: Geotechnical - Temporary

Item	1998 Guidelines	2020 Guidelines
Excavation	• Refers to the removal of ground for the purpose of constructing a building	• Refers to **any** ground removal • May include restrictions for staging of surcharge loads • Per WorkSafeBC Occupational Health and Safety Regulation, the GER must consider potential construction loading in stability assessments of slope cuts and limit or restrict such loading
Shoring	• Soil reinforcing and structural works for supporting the excavation cuts	• Soil reinforcing and **retention and** structural works for supporting excavation cuts, **and the structures, elements and features beyond those areas** • Includes consideration of groundwater and estimation and consideration of proximate structural loads • Includes support of elements/features beyond the excavation cut

Schedule B: Geotechnical – Temporary *Cont'd*

Item	1998 Guidelines	2020 Guidelines
Underpinning	• Soil reinforcing and structural works for supporting the excavation cuts	• Soil reinforcing and **retention and** structural works, **including specification of construction sequence, for supporting existing building foundations adjacent to excavation cuts** • Includes consideration of groundwater and estimation and consideration of proximate structural loads
Temporary Construction Dewatering	• Installation of well and pumping systems to maintain the stability of the excavation by control of groundwater level or flow	• Installation of well and pumping systems **and/or temporary cut-off structures** to maintain the stability of the excavation **and partially constructed buildings (ie., due to buoyancy)** by control of groundwater levels or flow • Includes consideration of measures to reduce temporary and long-term (ie., if subject structure will not be removed) off-site impacts such as settlement or subsidence due to raising or lowering the water table

Permanent Works

1998 Guidelines

- Design life is normally assumed to be approximately **50 years**

2020 Guidelines

- Design life is normally assumed to be between **50 to 75 years but may differ based on project requirements**

Schedule B: Geotechnical - Permanent

Item	1998 Guidelines	2020 Guidelines
Bearing Capacity of the Soil	• Allowable bearing of the ground for Support of the Building using Shallow Foundations. Includes consideration of factors such as subsurface conditions, live load, wind, seismic, frost, long term settlement, etc. affecting the building	• Similar to Definition in 1998 Guidelines but **does not** include consideration of Live and Wind Loads (as this is a Structural Engineering consideration) and **includes** consideration of subsurface soil or rock and groundwater conditions
Geotechnical Aspects of Deep Foundations	• Refers to geotechnical aspects of deep foundations for Support of the Building • Includes subsurface conditions • Includes seismic factors affecting the building	• Refers to geotechnical aspects of deep foundations for the **Subgrade** Support of the Building • Includes subsurface soil or rock and groundwater conditions • Includes the pile response to seismic ground and building movement • Consideration of corrosion should be addressed jointly by the SER and the GER • Where rock bolts or anchors are used to secure unfavourable jointing in bedrock supporting a building, these would be considered deep foundations
Compaction of Engineered Fill	• Similar to Definition in September 2020 Guidelines	• Similar to Definition in March 1998 Guidelines

Schedule B: Geotechnical – Permanent *Cont'd*

Item	1998 Guidelines	2020 Guidelines
Structural considerations of soil, including slope stability and seismic loading	• Includes the stability of slopes supporting or loading against the building and the design of the geotechnical aspects of the interaction between the ground and the building	• Includes assessment of the soil and groundwater conditions that affect the strength properties of the soil surrounding and supporting the building, and whether any of these conditions could affect the structural design of the building • Considerations must include whether any changes in soil properties caused by weather, temperature, ground movement, or seismic events could alter the interaction between the building and the surrounding supporting soil • Reference to Legislated Landslide Assessments for Proposed Residential Development in BC (EGBC, 2010a)
Backfill	• Normally does not include fill which does not impinge on the performance of the building or adjacent property	• Where on-site sidewalks and other hard-landscaped areas span backfill areas adjacent to the building that will be traversed by the public, measures should be considered to reduce the risk that hazards may develop on site due to settlement or other concerns (e.g. the potential for slips or trips)

