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SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Title - Sujet Emergency Power Modernization	
Solicitation No. - N° de l'invitation EP754-161586/A	**Amendment No. - N° modif.** 005
Client Reference No. - N° de référence du client 20161586	**Date** 2015-11-24
GETS Reference No. - N° de référence de SEAG PW-$$FP-004-68288	
File No. - N° de dossier fp004.EP754-161586	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à** 02:00 PM **on - le** 2015-12-03	**Time Zone** **Fuseau horaire** Eastern Standard Time EST
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☐ **Other-Autre:** ☐	
Address Enquiries to: - Adresser toutes questions à: Burns, Heather	**Buyer Id - Id de l'acheteur** fp004
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Centre Block Rehabilitation Project/Projet de réhabilitation de l'édifice du Centre
185 Sparks Street
185, rue Sparks
3rd Floor - 313/3ème étage - 313
Ottawa
Ontario
K1A 0S5

Canada

The following changes in the tender documents are effective immediately. This addendum will form part of the contract documents.

DRAWINGS

1. DRAWING E004

.1 Change trip setting on generator main circuit breakers from 3200 AT to 3000 AT.

.2 Change new emergency switchboard rating from 8000A to 6000A.

2. DRAWING M002

.1 Reference Detail 3/M002. Integral fuel oil booster pump and listed flex lines are supplied by Division 26. All other fuel oil system components shown are provided by Division 23.

3. DRAWING M302

.1 Revise size of motorized dampers MD-2B and MD-2C to 1000 x 1400.

.2 Revise inside diameter of generator exhaust venting to 500 mm. Transition generator exhaust venting from 50 mm thick wall to 25 mm thick wall at high level in mechanical plenum.

4. DRAWINGS M304 and M402

.1 Revise size of motorized dampers MD-5 and MD-6 to 1700 x 2600.

.2 Revise inside diameter of generator exhaust venting to 500 mm. Generator exhaust venting within exhaust tunnel to be 25 mm thick wall, in lieu of 50 mm thick.

SPECIFICATIONS

1. Add the following sections:

SECTION 01 31 32 - GEOTECHNICAL REPORT
SECTION 04 05 12 - MASONRY MORTAR AND GROUT
SECTION 04 05 19 - MASONRY ANCHORAGE AND REINFORCING
SECTION 04 05 23 - MASONRY ACCESSORIES
SECTION 04 22 00 - CONCRETE UNIT MASONRY

2. SECTION 26 05 01 - SYSTEM COORDINATION/SHORT CIRCUIT/DEVICE EVALUATION STUDY & ARC FLASH HAZARD ANALYSIS

.1 Add Item 3.2.5 to read:

“.5 Provide labels in English & French.”

3. SECTION 26 24 13.01 - GENERATOR SWITCHBOARD TO 600 V

.1 Delete Item 2.6.2.1 and add new Item 2.6.2.1 to read:

“.1 Interior surfaces: grey.”

4. SECTION 26 32 13.04 - DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)

.1 Delete Item 2.6.2.1.1 and add new Item 2.6.2.1.1 to read:

“.1 Radiator cooling fans to be direct driven, AMCA arrangement 4, plenum fans.”

.2 Add new Item 2.6.2.1.3 to read:

“.3 Enclosure for remote radiator access section, paneling and door, to be equal to construction quality standards set out in Section 23 32 48 – Acoustical Air Plenums.”

.3 Add new Item 2.6.2.2.7 to read:

“.7 Remote radiator package shall be able to maintain required cooling airflow with a back pressure of 0 pa.”

.4 Add new Item 2.7.7 to read:

“.7 Engine lubrication system to incorporate closed crank case ventilation.”

.5 Delete Item 2.8.2.1 and add new Item 2.8.2.1 to read:

“.1 Connect other end of each elbow with 1 m of flexible hose, listed to ULC 536.”

.6 Delete Item 2.8.5 and add new Item 2.8.5 to read:

“.5 Reference Section 23 11 13 – Piping, Valves Fittings and Accessories – Light Fuel Oil for associated external fuel oil system to be provided by Division 23 and coordinated with Division 26.”

.7 Delete Item 2.13.4 and add new Item 2.13.4 to read:

“.4 Generator winding insulation: Class H; winding temperature rise not to exceed 125°C as measured by resistance in ambient temperature of 40°C.”

.8 Delete Item 3.6.1 and add new Item 3.6.1 to read:

“.1 Provide all testing and maintenance including parts, labour, fuel and disbursements in accordance with CSA 282 (excluding weekly inspection work listed in Table 2) and manufacturer's recommendations for project warrantee period of 1 year from final acceptance.”

5. SECTION 31 23 16.26 - ROCK REMOVAL

.1 Delete Item 3.1.13 and add new 3.1.13 to read:

“.13 Rock bolts to be installed at direction of the departmental representative. Rock bolts to be 25 mm diameter hot rolled threadbar to CSA G30.18, 517 MPa yield. Set rock bolt 2 metres into rock with epoxy resin with bolt projecting out from face of rock 200 mm. At face of rock provide 130 by 130 by 32 thick anchor plate and threadbar nut. Grout plate to rock if rock face is irregular with non-shrink 40 MPa grout.”

Enclosures: Section 01 31 32 - Geotechnical Report – 20 pages
Section 04 05 12 - Masonry Mortar and Grout – Two (2) pages
Section 04 05 19 - Masonry Anchorage and Reinforcing – Four (4) pages
Section 04 05 23 - Masonry Accessories – One page
Section 04 22 00 - Concrete Unit Masonry – Two (2) pages

November 9, 2015 Project No. 1524638

Dan Carson, P.Eng.
WSP Canada Inc.
210 Gladstone Avenue, Suite 4001
Ottawa, Ontario
K2P 0Y6

GEOTECHNICAL DESIGN INPUT
PROPOSED CBUS ADDITION
PARLIAMENT HILL
OTTAWA, ONTARIO

Dear Mr. Carson:

This letter report presents geotechnical design input for the proposed Centre Block Underground Services (CBUS) addition at Parliament Hill in Ottawa, Ontario.

Based on a review of existing borehole information on the site, a general description of the subsurface conditions is presented. These interpreted subsurface conditions and available project details were used to prepare geotechnical engineering design guidelines for the project.

