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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.

Comments - Commentaires

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B3J 1T3

Title - Sujet Construction of New SAR MOB	
Solicitation No. - N° de l'invitation EB144-191545/A	**Amendment No. - N° modif.** 001
Client Reference No. - N° de référence du client EB144-19-1545	**Date** 2018-10-19
GETS Reference No. - N° de référence de SEAG PW-$PWA-121-5794	
File No. - N° de dossier PWA-8-80050 (121)	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à 02:00 PM** **on - le 2018-10-25**	**Time Zone** **Fuseau horaire** Atlantic Daylight Saving Time ADT
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☑ **Other-Autre:** ☐	
Address Enquiries to: - Adresser toutes questions à: Russell (PWA), Alex	**Buyer Id - Id de l'acheteur** pwa121
Telephone No. - N° de téléphone (902) 401-8180 ( )	**FAX No. - N° de FAX** (902) 496-5016
Destination - of Goods, Services, and Construction: **Destination - des biens, services et construction:**	

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Solicitation No. - N° de l'invitation	Amd. No. - N° de la modif.	Buyer ID - Id de l'acheteur
EB144-191545	001	pwa121

Client Ref. No. - N° de réf. du client	File No. - N° du dossier	CCC No./N° CCC - FMS No./N° VME

Amendment 001 is raised for Addendum #1.

All other terms and conditions remain.

Addendum No.1

October 19, 2018

R.096002.001

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

A. Questions from Bidders

B. Civil and Architectural including,

SSK 1

Geotechnical Report

C. Mechanical Addendum including,

Section 01 91 00 Commissioning

Section 22 30 05 Domestic Water Heaters

Section 23 82 22 Variable Refrigerant Flow (VRF) System

MSK-01 Control Schematics

D. Electrical Addendum including,

ESK-01 Revised Electrical Legend

Question 1: Reference Specification 23 07 13 Thermal Insulation for Ducting,

A) 3.5.1 Insulation Schedule states 2" Board on exterior supply air ducts. Does this refer to the attic supply air ductwork or should I apply Flexible Duct 3.4.1: 1" flex on all concealed supply air duct.

Answer 1A: There is no exterior supply air ducting; use 25mm thick flexible insulation on all supply air ductwork downstream of the ERV.

B) Reference 3.5.1 Insulation Schedule Note 1: Should I only allow for 10' of the E/A from the exterior to the ERV or allow for that E/A right to the unit?

Answer 1B: Provide 50mm thick insulation from the exterior wall to the ERV unit. All other exhaust air ducts shall be insulated 3000mm back from the exterior wall penetration.

C) 3.5.1 Insulation Schedule notes the F/A ducts downstream of the HRV, is the HRV inclusive to the ERV on the drawings.

Answer 1C: Yes.

D) Drawing M-3 only denotes S/A coming off the unit to the multiple diffusers. Is this supply air to be considered the fresh air?

Answer 1D: Yes

E) Should I be allowing the 1" Board or apply note 3.4.1 Flexible Duct note.

Answer 1E: Provide 25mm thick flexible insulation on the supply air ducting downstream of the ERV. Further information provided in this addendum.

Question 2: Reference Specification 21 07 20 Thermal Insulation for Piping

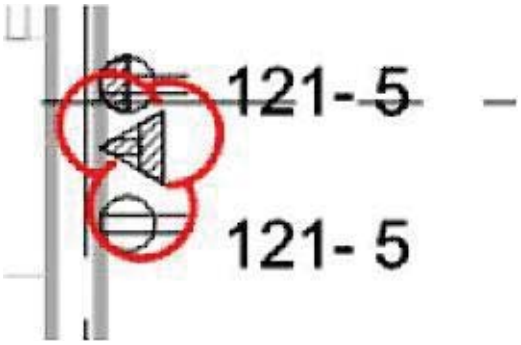
A) Drawing M-4 has 2 condenser units with outdoor refrigerant piping. Does the outdoor refrigerant require any insulation/jacketing.

Answer 2A: Yes, provide 25mm thick elastomeric pipe insulation; exterior piping shall be protected with aluminum jacket; further information provided in this addendum.

B) Drawing M-1: Do you require any insulation on the condensate drains from the AC units?

Answer 2B: Yes; provide 25mm thick fiberglass insulation with all-service jacket.

Question 3: Electrical Symbol Clarification



Answer 3: This is a high single data jack, further information is provided in this addendum.

Question 4: "The spec is calling for a 45 min. rating on the PVC windows . To my knowledge that can't be done. The windows may have to be Aluminum or possible Fiberglass to meet this rating. Do you want to stay with PVC or look at something else that is fire rated."

Answer 4:

- Section 08 53 00 PVC Windows
  - Delete item 2.1.2.2 regarding frames having a 45-minute fire-protection rating. There are no window frames having fire-protection ratings.
- Section 08 80 00 Glazing
  - Delete items 2.1.3 and 3.5.4 regarding glazing with a 45-minute fire-protection rating. This project does not have glazing with fire-protection ratings.
- Architectural drawings
  - Delete all references to windows having 45-minute fire-protection ratings. There are no fire-protection ratings on the windows.

Question 5 : Detail C/S-4 shows the roof sheathing as 19mm thick, where the roof schedule on A-04 shows it as 16mm thick. Please clarify which is to be provided.

Answer 5: 19mm roof sheathing

Question 6: Please provide a detail for Pilaster P-1 on Drawing S-1.

Answer 6: Information included as sketch in this addendum as SSK-1.

Question 7: Please provide a soils report for review.

Answer 7: Information included in this addendum, “Geotechnical Report”.

Question 8: Please confirm that demolition of the existing building is by Departmental Representative.

Answer 8: Yes.

Question 9: Flooring details on S-3 show a 16mm flooring while the Floor Assembly on A-02 shows it as 19mm. Please clarify which is to be provided.

Answer 9: 16mm plywood sub-floor.

Question 10: Detail E/S-4 shows a monotruss at the gable ends of the roof while roofing details on A-14 show a sistered 2x4 at the eaves and Gable. Please clarify which detail we are to follow.

Answer 10: Follow structural, detail E/S-4

A. RELOCATE POSITION OF BUILDING

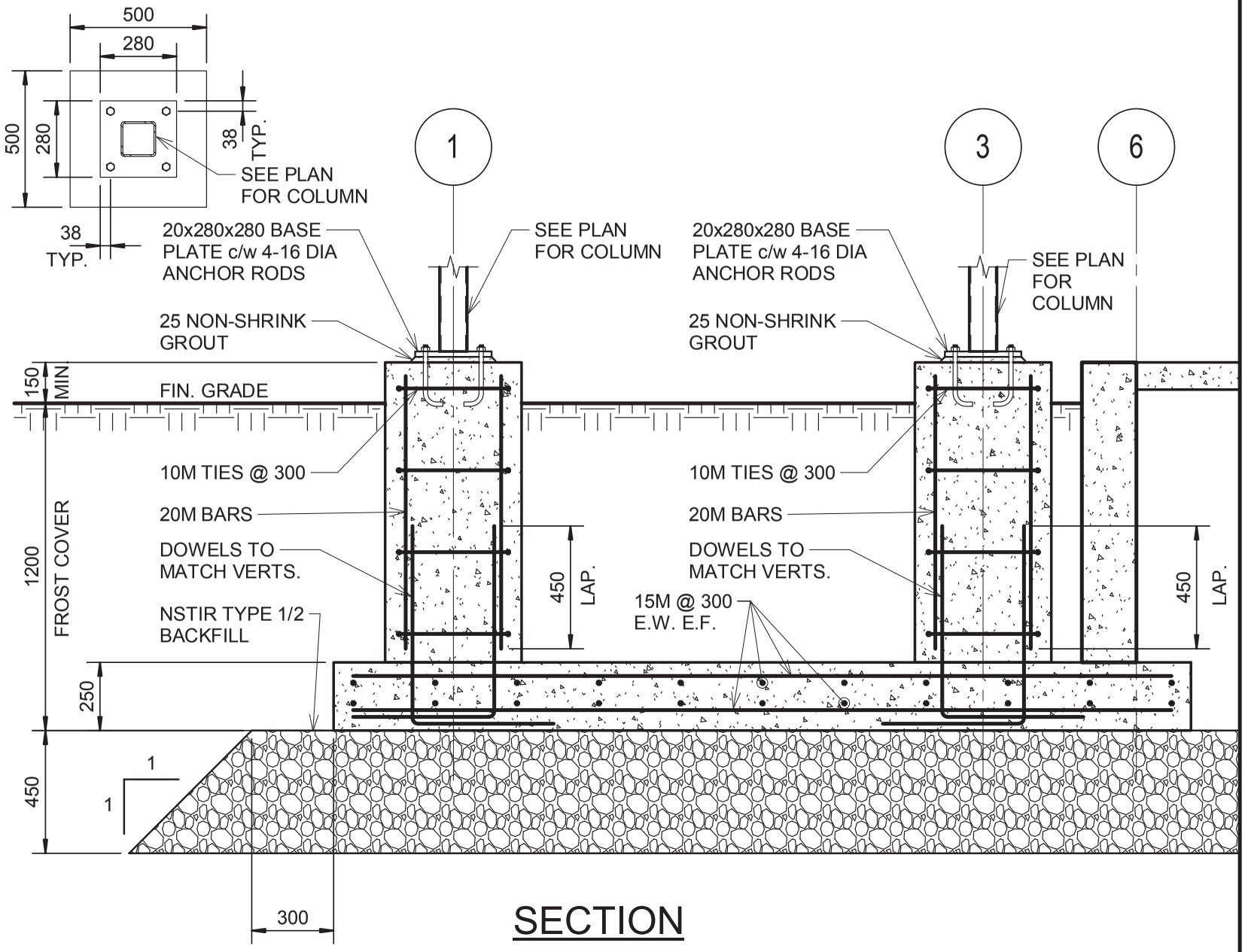
1. Building to be relocated to 2.176 metre from the face of the foundation to the fence (property line). This provides a limiting distance of 2.1 m from face of cladding to the fence.
    a. REVISE building location 376 mm to the North West.
    b. ADD 5.0 sq. m of asphalt removals to the asphalt removals shown on DWG D1 Civil Demolition Plan Issued for Tender Rev 1 dated 09/19/2018.
    c. ADD 6.65 sq. m of clear stone and geotextile between the fence at the South East side of the property and the new building.
    d. ADD 1.5 sq. m of asphalt to the total asphalt reinstatement shown on DWG C3 Site Plan Issued for Tender Rev 1 dated 09/19/2018.
    e. REVISE location of 2 bollards at North West corner of building to maintain offset from building corner as noted on DWG C3 Site Plan Issued for Tender Rev 1 dated 09/19/2018.
    f. ADD connection of two (2) rainwater leaders at Main Building – West Elevation DWG A-05 Elevations Issued for Tender Rev 1 dated 09/19/2018. Leaders to be connected to existing 100 mm storm sewer located approximately 3.0 m to the North West of the building face. Connection will be with 100 mm dia. DR35 PVC pipe c/w cut in tee and appurtenances required to connect to termination point of rain water leaders (approximately at finished grade elevation) . Expected depth of bury of existing 100 mm storm sewer is 2.0 m.

2. **DRAWINGS**

    a. A-02 Floor Plans
        i. Delete window B on North elevation in Room 103 PPE Storage
        ii. Add window C to to Room 205 Bedroom, 1500mm from inside face of exterior wall on West elevation.

    b. A-05 Elevations
        i. Delete windows B and C from the North Elevation
        ii. Add window C to the West Elevation, 1500mm from inside face of exterior wall
        iii. Delete “R” from window tags.
        iv. Rainwater leader along Grid 8 should be identified as such on drawing.
        v. All rainwater leaders to be tied into storm system.
        vi. Cladding, including trim, to be revised from cedar siding to metal siding on MacKay Bridge/Fence Elevation
            1. 26-gauge steel siding with SMP coating, typically known as WeatherXL
            2. 5-1/4-inch coverage width
            3. Colour: woodgrain finish: cedar, to be approved by Departmental Representative
            4. Hidden fasteners
            5. 40-year Limited Coating Warranty

    c. A-16 Door Schedule and Window Elevations
        i. Delete note referring to windows with 45-minute fire-protection ratings.



SECTION

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Project Title
BIO SEARCH & RESCUE MARINE OPERATIONS BUILDING

Dwg. Title
P1 PILASTER

Drawn By: RJL
Dwg Standards Ckd By:
Designed By: EL
Design Checked By:

Project No. R096002-001
Dwg. No. **SSK-1**
Rev. No.

Public Works and Government Services Canada (PWGSC)

Geotechnical Investigation
BIO Search and Rescue Marina Operations Building

Type of Document:
Final

Project Name:
BIO Search and Rescue Marina Operations Building, Dartmouth, Nova Scotia

Project Number:
HFX-00245073-A0

Prepared By:
Caroline McKay, P.Eng.
Jamie Harper, P.Eng.

Reviewed By:
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Date Submitted:
2018-07-06

Legal Notification

This report was prepared by EXP Services Inc. for the account of **Public Works and Government Services Canada**.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Table of Contents

EXP Quality System Checks	
Project No.: HFX-00245073-A0	Date: 2018.07.06
Type of Document: Final	Revision No.: 0
Prepared By: Caroline McKay, P.Eng. Jamie Harper, P.Eng.	
Reviewed By: Brian Walker, P.Eng.	

