1.1 **DESCRIPTION OF WORK**

.1 Work under this contract consists of construction of a new Community Correction Centre in Dartmouth, N.S. The work is generally described as follows:

- .1 New 2,700+ m^2 two-storey, sprinklered, steel-framed building, with partial basement.
- .2 New site work such as, but not limited to, new site grading, new driveway and parking lot, new sidewalks, stairs and retaining walls, new landscaping.
- .3 New civil site services work such as, but not limited to: connecting to existing water, sewer, and natural gas lines on Morris Drive and extending new service lines for water, sewer and natural gas to the building, storm water management, new sewage pump station, and new asphalt driveway, and parking lot.
  - .1 Water main connection: Include in the contract all costs associated with disinfecting the water main in accordance with the latest version of the ANSI/AWWA C651 Standard for Disinfecting Water Mains.
  - .2 Submit Disinfecting Water Main Report, with related bacterial analysis, to Departmental Representative after completion of new water main disinfection.
- .4 Mechanical such as but not limited to:
  - .1 HVAC system complete with ventilation equipment, heat pump air conditioning system, distribution ductwork and balancing.
  - .2 Gas-fired centralized hot water boilers and perimeter heating system.
  - .3 Plumbing system.
  - .4 Controls.
  - .5 Fire protection.
- .5 Electrical such as but not limited to:
  - .1 Electrical and telecommunications site services to building.
  - .2 Electrical distribution equipment, electrical wiring devices and grounding.
  - .3 Electrical wiring, equipment and devices associated with the sewage pump station.
  - .4 Interior and exterior lighting systems, control devices and emergency lighting and exit signs.
  - .5 Supply and installation of special systems such as telecommunications, fire alarm, security, and CCTV.
  - .6 General Contractor to provide all telecommunications services required to do commissioning of building systems. Maintain telecommunications services until end of 1-year warranty period.
- .7 Landscape such as but not limited to: finish site grading, new planting and sodding, gated enclosure around garbage area.
- .8 Interior signage and building signage.
- .9 Commissioning of building and building systems.
- .10 UXO construction support during excavation and tie-in of new building services in the Right-of-Way off Morris Drive. Refer also to Paragraph 1.1.3 of this Section.

.11 New natural gas line to be supplied and installed by Heritage Gas as part of the scope of this project. All associated work such as but not limited to: excavation and backfilling of new line, installation, tying-in and testing of new natural gas line will be by Heritage Gas.
- .1 General Contractor is to contract with Heritage Gas for this work and include all costs in the contract.

.12 Including all other work indicated on the drawings and/or required in the specifications.

.2 Site of Work is at the Corrections Services Canada property located off Morris Drive in the vicinity of the Burnside Industrial Park, Dartmouth, Nova Scotia. Reference Parcel 2003-1 on PWGSC Plan S-5799.

.3 Historical use of property by DND raised the potential for unexploded ordinances (UXO) on site. The site has been surveyed and cleared for UXO's by Gemtec Geotechnical as of spring 2015. A small area at the north-east corner remains uncleared.
- .1 UXO Tech will be required to be on site during excavation for building services in this area of the site to ensure the safety of the work for the General Contractor and the public.
- .2 PWGSC will engage the services of UXO Tech, via DCC, to provide UXO hazard construction support for the duration of the excavation work associated with new building services lines in north-east corner of the site.

1.2 **FAMILIARIZATION WITH SITE**

.1 Before submitting a bid, it is recommended that bidders inspect and examine the site and its surroundings and satisfy themselves as to the form and nature of the work and materials necessary for the completion of the work, the means of access to the site, the accommodation they may require, and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender. No allowance shall be made subsequently in this connection on account of error or negligence to properly observe and determine the conditions that will apply.

.2 Obtain prior permission from the Departmental Representative before carrying out such site inspection.

1.3 **CODES AND STANDARDS**

.1 Perform work in accordance with the 2010 National Building Code of Canada and any other code of provincial or local application, including all amendments up to bid closing date, provided that in any case of conflict or discrepancy, the more stringent requirement(s) shall apply.

.2 Materials and workmanship must meet or exceed requirements of specified standards, codes and referenced documents.

1.4 **INTERPRETATION OF DOCUMENTS**

.1 Supplementary to the Order of Precedence article of the General Conditions of the Contract, the Division 01 sections take precedence over the technical specification sections in other Divisions of the Specification Manual.

1.5 **TERM ENGINEER, ARCHITECT**

.1 Unless specifically stated otherwise, the term Engineer or Architect where used in the Specifications and on the Drawings shall mean the Departmental Representative as defined in the General Conditions of the Contract.

1.6 **SETTING OUT WORK**

.1 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.

.2 Provide devices needed to lay out and construct work.

.3 Supply such devices as straight edges and templates required to facilitate Departmental Representative's inspection of work.

1.7 **COST BREAKDOWN**

.1 Before submitting first progress claim submit breakdown of Contract price in detail as directed by Departmental Representative and aggregating contract price. Required forms will be provided for application of progress payment.

.2 List items of work numerically following the same division/section number system of the specification manual and thereafter sub-divide into major work components and building systems as directed by Departmental Representative.

.3 Upon approval by Departmental Representative, cost breakdown will be used as basis for progress payment.

1.8 **DOCUMENTS REQUIRED**

.1 Maintain at job site, one copy each of the following:
- .1 Contract Drawings.
- .2 Specifications.
- .3 Addenda.
- .4 Reviewed Shop Drawings.
- .5 List of outstanding Shop Drawings.
- .6 Change Orders.
- .7 Other modifications to Contract.
- .8 Field Test Reports.
- .9 Copy of Approved Work Schedule.
- .10 Health and Safety Plan and other safety related documents.
- .11 Other documents as stipulated elsewhere in the Contract Documents.

1.9 **PERMITS**

.1 In accordance with the General Conditions, obtain and pay for building permit, certificates, licenses and other permits as required by municipal, provincial and federal authorities.

.2 Provide appropriate notifications of project to municipal and provincial inspection authorities.

.3 Obtain compliance certificates as prescribed by legislative and regulatory provisions of municipal, provincial and federal authorities as applicable to the performance of work.

.4 Submit to Departmental Representative, copy of application forms and approval documents received for above referenced authorities.

1.10 **ADJACENT EXISTING BUILDINGS**

.1 Execute work with least possible interference or disturbance to adjacent existing buildings, neighbouring residential dwellings, local streets, and adjacent areas. Arrange with Departmental Representative to facilitate execution of work.

.2 Where security has been reduced by work of Contract, provide temporary means to maintain security.

.3 Provide temporary dust screens, barriers, warning signs in locations where renovation and alteration work is adjacent to areas which will be operative during such work.

1.11 **ROUGHING-IN**

.1 Be responsible for obtaining manufacturer's literature and for correct roughing-in and hook-up of equipment, fixtures and appliances.

1.12 **CUTTING, FITTING AND PATCHING**

.1 Ensure that cutting and patching required by all trades is included in total tender bid price submitted for the work.

.2 Obtain Departmental Representative’s approval before cutting, boring or sleeving any load-bearing members.

.3 Execute cutting, including excavation, fitting and patching required to make work fit properly.

.4 Where new work connects with existing and where existing work is altered, cut, patch and make good to match existing work. This includes patching of openings in existing work resulting from removal of existing services.

.5 Do not cut, bore, or sleeve load-bearing members, except where specifically approved by Departmental Representative.

.6 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.

.7 Fit work airtight to pipes, sleeves ducts and conduits.

1.13 **EXISTING SERVICES**

.1 Where work involves breaking into or connecting to existing services, carry out work at times directed by governing authorities, with minimum of disturbance to pedestrian, vehicular traffic, and building users.

.2 Before commencing work, establish location and extent of service lines in area of work and notify Departmental Representative of findings.

.3 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility. This includes disconnection of electrical power and communication services to tenant's operational areas. Adhere to approved schedule and provide notice to affected parties.

.4 Provide temporary services to maintain critical building and tenant systems.

.5 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.6 Protect, relocate or maintain existing active services as required. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction over service.

1.14 **CONCEALMENT**

.1 Conceal pipes, conduits, wiring etc. in wall construction except where indicated otherwise.

1.15 **LOCATION OF FIXTURES**

.1 Location of equipment, fixtures and outlets, shown or specified shall be considered as approximate. Actual location shall be as required to suit conditions at time of installation and is reasonable.

.2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

.3 Inform Departmental Representative when impending installation conflicts with other new or existing components. Follow directives for actual location.

.4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.16 **BILINGUAL NOTATIONS**

.1 Any items supplied and installed under this contract which have operating instructions on them and which can be expected to be used by the building tenants, must have such operating instructions in bilingual format – English and French.

.2 Factory embossed or recessed symbols illustrating equipment operation is an acceptable alternate to lettering.

.3 Items supplied with factory - embossed or recessed lettering in one official language with an applied sticker or decal representing the second official language is not acceptable unless the Departmental Representative gives prior approval before any such items are ordered.

.4 Internationally recognized colour coding such as red and blue center pieces for plumbing brass is acceptable.

.5 No extra costs will be paid for re-stocking or re-ordering of materials and equipment due to Contractor's failure to fully meet bilingual signage requirements specified herein.

.6 Ensure that all trades are made aware of above requirements.

1.17 **BUILDING SMOKING ENVIRONMENT**

.1 Comply with smoking restrictions. No smoking.

END OF SECTION

1.1 **SUBMITTALS**

.1 Upon acceptance of bid and prior to commencement of work, submit to Departmental Representative the following work management documents:
- .1 Work Schedule as specified herein.
- .2 Shop Drawing Submittal Schedule specified in Section 01 33 00.
- .3 Hot Work Procedures specified in Section 01 35 24.
- .4 Lockout Procedures specified in Section - 01 35 25.
- .5 Health and Safety Plan specified in Section 01 35 29.
- .6 Environmental Plan specified in Section 01 35 43.
- .7 Dust Control Plan specified in Section - 01 50 00.
- .8 Waste Management Plan specified in Section 01 74 21.
- .9 Common Product Requirements specified in Section 01 61 00.

1.2 **PROJECT SCHEDULE DATES**

.1 Construction completion, commissioning and occupancy for the building is scheduled for spring 2016.

1.3 **WORK SCHEDULE**

.1 Upon acceptance of bid submit:
- .2 Preliminary work schedule within 7 calendar days of contract award.
- .3 Detailed work schedule within 14 calendar days of contract award.

.2 Schedule to indicate all calendar dates from commencement to completion of all work within the time stated in the accepted bid.

.3 Provide sufficient details to clearly illustrate entire implementation plan, depicting efficient coordination of tasks and resources, to achieve completion of work on time and permit effective monitoring of work progress in relation to established milestones.

.4 Work schedule content to include as a minimum the following:
- .1 Bar (GANTT) Charts, indicating all work activities, tasks and other project elements, their anticipated durations, planned dates for achieving key activities and major project milestones supported with;
- .2 Written narrative on key elements of work illustrated in bar chart, providing sufficient details to demonstrate a reasonable implementation plan for completion of project within designated time.
- .3 Generally Bar Charts derived from commercially available computerized project management system are preferred but not mandatory.

.5 Work schedule must take into consideration and reflect the Work required, special conditions and operational restrictions as specified below and indicated on drawings.

.6 Schedule Work in cooperation with the Departmental Representative. Incorporate within Work Schedule, items identified by Departmental Representative during review of preliminary schedule.

.7 Completed schedule shall be approved by Departmental Representative. When approved, take necessary measures to complete work within scheduled time. Do not change schedule without Departmental Representative's approval.

.8 Ensure that all subtrades and subcontractors are made aware of the work restraints and operational restrictions specified.

.9 Schedule Updates:
- .1 Submit when requested by Departmental Representative.
- .2 Provide information and pertinent details explaining reasons for necessary changes to implementation plan.
- .3 Identify problem areas, anticipated delays, impact on schedule and proposed corrective measures to be taken.

.10 Departmental Representative will make interim reviews and evaluate progress of work based on approved schedule. Frequency of such reviews will be as decided by Departmental Representative. Address and take corrective measures on items identified by reviews and as directed by Departmental Representative. Update schedule accordingly.

.11 In every instance, change or deviation from the Work Schedule, no matter how minimal the risk or impact on safety or inconvenience to tenant or public might appear, will be subject to prior review and approval by the Departmental Representative.

1.4 **OPERATIONAL RESTRICTIONS**

.1 Contractor to meet with the Departmental Representative on a weekly basis to identify intended work areas, activities and scheduling for the coming week.

.2 Refer to Civil drawings and specifications in regards to tying into existing municipal services on Morris Drive.
1. Be responsible for all required permits and for giving notification to authorities having jurisdiction for inspection of new building service connections.

.3 Site circulation and access:
- .1 Site access will be off of Morris Drive.
- .2 Remove existing steel swing gate at DND easement and supply and install new steel swing gate at new location on DND easement, as indicated on drawings.

.4 Safety Signage:
- .1 Provide onsite, and erect as required during progress of work, proper signage. Mount where directed and as required on self-supporting stands or on fixed walls warning of construction activities in progress and alerting need to exercise caution in proceeding through disturbed areas of the construction site, and providing directions through any detours which may be required.

.4 (continued)

.2 Signage to be professionally printed and mounted on wooden backing, coloured and to express messages as directed by the Departmental Representative.

.3 Generally maximum size of sign should be in the order of 1.0 square meters. Number of signs required will be decided in conjunction with the Institution and as directed by Departmental Representative.

.4 Include costs for the supply, installation, and removal of these signs, in the bid price.

.5 Dust and Dirt Control:

.1 See Section 01 50 00 and Section 01 74 11 for dust control and cleaning requirements.

1.5 **PROJECT MEETINGS**

.1 Schedule and administer project meetings, held on a minimum bi-weekly basis, for entire duration of work and more often when directed by Departmental Representative as deemed necessary due to progress of work or particular situation.

.2 Prepare agenda for meetings.

.3 Notify participants in writing 4 days in advance of meeting date.

.1 Ensure attendance of all subcontractors.

.2 Departmental Representative will provide list of other attendees to be notified.

.4 Bi-weekly Project Meeting will be held on site at Contractor's construction trailer.

.5 Preside at meetings and record minutes.

.1 Indicate significant proceedings and decisions. Identify action items by parties.

.2 Distribute to participants by mail or by facsimile within 3 calendar days after each meeting.

.3 Make revisions as directed by Departmental Representative.

.4 Departmental Representative will advise whether submission of minutes by Email is acceptable. Decision will be based on compatibility of software among participants.

1.6 **WORK COORDINATION**

.1 The General Contractor is responsible for coordinating the work of the various trades and predetermining where the work of such trades interfaces with each other.

.1 Designate one person from own employ having overall responsibility to review contract documents and shop drawings, plan and manage such coordination.

.2 The General Contractor shall convene meetings between trades whose work interfaces and ensure that they are fully aware of the areas and the extent of where interfacing is required.

.1 Provide each trade with the plans and specs of the interfacing trade, as required, to assist them in planning and carrying out their respective work.

.2 (continued)

.2 Develop coordination drawings when deemed required illustrating potential interference between work of various trades and distribute to all affected parties including structural trade.

.1 Pay attention to overhead work above ceilings and within or near to building structural elements.

.2 Coordination drawings to identify all building elements, services lines, rough-in points and indicate from where various services are coming.

.3 Review coordination drawings at purposely called meetings. Have subcontractors sign-off on drawings and publish minutes of each meeting.

.4 Plan and coordinate work in such a way to minimize quantity of service line offsets.

.3 Submission of shop drawings and ordering of prefabricated equipment or prebuilt components shall only occur once coordination meeting for such items has taken place between trades and all conditions affecting the work of the interfacing trades has been made known and accounted for.

.4 Work Cooperation:

.1 Ensure cooperation between trades in order to facilitate the general progress of the work and avoid situations of spatial interference.

.2 Ensure that each trade provides all other trades reasonable opportunity for the completion of the work and in such a way as to prevent unnecessary delays, cutting, patching and the need to remove and replace completed work.

.5 No extra costs to the Contract will be considered by the Departmental Representative as a result of Contractor's failure to effectively coordinate all portions of the Work. Disputes between the various trades as a result of their not being informed of the areas and extent of interface work shall be the sole responsibility of the General Contractor to be resolved at own cost.

END OF SECTION

1.1 **GENERAL**

.1 The Departmental Representative will supply certain material and equipment in the Contract for installation and incorporation into the Work by the Contractor.

1.2 **MATERIAL SUPPLIED**

.1 Departmental Representative will supply the following materials to the Contract:

.1 set number of access control cards for staff member use.

1.3 **DELIVERY REQUIREMENTS**

.1 Materials supplied by the Departmental Representative will be turned over to the Contractor immediately upon delivery.

.2 Within three (3) calendar days of receipt of material supplied by Departmental Representative, the Contractor must:

.1 Conduct a complete review to verify that all materials have been received;

.2 Acknowledge receipt, identify any missing or damaged items, in writing;

.3 Failure to make a complete check of supplied materials or to acknowledge receipt of same shall not relieve Contractor's responsibility to replace or repair any item subsequently found to be missing or damaged.

1.4 **CONTRACTOR'S DUTIES**

.1 At project start-up meeting, obtain from Departmental Representative product technical data for all Owner Supplied Equipment. Ensure new construction and services are coordinated with supplied equipment requirements so as to install and incorporate supplied equipment into the Work.

.2 Be responsible for the protection of Owner Supplied Equipment against damage, loss, theft and fire from date of receipt, during loading, unloading, and until final installation of work is accepted by the Departmental Representative.

.3 Any damage or loss of such material shall result in the Contractor being responsible for replacement or repair of equipment at no additional cost to the Contract.

.4 The decision as to whether damaged items may be repaired or must be replaced with new equipment shall be the Departmental Representative's decision.

.5 Install such material and equipment and incorporate into the work. Perform assembly and make all connections as required to make item functional.

.6 Dispose of containers, crating and protective covering as directed by the Departmental Representative.

END OF SECTION

1.1 **RELATED SECTIONS**

.1 Section 01 14 10 – Scheduling and Management of Work

.2 Section 01 45 00 – Testing and Quality Control.

.3 Section 01 78 00 - Closeout Submittals.

.4 Section 01 91 13 – Commissioning Requirements

1.2 **SUBMITTAL GENERAL REQUIREMENTS**

.1 Submit to Departmental Representative for review requested submittals specified in various sections of the specifications including shop drawings, samples, permits, compliance certificates, test reports, work management plans and other data required as part of the work.

.2 Submit with reasonable promptness and in orderly sequence so as to allow for Departmental Representative's review and not cause delay in Work. Failure to submit in ample time will not be considered sufficient reason for an extension of Contract time and no claim for extension by reason of such default will be allowed.

.3 Do not proceed with work until relevant submissions have been reviewed.

.4 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.5 Where items or information is not produced in SI Metric units, provide soft converted values.

.6 Review submittals prior to submission.

.1 Ensure that necessary requirements have been determined and verified and that each submittal has been checked and coordinated with requirements of Work and Contract Documents.

.2 Submittals not stamped, signed, dated and identified as to specific project will be returned unexamined by Departmental Representative and considered rejected.

.7 Verify field measurements and affected adjacent Work are coordinated.

.8 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.9 Contractor's responsibility for errors, omissions or deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative's review.

.10 Submittal format for shop drawings:

.1 Paper originals, or alternatively clear and fully legible photocopies of originals.

.2 Electronic submissions: PDF submissions may be acceptable particularly to expedite review of time-sensitive materials and/or equipment. Decision to accept PDF shop drawing submissions is the responsibility of the Departmental Representative.

.10 (continued)

.3 Poorly printed, non-legible electronic submissions (photocopies or pdfs) will not be accepted and will be returned for resubmission.

.4 Facsimiles are not acceptable.

.11 Make changes or revision to submissions which Departmental Representative may require, consistent with Contract Documents and resubmit as directed by Departmental Representative. When resubmitting, identify in writing of any revisions other than those requested.

.12 Keep one reviewed copy of each submittal document on site for duration of Work.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means fabrication drawings, erection drawings, diagrams, illustrations, schedules, performance charts, technical product data, brochures, specifications, test reports installation instructions and other data which are to be provided by Contractor to illustrate compliance with specified materials and details of a portion of work.

.2 Shop Drawing Submittal Schedule:

.1 Submit within 10 working days of acceptance of bid a schedule listing all shop drawings to be submitted for project.

.2 Schedule shall be in format acceptable to Departmental Representative and indicate proposed submission date for each item, status of review and anticipated product delivery date to site. Track all submissions for entire project.

.3 Revise schedule as work progresses. Identify items which have been reviewed and finalized and indicating those outstanding.

.4 Update schedule at stipulated dates or project time intervals predetermined and agreed upon with Departmental Representative at commencement of Work.

.3 Shop Drawing Quantities:

.1 Hard copy print submissions: submit minimum eight (8) copies for distribution to Departmental Representative and other reviewers, or more as may be required to provide sufficient returned copies required by the General Contractor and sub-contractors plus four (4) copies which will be retained for by Departmental Representative.

.2 Electronic submissions (PDF): one electronic submission sent to Departmental Representative for review by all required reviewers. General Contractor to be responsible to make four (4) copies of the final reviewed copies of electronic submissions which will be retained by the Departmental Representative.

.4 Shop Drawings Format:

.1 Opaque white prints or photocopies of original drawings or standard drawings modified to clearly illustrate work specific to project requirements. Maximum sheet size to be 1000 x 707 mm.

.4 (continued)

.2 Product Data from manufacturer's standard catalogue sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactured products, to be original full colour brochures, clearly marked indicating applicable data and deleting information not applicable to project.

.3 Non or poorly legible drawings, photocopies or facsimiles will not be accepted and returned not reviewed.

.4 Facsimile submittals are not acceptable.

.5 Shop Drawings Content:

1. Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where items or equipment attach or connect to other items or equipment, confirm that all interrelated work have been coordinated, regardless of section or trade from which the adjacent work is being supplied and installed.
2. Supplement manufacturer's standard drawings and literature with additional information to provide details applicable to project.
3. Delete information not applicable to project on all submittals.

.6 Allow 10 calendar days for Departmental Representative's review of each submission.

.7 Adjustments or corrections made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, advise Departmental Representative in writing prior to proceeding with Work.

.8 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections and comments are made, fabrication and installation may proceed upon receipt of shop drawings. If shop drawings are rejected and noted to be Resubmitted, do not proceed with that portion of work until resubmission and review of corrected shop drawings, through same submission procedures indicated above.

.9 Be advised that costs and expenses incurred by Departmental Representative to conduct more than one review of incorrectly prepared shop drawing submittal for a particular material, equipment or component of work may be assessed against the Contractor in the form of a financial holdback to the Contract.

.10 Accompany each submissions with transmittal letter, in duplicate, containing:

.1 Date.

.2 Project title and project number.

.3 Contractor's name and address.

.4 Identification and quantity of each shop drawing, product data and sample.

.5 Other pertinent data.

.11 Submissions shall include:
- .1 Date and revision dates.
- .2 Project title and project number.
- .3 Name and address of:
  - .1 Subcontractor.
  - .2 Supplier.
  - .3 Manufacturer.
- .4 Contractor's stamp, signed by Contractor's authorized Representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
- .5 Cross references to particular details of contract drawings and specifications section number for which shop drawing submission addresses.
- .6 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.

.12 After Departmental Representative's review, distribute copies.

.13 The review of shop drawings by the Departmental Representative or by an authorized Consultant or designate is for sole purpose of ascertaining conformance with general concept. This review shall not mean that Canada approves the detail design inherent in the shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting all requirements of the construction and Contract Documents. Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of all sub-trades.

1.4 **SAMPLES**

.1 Submit for review samples as specified in respective specification Sections. Label samples with origin and intended use.

.2 Submit, at the same time, samples of the following products for Departmental Representative’s use in preparing colour schedule:
- .1 Plastic Laminate and PVC edging colour samples.
- .2 Solid surface colour samples.
- .3 Ceramic tile and grout colour samples.
- .4 Carpet colour samples.
- .5 Resilient sheet, tile and base/trim colour samples.

.3 Deliver samples to Departmental Representative's office or to other address as directed. Do not drop off samples at construction site except for pre-approved circumstances previously approved by Departmental Representative.

.4 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.5 Where colour, pattern or texture is criterion, submit full range of samples.

.6 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments will result in a cost increase to the Contract notify Departmental Representative in writing prior to proceeding with Work.

.7 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

.8 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

END OF SECTION

1.1 SECTION INCLUDES

.1 Fire Safety Requirements.
.2 Hot work Permit.
.3 Existing Fire Protection and Alarm Systems.

1.2 RELATED WORK

.1 Section 01 35 25 – Special Procedures on Lockout Requirements.
.2 Section 01 35 29 - Health and Safety Requirements.

1.3 REFERENCES

.1 Fire Protection Standards issued by Fire Protection Services of Human Resources Development Canada as follows:
  .1 FCC No. 301-June 1982 Standard for Construction Operations.
  .2 FCC No. 302-June 1982 Standard for Welding and Cutting.

.2 FCC standards, may be viewed at :
  .1 http://www.hrsdc.gc.ca/en/lp/lo/fp/standards/commissioner.shtm.
  .2 Fire Protection Services – Atlantic Region Office, Halifax, N.S., Tel. (902) 426-6053.

1.4 DEFINITIONS

.1 Hot Work defined as:
  .1 Welding work
  .2 Cutting of materials by use of torch or other open flame devices
  .3 Grinding with equipment which produces sparks.
  .4 Use of open flame torches such as for roofing work.

1.5 SUBMITTALS

.1 Submit copy of Hot Work Procedures and sample of Hot Work permit to Departmental Representative for review, within 14 calendar days of acceptance of bid.

.2 Submit in accordance with the Section 01 33 00 – Submittal Procedures.

1.6 FIRE SAFETY REQUIREMENTS

.1 Implement and follow fire safety measures during Work. Comply with following:
  .1 National Fire Code.
  .2 Fire Protection Standards FCC 301 and FCC 302.
  .3 Federal and Provincial Occupational Health and Safety Acts and Regulations.

.2 In event of conflict between any provisions of above authorities the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, Departmental Representative will advise on the course of action to be followed.

1.7 HOT WORK AUTHORIZATION

.1 Obtain Departmental Representative's written "Authorization to Proceed" before conducting any form of Hot work on site.

.2 To obtain authorization submit to Departmental Representative:
- .1 Contractor's typewritten Hot Work Procedures to be followed on site as specified below.
- .2 Description of the type and frequency of Hot Work required.
- .3 Sample Hot Work Permit to be used.

.3 Upon review and confirmation that effective fire safety measures will be implemented during performance of hot work, Departmental Representative will provide authorization to proceed as follows:
- .1 Issue one written "Authorization to Proceed" covering the entire project for duration of work or;
- .2 Subdivide the work, into pre-determined individual activities, ach activity requiring a separately written "Authorization to Proceed".

.4 Requirement for individual authorization based on:
- .1 Nature or phasing of work;
- .2 Risk to Facility operations;
- .3 Quantity of various trades needing to perform hot work on project or;
- .4 Other situation deemed necessary by Departmental Representative to ensure fire safety on premises.

.5 Do not perform any Hot Work until receipt of Departmental Representative's written "Authorization to Proceed" for that portion of work.

.6 In tenant occupied Facility, coordinate performance of Hot Work with Facility Manager through the Departmental Representative. When directed, perform Hot Work only during non-operative hours of Facility. Follow Departmental Representative's directives in this regard.

1.8 HOT WORK PROCEDURES

.1 Develop and implement safety procedures and work practices to be followed during the performance of Hot Work.

.2 Procedures to include:
- .1 Requirement to perform hazard assessment of site and immediate hot work area for each hot work event in accordance with Safety Plan requirements of Section 01 35 28 – Health and Safety Requirements.
- .2 Use of a Hot Work Permit system with individually issued permit by Contractor’s Superintendent to worker or subcontractor granting permission to proceed with Hot Work
- .3 Permit required for each Hot Work event.
- .4 Designation of a person on site as a Fire Safety Watcher responsible to conduct a fire safety watch for a minimum duration of 60 minutes immediately following the completion of the Hot Work.

.5 Compliance with fire safety codes and standards and occupational health and safety regulations specified.

.6 Site specific rules and procedures in force at the site as provided by the Facility Manager.

.3 Generic procedures, if used, must be edited and supplemented with pertinent information tailored to reflect specific project conditions. Label Document as being the Hot Work Procedures applicable to this contract.

.4 Procedures shall clearly establish worker instructions and allocate responsibilities of:

.1 Worker performing Hot Work,

.2 Person issuing the Hot Work Permit,

.3 Fire Safety Watcher,

.4 Subcontractor(s) and Contractor.

.5 Brief all workers and subcontractors on Hot Work Procedures and Permit system established for project. Stringently enforce compliance.

1.9 **HOT WORK PERMIT**

.1 Hot Work Permit to include, as a minimum, the following data:

.1 Project name and project number;

.2 Building name, address and specific room or area where hot work will be performed;

.3 Date of issue;

.4 Description of hot work type needed;

.5 Special precautions to be followed including type of fire extinguisher needed;

.6 Name and signature of permit user;

.7 Name of worker to which the permit is being issued;

.8 Permit validity period not to exceed 8 hours. Indicate start time /date and completion time / date;

.9 Worker signature with time /date upon hot work termination;

.10 Stipulated time period of safety watch;

.11 Fire Safety Watcher's, signature with time & date.

.1 Permit to be typewritten form. Industry Standard forms shall only be used if all data specified above is included on form.

.2 Each Hot Work Permit to be completed in full, signed and returned to Contractor's Superintendent for safe keeping on site.

1.10 **FIRE PROTECTION AND ALARM SYSTEMS**

.1 Fire protection and alarm systems shall not be:

.1 Obstructed.

.2 Shut-off, unless approved by Departmental Representative.

.3 Left inactive at the end of a working day or shift.

.4 Do not use fire hydrants, standpipes and hose systems for purposes other than fire fighting.

.5 Costs incurred, from the fire department, Facility owner and tenants, resulting from negligently setting off false alarms will be charged to the Contractor in the form of financial progress payment reductions and holdback assessments against the Contract.

1.11 **DOCUMENTS ON SITE**

.1 Keep Hot Work Permits and Hazard assessment documentation on site for duration of Work.

.2 Upon request, make available to Departmental Representative or to authorized safety representative for inspection.

END OF SECTION

1.1 SECTION INCLUDES

.1 Procedures to isolate and lockout electrical facility and other equipment from energy sources.

1.2 RELATED WORK

.1 Section 01 35 24 – Special Procedures on Fire Safety Requirements.

.2 Section 01 35 29 - Health and Safety Requirements.

1.3 REFERENCES

.1 CSA C22.1-06, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .1 CAN/CSA C22.3 No.1-06 - Overhead Systems.
- .2 CSA C22.3 No.7-06 - Underground Systems.

.2 COSH, Canada Occupational Health and Safety Regulations made under Part II of the Canada Labour Code.

1.4 DEFINITIONS

.1 Electrical Facility: means any system, equipment, device, apparatus, wiring, conductor, assembly or part thereof that is used for the generation, transformation, transmission, distribution, storage, control, measurement or utilization of electrical energy, and that has an amperage and voltage that is dangerous to persons.

.2 Guarantee of Isolation: means a guarantee by a competent person in control or in charge that a particular facility or equipment is isolated.

.3 De-energize: in the electrical sense, that a piece of equipment is isolated and grounded, e.g. if the equipment is not grounded, it cannot be considered de-energized (DEAD).

.4 Guarded: means that an equipment or facility is covered, shielded, fenced, enclosed, inaccessible by location, or otherwise protected in a manner that, to the extent that is reasonably practicable, will prevent or reduce danger to any person who might touch or go near such item.

.5 Isolate: means that an electrical facility, mechanical equipment or machinery is separated or disconnected from every source of electrical, mechanical, hydraulic, pneumatic or other kind of energy that is capable of making it dangerous.

.6 Live/alive: means that an electrical facility produces, contains, stores or is electrically connected to a source of alternating or direct current of an amperage and voltage that is dangerous or contains any hydraulic, pneumatic or other kind of energy that is capable of making the facility dangerous to persons.

1.5 **COMPLIANCE REQUIREMENTS**

.1 Perform lockouts in compliance with:
- .1 Canadian Electrical Code.
- .2 Federal and Provincial Occupational Health and Safety Acts and Regulations.
- .3 Regulations and code of practise as applicable to mechanical equipment or other machinery being de-energized.
- .4 Procedures specified herein.

.5 In event of conflict between any provisions of above authorities the most stringent provision will apply.

1.6 **SUBMITTALS**

.1 Submit copy of proposed Lockout Procedures and sample form of lockout permit and lockout tags proposed for use in accordance with Section 01 33 00 – Submittal Procedures. Submit with 14 calendar days of acceptance of bid.

1.7 **ISOLATION OF EXISTING SERVICES**

.1 Obtain Departmental Representative's written authorization prior to conducting work on an existing live or active electrical facilities and equipment and before proceeding with isolation of such item.

.2 To obtain authorization, submit to Departmental Representative following documentation:
- .1 Written Request for Isolation of the service or facility and;
- .2 Copy of Contractor's Lockout Procedures.

.3 Make a Request for Isolation for each event, unless directed otherwise by Departmental Representative, and as follows:
- .1 Fill-out standard forms in current use at the Facility when so directed by Departmental Representative or;
- .2 Where no forms exist at Facility, make written request indicating:
  - .1 The equipment, system or services to be isolated and it's location.
  - .2 Duration of isolation period, i.e: start time & date and completion time & date.
  - .3 Voltage of service feed to system or equipment being isolated.
  - .4 Name of person making the request.

.4 Do not proceed with isolation until receipt of written notification from Departmental Representative granting the Isolation Request and authorization to proceed with the work.
- .1 Note that Departmental Representative may designate another person at the Facility being authorized to grant the Isolation Request.

.5 Conduct safe, orderly shutdown of equipment or facilities, de-energize, isolate and lock out power and other sources of energy feeding the equipment or facility.

.6 Determine in advance, as much as possible, in cooperation with the Departmental Representative, the type and frequency of situations which will require isolation of existing services.

.7 Plan and schedule shut down of existing services in consultation with the Departmental Representative and the Facility Manager. Minimize impact and downtime of facility operations. Follow Departmental Representative's directives in this regard.

.8 Conduct hazard assessment as part of the process in accordance with healthy and safety requirements specified Section 01 35 29 – Health and Safety Requirements.

1.8 **LOCKOUTS**

.1 De-energize, Isolate and lockout electrical facility, mechanical equipment and machinery from all potential sources of energy prior to working on such items.

.2 Develop and implement clear and specific lockout procedures to be followed as part of the Work.

.3 Prepare type written Lockout Procedures describing safe work practices, procedures, worker responsibilities and sequence of activities to be followed on site by workforce to safely isolate an active piece of equipment or electrical facility and effectively lockout and tag out it's sources of energy.

.4 Include as part of the lockout procedures a system of lockout permits managed by Contractor's Superintendent or other qualified person designated by him/her as being "in-charge" a the site.

.1 A lockout permit shall be issued to specific worker providing a Guarantee of Isolation before each event when work must be performed on a live equipment or electrical facility.

.2 Duties of person managing the permit system to include:

.1 Issuance of permits and lockout tags to workers.

.2 Determining permit duration.

.3 Maintaining record of permits and tags issued.

.4 Making a Request for Isolation to Departmental Representative when required as specified above.

.5 Designating a Safety Watcher, when one is required based on type of work.

