RYZUK GEOTECHNICAL
Engineering & Materials Testing
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July 22, 2021
File No: 1808-80

Vancouver Island Health Authority
1952 Bay Street
Victoria, BC
V8R 1J8

Attn: Richard Brown (By E-mail: richard.brown@viha.ca)

Re: Proposed Long Term Care Facility
6910 Lantzville Rd – Lantzville, BC

As requested, we have completed an office based geotechnical investigation for the above referenced site. This report summarizes the results of our investigation and associated recommendations as related to the proposed development. Our work in this regard has been carried out in accordance with, and is subject to, our attached Terms of Engagement.

This report provides general information about the referenced site which has been interpolated/extrapolated from available nearby information and should be considered as preliminary information only. Actual underlying soil conditions could vary.

EXISTING SITE CONDITIONS

The site is roughly square in shape, and is bounded by Schook Road to the east, Lantzville Road to the south, a similar undeveloped lot to the west and single family residences to the north. The site is generally flat/level and is currently undeveloped with mature dense trees along the north and east property lines, and sparse younger trees throughout the remainder of the site. We have reviewed the Site Review – Phase 2, by Island Health Capital Planning Department, dated August 21, 2021 and understand the site shows no signs of being developed other than being logged a long time ago.

PROPOSED DEVELOPMENT

We have not reviewed preliminary architectural plans for the development; however, we understand that the proposed development will consist of the construction of two three storey buildings, at grade, with a single storey building linked at the centre. It is anticipated that the proposed building would be of wood-framed construction with reinforced concrete foundations.

INVESTIGATION PROCEDURE

Our investigation consisted of a desktop review of nearby projects we have had previous involvement with (including Cabela's and the HomeOutfittters/Homesense/Petsmart development to the east), geological mapping, aerial photographs, BC Water Resource Atlas, and other relevant geotechnical information.

SURFACE AND SUBSURFACE CONDITIONS

Based on our desktop background review we expect that subsurface soil conditions consist of a surficial layer of topsoil/organics, underlain by a layer of varying thickness consisting of sand and gravels, atop very dense silty sand with some gravel (glacial till).

Long term groundwater information was not available; however, we expect that perched water/seepage may be encountered within the existing topsoil and organics layer. In general, we expect the groundwater table to fluctuate seasonally, being higher in the winter months and lower in the summer months.

GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

On the basis of our investigation, we do not anticipate any unique geotechnical issues relating to development as proposed at the site. We expect that competent soils are present at shallow depth, and that such would be suitable for long term, stable support of the proposed long term care facility.

Excavation Considerations

While final design details are not yet available, it is anticipated that excavation will most practically be achieved with open cutslopes. The stability of excavation cutslopes can vary depending on the actual soil conditions encountered, the presence of static or perched groundwater, weather conditions, and the amount of time that they remain open. For planning purposes, we expect that temporary excavation cutslopes within the observed subsurface materials will be stable at the following configurations:

- 1 H to 1 V (Horizontal : Vertical) for topsoil,
- 1 H to 1 V for fill material,
- ½ H to 1 V for dense to very dense glacial till, and

Depending on the actual soil conditions and seepage encountered during excavation, the above slope configurations are subject to change and may be flattened. Depending on conditions, overburden soils exposed in open cutslopes may be required to be covered by poly sheeting to protect from weathering. All excavations deeper than 1.2 m and steeper than 0.75H:1V must be assessed by a geotechnical professional in accordance with WorkSafeBC guidelines.

Seismic Considerations

The Lantzville area is situated in a region of relatively high seismicity. Considerable earthquake risk exists, stemming from our proximity to the Cascadia subduction zone and numerous more local faults in southwestern BC and northwestern Washington State.

Based on the anticipated geologic conditions at the site, it is reasonable to expect the shear wave velocity in the upper 30 m (V_s^{30}) to be between 360 and 760 m/s. This corresponds to a Site Classification for Seismic Site Response of "C".