REGISTERED PROFESSIONAL ENGINEER
DATE: 07/06/18
C. E. McKay
9286
PROVINCE OF NOVA SCOTIA

1 Introduction

EXP Services Inc. (EXP) was retained by Public Works and Government Services Canada (PWGSC) to carry out a geotechnical investigation for the proposed Search and Rescue Marina Operations Building (SAR MOB) at the Bedford Institute of Oceanography (BIO) in Dartmouth, Nova Scotia. We understand the proposed project will include the construction of a new two storey, above ground building to replace the existing Inshore Rescue building. The exact building size and location were unknown at the time of this investigation.

This investigation was carried out to determine the sub-surface conditions at the site and to provide geotechnical information and design parameters for the new structure. Geotechnical recommendations are provided based on available information and our current understanding of the proposed development.

2 Site Description

The subject site is located at the south-east side of the BIO property along the Bedford Basin, between Endeavour Drive and the MacKay Bridge, in Dartmouth, Nova Scotia. The BIO facility is a modern oceanographic research facility operated by the Federal Government of Canada. It is understood that the new building will provide a modern facility for Inshore Rescue crews and training.

The proposed SAR MOB site currently comprises of a paved parking area to the north and partially grass covered area to the south. The existing Inshore Rescue building, located within the proposed site, was demolished prior to the geotechnical investigation. A depression in the ground surface remains where the building footprint was located.

The ground surface elevation within the site generally ranges from approximately 3.7 m along the north side to 2.3 m along the south side at the Harbour. A depression, approximately 1 m deep is located where the building was recently demolished. A chain link fence is located along the edge of the pavement area and along the east property boundary.

A photo log showing general site photos is provided in Appendix 1.

3 Fieldwork

The fieldwork for the geotechnical investigation consisted of four boreholes (BH18-01 to BH18-04). The boreholes were advanced to depths ranging from approximately 4.6 to 7.8 m below the ground surface (BGS). The investigation was carried out using a B-57 truck-mounted drill rig, supplied and operated by Logan Drilling Limited out of their operation located in Stewiacke, Nova Scotia. Field work was completed on June 14 and 15, 2018.

The geotechnical investigation was conducted under the supervision of EXP staff who logged the sub-surface stratigraphy and collected representative soil samples. The approximate elevation of the ground surface at the borehole locations were interpolated from topographic survey data attained by Alderney Surveys Limited on June 6, 2018.

EXP was responsible for service clearances to confirm that underground utilities were not present at the borehole locations. Local utilities were contacted to identify the location of services, and R.L. Dennis Associates Limited performed on-site locates to confirm suitable locations for the boreholes. This is provided as general information only. Third parties should make their own inquiries with local authorities to confirm the presence or absence of utilities on the site.

3.1 Investigation Methodology

The proposed locations of the boreholes were determined by EXP. Slight adjustments were made to the borehole locations to avoid underground services identified during the on-site locates. The boreholes were advanced in the approximate footprint of the proposed development.

The boreholes were advanced using standard, solid stem auger equipment as well as conventional casing/coring equipment. Representative soil samples were attained from the 50 mm diameter split spoon sampler during Standard Penetration Tests (SPT), conducted ahead of the auger/casing. Coring was conducted using HQ sized equipment, which uses HW sized casing. Coring was conducted in BH18-01, BH18-03 and BH18-04 through the cobble and boulder fill. Borehole BH18-02 was advanced by solid stem auger to practical refusal. A preliminary assessment of particle size, density, moisture, and colour was recorded for each soil sample.

The general site arrangement and locations of the boreholes are shown on Figure 1 in Appendix 1.

3.2 Sample Storage and Lab Testing

Soil samples were reviewed in the laboratory by an EXP engineer to confirm soil boundaries and descriptions. Representative samples from each of the different strata were selected for laboratory analysis. The following tests were carried out:

- Moisture Content tests were conducted on 3 soil samples.
- Sieve tests were conducted on 3 soil samples to classify the soil strata.

The results of geotechnical laboratory tests are provided in Appendix 2.

4 Surface and Sub-Surface Conditions

4.1 Summary of Conditions

The general stratigraphy encountered on the site included the following:

- Surface Cover (Asphaltic Concrete)
- Gravel Fill (GM)
- Cobble and Boulder Fill

In general, the site is underlain by fill. The fill is suspected to have been imported during various stages of site development. The depth to native soil or bedrock was not encountered within the depths investigated.

Groundwater seepage was observed in one of the four boreholes during drilling, where it was possible to detect it. Groundwater conditions below the cobble and boulder fill could not be assessed due to the addition of water required for the coring process.

It should also be noted that the soil stratigraphy detailed on the borehole records and in the descriptions of sub-surface conditions is only valid at the location where the boreholes were conducted. Soil stratigraphy can be expected to vary between borehole locations. A summary of the thickness of the various strata encountered during the investigation is provided below in Table 1. Detailed borehole records are provided in Appendix 3, and summary descriptions of the various strata are given below in subsequent paragraphs.

Table 1: Summary of Sub-Surface Stratigraphy

Borehole ID	Thickness of Asphaltic Concrete (m)	Thickness of Gravel Fill (m)	Thickness of Cobble/ Boulder Fill (m)	Depth of Borehole (m)
BH18-01	0.15	3.1	>4.6	7.8
BH18-02	--	2.4	>2.2	4.6
BH18-03	--	2.4	>3.7	6.1
BH18-04	--	2.1	>5.5	7.6

4.2 Asphaltic Concrete

Asphaltic concrete was encountered at the existing ground surface of BH18-01 and was approximately 150 mm thick.

4.3 Gravel Fill - (GM)

Gravel fill was encountered at existing ground surface or below the surficial asphaltic concrete at all borehole locations. The composition of the gravel fill was described under the Unified Soil Classification System (USCS) as 'Silty Gravel with Sand' (GM). The compactness of the gravel fill can be described as compact to very dense based on the

Standard Penetration Test (SPT) N-Values that typically ranged from 13 to greater than 50. The moisture content of the gravel fill ranged between 5.1 and 6.4 %. The gravel fill was generally grey in colour.

4.4 Cobble and Boulder Fill

A layer of cobble and boulder fill was encountered below the gravel fill in all four boreholes. Finer grained soils are present within the matrix of the cobble and boulder fill and was described under the USCS as 'Well-Graded Gravel with Silt and Sand' (GW-GM).

The fill was cored in boreholes BH18-01, BH18-03, and BH18-04 through the coarse cobbles and boulders. The recovered pieces of cobbles and boulders were noted to be comprised of varying types of rock. This material was likely placed during original site development.

4.5 Groundwater

Groundwater levels at the time of drilling are shown on borehole records and represent the first instance where soil samples with free water were encountered. Groundwater was only encountered in BH18-01 at a depth of 2.7 m below existing ground surface. Groundwater conditions below the cobble and boulder fill could not be assessed due to the addition of water required for the coring process.

It should be noted that groundwater conditions vary seasonally and in response to recent precipitation events. The boreholes conducted during this investigation represent a limited sampling of the site.

4.6 Geological Mapping and Bedrock

Published surficial geology mapping (Surficial Geology Map, Part of the Halifax Claim, OFM ME 2011-009) indicates that the site borders two different surficial units including:

- Till veneer (Beaver River Till), consisting of diamicton with sandy matrix and locally derived clasts. Sediments deposited by ice and derived from subglacial erosion (0.5 to 5 m thick). Some areas include exposed bedrock and thicker till deposits (> 5 m) of locally derived till.
- Anthropogenic, consisting of artificial or geological material that has been disrupted and redistributed by human activity; texture highly variable.

Published geology mapping (Bedrock Geology Map of the Halifax Area, Nova Scotia, OFM ME 2014-010) indicates the site is underlain by the Taylors Head Formation of the Goldenville Group, which includes grey, medium to thick bedded, very fine to medium metasandstone locally interlayered with green, cleaved metasiltstone, and rare black slate; calc-silicate nodules common. Bedrock was not encountered during this investigation.

5 Discussion and Recommendations

Geotechnical recommendations for the design and construction of the proposed development are given below, based on our current understanding of the proposed structure. Additional geotechnical input may be required as concepts evolve during the detailed design phase, and we would be pleased to provide any additional information required.

The key geotechnical considerations for the proposed work are summarized in the following points. Additional commentary and recommendations are provided in subsequent report sections.

- The building footings will be founded on existing fill. The existing fill will be suitable for use as a bearing stratum for footings, but will require compaction and proof rolling to identify any local loose/soft areas in the subgrade.
    - Placement of a 450 mm thick gravel mattress below the slab-on-grade and footings is recommended to mitigate differential settlements in the underlying uncontrolled fill.
    - The gravel mattress should consist of approved structural fill. Structural fill recommendations are provided in Subsection 5.4.1.
- Groundwater levels are expected to fluctuate with the tide and adjacent Harbour levels along the south side of the property.
    - Dewatering will be an important consideration for construction. The need for pumping from multiple sumps, interceptor/diversion trenches, French drains and similar groundwater control measures should be anticipated.
    - Water levels will need to be continuously maintained at sufficient depth to avoid potential loosening of subgrade soils and base heave in foundation excavations. Planning mass excavation and site development in periods of traditional dry weather and low groundwater levels is recommended.

5.1 Site Development

Final grades are unknown to us at this time; however, we assume finished grade will closely match the existing grades. EXP should be contacted once more details (site grades) are known to revise our recommendations, if required. Based on the findings of our investigation, the site preparations would consist of partial removal of the existing fill with approved structural fill for building construction.

5.1.1 Clearing and Grubbing

All surficial asphaltic concrete and soils containing organic materials should be stripped and removed from within the footprint of the proposed structure.

5.1.2 Proof Rolling and Over-Excavation

After removal of required materials and excavation to design subgrade elevations, the exposed soils should be compacted and proof rolled prior to the placement of any structural fill, backfill, form work, or concrete. A large 10 to 12 ton vibratory steel drum roller compactor or fully loaded tandem truck should be used for the proof rolling operations where possible. This work should be done in the presence of a qualified geotechnical inspector.

Any local soft or wet areas that exhibit excessive displacement during proof rolling will require over-excavation and replacement with approved fill to achieve a competent base for compaction of structural fill. As well, if large boulders or gap-graded material is encountered at subgrade, over-excavation and replacement with approved fill may be required. The excavations should be advanced to the depths directed by the geotechnical inspector, and backfilled in compacted lifts with approved structural fill to the satisfaction of the geotechnical inspector.

5.1.3 Re-Use of Existing Soils

The existing fill soils comprised of gravel fill could be considered for re-use and should be reviewed onsite during construction by the geotechnical engineer.

The cobble and boulder fill will not be suitable for re-use as structural fill in its existing form. A requirement for significant processing (crushing, screening, washing), and testing to confirm the materials meet the project requirements should be anticipated for re-use. The use of imported granular borrow would likely be less costly. Third parties must make their own assessment of the potential re-use of existing site materials for new construction.

5.1.4 Erosion Prevention and Protection of Work

The soils that will be exposed during construction on this site may be erodible. Temporary erosion prevention measures and sedimentation control features should be included in construction, in accordance with NSDEL's "Erosion and Sedimentation Control Handbook For Construction Sites". Hydro-seeding, the installation of sod or other erosion control measures, should also be constructed on permanent excavated slopes and stripped non-traffic areas to combat soil erosion.

5.2 Excavations and Groundwater Control

Trenches and excavations should be excavated in accordance with the requirements of the Nova Scotia Occupational Health and Safety Division. Excavations extending to a depth greater than 1.2 metres should be sloped at a maximum grade of 1 H:1 V. Deep excavations, or those that encounter sandy soils or groundwater, will require flatter slopes for stability, or the use of trench boxes or an engineered shoring system. Deep sumps, diversion trenches, French drains or the installation of well points to lower the elevation of groundwater a suitable distance below the base of excavations could also be useful in minimizing efforts to support excavations and allow for construction in the dry.

Typical dewatering methods including gravity drainage from interceptor/diversion trenches or pumping from sumps should be effective in typical shallow excavations. More aggressive dewatering systems may be needed for deep excavations. Groundwater control plans should be developed prior to construction and should include measures to continuously control groundwater during construction. Dewatering plans should be submitted to the Engineer as part of the submittal process prior to construction, and reviewed to confirm their adequacy.

The ground surface around excavations should be sloped to divert surface water from flowing into excavations. Any soil softened from exposure to water or freezing should be over-excavated before the placement of any additional backfill or concrete.

Finished surface grades adjacent to foundations should be sloped away from the foundations at a 2% grade for a minimum length of 3 m. These areas should be capped with an impervious material, such as asphaltic concrete or impermeable soil.

It is important to note that groundwater levels vary seasonally, with location across a site and in response to recent precipitation events, tidal effects and other factors. Further, the requirements for groundwater control will be a function of the approach selected for construction.

5.3 Geotechnical Parameters for Design

We anticipate that the foundations for the proposed building will consist of slab-on-grade, strip footings and spread footings. The following recommendations are provided on this basis. If different foundations are considered during design, we request the opportunity to review the alternative design and verify that any design assumptions we made are still valid.

5.3.1 Bearing Capacity and Foundation Design

The existing gravel, and cobble and boulder fill underlying the site will provide a suitable bearing stratum for footings. However, we recommend compaction with a large 10 to 12 ton vibrator roller and proof rolling of the existing fill prior to the placement of approved structural fill. We also recommend excavation to 450 mm below design footing and slab-on-grade elevations and placement of a layer of structural fill to improve bearing capacity. These excavations should include a 300 mm bench laterally beyond the edges of the footings and a 1H:1V splay down to the 450 mm depth. The excavation will have to also be sloped for safety. The thickness of the structural fill layer should be at least 450 mm and

static proof rolling should be performed to ensure that a competent base is provided for footings and slab-on-grade.