Schedule B: Geotechnical – Permanent *Cont'd*

Item	1998 Guidelines	2020 Guidelines
Permanent Dewatering	• Installation of well and drainage systems to maintain the groundwater at design levels and pressures • Normally related to pumping, drainage and/or cut-off of groundwater	• Similar to the definition in the1998 Guidelines but specifically relates to pumping, drainage and/or groundwater cut-off structures **that are required to limit hydrostatic pressures acting on the building** • Considerations should include seismic load and performance, soil and structure interaction, measures to reduce to reduce offsite impacts such as settlement or subsidence due to raising or lowering the water table • Includes specification of design groundwater elevation, which incorporates a 'freeboard' or factor of safety, and potentially relates to a specific return period, if available

Schedule B: Geotechnical – Permanent *Cont'd*

Item	1998 Guidelines	2020 Guidelines
Permanent Underpinning	• Soil reinforcing and structural works to support existing building foundations adjacent to new building • Normally included are both geotechnical and structural aspects	• Soil reinforcing, **retention** and structural works that support existing building foundations adjacent to new building • Normally includes gravity loads but the GER should coordinate with the SER to confirm whether lateral loads should be resisted. • Considerations should include both geotechnical and structural aspects, including lateral deformation, groundwater, freeze-thaw, proximate seismic loads, structural surcharge loads, vulnerability of the adjacent building to movement, corrosion and/or soil aggressivity, and design life. • Includes relevant permanent shoring (which is currently stated to not be encompassed in the scope of the retaining wall guidelines), referring to the permanent soil reinforcing, soil retention, and structural works for supporting excavation cuts, and the elements and features beyond or facilitating steep-to-vertical grade changes that substantially affect the building design or its safety, notwithstanding that such shoring does not apply to permanent support of adjacent buildings (as this is defined as permanent underpinning).

Schedule B: Plumbing

- Item 4.2 ‘ Site and foundation drainage systems’ has been added to the 2020 Guidelines. The definition will align with that to be published in the upcoming revised guideline, ‘Mechanical Engineering Services for Building Projects’
- Site and foundation drainage systems refers to the arrangement of site grading and buried (subsoil) pipes, trenches and other engineered systems that intercept surface and subsurface (both groundwater and interflow) water flow and direct it away from a building and its below grade envelope system
- A GER may be responsible for aspects of item 4.2 if neither a MER or CER is engaged on the project

Important Updates to the new Guidelines

- The GER is normally responsible for **assessing groundwater conditions**
- Installation and monitoring of groundwater piezometers should be carried out for **all** projects, unless it can be proven unnecessary
- The GER must use a risk-based approach to decision making when providing professional services, and one of the risk factors that must be considered is **climate change implications**
- The GER has a responsibility to notify the Client of future climate-related risks, reasonable adaptions to lessen the impacts of those risks, and the potential impacts should the client refuse to implement the recommended adaptions. The GER has a responsibility to notify the client of future climate related risks, reasonable adaptions to lessen the impact of those risks, and the potential impacts should the client refuse to implement the recommended adaptions. The GER has a responsibility to be aware of and meet the intent of any climate change requirements imposed by the client or the Authority Having Jurisdiction.

Coordinating Registered Professional

Guidelines for Geotechnical Engineering Services for Building Projects, 2020, Section 2.2.2:

The role of the CRP, as described in the Letter of Assurance, Schedule A, Confirmation of Commitment By Owner and Coordinating Registered Professional, is to coordinate the design work and Field Reviews of the RPs required for the project in order to ascertain that the design will substantially comply with *BCBC* or VBBL, and other applicable enactments respecting safety.

The role of the CRP is clearly defined in the *BCBC*, Note A-2.2.7.2.(1)(a) of Division C.

It is not intended for the CRP to assume responsibility for the adequacy or accuracy of the technical designs prepared the RPs, or for subsequent Field Reviews of the RPs who provide design and Field Review services. However, the CRP should provide a level of administrative overview beyond simply obtaining sealed drawings and Letters of Assurance, whether or not the CRP has a contractual relationship with the RPs involved in the project.