As determined from the 2015 National Building Code Seismic Hazard Calculation, for a 2% probability of exceedance in 50 years, the Peak Ground Acceleration (PGA) and Spectral Acceleration Values for Seismic hazard values for Site Class 'C'. The raw values provided from the National Seismic Hazard Calculator are provided as an attachment to this report.

Settlement Considerations

Provided all deleterious materials are removed, and all foundation elements are placed atop undisturbed dense native subgrade or approved engineered fill, we expect that settlement at this site will be minor, and of minimal significance to any structural or geotechnical design.

Foundation Design Considerations

We consider the use of conventional strip and pad footings to be feasible for the proposed development. It is anticipated that foundations would bear upon native dense to very dense glacial till, or an engineered fill atop such. All existing topsoil and fill materials must be removed, and the exposed subgrade inspected/approved by a geotechnical professional prior to placement of engineered fill or concrete. Foundation elements bearing on glacial till or approved engineered fill atop such can be dimensioned according to Table 1.

Table 1: Summary of Bearing Resistances

Subgrade	Limit State Design (LSD)	
	Strip Footing	Pad Footing
Native very dense silty gravelly sand (Glacial till); or, approved engineered fill atop such	450 kPa (SLS) 540 kPa (ULS)	540 kPa (SLS) 650 kPa (ULS)

For design purposes, foundations can be dimensioned on the basis of the following Serviceable Limit State (SLS) and Ultimate Limit State (ULS) factored bearing resistances. A geotechnical resistance factor of 0.5 was applied to the ultimate bearing capacity to achieve the ULS bearing resistance. Minimum footing widths of 0.4 and 0.6 m are recommended for strip and pad footings, respectively. Actual bearing resistance will need to be confirmed by a geotechnical professional once footing subgrade is exposed. Perimeter footings or footings in unheated areas

bearing on soil or fill should be placed at least 450 mm below final adjacent site grade to minimize the effects of seasonal frost and/or moisture variation.

Engineered Fill

If it is desired to raise grades back to design grade after removal of topsoil/deleterious materials, approved engineered fill would be required. Engineered fill, if required, should be placed upon approved subgrade and should consist of approved, well-graded, free draining granular material. The fill should be placed and compacted in suitably thin lifts under the supervision of a geotechnical professional to at least 95% of the Standard Proctor Maximum Dry Density (SPMDD) value, or judged equivalent. The recommended lift thickness is dependent on both the type of material and the method of compaction (i.e. 300 mm thick lifts for 19 mm minus crushed rock fill compacted with a vibratory diesel plate compactor), and such should be confirmed before placement of fill. The engineered fill must have a footprint that extends horizontally beyond the footings a distance equal to the thickness of the confined engineered fill, to provide adequate splay for foundation loads.

Foundation Wall Backfill

Foundation walls should be backfilled with clean, well graded granular material, with less than 5% passing the #200 sieve. Backfill should be placed and compacted in maximum 300 mm lifts to at least 95% of the SPMDD value. Additionally, adequate drainage should be provided for the backfill to prevent the buildup of hydrostatic pressure against the foundation walls.

Foundation walls can be designed on the attached Lateral Earth Pressure Diagrams and the following lateral earth pressure coefficients:

Table 3: Lateral Earth Pressure Coefficients

Lateral Earth Pressure Coefficient			
Wall Type	**Static K**		**ΔKae**
Yielding (unrestrained)	Active (K_a)	0.25	0.15
Non-yielding (restrained)	At-Rest (K_o)	0.43	0.22

A yielding wall is able to move a minimum of 0.2% of the height of the wall (rotation or translation) to allow active pressures to develop. Where such movement cannot occur, the non-yielding, at-rest earth pressure coefficient should be used. The above earth pressure coefficients are based on a friction angle of 35 degrees (compact gravelly sand). Lower earth pressure coefficients could be provided if better quality backfill material, such as imported crushed rock or site sourced blast rock fill, are used. Seismic earth pressures for yielding and non-yielding walls are based on 50% and 100% of the site class adjusted PGA, respectively.

In the case where the design assumptions above and noted on the attached diagrams are not satisfied, a site-specific assessment of the lateral earth pressures would be required.