Footings founded on structural fill placed over the compacted existing fill may be designed using a net geotechnical bearing reaction at Serviceability Limit States (SLS) of 150 kPa. Total and differential settlements of the structure are expected to be less than 25 mm and 15 mm respectively, at this level of applied bearing pressure. A factored net geotechnical bearing resistance at Ultimate Limit States (ULS) of 300 kPa may be used. This includes a geotechnical resistance factor of 0.5 in accordance with recommendations made in the National Building Code of Canada (NBCC 2015).

Perimeter footings should be founded at least 1.2 m below finished exterior grades for frost protection. Interior spread footings in heated structures should be founded at least 600 mm below slabs for confinement. Alternatively, foundation depths may be reduced if an insulation detail is incorporated in the design. EXP would be pleased to establish an insulation detail upon request.

5.3.2 Site Class for Seismic Response

We recommend that designers use a site class of C (very dense soil and soft rock) for seismic considerations, in accordance with Table 4.1.8.4.A (Site Classification for Seismic Site Response) in the 2015 National Building Code of Canada. Note that the site class is based on the investigation methods (SPT sampling and coring) and average conditions of the ground profile in the upper 30 m of the site.

5.4 General Recommendations

5.4.1 Structural Fill

Where required for development, structural fill should consist of well graded, sand and gravel with less than 12% fines (% passing the 0.080 mm sieve size). The particles comprising the fill should be durable and it should be free of organics, flat or elongated particles and all other deleterious materials. Examples of suitable structural fill for foundation backfill of perimeter frost walls would be a ‘Type 1' or ‘Type 2' Gravel meeting NSTIR Standard Specifications. Structural fill for under footings and slab-on-grade should consist of a 150 mm or 100 mm minus well graded, quarried material.

In wet areas, Surge Rock or Clear stone could be considered for use as structural fill. This can be reviewed during construction.

5.4.2 Backfill Considerations

All backfill should be placed in lifts, not to exceed 300 mm in thickness, and compacted to the following percentage of the optimum dry density, determined by Standard Proctor test (ASTM D698).

- Subgrade fill - 95%
- Structural fill within 1.5 m of retaining walls – 95%
- Structural fill beneath hardscape elements (sidewalks, curb, etc) – 98%
- Base and Sub-base courses beneath asphalt pavement – proof roll and 98%

- Structural fill beneath footings and slab-on-grade – proof roll coarse rock fill, gravel to 98%

Where possible, each lift of fill should be tested to confirm compaction prior to placing the next lift of fill. Thicker lifts may be used where it can be shown that adequate compactive effort is being achieved.

5.4.3 Geotextile Separators

Non-woven, needle-punched geotextile separators may be utilized where fines from the structural fill may be lost into existing cobble and boulder fill due to piping or internal erosion. Examples of where geotextile separators are recommended are where finer rock fill are placed against coarse, gap-graded rock fill or where rock fill is placed against native soils. This should be reviewed by a geotechnical engineer during construction.

6 Closure

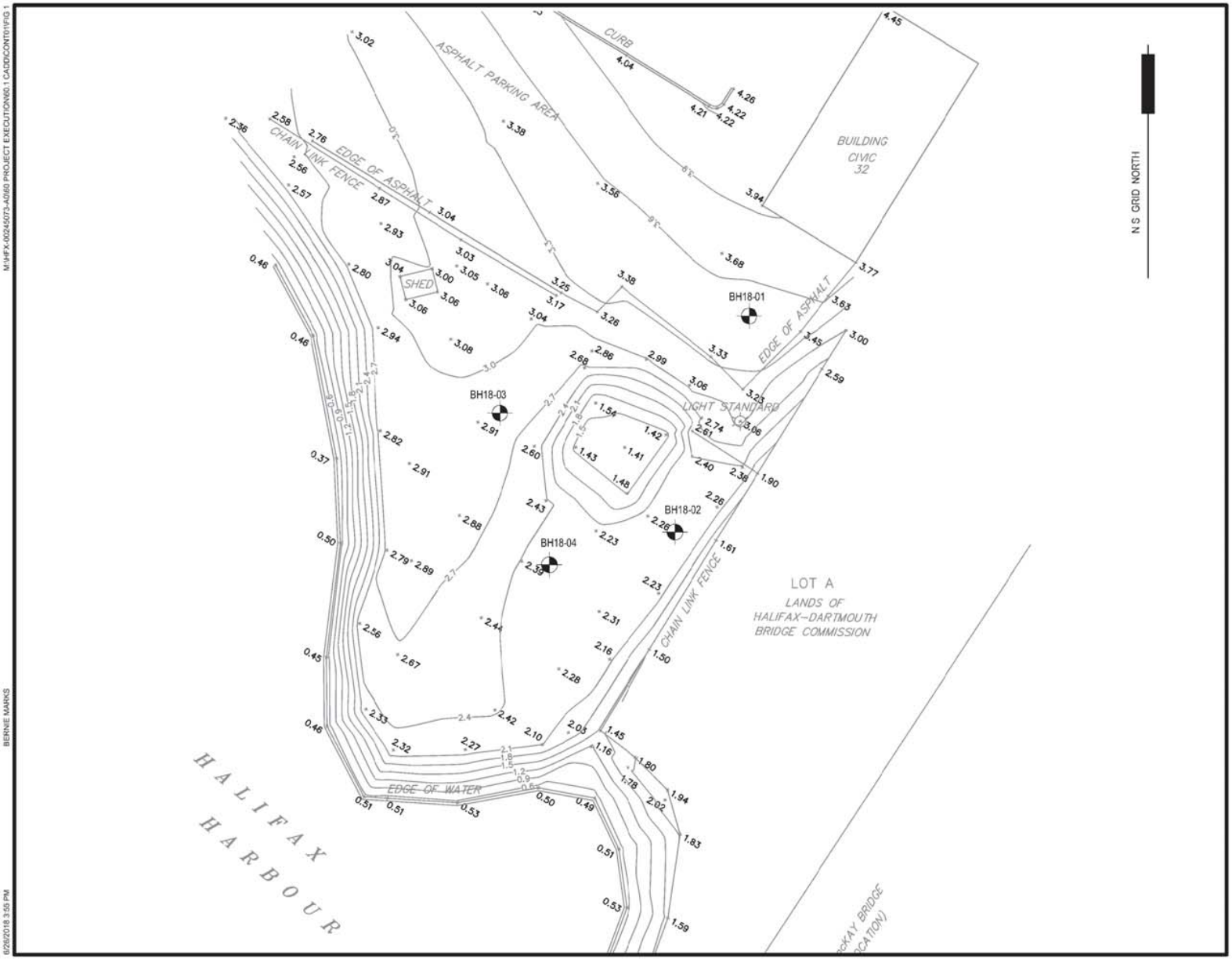
This report has been prepared to assist in the design and construction of the proposed BIO Search and Rescue Marina Operations Building. If any uncommon details are included in the final design of the proposed structures, the geotechnical engineer should be consulted. Similarly, if conditions different from those detailed on the borehole records are noted during construction, the engineer should be notified to allow reassessment of any design assumptions, if necessary.

Appendix 1 –
Photo Log
Borehole Location Plan

Photo 1: View across the site looking northeast.

Photo 2: View across the site looking southeast.

Photo 3: View of depression where previous building was removed.



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No	Issue	Date

LEGEND

APPROXIMATE BOREHOLE LOCATIONS

No	Revision	Date

PROJECT STATUS

Drawn By:	BJM
Dwg Standards Ckd By:	
Designed By:	CM
Design Checked By:	
Scale:	1:250

Project Title

BIO SEARCH AND RESCUE MARINA OPERATIONS BUILDING

Dwg. Title

BOREHOLE LOCATION PLAN

Project No.

HFX-00245073-A0

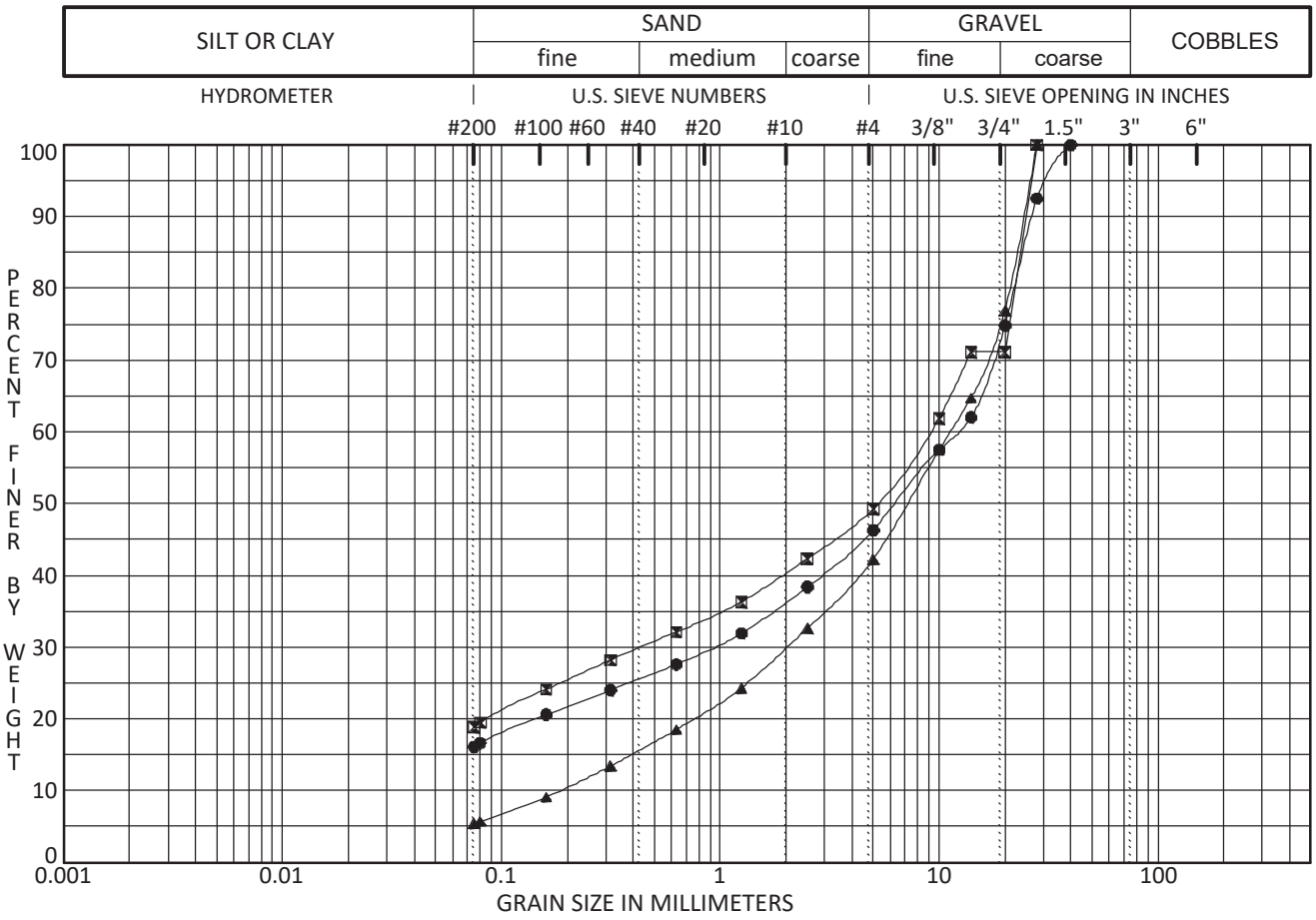
Dwg. No.

FIG. 1

Rev. No.