The reader is referred to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

BACKGROUND

The following is understood about the site and proposed works:

- The existing CBUS structure is located west of Centre Block, is entirely below grade, and extends to about 10 metres below the existing ground surface (i.e., to an elevation of about 77 metres).
- The proposed addition, which will be used for fuel storage, will be located at the northwest corner of the existing CBUS structure, and will also extend to about 10 metres depth.
- The interior dimensions of the proposed addition will measure about 5.2 by 8.0 metres in plan area.
- The floor slab of the existing generator room (which is adjacent to the proposed addition) is to be locally lowered.
- The area of the proposed addition is located just south of the existing gazebo, and is predominately grass surfaced.
- An existing 305 millimetre diameter watermain runs across the site, which will need to be relocated.

Golder Associates carried out a previous investigation on this site, which included the advancement of two boreholes (numbered 90-2 and 90-4) in the direct vicinity of the proposed CBUS addition. The results of that previous investigation are contained in the following report:

- Report by Golder Associates Ltd., titled "Centre Block Renovations Phase 2A, Parliamentary Precinct, Ottawa, Subsurface Geotechnical Investigation and Slope Reconnaissance Survey," dated 1990 (Report 891-1748).

The locations of the relevant existing boreholes are shown on the attached Site Plan (Figure 1).

SUBSURFACE CONDITIONS

The subsurface conditions encountered in the previously drilled boreholes are shown on the attached Record of Borehole and Drillhole Sheets (note that the boreholes are inclined from vertical; the depths shown on the Record of Drillhole Sheets correspond to drilled length rather than vertical depth).

In general, the subsurface conditions in the area of the proposed addition consist of about 0.4 to 0.6 metres of overburden (consisting mostly of silty sand) overlying faintly weathered to weathered, grey, fine grained, medium bedded limestone bedrock (unit B1 on the Record of Drillhole Sheets). Below about elevation 80.5 to 80.1 metres, the limestone is fresh to faintly weathered and thinly to medium bedded (unit B2 on the Record of Drillhole Sheets). The Rock Quality Designation (RQD) values measured on the bedrock core range from 0 to 70 percent for unit B1 (very poor to fair quality rock) and 40 to 80 percent for unit B2 (poor to good quality rock).

The measured groundwater level in borehole 90-4 was at elevation 76.51 metres on February 6, 1990.

DISCUSSION

This section of the letter report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the available information described herein and project requirements and is subject to the limitations in the "Important Information and Limitations of This Report" attachment which follows the text of this letter report.

Excavations

Overburden

The overburden at the site is only about 0.5 metres thick and typically consists of silty sand. No unusual problems are anticipated in excavating the existing overburden using conventional hydraulic excavating equipment. To prevent overburden material from falling into the deeper bedrock excavation below, unsupported side slopes in the overburden should be cut back at a maximum of 1 horizontal to 1 vertical. The toe of the overburden slope should be located at least 1 metre away from the edge of the bedrock excavation to help prevent overburden material from falling/sloughing into the excavation.

Bedrock Removal and Vibration Control

It is anticipated that up to 9 to 10 metres of bedrock removal will be required to reach the founding level of the CBUS addition. Some limited bedrock removal may also be required to lower the floor slab of the existing generator room.

Care will need to be taken in excavating the bedrock to limit vibrations induced by construction equipment. The site is located in close proximity to structures that are very sensitive to vibrations. Bedrock removal activities should be controlled to limit the peak particle velocities at all adjacent structures and services such that vibration induced damage will be avoided.

The following frequency dependent peak vibration limits have been specified for the previous Centre Block Renovation Project.

Frequency Range (Hz)	Vibration Limits (mm/s) Centre Block, CBUS, and Underground Utilities
< 10	5
10 to 40	5 to 40 (sliding log scale)
> 40	40

The vibration limits should be specified in the contract for *all* construction activities, irrespective of which bedrock removal method is used. Given the limited amount of bedrock excavation required, and the close proximity of the foundation walls for the CBUS building, it is anticipated that mechanical bedrock removal will be the most appropriate method of excavation. If controlled blasting is proposed, the contractor will need to provide a blast design prepared by a specialist in this field.

Perimeter line drilling should be used to achieve neat excavation limits and to minimize bedrock overbreak. Based on previous experience on Parliament Hill, it is expected that near vertical bedrock walls will be feasible for the construction period, with some rock-bolting and mesh. As an example, a common rock bolt arrangement used for excavations of this size would be 2 metre long bolts at 1.2 to 1.5 metre grid spacing. Some shotcreting and/or additional bolting may be needed if more fractured or faulted rock is encountered. If the final concrete walls are not designed for rock loads (the lateral earth pressures provided later in this report assume that no loads will be incurred from the bedrock), then any unstable wedges or blocks should be reinforced with corrosion protected rock anchors and/or steel fibre/mesh reinforced shotcrete. The final rock walls should be inspected by a qualified geotechnical engineer to confirm the adequacy of the rock support.

If blasting is proposed, blast induced damage to the bedrock must be avoided; otherwise (additional) rock reinforcement could be required. The blasting plan would need to include line drilling at a close spacing along the perimeter of the excavation so that a clean bedrock face is formed, or to carry out perimeter drilling and pre-shearing of the excavation limits using controlled blasting.

A pre-construction survey should be carried out of all of the surrounding structures and utilities. Selected existing interior and exterior cracks in the structures identified during the pre-construction survey should be monitored for lateral or shear movements by means of pins, glass plate telltales, and/or movement telltales.

The contractor should be required to submit a complete and detailed bedrock excavation/blasting and rock reinforcement plan and vibration monitoring proposal prior to commencing bedrock excavation activities. This would have to be reviewed and accepted in relation to the requirements of the specifications.

Bedrock excavation should commence at the furthest points from the closest structure or service to assess the ground vibration attenuation characteristics and to confirm the anticipated ground vibration levels based on the contractor's bedrock excavation plan.

Blasting, if carried out, should be conducted in accordance with Ontario Provincial Standard Specification (OPSS) 120, which provides the requirements for blast design and submissions, including pre-blast surveys. The vibration limits provided above should be used in lieu of the limits given in OPSS 120. Vibration monitoring should be carried out throughout all bedrock excavation operations.

Dewatering

The measured groundwater level in borehole 90-4 was at elevation 76.51 metres on February 6, 1990, which is below the anticipated founding level of the CBUS addition. In addition, the existing exterior drainage system of the CBUS structure would likely prevent the groundwater level from rising above the floor level of the existing structure. Therefore, groundwater inflow into the excavation should be minor. However, there may be instances where perched groundwater or incident precipitation may need to be pumped out of the base of the excavations. Groundwater, if encountered, should be controllable by pumping from sumps within the excavations. It is not expected that pumping volumes will be in excess of 50,000 litres per day; therefore, the requirement for a Permit to Take Water is not anticipated.