Grade Supported Floor Slab

Use of a grade supported floor slab for at grade slabs is considered feasible. A minimum 150 mm of 19 mm minus crushed rock or free draining coarse sand is recommended immediately beneath the slab. The slab construction should incorporate a standard sub slab polyethylene vapour barrier to minimize capillary rise of moisture into the slab. All sub slab fills should be compacted to at least 95% SPMDD value.

Foundation Drainage

We expect the conventional perimeter foundation drainage tied into the recommended free draining granular backfill material or engineered rock fill will be sufficient to maintain a locally low ground water table and prevent the buildup of hydrostatic pressure. Depending on the gradation of the backfill materials, use of a non-woven geotextile filter fabric overtop of the perimeter drain arrangement (drain rock and perforated pipe) may be necessary to prevent the finer backfill material from migrating into the voids within the uniform gravel/drain rock.

The final grade at the site should be shaped to direct surface water away from the building and foundation areas. Wherever possible, the surfacing of the backfill material should be such to inhibit infiltration of surface water into the perimeter wall backfill and foundation drains.

Pavement Considerations

In areas of light traffic within driveways and parking areas, 50 mm of asphalt over at least 100 mm of 20 mm minus crushed rock (granular base) atop a minimum of 150 mm of 75 mm minus crushed rock product (granular sub-base) is recommended. For heavier traffic areas, we recommend 75 mm of asphalt and the sub-base be thickened to 150 mm. The sub-base material should be placed directly atop approved native soil subgrade, or suitably recompacted existing fill materials provided that it is free of organic material. A concrete slab is often preferred in front of garbage enclosures. We recommend spot check in-situ density tests to ensure fill materials are compacted to a minimum 95% Modified Proctor Maximum Dry Density (MPMDD) for support of civil infrastructure.

CLOSURE

In summary, we consider the proposed development would be feasible from a geotechnical perspective. We trust the preceding is suitable for your purposes at present, however if you have any questions with respect to the above, please contact us.

Yours very truly,
Ryzuk Geotechnical

Matt Holbrook
Junior Engineer

Lane Campbell, M.Eng., P.Eng.
Senior Geotechnical Engineer

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. G. CAMPBELL
19505

Attachment
- Terms of Engagement
- Lateral Earth Pressure Diagrams
- 2015 NBC Seismic Hazard Report

RYZUK GEOTECHNICAL
ENGINEERING & MATERIALS TESTING

TERMS OF ENGAGEMENT

1. GENERAL

1.1. Ryzuk Geotechnical Ltd., its principals and employees (collectively the "Consultant") shall render the Services to the Client for the Project in accordance with the following terms of engagement (the "Engagement").

1.2. The Services, and any other associated documents, records or data, shall be carried out and/or prepared in accordance with generally accepted engineering practices commensurate with the timing and location in which the Services are performed. No other representations or warranties, expressed or implied, are made by the Consultant.

1.3. The Consultant may, at its discretion and at any stage, engage sub-consultants to perform all or any part of the Services.

2. COMPENSATION

2.1. All fees billed to the Client by the Consultant are payable in Canadian dollars. Invoices are due and payable by the Client on receipt of the invoice, without holdback. Interest on overdue accounts is 24% per annum.

3. REPRESENTATIVES

3.1. Each party must designate a representative who is authorized to act on behalf of that party and receive notices under this Engagement.

4. TERMINATION

4.1. Either party may terminate this Engagement without cause upon providing 30 days' written notice to the other party. On termination by either party under this section, the Client shall forthwith pay to the Consultant all fees invoiced by the Consultant for the Services performed, including all expenses and other charges incurred by the Consultant in respect of the Consultant's Engagement by the Client.

4.2. If either party is in breach of any term of this Engagement, the non-defaulting party may give written notice of the breach to the other party and thereafter terminate this Engagement forthwith if the defaulting party does not remedy said breach within 7 days' of being provided written notice of the breach. On termination by the Consultant under this section, the Client shall forthwith pay to the Consultant all fees invoiced for the Services performed to the date of termination, including all expenses and other charges incurred by the Consultant in respect of the Consultant's Engagement by the Client.