.6 Ensuring equipment or facility has been properly isolated, providing

.7 Collecting and safekeeping lockout tags, returned by workers, as a record of the event.

.5 Clearly establish, describe and allocate, the responsibilities of:
- .1 Workers.
- .2 Persons managing the lockout permit system.
- .3 Safety Watcher.
- .4 Subcontractor(s) and General Contractor.

.6 Generic procedures, if used, must be edited, supplemented with pertinent information to reflect specific project requirements.
- .1 Incorporate site specific rules and procedures in force at site as provided by Facility Manager through Departmental Representative.
- .2 Clearly label the document as being the Lockout procedures applicable to work of this contract.

.7 Use energy isolation lockout devices specifically designed and appropriate for type of facility or equipment being locked out.

.8 Use industry standard lockout tags.

.9 Provide appropriate safety grounding and guards as required.

1.9 **CONFORMANCE**

.1 Brief all workers and subcontractors on requirements of this section. Stringently enforce use and compliance.

1.10 **DOCUMENTS ON SITE**

.1 Post Lockout Procedures on site in common location for viewing by workers.

.2 Keep copies of Request for Isolation forms and lockout permits and tags issued to workers on site for full duration of the work.

.3 Upon request, make available to Departmental Representative or to authorized safety representative for inspection.

END OF SECTION

1.1 **RELATED WORK**

.1 Section 01 35 24 - Special Procedures on Fire Safety Requirements.

.2 Section 01 35 25 - Special Procedures on Lockout Requirements.

1.2 **DEFINITIONS**

.1 COSH: Canada Occupational Health and Safety Regulations made under Part II of the Canada Labour Code.

.2 Competent Person: means a person who is:
- .1 Qualified by virtue of personal knowledge, training and experience to perform assigned work in a manner that will ensure the health and safety of persons in the workplace, and;
- .2 Knowledgeable about the provisions of occupational health and safety statutes and regulations that apply to the Work and;
- .3 Knowledgeable about potential or actual danger to health or safety associated with the Work.

.3 Medical Aid Injury: any minor injury for which medical treatment was provided and the cost of which is covered by Workers' Compensation Board of the province in which the injury was incurred.

.4 PPE: personal protective equipment

.5 Work Site: where used in this section shall mean areas, located at the premises where Work is undertaken, used by Contractor to perform all of the activities associated with the performance of the Work.

1.3 **SUBMITTALS**

.1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit site-specific Health and Safety Plan prior to commencement of Work.
- .1 Submit within ten (10) working days of notification of Bid Acceptance. Provide 3 copies.
- .2 Departmental Representative will review Health and Safety Plan and provide comments.
- .3 Revise the Plan as appropriate and resubmit within five (5) working days after receipt of comments.
- .4 Departmental Representative's review and comments made of the Plan shall not be construed as an endorsement, approval or implied warranty of any kind by Canada and does not reduce Contractor's overall responsibility for Occupational Health and Safety of the Work.
- .5 Submit revisions and updates made to the Plan during the course of Work.

.3 Submit name of designated Health & Safety Site Representative and support documentation specified in the Safety Plan.

.4 Submit building permit, compliance certificates and other permits obtained.

.5 Submit copy of Letter in Good Standing from Provincial Workers Compensation or other department of labour organization.
- .1 Submit update of Letter of Good Standing whenever expiration date occurs during the period of Work.

.6 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.

.7 Submit copies of incident reports.

.8 Submit WHMTS MSDS - Material Safety Data Sheets.

1.4 **COMPLIANCE REQUIREMENTS**

.1 Comply with Occupational Health and Safety Act for Province of New Brunswick, and General Regulations made pursuant to the Act.

.2 Comply with Canada Labour Code - Part II (entitled Occupational Health and Safety) and the Canada Occupational Health and Safety Regulations (COSH) as well as any other regulations made pursuant to the Act.
- .1 The Canada Labour Code can be viewed at:
  www.http: //laws.justice.gc.ca/en/L-2/
- .2 COSH can be viewed at:
  www.http://laws.justice.gc.ca/eng/SOR-86-304/ n e.html
- .3 A copy may be obtained at:
  Canadian Government Publishing Public Works &
  Government Services Canada
  Ottawa, Ontario, K1A 0S9
  Tel: (819) 956-4800 (1-800-635-7943)
  Publication No. L31-85/2000 E or F

.3 Observe construction safety measures of:
- .1 Part 8 of National Building Code
- .2 Municipal by-laws and ordinances.

.4 In case of conflict or discrepancy between above specified requirements, the more stringent shall apply.

.5 Maintain Workers Compensation Coverage in good standing for duration of Contract. Provide proof of clearance through submission of Letter in Good Standing.

.6 Medical Surveillance: Where prescribed by legislation or regulation, obtain and maintain worker medical surveillance documentation.

1.5 **RESPONSIBILITY**

.1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons and environment adjacent to the site to extent that they may be affected by conduct of Work.

.2 Comply with and enforce compliance by all workers, sub-contractors and other persons granted access to Work Site with safety requirements of Contract Documents, applicable federal, provincial, and local by-laws, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.6 SITE CONTROL AND ACCESS

.1 Control the Work and entry points to Work Site. Approve and grant access only to workers and authorized persons. Immediately stop and remove non-authorized persons.

.1 Departmental Representative will provide names of those persons authorized by Departmental Representative to enter onto Work Site and will ensure that such authorized persons have the required knowledge and training on Health and Safety pertinent to their reason for being at the site, however, Contractor remains responsible for the health and safety of authorized persons while at the Work Site.

.2 Isolate Work Site from other areas of the premises by use of appropriate means.

.1 Erect fences, hoarding, barricades and temporary lighting as required to effectively delineate the Work Site, stop non-authorized entry, and to protect pedestrians and vehicular traffic around and adjacent to the Work and create a safe environment. See Section 01 50 00 – Temporary Facilities for minimum acceptable requirements.

.2 Post signage at entry points and other strategic locations indicating restricted access and conditions for access.

.3 Use professionally made signs with bilingual message in the 2 official languages or international known graphic symbols.

.3 Provide safety orientation session to persons granted access to Work Site. Advise of hazards and safety rules to be observed while on site.

.4 Ensure persons granted site access wear appropriate PPE. Supply PPE to inspection authorities who require access to conduct tests or perform inspections.

.5 Secure Work Site against entry when inactive or unoccupied and to protect persons against harm. Provide security guard where adequate protection cannot be achieved by other means.

1.7 PROTECTION

.1 Give precedence to safety and health of persons and protection of environment over cost and schedule considerations for Work.

.2 Should unforeseen or peculiar safety related hazard or condition become evident during performance of Work, immediately take measures to rectify situation and prevent damage or harm. Advise Departmental Representative verbally and in writing.

1.8 FILING OF NOTICE

.1 File Notice of Project with pertinent provincial health and safety authorities prior to beginning of Work.

.1 Departmental Representative will assist in locating address if needed.

1.9 **PERMITS**

.1 Post permits, licenses and compliance certificates, specified in Section 01 10 10 – General Instructions, at Work Site.

.2 Where a particular permit or compliance certificate cannot be obtained, notify Departmental Representative in writing and obtain approval to proceed before carrying out applicable portion of work.

1.10 **HAZARD ASSESSMENTS**

.1 Perform site specific health and safety hazard assessment of the Work and its site.

.2 Carryout initial assessment prior to commencement of Work with further assessments as needed during progress of work, including when new trades and subcontractors arrive on site.

.3 Record results and address in Health and Safety Plan.

.4 Keep documentation on site for entire duration of the Work.

1.11 **PROJECT/SITE CONDITIONS**

.1 Following are potential health, environmental and safety hazards at the site for which Work may involve contact:

.1 Historical use of site: former DND property raised potential of unexploded ordinances (UXO).

.1 Site has been surveyed, sifted and cleared of risk of UXO by Gemtec Geotechnical, fall 2014.

.2 Small area, at NE corner of property which abuts eastern neighbouring lot and street allowance for Morris Drive, has not been UXO cleared.

.3 Retain Gemtec Geotechnical to provide services in connection with UXO construction support during site work in this portion of the site.

.2 Known site and environmental conditions:

.1 Human Health and Ecological Risk Assessment (HHERA) Draft Report prepared by AMEC Consultants, identifies: arsenic, lead, PHC's and PAH's at above acceptable levels in the soil.

.2 Draft HHERA Report is included as APPENDIX 'A' to this Section as information for bidders.

.2 Above items shall not be construed as being complete and inclusive of potential health and safety hazards encountered during Work.

.3 Include above items in the hazard assessment of the Work.

.4 MSDS Data sheets of pertinent hazardous and controlled products stored on site can be obtained from Departmental Representative.

1.12 **MEETINGS**

.1 Attend pre-construction health and safety meeting convened and chaired by Departmental Representative, prior to commencement of Work, at time, date and location determined by Departmental Representative. Ensure attendance of:
- .1 Superintendent of Work
- .2 Designated Health & Safety Site Representative
- .3 Subcontractors

.2 Conduct regularly scheduled tool box and safety meetings during the Work in conformance with Occupational Health and Safety regulations.

.3 Keep documents on site.

1.13 **HEALTH AND SAFETY PLAN**

.1 Prior to commencement of Work, develop written Health and Safety Plan specific to the Work. Implement, maintain, and enforce Plan for entire duration of Work and until final demobilization from site.

.2 Health and Safety Plan shall include the following components:
- .1 List of health risks and safety hazards identified by hazard assessment.
- .2 Control measures used to mitigate risks and hazards identified.
- .3 On-site Contingency and Emergency Response Plan as specified below.
- .4 On-site Communication Plan as specified below.
- .5 Name of Contractor's designated Health & Safety Site Representative and information showing proof of his/her competence and reporting relationship in Contractor's company.
- .6 Names, competence and reporting relationship of other supervisory personnel used in the Work for occupational health and safety purposes.

.3 On-site Contingency and Emergency Response Plan shall include:
- .1 Operational procedures, evacuation measures and communication process to be implemented in the event of an emergency.
- .2 Evacuation Plan: site and floor plan layouts showing escape routes, marshalling areas. Details on alarm notification methods, fire drills, location of firefighting equipment and other related data.
- .3 Name, duties and responsibilities of persons designated as Emergency Warden(s) and deputies.
- .4 Emergency Contacts: name and telephone number of officials from:
  - .1 General Contractor and subcontractors.
  - .2 Pertinent Federal and Provincial Departments and Authorities having jurisdiction.
  - .3 Local emergency resource organizations.
- .5 Harmonize Plan with Facility's Emergency Response and Evacuation Plan. Departmental Representative will provide pertinent data including name of PWGSC and Facility Management contacts.

.4 On-site Communication Plan:
- .1 Procedures for sharing of work related safety information to workers and subcontractors, including emergency and evacuation measures.
- .2 List of critical work activities to be communicated with Facility Manager which have a risk of endangering health and safety of Facility users.

.5 Address all activities of the Work including those of subcontractors.

.6 Review Health and Safety Plan regularly during the Work. Update as conditions warrant to address emerging risks and hazards, such as whenever new trade or subcontractor arrive at Work Site.

.7 Departmental Representative will respond in writing, where deficiencies or concerns are noted and may request re-submission of the Plan with correction of deficiencies or concerns.

.8 Post copy of the Plan, and updates, prominently on Work Site.

1.14 **SAFETY SUPERVISION**

.1 Employ Health & Safety Site Representative responsible for daily supervision of health and safety of the Work.

.2 Health & Safety Site Representative may be the Superintendent of the Work or other person designated by Contractor and shall be assigned the responsibility and authority to:
- .1 Implement, monitor and enforce daily compliance with health and safety requirements of the Work
- .2 Monitor and enforce Contractor's site-specific Health and Safety Plan.
- .3 Conduct site safety orientation session to persons granted access to Work Site.
- .4 Ensure that persons allowed site access are knowledgeable and trained in health and safety pertinent to their activities at the site or are escorted by a competent person while on the Work Site.
- .5 Stop the Work as deemed necessary for reasons of health and safety.

.3 Health & Safety Site Representative must:
- .1 Be qualified and competent person in occupational health and safety.
- .2 Have site-related working experience specific to activities of the Work.
- .3 Be on Work Site at all times during execution of the Work.
- .4 All supervisory personnel assigned to the Work shall also be competent persons.

.5 Inspections:
- .1 Conduct regularly scheduled safety inspections of the Work on a minimum bi-weekly basis. Record deficiencies and remedial action taken.
- .2 Conduct Formal Inspections on a minimum monthly basis. Use standardized safety inspection forms. Distribute to subcontractors.
- .3 Follow-up and ensure corrective measures are taken.

.6 Cooperate with Facility's Occupational Health and Safety representative should one be designated by Departmental Representative.

.7 Keep inspection reports arid supervision related documentation on site.

1.15 **TRAINING**

.1 Use only skilled workers on Work Site who are effectively trained in occupational health and safety procedures and practices pertinent to their assigned task.

.2 Maintain employee records and evidence of training received. Make data available to Departmental Representative upon request.

.3 When unforeseen or peculiar safety-related hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.

1.16 **MINIMUM SITE SAFETY RULES**

.1 Notwithstanding requirement to abide by federal and provincial health and safety regulations; ensure the following minimum safety rules are obeyed by persons granted access to Work Site:
- .1 Wear appropriate PPE pertinent to the Work or assigned task; minimum being hard hat, safety footwear, safety glasses and hearing protection.
- .2 Immediately report unsafe condition at site, near-miss accident, injury and damage.
- .3 Maintain site and storage areas in a tidy condition free of hazards causing injury.
- .4 Obey warning signs and safety tags.

.2 Brief persons of disciplinary protocols to be taken for non-compliance. Post rules on site.

1.17 **CORRECTION OF NON-COMPLIANCE**

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.

.2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.

.3 Departmental Representative will stop Work if non-compliance of health and safety regulations is not corrected in a timely manner.

1.18 **INCIDENT REPORTING**

.1 Investigate and report the following incidents to Departmental Representative:
- .1 Incidents requiring notification to Provincial Department of Occupational Safety and Health, Workers Compensation Board or to other regulatory Agency.
- .2 Medical aid injuries.
- .3 Property damage in excess of $10,000.00,
- .4 Interruptions to Facility operations resulting in an operational lost to a Federal department in excess of $5000.00.

.2 Submit report in writing.

1.19 **HAZARDOUS PRODUCTS**

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS).

.2 Keep MSDS data sheets for all products delivered to site.
- .1 Post on site.
- .2 Submit copy to Departmental Representative.

1.20 **BLASTING**

.1 Blasting or other use of explosives is not permitted on site without prior receipt of written permission and instructions from Departmental Representative).

1.21 **POWDER ACTUATED DEVICES**

.1 Use powder actuated fastening devices only after receipt of written permission from Departmental Representative.

1.22 **CONFINED SPACES**

.1 Abide by occupational health and safety regulations regarding work in confined spaces.

1.23 **SITE RECORDS**

.1 Maintain on Work Site copy of safety related documentation and reports stipulated to be produced in compliance with Acts and Regulations of authorities having jurisdiction and of those documents specified herein.

.2 Upon request, make available to Departmental Representative or authorized Safety Officer for inspection.

1.24 **POSTING OF DOCUMENTS**

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on Work Site in accordance with Acts and Regulations of Province having jurisdiction.

.2 Post other documents as specified herein, including:
- .1 Site specific Health and Safety Plan
- .2 WFIMIS data sheets

END OF SECTION

Draft Report by Amec Consultants

QUANTITATIVE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT
Correctional Service Canada Proposed Facility
Parcel 2013-1 OF PID 40114084
Dartmouth, Nova Scotia

QUANTITATIVE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT CORRECTIONAL SERVICE CANADA PROPOSED FACILITY PARCEL 2013-1 OF PID 40114084 DARTMOUTH, NOVA SCOTIA

DRAFT REPORT

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Project No. TV1412091

GLOSSARY OF TERMS

AEC	Area of Environmental Concern
AMEC	AMEC Environment & Infrastructure, a division of AMEC Americas Limited
CCME	Canadian Council of Ministers of the Environment
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CWS	Canada Wide Standard
d/wk	days per week
EDI	Estimated Daily Intake
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
kg	Kilogram
m	Metres
m^2	Square metres
mg/cm^2	milligrams per square centimetre
mg/kg	milligram per kilogram
$mg/kg\text{-}day^{-1}$	milligrams per kilogram bodyweight per day
PCBs	Polychlorinated Biphenyl
PHC	Petroleum Hydrocarbons
PQRA	Preliminary Quantitative Risk Assessment
RAF	Relative Absorption Factor
SQG	Soil Quality Guideline
SSTLs	Site-specific Target Level
TDI	Tolerable Daily Intake
TRV	Toxicity Reference Value
THQ	Target Hazard Quotient
UF	Uncertainty Factor
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC), was retained by Public Works and Government Services Canada (PWGSC) to conduct a Human Health and Ecological Risk Assessment (HHERA) at a proposed Correctional Service Canada (CSC) facility on Parcel 2013-1 (the Site), which is a portion of PID 40114084, in Dartmouth, Nova Scotia.

The Site is currently undeveloped but CSC plans to build a Community Correctional Center (CCC) on-site, which will consist of a building with an approximate area of 1,700 m^2 and exterior parking for 30 staff/visitors. A Phase II Environmental Site Assessment (ESA) was completed (AMEC, July 2014) to investigate the fill areas within the footprint of the proposed structure and parking areas.

During previous investigations, AMEC identified potential areas of environmental concern. Therefore, PWGSC requested an HHERA to evaluate if risk management was necessary for the Site. The HHERA program relied on surface information and analytical data collected by AMEC (2014) and used the prescribed Health Canada, CCME, and FCSAP methods to assess the risk to potential human and ecological receptors at the Site.

Human Health Risk Assessment

The HHRA identified a variety of potential receptors including an adult inmate, visitor, adult facility worker, and construction worker; however, the proposed development for the Site includes a building, paved parking area, concrete walkways, and landscaped areas (maintained lawn, flowers, shrubs, etc). It does not include areas of bare soil or planned recreationally attractive areas. Therefore, direct contact with impacted soil (the only active exposure pathway identified) is unlikely for the planned site use and identified receptors, with the exception of the construction worker.

Based on the results of the HHRA, substantive health risks to the identified receptor (construction workers) are not expected as a result of remaining trace metal concentrations in soil. It is assumed that the impacted fill material will be reworked, compacted and covered by the Site development (i.e., building, asphalt parking areas, concrete walkways, and landscaped areas).

The calculated Site-specific Target Level (SSTL) for and corresponding Site maximum are presented below.

TABLE ES-1 Human Health Risk Assessment Results

Receptor	Maximum Concentration (mg/kg)	SSTL (mg/kg) Construction Worker	Comment
Aluminum	19,000	190,000	Maximum is less than SSTL. Further assessment is not required for the Site.
Arsenic	61	127	Maximum is less than SSTL. Further assessment is not required for the Site.
Iron	33,000	146,000	Maximum is less than SSTL. Further assessment is not required for the Site.

Ecological Risk Assessment

For ecological receptors, the risk to ecological receptors from arsenic in soil in the area of the proposed building is negligible. The risk to aquatic receptors due to groundwater concentrations of mercury is low based on the distance to the Halifax Harbour and the low concentrations observed in groundwater. The area of the possible former garage exhibited concentrations of F4G greater than the CCME CWS for PHC (CCME 2008) based on soil contact; however, a qualitative assessment of the impacts concluded that risk to ecological receptors is unlikely.

Recommendations

As noted throughout the report, this assessment has been undertaken for the areas sampled within the Site only (the area of the proposed development and the area of the possible former garage), and on the basis of several assumptions regarding future construction, including:

- that the proposed facility will not use more of the PID than that identified as the Site (i.e., the currently cleared area of the Site),
- that the building will be constructed on the current area of infilling,
- that the assumptions regarding land use and potential receptors are valid, and
- that any areas not covered by the building footprint, asphalt parking, or concrete walkways will be landscaped (i.e., covered with clean topsoil and grass/flowers/shrubs, etc.) and that this cover will be maintained and not allowed to deteriorate.

Should these assumptions cease to be valid or should the anticipated land use change, the HHERA will need to be revisited.

No further environmental investigation is recommended for the Site at this time. Should off-site disposal of the fill be required, further assessment related to the NS CSR may be required and off-site disposal costs will be incurred.

It is noted that this risk assessment does not address any potential risks related to possible UXO on the Site and any further site work needs to be completed under UXO supervision.

A risk management plan has been prepared under separate cover.

The statements made in this Executive Summary are subject to the same limitations included in Section 5.0 (Closure), and are to be read in conjunction with the remainder of this report.

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1.0 INTRODUCTION

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC), was retained by Public Works and Government Services Canada (PWGSC) to conduct a Human Health and Ecological Risk Assessment (HHERA) at a proposed Correctional Service Canada (CSC) facility on Parcel 2013-1 (the Site) which is a portion of PID 40114084, in Dartmouth, Nova Scotia. The Site location is shown in Figures 1 and 2.

The Site is currently undeveloped but CSC plans to build a Community Correctional Center (CCC) on-site, which will consist of a building with an approximate area of 1,700 m^2 and exterior parking for 30 staff/visitors. A Phase II Environmental Site Assessment (ESA) was completed (AMEC, July 2014) to investigate the fill areas within the footprint of the proposed structure and parking areas. As most of the fill will have to be removed and/or reworked for geotechnical purposes, the purpose of the Phase II ESA was to characterize soil and groundwater concentrations of contaminants of potential concern (COPC) within the fill.

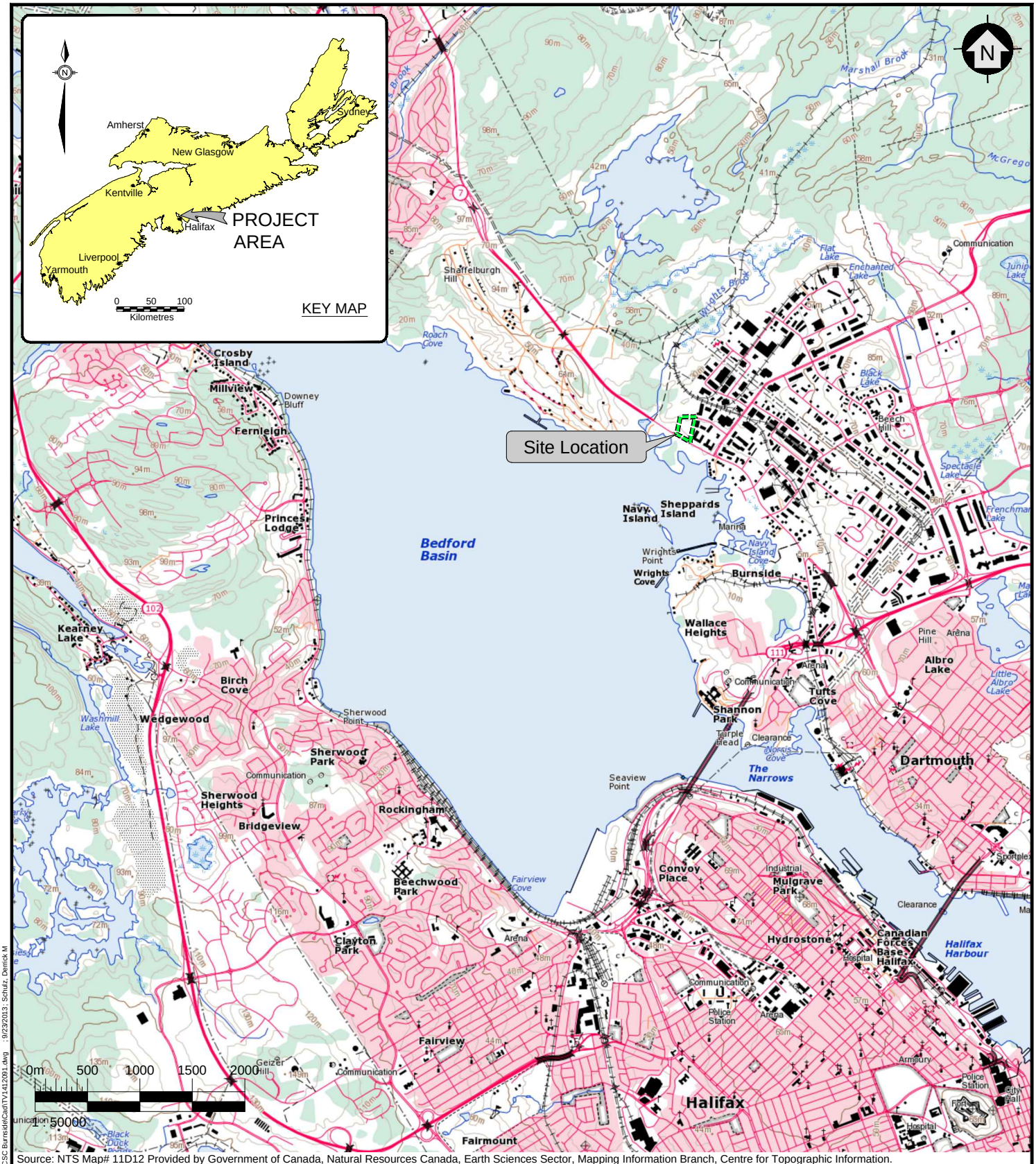
The purpose of this HHERA is to determine whether or not ecological or human health risks exist associated with residual chemical contamination identified on-Site and determine if risk management is required. This HHERA is based on accepted risk assessment standards including those published by Health Canada (HC 2010a, HC 2010b, and HC 2010c) and Environment Canada (EC, 2012a).

1.1 SITE DESCRIPTION AND HISTORY

The subject property is a 5.42 acre parcel (Parcel 2013-1), which is part of PID 40114084. Previous reports (with the exception of Gemtec [2013a, b] discussed in Section 1.3) have investigated all of PID 40114084. According to previous environmental investigations the property has been mainly undeveloped since at least 1931. There were two clearings along the south side of the property adjacent to Windmill Road and an area of infilling on the east side of the Site.

The Site is currently undeveloped and mostly wooded. The area of infilling on the east side of the Site is where the proposed building will be located. Trees and brush in the infilled area were removed as part of the Gemtec investigations in 2013. Access to the Site is via Morris Drive. There are currently two groundwater monitoring wells within the proposed area of development.

Overview of Site facing West



Source: NTS Map# 11D12 Provided by Government of Canada, Natural Resources Canada, Earth Sciences Sector, Mapping Information Branch, Centre for Topographic Information.

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PROJECT	DWN BY:	PROJECTION:	DATE:
Human Health and Ecological Risk Assessment of Development Area	DS	UTM Zone 20	July 2014
	CHK'D BY:	DATUM:	PROJECT NO:
	BA	NAD83	TV1412091
TITLE	REV. NO.:	SCALE:	FIGURE No.
General Site Location	N/A	1:50,000	1

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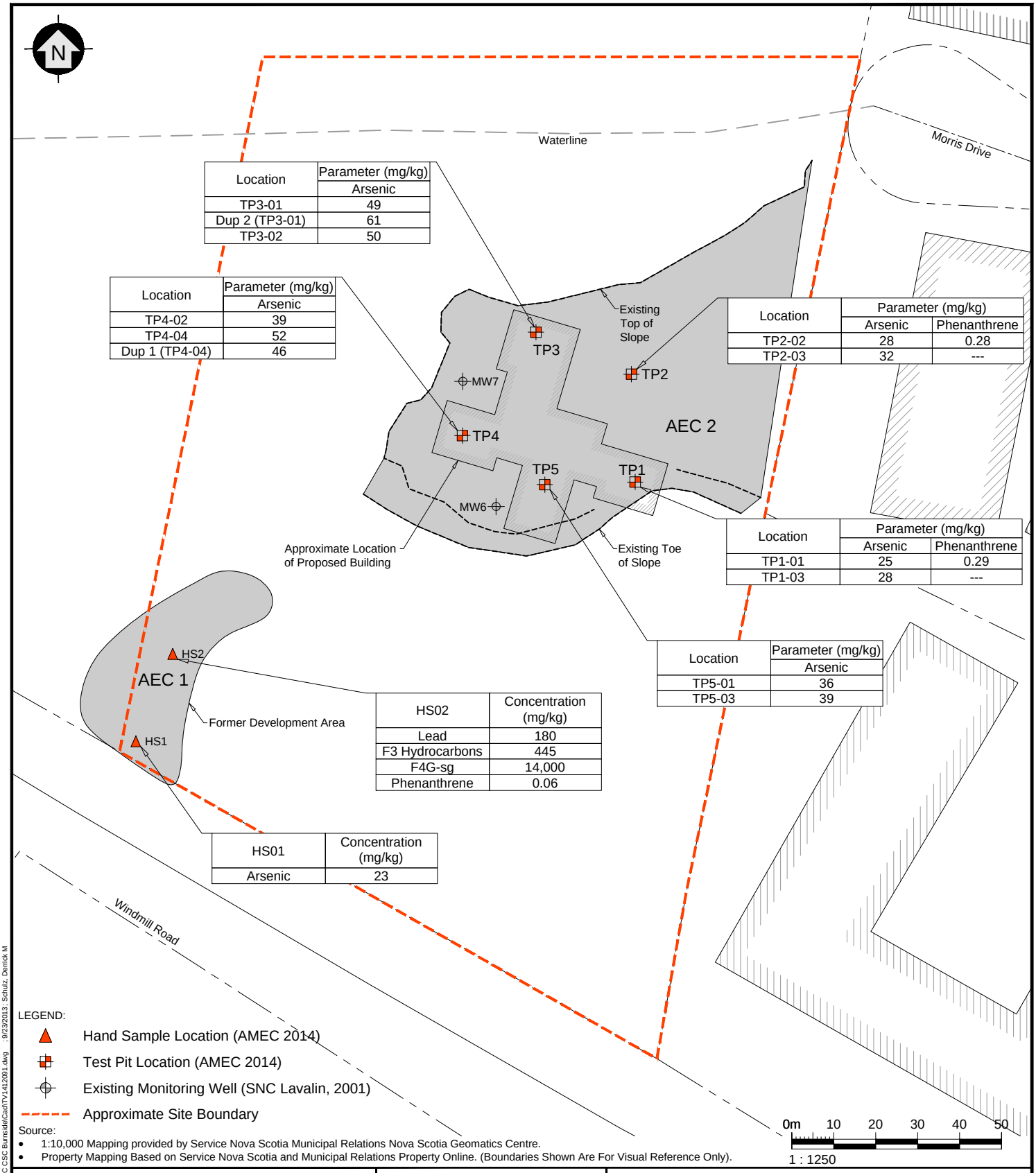

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PROJECT
Human Health and Ecological Risk Assessment of Development Area

DWN BY:	PROJECTION:	DATE:
DS	UTM Zone 20	July 2014
CHK'D BY:	DATUM:	PROJECT NO:
BA	NAD83	TV1412091

TITLE
Metals, PHC, and PAH Exceedances in Soil (CCME)

REV. NO.:	SCALE:	FIGURE No.
N/A	1:1,250	2

1.1.1 Current and Future Land Use

Parcel 2013-1 was previously owned by the Department of National Defence (DND), as part of the lands of Canadian Forces Ammunition Depot (CFAD) Bedford and was acquired by CSC in 2013. The Site is currently undeveloped and the surrounding portions of the PID are treed. An underground water line is located to the north of the Site (shown on Figure 2). Access to the new CCC will be from Morris Drive. The proposed development will be constructed on the current area of infilling and is understood to consist of a building with paved parking, concrete walkways, and possibly some landscaped areas.

1.1.2 Adjoining Properties

The eastern portion of the Site has access to Burnside Industrial Park via Morris Drive. To the north, and west of the Site a mature forest (mainly 40 years old) with fairly dense underbrush exists. To the south of the Site a provincial highway (No. 7) and associated lands are present. The Bedford Basin is located approximately 250 m downgradient of the Site.

1.1.3 Water Supply/Groundwater Usage

There are no potable wells in use at Site (AMEC 2014, AMEC 2011). Potable water and sewage disposal for the CCC will be supplied by Halifax Regional Municipality. Two groundwater monitoring wells (MW6 and MW7) are currently installed at the Site and were sampled during the Phase II ESA (AMEC, 2014).

1.2 ASSESSMENT STANDARDS

The subject property is on federal land; therefore, the appropriate guidelines for soil and groundwater are the Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines (SQG) for the Protection of Environmental and Human Health (accessed on-line, August 2014) and Federal Interim Groundwater Quality Guidelines (FIGQG) for Federal Contaminated Sites (EC, 2012b). Where these were not available, the Ontario Ministry of the Environment's (OMOE) *Rationale for the Development of Soil and Ground Water Standards for use at Contaminated Sites in Ontario* were consulted.

The *Nova Scotia Contaminated Sites Regulations (NS CSR), Tier I Environmental Quality Standards* for non-potable, coarse grained soil sites were referenced, for off-site soil disposal considerations.

While the property is commercial in nature and located within an industrial park, it will house people on a fulltime (24/7) basis. Therefore, residential standards were selected as most appropriate for human health screening, while commercial guidelines were adopted for ecological health screening.

The *PAH and Metals Baseline Study of Soil and Bedrock in Metro Halifax and Surrounding Area* (Neill and Gunter, 2001) and the *Review of Environment Canada's Background Soil Database (2004-2009), Version No. 1* (Dillon, 2011) were also consulted for average background concentrations of polycyclic aromatic hydrocarbon (PAH) and metals in the Halifax area and in Atlantic Canada, respectively.

1.3 PREVIOUS INVESTIGATIONS

A review of previous investigations at the Site is discussed in the following reports:

- *Desktop Historical Review, Proposed Correctional Service Canada Facility, Dartmouth, Nova Scotia, Final Report*, prepared for PWGSC by AMEC, March, 2011 and
- *DRAFT Phase II Environmental Site Assessment, Correctional Service Canada Proposed Facility, Portion of PID 40114048, Dartmouth, Nova Scotia*, prepared for PWGSC by AMEC, July 2014.

Concerns identified in the historical review consisted of:

- Potential for unexploded ordnance (UXO) at the Site;
- Potential environmental concern associated with a possible garage located at the south side of the property (adjacent to Highway 7);
- Potential environmental concern associated with past dumpsite on the eastern edge of the property; and
- Potential environmental concern associated with debris noted throughout the area in past reports.

As discussed above, Gemtec undertook the following investigations on the property in 2013:

- *Geotechnical Investigation, Proposed Dartmouth CCC Facility, Dartmouth, NS.* Prepared for Defence Construction Canada by Gemtec, November 2013.
- *MEC (Munition or Explosive of Concern) Site Survey, Technical Support, and Specification Development, Dartmouth, NS*. Prepared for Defence Construction Canada by Gemtec, November 2013.

The Gemtec Geotechnical Investigation and MEC Site Survey reports assessed only the area of proposed development (the Site). The MEC report indicated that the Site could have been a dump area for boulders and surface soils from the local area, which would account for the type of fill present. The geotechnical report indicated that the fill material at the Site consisted of "miscellaneous construction material with boulders, metal, concrete with debris and organics". Fill material was noted to range from 1.9 to 3.5 meters thick.