Shallow Foundations

Based on the subsurface conditions at this site and the proposed depth of the addition, the footings for the proposed addition will be within the limestone bedrock. Footings on or within competent limestone bedrock can be sized using an Ultimate Limit States (ULS) factored bearing resistance of 1,000 kilopascals. For footings bearing on or within competent bedrock, Serviceability Limit States (SLS) generally do not govern the design since the stress required to induce 25 millimetres of movement (the typical SLS criteria) exceed those at ULS. Accordingly, the post construction settlement of structural elements which derive their support from footings bearing on bedrock should be negligible.

Highly weathered or highly fractured bedrock encountered at founding level, which includes bedrock which can be excavated using hydraulic excavating equipment with only moderate effort, will need to be removed prior to construction of the footings. Should there be localized locations within the excavation where the bedrock surface, following removal of any highly weathered/fractured bedrock, is below the planned founding level, then the footing level should be lowered such that the footing will bear directly on the competent bedrock. Alternatively, the subgrade could be raised to the underside of the foundation using mass concrete.

Resistance to Sliding

A coefficient of friction of 0.7 (unfactored) may be used in the assessment of sliding resistance between cast-in-place concrete footings and the bedrock surface. If greater resistance is required, the footings could be provided with shear keys or prestressed rock anchors could be used to increase the normal stress level across the concrete/bedrock interface.

Seismic Design

The seismic design provisions of the 2010 National Building Code depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or rock below founding level. Based on Vertical Seismic Profile (VSP) testing carried out on Parliament Hill as part of a previous study, the average shear wave velocity to 30 metres depth (Vs_{30}) below the anticipated founding level will be about 2,200 metres per second. Accordingly, a Site Class A designation can be used for design purposes.

Rock Anchors

It is understood that rock anchors may be required for the proposed addition. The anchors could consist of either grouted or mechanical anchors.

In designing grouted rock anchors, consideration should be given to four possible anchor failure modes.

i) Failure of the steel tendon or top anchorage.

ii) Failure of the grout/tendon bond.

iii) Failure of the rock/grout bond.

iv) Failure within the rock mass, or rock cone pull-out.

Potential failure modes i) and ii) are structural and are best addressed by the structural engineer. Adequate corrosion protection of the steel components should be provided to prevent potential premature failure due to steel corrosion.

For potential failure mode iii), the factored bond stress at the concrete/rock interface may be taken as 750 kilopascals for ULS design purposes. If the response of the anchor under SLS conditions needs to be evaluated, for a preliminary assessment it may conservatively be taken as the elastic elongation of the unbonded portion of the anchor under the design loading.

For potential failure mode iv), the resistance should be calculated based on the buoyant weight of the potential mass of rock which could be mobilized by the anchor. This is typically considered as the mass of rock included within a cone (or wedge for a line of closely spaced anchors) having an apex at the tip of the anchor and having an apex angle of 60 degrees. For each individual anchor, the ULS factored geotechnical resistance can be calculated based on the following equation:

$$Q_r = \phi \frac{\pi}{3} \gamma' D^3 \tan^2(\theta)$$

Where: Q_r = Factored uplift resistance of the anchor, kilonewtons;

ϕ = Resistance factor, 0.4;

γ' = Effective unit weight of rock, use 17 kilonewtons per cubic metre;

D = Anchor length in metres; and,

θ = ½ of the apex angle of the rock failure cone, use 30 degrees.

Where the anchor load is applied at an angle to the vertical, the anchor capacity should be reduced as follows:

$$Q_r' = Q_r \cos(\alpha)$$

Where: Q_r' = Factored uplift resistance of the anchor subject to inclined load in kilonewtons;

Q_r = Factored uplift resistance of the anchor, kilonewtons; and,

α = Angle between the load direction and the vertical.

For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. In the case of group effects for a series of rock anchors in a rectangle with width "a" and length "b" installed to a depth "D", the equation for the volume of the truncated trapezoid failure zone would be as follows:

$$V = \frac{4}{3} D^3 sin^2\varphi + aD^2 \sin\varphi + bD^2 \sin\varphi + abD$$

Where: V = Volume of the truncated trapezoid failure zone in cubic metres;

D = Depth of anchor group in metres;

a = Width of anchor group in metres;

b = Length of the anchor group in metres; and,

φ = ½ of the apex angle of the rock failure cone, use 30 degrees.

The ULS factored geotechnical resistance for the truncated trapezoid failure formed by the group of anchors can then be calculated based on the following equation:

$$Q_r = \phi \ \gamma' V$$

Where: Q_r = Factored uplift resistance of the anchor, kilonewtons;

ϕ = Resistance factor, use 0.4;

γ' = Effective unit weight of rock, use 17 kilonewtons per cubic metre; and,

V = Volume of truncated trapezoid in cubic metres.

Further guidelines by the geotechnical engineer can and must be provided for assessing the anchor resistance once the final anchor layout and loads have been established.

It is recommended that pull-out tests be carried out on anchors to confirm their pull-out capacity (required by the 2012 Ontario Building Code for the use of a resistance factor of 0.6). For preliminary evaluation purposes, the testing procedures should be in accordance with the Post-Tensioning Institute's Recommendations for Prestressed Rock and Soil Anchors and testing procedures outlined in the Ontario Provincial Standard Specifications (OPSS) 942. A more detailed testing program should be developed once further details on the rock anchors (e.g., required loads, total number of anchors, anchor spacing etc.) are known.

Rock anchors intended as permanent structural elements should be provided with double corrosion protection and tested in accordance with OPSS 942.

The installation and testing of the anchors should be supervised by the geotechnical engineer. Care must be taken during grouting to ensure that the grouting pressure is sufficient to bond the entire length of the grout area with a minimum of voids. It is also suggested that the anchor holes be thoroughly flushed with water to remove all debris and rock flour. It is essential that rock flour be completely removed from the anchor holes to be grouted to ensure an adequate bond between the grout and the rock.

Prestressing of the anchors prior to loading would minimize anchor movement due to service loads.

Basement Floor Slabs

In preparation for the construction of the basement floor slabs (including the lowered basement floor slab), all loose, wet, and disturbed material should be removed from beneath the floor slabs.