- coordinate and review designs, drawings, and other contract documents prepared by RPs;

ensure the design team identifies any special design criteria, such as loads, settlement tolerances, seismic resistance, and other performance requirements that are stricter than those imposed by the Building Code, as well as additional geotechnical services not normally part of the scope of such projects, and advise the GER accordingly;

- coordinate the implementation of risk mitigation strategies (such as design intents or covenants) identified during the development permit process by the project team involved with detailed design and construction.

CITY OF VANCOUVER

An Introduction to…

MOBILIZING
BUILDING ADAPTATION
AND RESILIENCE

An Introduction to MBAR

What is MBAR?

- **M**obilizing **B**uilding **A**daptation and **R**esilience
- Led by BC Housing
- Multi-year, multi- stakeholder knowledge- & capacity- building project
- Focused on climate change adaptation and disaster resilience for housing.

MBAR aims to:

- Help stabilise communities during a natural disaster, and;
- Help building owners and occupants **better protect investments & adapt to climate change stressors and shocks**, such that *no one is stressed beyond their ability to cope*

MBAR Recommendations Matrix

Code and Authority Having Jurisdiction

- *National*
- *Provincial*
- *Municipal / Jurisdictional*
- *BC Housing*

Qualified Professionals

- *Coordinating Registered Professional (CRP)*
- *Architectural*
- *Structural*
- *Building Envelope*
- *Mechanical*
- *Elevators*
- *Electrical*
- *Geotechnical*
- *Environmental*
- *Landscape*

Other

- *Public*
- *K-12 Education*

MBAR Recommendations Matrix – *Cont'd*

Recommended Overall Measures

Area	No.	Flood Resiliency Measure	9	3/4	Reno
Coordinating Registered Professional (CRP)	C1	In consultation with design team, prepare a Design Philosophy Statement and have it placed on title	✓	✓	
	C2	Development Permit line item on Schedule B	✓	✓	
	C3	Consider sea gates with manual back-up if self-rising systems are specified (require storage near where they will be used)	✓	✓	✓
	C4	Consider 'short cuts' for floodwaters to and within a building (i.e. shafts, soil gas vents, electrical conduits, etc.)	✓	✓	✓
	C5	Specify warning signage or flashing lights at parkade entries showing when to not enter parkade (e.g., webcams on watercourse levels, moisture sensors in parkade, signs similar to forest fire warning signs)		✓	
	C6	When FARL[2] becomes FCL[3] during the lifespan of the building, future design team to upgrade in conformance with Design Philosophy Statement	✓	✓	✓
	C7	Moisture sensors to be monitored and alarmed	✓	✓	✓
	C8	Maintenance and Operations Manual to include section on education of tenants	✓	✓	
	C9	Vent shafts at parkade/property perimeter could serve as emergency exit points and deep sumps for pumping flood waters - Parkade level door adjacent to fan and accessing a ladder - Consider ability to open (from inside) vs building security - Emergency lighting required - Not feasible for 'interior' shafts		✓	
	C10	Consider cascade effects (i.e., fire due to flood, flood due to fire, power outages, seismic, closure of municipal infrastructure during the event including roads, sanitation/solid waste, potable water, etc)	✓	✓	✓
	C11	Address Amenity Area of Refuge requirements including reasonable expected duration of temporary power and provision of waste storage		✓	
	C12	Compile list of all above-grade openings (at or above FCL) which may require raising or retrofitting in the future (e.g., with a sea gate)	✓	✓	✓
	C13	Compile Schedule of Building Elements with associated Design Life (and Warranty Period) and include in Design Philosophy Statement	✓	✓	✓

The latest version of this document may be downloaded online at
www.horizoneng.ca/wordpress/resources/downloads

MBAR Recommendations Matrix – *Cont'd*

Recommended Administrative Measures

Area	No.	Flood Resiliency Measure	9	3/4	Reno
National	N1	Prescribe Factor of Safety against buoyancy of 'tanked' buildings in the National Building Code (NBC)			
	N2	Be prescriptive with respect to Importance Factor in consideration of buoyancy in the NBC			
	N3	Include structural / mechanical / electrical / elevator considerations during a flood event in Code, based on importance of building			
	N4	Specify duration of service period for emergency systems in the NBC			
	N5	Emergency notice of flooding to cell phones (i.e., through Alert Ready)			
	N6	Require manual back-up for passive systems in the NBC			
	N7	Specify Design Life of buildings in the NBC			
	N8	Encourage the use of provincial Letters of Assurance in the NBC and provide templates			