Appendix 2 –
Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION



	BH	SAMPLE	DEPTH(m)	Classification (USCS)	WC%	LL	PL	PI	Cc	Cu
●	**BH18-01**	**SS - 3**	**1.8**	**SILTY GRAVEL with SAND GM**	**5.1**					
⊠	**BH18-03**	**SS - 3**	**1.5**	**SILTY GRAVEL with SAND GM**	**6.4**					
▲	**BH18-04**	**SS - 6**	**3.4**	**WELL-GRADED GRAVEL with SILT and SAND GW-GM**	**7.4**				**1.95**	**60.96**

	BH	SAMPLE	DEPTH(m)	D60	D30	D10	%Gravel	%Sand	%Fines	Soil Deposit
●	**BH18-01**	**SS - 3**	**1.8**	**12.06**	**0.923**		**54.3**	**29.6**	**16.1**	**Fill**
⊠	**BH18-03**	**SS - 3**	**1.5**	**9.01**	**0.434**		**51.3**	**29.8**	**18.9**	**Fill**
▲	**BH18-04**	**SS - 6**	**3.4**	**11.24**	**2.012**	**0.184**	**58.5**	**36.1**	**5.4**	**Fill**

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CLIENT Public Works and Government Services Canada

LOCATION BIO, Dartmouth, Nova Scotia

PROJECT No. HFX-00246024-A0

Table 1- SUMMARY OF LABORATORY TEST RESULTS

CLIENT Public Works and Government Services Canada

LOCATION BIO, Dartmouth, Nova Scotia

PROJECT No. HFX-00246024-A0

TESTING:

Moisture Content:	3
Atterberg Limits:	0
Sieve Analysis:	3
Hydrometer Test:	0
UCS:	0

Soil Deposit	Borehole/Sample	Depth (m)	Water Content (%)	Atterberg Limits			Sieve Analysis			UCS (MPa)
				Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)	
Fill	BH18-01/SS - 3	1.8	5.1				54.3	29.6	16.1	
Fill	BH18-03/SS - 3	1.5	6.4				51.3	29.8	18.9	
Fill	BH18-04/SS - 6	3.4	7.4				58.5	36.1	5.4	

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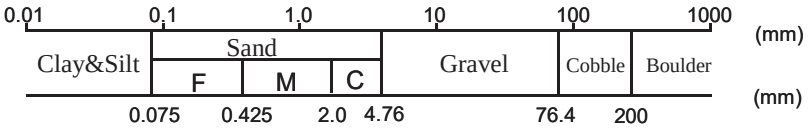
Appendix 3 –
Descriptive Terms Used on Test Hole Logs
Borehole Records

Descriptive Terms - Borehole and Test Pit Logs

Soils

Grain Size



Compactness (gravel, sand, tills)

N, Range	0 - 4	4 - 10	10 - 30	30 - 50	>50
Density	V. Loose	Loose	Compact	Dense	V. Dense

Consistency (silt, clay)

S, KPa	< 12.5	12.5 - 25	25 - 50	50 - 100	100 - 200
Consistency	V. Soft	Soft	Firm	Stiff	V. Stiff

Rock

RQD	**Overall Quality**	**Fracture Spacing**
0 - 25	Very Poor	< 50 mm Very Close
25 - 50	Poor	50 - 300 mm Close
50 - 75	Fair	0.3 - 1 m Moderate
75 - 90	Good	1 - 3 m Wide
90 - 100	Excellent	> 3 m Very Wide

Comp. Str., MPa	0.25 - 1	1 - 5	5 - 25	25 - 50	50 - 100	100 - 250	> 250
Description	Extremely Weak	Very Weak	Weak	Medium Strong	Strong	Very Strong	Extremely Strong

Sample Types (location to scale on log)

SS	Split Spoon	**B**	Shovel (bulk)
T	Shelby Tube	**H**	Carved Block
P	Piston	**V**	In Situ Vane
F	Auger	**NR**	No Recovery
W	Wash		

Rock Cores: BQ (36.5mm), NQ (47.6mm), HQ (63.5mm)

Notation and Symbols

N - N-value from standard penetration test; blows by 475 J drop hammer to advance std. 50mm O.D. split spoon sampler 0.3m

RQD - percent of core consisting of hard, sound pieces in excess of 100mm long (excluding machine breaks)

Recovery - sample recovery expressed as percent or length

S	- shear strength, kPa	**PL**	- plastic limit, percent
Sr	- shear strength, remoulded	**LL**	- liquid limit, percent
Dd	- dry density, t/m^3	▼	- groundwater level
W	- natural moisture content, percent	▽	- seepage

SYMBOLS AND TERMS USED ON THE BOREHOLE AND TEST PIT RECORDS

Soil Description

Behavioral properties (i.e., plasticity, permeability) take precedence over particle gradation in describing soils.

Terminology Describing Soil Structure

Desiccated	Having visible signs of weathering by oxidation of clay minerals,
Fissured	Having cracks and, hence, a blocky structure
Varved	Composed of regular alternating layers of silt and clay
Stratified	Composed of alternating layers of different soil type, e.g., silt and sand
Well Graded	Having wide range in grain size and substantial amounts of all
Uniformly Graded	Predominantly of one grain size

Terminology used for describing soil strata based upon the proportion of individual particle sizes present:

Trace, or occasional	Less than 10%
Some	10–20%
Adjective (e.g., silty or sandy)	20–35%
And (e.g., silt and sand)	35–50%

The standard terminology to describe cohesionless soils includes the relative density, as determined by laboratory test or by the Standard Penetration Test “N”-value: the number of blows of 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2-inch (50.8 mm) O.D. splitspoon sampler one foot (305 mm) into the soil.

Relative Density	“N” Value	Relative Density %
Very Loose	<4	<15
Loose	4–10	15–35
Compact	10–30	35–65
Dense	30–50	65–85
Very Dense	50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Undrained Shear Strength

Consistency	kips/sq. ft.	kPa	“N” Value
Very Soft	<0.25	<12.5	<2
Soft	0.25–.50	12.5–25	2–4
Firm	0.5–1.0	25–50	4–8
Stiff	1.0–2.0	50–100	8–15
Very Stiff	2.0–4.0	100–200	15–30
Hard	>4.0	>200	>30

BOREHOLE RECORD

CLIENT Public Works and Government Services Canada — PROJECT No. HFX-00246024-A0

LOCATION BIO, Dartmouth, Nova Scotia — BOREHOLE No. BH18-01

DATES of BORING Jun 14, 2018 — WATER LEVEL — DATUM CVGD

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD	OTHER TESTS
	3.5						mm		
0	3.4	ASPHALT - 150 mm							
		GRAVEL FILL			SS	1	300	24	
		Silty Gravel with Sand (GM), moist to wet, grey.							
1					SS	2	250	27	
					SS	3	450	59	
2									
		- groundwater encountered at 2.7 m depth during drilling							
3	0.3				SS	4	100	55	
		COBBLE/BOULDER FILL			RC	5	440		
		Cobbles and Boulders, Well-Graded Gravel with Silt and Sand matrix, wet, grey.			RC	6	400		
4					SS	7	250	37, 50 for 4"	
					RC	8	800		
5									
					SS	9	50	50 for 4"	
6					RC	10	110		
7	-4.3				SS	11	0	50 for 5"	
		End of Borehole @ 7.8 m Below Ground Surface							
8									
9									
10									

Undrained Shear Strength, kPa: 20 40 60 80

Water Content & Atterberg Limits: W_p W W_l

Standard Penetration Test, blows/0.3m: 10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test

□ Field Vane Test ■ Remoulded

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TEST PIT RECORD

CLIENT Public Works and Government Services Canada PROJECT No. HFX-00246024-A0

LOCATION BIO, Dartmouth, Nova Scotia BOREHOLE No. BH18-02

DATES of BORING Jun 15, 2018 WATER LEVEL DATUM CVGD

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES OTHER TESTS	Undrained Shear Strength, kPa / Water Content & Atterberg Limits
0	2.2							
		GRAVEL FILL Silty Gravel with Sand, moist to wet, brown to grey.						
2	-0.2							
		COBBLE/BOULDER FILL Cobbles and Boulders, Well-Graded Gravel with Silt and Sand matrix, wet, grey.						
4	-2.4							
		End of Borehole @ 4.6 m Below Ground Surface - auger refusal on inferred boulder						
10								

Undrained Shear Strength, kPa: 20 40 60 80

Water Content & Atterberg Limits: W_p W W_l

10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test

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BOREHOLE RECORD

CLIENT Public Works and Government Services Canada | PROJECT No. HFX-00246024-A0

LOCATION BIO, Dartmouth, Nova Scotia | BOREHOLE No. BH18-03

DATES of BORING Jun 15, 2018 | WATER LEVEL | DATUM CVGD

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD	OTHER TESTS
	2.9						mm		
0		GRAVEL FILL Silty Gravel with Sand (GM), moist to wet, brown to grey. - trace rootlets in SS1			SS	1	300	31	
1					SS	2	200	33	
					SS	3	150	18	
2					SS	4	300	34	
	0.5								
		COBBLE/BOULDER FILL Cobbles and Boulders, Well-Graded Gravel with Silt and Sand matrix, wet, grey.			RC	5	1300		
3									
					RC	6	600		
4									
5					RC	7	0		
6	-3.2								
		End of Borehole @ 6.1 m Below Ground Surface							
7									
8									
9									
10									

Undrained Shear Strength, kPa

20 40 60 80

Water Content & Atterberg Limits W_p W W_l

Standard Penetration Test, blows/0.3m

10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test

□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Public Works and Government Services Canada — PROJECT No. HFX-00246024-A0

LOCATION BIO, Dartmouth, Nova Scotia — BOREHOLE No. BH18-04

DATES of BORING Jun 15, 2018 — WATER LEVEL — DATUM CVGD

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY	N-VALUE OR RQD	OTHER TESTS
	2.3						mm		
0		GRAVEL FILL Sandy Gravel, trace silt, moist to wet, grey.			SS	1	150	19	
1					SS	2	200	15	
					SS	3	200	13	
2	0.2				SS	4	100	33, 50 for 0"	
		COBBLE/BOULDER FILL Cobbles and Boulders, Well-Graded Gravel with Silt and Sand (GW-GM) matrix, wet, grey.			RC	5	450		
3					SS	6	200	11	
4					SS	7	300	29	
					RC	8	600		
					SS	9	200	21	
5					RC	10	450		
6					SS	11	50	50 for 3"	
					RC	12	1070		
7	-5.3								
		End of Borehole @ 7.6 m Below Ground Surface							
8									
9									
10									

Undrained Shear Strength, kPa: 20 40 60 80

Water Content & Atterberg Limits: W_p W W_l

Standard Penetration Test, blows/0.3m: 10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test

□ Field Vane Test ■ Remoulded

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A. SPECIFICATIONS

1. Divisions 21, 22, 23, and 25:

1. Commissioning shall be included as part of the tender documents; refer to specification section 01 91 00 Commissioning.

2. Section 25 05 01, EMCS General Requirements:

1. Item 1.5.2.3: Delete reference to Delta network.
2. Item 1.8.1: Add the following: The new controls graphics shall match the existing EMCS graphics and software.

3. Section 22 42 00, Commercial Plumbing Fixtures:

1. Add the following to item 2.2.3 L1 – Lavatory: Vitreous china, wall hung lavatory, complete with front overflow, D-shaped bowl, self-draining deck with contoured back and side splash shields, faucet ledge, 100mm center faucet holes, concealed arms support. Overall dimensions: 521mm x 464mm. Faucet:100mm centers, two (2) handle, heavy-duty cast brass, polished chrome-plated finish, metal hold-down package, color indexed metal handles with vandal resistant screws, cast open grid strainer, vandal resistant spray outlet (1.9L/min), blade handle with sanitary hood, and handle temperature indicators. Trap: 32mm Polished chrome-plated cast brass body with clean-out plug. Supplies: Pair of chrome-plated finish, angle supplies, lockshield, screwdriver slot, 9.5mm x 305mm long flexible riser tubes, stainless steel wall flanges. Carrier: Concealed arm support system complete with coated rectangular steel uprights with welded feet; cast iron adjustable headers, steel sleeves, alignment truss, and mounting fasteners.

2. Add the following to item 2.2.4 L2 – Lavatory: Barrier-free, vitreous china, wall hung lavatory, complete with rear overflow, recessed self-draining deck, faucet ledge, 100mm center faucet holes, concealed arms support, and shroud/knee contact guard. Overall dimensions: 521mm x 464mm. Faucet:100mm centers, two (2) handle, heavy-duty cast brass, polished chrome-plated finish, metal hold-down package, color indexed metal handles with vandal resistant screws, offset cast open grid strainer, vandal resistant spray outlet (1.9L/min), blade handle with sanitary hood, and handle temperature indicators. Trap: 32mm Polished chrome-plated cast brass body with clean-out plug. Supplies: Pair of chrome-plated finish, angle supplies, lockshield, screwdriver slot, 9.5mm x 305mm long flexible riser tubes, stainless steel wall flanges. Carrier: Concealed arm support system complete with coated rectangular steel uprights with welded feet; cast iron adjustable headers, steel sleeves, alignment truss, and mounting fasteners.

3. Add the following to item 2.2.5 L3 – Lavatory: Vitreous china, wall hung lavatory, complete with rear overflow, faucet ledge, single faucet hole, and wall bracket and hardware. Overall dimensions: 500mm x 220mm. Faucet: cast brass, single hole mount with open grid strainer, polished chrome-plated finish, metal hold-down package, color coded plug button on handle, vandal resistant spray outlet (1.9L/min), vandal resistant lever handle. Trap: 32mm Polished chrome-plated cast brass body with clean-out plug. Supplies: Pair of chrome-plated finish, angle supplies, lockshield, screwdriver slot, 9.5mm x 305mm long flexible riser tubes,

stainless steel wall flanges.

4. Add the following to item 2.2.6 SH1 – Shower: Polished chrome shower trim including pressure balanced shower valve with integral check stops, vandal resistant escutcheon screws, and lever handle. Wall mounted vandal resistant shower head with ceramic tile anchor plate, 5.7 Lpm flow rate.

5. Add the following to item 2.2.7 SH2 – Shower: Barrier-free polished chrome shower trim including pressure balanced shower valve with integral check stops, vandal resistant escutcheon screws, and lever handle. Wall mounted vandal resistant shower head with ceramic tile anchor plate, 5.7 Lpm flow rate, detachable hand spray unit with flexible metal hose, 600mm minimum slide bar and diverter.

6. Modify item 2.2.8 to the following: .8 JS1 – Janitor Sink: Description remains the same, with the following exceptions: mop basin shall be corner unit with a 150mm drop front with stainless steel threshold only; basin complete with two (2) stainless steel wall guards.

7. Modify item 2.2.9 to the following: .9 CW – Clothes Washer Trim: Fire-rated washing machine outlet box; bulk molded compound thermoset fire-rated plastic box and plug; snap-on faceplate; 50mm PVC DWV drain; ¼ turn brass, lead-free ball valves; (2) adjustable galvanized steel mounting brackets; UL classified fire wrap insulation.