It is anticipated that this will be a drained structure; therefore, provision should be made for at least 300 millimetres of free draining granular material, such as 16 millimetre clear crushed stone, to form the base of the floor slabs. To prevent hydrostatic pressure build up beneath the floor slabs, the granular base for the floor slab should be drained. This should be achieved by installing rigid 100 millimetre diameter perforated pipes in the floor slab bedding at about 6 metre centres. The perforated pipes should discharge to a positive outlet such as a sump from which the water is pumped.

Basement Walls

The backfill and drainage requirements for basement walls, as well as the lateral earth pressures, will depend on the type of excavation that is made to construct the basement levels and the forming methods.

The following sections assume that water-tight construction will not be required. If water-tight construction will be required, then additional recommendations will be required.

Overburden Excavations

The following guidelines apply to the upper portions of the basement walls, above the bedrock surface.

The soils at this site are potentially frost susceptible and should not be used as backfill against exterior, unheated, or well insulated foundation elements within the depth of potential frost penetration (1.5 metres) to avoid problems with frost adhesion and heaving. Free draining backfill materials are also required if hydrostatic water pressure against the basement walls (and potential leakage) is to be avoided. The foundation and basement walls therefore should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I materials.

To avoid ground settlements around the foundations, which could affect site grading and drainage, all of the backfill materials should be placed in maximum 0.3 metre thick lifts and compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

The basement wall backfill (for the full height of the wall) should be drained by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in a geotextile, which leads by positive drainage to a storm sewer or to a sump from which the water is pumped.

Excavations in Bedrock

The following guidelines apply to the deeper portions of the walls, which will be constructed in the bedrock. Where the walls will be poured directly against the bedrock, vertical drainage such as Miradrain must be installed on the face of the bedrock to provide the necessary drainage. The top edge of the Miradrain should be sealed or covered with a geotextile to prevent the loss of soil into the void between the sheet and geotextile of the Miradrain.

Where the walls will be constructed using formwork, it will be necessary to backfill a narrow gallery between the shoring or bedrock face and the outside of the walls. The backfill should consist of 6 millimetre clear stone 'chip', placed by a stone slinger or chute.

In no case should the clear stone chip be placed in direct contact with other soils. For example, surface landscaping or backfill soils placed near the top of the clear stone back fill should be separated from the clear stone with a geotextile.

Both the drain pipe for the wall backfill and/or the Miradrain should be connected to a perimeter drain at the base of the excavation which is connected to a sump pump.

Lateral Earth Pressures

It is considered that three design conditions exist with regards to the lateral earth pressures that will be exerted on the walls:

1) Walls cast directly against the bedrock face.
2) Walls cast against formwork with a narrow backfilled gallery provided between the basement wall and the adjacent excavation bedrock face.
3) Walls cast against formwork with a wide backfilled gallery provided between the basement wall and the adjacent excavation face (including the upper portions of the walls, above the bedrock surface).

For the first case (walls cast against the bedrock with Miradrain), there will be no effective lateral earth pressures on the wall provided that unstable wedges or blocks in the rockmass are reinforced.

For the second case, the magnitude of the lateral earth pressure depends on the magnitude of the arching which can develop in the backfill and therefore depends on the width of the backfill, its angle of internal friction, as well as the interface friction angles between the backfill and both the rock face and the wall. The magnitude of the lateral earth pressure can be calculated as:

$$\sigma_h(z) = \frac{\gamma B}{2\tan\delta}\left(1 - e^{-2K\frac{z}{B}\tan\delta}\right) + Kq$$

Where:	$\sigma_h(z)$	=	Lateral earth pressure on the wall at depth z, kilopascals;
	K	=	Earth pressure coefficient, use 0.6;
	γ	=	Unit weight of retained soil, use 20 kilonewtons per cubic metre for clear stone chip;
	B	=	Width of backfill (between basement wall and bedrock face), metres;
	δ	=	Average interface friction angle at backfill-basement wall and backfill-rock face interfaces, use 15 degrees;
	z	=	Depth below top of formwork, metres; and,
	q	=	Surcharge at ground surface to account for traffic, equipment, or stock piled materials (use 15 kilopascals).

For the third case, the basement walls should be designed to resist lateral earth pressures calculated as:

$$\sigma_h(z) = K_o\,(\gamma z + q)$$

Where:	$\sigma_h(z)$	=	Lateral earth pressure on the wall at depth z, kilopascals;
	K_o	=	At-rest earth pressure coefficient, use 0.5;
	γ	=	Unit weight of retained soil, use 22 kilonewtons per cubic metre;
	z	=	Depth below top of wall, metres; and,
	q	=	Uniform surcharge at ground surface behind the wall to account for traffic, equipment, or stockpiled soil (use 15 kilopascals).

Conventional damp proofing of the basement walls is appropriate with the above design approach. For concrete walls poured against shoring or bedrock (i.e., without a drainage layer), damp proofing using a crystalline barrier such as Crystal Lok or Xypex could be used. The use of a concrete additive that provides reduced permeability should also be considered.

These lateral earth pressures would increase under seismic loading conditions. The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution). The combined pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(z) = K_o\,\gamma\,z + (K_{AE} - K_o)\,\gamma\,(H-z)$$

Where:	K_{AE}	=	The seismic earth pressure coefficient, use 0.8; and,
	H	=	The total depth to the bottom of the foundation wall (metres).

All of the lateral earth pressure equations are given in an unfactored format and will need to be factored for Limit States Design purposes.

It has been assumed that the CBUS addition will not be permitted to freeze. If these areas are to be unheated, additional guidelines for the design of the basement walls and foundations will need to be provided.

Site Servicing and Watermain Relocation

Excavations for the installation of site services are addressed in the sections above.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for the watermain. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of 300 millimetres of compacted OPSS Granular B Type II beneath the Granular A. The bedding material should in all cases extend to the spring line of the pipe. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill or native materials could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from the spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres.

The bedding and cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

It should generally be possible to re-use the excavated soil as trench backfill. Where the trench will be covered with a hard surfaced area, the type of material placed in the frost zone (between subgrade level and 1.8 metres depth, or the bedrock surface, whichever is higher) should match the soil exposed on the trench walls for frost heave compatibility. Well fractured or well broken rock will be acceptable as backfill for the lower portion of the trench in areas where the excavation is in rock. The rock fill should only be placed from at least 300 millimetres above the pipe to minimize the potential for damage due to impact or point load. The rock fill should be limited to a maximum of 300 millimetres in nominal size.