5. ENVIRONMENTAL

5.1. The Consultant's field investigation, laboratory testing and engineering recommendations will not address or evaluate contamination or pollution of soil or groundwater. The Consultant will cooperate with any environmental consultant retained by the Client during the field work phase of the investigation.

6. PROFESSIONAL RESPONSIBILITY

6.1. The Consultant will provide the Services in accordance with the standard of care, skill and diligence required of a geotechnical consulting firm providing similar services at the same time in the same geographic location and circumstances in British Columbia. The Services will be provided in accordance with procedures customarily provided in similar circumstances by similar professionals.

7. INSURANCE

7.1 Ryzuk Geotechnical maintains Professional Indemnity Insurance as follows:

7.1.1 $3,000,000 each and every claim

7.1.2 $5,000,000 in the aggregate

7.1.3 $5,000,000 commercial/general liability coverage.

8. LIMITATION OF LIABILITY

8.1. The Consultant shall not be responsible for:

8.1.1. the negligence or failure of any contractor or other professional retained by the Client to perform work or provide services in respect of the Project in accordance with the applicable contract documents and/or advice provided by the Consultant;

8.1.2. the design of or defects in equipment or materials supplied or provided by the Client or its contractors for incorporation into the Project;

8.1.3. any cross-contamination resulting from subsurface investigations;

8.1.4. any Project decisions made by the Client if such decisions are made without the Client first seeking advice from the Consultant and/or decisions contrary to or inconsistent with advice provided by the Consultant;

8.1.5. any consequential loss, injury or damages suffered by the Client or its agents and contractors, including but not limited to loss of use, earnings and business interruption;

8.1.6. the unauthorized distribution of any confidential document or reports prepared by or on behalf of the Consultant for the exclusive use of the Client;

8.1.7. damage to subsurface structures and utilities.

8.2. The Consultant will make all reasonable efforts prior to and during subsurface site investigations to minimize the risk of damaging any subsurface utilities/mains. If, in the unlikely event that damage is incurred where utilities are unmarked and/or undetected, the Consultant will not be held responsible for damages to the Project site or surrounding areas, utilities/mains or drilling equipment or the cost of any repairs thereto.

8.3. The Consultant's total liability to the Client for any errors, omissions, breaches of contract and/or negligence arising in connection with the Services is limited to the amount of the Consultant's fees for the Services and shall not exceed that amount under any circumstances. For greater clarity, this means that if the Client makes any claim, including any claim for contribution or indemnity, or brings any claims against the Consultant, then any damages for which the Consultant may be liable cannot exceed the total amount of fees paid to the Consultant by the Client.

8.4. The Client agrees to indemnify and to save and hold harmless the Consultant from any claim, demand, litigation, expense, legal fees, liability, damage, award or cost, of any form or type whatsoever, in respect of any claim for property damage, loss, or personal injury brought by any party including the Client's contractors, other professionals, or any third party, resulting from the Consultant's provision of the Services, except for such property damage, loss or personal injury that results directly from the gross negligence of the Consultant or its employees.

8.5. No claim may be brought against the Consultant in respect of the Consultant's provision of the Services, in contract, negligence or other civil wrong more than 2 years after any claim is discoverable.

9. DOCUMENTS AND REPORTING

9.1. All of the documents prepared by or on behalf of the Consultant in connection with the Project are instruments of service for execution of the Project and the Services. The Consultant retains the property and copyright in these documents, whether the Project is executed or not. These documents may not be used on any other project without the prior written agreement of the Consultant.

9.2. Documents that have been prepared specifically for the Project are applicable and may be relied upon only in the case where there has been no physical alteration to, or deviation from any of the information or plans provided to the Consultant by the Client or the Client's agents. If the Client makes any changes or deviations from original plans for the Project, the Client may request that the Consultant review and revise Project documents accordingly.

9.3. Identification and classification in respect of the extent, properties, or type of soils or other materials at the Project site will be based upon investigation and interpretation of results in a manner consistent with customarily accepted standard geotechnical consulting practices in the location where the Services were performed. Due to the nature of geotechnical consulting, there is an inherent risk that all potential conditions will not be detected at the Project site and that actual subsurface conditions may vary considerably from investigation points. The Client and any other party making use of any documents prepared by the Consultant in respect of the Project acknowledges and accepts this risk.