8. Add the following to item 2.2: .10 BT – Bathtub: Fiberglass tub for alcove installation, complete with armrests and textured bottom, integrated apron and tiling flange, above-the-floor rough-in, dimensions: 1524mm long x 762mm front-to-back x 533mm high, color: white. Shower/Tub Spout: Complete with pressure balancing valve, adjustable stop screw to limit handle turn, integrated diverter, non-diverter tub spout, (1) mode showerhead with rubber nozzles, (7.6L/min) flow restrictor; polished chrome finish.

9. Add the following to item 2.2: .11 S1 – Drop-in Sink: Stainless steel, single compartment sink with faucet ledge, 20 gauge, Type 302, 18-8 stainless steel, self-rimming, satin finish, sound dampened and undercoated, complete with rim seal, 89mm waste assembly, installation kit, 203mm widespread, 508mm wide x 521mm front-to-back x 203mm deep. Faucet: heavy-duty cast brass, 203mm center two handle, polished chrome-plated finish, brass swing gooseneck spout with vandal resistant spray outlet (5.7L/min), metal hold-down package, color indexed metal blade handles with sanitary hood. Supplies: Copper with compression stops. Trap: 32mm cast brass complete with cleanout.

10. Add the following to item 2.2: .12 S2 – Drop-in Sink: Stainless steel, single compartment sink with faucet ledge, 20 gauge, Type 302, 18-8 stainless steel, self-rimming, satin finish, sound dampened and undercoated, complete with rim seal, 89mm waste assembly, installation kit, 203mm widespread, 508mm wide x 521mm front-to-back x 203mm deep. Faucet: heavy-duty cast brass, 203mm center two handle, polished chrome-plated finish, brass swing gooseneck spout with vandal resistant spray outlet (5.7L/min), metal hold-down package, color indexed metal blade handles with sanitary hood. Supplies: Copper with compression stops. Trap: 32mm cast brass complete with cleanout.

4. **Section 23 07 13, Thermal Insulation for Ducting:**
   .1 Item 3.5 Ductwork Insulation Schedule: Rename the "F/A ducts downstream of heat recovery ventilators" to "Supply air ducts downstream of Energy Recovery Ventilators"; the insulation type shall be TIAC code C-2 (flexible insulation).

5. **Section 21 07 20, Thermal Insulation for Piping:**
   .1 Item 3.4 Piping Insulation Schedule: Add item to the schedule: Refrigerant Lines (Liquid & Gas) shall be insulated with 25mm thick elastomeric pipe insulation; exterior refrigerant pipe insulation shall be protected with aluminum jacket.

   .2 Item 3.4 Piping Insulation Schedule: Add item to the schedule: Condensate Drain lines from indoor AC units (Heat Pumps) shall be insulated with 25mm thick fiberglass pipe insulation with all-service jacket.

6. Add the following specification sections:
   .1 Section 01 91 00 Commissioning.
   .2 Section 22 30 05 Domestic Water Heaters.
   .3 Section 23 82 22 Variable Refrigerant Flow (VRF) System.

B. DRAWINGS:

1. Reference Drawing M-1, Sanitary Level 1 and Level 2:
1. Refer to the note located between gridlines "7-8" above gridline "A": change the ¾" to 19mm and change the 2" to 50mm.

2. Reference Drawing M-2, Domestic Water Level 1 and Level 2:
1. Refer to the note located between gridlines "7-8" below gridline "C": change the ¾" to 19mm and change the 2" to 50mm.

3. Reference Drawing M-4, Heating Level 1 and Level 2:
1. Level 1 Heating Plan: Delete the note "Concrete Pad for Condensers by Others"; concrete pad is specified on the architectural/structural drawings.

4. Reference Drawing M-6, Ventilation and Heating Details and Mechanical Schedules:
1. Attached sketch MSK-1 forms part of drawing M-6.

C. ATTACHMENTS:

.1 Section 01 91 00 Commissioning.
.2 Section 22 30 05 Domestic Water Heaters.
.3 Section 23 82 22 Variable Refrigerant Flow (VRF) System.
.4 Sketch MSK-1 Control schematics.

PART 1 GENERAL

1.1 Commissioning Process

.1 Undertake commissioning to CSA Z320-11, Building Commissioning Standards, as a minimum. Provide documentation to Departmental Representative.

.2 The main objectives of the commissioning process can be classified as follows:

1. To ensure installation of all new equipment conforms to the contract document.

2. Performance verification that all components of the equipment actually perform as specified. This will be verified by measurements, visual inspection, equipment data sheets, manufacturer's representative assistance at start-up, and integrated testing.

3. Operation & Maintenance Personnel fully trained to operate and maintain the new equipment and systems.

1.2 Related Sections

.1 All applicable Division 01 subsections.

.2 All Canadian Electrical Code Part I C22-12 requirements.

.3 All Division 21, 22, 23, and 25 sections.

1.3 Commissioning

.1 The commissioning process shall consist of:

1. Testing of the 'new' equipment and components installed.

2. Testing of system(s) including any existing system(s) which has been modified or extended as part of the work.

3. Remote monitoring and all other related Integrated System Performance Testing, and fine tuning.

1.4 Commissioning Schedule

.1 Within two (2) weeks of contract award, the contractor will be responsible for providing a detailed schedule for showing all commissioning activities. Schedule to include the following milestones as a minimum; testing, start-up, training, delivery of O&M Manual, sequencing of commissioning, acceptance, and occupancy.

.2 Unless otherwise specified in writing by the Departmental Representative, all testing and related requirements specified herein will be successfully performed prior to the issuance of the Interim Certificate of Completion.

1.5 Submittal

.1 Prior to start of Work; submit one (1) set of shop drawings to the Departmental Representative for review and comments, from an O&M perspective. This shall include all components and systems delivered within Division 1, 21, 22, 23, 25, 26, 27, and 28.

.2 Submit NMMS/CMMS documentation for all components or systems to be removed as part of this project prior to removal.

.3 Submit start-up report forms prior to scheduling commissioning activities.

.4 Submit O&M Manual for review and comments prior to scheduling commissioning activities and training of O&M personnel.

.5 Submit reports of testing, adjusting and balancing postponed due to seasonal, climatic, occupancy or other reasons beyond Contractor's control, promptly after execution of those services.

.6 Documentation will be required from all equipment manufacturers outlining that their respective equipment is operational, has been installed to their requirements, started and commissioned successfully.

.7 Submit not later than 2 weeks after award of contract. Request to make any changes to this commissioning specification, including; timing, procedures, tolerances and instruments. Request should be made in writing to the Departmental Representative, and approval obtained from the Departmental Representative not less than 3 weeks prior to start of commissioning.

1.6 Manufacturer's Involvement

.1 Arrange for Manufacturer to submit copies of all production test records for production test required by these specifications prior to shipping.

.2 Prior to start-up of equipment or systems, obtain manufacturer's installation, start-up and operation instructions and review with Departmental Representative.

.3 Use manufacturer's trained start-up personnel to maintain integrity of warranty.

.4 Verify with manufacturer that testing as specified will not void any warranties.

.5 Manufacturer's personnel to be experienced in design, installation and operation of equipment and systems and be able to interpret test results in clear, concise, logical manner.

.6 Report in writing to Departmental Representative any deficiencies or defects noted during performance of services.

1.7 Seasonal Testing

.1 Notwithstanding all inclusive requirements specified in this section, additional separate cycles of performance testing and verification will be required at later date for components and systems whose full operation is dependent on seasonal conditions.

.2 Contractor's responsibilities with respect to such commissioning activities will be as specified in relevant sections.

1.8 Responsibilities

.1 Departmental Representative is responsible for the review and approval of all documentation, overview of performance, verification of activities, and verification of accuracy of reported results.

.2 Where requested, the Departmental Representative is responsible for the witnessing and certification of the performance verification results.

.3 Contractor is responsible to perform all commissioning activities and record results.

.4 Responsibility of the satisfactory completion of the project, and demonstration that the requirements of the commissioning are satisfied rest with the Contractor, who will employ and pay for Specialists, supervision,

inspection and testing as required, to complete the work as described.

.5 Coordinate all sub-trades, other divisions, manufacturers, suppliers, and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.

.6 Coordinate the activities of this Section with the starting and testing of:

.1 Plumbing components and systems specified in Division 22.

.2 Mechanical components and systems specified in Division 23.

.3 Integrated Automation components and systems specified in Division 25.

.4 Electrical components and systems specified in Division 26.

.5 Where any components or systems require testing prior to starting, ensure that such work has been completed and approved prior to starting of these components and systems.

1.9 Preparation

.1 The contractor shall have contract documents, shop drawings, product data, and operation and maintenance data in hand during equipment performance verification process.

.2 Except when otherwise specified, complete all start-up and testing prior to acceptance test and hand-over of the project.

.3 Co-ordinate work and manpower requirements of sub-trades, suppliers, manufacturers, specialists, disciplines as required ensuring that all work is properly organized prior to start-up and testing.

.4 Where equipment or systems require testing prior to start-up, ensure that such work is completed and approved prior to delivery of equipment or systems.

.5 Notify Departmental Representative seven (7) days prior to time project will be ready for testing, adjusting, and balancing.

1.10 Computerized Maintenance Management System (CMMS)

.1 All contract work shall comply with the requirements of the PWGSC CMMS. It is required to provide CMMS inventory sheets and coding (sample provided in annex). Inventory sheets will include all product data, serial and model numbers, equipment description, and location. Departmental Representative will assist the Contractors by providing CMMS sequential numbers as are available.

.2 Collect and record all CMMS data for all new or relocated equipment being installed, replaced, removed from or taken out of service from existing inventory of equipment.

.3 Submit to the Departmental Representative an inventory sheet identified with CMMS number only for each existing system or component being removed prior to removal.

.4 Submit to Departmental Representative fully completed inventory data sheets for all new equipment two (2) weeks prior to seeking approval for proposed component identification. All CMMS

inventory sheets are to be added in to the O&M Manual.

.5 CMMS applies to all major components or systems. Minor items such as switches, thermostats, etc., are not to be inventoried under the CMMS. The Departmental Representative will provide clarification to the Contractors upon request.

1.11 Start-Up and Testing

.1 Before start-up, clean all newly installed equipment and or systems and verify same to be free from all contaminants.

.2 After testing, protect equipment and systems from construction activities.

.3 Conceal equipment and systems only after inspection and testing is completed and approved by Departmental Representative.

.4 Assume all liabilities and costs for inspections including disassembly and re-assembly after approval, starting, testing, and adjusting, including supply of testing equipment.

1.12 Witnessing of Starting and Testing

.1 Provide sufficient notice not less than seven (7) days prior to commencement.

.2 Departmental Representative may witness all or any portion of start-up and testing at their discretion.

.3 General Contractor to be present at all tests performed by sub-trades, suppliers, and equipment manufacturers.

1.13 Start-Up Activities

.1 Factory and or on-site testing

.2 Pre-start-up, component by component inspections.

.3 Check of all equipment, systems, installation, electrical connections, etc. for conformity to contract documents, equipment manufacturer's installation requirements, etc.

.4 Check of location, installation, setting of controls, limit and safety devices and operate as designed.

.5 Compilation of pre-start-up deficiency list and rectification of all deficiencies in writing to Departmental Representative.

.6 Start-up verification for proper and safe operation.

.7 Identification and correction of start-up and pre-commissioning deficiencies.

.8 Failure to follow specified start-up procedures shall result in a re-evaluation of equipment by independent testing agency selected by Departmental Representative. Should results reveal that the equipment start-up was not in accordance with specified requirements, the contractor shall remove from site and replace with new, which will also be subject to specific start-up procedures.

.9 Testing, Adjusting, and Balancing (TAB) shall be as specified in relevant sections and shall verify the performance of all systems to ensure that they meet requirements of the contract document.

.10 Electrical Breaker coordination to be verified and breaker adjustments completed if applicable.

1.14 Maintenance of Equipment and Systems

.1 After start-up, maintain equipment and systems as directed by equipment/system manufacturer.

.2 Provide Maintain equipment support and service as described in CSA C282 Emergency Electrical power supply for buildings maintenance logbook.

.3 In conjunction with the manufacturer, develop written maintenance program. Submit to Departmental Representative for approval before implementation.

1.15 Start-Up Documentation

.1 Assemble and submit start-up reports to the Departmental Representative and Departmental Representative before commencement of commissioning.

.2 Start-up documentation to include as a minimum, witness and certified by the Departmental Representative, factory or on-site test certificates, pre-start-up inspection reports, installation/start-up check lists signed, certified and witnessed.

.3 Marked-up schematics of systems as actually installed.

1.16 Commissioning Documentation

.1 All results of test, performance verification and commissioning procedures to be reported, documented, witnessed and certified by Departmental Representative

.2 All commissioning documentation to be reviewed and approved by the Departmental Representative.

.3 Fully completed forms with the exception of verification results data, are to be completed and submitted to the Departmental Representative within four (4) weeks of approval of shop drawings, or as specified.

.1 Supplementing the above, the Contractor shall provide project specific verification forms for electrical mechanical, control (EMCS) systems. Submit sample verification forms with shop drawing submission. Update forms as required and resubmit to Departmental Representative should there be changes to the initial scope of work. After contractor start-up and debugging of programming, complete verification process in the presence of the Departmental Representative.

.2 Component forms shall be completed as follows:

.1 The specified requirements shall be completed by Contractor and verified by the Departmental Representative.