A summary of the results of the findings of the Phase II ESA (AMEC, 2014) is provided below:

- No munitions or munitions scrap was identified during the field work by the UXO supervision team.
- Arsenic soil concentrations exceeded the CCME SQG across the site with concentrations ranging from 23 to 61 mg/kg. These values are greater than the average Halifax area background concentration (18 mg/kg).
- Lead in one hand sample exceeded the CCME SQG as well as the average Halifax area background concentration for lead (97 mg/kg)
- Hand sample location HS02 had concentrations of lead, F3 hydrocarbon, F4G, and phenanthrene exceeding CCME guidelines. The Petroleum Hydrocarbon (PHC) exceedances were noted to be in the lube oil range. HS02 was collected in the area of the possible former garage noted in the Historical Review (AMEC 2011). The identified impacts may be due to the historical use of the area as a garage.
- Phenanthrene was also present at concentrations greater than CCME guidelines at two test pit locations (TP1 and TP2). There were no other PAH exceedances in soil in the samples analyzed from the Site.
- There were no exceedances of applicable guidelines for VOCs in the soil samples analyzed from the Site.
- Groundwater concentrations of mercury at MW6 exceeded the FIGQG.

- There were no groundwater exceedances of the FIGQG for PHCs, PAHs, or VOCs in the samples analyzed from the Site.

It is noted that the data were also compared to the NS CSR Tier I Standards, for reference only, in the event off-site disposal (at a provincial facility) is required. Aluminum, arsenic, and iron concentrations in soil at several locations as well as lead and vanadium at single locations also exceeded the NS CSR standards. Additional treatment/disposal costs would be incurred, should this soil be moved off-site. There were no exceedances of the NS CSR for measured analytes in groundwater (noting that there are no CSR for trace metal parameters).

1.4 CONTAMINANT DISTRIBUTION

Based on the analytical data obtained to date (Tables 1 through 8, Appendix A), several parameters, including arsenic, lead, PHCs (F3 and F4G) and PAHs (phenanthrene) in soil exceeded the generic CCME CSG for human and ecological exposure. The distribution of soil exceedances within the areas assessed is presented on Figure 2.

1.5 OBJECTIVES

The purpose of this study is to evaluate potential human health and ecological risks associated with residual chemical contamination in soil and to identify if risk management for the Site is required. This will require analysis of exposure pathways and possible interactions with human and wildlife receptors to assess how the Site may affect humans and wildlife populations. To meet this objective, AMEC:

- Conducted a quantitative HHERA using the existing data (AMEC 2014); and
- Completed a report summarizing the findings.

This report does not evaluate potential risks that may have been present in the past; rather it is designed only to evaluate current and potential future exposures to chemical contaminants in soil. The risk assessment approach used to assess the data is discussed in the following sections.

2.0 HUMAN HEALTH RISK ASSESSMENT

This HHRA is conducted in accordance with current regulatory guidance documents, including:

- Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment, Version 2.0 (Health Canada, 2010a, revised 2012).
- Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values and Chemical Specific Factors, Version 2.0 (Health Canada, 2010b).
- Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment (Health Canada, 2010c).
- CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006).

2.1 PROBLEM FORMULATION

The Problem Formulation step is an information gathering and interpretation stage that focuses the assessment on the primary areas of concern for the Site. The Problem Formulation step defines the nature and scope of the risk assessment, permits practical boundaries to be placed on the overall scope of work, and ensures that the HHRA is directed at the key areas and issues of concern related to Site activities.

2.1.1 Exposure Pathway Assessment

The exposure assessment evaluates the likelihood that potential hazards may come into contact with potential human receptors. The likelihood of exposure is determined through consideration of the properties of individual hazards that control chemical mobility, and the various pathways through which the hazard could move to contact the receptor, or through which the receptor could move to contact the hazard. The exposure analysis also considers the possible mechanisms through which a hazard can be introduced to a human receptor.

Exposure pathways are used to describe how a substance could move from the impacted media (soil, water, *etc*.) to a point where it can come in contact with the body. Only those pathways for which there is a reasonable potential for exposure were considered quantitatively in this risk assessment. The likelihood of exposure includes consideration of the duration and frequency of exposure to chemicals of potential concern. The exposure scenarios that have been considered for human receptors at the Site include:

- Ingestion/dermal contact with soil;
- Inhalation/ingestion/dermal contact with dust;
- Ingestion of vegetation or garden produce grown in impacted soil;
- Ingestion/dermal contact with surface water;
- Ingestion/dermal contact with groundwater; and
- Inhalation of vapours.

AMEC identified the likelihood that the on-Site receptors may be exposed to the identified hazards through the various exposure scenarios using a qualitative method. The likelihood of exposure is considered and evaluated in terms of the series of definitions presented in Table 1.

TABLE 1 Exposure Definitions

Likelihood of Exposure	Definition
Very Unlikely	Level of exposure that could result in adverse effects is not expected.
Unlikely	Level of exposure that could result in adverse effects would probably not occur.
Possible	Level of exposure that could result in adverse effects might be expected.
Likely	Level of exposure that could result in adverse effects is expected. Exceedance of this exposure level might be expected.

The relevant exposure pathways are summarized in Table 2, which includes the qualitative evaluation of each pathway and a justification for the likelihood of exposure assigned based on Site-specific conditions. The likelihood of exposure includes consideration of the duration and frequency of exposure to each potential hazard and to the relative concentrations to which the receptor is likely to be exposed. Those hazard-exposure-receptor combinations considered to have the highest likelihood to contribute a health risk are carried forward for further quantitative analysis.

TABLE 2 Potential Exposure Scenarios – Human Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward?	Justification
Ingestion of soil	Possible	**Yes**	Trace metal, hydrocarbon, and PAH impacts were identified in the soil. On-Site receptors may be exposed directly to the impacted soil.
Dermal contact with soil			
Inhalation of re-suspended dust	Possible	**Yes**	Trace metal, hydrocarbon, and PAH impacts were identified in the soil. On-Site receptors may inhale re-suspended dust. This pathway is typically included in the calculation of ingestion/dermal contact guidelines.
Ingestion of vegetation/garden produce grown in impacted soil	Very Unlikely	No	It is very unlikely that edible produce would be grown at this Site based on its current and foreseeable future use.
Dermal contact with/Ingestion of surface water	Very Unlikely	No	There are no surface water bodies on Site.
Ingestion of groundwater	Very Unlikely	No	There are no water supply wells on the Site. There is no current or anticipated future use of groundwater on the subject property for drinking water purposes.
Inhalation of vapours (indoors)	Very Unlikely	No	Trace metals are not considered volatile. In addition, the identified hydrocarbons and PAHs on-Site (F3, F4G, and phenanthrene) are not considered volatile.
Inhalation of vapours (outdoors)	Very Unlikely	No	

Therefore, ingestion of/dermal contact with contaminated soil and inhalation of re-suspended dust are carried forward as possible exposure pathways in the HHRA.

2.1.2 Receptor Identification

Existing and intended land use is an important factor in evaluating the potential exposures and estimating risk. It is important that the most protective assumptions are made about the potential receptors. Taking into account current Federal regulatory guidance on risk assessments and information on the planned use of the site, the following receptors are considered:

- Adult Inmates – the duration of stay for inmates at the facility ranges from 6 months to 10 years. Inmates are able to leave the facility during the day. The minimum age for residents of the facility is eighteen.

- Visitors – family members and friends may visit inmates daily for a maximum of four hours per day. Visitors from all age groups are possible (i.e., infant, toddler, child, teen and adults).
- Adult Worker (i.e., commissionaires and facility staff) – for the purposes of this risk assessment, it is assumed that the same adult worker may be present at the Site five days a week, 48 weeks per year.
- An adult construction worker could be exposed to impacted soil during the construction activities. It is assumed that the same construction worker may be present 5 days a week for 52 weeks per year for duration of 1 year.

While a variety of potential receptors are identified above (adult inmate, visitor, adult facility worker), the proposed development for the Site includes a building, paved parking area, concrete walkway(s), and likely some landscaped areas (maintained lawn, flowers, shrubs, etc.). It does not include areas of bare soil or planned recreationally attractive areas. Therefore, direct contact with impacted soil (the only active exposure pathway identified in Table 2) is unlikely for the planned site use and identified receptors, with the exception of the construction worker. It is assumed that following site re-working and development, clean topsoil will be placed on remaining areas of bare soil to create landscaped areas, which, along with any vegetation/plants will prevent incidental contact with the underlying fill.

2.1.3 Human Health Screening

The identified affected environmental medium is soil. For the human health screening, soil analytical data are compared to applicable human-health-specific guidelines. Typically, only surface soils are included in human health screenings, as this is what people would come into contact with. However, it is understood that the existing fill in the proposed area of construction is not geotechnically suitable for the proposed building and that re-working of this fill will likely be required. As it is possible that re-working will bring subsurface soils to the surface and that the existing fill may be placed anywhere on the site during and after construction, all existing soil data has been included in the screening.

The soil data selected for use in this risk assessment were compiled from the Phase II ESA (AMEC, 2014).

As presented in Tables 1 through 4, Appendix A, COPCs with concentrations in soil in excess of CCME SQGs include arsenic, lead, PHCs (F3 and F4G), and PAHs (phenanthrene). COPCs with concentrations in excess of NS CSR standards include aluminum, arsenic, iron, lead, and vanadium.

The maximum concentration and human health screening guideline for COPCs are displayed in Table 3a. The human health screening guideline for direct contact (soil ingestion and dermal contact) is presented, where available, based on the exposure pathway screening presented in Section 2.1.1. The HRM regional background soil concentration (BSC) and Atlantic region BSC (Dillon, 2011) are also provided, for reference.

TABLE 3a Human Health Screening of Soil for Direct Contact

Parameter	Maximum Concentration (mg/kg)	Background Soil (mg/kg)	Human Health Screening Guidelines (mg/kg)	Comment
Aluminum	19,000	NA[1]/14,606[2]	15,400[3]	**Maximum exceeds the human health screening guideline. Further**

TABLE 3a Human Health Screening of Soil for Direct Contact

Parameter	Maximum Concentration (mg/kg)	Background Soil (mg/kg)	Human Health Screening Guidelines (mg/kg)	Comment
				assessment required.
Arsenic	61	19[1]/4.27[2]	31[4]	**Maximum exceeds the human health screening guideline. Further assessment required.**
Iron	33,000	NA[1]/22,961[2]	11,000[3]	**Maximum exceeds the human health screening guideline. Further assessment required.**
Lead	180	97[1]/13.7[2]	140[5]	**Maximum exceeds the human health screening guideline. Further assessment required.**
Vanadium	71	31[1]/31[2]	39[3]	**Maximum exceeds the human health screening guideline. Further assessment required.**
F3	445	NA[1]/NA[2]	15,000[6]	Maximum concentration is below the human health screening guideline. No further assessment required.
F4	14,000	NA[1]/NA[2]	21,000[6]	Maximum concentration is below the human health screening guideline. No further assessment required
Phenanthrene	0.29	1.286[1]/0.07[2]	5[7]	Maximum concentration is below the CCME interim screening guideline. No further assessment required.

Notes:
1. Average till (Neil and Gunter, 2001)
2. Recommended Atlantic Region BSC (Dillon, 2011)
3. NS CSR
4. CCME SQG for 10^{-5} Incremental Lifetime Cancer Risk (ILCR).
5. CCME SQG
6. CCME CWS for PHC
7. CCME SQG – Interim, recommended by CCME when impacts to surface water bodies are not a concern.

Bold result indicates Max exceeds screening guidelines.

It is noted that the screening guidelines used in Table 3a are based on residential land use and are; hence, protective of toddlers. As discussed, the Site will consist of a building and paved parking area and it is unlikely that people, other than construction workers during the construction phase, will have direct contact with the remaining impacted soil. Neither CCME nor NS CSR incorporate a construction worker scenario into their commercial or industrial guideline development; however, the Ontario Ministry of the Environment's (OMOE) *Rationale for the Development of Soil and Ground water Standards for use at Contaminated Sites in Ontario* have derived guidelines specifically for construction workers:

> *"…a low-frequency, high-intensity, human health exposure scenario without children present that is protective of a worker digging in the soil. It is used for sub-surface soils at commercial/industrial/community sites. The soil value is calculated using TRVs and a soil ingestion, dermal exposure and particulate inhalation exposure model."*

The maximum measured soil concentrations are screened against OMOE construction worker guidelines in Table 3b.

TABLE 3b Human Health Screening of Soil (Construction Worker)

Parameter	Maximum Concentration (mg/kg)	Human Health Screening Guidelines[1] (mg/kg)	Comment
Aluminum	19,000	NG	No guideline available. Further assessment required.
Arsenic	61	47	**Maximum exceeds the human health screening guideline. Further assessment required.**
Iron	33,000	NG	No guideline available. Further assessment required.
Lead	180	1,000	Maximum meets the human health screening guideline. Further assessment not required.
Vanadium	71	160	Maximum meets the human health screening guideline. Further assessment not required.

Notes:
[1] OMOE Table 3 Full Depth, Non-potable Water Scenario, Commercial/Industrial land use, coarse-grained soil, S3 (construction worker) component value
Bold result indicates Max exceeds screening guidelines

As shown in Table 3b, arsenic exceeds its respective OMOE guideline, while there are no guidelines protective of construction workers for aluminum and iron. Therefore, these parameters are carried forward in the HHRA.

2.1.4 Human Health Conceptual Site Model

Based on the qualitative risk evaluation, the Conceptual Site model (CSM) developed for evaluating the quantitative exposure of the human receptor includes:

- Arsenic is present in the surface soil on the Site in concentrations exceeding human health soil contact guidelines for construction workers, who may be exposed to the impacted soil via ingestion, dermal contact, and dust inhalation throughout the construction period. There are no available guidelines protective of construction workers for aluminum and iron.

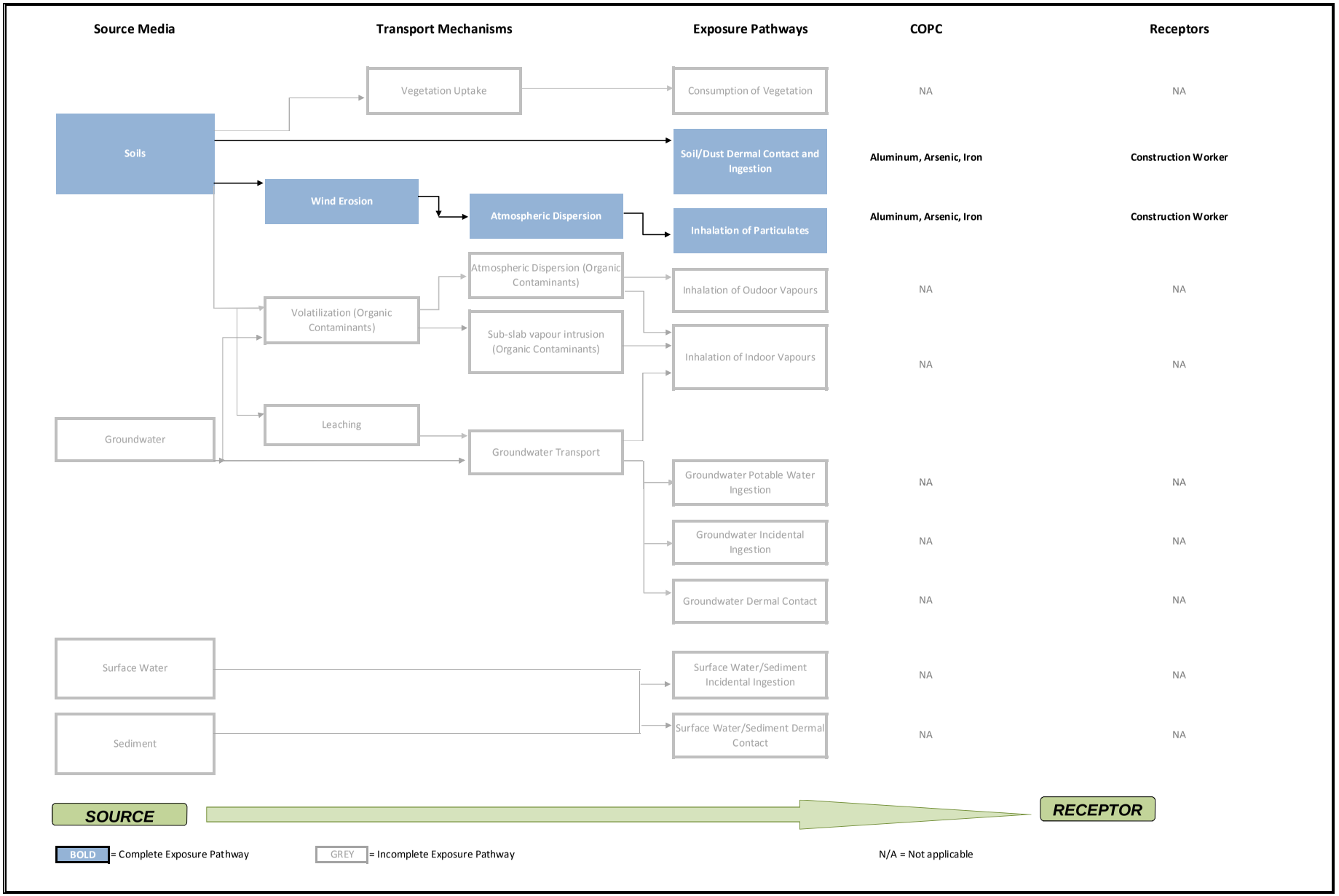
The CSM constructed for this HHRA is presented as Figure 3. The CSM provides a simplified representation of potential exposure pathways, linking COPC to each identified receptor.

2.2 EXPOSURE ASSESSMENT

2.2.1 Modelling Tools

AMEC used a risk assessment model based on Health Canada (2010a) to calculate the human health risk associated with aluminum, arsenic, and iron impacts identified in soil. The specific methods employed to develop the site-specific target levels (SSTLs) are consistent with CCME and Health Canada protocols and with standard HHRA methodologies. The equations used in the modelling of trace metal impacts are shown in the model input/output found in Appendix B.

Figure 3 Human Health Conceptual Site Model



2.2.2 Receptor Characteristics

Receptor characteristics are presented in Table 4. The important characteristics of the receptors (including body weight (BW), exposure duration, *etc*.) considered in the risk analysis are also presented in the input and output tables in Appendix B.

TABLE 4 Receptor Characteristics

Characteristic		Construction Worker
Exposure	D1 (hours per day exposed per 24 h/d)	10/24[1]
	D2 (days per week exposed per 7 d/wk)	5/7[1]
	D3 (weeks exposed per year)	52/52[1]
	D4 (years exposed to Site)	1[1]
BW	Body weight (kg)	70.7[2]
SIR	Soil ingestion rate (kg/d)	0.0001[2]
IR_{air}	Air inhalation rate (m^3/d)	14[2]
SR	Soil dermal contact rate (kg/d)	0.00114[2,3]
PM_{10}	Respirable Particulate Matter (ug/m^3)	250[2]
IR_{soil}	Soil inhalation rate (kg/d) (PM_{10} x IR_{air})/(1E9 ug/kg)	0.0000035[2,3]
SA_H	Skin surface area – Hands (cm^2)	890[2]
SA_O	Skin surface area – Other (arms) (cm^2)	2,500[2]
SL_H	Soil loading factor – Hands (kg/cm^2/event)	0.000001[2]
SL_O	Soil loading factor – Other (kg/cm^2/event)	0.0000001[2]
SR	Soil dermal contact rate (kg/d) [(SA_H x SL_H)+ (SAo x SL_O)]	0.00114[2,3]

[1] Assumed.
[2] Health Canada, PQRA Guidance, Part I (2010)
[3] Calculated

2.3 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to identify the types of adverse health effects a chemical may potentially cause as well as the relationship between the magnitude of exposure (dose) and the likelihood of an adverse effect (response). This is called the dose-response relationship. In addition, toxicity assessment involves the classification of the potential toxicological effects of chemicals as carcinogenic or non-carcinogenic, and the subsequent estimation of the amounts of chemicals that can be received by human receptors without experiencing adverse effects on their health. A toxicity assessment is conducted for all COPCs that are screened into the assessment and considers possible modes of toxicity following different routes and durations of exposure. The toxicity assessment provides an estimate of how much chemical exposure may occur without unacceptable health effects occurring from lifetime exposure (or a significant portion of a lifetime) and provides the basis to interpret exposure rates.

Chemical compounds may exhibit different toxicological mechanisms of action depending on the route (i.e., ingestion, inhalation, dermal) of exposure. Different toxicological reference values (TRVs) are often provided for oral and inhalation exposure routes, depending on whether toxicity studies have been conducted and assessed for that route. In general, very few studies are available for dermal TRVs. For all compounds, the oral TRV value was adopted to represent the dermal TRV. The dermal exposure estimates were modified through the use of a Relative Absorption Factor (RAF) following guidance provided by Health Canada (2010b).

The characterization of potential hazards associated with carcinogenic and non-carcinogenic exposures is assessed separately, based on the differences in the way these two types of chemicals may produce effects in the body, as described below.

2.3.1 Non-Carcinogens

For non-carcinogenic COPC, it is assumed that there is a threshold dose or concentration below which there will not be an adverse effect. TRVs for non-carcinogenic COPC are based on point estimates from a range of quantitative dose-response data (e.g., no-observed-adverse-effect level [NOAEL], lowest-observed-adverse-effect level [LOAEL]). These point estimates are often divided by uncertainty factors to derive the final TRV or Reference Dose (RfD). Uncertainty factors can account for intra-species variability (e.g., individual sensitivity and variability), inter-species variability (if animal data are used), extrapolation from sub-chronic to chronic exposure durations, and use of LOAELs. In addition, modifying factors can be applied to reflect the quality of the toxicological database. The final non-carcinogenic TRV represents a dose or air concentration for a COPC at which adverse effects are not expected to occur in populations of humans for the duration of exposure specified. For the purposes of this risk assessment, aluminum and iron are considered non-carcinogenic.

2.3.2 Carcinogens

The underlying assumption of regulatory risk assessment for compounds with known or assumed potential carcinogenic effects is that no threshold dose exists. In other words, it is assumed that a finite level of risk is associated with any dose above zero. Theoretically, even a single molecule could cause some level of risk. For carcinogenic effects, a two-step evaluation is used, in which the compound is assigned a weight-of-evidence classification, and then a cancer slope factor (CSF) is calculated. The weight-of-evidence classification is based on the likelihood of a compound being a human carcinogen. For the purposes of this risk assessment, arsenic is considered a carcinogen.

2.3.3 Toxicity Reference Values (TRVs)

An essential part of the risk assessment is the identification of appropriate toxicity values. This is typically done by a literature review of published toxicological assessments. Toxicity values have been established by several agencies including Health Canada, the USEPA, and the World Health Organization (WHO). Preference has been given to Health Canada values and where these are not established, values from the USEPA's Integrated Risk Information System (IRIS) have been employed as the best basis upon which to evaluate health risks. Summaries of the toxicity values selected for inclusion in the risk assessment are provided in Table 5.

TABLE 5 Selected Toxicity Values

Chemical	TRV		Route of Exposure	Source Agency
Aluminum	1.00 mg/kg-day	RfD	Ingestion	US EPA Region III (2014) [1]
Arsenic	1.80 $(mg/kg\text{-}day)^{-1}$	CSF	Ingestion	Health Canada (2010b)
	27 $(mg/kg\text{-}day)^{-1}$	CSF	Inhalation	Health Canada (2010b)
Iron	0.70 mg/kg-day	RfD	Ingestion	US EPA Region III (2014) [1]

[1] Regional Screening Level (RSL) Resident Soil Table, May 2014. Original source = PPRTV Screen

2.3.4 Bioavailability

Bioavailability refers to "the fraction of the total amount of material in contact with a body portal-of-entry (lung, gut, skin) that enters the blood". For example, not all COPC present in soil may be absorbed through the gut. Relative bioavailability is the amount of a substance entering the blood via a particular route of exposure (*e.g.*, gastrointestinal) relative to the study used to derive the toxicity values. These factors are then applied in the risk assessment to more realistically represent the portion of contaminants held in soil that are available. For instance, a relative bioavailability factor of 0.5 indicates that 50% of the administered (*e.g.*, ingested) toxicant is absorbed into the bloodstream compared to the absorption in the toxicity study.

Soil ingestion can be a significant exposure pathway, especially for young children. Subsequent to ingestion, a portion of the COPC in soil is released and absorbed during the digestive process. This fraction that is released into the gastrointestinal tract is termed the "bioaccessible" fraction. The "bioavailable" fraction is the fraction of the COPC absorbed from the gastrointestinal tract and into the bloodstream.

COPC bioavailability from soil can be significantly lower than bioavailability from diet. Toxicity studies used to derive Toxicity Reference Values (TRVs) are typically based on administered doses in diet. The relative bioavailability via oral and inhalation routes of exposure is conservatively assumed to be equal to 1. The bioavailability factors used in this assessment are provided in Table 6 and were sourced from Health Canada (2010b). Relative dermal absorption factors were not available from health Canada (2010b), nor were values recommended in the US EPA RBC tables from which the screening guidelines and TRVs for aluminum and iron were sourced. Following Health Canada guidance (2010b), a dermal relative absorption factor of 1% was applied for aluminum and iron.

> *For several inorganics, the quantitative data were considered insufficient to estimate chemical-specific dermal absorption fractions. The value of 1% was assigned to these inorganics, based on an analysis of other inorganics deemed to have sufficient data.* .

TABLE 6 Bioavailability Factors

Chemical	Bioavailability Factor (or Relative Absorption Factor)		
	Oral	Dermal	Inhalation
Aluminum	1 [a]	0.01 [b]	1 [a]
Arsenic	1 [a]	0.03 [b]	1 [a]
Iron	1 [a]	0.01 [b]	1 [a]

[a] Assumed
[b] Health Canada (2010b).

2.4 RISK CHARACTERIZATION

Risk characterization compares the estimated exposures with the identified toxicity values for each substance to determine the potential for an adverse effect.

In determining the risk associated with soil-related exposures to total arsenic, the estimated dose multiplied by slope factors are compared to the established risk factors (i.e. 10^{-5}). Details of the equations and input parameter values used in the risk assessment are provided in Appendix B, including a sample calculation. The model results indicate that the risk to the potential human receptors were all below the 10^{-5} risk factor.

2.4.1 Human Health Risk Assessment Results

The calculated SSTLs and corresponding maximum concentrations are presented in Table 7. The risk assessment spreadsheets are provided in Appendix B.

TABLE 7 Human Health Risk Assessment Results

Receptor	Maximum Concentration (mg/kg)	SSTL (mg/kg) Construction Worker	Comment
Aluminum	19,000	190,000	Maximum is less than SSTL. Further assessment is not required for the Site.
Arsenic	61	127	Maximum is less than SSTL. Further assessment is not required for the Site.
Iron	33,000	146,000	Maximum is less than SSTL. Further assessment is not required for the Site.

As shown, maximum measured concentrations of COPC met their respective SSTLs for the identified human health receptors (construction worker). No further assessment is warranted with respect to human health at this time.

Note that soil with concentrations exceeding NS CSR guidelines has been identified at the site, which may require further assessment and disposal costs in the event off-site disposal is required.

2.5 UNCERTAINTY ANALYSIS

As a result of the scientific investigations, literature reviews, and risk assessment guidance that have been undertaken or followed in the preparation of this HHRA, it is believed that the risk assessment results present a reasonable, yet conservative, evaluation of the risk to human receptors present at the Site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable, yet conservative, assumptions were made, or data were selected, in order to ensure that risks were not underestimated. A summary of the uncertainty analysis is provided in Appendix B.

3.0 ECOLOGICAL RISK ASSESSMENT

The purpose of this ERA is to evaluate the potential for ecological receptors to be harmed as a result of exposure to concentrations of COPCs found at the site. As with the HHRA, the ERA process follows a recognized framework that progresses from a qualitative initial phase (*i.e.*, problem formulation), through exposure and toxicity (effects) analysis, and culminates in a quantitative risk characterization. Following this framework, the limitations and uncertainties inherent in the ERA process, and the relevance of these limitations and uncertainties to the conclusions stemming from the assessment, are discussed. This ERA has been conducted in a manner consistent with accepted ERA methodologies and guidance published by regulatory agencies, including the CCME (1996; 1997), the USEPA (1998), and (FCSAP, 2010a, b and FCSAP 2012a,b).

3.1 PROBLEM FORMULATION

Problem formulation is the first step of risk assessment process and provides the framework upon which the ERA is developed. The problem formulation identifies the nature of issues associated with contamination at the site and the potential interaction between contaminants and ecological receptors (summarized by the ecological conceptual site model). The framework used for this ERA considered a qualitative evaluation of plant and soil invertebrate communities and effects at the population level for common mammals and birds, and at the individual level for species identified as endangered, threatened, or extirpated under the *Species at Risk Act* (SARA) or similar provincial legislation.

As there is no single set of ecological values or resources to be protected that can be generally applied to every site, the initial conceptual site model constructed for this site, which was based on a desktop review of the site and similar sites, was re-evaluated based on habitat and wildlife observed during site visits, as well as professional judgment.

3.1.1 Exposure Pathway Assessment

In order for chemicals to have deleterious effects, they need to gain access to the organism or receptor. The route by which this occurs is referred to as an exposure pathway, and is dependent on the nature of both the chemical and receptor. A complete exposure pathway is one that meets the following four criteria (USEPA, 1989):

- A source of COPC must be present;
- Transport mechanisms and media must be available to move the chemicals from the source to the ecological receptors;
- An opportunity must exist for the ecological receptors to contact the affected media; and
- A means must exist by which the chemical is taken up by ecological receptors, such as direct contact, ingestion or inhalation.

The relevant exposure pathways are summarized in Table 8 which includes a qualitative evaluation of each pathway and a discussion about whether the pathways are complete. Those complete hazard-exposure-receptor combinations considered to have the highest likelihood to contribute to an ecological health risk were carried forward in the ERA.

TABLE 8 Potential Exposure Pathways for Ecological Receptors

Exposure Pathway Description	Complete Pathway?	Carried Forward for Analysis?	Justification
Ingestion of soil	**Yes**	**Yes**	COPCs are present in surface and subsurface soils at the site. Although terrestrial receptors may come into contact with chemicals identified in surface soil, direct dermal contact is considered unlikely due to the presence of fur or feathers. However, ecological receptors may ingest soil through grooming or other related behaviors. As such, the ingestion of soil containing COPCs was considered further within this ERA.
Dermal contact with soil			
Ingestion of terrestrial invertebrates, vegetation, or small animal prey living at the site and exposed to contaminated soil	**Yes**	**Yes**	Terrestrial receptors on the site may ingest terrestrial invertebrates and terrestrial vegetation that are living at the site and have been exposed to the impacts in surface soil. Some receptors prey on small animals.
Contamination in soil leaching to aquatic environments	**Yes**	**Yes**	The Halifax Harbour is downgradient of the Site. Therefore, the soil leaching to marine aquatic receptors pathway was carried forward in the ERA.
Ingestion of surface water, freshwater, sediments, aquatic plants, invertebrates or fish	No	No	There are no surface water bodies on the Site.
Dermal contact with surface water or freshwater sediments			
Dermal contact with marine water or sediments	No	No	There are no surface water bodies on the Site.

3.1.2 Ecological screening

Ecological screening was conducted to identify potential chemical hazards to ecological health by comparing concentrations of COPCs to the CCME media specific criteria. The identified potentially affected environmental media are surface soil and groundwater. For the ERA screening, soil and groundwater analytical data are compared to applicable environmental guidelines. The soil and groundwater data selected for use in this risk assessment were compiled from the Phase II ESA (AMEC, 2014).

3.1.2.1 Soil

As presented in Tables 1 through 4, Appendix A, COPCs with concentrations in soil in excess of CCME SQGs include arsenic, lead, PHCs (F3 and F4G), and PAHs (phenanthrene). Note that a comparison to the NS CSR, completed for off-site disposal considerations has been discussed within the HHRA and only those COPC that exceed CCME SQGs are carried forward into the ERA screening.

The maximum soil concentration and ecological health screening guideline for COPCs are displayed in Table 9. The ecological health screening guideline for direct contact is presented, where available, based on the exposure pathway screening presented in Table 8.

TABLE 9 Ecological Health Screening of Soil

Parameter	Maximum Concentration (mg/kg)	Ecological Health Screening Guidelines (mg/kg)	Comment
Arsenic	61	26[1]	**Maximum exceeds the ecological health screening guideline. Further assessment required.**
Lead	180	600[1]	Maximum concentration is below the ecological health screening guideline. No further assessment required.
F3	445	1,700[2]	Maximum concentration is below the ecological health screening guideline. No further assessment required.
F4G	14,000	3,300[2]	**Maximum exceeds the ecological health screening guideline. Further assessment required.**
Phenanthrene	0.29	12[3]	Maximum concentration is below the ecological health screening guideline. No further assessment required.

Notes:
1. CCME SQG
2. CCME CWS for PHC, ecological soil contact
3. OMOE Table 3, Full Depth, Non-potable Water Scenario, coarse-grained soil, commercial/industrial land use, ecological soil contact

Bold result indicates Max exceeds screening guidelines.

In summary, arsenic in soil at the building site and PHC F4G in soil at the location of the possible former garage remain at concentrations above ecological screening guidelines and further assessment is required.

3.1.2.2 Groundwater

As presented in Tables 5 through 8, Appendix A, mercury concentrations in water exceed the FIGWQG. No exceedances of the NS CSR groundwater standards were noted. The maximum groundwater concentration and ecological health screening guideline for mercury are displayed in Table 10. The ecological health screening guideline for marine aquatic life is presented, based on the exposure pathway screening presented in Section 3.1.1

TABLE 10 Ecological Screening of Groundwater

Parameter	Maximum Concentration (µg/L)	Aquatic Life Criteria [1] (µg/L)	Comment
Mercury	0.08	0.016	The maximum measured concentration exceeds the guideline for MAL.

Notes:
1. FIGWQG, Environment Canada, 2012

Bold result indicates maximum exceeds screening guidelines.

The FIGWQG for mercury is the CCME surface water quality guideline for the protection of marine aquatic life (meant to be applied directly to surface water analyses or groundwater within 10m of the receiving body).

However, the FIGWQG states that:

"*For inorganic substances, the Canadian Water Quality guidelines for the Protection of Aquatic Life are applied directly to groundwater, due to the high level of variability in the behaviour of inorganic substances in groundwater and the lack of biodegradation of these substances ... For most contaminants, including petroleum hydrocarbons and metals, if there are no surface water bodies within 500 m then the contaminants are unlikely to reach surface water*"

As the harbour is located over 200 metres from the Site, it is likely that some attenuation and dilution of the COPC will take place prior to discharge into the receiving environment (the harbour) and that applying a surface water guideline directly to a groundwater source located over 200 m away is overly conservative. The OMOE publishes guidelines for non-potable groundwater, protective of aquatic receptors, based on a separation distance of 30 metres (site to surface water body). The OMOE groundwater guideline for mercury protective of aquatic life is $1.3x10^{13}$ µg/L (which is well above the solubility limit of 60 µg/L). The maximum measured mercury concentration at the Site (0.08 µg/L) is below this groundwater guideline and also below the Ontario background value of 0.1 µg/L. Additionally, the CCME MAL criterion for mercury (which was adopted as the FIGWQG) is based on a lowest observed adverse effect level (LOAEL) of 0.16 µg/L. The highest concentration of mercury observed in Site groundwater was 0.08 µg/L. Therefore, the risk to aquatic organisms in Halifax Harbour from existing mercury concentrations in Site groundwater is negligible. No further assessment of mercury in groundwater is required at this time.