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Acknowledgments

We would like to thank the building and flood experts who have contributed to the development of these recommendations or have otherwise increased the understanding of the project team, including:

- Wilma Leung, Senior Manager, Technical Research & Education, BC Housing
- Thomas Leung, P.Eng., Struct.Eng., TLSE Engineering Inc.
- Tamsin Lyle, M.Eng., MRM, P.Eng., Ebbwater Consulting
- Sean Maclean, M.Arch, JSHeld
- Robert Lepage, MASc., P.Eng., RDH Building Science
- Nav Chahal, Technical Safety BC
- Mike Currie, P.Eng., FEC, Kerr Wood Leidal Associates
- Marcus Dell, MASc., P.Eng., RDH Building Science
- Kees Lokman, MDEsS, MSc, Assistant Professor of Landscape Architecture, UBC
- John Sherstobitoff, P.Eng., Ausenco Engineering Canada Inc
- Harshan Radhakrishnan, P.Eng., Engineers and Geoscientists BC
- Emmanuel A. Domingo P.Eng., FEC, LMDG Building Code Consultants
- Edwin Zander, Eng.L., Williams Engineering Canada
- Dustin Purser, AES Engineering
- Craig Dedels, Integral Group
- Arash Azadeh, BC Housing
- Anca Cojocaru, P.Eng., Integral Group
- Amela Brudar, Architect AIBC, MRAIC, LEED AP BD+CPRINCIPAL, GBL Architects

- Karen Savage, P.Eng., FEC, Horizon Engineering Inc (karen@horizoneng.ca)
- Diane Meehan, EIT, Horizon Engineering Inc (diane@horizoneng.ca)

Design Philosophy Statement - Example

Example: Designed to remain dry below FCL until coastal floodwater exceeds FCL at which time parkade will flood via alarmed vent shaft. Signage will educate tenants to not enter parkade when ponding in adjacent streets occurs and to exit when alarm sounds. Lane vent shaft developed as safe egress for P1-P3 levels. Elevators will not descend below main floor when above alarm sounds. Tenant education and emergency lighting to direct individuals to east P4 exit should they hear water falling down vent shaft.

Building:	Building Name
Address:	Some Street, Vancouver, BC
Development Description:	› Commercial / residential mixed-use building › Excavation depths of 13 to 15 metres › Approximately 32.4 metres (106.2 feet) by 131.9 metres (432.7 feet) › Near the historic shoreline
Applicable Building Code:	Vancouver Building By-Law, 2019
Building Design Life:	75 years assumed
Number of Storeys:	11 to 14 (commercial / residential)
Number of underground levels:	4
Types of construction:	Reinforced Concrete
Closest water body:	
Next closest water body:	
Geology:	› Salish Sediments comprised of landfill underlain by beach sediments, over › <3 metres of Capilano Sediments, over › Vashon Drift , over › Tertiary Bedrock, which is expected to be encountered within 10 metres of surface based on the GSC map.
Primary type of flooding:	Coastal and groundwater
Flood Construction Level (FCL):	El. 4.6 metres (Fraser Creek) GVRD datum
Flood Adaptation and Resiliency Elevation (FARE):	TBD
Maximum Design Groundwater Elevation (MDGE):	TBD
Waterproofing/tanking system:	Conventional perimeter drainage and enhanced dampproofing (TBC)