.2 The shop drawing information shall be completed by hand and shall reflect APPROVED shop drawings.

.3 The installed information shall be completed by the contractor from nameplates on installed equipment. This shall be completed by hand.

.4 The systems verification cannot take place before all related components have been verified as correct.

.5 Integrated systems verification cannot take place before all related systems have been verified as correct.

.6 Verification forms will be provided for information and convenience to the Contractor and will not relieve the Contractor of responsibility for verification of components, systems, or integrated systems not included on the verification forms.

.7 A verification form is to be completed for each integrated system in a category requiring verification.

.8 System and Integrated system verification forms are to be completed by the Contractor and verified by the Departmental Representative.

1.17 Training

.1 In accordance with CSA Building Commissioning Z320-11

.2 As supplemented in other sections of the contract documents.

1.18 Start of Commissioning

.1 Notify Departmental Representative not less than seven (7) days prior to commencement of commissioning.

.2 Commissioning to be in accordance with the completion schedule for the project and commissioning plan.

.3 Start commissioning only after completion of start-up, TAB, and any elements of building affecting start-up and performance verification of systems has been rectified.

.4 Contractor to provide sufficient 'qualified' personnel to Departmental Representative's satisfaction at field locations and at the central operation work (monitoring) station to successfully test and commission components, systems, and integrated systems.

1.19 Commissioning General Requirements

.1 Carry out commissioning under actual or simulating operating range in all modes. (i.e.: regular, emergency, day, night, heating, and cooling).

.2 Each system to be tested independently. If interlocked with or operation is affected by other systems, in unison with those systems.

.3 Commissioning procedures to be repeatable and reported results are to be verifiable.

.4 Follow equipment manufacturer's instruction re: operating and safety aspects.

1.20 Conflicts

.1 If requirements of this or other sections of construction or commissioning specification conflict, report to the Departmental Representative before start-up and obtain clarification.

.2 Failure to report conflicts and obtain clarification will result in application of most stringent requirement.

1.21 Commissioning Meeting

.1 In accordance with requirements of project meeting supplemented as specified herein, commissioning meetings will be held at same time as, and form part of regular construction progress meetings, or can be separate.

.2 Commissioning meetings will be held in conjunction with the project meetings during the construction phase. Meetings to continue on regular basis until issuance of Interim Certificate of Completion, after which meetings will occur as required to address operational and warranty issues.

.3 Purpose of meetings shall be to resolve issues, monitor progress, identify deficiencies relating to commissioning.

.4 To be present at the meetings, General Contractor and all his sub-contractors, Departmental Representative, operational staff and Project Manager.

.5 Departmental Representative to put forward agenda, chair meeting as well as record and distribute minutes.

1.22 Records of Commissioning Activities

.1 Maintain accurate, detailed records of commissioning activities including names of technicians, supervisors and dates of commissioning activities.

1.23 Inter-Disciplinary Co-Ordination

.1 Be present, assist, and witness commissioning of all systems and equipment of other disciplines which impact upon, interface with, are interlocked or interconnected with system being commissioned.

1.24 Pre-Commissioning Review

.1 Review contract documents and confirm in writing to Departmental Representative adequacy of provisions for commissioning and all other aspects of design pertinent to the success of commissioning.

.2 Before starting commissioning, review:

1. Installation
2. Documentation
3. Design Criteria and Intents
4. All Start-up Documentation
5. Commissioning Specifications, requirements and forms
6. Commissioning Plan
7. Commissioning Schedules
8. Commissioning Standards and Procedures
9. Cleanliness of Systems
10. As-built drawings (marked-up)
11. O&M Manual

.3 Report to Departmental Representative in writing all discrepancies and deficiencies.

1.25 Operation of System During Commissioning

.1 Operate and maintain for the length of time required as determined by the Departmental Representative for commissioning to be completed, and as required for verification of reported results.

1.26 Commissioning Tolerances

.1 Definitions:

.1 Application tolerances: Specified range of acceptable deviations of measured values from specified values or specified design criteria.

.2 Measurement tolerances: Unless specified otherwise, all measured and reported values to be within ± 2% of actual values.

.3 Instrument accuracy tolerances: Accuracy of measured value as percentage of actual value. Refer to relevant sections of these commissioning specifications.

.2 Values measured during verification of reported results to be within ± 5% of reported results.

1.27 Results

.1 If start-up, testing and or PV produce unacceptable results, repair, replace or repeat specified stating and or PV procedures until acceptance results are achieved.

.2 Provide manpower and materials, bear cost for re-commissioning.

1.28 Instruments

.1 Submit list of all instruments proposed to be used, listing all data including serial number, current calibration certificate date, calibration expiry date for review and approval by Departmental Representative.

.2 Provide safety equipment required for personnel involved in the starting testing and commissioning program.

.3 In addition to instruments listed in the specification document, provide the following:

1. Two way radio

2. Ladders

3. Other equipment

4. Safety equipment for start-up and testing personnel.

5. Provide list of equipment and instruments to be used in the start-up, TAB, testing for review and approval by the Departmental Representative.

1.29 Installed Instrumentation

.1 Instruments installed under Contract may be used for TAB and PV if:

1. Accuracy complies with these specifications.

2. Calibration certificates have been deposited with the Departmental Representative.

3. Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.30 Witnessing Commissioning

.1 Commissioning Manager will witness all activities. Departmental Representative may witness some activities to satisfy the design intent has been met.

.2 Departmental Representative will certify all the results.

.3 Contractor to be present at all tests.

1.31 Authorities Having Jurisdiction

.1 The contractor will complete initial start-up successfully prior to performance verifications and certification by presiding authorities having jurisdiction.

.2 To facilitate the turnover of the project, call and arrange for authorities to witness procedures in a manner that avoids unnecessary duplication of tests. It shall be the responsibility of the Contractor to confirm which tests the presiding authorities having jurisdiction are required to attend. Confirm that the presiding authorities will be present for each test, as required.

.3 Any cost associated with presiding authorities attending testing during the daytime and during off-hours shall be the responsibility of the Contractor. Include all such cost in your tender.

.4 Obtain Certificates of Approval, acceptance and compliance with the rules and regulations of authority having jurisdiction. Provide copies to the Departmental Representative within five (5) days of tests with the commissioning report.

.5 Submit reports generated by special testing agencies to the Departmental Representative prior to the issuance of the Interim Certificate of Completion.

.6 Special Testing agencies shall be approved by the Departmental Representative with acceptable facilities and qualifications.

1.32 Deficiencies, Faults, Defects, Repetition

.1 Correct all deficiencies found during start-up and commissioning to satisfaction of the Departmental Representative.

.2 Report faults, defects affecting commissioning to Departmental Representative in writing as they become apparent. Unless instructed otherwise, halt commissioning until same is rectified.

.3 Where verification of reported results fails to receive Departmental Representative approval, and where repetition of verification again fails to receive approval, and where Departmental Representative deems Contractor's request for 2nd verification was premature, then all costs incurred by Departmental Representative for 3rd and subsequent verifications to be borne by the contractor.

1.33 Activities Upon Completion of Commissioning

.1 After commissioning is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.

.2 Permanently and indelibly mark all settings to allow restoration at any time during life of facility. Markings not be eradicated or covered in any way.

.3 Record 'as commissioned' settings in commissioning report.

1.34 Completion of Commissioning

1. Co-operate fully with Departmental Representative during all stages of acceptance and occupancy of the facility.

2. Upon completion of commissioning, leave all systems in normal operating mode.

3. Except for warranty and seasonal verification activities specified in these commissioning specifications, commissioning to be completed prior to issuance of Interim Certificate of Completion.

4. Compile test reports, verification forms, and certificates, by Division, by specification Section, into one Commissioning Manual.

5. Submit draft manual for review and approval o the Departmental Representative 2 weeks prior to application for Interim Certificate of Completion for the project.

6. Submit 3 copies of the approved manual prior to Interim Certificate of Completion.

END OF SECTION

Part 1 – General

1.1 References

.1 Canadian Standards Association (CSA):
- .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .2 CAN/CSA C22.2 No.110, Construction and Test of Electric Storage Tank Water Heaters.
- .3 CAN/CSA-C191 Series, CSA Standards on Performance of Electric Storage Tank Water Heaters.
- .4 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

.2 National Plumbing Code 2015.

.3 ASHRAE 90.1b latest edition Standard for Energy Efficiencies.

1.2 Related Sections

.1 Section 21 05 01 – Mechanical General Requirements.

.2 Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.3 Section 23 05 54 – Mechanical Identification.

.4 Section 23 05 21 – Thermometers and Pressure Gauges – Piping Systems.

.5 Section 22 11 18 – Domestic Water Piping – Copper.

1.3 Shop Drawings

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

.2 Indicate equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled, recovery times, voltages, wiring diagrams, weights, dimensions, and required clearances.

1.4 Closeout Submittals

.1 Provide maintenance and engineering data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

Part 2 – Products

2.1 Domestic Hot Water Heater – Electric

.1 The heater shall be listed by Underwriters' Laboratories and approved to the NSF Standard 5 by UL.

.2 The tank shall have 1103 kPa working pressure and be equipped with an extruded high-density anode. All internal surfaces of the heater exposed to water shall be glass-lined with an alkaline borosilicate composition that has been fused to steel by firing at a temperature range of 760°C to 870°C.

.3 Electric heating elements shall be low watt density. Each element shall be controlled by an individually mounted thermostat and high temperature cut-off switch. All internal circuits shall be fused.

.4 The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panel and shall enclose the tank with foam insulation.

.5 Electrical junction box with heavy duty terminal block shall be provided. The drain valve shall be located in the front for ease of servicing.

.6 Manufacturer shall supply ASME rated temperature and pressure relief valve. Fully illustrated manual to be included.

2.2 Trim and Instrumentation

.1 Drain valve: 25mm with hose end.

.2 Thermometer: 100mm dial type with red pointer and thermo well filled with conductive paste.

.3 Pressure gauge: 75mm dial type with red pointer, siphon, and shut-off cock.

.4 Thermowell filled with conductive paste for control valve temperature sensor.

.5 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.

.6 Magnesium anodes adequate for twenty (20) years of operation and located for easy replacement.

Part 3 - Execution

3.1 Installation

.1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.

.2 Tank to be located to ensure adequate access and clearance for servicing. Tank to be placed on a minimum 100mm thick concrete housekeeping pad; pad provided by the General Contractor.

.3 Provide unions, flanges, or other mechanical joints on all piping connections.

.4 Install safety (temperature and pressure) valve as shown on plans. Pipe discharge to funnel floor drain.

.5 Provide insulation between tank and supports.

3.2 Field Quality Control

.1 Manufacturer's factory trained, certified personnel to start up (and commission) DHW heaters.

END OF SECTION

Part 1 - General

1.1 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 23 23 00 - Copper Tubing and Fittings- Refrigerant.

1.2 References

.1 Air-Conditioning and Refrigeration Institute (ARI):
  .1 ARI 210/240, Unitary Air Conditioning and Air-Source Heat Pump Equipment.
  .2 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI).

.2 American National Standards Institute/National Fire Protection Association (ANSI/NFPA):
  .1 ANSI/NFPA 90A, Standard for Installation of Air Conditioning and Ventilating Systems.

.3 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
  .1 ASHRAE Standard 15, Safety Standard for Refrigeration Systems.
  .2 ASHRAE Standard 90.1.

.4 AHRI Standard 1230.

.5 Canadian Standards Association (CSA International):
  .1 CAN/CSA-C273.3, Performance Standard for Split-System Central Air-Conditioners and Heat Pumps.
  .2 CAN/CSA-C656-05, Performance Standard for Split-System and Single Package Central Air Conditioners and Heat Pumps.
  .3 CAN/CSA B52 Mechanical Refrigeration Code.

.6 Environment Canada, (EC)/Environmental Protection Services (EPS):
  .1 EPS 1/RA/2, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

.2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

1.3 Shop Drawings and Product Data

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

.2 Indicate:
- .1 Capacities.
- .2 ARI Ratings.
- .3 Sound Power levels.
- .4 Installation instructions.
- .5 Start-up Instructions.
- .6 O&M, Instructions.

Part 2 - Products

2.1 General

.1 Heat pumps: CSA approved and carry ARI or CSA certification seal.

.2 Type of Refrigerant: R410A; variable refrigerant flow (VRF).

.3 The specified mechanical system shall be a VRF (variable refrigerant flow) HVAC system. The high efficiency modular variable refrigerant system shall consist of variable speed drive scroll compressor air-cooled condensing unit. The HVAC refrigerant system is based on a two-pipe configuration, capable of providing heating and cooling to the designated zone. Three-pipe VRF systems are acceptable; however, the design and additional (if any) must be carried by the Mechanical Contractor.

.4 VRF system piping refrigerant charges per circuit are not to be exceeded.

.5 VRF manufacturer shall provide electric solenoid valves for each condenser unit to minimize the refrigerant charge potential leakage within the building. Valves shall be integrated to and wired by the manufacturer.

.6 All control and network wiring of VRF units by a sub-contractor (controls) to the mechanical contractor.

2.2 Unit/Equipment Drainage

.1 Provide condensate drainage piping for all indoor heat pump units and the BC controller unit. All drainage piping shall be sloped (min. 1:80) away from the units.

2.3 Variable Refrigerant Flow Heat Pumps

.1 General:
.1 See also the equipment schedules and details on the Drawings.

.2 Performance data: as indicated.
.1 Electrical: 208 /1/60.