3.1.3 Habitat Description

3.1.3.1 Proposed Building Area

As previously discussed, the area of the Site where the building will be constructed is highly disturbed, consisting of dumped fill that has been extensively test-pitted for the purposes of geotechnical, environmental, and UXO investigations. Following construction, this area will consist of a building, asphalt parking areas, and concrete walkway(s). While there will likely be landscaped areas (grass, flowers, shrubs) present, these areas will be man-made (using imported, clean top-soil) and maintained (or mowed) and as such, are not considered to represent functional ecological habitat. Therefore, for contact with contaminants in soil, there will be no plausible ecological exposure pathways present and no valuable ecological components (VECs) would be identified. Since there will be no functional habitat in this area of the Site, there are no complete exposure pathways and risk to VECs is negligible. Based on the future site development plans (i.e., building and asphalt parking over an in-filled area), no further evaluation of direct soil contact and assessment of terrestrial receptors is required. As such, exposure to remaining arsenic-impacted soil in this area is unlikely and is not considered further in this ERA.

3.1.3.2 Former Garage Area

The area of the site located at the south side of the property (adjacent to Highway 7), which is the location of the possible former garage, is wooded. Based on observations and a review of available land-based and aerial photographs taken of the site, the vegetative communities in this area of the Site appeared to be generally healthy. Soil invertebrates were observed

during soil sampling in this area. Therefore, significant adverse effects to plant and soil invertebrate communities in this area of the Site are not anticipated and plant and soil invertebrate communities appear functionally intact.

The only COPC that exceeded ecological screening guidelines in this area was F4G in one sample (HS02). Only low levels of PHC F1, F2, and F3 (i.e., all <CCME SQGs) were detected in the soil samples taken from this area. Ecological risks due to the reported F4G concentration in HS02 are considered unlikely for the following main reasons:

- The elevated concentration represents a small area of the contiguous habitat available on the remaining (undisturbed) portions of the Site and of the larger PID (i.e., the area beyond the Site). The primary focus of ERA is on risk at the population level. The F4G concentration in soil would affect the habitat of only a few individual birds or mammals, and would be unlikely to result in an adverse effect at the population level.

- The existing CCME CWS F4 guideline was calculated based on extrapolating the toxicity of whole crude oil (which contains lighter, more toxic components). CCME CWS (2008) states that "*Since the whole product contained appreciable portions of CWS fractions F1, F2 and F3 in addition to the heavier hydrocarbon fraction (including asphaltenes) found in F4, there is a strong likelihood that the actual observed toxicity thresholds would occur at higher soil concentrations had the test organisms been exposed to F4 alone"*. F4 is largely insoluble with low bioavailability and is unlikely to be substantially toxic to plants and soil invertebrates.

- The F4G laboratory method is a gravimetric determination (i.e., by weight) of all extractable organic material in the soil sample and is not specific to F4 nor to petroleum hydrocarbons. Sample HS02 was a highly organic sample from the forest floor; hence, the reported F4G concentration likely includes a significant portion of non-petrogenic hydrocarbons.

Therefore, potential risks to ecological receptors from the reported F4G concentration in HS02 are considered unlikely.

3.2 UNCERTAINTY ANALYSIS

As a result of the scientific investigations, literature reviews, and risk assessment guidance followed in the preparation of this ERA, it is believed that the risk assessment results present a reasonable yet conservative evaluation of the risk to ecological receptors present at the site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable yet conservative assumptions were made, or data were selected, in order to ensure that risks were not underestimated. Uncertainties are inherent in every aspect of the ERA process. The most effective way to decrease uncertainty is to collect site-specific data. Application of site-specific information assists in reduction of uncertainty by allowing removal of generic data.

Despite incorporation of a considerable amount of site-specific data, the ERA incorporates assumptions that lead to uncertainty. Significant aspects of uncertainty inherent in this risk assessment are discussed qualitatively in Appendix C.

4.0 CONCLUSIONS AND RECOMMENDATIONS

AMEC completed a HHERA for two areas of potential environmental concern at the Site. The conclusions are summarized below.

4.1 CONCLUSIONS

The HHRA identified a variety of potential receptors including an adult inmate, visitor, adult facility worker, and construction worker; however, the proposed development for the Site includes a building, paved parking area(s), and concrete walkway(s), and landscaped areas (maintained lawn, flowers, shrubs, etc). It does not include areas of bare soil or planned recreationally attractive areas. Therefore, direct contact with impacted soil (the only active exposure pathway identified) is unlikely for the planned site use and identified receptors, with the exception of the construction worker. Based on the results of the HHRA, substantive health risks to the identified receptor (construction workers) are not expected as a result of remaining trace metal concentrations in soil. It is assumed that the impacted fill material will be reworked, compacted and covered by the Site development (i.e., building, asphalt parking area(s), concrete walkway(s), and landscaped areas).

For ecological receptors, the risk to ecological receptors from arsenic in soil in the area of the proposed building is negligible. The risk to aquatic receptors due to groundwater concentrations of mercury is low based on the distance to the Halifax Harbour and the low concentrations observed in groundwater. The area of the possible former garage exhibited concentrations of F4G greater than the CCME CWS for PHC (CCME 2008) based on soil contact; however, a qualitative assessment of the impacts concluded that risk to ecological receptors is unlikely.

4.2 RECOMMENDATIONS

As noted throughout the report, this assessment has been undertaken for the areas sampled within the Site only (the area of the proposed development and the area of the possible former garage), and on the basis of several assumptions regarding future construction, including:

- that the proposed facility will not use more of the PID than that identified as the Site (i.e., the currently cleared area of the Site),
- that the building will be constructed on the current area of infilling,
- that the assumptions regarding land use and potential receptors are valid, and
- that any areas not covered by the building footprint, asphalt parking, or concrete walkways will be landscaped (i.e., covered with clean topsoil and grass/flowers/shrubs, etc.) and that this cover will be maintained and not allowed to deteriorate.

Should these assumptions cease to be valid or should the anticipated land use change, the HHERA will need to be revisited.

No further environmental investigation is recommended for the Site at this time. Should off-site disposal of the fill be required, further assessment related to the NS CSR may be required and off-site disposal costs will be incurred.

It is noted that this risk assessment does not address any potential risks related to possible UXO on the Site and any further site work needs to be completed under UXO supervision.

A risk management plan has been prepared under separate cover.

5.0 CLOSURE

This report was prepared for the exclusive use of Public Works and Government Services Canada and Correctional Service Canada, and is intended to provide a human health and ecological risk assessment for the Site. 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 the third party. Should additional parties require reliance on this report, written authorization from AMEC will be required. With respect to third parties, AMEC has no liability or responsibility for losses of any kind whatsoever, including direct or consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

The report is based on data and information collected during the investigations (AMEC 2011, AMEC 2014, Gemtec 2013a and Gemtec 2013b) of the property. It is based solely on a review of historical information and data obtained by AMEC as described in this report, and discussion with a representative of the owner/occupant, as reported herein. Except as otherwise maybe specified, AMEC disclaims any obligation to update this report for events taking place, or with respect to information that becomes available to AMEC after the time during which AMEC completes the HHERA.

In evaluating the property, AMEC has relied in good faith on information provided by other individuals noted in this report. AMEC has assumed that the information provided is factual and accurate. In addition, the findings in this report are based, to a large degree, upon information provided by the current owner/occupant. AMEC accepts no responsibility for any deficiency, misstatement or inaccuracy contained in this report as a result of omissions, misinterpretations or fraudulent acts of persons interviewed or contacted.

AMEC makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this report, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel. This Report is also subject to the further Standard Limitations contained in Appendix D.

We trust that the information presented in this report meets your current requirements. Should you have any questions, or concerns, please do not hesitate to contact the undersigned.

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APPENDIX A

ANALYTICAL DATA AND LABORATORY CERTIFICATES OF ANALYSIS

TABLE 1 METALS IN SOIL
(All units in mg/kg)

		Sample ID	**TP1-01**	**TP1-03**	**TP2-02**	**TP2-03**	**TP3-01**	**DUP2** (Duplicate of TP3-01)	**TP3-02**	**TP4-02**
		Sample Depth	0.3	2	1.0	2	0.3		1.0	1
		Date Sampled	9-Jun-14	9-Jun-14	9-Jun-14	9-Jun-14	9-Jun-14	9-Jun-14	9-Jun-14	9-Jun-14
Parameters	**CCME SQG[a] Residential / Parkland**	**NS CSR[b]**								
Acid Extractable Aluminum (Al)	NGA	15,400	**17,000**	**19,000**	**18,000**	12,000	15,000	**16,000**	**17,000**	15,000
Acid Extractable Antimony (Sb)	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2
Acid Extractable Arsenic (As)	12	31	25	28	28	**32**	**49**	**39**	**50**	**39**
Acid Extractable Barium (Ba)	500	10,000	43	50	38	26	25	28	26	20
Acid Extractable Beryllium (Be)	4	38	<2	<2	<2	<2	<2	<2	<2	<2
Acid Extractable Bismuth (Bi)	NGA	NGA	<2	<2	<2	<2	<2	<2	<2	<2
Acid Extractable Boron (B)	NGA	4,300	<50	<50	<50	<50	<50	<50	<50	<50
Acid Extractable Cadmium (Cd)	10	14	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Acid Extractable Chromium (Cr)	64	220	23	24	23	18	20	21	21	20
Acid Extractable Cobalt (Co)	50	22	12	12	13	10	11	12	12	11
Acid Extractable Copper (Cu)	63	1,100	35	33	35	27	24	27	24	25
Acid Extractable Iron (Fe)	NGA	11,000	**31,000**	**33,000**	**32,000**	**25,000**	**27,000**	**28,000**	**28,000**	**27,000**
Acid Extractable Lead (Pb)	140	140	88	110	78	55	34	38	35	30
Acid Extractable Lithium (Li)	NGA	NGA	26	26	26	21	22	24	23	23
Acid Extractable Manganese (Mn)	NGA	NGA	590	550	650	500	600	620	590	630
Acid Extractable Mercury (Hg)	6.6	6.6	0.1	0.2	0.1	0.1	<0.1	<0.1	<0.1	<0.1
Acid Extractable Molybdenum (Mo)	10	110	<2	<2	<2	<2	<2	<2	<2	<2
Acid Extractable Rubidium (Rb)	NGA	NGA	28	27	27	24	25	26	26	25
Acid Extractable Nickel (Ni)	50	330	11	10	9	8	8	9	10	8
Acid Extractable Selenium (Se)	1	80	<1	<1	<1	<1	<1	<1	<1	<1
Acid Extractable Silver (Ag)	20	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acid Extractable Strontium (Sr)	NGA	9,400	11	12	10	11	11	11	12	8
Acid Extractable Thallium (Tl)	1	1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acid Extractable Tin (Sn)	50	9,400	9	12	6	9	<2	<2	<2	<2
Acid Extractable Uranium (U)	23	23	0.7	0.7	0.8	0.6	0.6	0.6	0.6	0.6
Acid Extractable Vanadium (V)	130	39	24	22	21	16	19	20	20	17
Acid Extractable Zinc (Zn)	200	5,600	140	110	110	77	87	94	92	82

General Notes:

(a) CCME Soil Quality Guidelines (SQG), Residential Land Use (Updated to 2012)

(b) Nova Scotia Contaminated Sites Regulations - Residential/Parkland land use, Coarse grained soil. July 6, 2013.

NC = Not Calculated, NGA = No Guideline Available

Shaded = Exceedance of CCME SQG

Bold Underlined = Exceedance of NS CSR

TABLE 1 METALS IN SOIL
(All units in mg/kg)

		Sample ID	**TP4-04**	**DUP1** (Duplicate of TP4-04)	**TP5-01**	**TP5-03**	**HS01**	**HS02**
		Sample Depth	3.0	3.0	0.3	2.0	0.3	0.3
		Date Sampled	10-Jun-14	10-Jun-14	9-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14
Parameters	**CCME SQG[a] Residential / Parkland**	**NS CSR[b]**						
Acid Extractable Aluminum (Al)	NGA	15,400	**18,000**	**17,000**	**16,000**	15,000	11,000	2,600
Acid Extractable Antimony (Sb)	20	7.5	<2	<2	<2	<2	<2	<2
Acid Extractable Arsenic (As)	12	31	**52**	**46**	**36**	**61**	23	4
Acid Extractable Barium (Ba)	500	10,000	30	23	30	22	7	47
Acid Extractable Beryllium (Be)	4	38	<2	<2	<2	<2	<2	<2
Acid Extractable Bismuth (Bi)	NGA	NGA	<2	<2	<2	<2	<2	<2
Acid Extractable Boron (B)	NGA	4,300	<50	<50	<50	<50	<50	<50
Acid Extractable Cadmium (Cd)	10	14	<0.3	<0.3	<0.3	<0.3	<0.3	0.4
Acid Extractable Chromium (Cr)	64	220	23	22	21	19	6	5
Acid Extractable Cobalt (Co)	50	22	14	14	12	12	<1	<1
Acid Extractable Copper (Cu)	63	1,100	32	30	38	26	2	29
Acid Extractable Iron (Fe)	NGA	11,000	**30,000**	**29,000**	**31,000**	**26,000**	11,000	4,500
Acid Extractable Lead (Pb)	140	140	39	33	62	25	4.2	**180**
Acid Extractable Lithium (Li)	NGA	NGA	26	25	25	23	<2	<2
Acid Extractable Manganese (Mn)	NGA	NGA	920	730	630	550	24	48
Acid Extractable Mercury (Hg)	6.6	6.6	<0.1	<0.1	0.1	<0.1	<0.1	0.2
Acid Extractable Molybdenum (Mo)	10	110	<2	<2	<2	<2	<2	<2
Acid Extractable Rubidium (Rb)	NGA	NGA	30	28	28	25	<2	10
Acid Extractable Nickel (Ni)	50	330	9	8	9	7	2	4
Acid Extractable Selenium (Se)	1	80	<1	<1	<1	<1	<1	<1
Acid Extractable Silver (Ag)	20	77	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
Acid Extractable Strontium (Sr)	NGA	9,400	10	10	12	8	<5	10
Acid Extractable Thallium (Tl)	1	1	0.1	<0.1	0.1	<0.1	<0.1	0.1
Acid Extractable Tin (Sn)	50	9,400	<2	<2	3	<2	<2	3
Acid Extractable Uranium (U)	23	23	0.7	0.7	0.6	0.5	0.3	0.2
Acid Extractable Vanadium (V)	130	39	19	18	18	15	**71**	26
Acid Extractable Zinc (Zn)	200	5,600	95	90	110	76	7	23

General Notes:

(a) CCME Soil Quality Guidelines (SQG), Residential Land Use (Updated to

(b) Nova Scotia Contaminated Sites Regulations - Residential/Parkland lanc

NC = Not Calculated, NGA = No Guideline Available

Shaded = Exceedance of CCME SQG

Bold Underlined = Exceedance of NS CSR

TABLE 2: PETROLEUM HYDROCARBONS IN SOIL
(All units in mg/kg)

			Sample ID	TP1-01	TP2-02	TP3-02	TP4-04	DUP1 (Duplicate of TP4-04)	TP5-03	HS01	HS02
			Depth (m)	0.3	1.0	1.0	3.0	3.0	2.0	0.3	0.3
			Date Sampled	9-Jun-14	9-Jun-14	9-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14
Parameters	**CCME SQG[a]**	**CWS[b]**	**NS CSR[c]**								
Benzene	0.03	---	0.099	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	0.37	---	77	0.08	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Ethylbenzene	0.082	---	30	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Xylene (Total)	11	---	8.8	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6 - C10 (less BTEX)	NGA	30 (F1)	NGA	<3	<3	<3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons	NGA	150 (F2)	NGA	<10	<10	<10	<10	<10	<10	<10	<10
>C16-C21 Hydrocarbons	NGA	300 (F3)	NGA	<10	<10	<10	<10	<10	<10	<10	65
>C21-<C32 Hydrocarbons	NGA		NGA	56	26	27	<20	<20	<20	35	380
Modified TPH (Tier1)	NGA	---	1,100	56	26	27	<20	<20	<20	35	440
Reached Baseline at C32	N/A	N/A	N/A	Yes	Yes	Yes	NA	NA	NA	Yes	No
F4G-sg (Grav. Heavy Hydrocarbons)	---	2800	---	---	---	---	---	---	---	---	14,000
Hydrocarbon Resemblance	N/A	N/A	N/A	Lube oil fraction	Lube oil fraction	Lube oil fraction	NA	NA	NA	Lube oil fraction	Lube oil fraction

General Notes:

(a) CCME Canadian Soil Quality Guidelines (CCME, 2013), Residential/Parkland, Surface Soil, Coarse Grained Soil. The CCME human health based guidelines shown for benzene are based on a target cancer risk of 10^{-5}, consistent with Health Canada and Atlantic Canada Regulators recommendations. To be conservative surface soil criteria have been applied to both surface and subsurface soil samples, in the event that the soil at the site becomes reworked (ie. test pitting, excavation etc.).

(b) CCME Canada Wide Standards for Petroleum Hydrocarbons in Soil, User Guidance (CCME, 2008)Coarse-Grained Surface Soils, Residential/Parkland Land Use To be conservative surface soil criteria have been applied to both surface and subsurface soil samples, in the event that the soil at the site becomes reworked (ie. test pitting, excavation etc.).

(c) Nova Scotia Contaminated Sites Regulations - Residential/Parkland land use, Coarse grained soil. July 6, 2013.

NGA = No Guideline Available
N/A = Not Applicable
Shaded = Exceedance of CCME
Bold Underlined = Exceedance of NS CSR

TABLE 3: PAHs IN SOIL
(All units in mg/kg)

			Sample ID	**TP1-01**	**TP2-02**	**TP3-02**	**TP4-04**	**DUP1** (Duplicate of TP4-04)	**TP5-03**	**HS01**	**HS02**
			Depth (m)	0.3	1.0	1.0	3.0	3.0	2.0	0.3	0.3
			Date Sampled	9-Jun-14	9-Jun-14	9-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14
	CCME PEFs (for B(a)P TPE	**CCME SQG[a] Environmental Health**	**NS CSR [b]**								
1-Methylnaphthalene	N/A	NGA	72	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	N/A	NGA	72	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	N/A	NGA	3,900	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	N/A	NGA	4.5	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	N/A	2.5	24,000	0.08	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benz(a)anthracene	0.1	1	NGA	0.21	0.18	0.01	<0.01	<0.01	<0.01	<0.01	0.03
Benzo(a)pyrene	1	20	NGA	0.24	0.21	0.01	<0.01	<0.01	<0.01	<0.01	<0.08
Benzo(b)fluoranthene	0.1	1	NGA	0.19	0.17	0.01	<0.01	0.01	<0.01	<0.01	<0.04
Benzo(g,h,i)perylene	0.01	NGA	NGA	0.14	0.13	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(j)fluoranthene	0.1	NGA	NGA	0.13	0.11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	0.1	1	NGA	0.12	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	0.01	NGA	NGA	0.20	0.18	0.02	<0.01	0.01	<0.01	<0.01	0.04
Dibenz(a,h)anthracene	1	1	NGA	0.04	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	N/A	50	3,500	0.42	0.39	0.03	<0.01	<0.01	0.01	<0.01	0.07
Fluorene	N/A	NGA	2,700	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	0.1	1	NGA	0.13	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	N/A	0.013 (0.6)[d]	2.2	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	N/A	NGA	NGA	0.06	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	N/A	0.046 (5)[e]	NGA	0.29	0.28	0.02	<0.01	<0.01	<0.01	<0.01	0.06
Pyrene	N/A	10	2,100	0.36	0.32	0.03	<0.01	<0.01	<0.01	<0.01	0.05
B(a)P Total Potency Equivalents (TPE) [c]	N/A	5.3	NGA	0.3614	0.3211	0.0188	0.0126	0.0132	0.0126	0.0126	0.0520

General Notes:

(a) CCME = Canadian Council of Ministers of the Environment (CCME), Canadian Soil Quality Guidelines, Polycyclic Aromatic Hydrocarbons Commercial or Residential land use, 2008, revised 2010. CCME 1991 interim guidelines have been applied to applicable parameters for environmental health, soil contact pathway.

(b) Nova Scotia Contaminated Sites Regulations - Residential/Parkland land use, Coarse grained soil. July 6, 2013.

(c) Benzo(a) Pyrene Total Potency (B(a)P TPE) is the sum of estimated cancer potency relative to all B(a)P for all potentially carcinogenic unsubstituted PAHs. The B(a)P TPE for a soil sample is calculated by multiplying the concentration of each PAH in the sample by its B(a)P Potency Equivalent Factor (PEF), as indicated above, and summing the products. Where results are <RDL, 1/2 the RDL was used in the B(a)P TPE calculation.

(d) 1997 provisional SQG_E for use if surface water is not a concern at the Site.

(e) 1991 Interim soil quality guideline for use if surface water is not a concern at the Site.

NGA = No guideline available

Shaded = Exceedance of CCME SQG

Bold Underlined = Exceedance of NS CSR

TABLE 4: VOCs IN SOIL
(All units in µg/kg)

		Sample ID	TP1-01	TP2-02	TP3-02	TP4-04	DUP1 (Duplicate of TP4-04)	TP5-03	HS01	HS02
		Sample Depth (m)	0.3	1.0	1.0	3.0	3.0	2.0	0.3	0.3
		Date Sampled	9-Jun-14	9-Jun-14	9-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14	10-Jun-14
Parameters	**CCME SQG[a]**	**NS CSR [b]**								
1,1,1-Trichloroethane	5,000	380	<30	<30	<30	<30	<30	<30	<30	<30
1,1,2,2-Tetrachloroethane	5,000	NGA	<30	<30	<30	<30	<30	<30	<30	<30
1,1,2-Trichloroethane	5,000	300	<30	<30	<30	<30	<30	<30	<30	<30
1,1-Dichloroethane	5,000	3,500	<30	<30	<30	<30	<30	<30	<30	<30
1,1-Dichloroethylene	5,000	50	<30	<30	<30	<30	<30	<30	<30	<30
1,2-Dichlorobenzene	1,000	10,000	<30	<30	<30	<30	<30	<30	<30	<30
1,2-Dichloroethane	5,000	50	<30	<30	<30	<30	<30	<30	<30	<30
1,2-Dichloropropane	5,000	50	<30	<30	<30	<30	<30	<30	<30	<30
1,3-Dichlorobenzene	1,000	420,000	<30	<30	<30	<30	<30	<30	<30	<30
1,4-Dichlorobenzene	1,000	670	<30	<30	<30	<30	<30	<30	<30	<30
Methyl t-butyl ether (MTBE)	NGA	50	<30	<30	<30	<30	<30	<30	<30	<30
Benzene	30	99	<30	<30	<30	<30	<30	<30	<30	<30
Bromodichloromethane	NGA	NGA	<30	<30	<30	<30	<30	<30	<30	<30
Bromoform	NGA	2,700	<30	<30	<30	<30	<30	<30	<30	<30
Bromomethane	NGA	50	<50	<50	<50	<50	<50	<50	<50	<50
Carbon Tetrachloride	5,000	50	<30	<30	<30	<30	<30	<30	<30	<30
Chlorobenzene	1,000	50	<30	<30	<30	<30	<30	<30	<30	<30
Chloroethane	NGA	NGA	<200	<200	<200	<200	<200	<200	<200	<200
Chloroform	5,000	50	<50	<50	<50	<50	<50	<50	<50	<50
cis-1,2-Dichloroethylene	5,000	3,400	<30	<30	<30	<30	<30	<30	<30	<30
cis-1,3-Dichloropropene	5,000	1,700	<30	<30	<30	<30	<30	<30	<30	<30
Dibromochloromethane	NGA	270	<30	<30	<30	<30	<30	<30	<30	<30
Ethylbenzene	82	30,000	<30	<30	<30	<30	<30	<30	<30	<30
o-Xylene	11,000	8,800	<30	<30	<30	<30	<30	<30	<30	<30
p+m-Xylene			<30	<30	<30	<30	<30	<30	<30	<30
Ethylene Dibromide	NGA	50	<30	<30	<30	<30	<30	<30	<30	<30
Methylene Chloride(Dichloromethane)	5,000	710	<30	<30	<30	<30	<30	<30	<30	<30
Styrene	5,000	16,000	<30	<30	<30	<30	<30	<30	<30	<30
Tetrachloroethylene	200	160	<30	<30	<30	<30	<30	<30	<30	<30
Toluene	370	77,000	<30	<30	<30	<30	<30	<30	<30	<30
Total Xylenes	11,000	8,800	<50	<50	<50	<50	<50	<50	<50	<50
trans-1,2-Dichloroethylene	5,000	84	<30	<30	<30	<30	<30	<30	<30	<30
trans-1,3-Dichloropropene	5,000	1,700	<30	<30	<30	<30	<30	<30	<30	<30
Trichloroethylene	10	360	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (FREON 11)	NGA	NGA	<30	<30	<30	<30	<30	<30	<30	<30
Vinyl Chloride	NGA	20	<20	<20	<20	<20	<20	<20	<20	<20
1,3-Dichloropropene (cis+trans)	NGA	1,700	<25	<25	<25	<25	<25	<25	<25	<25

General Notes:

(a) CCME Soil Quality Guidelines (SQG), Residential Parkland Land Use (Updated to 2012).

(b) Nova Scotia Contaminated Sites Regulations - Residential/Parkland land use, Coarse grained soil. July 6, 2013.

NC = Not Calculated, NGA = No Guideline Available

Shaded = Exceedance of CCME SQG

Bold Underlined = Exceedance of NS CSR

TABLE 5: METALS IN GROUNDWATER
(All units in µg/L)

	Sample ID	MW6	MW7
	Date Sampled	6-Jun-14	6-Jun-14
Parameters	**FIGWQG[a]**		
Dissolved Aluminum (Al)	NGA	14	53
Dissolved Antimony (Sb)	NGA	<1.0	<1.0
Dissolved Arsenic (As)	12.5	<1.0	<1.0
Dissolved Barium (Ba)	500 [b]	29	30
Dissolved Beryllium (Be)	100 [b]	<1.0	<1.0
Dissolved Bismuth (Bi)	NGA	<2.0	<2.0
Dissolved Boron (B)	5000 [b]	<50	<50
Dissolved Cadmium (Cd)	0.12	0.051	0.12
Dissolved Calcium (Ca)	NGA	32000	30000
Dissolved Chromium (Cr)	56	<1.0	3.0
Dissolved Cobalt (Co)	NGA	<0.40	<0.40
Dissolved Copper (Cu)	2 [b]	<2.0	<2.0
Dissolved Iron (Fe)	NGA	<50	<50
Dissolved Lead (Pb)	2 [b]	<0.50	<0.50
Dissolved Magnesium (Mg)	NGA	3300	3000
Dissolved Manganese (Mn)	NGA	<2.0	44
Total Mercury (Hg)	0.016	0.080	0.023
Dissolved Molybdenum (Mo)	NGA	<2.0	<2.0
Dissolved Nickel (Ni)	83 [b]	<2.0	<2.0
Dissolved Phosphorus (P)	NGA	<100	<100
Dissolved Potassium (K)	NGA	2600	2100
Dissolved Selenium (Se)	54 [b]	<1.0	<1.0
Dissolved Silver (Ag)	1.5 [b]	<0.10	<0.10
Dissolved Sodium (Na)	NGA	230000	160000
Dissolved Strontium (Sr)	NGA	110	97
Dissolved Thallium (Tl)	NGA	<0.10	<0.10
Dissolved Tin (Sn)	NGA	<2.0	<2.0
Dissolved Titanium (Ti)	NGA	<2.0	<2.0
Dissolved Uranium (U)	NGA	<0.10	<0.10
Dissolved Vanadium (V)	NGA	<2.0	<2.0
Dissolved Zinc (Zn)	10 [b]	<5.0	5.6

General Notes:

(a) Federal Interim Groundwater Quality Guidelines, protection of marine aquatic life (Updated 2012) adopted from CCME (surface water guidelines protective of marine aquatic life), unless otherwise noted [see (b)]

(b) adopted from BC Contaminated Sites Regulation, 10x factor for dilution in surface water was removed

NGA = No Guideline Available for marine aquatic life

NC = Not Calculated

Shaded = exceedance of FIGWQG

TABLE 6: PHCs IN GROUNDWATER
(All units in mg/L)

		Sample ID	**MW6**	**MW7**
		Date Sampled	6-Jun-14	6-Jun-14
Parameters	**FIGWQG [a]**	**NS CSR [b]**		
Benzene	0.2	2.6	<0.001	<0.001
Toluene	8.9	20	<0.001	<0.001
Ethylbenzene	11	20	<0.001	<0.001
Xylene (Total)	NGA	20	<0.002	<0.002
C6 - C10 (less BTEX)	NGA	NGA	<0.01	<0.01
>C10-C16 Hydrocarbons	NGA	NGA	<0.05	<0.05
>C16-C21 Hydrocarbons	NGA	NGA	<0.05	<0.05
>C21-<C32 Hydrocarbons	NGA	NGA	<0.1	<0.1
Modified TPH (Tier1)	NGA	20	<0.1	<0.1
Reached Baseline at C32	N/A	N/A	N/A	N/A
Hydrocarbon Resemblance	N/A	N/A	N/A	N/A

General Notes:

(a) Federal Interim Groundwater Quality Guidelines, protection of marine aquatic life (Updated 2012)

(b) Nova Scotia Contaminated Sites Regulations - Agricultural/Residential land use, non-potable groundwater, coarse grained soil. July 6, 2013.

NGA = No Guideline Available

NC = Not Calculated

Shaded = exceedance of CCME CWQG

Bold Underlined = exceedance of NS CSR

TABLE 7: PAHs IN GROUNDWATER
(All units in µg/L)

		Sample ID	MW6	MW7
		Date Sampled	6-Jun-14	6-Jun-14
Parameters	**FIGWQG [a]**	**NS CSR [b]**		
1-Methylnaphthalene	NGA	6,200	<0.050	<0.050
2-Methylnaphthalene	NGA	6,200	<0.050	<0.050
Acenaphthene	NGA	NGA	<0.010	<0.010
Acenaphthylene	NGA	36	<0.010	<0.010
Anthracene	NGA	NGA	<0.010	<0.010
Benzo(a)anthracene	NGA	NGA	<0.010	<0.010
Benzo(a)pyrene	NGA	NGA	<0.010	<0.010
Benzo(b)fluoranthene	NGA	NGA	<0.010	<0.010
Benzo(g,h,i)perylene	NGA	NGA	<0.010	<0.010
Benzo(j)fluoranthene	NGA	NGA	<0.010	<0.010
Benzo(k)fluoranthene	NGA	NGA	<0.010	<0.010
Chrysene	NGA	NGA	<0.010	<0.010
Dibenz(a,h)anthracene	NGA	NGA	<0.010	<0.010
Fluoranthene	NGA	NGA	<0.010	<0.010
Fluorene	NGA	NGA	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	NGA	NGA	<0.010	<0.010
Naphthalene	1.4	600	<0.20	<0.20
Perylene	NGA	NGA	<0.010	<0.010
Phenanthrene	NGA	NGA	0.014	<0.010
Pyrene	NGA	NGA	<0.010	<0.010

General Notes:

(a) Federal Interim Groundwater Quality Guidelines, protection of marine aquatic life (Updated 2012)

(b) Nova Scotia Contaminated Sites Regulations - Agricultural/Residential land use, non-potable groundwater, coarse grained soil. July 6, 2013.

NGA = No Guideline Available

NC = Not Calculated

Shaded = exceedance of CCME CWQG

Bold Underlined = exceedance of NS CSR

TABLE 8: VOCs IN GROUNDWATER
(All units in µg/L)

		Sample ID	MW6	MW7
		Date Sampled	6-Jun-14	6-Jun-14
Parameters	**FIGWQG [a]**	**NS CSR [b]**		
1,2-Dichlorobenzene	42	5,400	<0.5	<0.5
1,3-Dichlorobenzene	42	NGA	<1	<1
1,4-Dichlorobenzene	NGA	220	<1	<1
Chlorobenzene	25	14	<1	<1
1,1,1-Trichloroethane	NGA	640	<1	<1
1,1,2,2-Tetrachloroethane	NGA	32	<0.5	<0.5
1,1,2-Trichloroethane	NGA	47	<1	<1
1,1-Dichloroethane	NGA	320	<2	<2
1,1-Dichloroethylene	NGA	NGA	<0.5	<0.5
1,2-Dichloroethane	NGA	16	<1	<1
1,2-Dichloropropane	NGA	16	<0.5	<0.5
Benzene	NGA	2,600	<1	<1
Bromodichloromethane	NGA	NGA	<1	<1
Bromoform	NGA	3,800	<1	<1
Bromomethane	NGA	5.6	<0.5	<0.5
Carbon Tetrachloride	NGA	0.56	<0.5	<0.5
Chloroethane	NGA	NGA	<8	<8
Chloroform	NGA	3	<1	<1
Chloromethane	NGA	NGA	<8	<8
cis-1,2-Dichloroethylene	NGA	NGA	<0.5	<0.5
cis-1,3-Dichloropropene	NGA	NGA	<0.5	<0.5
Dibromochloromethane	NGA	1,100	<1	<1
Ethylbenzene	NGA	20,000	<1	<1
Ethylene Dibromide	NGA	5.2	<0.2	<0.2
Methylene Chloride(Dichloromethane)	NGA	3,400	<3	<3
o-Xylene	NGA	20,000	<1	<1
p+m-Xylene	NGA	20,000	<2	<2
Styrene	NGA	1,300	<1	<1
Tetrachloroethylene	NGA	110	<1	<1
Toluene	NGA	20,000	<1	<1
trans-1,2-Dichloroethylene	NGA	NGA	<0.5	<0.5
trans-1,3-Dichloropropene	NGA	NGA	<0.5	<0.5
Trichloroethylene	NGA	20	<1	<1
Trichlorofluoromethane (FREON 11)	NGA	NGA	<8	<8
Vinyl Chloride	NGA	1.1	<0.5	<0.5

General Notes:
(a) Federal Interim Groundwater Quality Guidelines, protection of marine aquatic life (Updated 2012)
(b) Nova Scotia Contaminated Sites Regulations - Agricultural/Residential land use, non-potable groundwater, coarse grained soil. July 6, 2013.