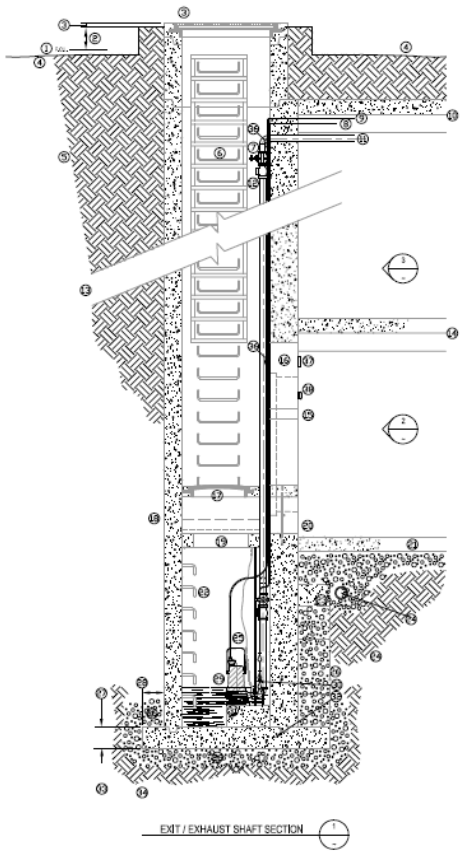
Existing grades:	El. 4.1 metres to El. 6.0 metres
Main Floor:	Minimum El. 4.4 metres (with perimeter curb wall) to Maximum El. 5.8 metres
Parkade Ramp Entry:	El. 4.7 metres
Slab-on-grade:	P4: El. -7.57 metres P3: El. -4.78 metres
Sewer connections:	TBD
Vent shaft rims:	~El. 4.73 metres (15.5 feet), ~El. 5.56 metres (18.2 feet) and ~El. 4.60 metres (15.1 feet)
Sump rims:	Catchbasin in lane: El. 4.50 metres (14.8 feet) Others TBD
Other penetrations:	TBD
Other connections to sewer/ground?	No sewage heat recovery or geothermal is proposed - TBC
Electrical room above FCL?	No
Backup generator above FCL?	No
Emergency power duration?	8 hours
Elevator Water Sensor?	Yes / No
Pull Pit Water Sensor?	Yes / No
On-site power generation?	Yes - TBC

Intent of Design Team for future upgrades:

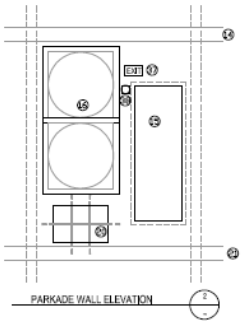
Examples: Elevate rims of vent and EVequipment shafts

Discipline	Firm	QP of Record	Other Key Individual
Architect			
Code Consultant			
Structural Engineer			
Mechanical Engineer			
Electrical Engineer			
Geotechnical Engineer			
Building Envelope Engineer			
Landscape Architect			
Environmental Engineer			
Civil Engineer			

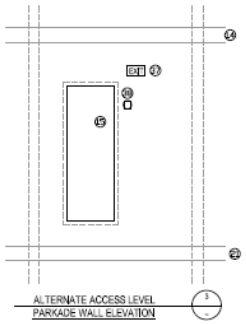
Vent Shaft Detail



EXIT / EXHAUST SHAFT SECTION



PARKADE WALL ELEVATION



ALTERNATE ACCESS LEVEL
PARKADE WALL ELEVATION

KEYNOTES:

1. FLOOD CONSTRUCTION LEVEL (F.C.L.) AS ESTABLISHED FOR LOCATION.
2. LANDSCAPE FEATURE (OR SIMILAR) TO MIN. 18" ABOVE F.C.L.
3. EXHAUST GRATE (*) TO SUIT LOADING CONDITIONS, SURFACE OF FRAME TO EXTEND 2" ABOVE SURROUNDING SURFACES, GRATE TO BE FITTED WITH ESCAPE HATCH C/W MAS LOCK AND MANUAL LATCH, BOTH ONLY RELEASABLE FROM WITHIN THE SHAFT, ALLOW CLEARANCES ABOVE SHAFT TO PERMIT FUTURE EXTENSION OF THE SHAFT, TO COMPENSATE FOR INCREASES IN F.C.L.
4. AVERAGE GRADE (REFER TO LANDSCAPE DWGS) MAY BE BELOW OR ABOVE F.C.L.
5. COMPACTED FILL AND/OR UNDISTURBED SOIL.
6. LADDER C/W SAFETY CAGE.
7. ISOLATION VALVE.
8. WEATHERTIGHT CONTROL WIRING TO CONTROL PANEL.
9. WEATHERTIGHT POWER CONDUIT FROM CONTROL PANEL.
10. SUSPENDED SLAB/SLABBAND
11. SANITARY FORCE MAIN.
12. CHECK VALVE.
13. HEIGHT TO SUIT PROJECT CONDITIONS. PROVIDE ALTERNATE ACCESS EXITS AT ALL LEVELS BELOW F.C.L., WHERE ACCESS TO ESCAPE SHAFTS IS POSSIBLE. MAINTAIN SIMILAR RISE FROM TOP OF SLAB TO BASE OF DOOR.
14. SUSPENDED SLAB/SLABBAND.
15. EXIT DOOR (OPENS INTO SHAFT)
16. EXHAUST FAN OPENING(S) (DESIGN ALLOWS FOR UP TO 2@MAX 30" FANS)
17. ACCESS COVER TO PUMP CHAMBER.
18. BASE OF EXIT SHAFT (MIN 12" ABOVE SLAB).
19. 30"x30" OPENING INTO PUMP CHAMBER.
20. 10"x10" OVERFLOW OUTLET C/W MINIMUM 10"x10" SECURITY BARS.
21. PARKADE SLAB-ON-GRADE (*), SLOPED AWAY FROM SHAFT, TOWARD CONVENTIONAL PARKADE DRAINAGE SYSTEM.
22. MANHOLE LADDER - RUNGS 12" O/C (VERTIC).
23. CONVENTIONAL FOOTING HEIGHT (STEPS DOWN) (**).
24. CONVENTIONAL INTERIOR DRAIN TILE, IF REQUIRED (**).
25. CONTROL FLOATS (QUANTITY TO SUIT).
26. FREEDRAINING FILL, OR UNDISTURBED SOIL, AS REQUIRED (**).
27. FOUNDATION BASE (MIN. 8" THICK, REFER TO STRUCTURAL) (**).
28. FOOTING TO EXTEND BEYOND WALL, IF REQUIRED (REFER TO STRUCTURAL) (**).
29. SUMP PUMP FOR POST-FLOOD DE-WATERING (QUANTITY TO SUIT DESIRED DE-WATERING DURATION. DESIGN ALLOWS FOR UP TO 3 PUMPS).
30. LIFT-OUT RAIL ASSEMBLY, COMPATIBLE WITH HATCH SIZE.
31. CONCRETE PUMP PEDESTAL.
32. DROP FOOTING FOR PUMP CHAMBER (**).
33. DRAINAGE LAYER, IF REQUIRED (**).
34. UNDISTURBED SOIL.
35. PUMP CHAMBER.
36. WEATHERPROOF EMERGENCY LIGHTING IN SHAFT (UPS POWER, ONLY ILLUMINATES WHEN ACTIVATED).
37. WEATHERPROOF EXIT SIGN (UPS POWER, ONLY ILLUMINATES WHEN ACTIVATED).
38. WEATHERPROOF EMERGENCY RELEASE BUTTON, PROVIDE WARNING SIGN "ALARM WILL SOUND IF THIS BUTTON IS PUSHED".
39. OPENING IN CAGE FOR ACCESS TO LADDER FROM ALTERNATE LEVEL EXIT(S).
40. OPERABLE "HATCH" (*) FOR EXITING SHAFT ABOVE GRADE, RELEASE OF MAG-LOCK (EMERGENCY OR CONTROL RELEASE) AND MANUAL LATCH REQUIRED TO OPEN "HATCH". LATCHING DEVICES SHALL BE PROTECTED FROM ACCESS FROM ABOVE.
41. CATWALK GRATE, FOR FOOT TRAFFIC LOADING. NOT AFFECTED TO BE "WELL-PROOF" (POST WARNING SIGN ON ACCESS DOOR), TO MINIMIZE IMPACT ON EXHAUST AIRFLOW.