9.4. Any conclusions and recommendations provided within any document prepared by the Consultant for the Client will be based on the scope of investigation by the Consultant and any additional information provided to the Consultant by the Client or the Client's agents. The Consultant disclaims responsibility for any deficiency or inaccuracy resulting from the Consultant being provided with inaccurate or fraudulent information by the Client or the Client's agents.

10. JOBSITE SAFETY AND CONTROL

10.1. The Client acknowledges that control of the Project site remains solely with the Client, and/or the Client's agents and/or contractors. The presence of the Consultant's personnel on the Project site does not relieve the Client, the Client's agents and/or contractors from their responsibilities for Project site safety. The Client must inform the Consultant of all hazardous or otherwise dangerous conditions at the Project site of which the Client, its agents, and/or contractors are aware.

10.2. The Client acknowledges that during the course of a geotechnical investigation a previously unknown hazard or contaminant may be discovered. Discovery and/or identification of a hazard/contaminant may necessitate procedures to ensure the safety and protection of persons and/or the environment being undertaken. The Client shall be responsible for payment of any additional expenses incurred as a result of discovery of a hazard/contaminant. The Client acknowledges that certain circumstances require government and/or regulatory authorities to be notified of hazardous conditions and/or contaminants. The Client shall not make any claim or bring any action against the Consultant in the event the Consultant provides any required notification of a hazard and/or contaminant to a government and/or regulatory authority.

11. FIELD SERVICES

11.1. If the Consultant is requested or required to provide field review Services for the Project and the Client declines to authorize or otherwise limits the scope of same in a manner inconsistent with the Consultant's advice or recommendations, the Consultant may provide qualified certifications in respect of any work completed by the Client and/or its contractors that was not overseen by the Consultant.

12. DISPUTE RESOLUTION

12.1. If requested in writing by either the Client or the Consultant, the Client and the Consultant shall attempt to

resolve any dispute between them arising out of or in connection with this Engagement by entering into structured non-binding negotiations with the assistance of a mediator on a without prejudice basis. The mediator shall be appointed by agreement of the parties. If a dispute cannot be settled within a period of thirty (30) calendar days with assistance of a mediator, the dispute shall be referred to and finally resolved by a British Columbia Court.

13. CONFIDENTIALITY

13.1. During the term of the Engagement, the Consultant shall not use or disclose any of the Client's confidential information to any third party other than the Consultants legal and/or financial advisors without authorization from the Client. The Consultant will use any confidential information for the sole purpose of carrying out the Services. The Consultant may share photos of the Project so long as such photos do not disclose any information not otherwise available or readily visible by the public. Unless already made public, the Consultant will not share Client or Project site address information on social media or with third parties.

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 49.244N 124.067W **User File Reference:** Proposed Long Term Care Facility 2021-06-28 15:52 UT

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.513	0.363	0.263	0.112
Sa (0.1)	0.792	0.561	0.405	0.171
Sa (0.2)	0.983	0.700	0.503	0.212
Sa (0.3)	1.010	0.719	0.515	0.212
Sa (0.5)	0.909	0.639	0.450	0.175
Sa (1.0)	0.533	0.356	0.240	0.086
Sa (2.0)	0.325	0.210	0.136	0.046
Sa (5.0)	0.105	0.060	0.033	0.010
Sa (10.0)	0.037	0.021	0.011	0.004
PGA (g)	0.433	0.307	0.221	0.091
PGV (m/s)	0.671	0.452	0.307	0.108