NGA = No Guideline Available
NC = Not Calculated
Shaded = exceedance of CCME CWQG
Bold Underlined = exceedance of NS CSR

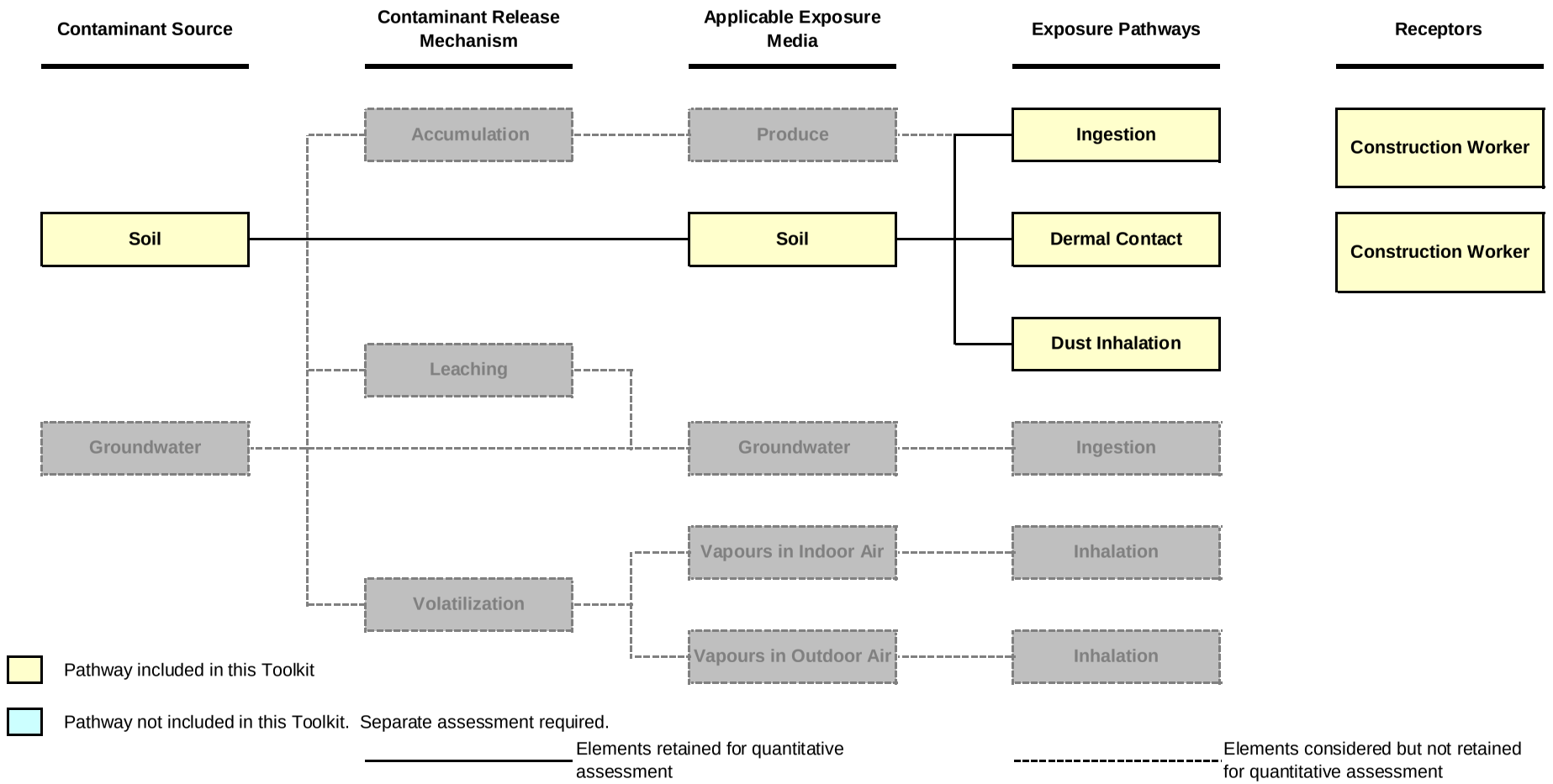
APPENDIX B

HHRA SUPPORTING INFORMATION

Conceptual Site Model

Tier II Metals Toolkit

v1.01



Input Parameters Summary

Tier II Metals Toolkit, v1.01

Site Name: Correctional Facility - Burnside
Project No.: TV1412091

Completed by: Erin Smith
Date: 8-Aug-14

Conceptual Model		
Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Aluminum	
Soil concentration	19000	
# Applicable exposure media	1	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Values used in calculations are highlighted in BOLD

Default Factors

Receptor Characteristics

		Units	Infant	Toddler	Child	Teen	Adult 20+	Adult - Female
ED	Exposure duration	years	0.5	4.5	7	8	61	45
ATn	Averaging time (non-carcinogens)	days	182.5	1642.5	2555	2920	22265	16425
ATc	Averaging time (carcinogens)	days	29200	29200	29200	29200	29200	29200
SIR	Soil ingestion rate	kg soil/day	0.00002	0.00008	0.00002	0.00002	0.00002	0.00002
BW	Body weight	kg bw	8.2	16.5	32.9	59.7	70.7	62.2
SAhands	Skin surface area - hands	cm2	320	430	590	800	890	820
SAbody	Skin surface area - body	cm2	1460	2580	4550	2230	2500	2270
AFhands	Soil adherence factor - hands	kg/cm2/event	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
AFbody	Soil adherence factor - body	kg/cm2/event	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08
InhR	Inhalation rate	m3/day	2.1	9.3	14.5	15.8	15.8	14.9
DWing	Drinking water ingestion rate	L/day	0.3	0.6	0.8	1	1.5	1.5

Exposure Characteristics

		Units	Residential	Commercial	Industrial
ET	Exposure time	hours/day	24	8	8
EF	Exposure frequency	days/year	365	260	240

User Inputs

Receptor Characteristics

		Units	User Defined
ED	Exposure duration	years	**1**
ATn	Averaging time (non-carcinogens)	days	**365**
ATc	Averaging time (carcinogens)	days	**12775**
SIR	Soil ingestion rate	kg soil/day	**0.0001**
BW	Body weight	kg bw	**70.7**
SAhands	Skin surface area - hands	cm2	**890**
SAbody	Skin surface area - body	cm2	**2500**
AFhands	Soil adherence factor - hands	kg/cm2/event	**1.00E-06**
AFbody	Soil adherence factor - body	kg/cm2/event	**1.00E-07**
InhR	Inhalation rate	m3/day	**14**
DWing	Drinking water ingestion rate	L/day	**1.5**

Exposure Characteristics

		Units	User Defined
ET	Exposure time	hours/day	**10**
EF	Exposure frequency	days/year	**260**

Calculated Values

Receptor Characteristics

		Units	User Defined
SR	Soil dermal contact rate	kg soil/day	**1.14E-03**
IRs	Soil inhalation rate	kg soil/day	**3.50E-06**

Age-Adjusted Receptor Characteristics

		Units	Lifetime Composite
SIR	Soil ingestion rate	kg soil - year/kg bw-d	
SR	Soil dermal contact rate	kg soil - year/kg bw-d	
IRs	Soil inhalation rate	kg soil - year/kg bw-d	

Exposure Characteristics

		Units	User Defined
ET1	Exposure term 1	unitless	**7.12E-01**
ET2	Exposure term 2	unitless	**4.17E-01**

Example Calculation Worksheet

Tier II Metals Toolkit, v1.01

Non-Carcinogenic CoPC

Site Name: Correctional Facility - Burnside

Project No.: TV1412091

Conceptual Model		
Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Aluminum	
Soil concentration	19000	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Results Summary		
Soil Concentration (C_{soil})	19000	mg/kg
Chronic Daily Intake	2.16E-02	mg/kg bw-day
SSTL	190494	mg/kg
Hazard Quotient	1.99E-02	

where: $HQ = \frac{C_{soil}}{SSTL} \times SAF$

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{(TDI_{oral} - EDI) \times SAF \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1} + BSC$$

where:		Value	Units	Reference
Tolerable Daily Intake oral	TDI_{oral} =	1.00E+00	mg CoPC/kg bw - day	PPRTV
Tolerable Daily Intake inhaled	TDI_{inh} =		mg CoPC/kg bw - day	
Estimated Daily Intake	EDI =		mg CoPC/kg bw - day	** EDI data incomplete - not used in calculation **
Estimated Daily Intake inhaled	EDI_{inh} =		mg CoPC/kg bw - day	
Soil Allocation Factor	SAF =	2.00E-01	unitless	EDI data incomplete - Soil allocation set at default 20%
Body Weight	BW =	7.07E+01	kg bw	Health Canada (2006)
Absorption Factor - gut	AF_g =	1.00E+00	unitless	Default
Absorption Factor - skin	AF_s =	1.00E-02	unitless	Health Canada (2010)
Absorption Factor - lung	AF_I =	1.00E+00	unitless	Default
Soil Ingestion Rate	SIR =	1.00E-04	kg soil/day	Health Canada (2006)
Soil Dermal Contact Rate	SR =	1.14E-03	kg soil/day	calculated
Soil Inhalation Rate	IR_s =	3.50E-06	kg soil/day	calculated
Exposure Term	ET_1 =	7.12E-01	unitless	calculated
Exposure Term (inhalation only)	ET_2 =	4.17E-01	unitless	calculated
Background Soil Concentration	BSC =	1.46E+04	mg CoPC/kg soil	Dillon, 2011

Example Calculation =

$$\frac{1.00E+00 \times 0.2 \times 70.7}{((1 \times 0.0001) + (0.01 \times 1.14E-03) + (1 \times 3.50E-06) \times 4.17E-01) \times 7.12E-01} + 14606$$

SSTL (mg/kg) = 190494

If EDI > TDI, calculate SSTL as lowest of 10% EDI or 20% TDI

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{TDI_{oral} \times 0.2 \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1}$$

Example Calculation =

SSTL (mg/kg) = EDI does not exceed TDI, SSTL calculated above

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{0.1 \times EDI \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1} + BSC$$

Example Calculation =

SSTL (mg/kg) = EDI does not exceed TDI, SSTL calculated above

Input Parameters Summary

Tier II Metals Toolkit, v1.01

Site Name: Correctional Facility - Burnside
Project No.: TV1412091

Completed by: Erin Smith
Date: 8-Aug-14

Conceptual Model		
Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Arsenic	
Soil concentration	61	
# Applicable exposure media	1	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Values used in calculations are highlighted in BOLD

Default Factors

Receptor Characteristics

		Units	Infant	Toddler	Child	Teen	Adult 20+	Adult - Female
ED	Exposure duration	years	0.5	4.5	7	8	61	45
ATn	Averaging time (non-carcinogens)	days	182.5	1642.5	2555	2920	22265	16425
ATc	Averaging time (carcinogens)	days	29200	29200	29200	29200	29200	29200
SIR	Soil ingestion rate	kg soil/day	0.00002	0.00008	0.00002	0.00002	0.00002	0.00002
BW	Body weight	kg bw	8.2	16.5	32.9	59.7	70.7	62.2
SAhands	Skin surface area - hands	cm2	320	430	590	800	890	820
SAbody	Skin surface area - body	cm2	1460	2580	4550	2230	2500	2270
AFhands	Soil adherence factor - hands	kg/cm2/event	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
AFbody	Soil adherence factor - body	kg/cm2/event	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08
InhR	Inhalation rate	m3/day	2.1	9.3	14.5	15.8	15.8	14.9
DWing	Drinking water ingestion rate	L/day	0.3	0.6	0.8	1	1.5	1.5

Exposure Characteristics

		Units	Residential	Commercial	Industrial
ET	Exposure time	hours/day	24	8	8
EF	Exposure frequency	days/year	365	260	240

User Inputs

Receptor Characteristics

		Units	User Defined
ED	Exposure duration	years	**1**
ATn	Averaging time (non-carcinogens)	days	**365**
ATc	Averaging time (carcinogens)	days	**12775**
SIR	Soil ingestion rate	kg soil/day	**0.0001**
BW	Body weight	kg bw	**70.7**
SAhands	Skin surface area - hands	cm2	**890**
SAbody	Skin surface area - body	cm2	**2500**
AFhands	Soil adherence factor - hands	kg/cm2/event	**1.00E-06**
AFbody	Soil adherence factor - body	kg/cm2/event	**1.00E-07**
InhR	Inhalation rate	m3/day	**14**
DWing	Drinking water ingestion rate	L/day	**1.5**

Exposure Characteristics

		Units	User Defined
ET	Exposure time	hours/day	**10**
EF	Exposure frequency	days/year	**260**

Calculated Values

Receptor Characteristics

		Units	User Defined
SR	Soil dermal contact rate	kg soil/day	**1.14E-03**
IRs	Soil inhalation rate	kg soil/day	**3.50E-06**

Age-Adjusted Receptor Characteristics

		Units	Lifetime Composite
SIR	Soil ingestion rate	kg soil - year/kg bw-d	
SR	Soil dermal contact rate	kg soil - year/kg bw-d	
IRs	Soil inhalation rate	kg soil - year/kg bw-d	

Exposure Characteristics

		Units	User Defined
ET1	Exposure term 1	unitless	**7.12E-01**
ET2	Exposure term 2	unitless	**4.17E-01**

Example Calculation Worksheet

Tier II Metals Toolkit, v1.01

Carcinogenic CoPC

Site Name: Correctional Facility - Burnside
Project No.: TV1412091

Conceptual Model

Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Arsenic	
Soil concentration	61	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Results Summary

Lifetime Average Daily Dose		2.38E-06	mg/kg bw-day
	SSTL	127	mg/kg
	ILCR	4.97E-06	

where: $ILCR = \frac{C_{soil}}{SSTL - BSC} \times TR$

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{TR \times BW}{((ET1 \times SFo \times AFg \times SIR) + (ET1 \times SFo \times AFs \times SR) + (ET1 \times ET2 \times SFi \times AFl \times IRs)) \times (ATn / ATc)} + BSC$$

		Value	Units	Reference
where:				
Oral Slope Factor	SF_o =	1.80E+00	1/ (mg CoPC/kg bw - day)	Health Canada (2009)
Inhalation Slope Factor	SF_i =	2.80E+01	1/ (mg CoPC/kg bw - day)	Health Canada (2009)
Target Risk	TR =	1.00E-05	unitless	
Body Weight	BW =	7.07E+01	kg bw	Health Canada (2006)
Absorption Factor - gut	AF_g =	1.00E+00	unitless	Default
Absorption Factor - skin	AF_s =	3.00E-02	unitless	Health Canada (2010)
Absorption Factor - lung	AF_l =	1.00E+00	unitless	Default
Soil Ingestion Rate	SIR =	1.00E-04	kg soil/day	Health Canada (2006)
Soil Dermal Contact Rate	SR =	1.14E-03	kg soil/day	calculated
Soil Inhalation Rate	IR_s =	3.50E-06	kg soil/day	calculated
Age-adjusted Soil Ingestion Rate	SIR_{adj} =		kg soil - year/kg bw-d	calculated
Age-adjusted Soil Dermal Contact Rate	SR_{adj} =		kg soil - year/kg bw-d	calculated
Age-adjusted Soil Inhalation Rate	IRs_{adj} =		kg soil - year/kg bw-d	calculated
Exposure Frequency	EF =		days/year	Health Canada (2006)
Exposure Term	ET_1 =	7.12E-01	unitless	calculated
Exposure Term (inhalation only)	ET_2 =	4.17E-01	unitless	calculated
Averaging Time (non-carcinogens)	ATn =	3.65E+02	days	Health Canada (2006)
Averaging Time (carcinogens)	ATc =	1.28E+04	days	Health Canada (2006)
Background Soil Concentration	BSC =	4.27E+00	mg CoPC/kg soil	Dillon, 2011

Example Calculation =

$$\frac{1.00E\text{-}05 \times 70.7}{((7.12E\text{-}01 \times 1.8 \times 1 \times 0.0001) + (7.12E\text{-}01 \times 1.8 \times 0.03 \times 1.14E\text{-}03) + (7.12E\text{-}01 \times 4.17E\text{-}01 \times 28 \times 1 \times 3.50E\text{-}06)) \times (365 / 12775)} + 4.27$$

SSTL (mg/kg) = 127

Input Parameters Summary

Tier II Metals Toolkit, v1.01

Site Name: Correctional Facility - Burnside
Project No.: TV1412091

Completed by: Erin Smith
Date: 8-Aug-14

Conceptual Model		
Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Iron	
Soil concentration	33000	
# Applicable exposure media	1	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Values used in calculations are highlighted in BOLD

Default Factors

Receptor Characteristics

		Units	Infant	Toddler	Child	Teen	Adult 20+	Adult - Female
ED	Exposure duration	years	0.5	4.5	7	8	61	45
ATn	Averaging time (non-carcinogens)	days	182.5	1642.5	2555	2920	22265	16425
ATc	Averaging time (carcinogens)	days	29200	29200	29200	29200	29200	29200
SIR	Soil ingestion rate	kg soil/day	0.00002	0.00008	0.00002	0.00002	0.00002	0.00002
BW	Body weight	kg bw	8.2	16.5	32.9	59.7	70.7	62.2
SAhands	Skin surface area - hands	cm2	320	430	590	800	890	820
SAbody	Skin surface area - body	cm2	1460	2580	4550	2230	2500	2270
AFhands	Soil adherence factor - hands	kg/cm2/event	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
AFbody	Soil adherence factor - body	kg/cm2/event	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08	1.00E-08
InhR	Inhalation rate	m3/day	2.1	9.3	14.5	15.8	15.8	14.9
DWing	Drinking water ingestion rate	L/day	0.3	0.6	0.8	1	1.5	1.5

Exposure Characteristics

		Units	Residential	Commercial	Industrial
ET	Exposure time	hours/day	24	8	8
EF	Exposure frequency	days/year	365	260	240

User Inputs

Receptor Characteristics

		Units	User Defined
ED	Exposure duration	years	**1**
ATn	Averaging time (non-carcinogens)	days	**365**
ATc	Averaging time (carcinogens)	days	**12775**
SIR	Soil ingestion rate	kg soil/day	**0.0001**
BW	Body weight	kg bw	**70.7**
SAhands	Skin surface area - hands	cm2	**890**
SAbody	Skin surface area - body	cm2	**2500**
AFhands	Soil adherence factor - hands	kg/cm2/event	**1.00E-06**
AFbody	Soil adherence factor - body	kg/cm2/event	**1.00E-07**
InhR	Inhalation rate	m3/day	**14**
DWing	Drinking water ingestion rate	L/day	**1.5**

Exposure Characteristics

		Units	User Defined
ET	Exposure time	hours/day	**10**
EF	Exposure frequency	days/year	**260**

Calculated Values

Receptor Characteristics

		Units	User Defined
SR	Soil dermal contact rate	kg soil/day	**1.14E-03**
IRs	Soil inhalation rate	kg soil/day	**3.50E-06**

Age-Adjusted Receptor Characteristics

		Units	Lifetime Composite
SIR	Soil ingestion rate	kg soil - year/kg bw-d	
SR	Soil dermal contact rate	kg soil - year/kg bw-d	
IRs	Soil inhalation rate	kg soil - year/kg bw-d	

Exposure Characteristics

		Units	User Defined
ET1	Exposure term 1	unitless	**7.12E-01**
ET2	Exposure term 2	unitless	**4.17E-01**

Example Calculation Worksheet

Tier II Metals Toolkit, v1.01

Non-Carcinogenic CoPC

Site Name: Correctional Facility - Burnside

Project No.: TV1412091

Conceptual Model		
Exposure Scenario	User Defined	- Construction Worker
Receptor	User Defined	- Construction Worker
CoPC	Iron	
Soil concentration	33000	
Target risk	1.E-05	
Age-adjustment?	FALSE	

Results Summary		
Soil Concentration (C_{soil})	33000	mg/kg
Chronic Daily Intake	3.75E-02	mg/kg bw-day
SSTL	146082	mg/kg
Hazard Quotient	4.52E-02	

where: $HQ = \frac{C_{soil}}{SSTL} \times SAF$

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{(TDI_{oral} - EDI) \times SAF \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1} + BSC$$

where:		Value	Units	Reference
Tolerable Daily Intake oral	TDI_{oral} =	7.00E-01	mg CoPC/kg bw - day	PPRTV
Tolerable Daily Intake inhaled	TDI_{inh} =		mg CoPC/kg bw - day	
Estimated Daily Intake	EDI =		mg CoPC/kg bw - day	** EDI data incomplete - not used in calculation **
Estimated Daily Intake inhaled	EDI_{inh} =		mg CoPC/kg bw - day	
Soil Allocation Factor	SAF =	2.00E-01	unitless	EDI data incomplete - Soil allocation set at default 20%
Body Weight	BW =	7.07E+01	kg bw	Health Canada (2006)
Absorption Factor - gut	AF_g =	1.00E+00	unitless	Default
Absorption Factor - skin	AF_s =	1.00E-02	unitless	Health Canada (2010)
Absorption Factor - lung	AF_I =	1.00E+00	unitless	Default
Soil Ingestion Rate	SIR =	1.00E-04	kg soil/day	Health Canada (2006)
Soil Dermal Contact Rate	SR =	1.14E-03	kg soil/day	calculated
Soil Inhalation Rate	IR_s =	3.50E-06	kg soil/day	calculated
Exposure Term	ET_1 =	7.12E-01	unitless	calculated
Exposure Term (inhalation only)	ET_2 =	4.17E-01	unitless	calculated
Background Soil Concentration	BSC =	2.30E+04	mg CoPC/kg soil	Dillon, 2011

Example Calculation = $\frac{7.00E\text{-}01 \times 0.2 \times 70.7}{((1 \times 0.0001) + (0.01 \times 1.14E\text{-}03) + (1 \times 3.50E\text{-}06) \times 4.17E\text{-}01) \times 7.12E\text{-}01} + 22961$

SSTL (mg/kg) = 146082

If EDI > TDI, calculate SSTL as lowest of 10% EDI or 20% TDI

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{TDI_{oral} \times 0.2 \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1}$$

Example Calculation =

SSTL (mg/kg) = EDI does not exceed TDI, SSTL calculated above

$$SSTL\ (mg_{CoPC}/kg_{soil}) = \frac{0.1 \times EDI \times BW}{((AF_g \times SIR) + (AF_s \times SR) + (AF_I \times IR_s) \times ET_2) \times ET_1} + BSC$$

Example Calculation =

SSTL (mg/kg) = EDI does not exceed TDI, SSTL calculated above

HUMAN HEALTH RISK ESTIMATION UNCERTAINTIES

Risk estimates normally include an element of uncertainty, and generally these uncertainties are addressed by incorporating conservative assumptions in the analysis. As a result, risk assessments tend to overstate the actual risk. Although many factors are considered in preparation of a risk analysis, analysis results are generally only sensitive to very few of these factors. The uncertainty analysis is included to demonstrate that assumptions used are conservative, or that the analysis result is not sensitive to the key assumptions.

A risk assessment containing a high degree of confidence will be based on:

- conditions where the problem is defined with a high level of certainty based on data and physical observations;
- an acceptable and reasonable level of conservatism in assumptions which will ensure that risks are overstated; or,
- an appreciation of the bounds and limitations of the final solution.

The exposure assessment performed as part of this study was based on:

- available data to describe existing surface soil conditions;
- sound conservative assumptions for certain parameters, as required; and
- well-understood and generally accepted methods for risk prediction.

Uncertainties in Toxicological Information

There is a very limited amount of toxicological information on the effects associated with human exposures to low levels of chemicals in the environment. What human information is available is generally based on epidemiological studies of occupationally exposed workers. These studies are generally limited in scope and provide results that may not be applicable to chronic or continuous exposures to low levels of chemicals. Because human toxicological information is limited, reference doses and cancer potency estimates for many compounds are based on the results of dose-response assessment studies using animals. The use of experimental animal data to estimate potential biological effects in humans introduces uncertainties into the evaluation of potential human health effects. These estimations require that a number of assumptions be made:

- The toxicological effect reported in animals is relevant and could occur in humans.
- The assumption that extrapolation from high-dose studies to low-dose environmental exposures
- adequately represents the shape of the dose-response curve in the low-dose exposure range.
- Short-term exposures used in animal studies can be extrapolated to chronic or long-term exposures in humans.
- The uptake of a compound from a test vehicle (drinking water, food, etc.) in animals will be the same as the uptake of the chemical from environmental media (soil, sediment, air-borne particulate matter) in humans.
- The pharmacokinetic processes that occur in the test animals also occur in humans.

There are clearly a number of uncertainties associated with extrapolating from experimental animal data to humans. In order to address these weaknesses, regulatory agencies, such as Health Canada and the USEPA incorporate a large number of conservative assumptions to try and account for the uncertainties associated with this process. The uncertainties are accounted for by the use of Uncertainty Factors that are used to lower the reference dose well below the

level at which adverse health effects have been reported in the test species. Uncertainty factors are generally applied by factors of 10 and are used to account for the following types of uncertainties:

- Variation within the population (protection of sensitive members of the population).
- Differences between humans and the test species.
- Differences in using short or medium-term studies to estimate the health effects associated with long-term or chronic exposures.
- Limitations in the available toxicological information.

The magnitude of the uncertainty factors applied by the various regulatory agencies provides an indication of the level of confidence that should be placed in the reference value. Uncertainty factors typically range between 100 and 10,000, although some can be lower than 10. The latter values are found for a few chemicals where sound and substantial human toxicological information is available to enable the setting of toxicological end-point solely on the basis of human epidemiological information. The application of uncertainty factors are intended to introduce a high degree of conservatism into the risk assessment process and to ensure, as far as possible, that limited exposures that exceed the reference concentrations will not re suit in adverse human health effects. Because risk assessments that use these regulatory limits incorporate the conservatism used in the development of the toxicological information, the results can generally be viewed as being extremely conservative.

Modelling Assumptions

The Table below contains a summary of the assumptions used in the human health risk analysis, providing an evaluation for each assumption and an opinion as to whether the assumption is acceptable.

Evaluation of Assumptions used in the Risk Assessment

Risk analysis study factor/Assumption	Justification	Analysis likely to over/under estimate exposure	Acceptable assumption?
Chemical Screening			
Delineation of arsenic in soil for the facility has not occurred.	Delineation was not accomplished for samples from TP1 to TP5 in the vicinity of the planned facility. Sampling was meant to provide a cross-section of concentrations in the area of fill. It is assumed the range of concentrations was captured and that concentrations in the fill are below the calculated SSTL of 127 mg/kg for a construction worker.	Neutral to under estimate	Yes
Measured concentrations are representative	Laboratory QA/QC and duplicate analysis indicates the chemistry are valid.	Over-estimate to neutral	Yes
Receptor characteristics			
Soil ingestion rate	Used the Health Canada rate for a construction worker.	Over estimate	Yes
Dermal exposure	Used the health Canada Assumption of 1 dermal exposure event per day.	Neutral	Yes
Soil inhalation rate	Assumed the higher Health Canada recommended airborne concentration of respirable particles for dust on unpaved roads.	Over-estimate to neutral	Yes
Toxicity Assessment			
Slope factors were available from health Canada.	Used the Health Canada approved Toxicity Reference Value, as per Health Canada guidance on selection of TRVs.	Over estimate to neutral	Yes

APPENDIX C

ERA SUPPORTING INFORMATION

ERA Uncertainty Analysis

The ERA incorporates assumptions that lead to uncertainty. This section qualitatively discusses some significant aspects of uncertainty inherent in this risk assessment.

Habitat Survey and Receptor Selection. This risk assessment did no conduct an examination of existing habitats and the species that may exist within them through a site. A review of photographs and aerials was completed to evaluate habitat potential.

Utilization of Receptors as Sentinels to Represent Other Organisms. The use of receptors as sentinels is intended to limit the number of ecological receptors evaluated. Specific receptors were not selected for the PQERA as the majority of the Site (fill area) will be paved or covered with a building (not habitat).

Species at Risk. A review of Species at Risk potentially present at the property was not conducted for the PQERA.

Receptor-Specific Toxicity Data. For most COPCs and receptors, toxicity data are available in some form. However, it is important to note that toxicity data are not necessarily available for the particular receptor species under consideration. Toxicity values are not necessarily specific to the receptor species, or to a reproductive or population-level endpoint. As a result, there is uncertainty associated with the extrapolations that may be used to translate toxicity data from one species into a TRV for a second species despite the fact that the toxicity data represent organisms that are expected to be sensitive to the COPC and that the conversion factors are scientifically based, and are applied in a reasonable manner.

Data Limitations. The quality of a risk assessment calculation often hinges on the size, extent and quality of the data. The time available for collection of data precluded consideration of fluctuations in measured concentrations due to daily or seasonal influences. For the site, sufficient site-specific soil data have been collected for both metals and PHCs to complete the PQERA.

Selection of COPCs. The COPCs were selected independently in each of the media and/or areas evaluated in the ecological risk assessment, and the analysis was completed to include all relevant media and/or areas if the substance exceeded screening criteria for any one of these. For each of the media, there are gaps in understanding of the toxicology of constituents of concern, and the physical and chemical properties of these chemicals. The approach for selecting COPCs included comparison of detected chemical concentrations in soil values that are believed to be protective of most North American species, in most ecosystems. However, contaminant concentrations in soil are likely to be stable or decline over time. Because empirical data do not exist for all possible COPCs and media, it is possible that relevant test species and sometimes even the same environmental media have not been evaluated in the proper context for comparison.

Chemical Speciation. The fate, food chain interactions, and toxicity of a number of inorganic contaminants (such as aluminum) depend to a large extent upon their chemical form. Oral reference

doses, however, are typically based on chemical forms that have high bioavailability (*e.g.*, salts). When administered in food or water to laboratory animals, it is expected that the bioavailability of the toxicant is maximal. When trace elements are ingested by wildlife, some portion will be of natural origin, distributed through soil fractions ranging from inorganic soil particles to biological materials, having widely varying bioaccessibility. Another portion may be present in soils as a contaminant, and the speciation and bioaccessibility of the contaminant fraction will also vary, depending upon site conditions and the source of the contaminant. As such, conservative assumptions about chemical form, bioavailability, and absorption over the gut were generally carried forward in the risk assessment, and the potential for toxicity is likely to be overstated. For example, it has been assumed that 100% of each ingested COPC is absorbed from ingested food, and is available to the organism as a potentially toxic substance. This may be reasonable for some COPCs, but will be highly conservative for others. For soil, bioaccessibility was conservatively assumed to be 1.0.

Food Chain Interactions. Food chain modelling was not completed for this PQERA.

Wildlife Exposure Factors. Food chain modelling was not completed for this PQERA.

Measurement Endpoints from the Toxicity Data. Food chain modelling and the calculation of ecological hazard quotients was not completed for this PQERA.

APPENDIX D

LIMITATIONS

LIMITATIONS

1. The work performed in this report was carried out in accordance with the Standard Terms of Conditions made part of our contract. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.
2. The report was prepared in accordance with generally accepted environmental study and/or engineering practices for the exclusive use of Defence Construction Canada and the Department of National Defence. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.
3. Third party information reviewed and used to develop the opinions and conclusions contained in this report is assumed to be complete and correct. This information was used in good faith and AMEC does not accept any responsibility for deficiencies, misinterpretation or incompleteness of the information contained in documents prepared by third parties.
4. The services performed and outlined in this report were based, in part, upon visual observations of the site and attendant structures. Our opinion cannot be extended to portions of the site which were unavailable for direct observation, reasonably beyond our control.
5. The objective of this report was to assess environmental conditions at the site, within the context of our contract and existing environmental regulations within the applicable jurisdiction. Evaluating compliance of past or future owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.
6. Our observations relating to the condition of environmental media at the site are described in this report. It should be noted that compounds or materials other than those described could be present in the site environment.
7. The findings and conclusions presented in this report are based exclusively on the field parameters measured and the chemical parameters tested at specific locations. It should be recognized that subsurface conditions between and beyond the sample locations may vary. AMEC cannot expressly guarantee that subsurface conditions between and beyond the sample locations do not vary from the results determined at the sample locations. Notwithstanding these limitations, this report is believed to provide a reasonable representation of site conditions at the date of issue.
8. The contents of this report are based on the information collected during the monitoring and investigation activities, our understanding of the actual site conditions, and our professional opinion according to the information available at the time of preparation of this report. This report gives a professional opinion and, by consequence, no guarantee is attached to the conclusions or expert advice depicted in this report. This report does not provide a legal opinion in regards to Regulations and applicable Laws.
9. Any use of this report by a third party and any decision made based on the information contained in this report by the third party is the sole responsibility of the third party. AMEC will not accept any responsibility for damages resulting from a decision or an action made by a third party based on the information contained in this report.

1.1 **RELATED WORK**

.1 Section 01 50 00 – Temporary Facilities.

.2 Section 01 74 21 – Construction Waste Management and Disposal.

.3 Section 31 23 10 – Excavation, Trenching and Backfilling.

1.2 **DEFINITIONS**

.1 Hazardous Material: Product, substance, or organism that is used for its original purpose; and that is either dangerous goods or a material that may cause adverse impact to the environment or adversely affect health of persons, animals, or plant life when released into the environment.

1.3 **FIRES**

.1 Fires and burning of rubbish on site is not permitted.

1.4 **CONTRACTOR'S ACTIVITIES**

.1 Confine operations to the work limits identified on site. Fence to protect others from harm.

.2 Conduct operations at all times in such a manner as to preserve the natural features and vegetation in the area. Cut and fill slopes shall be blended with adjoining topography. Material from cut and fill slopes or excavations will not be permitted to sluff or roll into surrounding tree cover of to bury any plant material designated to be retained.

.3 Provide approved dust control measures as approved by Departmental Representative.

.4 When, in the opinion of the Departmental Representative, damage from construction activities results in damage or destruction of vegetation or other environmental or aesthetic features beyond the designated work area (limit of contract), the Contractor is responsible, at no additional expense to the Contract, to restore the damaged areas to the satisfaction of the Departmental Representative.

.5 Provide adequate precautions, such as but not limited to, fencing, signage, etc. to ensure safety on the site.

.6 Conduct or permit attendance at briefing sessions for all trades and construction workforce, highlighting the requirements of environmental procedures and protections outlined in the specifications.

1.5 **HAZARDOUS MATERIAL HANDLING**

.1 Store and handle hazardous materials in accordance with applicable federal and provincial laws, regulations, codes and guidelines. Store in location that will prevent spillage into the environment.

.2 Label containers to WHMIS requirements and keep MSDS data sheets on site for all hazardous materials.

.3 Maintain inventory of hazardous materials and hazardous waste stored on site. List items by product name, quantity and date when storage began.

.4 Store and handle flammable and combustible materials in accordance with National Fire Code.

.5 Transport hazardous materials in accordance with federal Transportation of Dangerous Goods Regulations and applicable Provincial regulations.

.6 Fueling or maintenance of vehicles and equipment is not permitted on site.

.7 Exercise care in handling fuel or dangerous fluids to minimize potential for spills.

.8 Report immediately any spills to the Departmental Representative.

1.6 **CUTTING TREES, SHRUBS AND WOODY VEGETATION**

.1 Restrict vegetation removal to areas indicated on drawings or as identified by Departmental Representative.

.2 Protect roots to drip line during excavation and site grading, etc. to prevent disturbance or damage to protected vegetation. Prevent traffic, dumping or storage of materials over root zones of protected trees.

.3 Dispose of any brush and shrub material off site.

1.7 **GRUBBING, EXCAVATION, BURYING, GRADING**

.1 Stripping of topsoil will be permitted only in areas designated or as indicated by Departmental Representative.

.2 Dispose of all unsuitable material or excess material off-site, in conformance with applicable regulations.

.3 Cuts and fills are to be properly stabilized to prevent erosion. Employ short-term erosion control techniques as approved by Departmental Representative.

.4 Install, inspect and maintain in proper working order temporary erosion, siltation and pollution control measures as directed and approved by the Department Representative. Remove device in proper manner and conclusion of the Work.

.5 Provide temporary drainage and pumping as required to keep excavation and site free from water.

.6 Pumping water containing silt in suspension into waterways or drainage systems is not permitted.

.7 To minimize run-off, work on slope or excavations may be halted during periods of heavy rainfall as directed by Departmental Representative.

1.8 **DISPOSAL OF WASTES**

.1 Do not bury rubbish and waste materials on site. Dispose in accordance with project waste management requirements specified in Section 01 74 21 - Building Construction Waste Management and Disposal.

.2 Do not dispose of hazardous waste or volatile materials, such as mineral spirits, paints, thinners, oil or fuel into waterways, storm or sanitary sewers or waste landfill sites.

.3 Dispose of hazardous waste in accordance with applicable federal and provincial laws, regulations, codes and guidelines.

1.9 **POLLUTION CONTROL**

.1 Control emissions from equipment and plant to local authorities' emission requirements.

.2 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

.3 Cover or wet down dry materials and rubbish to prevent blowing dust and debris.

.4 Have appropriate emergency spill response equipment and rapid clean-up kit on site located adjacent to hazardous materials storage area. Provide personal protective equipment required for clean-up.