All trench backfill materials should be placed in maximum 300 millimetre loose lifts and be uniformly compacted to at least 95 percent of the material's standard Proctor maximum dry density. Backfilling operations during cold weather should avoid inclusions of frozen lumps of material, snow and ice.

Cement Type and Corrosion Potential

The design input provided in this report is based on solely on existing information. The existing available records do not provide information on corrosion potential for buried ferrous elements or sulphate attack on buried concrete elements. However, based on experience with similar site conditions, the designers should assume that there is an elevated potential for corrosion of buried ferrous elements at this site. Concrete made with Type GU should be acceptable for substructures.

Additional Considerations

All foundation and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that bedrock having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placement and compaction of any engineered fill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction viewpoint. Also, the proposed bedrock excavation and monitoring plans proposed by the contractor should be reviewed.

Golder Associates should review the detailed drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

Closure

We trust that this letter report is sufficient for your current requirements. Please contact the undersigned should you have any questions.

Yours truly,

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
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Attachments: Important Information and Limitations of This Report
Figure 1 – Site Plan
List of Abbreviations and Symbols
Lithological and Geotechnical Rock Description Terminology
Record of Borehole Sheets – Previous Investigation

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, **WSP Canada Inc.** The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan\delta$
c'	effective cohesion
c_u, s_u	undrained shear strength (ϕ = 0 analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan\phi'$
2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index
A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

RECORD OF DRILLHOLE 90-2

PROJECT 891-2595

LOCATION See figure 2
INCLINATION -45 AZIMUTH 328
DRILLING DATE Jan. 24-25,1990
DRILL RIG Rotary Diamond
DRILLING CONTRACTOR Marathon Drilling Co Ltd
SHEET 1 of 2
DATUM Geodetic

FR-FRACTURE, CL-CLEAVAGE, SH-SHEAR, VN-VEIN, F-FAULT, J-JOINT, P-POLISHED, S-SLICKENSIDED, SM-SMOOTH, R-ROUGH, ST-STEPPED, PL-PLANAR, FL-FLEXURED, UE-UNEVEN, W-WAVY, C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION
0		GROUND SURFACE	87.67 / 0.00				
		Medium brown SILTY SAND, some gravel.					
		BEDROCK SURFACE	87.08 / 0.84	1	50 DC	22 / 15	
1	NXL RC	Faintly weathered to weathered, light to medium grey, fine to medium grained, medium bedded, stylolitic, mottled, crystalline LIMESTONE interbedded with argillaceous layers. (UNIT B1)		2	0.08	100%	
	JAN. 24 NXL RC			3	0.11	100%	BC,Fe-stain; BC,Fe-stain
2	NXL RC			4	0.08	100%	BC,Fe-stain; J,R,UE,Fe-stain
	NXL RC			5	0.11	100%	J,R,UE,Fe-stain; B,R,UE,Fe-stain
3	NXL RC			6	0.07	100%	BC,Fe-stain
4	NXL RC	Two 5mm argillaceous layers overlying a non-mottled limestone layer at 5.15m depth.		7	0.12	0%	B,R,UE,Fe-stain; B,R,UE,Fe-stain Carbonate VN; B,R,UE,Fe-stain; J,R,UE,Fe-stain
5	NXL RC			8	0.11	0%	B,R,PL,Fe-stain; B,R,PL,Fe-stain; J,R,UE,Fe-stain; B,R,UE,Fe-stain
6 / 7	NXL RC			9	0.19	0%	B,SM,UE; B,R,UE; B,R,UE; B,R,UE
8 / 9	NXL RC			10	0.18	0%	J,R,UE,Fe-stain; B,R,UE; B,R,UE; B,R,UE; B,R,UE
10	JAN. 25	CONTINUED ON SHEET 2	80.60 / 10.00	11			B,R,UE

Other columns: STRATA PLOT; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.3M; DIP w.r.t. CORE AXIS; HYDRAULIC CONDUCTIVITY; DIAMETRAL POINT LOAD INDEX (MPa); NOTES WATER LEVELS INSTRUMENTATION

DEPTH SCALE
1 : 50

Golder Associates

LOGGED LO,SPM
DATE Jan. 24-25,1990
CHECKED MvB

RECORD OF DRILLHOLE 90-2

SHEET 2 of 2

LOCATION See figure 2
INCLINATION -45 AZIMUTH 328
DRILLING DATE Jan. 24-25,1990
DRILL RIG Rotary Diamond
DRILLING CONTRACTOR Marathon Drilling Co Ltd
DATUM Geodetic

PROJECT 891-2556

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED
CL-CLEAVAGE J-JOINT R -ROUGH UE-UNEVEN
SH-SHEAR P-POLISHED ST-STEPPED W -WAVY
VN-VEIN S-SLICKENSIDED PL-PLANAR C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH
10		CONTINUED FROM SHEET 2	80.60			
	NXL RC	Fresh to faintly weathered, light to medium grey, fine to medium grained, thin to medium bedded, styloiltic nodular, crystalline LIMESTONE interbedded with argillaceous layers. (UNIT B2)	80.49 10.15	11	0.08	0%
	NXL RC			12	0.09	0%
	JAN. 25 NXL RC			13	0.08	0%
		END OF HOLE	78.88 15.64			

RECOVERY: TOTAL CORE % / SOLID CORE % | R.Q.D. % | FRACT. INDEX PER 0.3M | DISCONTINUITY DATA: DIP w.r.t. CORE AXIS / TYPE AND SURFACE DESCRIPTION | HYDRAULIC CONDUCTIVITY k, cm/sec | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION

DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION:

- B,R,UE
- B,R,UE
- J,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,PL
- B,R,PL
- B,R,UE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED LQ,SPM
DATE Jan. 24-25,1990
CHECKED MvB

RECORD OF DRILLHOLE 90-4

SHEET 1 of 2

PROJECT 891-2696

LOCATION: See figure 2
INCLINATION: -60 AZIMUTH: 244

DRILLING DATE: Jan. 23-24,1990
DRILL RIG: Rotary Diamond
DRILLING CONTRACTOR: Marathon Drilling Co Ltd

DATUM: Geodetic

Legend: FR-FRACTURE, CL-CLEAVAGE, SH-SHEAR, VN-VEIN, F-FAULT, J-JOINT, P-POLISHED, S-SLICKENSIDED, SM-SMOOTH, R-ROUGH, ST-STEPPED, PL-PLANAR, FL-FLEXURED, UE-UNEVEN, W-WAVY, C-CURVED