2.4 Exterior Condenser Unit

.1 General:
.1 See also the equipment schedules and details on the drawings.
.2 Variable speed, high-efficient scroll compressor technology.
.3 Simultaneous heating and cooling capacity.
.4 Modular units, capable of being twinned to provide up to 144 MBH of cooling capacity.
.5 Provide twinning kits as required, based on the number of units indicated.

.2 Performance data: as indicated.
.1 Electrical: 208 /3/60.
.2 Separate power supply and weather-proof (WP) disconnect required for each unit in each pair of units.

.3 The outdoor unit shall have a powder coated finish. The outdoor unit shall be completely factory assembled, piped, and wired. The unit shall be thoroughly run tested at the factory without exception. Alternate product offerings shall provide the owner with written confirmation and results for the factory run test on the unit.

.4 Acoustic Performance: Outdoor units shall have a sound pressure level (SPL) rating no higher than a maximum of 63 dB(A) as measured a horizontal distance 1 m from the unit. The system shall have a low sound operational mode where the SPL rating is no higher than 53 dB (A) B see specific acoustic data for system combination options. Alternate product offerings shall provide all necessary factory or field acoustic treatment as required to achieve or exceed the above performance levels at no additional cost.

.5 System Refrigerant Pipework: Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection. The outdoor unit(s) shall have the ability to operate with a maximum height difference of 50m and can, when combined in a modular format have a total refrigerant tubing length of 550m - 800m when serving up to Qty 50 indoors units. The greatest length is not to exceed 165m between the outdoor unit and the indoor units without the need for line size changes or traps. Please confirm system layout limitations and piping sizes with the manufacturer. The Modular Variable Speed Drive outdoor unit shall have rated performance for operation in heating and cooling mode as detailed is the product technical data sheets. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

.6 Condensing Unit Cabinet Construction: The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel. Unit cabinet shall be able to withstand 960 hours of Salt Spray.

.7 Variable Speed Condenser Fan: The modular outdoor unit module shall be furnished with

one direct drive, inverter driven, variable speed propeller type fan. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. The fan motor shall be mounted for quiet operation. The fan shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have vertical discharge airflow.

.8 Refrigerant: R410A refrigerant shall be required for the modular outdoor unit system.

.9 Wrap Around High Efficiency Condenser Coil: The outdoor coil shall be of the wrap around configuration with nonferrous construction with lanced or corrugated plate fins on copper tubing a minimum clearance of 38mm shall be allowed between modular units to facilitate sufficient air flow across the wrap around condenser coils. The coil fins shall have a factory applied corrosion resistant blue-fin finish particularly effective in urban environments. The outdoor coil shall include four (4) circuits with two position valves for each circuit, except for the last stage. The coil shall be protected with an integral metal guard. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

.10 Variable Speed Scroll Compressor: The High Efficiency Modular Air-cooled outdoor units shall be provided complete with an inverter driven scroll hermetic compressor(s). The compressor motor shall be of DC Brushless configuration with AUTO TUNING INVERTER control to achieve optimum compressor/motor performance levels particularly during off design conditions. A crankcase heater(s) shall be factory mounted on the compressor(s). Each compressor shall be capable of modulation down to 19% of rated capacity. The compressor shall be equipped with an internal thermal overload. The compressor shall be mounted to avoid the transmission of vibration.

.11 Electrical: The outdoor unit electrical power shall be 208/230 volts, 3 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limitations of 187-228 volts (208V/3/60Hz). The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units and the outdoor unit shall be 30 VDC completed using a 2-conductor, twisted pair non-polar shielded cable to provide total integration of the system. The branch-circuit controller shall be controlled by integral microprocessors. The inrush current to the outdoor unit shall not exceed the design full load amp FLA rating for the unit. Alternate systems with solid state or constant speed scroll compressors with significant inrush current characteristic will not be acceptable for this application.

.12 Modular Configuration: The outdoor condensing unit shall consist of one module rated for the designated proportion of the total system cooling/heating capacity. The module is furnished with an inverter driven scroll compressor and inverter driven variable speed propeller type condenser fan. Single compressor individual outdoor condensing units with capacities more than 35.2 kW's are not acceptable for this application based on reduced operational life cycles and limited compressor redundancy levels. The modular outdoor unit combinations are designed to balance the run hours seen by each individual inverter driven scroll compressor to extend overall outdoor unit life cycle and reduced ongoing maintenance costs. The modules shall be installed in a side by side configuration without the need for intermediate external oil balancing pipework. Alternate modular systems which require additional onsite oil balancing infrastructure between modules shall not be deemed appropriate for this application. The individual modules shall be manufactured to dimensions which allow each individual to be moved through a standard 800mm wide doorway particularly beneficial for retrofit applications. Alternate units that are not designed to

the above dimensional specifications must show significant savings to the customer to compensate for the associated impact on system installation costs.

2.5 Branch Circuit Controllers

.1 The branch circuit controllers shall be specifically used with R410A systems. These units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The branch circuit controllers shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller.

.2 The branch circuit controllers shall be constructed from galvanised steel plate partially insulated with polyurethane foam. The base of the unit shall have a foamed polystyrene tray. The master branch circuit controller shall be connected to the outdoor unit via a high pressure and low-pressure pipe. The master branch circuit controller shall include a gas/liquid separator, which will separate high pressure liquid and high-pressure gas. A brass header pipe with three solenoid valves for each distribution port shall distribute the correct phase of refrigerant to each indoor unit. The branch circuit controller shall also include a tube in tube heat exchanger which will recover waste heat from units in cooling operation and distribute this to units requiring heating. The opposite will happen in cooling operation. An integral condensate pan and drain shall be provided. The refrigeration process in the branch circuit controller shall be maintained by LEV's (linear expansion valves) which will be controlled by pressure and temperature sensors. The master branch circuit controller range will have different amounts of distribution ports depending on the number of indoor units it is serving, from 8,10,13 to 16 port boxes. A brass

header pipe with three solenoid valves for each distribution port shall distribute the correct phase of refrigerant to each indoor unit. The boxes will require 208-230/1/60 VAC main supply. Control will be via the 30 V DC signal from the outdoor unit. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 15.8 kW and/or three indoor units. Branches may be twinned to allow more than 15.8 kW. Each branch shall have multiple two-position valves to control refrigerant flow. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

2.6 Controls Network

.1 The VRF Controls Network shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web-based interface, graphical user workstation, and system integration to Building Management Systems via BACnet.

.2 The VRF Controls Network consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web-based interface communicating over a high-speed communication bus. The VRF Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using BACnet interfaces.

.3 The VRF Controls Network consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web-based interface communicating over a high-speed communication bus. The VRF Controls Network shall support operation monitoring, scheduling, error email distribution,

personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using BACnet interfaces.

.4 Electrical Characteristics: The VRF controls network shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

.1 Wiring: Control wiring shall be installed in a system daisy chain configuration from indoor unit to remote controller to indoor unit, to the branch circuit controllers (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit. Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply.

.2 Control wiring for the remote controllers shall be from the remote controller to the first associated indoor unit then to the remaining associated indoor units in a daisy chain configuration.

.3 Wiring type: Wiring shall be 2-conductor (16 AWG), twisted shielded pair, stranded wire. Network wiring shall be CAT-5e with RJ-45 connection.

2.7 Remote Room Controllers

.1 The remote controller shall be capable of controlling up to 16 indoor units (defined as 1 group) from this compact 125 x 125mm (approximate) wall-mounted controller. The Remote Controller shall be capable of connecting anywhere on the communication bus and shall not require being physically located in the same room as the indoor unit(s) under its control.

.2 The Remote Controller shall control the following grouped operation for up to

sixteen indoor units collectively: On/Off, Operation Mode (cool, heat, auto dry, and fan), temperature setting, fan speed setting, and airflow direction setting. The Remote Controller shall have three timer options: one on/off setting defined for one day, repeated daily timer, and auto-off timer function. The Remote Controller shall be able to limit the set temperature range from the Remote Controller and via a PC. The room temperature shall be sensed at either the Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Remote Controller shall display a four-digit error code in the event of system abnormality/error.

.3 The Remote Controller shall only be used in same group with other Remote Controllers with a maximum of two Remote Controllers per group. The Remote Controller shall require manual addressing using rotary dial switch to the communication bus. The Remote Controller shall connect using two-wire, stranded, non-polar control wire to connection terminal on the indoor unit.

2.8
Central Controller

.1 The Central controller shall have the capacity to control up to 50 indoor units/groups up to a maximum of 150 indoor units with expansion controllers. The centralized controller combines Web function, which enable the air conditioner system management on a PC browse screen. The system management can be undertaken via standard telephone line or internet connection. The central controller features a 225mm wide color LCD touch panel. The settings can be adjusted by touching the corresponding icons on the LCD display.

2.9 Web-Based Platform and Communications

.1 The VRF manufacturer shall provide a hub and a computer/server/gateway/translator loaded with BACnet compatible software to communicate with the EMCS system.

.2 The centralized controller effectively communicates with the various evaporators, room controllers, and the condenser units.

.3 All communications wiring shall be min. Cat 5. Wiring and conduit by the VRF supplier. Conform to Div. 26 requirements.

2.10 System Integration

.1 The VRF controls shall be capable of supporting integration with Building Management Systems (BMS) via our BACnet interfaces.

2.11 Bacnet Interface

.1 The VRF BACnet interface shall be compliant with BACnet/IP (ANSI/ASHRAE 135-1995, 135a) and UDP/IP of Ethernet (ANSI/ASHRAE 135-1995, 135b). The BACnet interface shall require a dedicated network computer and activated BACnet software function. The BACnet software license shall be on a per central controller basis for a maximum of 50 indoor units controlled by one Centralized Controller. The BACnet interface shall support a maximum of ten Centralized Controllers for a maximum of 500 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

2.12 Power Supply

.1 The power supply shall supply 24VDC for the centralized controller 30 VDC voltage for the central control transmission. The power supply can power a maximum of one centralized controller. The power supply module shall be installed in an internal environment which has a temperature operating range -10 to 55^0C and relative humidity range of 30 to 90% without any risk of condensation. The power supply shall be rated for a 120/1/60 or 208/1/60 incoming power supply.

Part 3 - Execution

3.1 Installation

.1 Install where indicated and in accordance with manufacturer's instructions.

.2 Secure with hold-down bolts. Secure exterior insulated refrigerant piping using galvanized steel unistrut and cushion pipe clamps.

.3 Make piping connections. Provide flexible refrigerant piping connections at each outdoor unit location. Insulate exterior refrigerant piping as per section 21 07 18.

.4 Nothing to obstruct ready access to components or to prevent removal of components for servicing.

.5 Controls Wiring: The Contractor shall be responsible for the interconnecting control wiring between the indoor and outdoor units and control wiring between remote controllers, centralized control and relevant components. This work shall be co-ordinated with the Controls Contractor for the rooting and trunking of the cables. All control wiring are to be carried out in 2 core 16 AWG shielded cabling with colour coding and tagged with ID number at 10 ft. intervals as per schematics for ease of identification and maintenance. Control wiring shall not be run next to power wiring. A minimum space of 100mm between both control and power cables shall apply.

.6 The fixing of all air conditioning equipment, installation of all refrigerant pipework and full commissioning shall be performed by a specialist refrigerant installer who shall be authorized to install VRF equipment. The installation of all internal and external units, refrigerant pipework, inter-connecting wiring, commissioning and testing shall be carried out by an approved refrigerant systems installer. Full access shall be afforded to site during the installations stage of the project to allow them to verify that installation methods are fully

in accordance with the VRF manufacturer's requirements and that the equipment warranties will not be invalidated.

.7 Refrigerant Pipework:

.1 Supply, install, test and commission all interconnecting refrigeration pipework between the outdoor and indoor units.

.2 All pipework to be carried out in refrigerant quality ACR copper tubing and complete with the appropriate headers and joints. All pipework must be suitable for R410A.

.3 All pipe fittings to be torqued as per manufactures specs.

.4 Longest possible lengths of copper pipe should be utilised to minimise joints on site.

.5 Appropriate refrigeration installation tools must be utilised. Dry Nitrogen must always be utilised in the system during brazing.

.6 After installation of pipework, and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested. 303 kPa test for 3 minutes minimum, then 1495 kPa for 3 minimum, then 3295 kPa for 3 minutes minimum, then strength test to 4135 kPa check the system for leaks and deformation, then lower the pressure back to 3295 kPa and pressure test for 24 hours and checked for leaks. Vacuumed/dehydrated to 300 microns and hold at that vacuum for 12 hours (minimum).

.7 Refrigerant (R410A) charge weight must be calculated, to the actual installed length of pipe work in accordance to the manufacturer's recommendations.

.8 The charging should be carried out with an appropriate charging station.

.9 Pipework to be properly fixed and supported at a minimum of 1.5m centres or as specified by local code and where required should be run on galvanised trays. All pipework to be labelled with ID number (condensing units ref.) at 3m intervals.

.10 Joints in copper pipe shall be brazed. Brazing shall be carried out to the

requirements of the local code and as per the Canadian copper & brass development association recommendations.

3.2 Drainage Piping

.1 Install so that no water can accumulate and arrange for easy access for cleaning.

.2 A condensate pipe shall be installed to each heat pump unit. This shall be installed and insulated all as per Section 21 07 18. Minimum size of condensate pipes to be 32mm copper, insulated and pumped or by gravity from each heat pump. Drains to run at a slope of 1:80 min.

3.3 Start-Up and Commissioning

.1 Manufacturer to certify installation, provide start-up, commissioning and operator training services.