.5 Report, spills of petroleum and other hazardous materials as well as accidents having potential of polluting the environment to Federal and Provincial Department of the Environment.

.1 Notify Departmental Representative and submit a written spill report to Departmental Representative within 24 hours of occurrence.

END OF SECTION

1.1 **RELATED SECTIONS**

.1 Section 01 33 00 – Submittal Procedures.

.2 Section 01 78 00 – Closeout Submittals.

1.2 **INSPECTION**

.1 Facilitate Departmental Representative's access to Work.

.2 Give timely notice requesting inspection of Work designated for special tests, inspections or approvals by Departmental Representative or by inspection authorities having jurisdiction.

.3 If Contractor covers or permits to be covered Work designated for special tests, inspections or approvals before such is made, uncover Work until particular inspections or tests have been fully and satisfactorily completed and until such time as Departmental Representative gives permission to proceed. Pay costs to uncover and make good such work.

.4 In accordance with the General Conditions, Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents.

1.3 **INDEPENDENT AGENCIES INSPECTION**

.1 Departmental Representative will engage and pay for service of Independent Inspection and Testing Agencies for purpose of inspecting and testing portions of Work except for the following which remain part of Contractor's responsibilities:

- .1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.
- .2 Inspection and testing performed exclusively for Contractor's convenience.
- .3 Testing and adjustment of conveying systems.
- .4 Mill tests and certificates of compliance.
- .5 Tests as specified within various sections designated to be carried out by Contractor under the supervision of Departmental Representative.
- .6 Additional tests specified in Clause 1.3.2 below.

.2 Where tests or inspections by designated Testing authority reveal work not in accordance with contract requirements, Contractor shall pay costs for additional tests and inspections as Departmental Representative may require to verify acceptability of corrected work.

.3 Employment of inspection and testing agencies by Departmental Representative does not relax responsibility to perform Work in accordance with Contract Documents.

1.4 **ACCESS TO WORK**

.1 Facilitate Departmental Representative's access to Work.

.2 Furnish labour and facility to provide access to the work being inspected and tested.

.3 Co-operate to facilitate such inspections and tests.

.4 Make good work disturbed by inspections and tests.

1.5 **PROCEDURES**

.1 Notify Departmental Representative sufficiently well in advance of when the Work is ready for testing, in order for Departmental Representative to make attendance arrangements with Testing Agency.

.1 At a minimum provide Departmental Representative 48 hours advance notice.

.2 When so directed by Departmental Representative, notify the Testing Agency directly.

.2 Submit representative samples of materials, in required quantities, to Testing Agency for testing purposes. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.

1.6 **REJECTED WORK**

.1 Remove and replace defective Work, whether result of poor workmanship, use of defective or damaged products and whether incorporated in Work or not, which has been identified by Departmental Representative as failing to conform to Contract Documents.

.2 Make good damages to existing or new work resulting from removal or replacement of defective work.

1.7 **TESTING BY CONTRACTOR**

.1 Provide all necessary instruments, equipment and qualified personnel to perform tests designated as Contractor’s responsibilities herein or elsewhere in the Contract Documents.

.2 At completion of tests, turn over 2 sets of fully documented tests reports to the Departmental Representative. Submit in accordance with Section 01 33 00. Additionally, obtain other copies in sufficient quantities to enable on complete set of test reports to be placed in each of the maintenance manuals specified in Section 01 78 00.

.3 Submit mill test certificates and other certificates as specified in various sections.

.4 Submit adjustment and balancing reports for mechanical, electrical and other equipment systems specified in various trade sections.

.5 Furnish test results.

1.7 **MOCK-UPS**

.1 Prepare mock-ups of certain work as specified in various sections of the Specifications. Include in each mock-up all related work components representative of final assembly.

.2 Construct in locations acceptable to Departmental Representative.

.3 Prepare mock-ups for Departmental Representative's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work. Provide a minimum 48 advance notice for Departmental Representative’s review of mock-ups.

.4 Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.5 If requested, Departmental Representative will assist in preparing a schedule fixing dates for preparation.

.6 Dismantle and remove mock-up when directed by Departmental Representative, unless approval is given for mock-up to remain as part of the Work.

END OF SECTION

1.1 SITE ACCESS AND PARKING

.1 The Contractor is advised that parking facilities for his workers and subcontractors will be on property. Follow all instructions from the Departmental Representative in regards to parking facilities.

1.2 BUILDING ACCESS

.1 Use only access and circulation routes within site as designated by Departmental Representative to access construction site.

1.3 CONSTRUCTION SITE OFFICE

.1 Be responsible for and provide own site office including electricity, heat, lights and telephone.

.2 All visitors to site must first come to and register at Construction Site Office.

.3 Departmental Representative's site office:

- .1 Provide temporary office for Departmental Representative.
- .2 Minimum space requirement of 2440mm by 2440mm in area, with space for chair and work table or desk, with power, heat and light sufficient to carry out office type work.
- .3 Maintain power, heat and lights to site office for the duration of the Contract.

1.4 MATERIAL STORAGE

.1 Locate site storage trailers where directed by Departmental Representative.

.2 Coordinate delivery to minimize storage period on site before being needed for incorporation into work.

.3 Be responsible for security of material stored on site. Provide secure enclosure around material storage area to a minimum standard as outlined in sentence 1.5 - Site Enclosures.

1.5 SITE ENCLOSURES

.1 Provide temporary construction fence to enclose various construction areas of work site. Provide all required temporary fence gates, for pedestrians and vehicles, lockable as may be required to maintain site safety and security.

.3 Obtain Departmental Representative's approval beforehand of location and layout of all temporary fence enclosures.

.4 Provide warning signs affixed to all fenced areas, identifying those enclosed areas as "Construction Zones" with access restricted to only those persons so authorized by General Contractor.

.5 Do not construe fencing as an acceptable replacement for pedestrian walkway and hoarding requirements specified below.

1.6 **SANITARY FACILITIES**

.1 Provide temporary sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.7 **ENCLOSURE OF STRUCTURE**

.1 Provide temporary weathertight enclosures and protection for exterior openings and /or modifications to roofing, flashing, etc. which may permit water entry until permanently enclosed.

.2 Provide weathertight and heated enclosures to conduct exterior work during winter and other inclement weather conditions. Erect to allow accessibility for installation of materials and working inside of enclosure.

.3 Design enclosures to withstand wind pressure and snow loading.

1.8 **INSTALLATION AND REMOVAL**

.1 Provide temporary controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.9 **DEWATERING**

.1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

1.10 **WATER SUPPLY**

.1 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.

.2 Permanent water supply system installed under this Contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage.

1.11 **TEMPORARY POWER AND LIGHTING**

.1 Supply, install and pay all costs for temporary power during construction for temporary lighting and operating of power tools to a maximum supply of 230 volts, 30 amps.

.2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.

.3 Perform work and make all connections in accordance with the Canadian Electrical Code, in compliance with the federal and provincial Occupational Health and Safety Regulations as specified in Section 01 35 29 and to lockout requirements specified in Section 01 35 25.

.4 Provide and maintain temporary lighting throughout project to conduct work. Ensure illumination level is not less than 162 lx in all locations.

.5 Electrical power and lighting systems installed under this Contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage and replace lamps which have been used for more than 3 months.

.6 Provide and maintain temporary lighting throughout project to conduct work.

1.12 **TEMPORARY HEATING AND VENTILATING**

.1 Supply, install and pay all costs for temporary heat and ventilation used during construction, including costs of installation, fuel, operation, maintenance and removal of equipment. Use of direct-fired heaters discharging waste products into work areas will not be permitted.

.2 Provide temporary heat and ventilation in enclosed areas as required to:
- .1 Facilitate progress of work.
- .2 Protect work and products against dampness and cold.
- .3 Prevent moisture condensation on surfaces.
- .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
- .5 Provide adequate ventilation to meet health regulations for safe working environment.

.3 Maintain strict supervision of operation of temporary heating equipment to:
- .1 Conform with applicable codes and standards.
- .2 Enforce safe practices.
- .3 Prevent abuse of services.
- .4 Prevent damage to finishes.
- .5 Vent direct-fired combustion units to outside.

.4 Maintain temperature of minimum 10 degrees C in areas where construction is in progress.

.5 Ventilating:
- .1 Prevent accumulations of dust, fumes, mists vapours or gases in areas occupied during construction.
- .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
- .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
- .4 Ventilate storage spaces containing hazardous or volatile materials.
- .5 Ventilate temporary sanitary facilities.
- .6 Continue operation of ventilation and exhaust system for time after cessation of work progress to assure removal of harmful contaminants.

.6 Departmental Representative may allow use of permanent heating system of building when available. Be responsible for damage to heating system when use is permitted.

.7 Upon completion of Work for which permanent heating system is used, replace filters, clean bearings, service pumps and boilers using factory trained technicians and provide documentation, clean strainers, and test water chemistry.

.8 Pay costs for maintaining temporary heat when using permanent heating system.

.9 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
- .1 Conform with applicable codes and standards.
- .2 Enforce safe practices.
- .3 Prevent abuse of services.
- .4 Prevent damage to finishes.
- .5 Vent direct-fired combustion units to outside.

.10 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.13 **SCAFFOLDING**

.1 Design, construct and maintain scaffolding in rigid, secure and safe manner in accordance with CAN/CSA-S269.2-M87 (R2003) and CSA Z797-09 (R2014).

.2 Submit in accordance with 01 33 00 requirements, scaffolding shop drawing prepared by a Structural Engineer licensed to practice in the Province of Nova Scotia.

.3 Provide and maintain scaffolding, rampes, ladders, swing staging, platforms and temporary stairs.

.4 Erect scaffolding independent of walls. Remove scaffolding when no longer required.

1.14 **HOISTING**

.1 Provide, operate and maintain hoists required for moving of workers, materials and equipment. Hoists to be operated by qualified operators.

1.15 **ELEVATOR**

.1 Permanent elevator is not to be used by construction personnel or transporting materials.

1.16 **PROTECTION AND MAINTENANCE OF TRAFFIC**

.1 Contractor’s traffic on roads for deliveries or hauling of materials to and from site to interfere as little as possible with local area traffic.

.2 Verify adequacy of existing roads and allowable load limit on these roads. Contractor to be responsible for repair of damage to roads caused by construction activities.

.3 Provide snow removal during period of Work.

1.17 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction or requirements of Institution, whichever is more stringent.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

1.18 CONSTRUCTION SIGN AND NOTICES

.1 Contractor or subcontractor advertisement signboards are not permitted on site.

.2 Safety and Instruction Signs and Notices:

.1 Signs and notices for safety and instruction shall be in both official languages or commonly understood graphic symbols conforming to CAN3-Z321-96(R2006).

.3 Maintenance and Disposal of Site Signs:

.1 Maintain approved signs and notices in good condition for duration of project and dispose of offsite on completion of project or earlier if directed by Departmental Representative.

1.19 CLEAN-UP

.1 Remove construction debris, waste materials, packaging materials from work site daily.

.2 Clean mud or dirt tracked onto paved or surfaced roadways and sidewalks daily.

.3 Provide snow removal during period of Work, and comply with directions from Departmental Representative as to location of snow piles.

1.20 REMOVAL OF TEMPORARY FACILITIES

.1 Remove temporary facilities from site when directed by Departmental Representative.

.2 Be responsible to repair and make good all damage, to match existing condition of, existing roads, sidewalks, grassed areas, etc. caused by new work and removal of temporary facilities.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

.1 Control erosion to reduce negative impacts on water and air quality.

.2 Prevent loss of soil during construction by storm water runoff and/or wind erosion.

.3 Prevent sedimentation of receiving streams.

.4 Prevent polluting the air with dust and particulate matter.

.5 Temporary and/or permanent control measures to protect plants, watercourses and surrounding properties from environmental pollution and damage.

.6 Project and site specific Erosion and Sedimentation Control (ESC) Plan.

1.2 REFERENCES

.1 United States Environmental Protection Agency (USEPA) Document No. EPA 832/R-92-005 (September 1992), Storm Water Management for Construction Activities, Chapter 3.

.2 Nova Scotia Environment Act. 1994-95, c. 1, s. 1. and Nova Scotia Water Resources Protection Act. 2000, c. 10, s. 1.

1.3 DEFINITIONS

.1 Erosion: A combination of processes in which materials of the earth's surface are loosened, dissolved or worn away, and transported from one place to another by natural agents.

.2 Sedimentation: The addition of soils to water bodies by natural and human related activities.

.3 Storm Water Runoff: Precipitation that does not soak into the ground or evaporate, but flows along the surface of the ground as runoff.

.4 Erosion and Sediment Control (ESC) Plan: Plan identifying the applicable stabilization and structural strategies that will be employed to limit sediment and erosion during construction.

.5 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to human kind; or degrade environment aesthetically, culturally and/or historically.

.6 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.4 EROSION AND SEDIMENTATION CONTROL PLAN (ESC)

1.5 WATERWAY PROTECTION

.1 Do not operate construction equipment in waterways.

.2 Do not dump excavated fill, waste material or debris in waterways.

1.6 POLLUTION AND DUST CONTROL

.1 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads, parking areas, and staging areas.

.2 Apply water with distributors equipped with means of shut-off and with spray system to ensure uniform application.

Part 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

Part 3 EXECUTION

3.1 EXECUTION

.1 Maintain temporary erosion and pollution control features installed under this contract.

3.2 EROSION AND SEDIMENTATION CONTROL PLAN IMPLEMENTATION

.1 Manager: Contractor to designate an on-site party (or parties) responsible for instructing workers and overseeing and documenting results of the Erosion and Sediment Control (ESC) Plan for the Project.

.2 Distribution: Contractor to distribute copies of the ESC Plan to the Job Site Foreman and each Sub-contractor.

.3 Provide permanent and temporary measures identified by the Erosion and Sediment Control (ESC) Plan to:

.1 Prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.

.2 Prevent sedimentation of storm sewer or receiving streams.

.3 Prevent polluting the air with dust and particulate matter.

.4 Limit initial earth disturbance to that necessary to install control measures.

.5 Stabilization: Following initial soil disturbance or re-disturbance, permanent or temporary stabilization shall be completed within:

.1 Seven days for the surface of all perimeter controls, and all perimeter slopes.

.2 Fourteen days for all other disturbed or graded areas.

.6 Use the permanent driveway or entrance location as a stabilized construction entrance. Top dress as necessary to prevent tracking of sediment onto public streets or rights-of way.

.7 At any location where surface runoff from disturbed or graded areas flows off the property, install control measures to prevent sediment from being transported off-site.

.8 Swales or other areas that transport concentrated flow to be sodded.

.9 Construction Control Measures in Accordance with US EPA 832/R-92-005

.10 Maintain permanent and temporary erosion and sediment control features installed under this contract. Remove only when authorized by Departmental Representative.

.11 Remove control features when directed by the Departmental Representative. Take care to avoid causing turbidity, and excessive re-suspension of particles when removing control features.

.12 Be responsible to implement a Soil and Erosion Control Plan prior to construction, provide all required documentation as needed or required by Departmental Representative. Obtain written approval from Departmental Representative before implementation and start of any work.

3.3 FIRES

.1 Fires and burning of rubbish on site not permitted.

3.4 DISPOSAL OF WASTE

.1 Refer to Section 01 74 21 – Construction Waste Management and Disposal for procedures for disposal of regular and hazardous waste materials.

.2 Do not bury rubbish and waste materials on site.

.3 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

3.5 DRAINAGE

.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.

.2 Do not pump water containing suspended materials into waterways, sewer or drainage systems without prior removal of contaminants.

.3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with ESC Plan and local authority requirements.

3.6 SITE CLEARING AND GRADING

.1 Minimize stripping of topsoil and vegetation.

.2 Schedule Work to minimize exposure of subsoils to erosion.

.3 Perform clearing and grading work to minimize the effects of erosion on site and to the requirements of the ESC Plan.

.4 Grading shall not impair existing surface drainage, create an erosion hazard, or create a source of sediment to any adjacent watercourse of property.

3.7 PLANT PROTECTION

.1 Protect trees and plants on site and adjacent properties not indicated for removal.

.2 Wrap in burlap, trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 metres.

.3 Protect roots of designated trees to drip line during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.

.4 Cleanly cut roots that need to be removed with sharp hand cutting tools. Cover roots exposed during construction and scheduled to remain with moist soil until permanent root cover is in place.

.5 The Departmental Representative may retain an arborist to monitor the condition of trees and plants during construction, and to report on damage and remedial care.

.6 Minimize stripping of topsoil and vegetation.

3.8 WORK ADJACENT TO WATERWAYS

.1 Do not discharge waste waters derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines, directly into storm water system or adjacent waterways.

.2 Do not discharge rinse water from concrete trucks or mixing drums on site.

.3 Do not use waterway beds for borrow material.

.4 Design and construct temporary crossings to minimize erosion to waterways.

.5 Do not skid logs or construction materials across waterways.

.6 Avoid indicated spawning beds when constructing temporary crossings of waterways.

.7 Do not blast under water or within 100 metres of indicated spawning beds.

.8 Provide a suitable method for silt protection reviewed by the Departmental Representative in areas where there is the possibility of silt entering the waterway.

3.9 AIRBORNE POLLUTION AND PARTICULATE CONTROL

.1 Control emissions from equipment and plant to local authorities emission requirements.

.2 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

.3 Demolish to minimize dusting. Cover or wet down dry materials and rubbish to prevent blowing dust and debris.

.4 Provide dust control for temporary roads. Control dust by application of water, or calcium chloride after obtaining permission from the Departmental Representative.

.5 Keep paved surfaces clean, including public roadways.

.6 Install and make operational before any site work can commence a wheel/tire wash station for all vehicles leaving the site. Wash to Departmental Representative's approval all wheels/tires of all vehicles before leaving the site. Also wash vehicles (including underside) that Departmental Representative may deemed as possible contaminants to adjacent sites, a rumble strip as described in ESC plan other pre-approved methods.

.7 Cover all site materials and stockpiles with tarps at the end of each day.

3.10 SPILL CONTAINMENT

.1 Take precautions to avoid contamination of the site from fuel and other petroleum products, fertilizers, paints and coatings, and other hazardous fluids.

.2 Monitor on site vehicles for fluid leaks. Implement a preventative maintenance program to keep vehicles free from leaks.

.3 Keep and maintain hydrocarbon containment and clean up materials on site for the duration of construction activities.

.4 Ensure personnel are trained in the proper use of containment and clean up materials.

.5 Be responsible for all spills and will be liable for any resulting property damage, any costs incurred by the Departmental Representative for contaminants and clean-up of the spilled material, and any costs, liability or penalties incurred by the Departmental Representative due to the Contractor's failure to comply with relevant legislation.

3.11 EMERGENCY NOTIFICATION

.1 To report an environmental emergency in the Maritimes:

.1 Telephone 1-800-565-1633.

3.12 ENVIRONMENTAL PERMITS

.1 Contractor responsible for any necessary environmental permits.

END OF SECTION

1.1 **GENERAL**

.1 Use new material and equipment unless otherwise specified.

.2 Within 7 days of written request by Departmental Representative, submit following information for any materials and products proposed for supply:

- .1 Name and address of manufacturer.
- .2 Trade name, model and catalogue number.
- .3 Performance, descriptive and test data.
- .4 Compliance to specified standards.
- .5 Manufacturer's installation or application instructions.
- .6 Evidence of arrangements to procure.
- .7 Evidence of manufacturer delivery problems or unforeseen delays.

.3 Provide material and equipment of specified design and quality, performing to published ratings and for which replacement parts are readily available.

.4 Use products of one manufacturer for equipment or material of same type or classification unless otherwise specified.

.5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.2 **PRODUCT QUALITY**

.1 Contractor shall be solely responsible for submitting relevant technical data and independent test reports to confirm whether a product or system proposed for use meets contract requirements and specified standards.

.2 Final decision as to whether a product or system meets contract requirements rest solely with the Departmental Representative in accordance with the General Conditions of the Contract.

1.3 **ACCEPTABLE MATERIALS AND ALTERNATIVES**

.1 Acceptable Materials: When materials specified include trade names or trade marks or manufacturer's or supplier's name as part of the material description, select and only use one of the names listed for incorporation into the Work.

.2 Alternative Materials: Submission of alternative materials to trade names or manufacturer's names specified must be done during the bidding period following procedures indicated in the Instructions to Bidders.

.3 Substitutions: After contract award, substitution of a specified material will be dealt with as a change to the Work in accordance with the General Conditions of the Contract.

1.4 **MANUFACTURERS INSTRUCTIONS**

.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods to be used.
Do not rely on labels or enclosure provided with products. Obtain written instructions directly from manufacturers.

.2 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer's instructions, so that Departmental Representative will designate which document is to be followed.

1.5 **AVAILABILITY**

.1 Immediately notify Departmental Representative in writing of unforeseen or unanticipated material delivery problems by manufacturer. Provide support documentation as per clause 1.1.2 above.

1.6 **WORKMANSHIP**

.1 Ensure quality of work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed.

.2 Remove unsuitable or incompetent workers from site as stipulated in the General Conditions of the Contract.

.3 Ensure cooperation of workers in laying out work. Maintain efficient and continuous supervision on site at all times.

.4 Coordinate work between trades and subcontractors.

.5 Coordinate placement of openings, sleeves and accessories.

1.7 **FASTENINGS – GENERAL**

.1 Provide metal fastenings and accessories in same texture, colour and finish as base metal in which they occur. Prevent electrolytic action between dissimilar metals. Use non- corrosive fasteners, anchors and spacers for securing exterior work and in humid areas.

.2 Space anchors within limits of load bearing or shear capacity and ensure that they provide positive permanent anchorage. Wood or organic material plugs not acceptable.

.3 Keep exposed fastenings to minimum, space evenly and lay out neatly.

.4 Fastenings which cause spalling or cracking of material to which anchorage is made, are not acceptable.

.5 Do not use explosive actuated fastening devices unless approved by Departmental Representative. See section on Health and Safety Requirements in this regard.

1.8 **FASTENINGS – EQUIPMENT**

.1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

.2 Use heavy hexagon heads, semi-finished unless otherwise specified.

.3 Bolts may not project more than one diameter beyond nuts.

.4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur and, use resilient washers with stainless steel.

1.9 **STORAGE, HANDLING AND PROTECTION**

.1 Deliver, handle and store materials in manner to prevent deterioration and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled materials in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work. Provide additional cover where manufacturer's packaging is insufficient to provide adequate protection.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Immediately remove damaged or rejected materials from site.

.9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.10 **CONSTRUCTION EQUIPMENT AND PLANT**

.1 On request, prove to the satisfaction of Departmental Representative that the construction equipment and plant are adequate to manufacture, transport, place and finish work to quality and production rates specified. If inadequate, replace or provide additional equipment or plant as directed.

.2 Maintain construction equipment and plant in good operating order.

END OF SECTION

1.1 **GENERAL**

.1 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.

.2 Store volatile waste in covered metal containers, and remove from premises at end of each working day.

.3 Maintain Work in tidy condition, free from accumulation of waste products and debris.

.4 Clear ice and snow from access to building.

.5 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

1.2 **MATERIALS**

.1 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

1.3 **CLEANING DURING CONSTRUCTION**

.1 Maintain work areas in a tidy condition, free from accumulations of waste material and debris. Clean areas on a daily basis.

.2 Keep building entrances, and occupied areas of building in a clean dust free condition at all times. Conduct thorough cleaning of these areas at end of each workshift when used by workers or affected by the Work.

.3 Provide on-site lockable metal containers for collection of waste materials and debris. Locate where approved and directed by Derartmental Representative.

.4 Use separate collection bins, clearly marked as to purpose, for source separation and recyling of waste and debris in accordance with waste management requirements specified. Refer to Section 01 74 21 – Construction Waste Management and Disposal.

.5 Remove waste materials, and debris from site on a daily basis.

.6 Clean interiors prior to start of finishing work and maintain areas free of dust and other contaminants during finishing operations.

.7 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

.8 Provide dust barriers, dividers, seals on doors and employ other dust control measures as required to ensure that dust and dirt, generated by work, are not transmitted to other existing areas of building. Should dust migrate into adjacent areas of building, employ such means as may be necessary to immediately clean all contaminated surfaces to the satisfaction of the Departmental Representative.

1.4 **FINAL CLEANING**

.1 In preparation for acceptance of the completed work perform final cleaning.

.2 Remove waste products and debris and leave Work clean and suitable for occupancy.

.3 Prior to final review remove surplus products, tools, construction machinery and equipment.

.4 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

.5 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture and fitments, walls, floors, and ceilings.

.6 Clean lighting reflectors, lenses, and other lighting surfaces.

.7 Vacuum clean and dust building interiors, behind grilles, louvres and screens.

.8 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.9 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.10 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.11 Remove dirt and other disfiguration from exterior surfaces.

.12 Clean and sweep roofs, gutters, areaways, and sunken wells.

.13 Sweep and wash clean paved areas.

.14 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

.15 Clean roofs, downspouts, and drainage systems.

.16 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
Remove snow and ice from access to building.

.17 Clean equipment, washroom fixtures to a sanitary condition.

END OF SECTION

1.1 **RELATED WORK**

.1 Section 01 35 43 - Environment Procedures.

1.2 **GENERAL**

.1 Carry out work placing maximum emphasis on the areas of:
- .1 Waste reduction;
- .2 Diversion of waste from landfill and;
- .3 Material Recycling.

1.3 **DEFINITIONS**

.1 Hazardous Material: Product, substance, or organism that is used for its original purpose, and that is either dangerous goods or a material that may cause adverse impact to the environment or adversely affect health of persons, animals, or plant life when released into the environment.

1.4 **WASTE MANAGEMENT PLAN**

.1 Prior to commencement of work, prepare waste Management Workplan.

.2 Divert as much waste as possible from landfill.

.3 Coordinate work of subtrades and subcontractors to ensure all possible waste reduction and recycling opportunities are taken. Follow waste management requirements specified in trade sections of the Specifications.

.4 Reduce waste during installation of new materials. Undertake practices which will optimize full use of materials and minimize waste.

.5 Develop innovative procedures to reduce quantity of waste generated by construction such as by delivering materials to site with minimal packaging etc.

.6 Provide on-site facilities to collect, handle and store anticipated quantities of reusable, salvageable and recyclable materials.

.7 During demolition and removal work separate materials and equipment at source, carefully dismantling, labelling and stockpiling alike items for the following purposes:
- .1 Reinstallation into the work where indicated.
- .2 Salvaging reusable items not needed in project which Contractor may sell to other parties.
- .3 Sending as many items as possible to locally available recycling facility.
- .4 Segregating remaining waste and debris into various individual waste categories for disposal in a "non-mixed state" as recommended by waste processing/landfill sites.

.8 Isolate product packaging and delivery containers from general waste stream. Send to recycling facility or return to supplier/manufacturer.

.9 Send leftover material resulting from installation work for recycling whenever possible.

.10 Establish methods whereby hazardous and toxic materials, and their containers used on site are properly handled, stored and disposed in accordance with applicable federal, provincial and municipal laws and regulations.

1.5 **DISPOSAL REQUIREMENTS**

.1 Burying or burning of rubbish and waste materials is prohibited.

.2 Disposal of waste, volatile materials, mineral spirits, oil, or paint thinner into waterways, storm, or sanitary sewers is prohibited.

.3 Dispose of waste only at approved waste processing facility or landfill sites approved by authority having jurisdiction.

.4 Contact the authority having jurisdiction prior to commencement of work, to determine what, if any, demolition and construction waste materials have been banned from disposal in landfills and at transfer stations. Take appropriate action to isolate such banned materials at site of work and dispose in strict accordance with provincial and municipal regulations.

.5 Transport waste intended for landfill in separated condition, following rules and recommendations of Landfill Operator in support of their effort to divert, recycle and reduce amount of solid waste placed in landfill.

.6 Collect, bundle and transport salvaged materials to be recycled in separated categories and condition as directed by recycling facility. Ship materials only to approved recycling facilities.

.7 Sale of salvaged items by Contractor to other parties not permitted on site.

END OF SECTION

1.1 **SECTION INCLUDES**

.1 Administrative procedures preceding inspection and acceptance of Work by Departmental Representative.

1.2 **RELATED SECTIONS**

.1 Section 01 78 00 - Closeout Submittals.

1.3 **INSPECTION AND DECLARATION**

.1 Contractor's Inspection: Coordinate and perform, in concert with subcontractors, an inspection and check of all Work. Identify and correct deficiencies, defects, repairs and perform outstanding items as required to complete work in conformance with Contract Documents.

.1 Notify Departmental Representative in writing when deficiencies from Contractor's inspection have been rectified and that Work is deemed to be complete and ready for Departmental Representative's inspection of the completed work.

.2 Departmental Representative's Inspection: Accompany Departmental Representative during all substantial and final inspections of the Work.

.1 Address defects, faults and outstanding items of work identified by such inspections.

.2 Advise Departmental Representative when all deficiencies identified have been rectified.

.3 Note that Departmental Representative will not issue a Certificate of Substantial Performance of the work until such time that Contractor performs following work and turns over the specified documents:

.1 Project record as-built documents;
.2 Final Operations and Maintenance manuals;
.3 Maintenance materials, parts and tools;
.4 Compliance certificates from applicable authorities;
.5 Reports resulting from designated tests complete with submission of test reports;
.6 Demonstration and training complete with user manuals;
.7 Manufacturer’s guarantee certificates;
.8 Testing, adjusting and balancing of equipment and systems complete with submission of test reports.
.9 Commissioning of equipment and systems specified.

.4 Correct all discrepancies before Departmental Representative will issue the Certificate of Completion.

END OF SECTION

1.1 **RELATED SECTIONS**

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 77 00 - Closeout Procedures.

1.2 **SECTION INCLUDES**

.1 Project Record Documents.

.2 Operations and Maintenance data.

1.3 **PROJECT RECORD DOCUMENTS**

.1 Departmental Representative will provide two (2) white print sets of contract drawings and two (2) copies of Specifications Manual specifically for "as-built" purposes.

.2 Maintain at site one set of the contract drawings and specifications to record actual as-built site conditions.

.3 Maintain up-to-date, real time as-built drawings and specifications in good condition and make available for inspection by the Departmental Representative upon request.

.4 'As-Built' Drawings:

.1 Record changes in red ink on the prints. Mark only on one set of prints during construction. At completion of work, neatly transfer notations to second set (also by use of red ink).

.2 Once red-line As-Built drawings are completed, electronically scan the As-builts at full-size and sufficiently high resolution to allow legibility and clarity of reading the information.

.3 Submit both sets of As-Built drawing mark-ups as well as the electronic scan files to Departmental Representative at completion of Work.

.4 Stamp all drawings with "As-Built Drawings". Label and place Contractor's signature and date.

.5 Show all modifications, substitutions and deviations from what is shown on the contract drawings or in specifications.

.5 Record following information:

.1 Depths of various elements in relation to a specified datum.

.2 Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure;

.3 Field changes of dimension and detail;

.4 Location of all new building services and utilities;

.5 Chases for mechanical, electrical and other services;

.6 All design details dimensions and marked-up to consistently report finished installation conditions;

.7 Any details produced in the course of the contract by the Departmental Representative to supplement or to change existing design drawings;

.5 (continued)

.8 All change orders issued over the course of the contract must be documented on the finished as-built documents, accurately and consistently depicting the changed condition as it applies to all affected drawing details.

.6 'As-Built' Specifications: legibly mark in red each item to record actual construction.

.7 Maintain 'As-Built' documents current as the contract progresses. Departmental Representative will conduct reviews and inspections of the documents on a regular basis. Failure to maintain as-builts current and complete to satisfaction of Departmental Representative shall be subject to financial penalties in the form of progress payment reductions and holdback assessments.

1.4 **REVIEWED SHOP DRAWINGS**

.1 Provide a complete set of all shop drawings reviewed for project to incorporate into each copy of the Operations & Maintenance manuals.

.2 Submit full sets at same time and as part of the contents of the Operation and Maintenance manuals specified.

1.5 **OPERATIONS AND MAINTENANCE MANUAL**

.1 Operations & Maintenance Manual - Definition: an organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual products or systems as specified in individual sections of the specifications.

.2 Manual Language: final manuals to be in English language.

.3 Number of copies required:

.1 Submit two (2) interim copies of the manual for review and inspection by Departmental Representative. Make revisions and additions as directed and resubmit.

.2 Upon review and acceptance by Departmental Representative, submit four (4) final hard copies plus 1 electronic copy in DVD format.

.1 Ensure all electronically scanned documents included in the O & M manuals are of sufficiently high resolution to allow legibility and clarity of reading the information.

.3 Interim copies are not to be considered as part of the final copies unless they have been fully revised and are identical to the final approved version.

.4 Submission Date: submit complete operation and maintenance manual to Departmental Representative 3 weeks prior to application for Certificate of Substantial Performance of the work.

.5 Binding:
- .1 Assemble, coordinate, bind and index required data into Operation and Maintenance Manual.
- .2 Use vinyl, hard covered, 3 "D" ring binders, loose leaf, sized for 215 x 280 mm paper, with spine pocket.
- .3 Where multiple binders are needed, correlate data into related consistent groupings.
- .4 Identify contents of each binder on spine.
- .5 Organize and divide data following same numerical system as the section numbers of the Specification Manual.
- .6 Dividers: separate each section by use of cardboard dividers and labels. Provide tabbed fly leaf for each individual product and system and give description of product or component.
- .7 Type lists and notes. Do not hand write.
- .8 Drawings, diagrams and manufacturers' literature must be legible. Provide with reinforced, punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.6 Manual Contents:
- .1 Cover sheet containing:
  - .1 Date submitted.
  - .2 Project title, location and project number.
  - .3 Names and addresses of Contractor, and all Sub-contractors.
- .2 Table of Contents: provide full table of contents in each binder(s), clearly indicate which contents are in each binder.
- .3 List of maintenance materials.
- .4 List of spare parts.
- .5 List of special tools.
- .6 Original or certified copy of warranties and product guarantees.
- .7 Copy of approval documents and certificates issued by Inspection Authorities.
- .8 Copy of reports and test results performed by Contractor as specified.
- .9 Product Information (PI Data) on materials, equipment and systems as specified in various sections of the specifications. Data to include:
  - .1 List of equipment including manufacturer's name, supplier, local source of supplies and service depot(s). Provide full addresses and telephone numbers.
  - .2 Nameplate information including equipment number, make, size, capacity, model number and serial number.
  - .3 Parts list.
  - .4 Installation details.
  - .5 Operating instructions.
  - .6 Maintenance instructions for equipment.
  - .7 Maintenance instructions for finishes.

.7 Shop drawings:
- .1 Include complete set of reviewed shop drawings into each copy of the operations and maintenance manual.
- .2 Fold and bind material professionally in a manner that corresponds with the specification section numbering system.

.7 (continued)

.3 When large quantity of data is submitted, place into separate binders of same size as Operations & Maintenance binders.

.8 Equipment and Systems Data: the following list indicates the type of data and extent of information required to be included for each item of equipment and for each system:

.1 Description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.5 Manufacturer's printed operation and maintenance instructions.

.6 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.7 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.8 Include test and balancing reports.

.9 Additional requirements as specified in individual specification sections.

.9 Materials and Finishes Maintenance Data:

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

.10 Maintenance Materials:

.1 Extra stock Materials:

.1 Provide maintenance materials, in quantities specified in individual specification Sections.

.2 Maintenance materials to be from same manufacturer, product line and run as items installed in the Work.

.3 Deliver maintenance materials to site and store in location as directed by Departmental Representative.