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (M) | RUN No. | PENETRATION RATE (M/MIN) | FLUSH % RETURN COLOUR | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.3M | DISCONTINUITY DATA (DIP W.R.T. CORE AXIS; TYPE AND SURFACE DESCRIPTION) | HYDRAULIC CONDUCTIVITY K, cm/sec | DIAMETRAL POINT LOAD INDEX (MPa) | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	87.38 / 0.00
Medium brown SILTY SAND, trace gravel and brick.	
BEDROCK SURFACE	87.01 / 0.43
Faintly weathered to weathered, light to medium grey, fine grained, medium bedded, stylolitic, mottled, crystalline LIMESTONE. (UNIT B1) 6mm argillaceous layer over non-mottled limestone at 5.12m depth.	
FOR DETAILED DESCRIPTION, SEE SHEET 2.	80.12 / 8.38
	78.72 / 10.00

Run No.	Drilling Record	Penetration Rate	Flush
1	NXL	0.09	100%
2	NXL	0.12	100%
3	NXL RC	0.17	100%
4	NXL RC	0.14	100%
5	NXL RC	0.10	75%
6	NXL RC	0.14	75%

Drilling record: JAN 23

Discontinuity data (type and surface description), in order of depth:

- B,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE
- B,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE
- B,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE,Fe-stain
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE,mud
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE
- B,R,UE,mud Carbonate VN
- J,R,UE,Fe-stain
- B,R,UE
- B,R,UE
- B,R,UE

Notes / Instrumentation: Granular Backfill; Bentonite Seal; Caved; Bentonite Seal; Granular Filter

CONTINUED ON SHEET 2

DEPTH SCALE 1 : 50

Golder Associates

LOGGED LQ,SPM
DATE Jan 23-24,1990
CHECKED MvB

RECORD OF DRILLHOLE 90-4

LOCATION See figure 2
INCLINATION -60 AZIMUTH 244

DRILLING DATE Jan. 23-24,1990
DRILL RIG Rotary Diamond
DRILLING CONTRACTOR Marathon Drilling Co. Ltd

SHEET 2 of 2
DATUM Geodetic

PROJECT 891-2595

FR-FRACTURE, CL-CLEAVAGE, SH-SHEAR, VN-VEIN
F-FAULT, J-JOINT, P-POLISHED, S-SLICKENSIDED
SM-SMOOTH, R -ROUGH, ST-STEPPED, PL-PLANAR
FL-FLEXURED, UE-UNEVEN, W -WAVY, C -CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR
10		CONTINUED FROM SHEET 2	78.72 / 10.00			
10–11	JAN. 23 NXL RC	Fresh to faintly weathered, light to medium grey, fine to medium grained, thin to medium bedded, stylolitic, nodular, crystalline LIMESTONE. Nodules vary from 1.5 to 25mm in diameter. (UNIT B2)		6	0.14	75%
11–12	NXL RC			7	0.11	75%
12–15	NXL RC			8	0.14	75%
15	JAN. 24 NXL RC			9	0.13	75%
15.7		END OF HOLE	73.78 / 15.70			

DISCONTINUITY DATA — TYPE AND SURFACE DESCRIPTION:

B,R,UE
B,R,UE
B,R,UE
B,R,UE
B,R,UE
B,R,UE
B,R,UE
J,R,UE
B,R,UE
B,SM,PL
B,R,PL
B,R,UE
B,R,UE
B,R,UE
B,R,UE
B,R,UE,mud

NOTES / WATER LEVELS / INSTRUMENTATION:

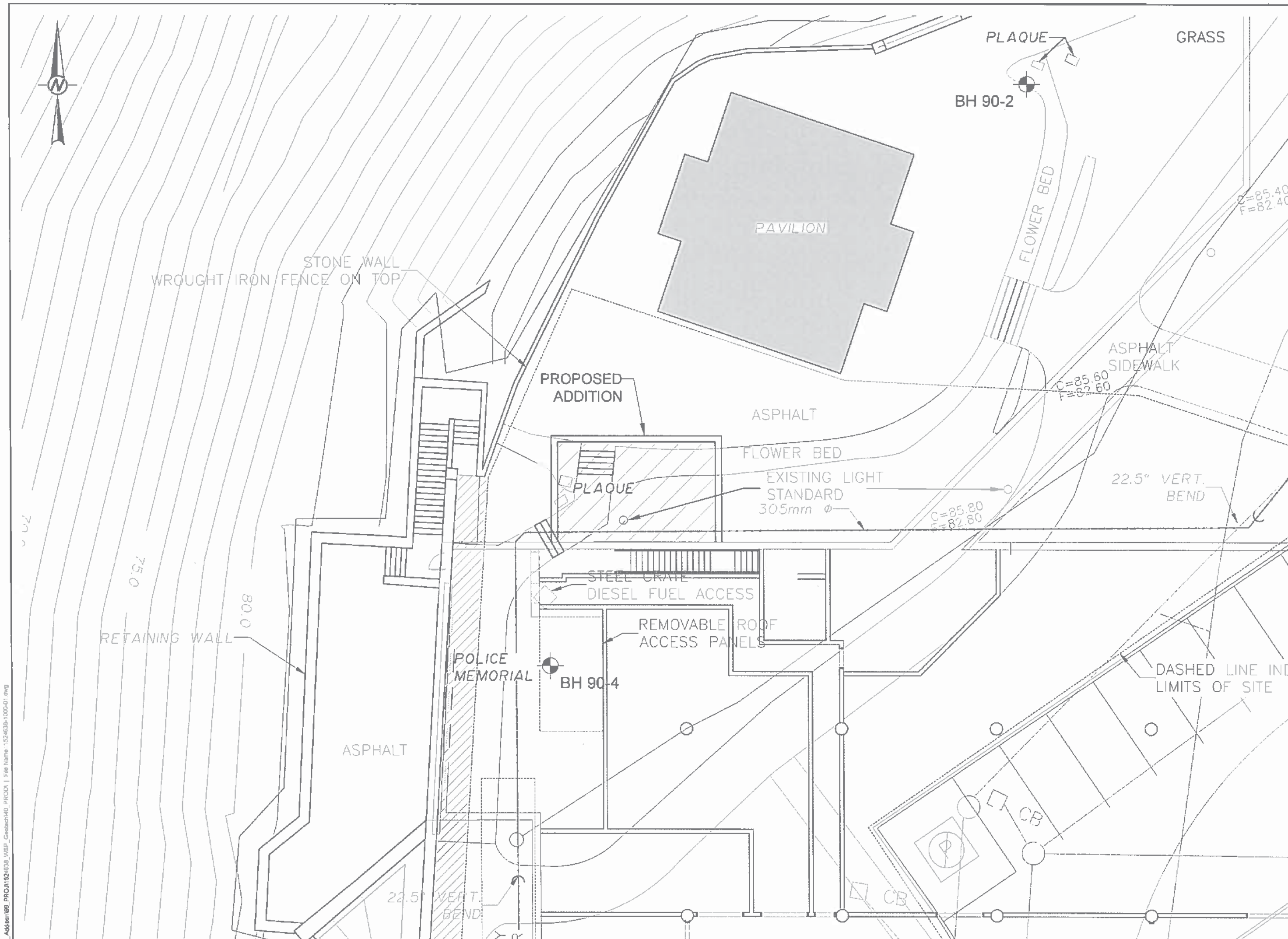
Granular Filter

WATER LEVEL IN STANDPIPE AT ELEV. 76.51m ON FEB. 6/90.

DEPTH SCALE 1 : 50

Golder Associates

LOGGED LQ,SPM
DATE Jan. 23-24,1990
CHECKED MvB



KEY MAP

LEGEND

APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION

NOTE(S)

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. LETTER No. 1524638

REFERENCE(S)

BASE MAP SUPPLIED BY WSP CANADA INC. IN ELECTRONIC FORMAT

0 5 10
1:200 METRES

CLIENT
WSP CANADA INC.

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-08-11
DESIGNED	----
PREPARED	JEM
REVIEWED	SD
APPROVED	TMS

PROJECT
GEOTECHNICAL DESIGN INPUT - PROPOSED CBUS ADDITION
PARLIAMENT HILL, OTTAWA, ONTARIO

TITLE
SITE PLAN

PROJECT NO.	PHASE	REV	FIGURE
1524638	----	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 04 05 19 – Masonry Anchorage and Reinforcing

.2 Section 04 22 00 – Concrete Unit Masonry.

1.2 REFERENCES

.1 CSA A179-04 (R2014), Mortar and Grout for Masonry Construction.

.2 CAN/CSA-A23.1-04 (R2014), Concrete Materials and Methods of Concrete Construction.

.3 CAN/CSA-A23.2-04, Methods of Test For Concrete.

Part 2 Products

2.1 MATERIALS

.1 Mortar and grout: CSA A179-04 (R2014).

.2 Use aggregate passing 1.18mm sieve where 6mm thick joints are indicated.

.3 Colour: ground coloured natural aggregates or metallic oxide pigments.

.4 Concrete: CAN/CSA A23.1, A23.2.

2.2 MATERIAL SOURCE

.1 Use same brands of materials and source of aggregate for entire project.

2.3 MORTAR TYPES

.1 Mortar for exterior masonry above grade:

  .1 Loadbearing: Type S, f'c = 12.5 MPa

  .2 Non-loadbearing: Type S based on proportion specifications.

  .3 Parapet walls, chimneys, unprotected walls: Type S, f'c = 12.5 MPa

.2 Mortar for interior masonry:

  .1 Loadbearing: Type S, f'c = 12.5 MPa

  .2 Non-loadbearing: Type S based on proportion specifications.

.3 Provide two mortar colours as selected by the department representative from the manufacturer's standard & extended range of colours.

2.4 GROUT

.1 Grout: to CSA A179-04, f'c = 20 MPa.

.2 Colour: provide two grout colours as selected by the Department Representative from the manufacturer's standard and extended range of colours.

2.5 CONCRETE

.1 Fill bond beams and lintels with 20 MPa pea gravel concrete.

Part 3 Execution

3.1 GENERAL

.1 Do masonry mortar and grout work in accordance with CSA A179-04 except where specified otherwise.

3.2 MIXING

.1 Mix grout to semi-fluid consistency.

.2 Prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than one (1) hour nor more than two (2) hours then remix with sufficient water to produce mortar of proper consistency for pointing.

End of Section

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 20 00 – Concrete Reinforcement

.2 Section 03 30 00.01 – Cast-In-Place Concrete Short Form

.3 Section 04 05 23 – Masonry Accessories

.4 Section 04 22 00 – Concrete Unit Masonry

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-A23.1/A23.2-09 (R2014). Concrete Materials and Methods of Concrete Construction / Methods of Test and Standard Practices for Concrete.

.2 CAN/CSA-A179-04 2004 (R2014). Mortar and Grout for Unit Masonry.

.3 CAN/CSA-A370-04 2004(R2014). Connectors for Masonry.

.4 CSA-A371-04 2004 (R2014). Masonry Construction for Buildings.

.5 CAN/CSA-G30. 18-M92 (R2007). Billet-Steel Bars for Concrete Reinforcement.

.6 CSA-S304.1-04 (R2010). Design of Masonry Structures.

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM A1064 / A1064M – 15. Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer’s printed product literature, specifications and data sheet in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit two copies of WHMIS MSDS – Material Safety Data Sheets in accordance with Section 01 33 00 – Submittal Procedures. Indicate VOC’s for galvanized protective coatings and touch-up products.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop drawings consist of bar bending details, lists and placing drawings.

.3 On placing drawings, indicate sizes, spacing, location and quantities of reinforcement and connectors.

.3 Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

.1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.3 Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 Construction / Demolition Waste Management.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and other packaging material in appropriate on-site containers for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Bar reinforcement: to CSA-A371 and CAN/CSA G30.18, Grade 350.

.2 Wire reinforcement: to CSA-A371and CSA G30.14.

- .1 Continuous HDMR Ladder type reinforcing: Solid Stainless steel. 2 continuous side rods of 2.4mm diameter rods. Provide in 3000mm lengths with laps as indicated on structural.

.3 Connectors: to CAN/CSA-A370 and CSA-S304.1.

.4 Corrosion protection: to CSA-S304.1 and CSA-A370. Solid stainless steel.

2.2 FABRICATION

.1 Fabricate reinforcing in accordance with CSA-A23.1 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Ontario.

.2 Fabricate connectors in accordance with CAN/CSA-A370.

.3 Obtain Departmental Representative's approval for locations of reinforcement splices other than shown on placing drawings.

.4 Ship reinforcement and connectors, clearly identified in accordance with drawings.

2.3 SOURCE QUALITY CONTROL

.1 Upon request, provide Departmental Representative with certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum 5 weeks prior to commencing reinforcement work.