.2 Manufacturer to certify performance.

.3 Manufacturer to provide verbal, video and written instructions to operating personnel.

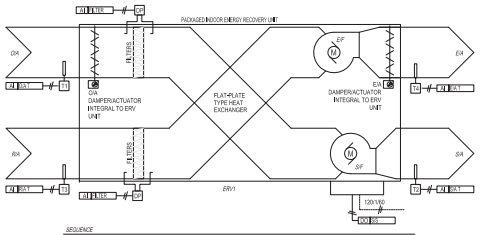
.4 Submit written report to the Departmental Representative.

.5 Full equipment Commissioning logs shall be supplied by the local distributor. These shall be completed fully and included with the main Operation & Maintenance Manuals prior to hand over. In addition, copy pages shall be returned to the unit manufacturer’s head office in order that the installation is logged and warranty honoured.

END OF SECTION

LEGEND

TAG	SYMBOL	CONTROL POINT	PHE(LP) EUE(LE)	POWER	DESCRIPTION
SF		-	-	-	SUPPLY AIR FAN PROVIDED BY MECHANICAL CONTRACTOR
EF		-	-	-	EXHAUST AIR FAN PROVIDED BY MECHANICAL CONTRACTOR
		-	-	-	FILTER BANK, PROVIDED BY MECHANICAL CONTRACTOR
AI	AI [name]	-	E	LV	CONTROL POINT (ANALOG IN), PROVIDED BY CONTROLS CONTRACTOR
DO	DO [name]	-	E	LV	CONTROL POINT (DIGITAL OUT), PROVIDED BY CONTROLS CONTRACTOR
		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY CONTROLS CONTRACTOR
		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY CONTROLS CONTRACTOR
	DP	FILTER	E	LV	DIFFERENTIAL PRESSURE SENSOR, PROVIDED BY CONTROLS CONTRACTOR
	T1	OA T	E	LV	OUTSIDE AIR DUCT TEMPERATURE SENSOR, PROVIDED BY CONTROLS CONTRACTOR
	T2	SA T	E	LV	SUPPLY AIR DUCT TEMPERATURE SENSOR, PROVIDED BY CONTROLS CONTRACTOR
	T3	RA T	E	LV	RETURN AIR DUCT TEMPERATURE SENSOR, PROVIDED BY CONTROLS CONTRACTOR
	T4	EA T	E	LV	EXHAUST AIR DUCT TEMPERATURE SENSOR, PROVIDED BY CONTROLS CONTRACTOR



SEQUENCE

THE ENERGY RECOVERY VENTILATOR (ERV1) IS CONTROLLED ON A TIME OF DAY SCHEDULE AND SHALL OPERATE CONTINUOUSLY DURING THE OCCUPIED HOURS. THE ERV UNIT WILL BE TURNED OFF DURING THE UNOCCUPIED PERIODS.

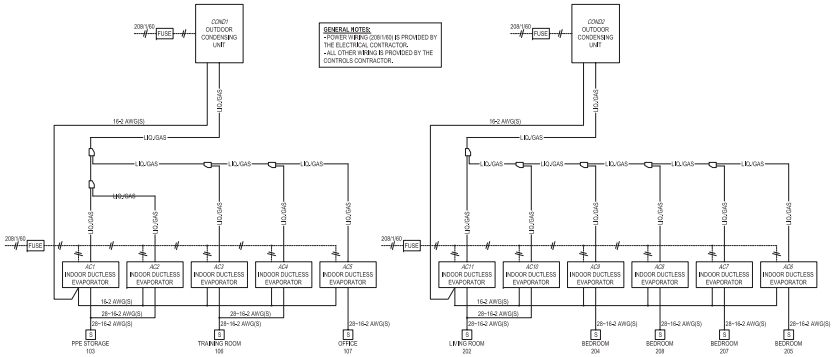
UPON START-UP OF THE ERV UNIT, THE INTEGRAL OUTSIDE AIR AND EXHAUST AIR DAMPERS OPEN FULLY. ONCE THE DAMPERS ARE COMPLETELY OPEN, THE SUPPLY AND EXHAUST AIR FANS START.

THE DIFFERENTIAL PRESSURE SENSORS PROVIDE FILTER STATUS TO THE BUILDING EMCS.

TEMPERATURE SENSORS (T1, T2, T3, AND T4) PROVIDE TEMPERATURE INDICATION AT THE FOLLOWING POINTS FOR THE ERV UNIT: OUTSIDE AIR, SUPPLY AIR TEMPERATURE, RETURN AIR TEMPERATURE, AND THE EXHAUST AIR TEMPERATURE, RESPECTIVELY.

THE ERV UNIT DOES NOT NEED A DEFROST CONTROL MODE.

4 MSK-1 ENERGY RECOVERY VENTILATOR CONTROL (ERV1)
N.T.S.

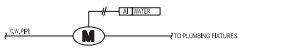


5 MSK-1 VARIABLE REFRIGERANT FLOW SYSTEM#1 CONTROL
N.T.S.

6 MSK-1 VARIABLE REFRIGERANT FLOW SYSTEM#2 CONTROL
N.T.S.

LEGEND

TAG	SYMBOL	CONTROL POINT	PHE(LP) EUE(LE)	POWER	DESCRIPTION
AI	AI [name]	-	E	LV	CONTROL POINT (ANALOG IN), PROVIDED BY CONTROLS CONTRACTOR
		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY CONTROLS CONTRACTOR
	M	-	E	-	COLD WATER METER, PROVIDED BY MECHANICAL CONTRACTOR



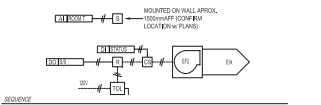
SEQUENCE

THE WATER METER PROVIDES THE WATER CONSUMPTION (CUM.) MEASUREMENT TO THE FACILITY'S BMS.

1 MSK-1 WATER METER CONTROL
N.T.S.

LEGEND

TAG	SYMBOL	CONTROL POINT	PHE(LP) EUE(LE)	POWER	DESCRIPTION
AI	AI [name]	-	E	LV	CONTROL POINT (ANALOG IN) PROVIDED BY CONTROLS CONTRACTOR
DI	DI [name]	-	E	LV	CONTROL POINT (DIGITAL IN) PROVIDED BY CONTROLS CONTRACTOR
DO	DO [name]	-	E	LV	CONTROL POINT (DIGITAL OUT) PROVIDED BY CONTROLS CONTRACTOR
.		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY CONTROLS CONTRACTOR
.		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY ELECTRICAL CONTRACTOR
.	S	-	E	24V	ROOM/PICE TEMPERATURE SENSOR PROVIDED BY CONTROLS CONTRACTOR
.	CS	STATUS	E	-	ELECTRICAL CURRENT SENSOR PROVIDED BY CONTROLS CONTRACTOR
.	R	-	E	LV	ELECTRICAL RELAY SWITCH PROVIDED BY CONTROLS CONTRACTOR
.	TOL	-	E	120V	MAGNETIC THERMAL OVERLOAD SWITCH BY ELECTRICAL CONTRACTOR



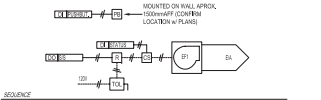
SEQUENCE

THE ELECTRICAL ROOM EXHAUST FAN (EF2) IS CONTROLLED TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. IF THE SPACE TEMPERATURE IS ABOVE SETPOINT, THE EXHAUST FAN IS COMMANDED TO START. THE EXHAUST FAN WILL STOP ONCE THE ROOM TEMPERATURE FALLS 2°C BELOW SETPOINT. THE CURRENT SENSOR PROVIDES FAN STATUS TO THE EMCS SYSTEM.

2 MSK-1 ELECTRICAL RM. HVAC CONTROL (EF2)
N.T.S.

LEGEND

TAG	SYMBOL	CONTROL POINT	PHE(LP) EUE(LE)	POWER	DESCRIPTION
AI	AI [name]	-	E	LV	CONTROL POINT (ANALOG IN) PROVIDED BY CONTROLS CONTRACTOR
DI	DI [name]	-	E	LV	CONTROL POINT (DIGITAL IN) PROVIDED BY CONTROLS CONTRACTOR
DO	DO [name]	-	E	LV	CONTROL POINT (DIGITAL OUT) PROVIDED BY CONTROLS CONTRACTOR
.		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY CONTROLS CONTRACTOR
.		-	E	-	ELECTRICAL WIRING (2 WIRE) PROVIDED BY ELECTRICAL CONTRACTOR
.	PB	-	E	24V	WALL MOUNTED PUSHBUTTON PROVIDED BY CONTROLS CONTRACTOR
.	CS	STATUS	E	-	ELECTRICAL CURRENT SENSOR PROVIDED BY CONTROLS CONTRACTOR
.	R	-	E	LV	ELECTRICAL RELAY SWITCH PROVIDED BY CONTROLS CONTRACTOR
.	TOL	-	E	120V	MAGNETIC THERMAL OVERLOAD SWITCH BY ELECTRICAL CONTRACTOR



SEQUENCE

THE PPE STORAGE ROOM EXHAUST FAN (EF1) IS CONTROLLED BY THE WALL MOUNTED PUSHBUTTON. PUSHED ONCE, THE EXHAUST FAN WILL START; PUSHED AGAIN, THE EXHAUST FAN WILL STOP. THE CURRENT SENSOR PROVIDES STATUS INDICATION TO THE BUILDING EMCS.

3 MSK-1 PPE STORAGE RM. CONTROL (EF1)
N.T.S.

Public Works and Government Services Canada / Travaux Publics et Services gouvernementaux Canada

Mechanical & Electrical Consultants:
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Consulting Engineers
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no.	date
1	ISSUED FOR TENDER 2018/10/18

project / projet
BIO SEARCH & RESCUE MARINA OPERATIONS BUILDING
Dartmouth, Nova Scotla

drawing / dessin
CONTROL SCHEMATICS

designed / conçu
date 06/07/18
drawn TDM / dessiné
date 06/07/18
approved / approuvé
date 06/07/18
Tender / Soumission
PWGSC Project Manager / Administrateur de projets TPSGC
project number / no. du projet
R.09002.001
drawing no. / no. du dessin
MSK-1

E-FORM/CODE: 552705 Version 1

A. SPECIFICATIONS

.1 Divisions 26, 27 and 28:

.1 Commissioning shall be included as part of the tender documents; refer to specification section 01 91 00 Commissioning.

.2 Specification Section 28 31 00.02 Multiplex Fire alarm and Voice Communication Systems

.1 Item 1.4.3: revise to: System to carry out fire alarm and protection functions; including receiving alarm signals; initiating alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signaling to fire department"

.2 Item 1.4.8: Add the following: System to be compatible with existing fire alarm system and tied into existing system.

.3 Item 1.9.1: revise to: Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.

.4 Item 2.2: revise to:

2.2 System Operation: Single Stage

.1 Actuation of any alarm initiating device to:

.1 Cause electronic latch to lock-in alarm at central control unit.

.2 Indicate zone of alarm at central control unit.

.3 Cause audible signaling devices to sound continuously throughout building and at central control unit.

.4 Transmit signal to monitoring agency via alarm panel.

.5 Cause air conditioning and ventilation units to shut down.

.2 Acknowledging alarm: indicated at central control unit.

.3 Possible to silence signals by alarm silence switch at control unit, after 60 second period of operation.

.4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

.5 Actuation of supervisory devices to:

.1 Cause electronic latch to lock-in supervisory state at central control unit.

.2 Indicate respective supervisory zone at central control unit.

.3 Cause audible signal at central control unit to sound.

.4 Activate common supervisory sequence.

.6 Resetting alarm or supervisory device not to return system indications/functions back to normal until control unit has been reset.

.7 Trouble on system to:

.1 Indicate circuit in trouble at central control unit.

.2 Activate system trouble indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.

.8 Trouble on system to be suppressed during course of alarm.

.9 Trouble condition on any circuit in system not to initiate any alarm conditions.

.5 Item 3.2.1: revise to: Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and to CAN/ULC-S537.

.6 Item 3.2.2.1: revise to: Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors, sprinkler system, transmit alarm to control panel and actuate alert.

B. DRAWINGS:

1. Reference Drawing E-1 – Legend & Luminaire Schedule

1. Single high data symbol to be added to electrical legend. Refer to ESK-1 Revised Electrical Legend.pdf.
2. Luminaire types 5 and 6 diameters to be revised to 152mm.

2. Reference Drawing E-5 – Details

1. Detail 7/E-5 – Signaling circuit 3 (CCT#3) to be deleted. Associated wiring, distribution module, bedroom horns and end of line resistor to be deleted.
2. Fire alarm panel to be circuited from circuit 101-46 and complete with lockable breaker.

C. ATTACHMENTS:

.1 ESK-1 Revised Electrical Legend.pdf

SINGLE LAN OUTLET, CONSISTING OF A 102mm SQUARE BACKBOX COMPLETE WITH A SINGLE GANG TILE RING, FLUSH WALL MOUNTED 152mm ABOVE COUNTER BACKSPLASH, OR 1168mm A.F.F, UNLESS INDICATED OTHERWISE

Job Title: BIO SEARCH & RESCUE MARINA OPERATIONS BUILDING

o n s a F.C. O'Neill, Scriven and Assoc's Limited Consulting Engineers	Sheet Title: Revised Electrical Legend		Client Bedford Institute of Oceanography	
	Dwn. TRP	Ck'd RGR	Date: 10/18/18	Dwg.No. ESK-1