SYSTEM NOTES:

TO MAINTAIN BUILDING SECURITY, ALL "ESCAPE" EXITS SHALL BE FITTED WITH MAG-LOCKS (ON UNINTERRUPTED POWER SUPPLY (UPS)) THAT WILL ONLY DE-ENERGIZE UPON SENSING OF ACCUMULATED MOISTURE WITHIN THE PARKADE. OVERRIDE BUTTONS SHALL BE PROVIDED WITHIN THE PARKADE AT HIGH LEVEL (NEAR THE TOP OF THE DOOR), ON ALL LEVELS EQUIPPED WITH "ESCAPE" EXITS AND IN THE SHAFT (ONE LEVEL BELOW THE EXIT GRATE) FOR EMERGENCY USE. ACTIVATION OF ANY BUTTON WILL RELEASE ALL THE MAG-LOCKS AND INITIATE AN ALARM THAT WILL CONTINUE TO SOUND UNTIL IT IS MANUALLY RESET, AT THE CONTROL PANEL.
WHEN ACCUMULATED MOISTURE IS IDENTIFIED BY THE CONTROL SYSTEM, ALL "ESCAPE" MAG-LOCKS WILL BE RELEASED, THE EMERGENCY LIGHTING IN THE SHAFT WILL ILLUMINATE, AND THE EXIT SIGNS ADJACENT TO THE ENTRY DOORS WILL ILLUMINATE; THE EXIT ALARM WILL NOT SOUND.

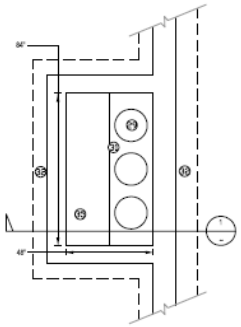
SYSTEM REQUIRES ANNUAL TESTING TO ENSURE OPERABILITY. ACTIONS TO INCLUDE FLOODING OF THE CHAMBER, TO ENSURE SENSOR AND FLOAT OPERATION, AS WELL AS PUMP START/OPERATION, IS CONFIRMED.

PUMPS TO BE ON EMERGENCY POWER, WHERE AVAILABLE.

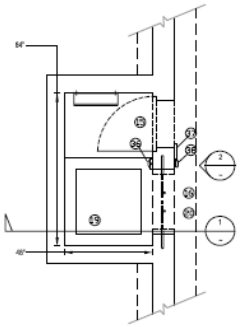
PUMPS MAY BE AUTOMATIC (FLOAT CONTROLLED), TO START AS SOON AS SUFFICIENT FLUID ACCUMULATION IN THE SUMP OCCURS, OR MANUALLY (REQUIRED HUMAN INTERVENTION REQUIRED), TO START AFTER SITE HAS BECOME FULLY FLOODED AND REMEDIATION ACTION HAS COMMENCED. AUTOMATIC OPERATION WILL INCREASE THE AVAILABLE "ESCAPE TIME" FOR THE LEVEL BEING FLOODED.

* OUTLET MAY BE ADAPTED TO A LOUVERED OUTLET; THE LISTED MINIMUM DIMENSIONS WOULD APPLY TO THE BASE OF THE LOUVER.

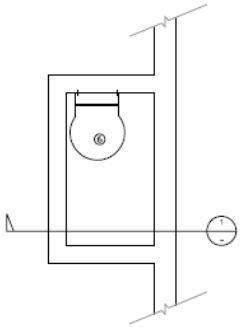
** FOUNDATION CONDITIONS OF PROJECT MAY VARY (STRIP FOOTINGS, PILES, RAFT SLAB, ECT.); REFER TO STRUCTURAL DESIGN. ADAPTATION OF CONDITIONS/REQUIREMENTS MAY BE REQUIRED.



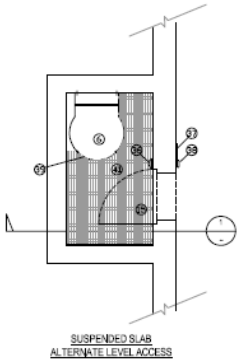
PUMP CHAMBER BASE



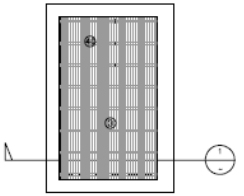
SLAB-ON-GRADE



SUSPENDED SLAB



SUSPENDED SLAB
ALTERNATE LEVEL ACCESS



EXIT GRATE

Thank you.

Questions?