.2 Upon request, inform Departmental Representative of proposed source of material to be supplied.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTION

.1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 GENERAL

.1 Supply and install masonry connectors and reinforcement in accordance with CAN/CSA-A370, CSA-A371, CAN/CSA-A23.1 and CSA-S304.1 unless indicated otherwise.

.2 Prior to placing concrete, mortar or grout, obtain Departmental Representative's approval of placement of reinforcement and connectors.

.3 Supply and install additional reinforcement to masonry as indicated.

3.3 BONDING AND TYING

.1 Bond walls of two or more wythes using metal connectors in accordance with CSA-S304, CSA-A371 and as indicated.

.2 Tie masonry veneer to backing in accordance with NBC (2010), CSA-S304.1, CSA-A371 and as indicated.

3.4 REINFORCED LINTELS AND BOND BEAMS

.1 Reinforce masonry lintels and bond beams as indicated.

.2 Place and grout reinforcement in accordance with CSA-S304.1, CSA-A371, and CAN/CSA-A179.

3.5 GROUTING

.1 Grout masonry in accordance with CSA-S304.1, CSA-A371 and CAN/CSA-A179 and as indicated.

3.6 ANCHORS

.1 Supply and install metal anchors as indicated.

3.7 LATERAL SUPPORT AND ANCHORAGE

.1 Supply and install lateral support and anchorage in accordance with CSA-S304.1 and as indicated.

.2 Where new masonry butts into existing masonry connect new to existing by toothing the new masonry wall into the existing masonry, or drill and grout the horizontal reinforcing called up on the structural drawings 150mm into the existing adjacent walls.

3.8 MOVEMENT JOINTS

.1 Reinforcement will not be continuous across movement joints unless otherwise indicated.

3.9 FIELD BENDING

.1 Do not field bend reinforcement and connectors except where indicated or authorized by Departmental Representative.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars and connectors which develop cracks or splits.

3.10 FIELD TOUCH-UP

.1 Touch up damaged and cut ends of galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

3.11 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 04 05 12 – Masonry Mortar and Grout

.2 Section 04 05 19 – Masonry Anchorage and Reinforcing

.3 Section 04 22 00 – Concrete Unit Masonry

1.2 REFERENCES

.1 CAN3-A370-94 (R1999), Connectors for Masonry.

.2 CAN3-A371-M04 (R2014), Masonry Construction for Buildings.

.3 ASTM D2240-05 (R2010), Standard Test Method for Rubber Property, Durometer Hardness.

Part 2 Products

2.1 MATERIALS

.1 Control joint filler: purpose-made elastomer, outsized 30% to 50%, 20 durometer hardness, round solid rod, conforming to ASTM D2240.

.2 Masonry flashing:
- .1 Dual polycrepe, reinforced fibreglass.
- .2 Lap adhesive: Recommended by manufacturer of flashing material.
- .3 Continuous metal through-wall flashing: exterior wall cavities (where shown on drawings) - 26 gauge prefinished steel.

Part 3 Execution

3.1 CONTROL JOINTS

.1 Install continuous control joint fillers in control joints.

3.2 MASONRY FLASHING

.1 Install flashings in masonry in accordance with CAN3-A371, CAN3-S304.1.

3.3 METAL THROUGH WALL FLASHING

.1 Install continuous metal through-wall flashing where indicated.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 04 05 12 - Mortar and Grout for Masonry

.2 Section 04 05 19 - Masonry Reinforcing and Connectors.

.3 Section 04 05 23 - Masonry Accessories

Part 2 Products

2.1 MATERIALS

.1 Autoclaved cellular masonry units shall conform to CSA A165 Series-04.

.2 Classification: H/15/A/M for standard weight, hollow units.

.3 Size: metric modular, thickness as specified on drawings.

.4 Special Shapes: provide bullnose units for all corners.

Part 3 Execution

3.1 LAYING CONCRETE MASONRY UNITS

.1 Bond: stacked.

.2 Jointing: concave.

.3 Coursing height: except where imperial coursing is specified, 200mm for one (1) block and one (1) joint.

.4 Carry up all walls in a uniform manner without any one wall raised more than 1200mm above another at one time.

.5 Set masonry units in stacked bond and tooth bond all intersections of walls.

.6 Lay blocks in a full bed of mortar, i.e., the full bed of mortar must cover the webs of all blocks as well as the outer and inner walls. Whenever it is found that this provision is not carried out, walls shall be taken down and rebuilt, or, at Departmental Representative's discretion, all voids shall be filled with 15 MPa concrete grout.

.7 Where block work is to be exposed, courses shall be level, and vertical joints shall be aligned. Joints shall be slightly tooled concave. Use stainless steel jointing tools.

.8 Chipped blocks shall not be used where block work, either painted or unpainted, is to be exposed.

.9 Except where imperial coursing is specified, the maximum joint thickness shall be 10mm.

.10 Machine cut with a carborundum saw all exposed masonry units which are adjusted in size.

.11 Carry all walls and partitions up to the underside of construction above and finish against underside of roof deck or floor slab above (in accordance with details shown on the drawings).

.12 As required, all conduits, etc., provide and erected by other trades, shall be built-in without breaking bond.

.13 At all openings in masonry walls completely fill hollow units with concrete at the jambs, and reinforce vertically.

.14 Provide lintel blocks with steel reinforcing at all openings in masonry walls unless shown otherwise on the drawings.

.15 Build-in steel door frames and fill frames with mortar as walls are brought up. Protect galvanized finishes (to remain exposed as final finish) from damage during erection.

3.2 CLEANING OF MASONRY BLOCK

.1 Allow mortar droppings on unglazed concrete masonry to partially dry then remove by means of trowel. Follow by rubbing lightly with small piece of block and finally by brushing.

3.3 DAMAGE DURING INSTALLATION

.1 Do not install defective units. Replace any units damaged by contractor at contractor's expense. All damaged units not reported as damaged upon inspection at time of delivery are presumed to have been damaged by contractor or improper job site handling. Do not allow units to be mishandled. Keep cap cover on all units until installed. Contractor, at his expense, shall remove any scratches, tar or dirt caused by mishandling.

3.4 SEALANT APPLICATION

.1 Site apply a coat of sealer in accordance with Manufacturer’s written instructions.

.2 Apply sealant after all walls are completed and after walls are cleaned and have dried in accordance with manufacturer’s recommendations.

.3 Apply uniform coating of sealant evenly across entire surface. Do not allow drips or runs to form.

End of Section