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

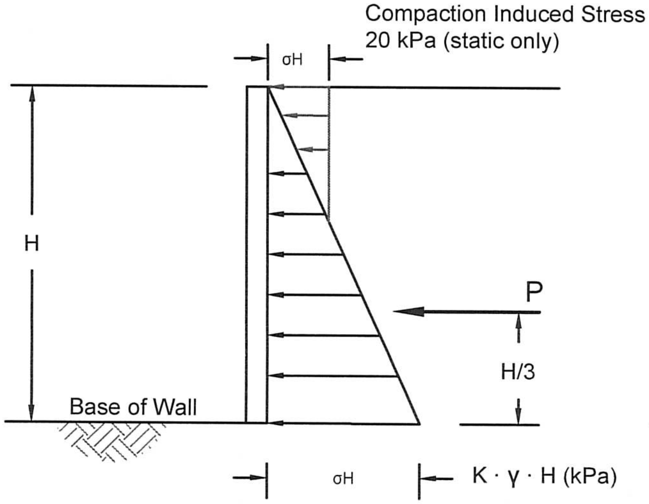
Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

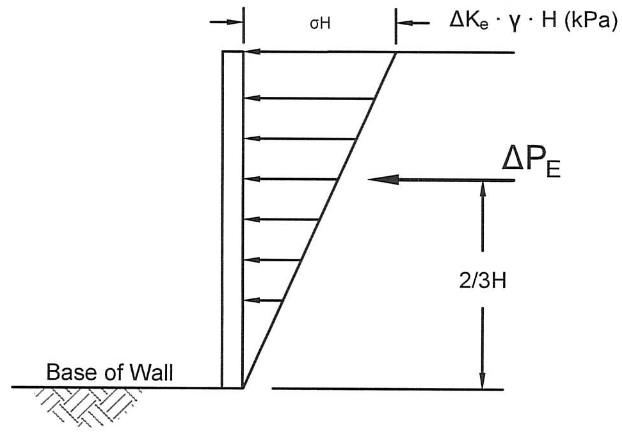
Natural Resources Canada Ressources naturelles Canada

Canada

Lateral Earth Pressures STATIC CONDITIONS

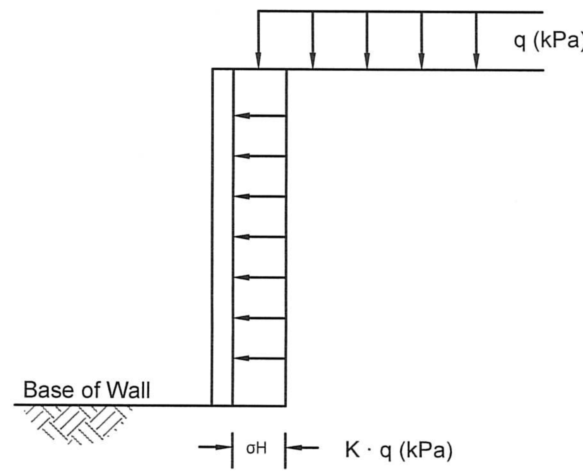


Lateral Earth Pressures SEISMIC INCREMENT (Added to Static Earth Pressures)



Dynamic Load to be added to Static Lateral Pressures

Uniform Surcharges, q (Floor Loads or Traffic Loads)



σH* = Lateral Pressure from Uniform Surchage

*Only applicable where surchage load is less than 30% of total lateral load on wall

Where:

γ = Dry Backfill unit weight 20.4 kN/m^3

H = Wall height (m)

σH = lateral earth pressure (kPa)

P = Resultant load (kN)

K = dimensionless coefficient, K_a or K_o (see Report)

Analysis Assumptions:

- Wall friction is half the soil
- Drainage is provided, such that hydrostatic pressures do not develop against wall
- Dynamic loading based on 50% of the Peak Ground Acceleration (PGA) for yielding wall and 100% PGA for a non-yielding wall
- Yielding wall assumes that wall movement of 0.2%H (rotation or translation) is possible
- The grade is flat and level adjacent to the wall
- No surcharge loads from adjacent structures or stockpiles within a horizontal distance equal to the wall height
- No equipment larger than a skid steer permitted within 1.5 m of the wall during backfill
- Compaction induced stresses will be relieved during a seismic event and are not included in Seismic load

NOTES

1. Above Diagrams are not to scale
2. All loads are unfactored.

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LATERAL EARTH PRESSURE DIAGRAMS

UPDATED MAY 2021