.4 Maintenance materials are not to be used to correct deficiencies.

.10 (continued)

.2 Special Tools:

.1 Provide special tools, in quantities specified in individual specification Sections.

.2 Provide tags identifying their associated function and equipment.

.3 Deliver to site and store in location as directed by Departmental Representative.

.11 Warranties:

.1 Submit, warranty information to Departmental Representative for approval.

.2 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.3 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.4 Conduct one-year warranty inspection, measured from time of acceptance, by Departmental Representative.

.1 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.11.4 (continued)

.1 (continued)

.12 Typical response time and repair time expected for various warranted equipment.

.2 Procedure and status of tagging of equipment covered by extended warranties.

.3 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.5 Respond in timely manner to oral or written notification of required construction warranty repair work.

.6 Written verification to follow oral instructions.

1.6 SPARE PARTS, TOOLS AND MAINTENANCE MATERIALS

.1 Provide spare parts, special tools and extra materials for maintenance purposes in quantities specified in individual specification sections.

.2 Tag all items with associated function or equipment.

.3 Provide items of same manufacture and quality as items in Work.

.4 Deliver to site in well packaged condition. Store in location as directed by Departmental Representative.

.5 Clearly mark as to contents indicating:

.1 Part number.

.2 Identification of equipment or system for which parts are applicable.

.3 Installation instructions or intended use as applicable.

.4 Name, address and telephone number of nearest supplier.

.5 Prepare and submit complete inventory list of items supplied. Include list within Maintenance Manual.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 Commissioning: Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives.
.1 Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
.2 Verify and document proper performance of equipment and systems.
.3 Verify that O&M documentation left on site is complete.
.4 Verify that the Owner's operating personnel are adequately trained.

.2 The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product in compliance with their contracts and the construction documents. It does however add additional requirements for the contractor to document and demonstrate the system operation.

.3 Abbreviations: The following are common abbreviations used in the *Specifications* and in the *Commissioning Plan.* Definitions are found in Section 1.6.

A/E	Architect and design engineers
CA	Commissioning authority
CC	Controls contractor
Cx	Commissioning
Cx Plan	Commissioning Plan document
EC	Electrical contractor
FT	Functional performance test
GC	General Contractor
LEED	Leadership in Energy and Environmental Design
MC	Mechanical contractor
DR	Departmental Representative
PC	Prefunctional checklist
Subs	Subcontractors to General
TAB	Test and balance contractor

1.2 COORDINATION

.1 Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CA), the Departmental Representative (DR), the General Contractor (GC), the architect and design engineers (particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building operator is also a member of the commissioning team.

.2 Management: The CA is hired by the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to Section 01 91 13 Part 1.6 for additional management details.

.3 Scheduling: The GC according to established protocols to schedule shall schedule the commissioning activities and provide sufficient notice to the OR and CA. The GA will integrate all commissioning

activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

.4 The commissioning plan includes a preliminary commissioning schedule.

1.3 COMMISSIONING PROCESS

.1 Commissioning Plan: The Commissioning Plan, provided as part of the bid documents, is binding on the Contractor. The commissioning plan provides guidance in the execution of the commissioning process. The Specifications will take precedence over the Commissioning Plan.

.2 Commissioning Process:

.1 Commissioning during construction begins with a scoping meeting conducted by the GC where the commissioning process is reviewed with the commissioning team members.

.2 The Subs develop start-up plans and start-up documentation, including prefunctional checklists to be completed, during the start-up process.

.3 The Subs, under their own direction, execute and document the prefunctional checklists and perform start-up and initial checkout. The CA approves the checklists and start-up when completed. This may include the CA witnessing start-up of selected equipment.

.4 The CA and Subs develop specific equipment and system functional performance test procedures.

.5 The procedures are executed by the Subs, under the direction of, the GC and witnessed by the CA.

.6 Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.

.7 The CA reviews the O&M documentation for completeness.

.8 Commissioning is completed before Substantial Completion.

.9 The CA reviews pre-approves and coordinate the training for Departmental's Representatives and submit forms to document the training has been completed.

1.4 RELATED WORK

.1 Specific commissioning requirements are given in the following sections of these specifications. All of the following sections apply to the Work of this section.

.1 Mechanical General items specified on the drawings Alerts the mechanical contractor to Cx responsibilities in 01 91 36.

.2 TAB items specified on the drawings Alerts the TAB of Cx responsibilities in 01 91 14.

.3 01 91 14 Mechanical Cx Describes the Cx responsibilities of the mechanical, controls and TAB contractors and the prefunctional testing and start-up responsibilities of each.

.4 01 91 34 Mechanical Testing Requirements Describes the specific functional testing requirements for mechanical equipment in the project.

.5 01 91 35 Mechanical Prefunctional Provides the prefunctional checklists for use on this project, including mechanical and electrical items.

.6 01 91 36 Mechanical Functional Provides example functional test procedures and formats for mechanical equipment.

.7 Electrical General items specified on the drawings Alerts the electrical contractor of Cx responsibilities in 01 91 15.

.8 01 91 15 Electrical Cx Describes the Cx responsibilities of the electrical contractor.

.9 01 91 38 Electrical Testing Requirements Describes the specific functional testing requirements for electrical equipment in the project.

.10 01 91 39 Electrical Prefunctional Points to Section electrical Checklists.

.11 01 91 40 Electrical Functional Provides example functional test procedures Tests–Examples and formats for electrical equipment.

.12 01 91 13 Commissioning Describes the commissioning process, responsibilities common to all parties, responsibilities of the A/E, CA, OR, GC and Suppliers, focusing on the CA. The unique MC, CC, TAB and EC responsibilities are included on the drawings.

1.5 RESPONSIBILITIES

.1 The responsibilities of various parties in the commissioning process are provided in this section. The responsibilities of the mechanical contractor, TAB, controls contractor and electrical contractor are in Division 01. It is noted that the services for the Project Manager, Architect, HVAC mechanical, electrical designers/engineers and the Commissioning authority are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process.

.2 Contractor is responsible for the costs associated with commissioning work performed under their control.

.3 All Parties
- .1 Follow the Commissioning Plan.
- .2 Attend commissioning scoping meeting and additional meetings, as necessary.

.4 Architect (of A/E)
- .1 *Construction and Acceptance Phase*
  - .1 Attend the commissioning scoping meeting and selected commissioning team meetings.
  - .2 Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
  - .3 Provide any design narrative documentation requested by the CA.
  - .4 Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.

.5 Mechanical and Electrical Designers/Engineers (of the A/E)
- .1 *Construction and Acceptance Phase*
  - .1 Perform normal submittal review, construction observation, and as-built drawing preparation, as contracted. One site observation should be completed just prior to system start-up.
  - .2 Provide any design narrative and sequences documentation requested by the CA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - .3 Attend commissioning scoping meetings and other selected commissioning team meetings.
  - .4 Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.

.6 Commissioning Authority (CA): The CA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the Construction Manager and the A/E. The primary role of the CA is to witness the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CA.
- .1 *Construction and Acceptance Phase*
  - .1 Witnesses commissioning activities and receives test forms from the GC for inclusion in the final commissioning plan being compiled for the Owner.

.2 Revise, as necessary, the Commissioning Plan-Construction Phase.
.3 Attend commissioning scoping meeting and other commissioning meetings organized by the GC.
.4 Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
.5 Before start-up, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
.6 Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
.7 Review and approve prefunctional tests and checklists.
.8 Review and approve start-up and initial systems checkout plan with Subs.
.9 Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
.10 Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Receive documentation on this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
.11 Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Receive documentation on this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
.12 Review and approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
.13 Review and approve systems start-up by reviewing start-up reports and by selected site observation.
.14 Review TAB execution plan.
.15 Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB is executed.
.16 Approve air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
.17 Review and approve the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone datalogger monitoring or manual functional testing.
.18 Analyze any functional performance trend logs and monitoring data to verify performance.
.19 Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved. Perform actual functional testing without contractors on equipment so specified in Sections 01 91 34 and 01 91 38.
.20 Maintain a master deficiency and resolution log and a separate testing record. Provide the OR with written progress reports and test results with recommended actions.
.21 Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
.22 Approve the training of the Owner's operating personnel.
.23 Compile and maintain a commissioning record and building systems book(s).
.24 Review and approve the preparation of the O&M manuals.
.25 Provide a final commissioning report (as described in this section).

.7 Departmental's Representative (DR)

.1 *Construction and Acceptance Phase*

.1 Facilitate the coordination of the commissioning work by the CA, and, with the GC and CA, ensure that commissioning activities are being scheduled into the master schedule.

.2 Review and approve the final Commissioning Plan—Construction Phase.
.3 Attend a commissioning scoping meeting and other commissioning team meetings.
.4 Perform the normal review of Contractor submittals.
.5 Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.
.6 Review and approve the functional performance test procedures submitted by the CA, prior to testing.
.7 When necessary, observe and witness prefunctional checklists, start-up and functional testing of selected equipment.
.8 Review commissioning progress and deficiency reports.
.9 Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
.10 Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Project Manager.
.11 Assist the GC in coordinating the training of owner personnel.

.2 *Warranty Period*
.1 Assist the CA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

.8 General Contractor (GC)

.1 *Construction and Acceptance Phase*
.1 Facilitate commissioning work and report and provide documentation to the CA. Ensure that commissioning activities are being scheduled into the master schedule.
.2 Include the cost of commissioning in the total contract price.
.3 Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.
.4 In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
.5 Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
.6 A representative shall attend a commissioning scoping meeting and other necessary meetings to facilitate the Cx process.
.7 Coordinate the training of owner personnel.
.8 Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

.2 *Warranty Period*
.1 Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified.

.9 Equipment Suppliers

.1 Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
.2 Assist in equipment testing per agreements with Subs. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone datalogging equipment that may be used by the CA. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
.3 Provide information requested by CA regarding equipment sequence of operation and testing procedures.
.4 Review test procedures for equipment installed by factory representatives.

1.6 DEFINITIONS

.1 Acceptance Phase – phase of construction after start-up and initial checkout when functional performance tests, O&M documentation review and training occurs.

.2 Approval – acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

.3 Architect/Engineer (A/E) – the prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.

.4 Basis of Design – The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included.

.5 Commissioning Authority (CA) – a third partyagent, not otherwise associated with the A/E team members or the Contractor, though he/she may be hired as a subcontractor to them. The CA directs and coordinates the day-to-day commissioning activities. The CA does not take an oversight role like the GC. The CA is part of the Construction team or shall report directly to the GC.

.6 Commissioning Plan – an overall plan, developed before or after bidding, that provides the structure, schedule and coordination planning for the commissioning process.

.7 General Contractor (GC) – the firm responsible for overall planning, coordination and control of the project. The GC is responsible for:
.1 Specifying project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, selecting project participants.
.2 Maximizing resource efficiency through procurement of labour, materials and equipment.
.3 Implementing various operations through proper coordination and control of planning, design, estimating, contracting, and construction in the entire process.
.4 Developing effective communications and mechanisms for resolving conflicts.

.8 Contract Documents – the documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).

.9 Contractor – the contractor or authorized representative.

.10 Control System – the central building energy management control system.

.11 Datalogging – monitoring flows, currents, status, pressures, etc. of equipment using stand-alone dataloggers separate from the control system.

.12 Deferred Functional Tests – FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

.13 Deficiency – a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent).

.14 Design Intent – a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.

.15 Design Narrative or Design Documentation – sections of either the Design Intent or Basis of Design.

.16 Factory Testing – testing of equipment on-site or at the factory by factory personnel with an Departmental's Representative present.

.17 Functional Performance Test (FT) – test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The Systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. FTs are performed after prefunctional checklists and start-up are complete.

.18 Indirect Indicators – indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.

.19 Manual Test – using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

.20 Monitoring – the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.

.21 Non-Compliance – see Deficiency.

.22 Non-Conformance – see Deficiency.

.23 Over-written Value – writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 10°C to ¯25°C to verify economizer operation). See also "Simulated Signal."

.24 Owner-Contracted Tests – tests paid for by the Owner outside the GC's contract and for which the CA does not oversee. These tests will not be repeated during functional tests if properly documented.

.25 Phased Commissioning – commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.

.26 Prefunctional Checklist (PC) – a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CA to the Sub. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist. Even without a commissioning process, contractors typically perform some, if not many, of the prefunctional checklist items. However, few contractors document in writing the execution of these checklist items. Therefore, for most equipment, the contractors execute the checklists on their own. The commissioning authority only requires that the procedures be documented in writing, and does not witness much of the prefunctional checklisting, except for larger or more critical pieces of equipment.

.27 Departmental's Representative (DR) – the contracting and managing authority for the Owner over the design and/or construction of the project.

.28 Sampling – functionally testing only a fraction of the total number of identical or near identical pieces of equipment. Refer to Section 01 91 13, for details.

.29 Seasonal Performance Tests – FT that are deferred until the system(s) will experience conditions closer to their design conditions.

.30 Simulated Condition – condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).

.31 Simulated Signal – disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

.32 Specifications – the construction specifications of the Contract Documents.

.33 Start-up – the initial starting or activating of dynamic equipment, including executing prefunctional checklists.

.34 Subs – the subcontractors to the GC who provide and install building components and systems.

.35 Test Procedures – the step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CA.

.36 Test Requirements – requirements specifying what modes and functions, etc. shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the Contract Documents (Sections 01 91 34; 01 91 38, etc.).

.37 Trending – monitoring using the building control system.

.38 Vendor – supplier of equipment.

.39 Warranty Period – warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least two (2) years, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.7 SYSTEMS TO BE COMMISSIONED

Equipment and System	Functional Test Requirements Specified In:
HVAC System	
__ Pumps	01 91 34
__ Motorized Dampers	01 91 34
__ Air Source Heat Pump System	01 91 34
__ Unit Heater	01 91 34
__ Force Flow Heater	01 91 34
__ Testing, Adjusting and Balancing work	01 91 34
__ Control System	01 91 34
__ Air Handling Units (HRVs)	01 91 34
__ Fan Coil	01 91 34
__ Boilers	
Utilities	
__ Sewage Lift Station	33 32 14

Equipment and System	Functional Test Requirements Specified In:
Electrical System	
__ Digital Metering	26 09 23
__ Service Entrance Board	26 24 02
__ Panelboards and Breakers	26 24 17
__ Motor Starters to 600V	26 29 10
__ Variable Speed Drive	26 29 23
__ Networked Lighting Control System	26 50 05
__ Equipment for Emergency Lighting	26 52 01
__ Exit Lighting	28 23 00
__ Telecommunications System	27 05 13
__ Public Address and Mass Notification System	27 51 16
__ Video Intercom System	27 51 23
__ Access Control and Security System	28 13 00
__ Closed Circuit Television (CCTV) Video Surveillance	28 23 00
__ Personal Protection Alarm System	28 26 00
__ Multiplex Fire Alarm System	28 31 00
Plumbing	
__ Domestic Hot Water Heaters	01 91 34
__ Plumbing Systems	01 91 34
__ Sump Pump	01 91 34
__ Plumbing Fixtures	01 91 34
__ Water Meter	01 91 34
__ Mechanical	33 32 14
__ Electrical	33 32 14

PART 2 – PRODUCTS

2.1 TEST EQUIPMENT

.1 All standard testing equipment required to perform start-up and initial checkout and required functional performance testing shall be provided by the contractor responsible for the equipment being tested. For example, the mechanical contractor shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system, except for equipment specific to and used by TAB in their commissioning responsibilities. Two-way radios shall be provided by the Division Controller.

.2 Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone datalogging equipment that may be used by the CA.

.3 Datalogging equipment and software required to test equipment will be provided by the CA, but shall not become the property of the Owner.

.4 All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°C and a resolution of + or – 0.1°C. Pressure sensors shall have an accuracy of + or – 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

.5 Refer to Section 01 91 13, Part 3.6 E for details regarding equipment that may be required to simulate required test conditions.

PART 3 – EXECUTION

3.1 MEETINGS

.1 Scoping Meeting. Refer to Commissioning Plan.

.2 Miscellaneous Meetings. Other meetings will be planned and conducted as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CA will plan these meetings and will minimize unnecessary time being spent by Subs. Only two or three meetings are anticipated for this project and they shall occur concurrently with some of the testing activities.

3.2 REPORTING

.1 The CA will report to the OR.

.2 Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

.3 A final summary report (about four to six pages, not including backup documentation) by the CA will be provided to the OR, focusing on evaluating commissioning process issues and identifying areas where

the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

3.3 SUBMITTALS

.1 The Commissioning authority will review and approve submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the GC, OR or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

.2 The CA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

.3 These submittals to the CA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CA will review and approve them.

3.4 START-UP PRE-FUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

.1 The following procedures apply to all equipment to be commissioned, according to Section 1.7 - Systems to be Commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified PCs and start-up.

.2 General: Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

.3 Start-up and Initial Checkout Plan: The CA shall review all equipment. The primary role of the CA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for executing functional performance tests are identified in the testing requirements in Sections 01 91 34 and 01 91 38

.1 The GC and Subs adapt, if necessary, the representative prefunctional checklists and procedures from Section 01 91 35. These checklists indicate required procedures to be executed as part of start-up and initial checkout of the systems and the party responsible for their execution.

.2 These checklists and tests are provided by the Contractor to the CA. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.

.3 The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:

.1 The example prefunctional checklists.

.2 The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.

.3 The manufacturer's normally used field checkout sheets.
.4 The subcontractor submits the full start-up plan to the CA for review and approval.
.5 The CA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
.6 The full start-up procedures and the approval form may be provided to the GC for review and approval, depending on management protocol.

.4 Sensor and Actuator Calibration: All field-installed temperature, relative humidity and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner before-hand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
.1 All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
.2 Sensor Calibration Methods:
.1 All Sensors: Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable, are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°C of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
.3 Sensors Without Transmitters:
.1 Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
.4 Sensors With Transmitters:
.1 Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument- measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
.2 Tolerances, Standard Applications:

Sensor	Required Tolerance (+/-)	Sensor	Required Tolerance (+/-)
AHU wet bulb or Dew point	1.0C	Flow rates, Water	4% of design
		Relative humidity	4% of design
Outside air, space air, duct air temps	0.4C		
Watt-hour, voltage & amperage	1% of design	Barometric pressure	0.3 kPa
Pressures, air, water and gas	3% of design		
Flow rates, air	10% of design		

.5 Valve and Damper Stroke Setup and Check

.1 EMS Readout: For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

.5 Execution of Prefunctional Checklists and Start-up:

.1 Four weeks prior to start-up, the Subs and vendors schedule start-up and checkout with the GC and CA. The performance of the prefunctional checklists, start-up and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.

.2 The CA shall observe, the procedures for each piece of primary equipment.

.3 For lower-level components of equipment, (e.g., heaters, sensors, controllers), the CA shall observe a sampling of the prefunctional and start-up procedures. The sampling shall be randomly selected by the CA.

.4 The Subs and vendors shall execute start-up and provide the CA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.

.5 Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

.6 Deficiencies, Non-Conformance and Approval in Checklists and Start-up.

.1 The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CA within two days of test completion.

.2 The CA reviews the report and submits either a non-compliance report or an approval form to the Sub or GC. The CA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CA will involve the GC and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the checklists and start-up of each system to the GC using a standard form.

.3 Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party. Refer to Part 3.7 herein for details.

3.5 FUNCTIONAL PERFORMANCE TESTING

.1 This sub-section applies to all commissioning functional testing for all divisions.

.2 The general list of equipment to be commissioned is found in Section 01 91 13, Part 1.4. The specific equipment and modes to be tested are found in Sections 01 91 34 and 01 91 38.

.3 The parties responsible to execute each test are listed with each test in Sections 01 91 34 and 01 91 38.

.4 Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested. Specific modes required in this project are given in Sections 01 91 34 and 01 91 38.

.5 Development of Test Procedures: Using the testing parameters and requirements in Sections 01 91 34 and 01 91 38 the GC and Subs shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. The CA shall review owner-contracted, factory testing or required owner acceptance tests which the CA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the *Specifications*. Redundancy of testing shall be minimized. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form. The test procedure forms shall include (but not be limited to) the following information:

.1 System and equipment or component name(s)
.2 Equipment location and ID number
.3 Unique test ID number, and reference to unique prefunctional checklist and start-up documentation ID numbers for the piece of equipment
.4 Date
.5 Project name
.6 Participating parties
.7 A copy of the specification section describing the test requirements
.8 A copy of the specific sequence of operations or other specified parameters being verified
.9 Formulas used in any calculations
.10 Required pre-test field measurements
.11 Instructions for setting up the test.
.12 Special cautions, alarm limits, etc.
.13 Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
.14 Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
.15 A section for comments
.16 Signatures and date block for the CA

.6 Test Methods:

.1 Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. Sections 01 91 34

and 01 91 38. Specify which methods shall be used for each test. The CA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the OR and GC. The CA will determine which method is most appropriate for tests that do not have a method specified.

.2 Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

.3 Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. E.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

.4 Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.

.5 Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 12°C, when the outside air temperature is above 12°C, temporarily change the lockout setpoint to be 1°C above the current outside air temperature.

.6 Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.

.7 Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

.8 Sampling Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. The specific recommended sampling rates are specified with each type of equipment in Sections 01 91 34, 01 91 38. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.

A common sampling strategy referenced in the *Specifications* as the “xx% Sampling—yy% Failure Rule” is defined by the following example.

Xx = the percent of the group of identical equipment to be included in each sample.
Yy = the percent of the sample that if failing, will require another sample to be tested. The example below describes a 20% Sampling—10% Failure Rule.

.1 Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”

.2 If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).

.3 If 10% of the units in the second sample fail, test all remaining units in the whole group.

.4 If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

.7 Coordination and Scheduling: The Subs shall provide sufficient notice to the CA regarding their completion schedule for the prefunctional checklists and start-up of all equipment and systems. The GC will schedule functional tests through the OR, CA and affected Subs. The CA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests and provide written documentation. In general, functional testing is conducted after prefunctional testing and start-up has been satisfactorily completed. The control system is sufficiently tested and approved by the CA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

.8 Test Equipment: Refer to Section 01 91 13, Part 2 for test equipment requirements.

.9 Problem Solving: The CA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the GC, Subs and A/E.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

.1 Documentation. The CA shall witness the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms shall be provided to the CA for review and approval. The CA will include the filled out forms in the O&M manuals.

.2 Non-Conformance:

.1 The CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the OR.

.2 Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.

.3 Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the OR.

.4 As tests progress and a deficiency is identified, the CA discusses the issue with the executing contractor.

.1 When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:

.1 The CA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CA submits the non-compliance reports to the GC for signature, if required. A copy is provided to the Sub and CA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CA.

.2 The GC reschedules the test and the test is repeated.

.2 If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

.1 The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the CA, GC and OR and to the Sub representative assumed to be responsible.

.2 Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.

.3 The CA documents the resolution process.

.4 Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and

provides it to the CA. The GC reschedules the test and the test is repeated until satisfactory performance is achieved.

.5 Cost of Retesting:

.1 The cost for the Sub to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.

.2 For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CA and OR will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CA's and OR's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.

.3 The time for the CA and OR to direct any retesting required because a specific prefunctional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.

.4 Refer to the sampling section of Section 01 91 13, Part 3.6 for requirements for testing and retesting identical equipment.

.6 The Contractor shall respond in writing to the CA and OR at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

.7 The CA retains the original non-conformance forms until the end of the project.

.8 Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

.3 Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the GC or OR. In such case, the Contractor shall provide the Owner with the following:

.1 Within one week of notification from the GC or OR, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the GC or OR within two weeks of the original notice.

.2 Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.

.3 The GC or OR will determine whether a replacement of all identical units or a repair is acceptable.

.4 Two examples of the proposed solution will be installed by the Contractor and the GC will be allowed to test the installations for up to one week, upon which the GC or OR will decide whether to accept the solution.

.5 Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

.4 Approval: The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA and by the GC, if necessary. The CA recommends acceptance of each test to the OR using a standard form. The OR gives final approval on each test using the same form, providing a signed copy to the CA and the Contractor.

3.7 OPERATION AND MAINTENANCE MANUALS

.1 Standard O&M Manuals.

.1 The specific content and format requirements for the standard O&M manuals are detailed on the drawings. Special requirements for the controls contractor and TAB contractor are found Section 01 91 14, Part 3.6.

.2 A/E Contribution: The A/E will include in the beginning of the O&M manuals a separate section describing the systems including:

.1 The design intent narrative prepared by the A/E and provided as part of the bid documents, updated to as-built status by the A/E.

.2 Simplified professionally drawn single line system diagrams on 8 ½" x 11" or 11" x 17" sheets. These shall include heating system, supply air systems, exhaust systems and fire protection systems. These shall show major pieces of equipment such as pumps, boilers, control valves, expansion tanks, coils, service valves, etc.

.3 CA Review and Approval: Prior to substantial completion, the CA shall review the O&M manuals, documentation and redline as-builds for systems that were commissioned and verify compliance with the Specifications. The CA will communicate deficiencies in the manuals to the GC, OR or A/E, as requested. Upon a successful review of the corrections, the CA recommends approval and acceptance of these sections of the O&M manuals to the GC, OR or A/E. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

.2 Commissioning Record in O&M Manuals:

.1 The CA is responsible to compile, organize and index the following commissioning data by equipment into labelled, indexed and tabbed, three-ring binders and deliver it to the OR. Three copies of the manuals will be provided. The format of the manuals shall be:

Tab I-1	Commissioning Plan
Tab I-2	Final Commissioning Report
Tab 01	System Type 1 (HRV, boiler system, etc.)
Sub-Tab A	Design narrative and criteria, sequences, approvals for Equipment 1
Sub-Tab B	Start-up plan and report, approvals, corrections, blank prefunctional checklists *Coloured Separator Sheets—for each equipment type (fans, pumps, chiller, etc.)*
Sub-Tab C	*Functional tests (completed), trending and analysis, approvals and corrections, training plan, record and approvals, blank functional test forms and a recommended re-commissioning schedule.*
Tab 02	*System Type 2…..repeat as per System 1*
Tab 03	*Re-commissioning Plan*

.2 Final Report Details: The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

.1 Equipment meeting the equipment specifications,

.2 Equipment installation,

.3 Functional performance and efficiency,

.4 Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method

used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

.3 Other documentation will be retained by the CA.

3.8 TRAINING OF OWNER PERSONNEL

.1 The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed in accordance with the project specifications.

3.9 WRITTEN WORK PRODUCTS

.1 The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan—Construction Phase, lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

	Product	**Developed By**
.1	Final commissioning plan	CA
.2	Meeting minutes	GC, regular job meetings
.3	Commissioning schedules	GC and DR
.4	Equipment documentation submittals	Subs
.5	Sequence clarifications	Subs and A/E as needed
.6	Pre-functional checklists	
.7	Start-up and initial checkout plan	Subs
.8	Start-up and initial checkout forms filled out	Subs
.9	Final TAB report	TAB
.10	Issues log (deficiencies)	CA
.11	Commissioning Progress Record	CA
.12	Deficiency reports	CA
.13	Functional test forms	Subs, approved by CA
.14	Filled out functional tests	GC
.15	O&M manuals	Subs
.16	Final commissioning report	CA
.17	Misc. approvals	CA

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 The purpose of this section is to specify mechanical contractor (MC) responsibilities in the commissioning process.

.2 The systems to be commissioned are listed in Section 01 91 13.

.3 Commissioning requires the participation of the MC to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 01. The MC shall be familiar with all parts of Division 01 and the commissioning plan (01 91 31) and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RESPONSIBILITIES

.1 Mechanical, Controls and TAB Contractors: The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors are as follows (all references apply to commissioned equipment only):

.1 Include and itemize the cost of commissioning in the contract price.

.2 In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

.3 Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.

.4 Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment.

.5 Develop prefunctional testing procedures and functional performance testing procedures as outlined in 01 91 35 and 01 91 36. In addition, submit the start-up and checkout materials, shipped with equipment to the CA.

.6 Provide functional performance and equipment start-up sheets to the CA.

.1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

.2 The Commissioning Agent may request further documentation necessary for the commissioning process.

.3 This data request may be made prior to normal submittals.

.7 Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.

.8 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.9 Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists for all commissioned equipment. Submit to CA for review and approval prior to startup. Refer to Section 01 91 13 for further details on start-up plan preparation.

.10 During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.

.11 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

.12 Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air or water related systems.
.13 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
.14 Provide skilled technicians to perform functional performance testing for the equipment listed in sections 01 91 34 and 01 91 13. Assist the CA in interpreting the monitoring data, as necessary.
.15 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, OR and A/E and retest the equipment.
.16 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
.17 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
.18 Provide training of the Owner's operating staff using expert qualified personnel, as specified.
.19 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
.20 Warranty Period:
- .1 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings.
- .2 Mechanical Contractor: The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in 1.2.1 are:
  - .1 Provide startup for all HVAC equipment.
  - .2 Assist and cooperate with the TAB contractor and CA by:
    - .1 Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
    - .2 Including cost of sheaves and belts that may be required by TAB.
    - .3 Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide a tight plug.
    - .4 Providing temperature and pressure taps for TAB and commissioning testing.
  - .3 Install a P/T plug at each water sensor which is an input point to the control system.
  - .4 List and clearly identify on the as-built drawings the locations of all air-flow stations.
  - .5 Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.
  - .6 Notify the OR and CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the OR or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.
- .3 Controls Contractor. The commissioning responsibilities of the controls contractor, during construction and acceptance phases in addition to those listed in 1.2.1 are:
  - .1 Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment. They shall include:
    - .1 An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
    - .2 All interactions and interlocks with other systems.

.3 Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
.4 Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but might require additional narrative).
.5 Start-up sequences.
.6 Warm-up mode sequences.
.7 Normal operating mode sequences.
.8 Unoccupied mode sequences.
.9 Shutdown sequences.
.10 Capacity control sequences and equipment staging.
.11 Temperature and pressure control: setbacks, setups, resets, etc.
.12 Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
.13 Effects of power or equipment failure with all standby component functions.
.14 Sequences for all alarms and emergency shut downs.
.15 Seasonal operational differences and recommendations.
.16 Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
.17 Schedules, if known.
.18 To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
.19 Prepare and submit functional performance test forms.

.1 Control Drawings Submittal

.1 The control drawings shall have a key to all abbreviations.

.2 The control drawings shall contain graphic schematic depictions of the systems and each component.

.3 The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

.4 Provide a full points list with at least the following included for each point:

.1 Controlled system
.2 Point abbreviation
.3 Point description
.4 Display unit
.5 Control point or setpoint (Yes/No
.6 Monitoring point (Yes/No)
.7 Intermediate point (Yes/No)
.8 Calculated point (Yes/No)

Key:
Point Description: DB temp, airflow, etc.
Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
Intermediate Point: Point whose value is used to make a calculation which then controls equipment

(space temperatures that are averaged to a virtual point to control reset).
Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
Calculated Point: "Virtual" point generated from calculations of other point values.
The Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

.5 An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

.6 Assist and cooperate with the TAB contractor in the following manner:

.1 Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

.2 For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.

.3 Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

.7 Assist and cooperate with the CA in the following manner:

.1 Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified for the controls contractor in Section 01 91 34 and 01 91 38. Assist in the functional testing of all equipment specified in Section 01 91 34 and 01 91 38. Provide two-way radios during the testing.

.2 Execute all control system trend logs specified in Sections 01 91 34, 01 91 38 and on the drawings.

.8 The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Section 01 91 13. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

.1 System name.

.2 List of devices.

.3 Step-by-step procedures for testing each controller after installation, including:

.1 Process of verifying proper hardware and wiring installation.

.2 Process of downloading programs to local controllers and verifying that they are addressed correctly.

.3 Process of performing operational checks of each controlled component.
.4 Plan and process for calibrating valve and damper actuators and all sensors.
.5 A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

.4 A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
.5 A description of the instrumentation required for testing.
.6 Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work.
.7 Coordinate with the CA and TAB contractor for this determination.

.9 Provide a signed and dated certification to the CA and OR upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
.10 Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified on the drawings. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

.4 TAB Contractor: The duties of the TAB contractor, in addition to those listed in 1.2.1 are:
.1 Six (6) weeks prior to starting TAB, submit to the GC the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician was lead on. The Owner will approve the site technician's qualifications for this project.
.2 Submit the outline of the TAB plan and approach for each system and component to the CA, GC and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
.3 The submitted plan will include:
.1 Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
.2 An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
.3 All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
.4 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
.5 Final test report forms to be used.
.6 Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning,

branch/submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

.7 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

.8 Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).

.9 The identification and types of measurement instruments to be used and their most recent calibration date.

.10 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

.11 Confirmation that TAB understands the outside air ventilation criteria under all conditions.

.12 Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).

.13 Details of how building static and exhaust fan / relief damper capacity will be checked.

.14 Proposed selection points for sound measurements and sound measurement methods.

.15 Details of methods for making any specified coil or other system capacity measurements.

.16 Details of any TAB work to be done in phases or of areas to be built later.

.17 Details regarding specified deferred or seasonal TAB work.

.18 Details of any specified false loading of systems to complete TAB work.

.19 Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

.20 Details of any required interstitial cavity differential pressure measurements and calculations.

.21 Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

.22 Plan for formal progress reports (scope and frequency).

.23 Plan for formal deficiency reports (scope, frequency and distribution).

.4 A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and GC at least twice a week.

.5 Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

.6 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

.7 Provide the CA with any requested data, gathered, but not shown on the draft reports.

.8 Provide a final TAB report for the CA with details, as in the draft.

.9 Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 01 91 34.

1.3 RELATED WORK

.1 Refer to Section 01 91 34, Part 1.4 for a listing of all sections where commissioning requirements are found.

.2 Refer to Section 01 91 13 Part 1.7 for systems to be commissioned and section 01 91 13 Part 1.6 and 01 91 34 for functional testing requirements.

.3 Refer to Section 25 08 20 for requirements for EMCS commissioning.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

.1 MC shall provide all test equipment necessary to fulfill the testing requirements of this Division.

.2 Refer to Section 01 91 13 Part 2.1 for additional requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS

.1 MC shall provide submittal documentation relative to commissioning as required in this Section Part 1 and Section 01 91 13.

3.2 START-UP

.1 The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 13. MC has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

.2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and GC. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 TAB

.1 Refer to the TAB responsibilities above.

3.4 FUNCTIONAL PERFORMANCE TEST

.1 Refer to Section 01 91 13 Part 1.4 for a list of systems to be commissioned and to Part 3.6 for a description of the process and to Section 01 91 34 for specific details on the required functional performance tests.

3.5 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

.1 Refer to Section 01 91 13 Part 3.4 for specific details on non-conformance issues relating to prefunctional checklists and tests.

.2 Refer to Section 01 91 13 Part 3.7 for issues relating to functional performance tests.

3.6 OPERATION AND MAINTENANCE (O&M) MANUALS

.1 The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

.2 MC shall compile and prepare documentation for all equipment and systems covered on the drawings and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and the drawings, prior to the training of owner personnel.

.3 The CA shall receive a copy of the O&M manuals for review.

.4 Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the controls contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs and on a DVD.

.1 Three copies of the controls training manuals in a separate manual from the O&M manuals.

.2 Operation and Maintenance Manuals containing:

.1 Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.

.2 Full as-built set of control drawings (refer to Submittal section above for details).

.3 Full as-built sequence of operations for each piece of equipment.

.4 Full points list. In addition to the updated points list required in the original submittals (Part 1 of this section), a listing of all rooms shall be provided with the following information for each room:

.1 Floor
.2 Room number
.3 Room name
.4 Air handler unit ID
.5 Reference drawing number
.6 Air terminal unit tag ID
.7 Heating and/or cooling valve tag ID
.8 Minimum cfm
.9 Maximum cfm

.5 Full print out of all schedules and set points after testing and acceptance of the system.

.6 Full as-built print out of software program.

.7 Electronic copy on disk of the entire program for this facility.

.8 Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

.9 Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.

.10 Control equipment component submittals, parts lists, etc.

.11 Warranty requirements.

.12 Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

.3 The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
- .1 Sequences of operation
- .2 Control drawings
- .3 Points lists
- .4 Controller / module data
- .5 Thermostats and timers
- .6 Sensors and DP switches
- .7 Valves and valve actuators
- .8 Dampers and damper actuators
- .9 Program setups (software program printouts)

.4 Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.

.5 Special TAB Documentation Requirements: The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.
- .1 Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
- .2 The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

.6 Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA. Refer to Section 01 91 13, Part 3.8 for details.

3.7 TRAINING OF OWNER PERSONNEL

.1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 13 for additional details.

.2 Mechanical Contractor: The mechanical contractor shall have the following training responsibilities:
- .1 Provide the CA with a training plan two weeks before the planned training according to the outline described in Section 01 91 13, Part 3.9.
- .2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, air handling units, VAV terminal units, controls, hot water heaters, fan coils and VRF heat pumps, etc.
- .3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
- .6 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
- .7 The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance Manual and illustrate whenever possible the use of the O&M manuals for reference.
- .8 Training shall include:
  - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

.2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
.3 Discussion of relevant health and safety issues and concerns.
.4 Discussion of warranties and guarantees.
.5 Common troubleshooting problems and solutions.
.6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
.7 Discussion of any peculiarities of equipment installation or operation.
.8 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 is recommended.

.9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
.10 The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
.11 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.
.12 Duration of Training. The mechanical contractor shall provide training on each piece of equipment as specified.

.3 Controls Contractor: The controls contractor shall have the following training responsibilities:
.1 Provide the CA with a training plan four weeks before the planned training according to the outline described in Section 01 91 13, Part 3.9.
.2 The controls contractor shall provide designated Owner personnel training on the control system in this facility as required by the project specifications.
.3 Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.
.4 The trainings will be tailored to the needs and skill-level of the trainees.
.5 The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
.6 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
.7 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

3.8 DEFERRED TESTING

.1 Refer to Section 01 91 13, Part 3.5 for requirements of deferred testing.

3.9 WRITTEN WORK PRODUCTS

.1 Written work products of Contractors will consist of the start-up and initial checkout plan described in Section 01 91 13 and the filled out start-up, initial checkout and prefunctional checklists.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 The purpose of this section is to specify responsibilities of the Electrical Contractor (EC) in the commissioning process. Other electrical system testing is required under the direction of the A/E.

.2 The list of commissioned equipment and systems is found in Section 01 91 13.

.3 Commissioning requires the participation of the EC to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 01. The EC shall be familiar with all parts of Division 01 and the commissioning plan and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RESPONSIBILITIES

.1 Electrical Contractors. The commissioning responsibilities applicable to the electrical contractor are as follows (all references apply to commissioned equipment only):

.1 *Construction and Acceptance Phases*

.1 Include the cost of commissioning in the contract price.

.2 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.

.3 Attend a commissioning scoping meeting and other necessary meetings to facilitate the Cx process.

.4 Contractors shall provide normal cut sheets and shop drawing submittals to the CA of commissioned equipment.

.5 Provide functional performance and equipment start-up sheets to the CA.

.1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

.2 The Commissioning Agent may request further documentation necessary for the commissioning process.

.3 This data request may be made prior to normal submittals.

.6 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CA for review and approval.

.7 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.8 Provide specific functional performance test procedures specified in Section 01 91 38. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

.9 Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review.

.10 During the startup and initial checkout process, execute and document the electrical-related portions of the prefunctional checklists for all commissioned equipment.

.11 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

.12 Address current A/E punch list items before functional testing.

.13 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
.14 Perform functional performance testing, witnessed by the CA, for equipment specified in Sections 01 91 38 and 01 91 13. Assist the CA in interpreting the monitoring data, as necessary.
.15 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, OR and A/E and retest the equipment.
.16 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
.17 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
.18 Provide training of the Owner's operating personnel as specified.
.19 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

.2 Warranty Period

.1 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified.

.2 Electrical Designer/Engineer

.1 Refer to Section 01 91 13 for the responsibilities of the Electrical Designer/Engineer.

1.3 RELATED WORK

.1 Refer to Sections 01 91 13 for a listing of all sections where commissioning requirements are found.

.2 Refer to Section 01 91 13 for systems to be commissioned and section 01 91 13 and 01 91 38 for functional testing requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

.1 The EC shall provide all test equipment necessary to fulfill the testing requirements of this Division.

.2 Refer to Section 01 91 13 Part 2.1 for additional electrical requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS

.1 The EC shall provide submittal documentation relative to commissioning to the CA as requested by the CA. Refer to Section 01 91 13 Part 3.3 for additional electrical requirements.

3.2 START-UP

.1 The electrical contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 13 Part 3.4. The EC has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives

of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

.2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CA and OR. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 FUNCTIONAL PERFORMANCE TEST

.1. Refer to Section 01 91 13 for a list of systems to be commissioned and a description of the process and to Section 01 91 38 for specific details on the required functional performance tests.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

.1 Refer to Section 01 91 13 for specific details on non-conformance issues relating to prefunctional checklists and tests.

.2 Refer to Section 01 91 13 for issues relating to functional performance tests.

3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS

.1 The EC shall compile and prepare documentation for all equipment and systems covered on the drawings and deliver to the GC for inclusion in the O&M manuals, according to the drawings.

.2 The CA shall receive a copy of the O&M manuals for review.

3.6 TRAINING OF OWNER PERSONNEL

.1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 13 for additional details.

.2 The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 13 for additional details.

.3 Electrical Contractor. The electrical contractor shall provide training as specified and shall provide documentation to the CA describing the training when completed. The electrical contractor shall have the following training responsibilities:

.1 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.

.2 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.

.3 The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

.4 Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative.

.5 Duration of Training: The electrical contractor shall provide training on each piece of equipment. Training is expected to take no more than one day. Cover the lighting controls and power distribution.

END OF SECTION

PART 1 - GENERAL

1.1 ABBREVIATIONS AND DEFINITIONS

.1 The following are common abbreviations used in this document:

.1	A/E	Architect and design engineers
.2	CA	Commissioning authority
.3	CC	Controls contractor
.4	Cx	Commissioning
.5	Cx Plan	Commissioning Plan document
.6	EC	Electrical contractor
.7	FT	Functional performance test
.8	GC	General contractor
.9	MC	Mechanical contractor
.10	PC	Prefunctional checklist
.11	PM	Project manager
.12	Subs	Subcontractors to General
.13	TAB	Test and balance contractor

1.2 PURPOSE OF THE COMMISSIONING PLAN

.1 The purpose of the construction phase commissioning plan is to:

.1 Provide direction for the commissioning process during construction, particularly providing resolution for issues and providing details that cannot be, or were not, fully developed during design, such as scheduling, participation of various parties of this particular project, actual lines of reporting and approvals, coordination, etc.

.2 This plan does not provide a detailed explanation of required testing procedures. The detailed testing requirements and procedures are found in the Specifications, Sections 01 91 34, 01 91 35, 01 91 36, 01 91 38, 01 91 39, 01 91 40. Additionally, this plan does not provide extensive narrative on all commissioning concepts, as may be provided in other commissioning guides.

1.3 COMMISSIONING SCOPE

.1 Commissioning during the construction of this project is intended to achieve the following specific objectives:

.1 According to the Contract Documents:

.1 Ensure that applicable equipment and systems are installed properly and receive adequate operational checkout by installing contractors.

.2 Verify and document proper performance of equipment and systems.

.3 Ensure that O&M documentation left on site is complete.

.4 Ensure that the Owner’s operating personnel are adequately trained.

1.4 COMMISSIONED SYSTEMS

.1 Refer to Section 01 91 13.

1.5 FORMS

.1 Construction Phase Blank Forms (A to E) are attached at the end of this section for information.

1.6 GENERAL BUILDING INFORMATION

.1 Project: Dartmouth Community Correction Centre

.2 Location: Dartmouth, Nova Scotia

.3 Number of stories: 2

1.7 CONSTRUCTION/CX TEAM DATA (PRIMARY PARTIES)

Team Member	Co. & Contact Names	Contact Information
Owner Contact	TBD	
Project Manager (PM)	TBD	
General Contractor	TBD	
Site Supervisor Site Coordinator	TBD	
Commissioning Authority	TBD	
Prime Consultant	TBD	
Architect	TBD	
Mechanical Designer/Eng.	TBD	
Electrical Designer/Eng.	TBD	
Mechanical Contractor HVAC Site Supervisor	TBD	
Refrigeration Contractor	TBD	
Piping Contractor	TBD	
Sheet Metal Contractor	TBD	
Electrical Contractor	TBD	
Site Supervisor	TBD	
TAB Contractor	TBD	
Controls Contractor Project Manager Project Engineer	TBD TBD	

1.8 TEAM MEMBERS

.1 The members of the commissioning team consist of the CA, PM, assigned members of the CC, GC, A/E (particularly the mechanical engineer), the mechanical contractor, electrical contractor, TAB representative, controls contractor, any other installing subcontractors or suppliers of equipment.

1.9 GENERAL MANAGEMENT PLAN

.1 In general, the CA coordinates the commissioning activities. The CA's responsibilities, along with all other contractors' commissioning responsibilities are detailed in the specifications. The Specifications will take precedence over this Cx Plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to the management protocols section below. For this project the CA was engaged by the Prime Consultant.

1.10 GENERAL DESCRIPTIONS OF ROLES

.1 CA Witnesses testing, preparation of the Cx Plan and Cx manual.

.2 PM Final approval of the Cx process and manual.

.3 GC Facilitates the Cx process, ensures that Subs perform their responsibilities and integrates Cx into the construction process and schedule.

.4 Subs: Demonstrate proper system performance.

.5 A/E: Perform construction observation, approve O&M manuals and assist in resolving problems.

.6 Mfr: The equipment manufacturers and vendors provide documentation to facilitate the commissioning.

1.11 COMMISSIONING SCOPING MEETING

.1 A commissioning scoping meeting will be scheduled at one of the regular site meetings and when the mechanical systems are approximately 50% complete. In attendance are the respective representatives of the GC, CA, PM, A/E and the mechanical, electrical, controls, and TAB subs. At the meeting commissioning parties are introduced and the commissioning process reviewed, management and reporting lines determined. The Cx Plan is reviewed, process questions are addressed, lines of reporting and communications determined. Also covered is the general list of each party's responsibilities, who is responsible to develop the startup plan for each piece of equipment and the proposed commissioning schedule. The outcome of the meeting is increased understanding by all parties of the commissioning process and their respective responsibilities. The meeting provides the CA additional information needed to finalize the Cx Plan, including the commissioning schedule.

.2 Prior to this meeting the CA is given, by the GC, all drawings and specifications and the construction schedule by trade. The CA keeps notes from the meeting and distributes them to each team member.

1.12 SITE OBSERVATION

.1 The CA, and A&E Team make periodic visits to the site, as necessary,to witness equipment and system installations.

1.13 MISCELLANEOUS MEETINGS

.1 The CA may review construction meeting minutes, change orders or SIs for the same purpose.

.2 Later during construction, necessary meetings between various commissioning team parties will be scheduled by the CA, through the GC, as required.

1.14 SUBMITTALS AND PROCEDURES

.1 The CA may review submittals for commissioning requirements.

1.15 PREFUNCTIONAL CHECKLISTS, TESTS AND STARTUP

.1 Prefunctional checklists (PC) are important to ensure that the equipment and systems are hooked up and operational and that functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout by the Contractor. No sampling strategies are used. In general, the prefunctional testing for a given system, must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

.2 Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist.

.3 Prefunctional tests shall include those recommended by the equipment manufacturer, or in the absence of specific recommendations by the manufacturer as agreed by the Contractors and commissioning authority.

.4 Prefunctional tests shall be documented in writing by the installing technician. The CA will not witness much of the prefunctional checklisting, except for testing of larger or more critical pieces of equipment and some spot-checking.

.5 The prefunctional checklists shall be submitted to the CA for review and inclusion in the commissioning binder.

.1 Start-up plan:

.1 The Contractor shall submit to the CA manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians from the contractor.

.2 Execution of Checklists and Startup:

.1 Four weeks prior to startup, the Subs and vendors schedule startup and initial checkout with the GC and CA. The startup and initial checkout are directed and executed by the Sub or vendor. The CA, and GC if necessary, observes the procedures. For components of equipment, (e.g., radiant panels, fans, heat pumps, etc.), the CA observes a sampling of the prefunctional and start-up procedures. To document the process of startup and checkout, the site technician performing the line item task initials and dates each paragraph of procedures in the "Startup Plan" and checks off items on the prefunctional and manufacturer field checkout sheets, as they are completed. Only individuals having direct knowledge of a line item being completed shall check or initial the forms. The Subs and vendors execute the checklists and tests and submit a signed copy of the completed start-up and prefunctional tests and checklists to the CA. Further details are found in the Specifications Section 01 91 13, Part 3.4. The CA may review prefunctional checklists in progress, as necessary.

.3 Deficiencies and Non-Conformance:

.1 The Subs clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and deficiencies are provided to the CA within two days of test completion.

.2 The Subs and vendors shall correct and retest deficiencies or uncompleted items, involving the GC and others as necessary. The installing Subs or vendors correct all areas that are deficient or incomplete according to the checklists and tests.

.4 TAB:

.1 The TAB contractor submits the outline of the TAB plan and approach to the CA and the controls contractor eight weeks prior to starting the TAB. Included in the approach, is an explanation of the intended use of the building control system. The CA reviews the plan and approach for understanding and coordination issues and may comment, but does not "approve." The controls contractor reviews the feasibility of using the building control system for assistance in the TAB work.

.2 The TAB shall submit weekly written reports of discrepancies, contract interpretation requests and lists of completed tests to the CA and GC.

.3 Functional performance testing does not begin until the TAB work is complete. A checklist form for reviewing the TAB plan is provided as one of the prefunctional checklists in Specifications Section 01 91 35.

.4 TAB work will not begin until the control system has been prefunctionally tested and selective functional tests have been performed and approved by the CA.

.5 Controls Checkout Plan:

.1 The controls contractor shall develop and submit a written step-by-step plan to the CA which describes the process they intend to follow in checking out the control system and the forms on which they will document the process. The controls contractor will also meet with the TAB contractor prior to the start of TAB and review the TAB plan to determine the capabilities of the control system for use in TAB. The controls contractor will provide the TAB with any necessary unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.). The controls contractor shall also provide a technician qualified to operate the controls to assist the TAB contractor in performing TAB. Additional details are found in Specifications Section 01 91 14.

.2 All controls prefunctional checklists, calibrations, start-up and selected functional tests of the system shall be completed and approved by the CA prior to TAB. The controls contractor shall execute the tests and trend logs assigned to them in Section 01 91 34 and 01 91 38 and remain on site for assistance for mechanical system functional tests as specified in the same sections.

1.16 DEVELOPMENT OF FUNCTIONAL TEST AND VERIFICATION PROCEDURES

.1 Overview: Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences state. The commissioning agent shall witnesses functional test procedures, but the testing is performed by the installing contractor or vendor. Tests shall be documented and submitted to the CA by the Contractor.

.2 The specification "Testing Requirements" Sections 01 91 34 and 01 91 38 provide specific functional testing scope for each piece of commissioned equipment. A detailed description of the functional and prefunctional testing procedures and process is found in the Specifications, 01 91 13 Part 3.

.3 Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. According to the Specifications, not all pieces of identical equipment receive in-depth testing. The CA reviews owner-contracted, factory or required owner acceptance tests and determines what further testing may be required to comply with the Specifications. Redundancy is minimized.

1.17 EXECUTION OF FUNCTIONAL TESTING PROCEDURES

.1 Overview and Process: The GC shall schedule functional tests through the affected Subs and notify the PM and CA. For any given system, prior to performing functional testing, the CA shall wait until the prefunctional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing.

.2 The CA shall witness and document the functional testing of all equipment and systems according to the Specifications and the Cx Plan. The Subs execute the tests. The control system is tested before it is used to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems. Refer to specification section 01 91 13 Part 3 for additional process details.

.3 Deficiencies and Retesting: The CA documents the results of the test. Corrections of minor deficiencies identified are made during the tests at the discretion of the CA. The CA records the results of the test on the procedure or test form. Deficiencies or non-conformance issues are noted and reported to the PM on Form E (Commissioning Corrective Action Report). Subs correct deficiencies, notify the CA and return Form E certifying correction. The GC schedules retesting through the PM. Decisions regarding deficiencies and corrections are made at as low a level as possible, preferably between CA or PM and the Sub. For areas in dispute, final authority, besides the Owner's, resides with the A/E. The CA recommends acceptance of each test to the PM. The PM gives final approval on each test using Form B or C (Commissioning Test or Review Approval or Commissioning Prefunctional Checklist and Startup Submittal / Approval) form.

.4 The Owner's facilities operating staff are encouraged to attend and participate in the testing process. The CA will notify the PM, who will then notify the facility staff when the commissioning events will occur.

1.18 O&M MANUALS AND WARRANTIES

.1 Standard O&M Manuals: The CA reviews the O&M manuals,documentation and redline as-builts for systems that were commissioned to verify compliance with the Specifications. The CA recommends approval and acceptance of these sections of the O&M manuals to the PM. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. Refer to Specifications 01 91 13 Part 3.7 for further details.

.2 Commissioning Record: The CA will compile a commissioning binder that represents the commissioning activities and submit it to the owner for their record.

1.19 TRAINING AND ORIENTATION OF OWNER PERSONNEL

.1 Owner training and orientation on equipment and systems shall be provided by the Contractor in accordance with the project specifications.

.2 Submit records of the training activity, initialed by the attendees, to the CA for inclusion in the Commissioning Binder.

1.20 WARRANTY PERIOD

.1 During the warranty period, seasonal testing and other deferred testing required is completed according to the Specifications. Deficiencies shall be corrected by the appropriate Subs, witnessed by facilities staff. The CA will return to the project approximately 10 months into the 12 month warranty period. During this visit(s)

the CA will review with facility staff the current building operation. The CA will identify areas that may come under warranty or under the original construction contract.

1.21 SCHEDULE

.1 The following sequential priorities are followed:

.1 Equipment is not "temporarily" started (for heating or cooling), until pre-start checklist items and all manufacturer's pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.

.2 Functional testing is not begun until prefunctional and start-up and TAB is completed, for a given system (this does not preclude a phased approach).

.3 The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing completed.

.4 TAB is not performed until the controls system has been sufficiently functionally tested and approved by the CA for TAB work.

.5 TAB is not performed until the envelope is completely enclosed and ceiling complete, unless the return are is ducted.

1.22 INITIAL COMMISSIONING SCHEDULE SUMMARY

Task/Activity	**Estimated Start Date**	**Estimated End Date**
Initial scoping meeting and final plan	TBD	
Submittals obtained and reviewed		
Begin construction site visits/inspections		
Prefunctional forms developed and distributed		
Startup and initial checkout plans		
Startup and initial checkout executed		
TAB-Water/Air		
Functional performance tests		
O&M documentation review and verification		
Training and training verification		
Final commissioning report		

END OF SECTION

Project: _____

Attach additional pages as necessary for issues requiring more explanation and tracking.

Prepared by:_____ Page _____ of _____

#	Issue	Date Found	Effects	Possible Cause	Recommendations	Actions Taken	O&M Doc. Issue?	Fix (√ or Date)

END OF SECTION

Project:

__Completed Pre-Functional Test

Equipment Name:_____ Equipment Tag: _____

Pre-Functional Test Description: _____

__Completed Functional Test

Equipment Name:_____ Equipment Tag: _____

Functional Test Description: _____

The test(s) of the above equipment or the review of the referenced document(s) have been completed and performance of the component, system or documents complies with the acceptance criteria in the testing or document requirements of the Specifications and Contract Documents, subject to the changes being made as listed below or on an attached sheet.

__Sheets attached

A copy of the completed test or document review is attached. (Y/N) ____

Commissioning Agent Approval:

_____ _____

Commissioning Agent Date

General Contractor Approval:

The test or review results relating to the above equipment has been reviewed and approved as complying with the contract documents.

_____ _____

General Contractor Date

Exclusions:

END OF SECTION

Project:

SUBMITTAL NO: _____ ❑ New ❑ Resubmittal
Cx Section No: _____

From (initially):_____ To: _____

Equipment or System Tag and Name: _____
_____

_____

Included:
___Prefunctional checklist form
___Startup and Initial Checkout: ___Documentation format, ___Execution Plan

Submissions / Returns

	Return of completed forms	Submission of completed forms	Submission of completed forms
Path	To (__GC, __CA): _____ from (sub): _____	To (__CA, __A/E, __Owner)_____ __ from (__GC, __CA): _____	To (__CA, __A/E, __Owner, __GC) _____from (__GC, __CA): _____
Comments by Submitter	This checklist ___ and startup report has been executed successfully per the contract documents. ❑ Notes attached	This completed checklist ___and startup report has been reviewed. ❑ Notes attached	This completed checklist ___and startup report has been reviewed. ❑ Notes attached
Copies			
Submitter Signature			
Title			
Date			
Code			

Submitting Codes:

Sb = Submitted as documentation of a completed checklist and/or startup report.
A = Approved as complying with the contract documents.
NC = Note Corrections. Approved, but need to resubmit for the record, after correcting.
NA = Not Acceptable. Resubmittal required for review.

Abbreviations: CA = commissioning agent/authority
GC = General Contractor,
A/E = architect or engineer of record
Sub = responsible subcontractor or vendor.

END OF SECTION

Project:

From (initially): _____ To: _____

SUBMITTAL NO: _____
❑ New ❑ Resubmittal

Equipment or System Name: _____ ID #: _____
_____ _____
_____ _____

Cx Section No: _____

Submittal Type:

❑ Documentation (describe) _____
_____

❑ Functional test procedure forms: _____

❑ Completed functional test procedure record or report: _____

❑ Prefunctional checklist: _____

❑ Startup and initial checkout forms: _____

❑ Completed startup documentation or report: _____

Submissions / Returns

Path	To _____ from (initially) _____	To _____ from _____	To _____ from _____	To _____ from _____	To _____ from _____
Comments by Submitter	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached	❑ Notes attached
Copies					
Submitter Signature					
Title					
Date					
Code					

Submitting Codes:

I = Initial Submittal: The attached submittal has been reviewed, and the equipment, documents or performance represented comply with the contract documents.
A = Approved as complying with the contract documents.
C = Note Corrections. Approved, but need to resubmit for the record, after correcting.
NA = Not Acceptable. Resubmittal required for review.

END OF SECTION

Project:

Equipment:_____ Equipment ID: _____

Identified from: __Test, __Review, __Discussion ____, ☐ Site visit _____
Date

The above equipment has been observed, tested or the performance report reviewed and was found to not comply with the contract documents.

Deficiencies or Issues and Effects:

_____

_____

_____

Corrective Action: ☐ Required ☐ Recommended.

_____

_____

_____

For testing to proceed in a timely manner, it is imperative that the required corrective action be completed by:

_____

Date or Event

_____ _____ _____ _____

Commissioning Agent Date Owner's Representative Date

Forwarded to the following parties on _____ for corrective action:
Date

_____

Attachments (Y / N)_____

Fill in the following section and return entire form to commissioning agent when corrected.

Statement of Correction

The above deficiencies have been corrected with the following actions:

_____

_____

_____ _____ _____

Signature Firm Date

END OF SECTION

PART 1 - GENERAL

1.1 INCLUDED SYSTEMS AND EQUIPMENT

.1 The following is a list of the Mechanical system equipment and system test requirements included in this section:
- .1 Unit/Forced Flow Heaters
- .2 Heat Recovery Ventilator
- .3 Fans & Motorized Dampers
- .4 Testing, Adjusting and Balancing (TAB)
- .5 Controls
- .6 Pumps
- .7 Fan Coils
- .8 Sump Pump
- .9 Hot Water Heaters
- .10 Plumbing Fixtures
- .11 Variable Refrigerant Volume Air Source Heat Pump
- .12 Boilers

1.2 DESCRIPTION

.1 This section specifies the contractors responsibility to execute functional testing requirements for mechanical systems and equipment. The general functional testing process, requirements and test method definitions are described in Section 01 91 13. The test requirements for each piece of equipment or system shall contain the following:
- .1 A list of the integral components being tested.
- .2 Prefunctional checklists associated with the components.
- .3 Functions and modes to be tested.
- .4 Required conditions of the test for each mode.
- .5 Special procedures.
- .6 Required methods of testing.
- .7 Required monitoring.
- .8 Acceptance criteria.
- .9 Sampling strategies allowed.

1.3 PREREQUISITES

.1 Provide the following check list, signed off, prior to functional testing of each system.

.1 __ All related equipment has been started up and start-up reports and prefunctional checklists submitted and approved ready for functional testing.

.2 __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed. Controls Contractor Signature or Verbal with date.

- .3 __ Piping system flushing complete and required report submitted to the CA.
- .4 __ Test and Balance (TAB) complete.
- .5 __ These functional test procedures reviewed and approved by installing contractor.
- .6 __ Safeties and operating ranges verified.
- .7 __ Test requirements and sequences of operation attached.
- .8 __ Schedules and setpoints attached.
- .9 __ False loading equipment, system and procedures ready.
- .10 __ Sufficient clearance around equipment for servicing.

.11 __ Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.).
.12 __ Other miscellaneous checks of the prefunctional checklist and start-up reports completed successfully.

1.4 MONITORING

.1 All control system monitored points shall be trended by the controls contractor.

.2 Hard copies of monitored data must be in columnar format with time down the left column and at least 5 columns of point values on the same page.

.3 Graphical output will be required for all output.

PART 2 - PRODUCTS Not Applicable.

PART 3 - EXECUTION

3.1 HEAT RECOVERY VENTILATOR (HRV)

.1 Parties Responsible to Execute Functional Test:
.1 Controls contractor: operate the controls to activate the equipment as needed.
.2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned.
.2 Test damper interlocks and correct modulation in all modes.
.3 Heating, Cooling and heat recovery system operation. In addition to simulating the peak performance of these systems also set up trend monitoring to observe the output from these systems throughout the year.
.4 Sensor and actuator calibration checks: on SAT, MAT, OSAT, OSA & RA damper and valve positions, SF cfm reading with TAB, and other random checks (EMS readout against hand-held calibrated instrument or observation must be within specified tolerances).
.5 Check and document installed filter efficiencies.

.4 Required Monitoring:
.1 All points listed below which are control system monitored points shall be trended by the controls contractor.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)
For HRV				

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)
RAT	5	5 days incl. weekend	Y	Y
RAH	5	5 days incl. weekend	Y	Y
HC LAT	5	5 days incl. weekend	Y	Y
SAT	5	5 days incl. weekend	Y	Y
SAH	5	5 days incl. weekend	Y	Y
SF/RF speed	5	5 days incl. weekend	Y	Y
Damper Specification	5	5 days incl. weekend	Y	Y
OSAT	5	5 days incl. weekend	Y	Y
Indoor dry-bulb 8 zones (expected to be most problematic, 2 on each level)	5	5 days incl. weekend	Y	Y

3.2 FANS

.1 Parties Responsible to Execute Functional Test:
- .1 Controls contractor: operate the controls to activate the equipment, if BAS controlled.
- .2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functions/Modes Required To Be Tested, Test Methods and Seasonal Test Requirements. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.
- .1 Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned.
- .2 Check all alarms and safeties and flow switch functions.

.4 Acceptance Criteria: For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.3 DOMESTIC HOT WATER HEATER

.1 Parties Responsible to Execute Function Test:
- .1 Controls contractor: to operate the controls as needed.
- .2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Test each sequence in the sequence of operations, and other significant modes and sequence not mentioned.
.2 Check all alarms and safeties.

3.4 TEST AND BALANCE WORK (TAB)

.1 Parties Responsible to Execute Functional Test

.1 Controls contractor: operate the controls to activate the equipment.
.2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.

.4 The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

.5 A random sample of up to 20% the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical or sound measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work.
.1 A failure of more than 10% of the selected items of a given system shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report.
.2 The random testing will include the verification of minimum outdoor air intake flows at minimum, maximum and intermediate total airflow rates for all of the air handlers. Other selected data to be verified will be made known upon day of testing.

.6 Verify that final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked by the TAB Contractor.

.7 Verification that the water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from the pump to the load having all balancing valves wide open.

3.5 BUILDING AUTOMATION SYSTEM (BAS)

.1 Parties Responsible to Execute Functional Test:

.1 Controls contractor: operate the controls to activate the equipment.
.2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the BAS testing

requirements, except for any integrated functions or interlocks listed below.

.4 In addition to the controlled equipment testing, the following tests are required for the BAS, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

Function/Mode	**Test Method** **Manual (demonstration), Monitoring, Either or Both**
MISCELLANEOUS FUNCTIONS	
.1 All specified functions and features are set up, debugged and fully operable.	Verbal discussion of features
.2 Power failure and battery backup and power-up restart functions.	Demonstration
.3 Specified trending and graphing features demonstration.	See equipment trends
.4 Global commands features.	Demonstration
.5 Security and access codes.	Demonstration
.6 Occupant over-rides (manual, telephone, key, keypad, etc.)	Demonstration
.7 O&M schedules and alarms	Demonstration
.8 Scheduling features fully functional and setup, including holidays.	Observation in terminal screens or printouts
.9 Date and time setting in central computer and verify field panels read the same time	Demonstration
.10 Included features not specified to be setup are installed (list).	Demonstration
.11 Occupancy sensors and controls.	Demonstration
.12 Demonstrate functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad.	Demonstration of 100% of panels and 10% of ports
.13 All graphic screens and value readouts completed.	Demonstration
.14 Setpoint changing features and functions.	Done during equipment testing
.15 Communications to remote sites.	Demonstration
.16 Sensor calibrations.	Sampled during equipment tests
.17 Final as-builts or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&Ms.	Observation
.18 Verify that points that are monitored only, having no control function, are checked for proper reporting to BAS.	Observation

INTEGRATED TESTS	
.19 Duty cycling.	Monitoring
.20 Sequential staging ON of equipment.	Either
.21 Optimum start-stop functions.	Monitoring
.22 All control strategies and sequences not tested during controlled equipment testing.	Either
.23 Other integrated tests specified in the contract documents.	

.5 Acceptance Criteria:
.1 For the conditions, sequences and modes tested, the BAS, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

.6 Sampling Strategy for demonstrating performance of identical units:
.1 Sample 10% of the field panels for procedure 9, and 10% of the local ports for procedure 12. If 10% fail, test another 10%. If 10% of those fail, test all remaining units at the contractor's expense.

3.6 FORCE FLOW/UNIT HEATERS

.1 Parties Responsible to Execute Functional Test:

.1 Controls contractor: operate the controls as needed.
.2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Record space temperatures.
.2 Confirm fan operation.

3.7 PUMPS

.1 Parties Responsible to Execute Functional Test:
.1 Controls contractor: operate the controls as needed.
.2 Mechanical contractor or vendor: assist in testing sequences.
.3 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Test control through every cycle of operation.
.2 Provide trend logs of system flow and discharge pressure.

3.8 FAN COILS

.1 Parties Responsible to Execute Functional Test
.1 Controls contractor: operate the controls as needed.
.2 Mechanical contractor or vendor: assist in testing sequences.
.3 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functions/Modes Required To Be Tested, Test Methods and Seasonal Test Requirements. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.
.1 Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned.
.2 Check all alarms and safeties and flow switch functions.

3.9 SUMP PUMP

.1 Parties Responsible to Execute Functional Test
.1 Controls contractor: operate the controls as needed.
.2 Mechanical contractor or vendor: assist in testing sequences.
.3 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Test controls through every cycle of operation.
.2 Check all alarms and safeties.

3.10 PLUMBING FIXTURES

.1 Parties Responsible to Execute Functional Test:

.1 Mechanical contractor or vendor: assist in testing sequences.
.2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
.1 Check water temperature and confirm flow.
.2 Confirm no cross contamination.

3.11 AIR SOURCE HEAT PUMP

.1 Parties responsible for executing functional test:
.1 Controls contractor.
.2 HVAC mechanical contractor
.3 CA: to witness

.2 Prerequisites: the applicable checklist items listed in the beginning of this section wmust be submitted to the CA.

.3 Functional Performance Testing:
.1 Test each sequence in the sequence of operations and other significant modes and sequences not

mentioned.

.2 Required Monitoring: provide trend logs of system fluid temperatures and air temperatures.

3.12 BOILERS

.1 Parties Responsible to Execute Functional Test
- .1 Controls contractor: operate the controls as needed.
- .2 Mechanical contractor or vendor: assist in testing sequences.
- .3 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of this Section shall be submitted to the CA.

.3 Functional Performance Testing:
- .1 Test control through every cycle of operation.
- .2 Verify outdoor air reset operation
- .3 Verify staging of boilers
- .4 Verify DHW heating control

END OF SECTION

1 GENERAL

.1 Contractor shall be responsible for submitting blank forms for the prefunctional test to the CA.

.2 Contractor may use the included sample blank forms for developing equipment specific blank test forms. Note that sample forms are not included for every piece of equipment which is to be commissioned. These forms are included to indicate the level of detail required.

.3 Contractor shall submit a customized blank prefunctional test forms for each system included for commissioning listed in the commissioning plan and commissioning specification section 01 91 13 and the drawings.

.4 Prefunctional testing performed on non-approved forms shall not be accepted.

.5 Contractor shall make necessary modifications to forms as noted by the CA.

END OF SECTION

1 GENERAL

.1 Contractor shall be responsible for submitting final Functional Test Procedures forms to CA for approval.

.2 Contractor may use included sample forms for developing final procedures.

.3 Contractor shall submit forms for each system intended to be commissioned as listed in commissioning plan and specification section 01 91 13.

.4 Blank forms shall be submitted well in advance of any scheduled test for review and approval.

.5 Contractor shall make the necessary modifications to the blank forms as instructed by the CA.

2 FORMS

.1 The following forms are attached at the end of this Section:
- .1 Air Handling Units (AHU or HRV).
- .2 Domestic Hot Water Heater.
- .3 Air Source Heat Pump.

END OF SECTION

FT-_____ Air Handling Unit (AHU or HRV)_____

1. Prerequisite Checklist

a. __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

_____ _____
Controls Contractor Signature or Verbal Date

b. __ Vibration control completed.
c. __ Test and balance (TAB) completed and approved for the air systems.
d. __ All A/E punch list items for this equipment corrected.
e. __ These functional test procedures reviewed and approved by installing contractor.
f. __ Safeties and operating ranges reviewed.
g. __ Test requirements and sequences of operation attached.
h. __ Schedules and setpoints attached.
i. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
j. __ Control Program Review. Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

2. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting.

"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (_____). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Loc-ation OK[1]	**1st** Gage or BAS Value	Instr. Meas'd Value	**Final** Gage or BAS Value	Pass Y/N?

Sensor & Location	Loc-ation OK[1]	**1st** Gage or BAS Value	Instr. Meas'd Value	**Final** Gage or BAS Value	Pass Y/N?

[1]Sensor location is appropriate and away from causes of erratic operation.

3. Device Calibration Checks. The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during prefunctional checklisting and startup.

"In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	**Procedure / State**	**1st** BAS Value	Site Observation	**Final** BAS Reading	Pass Y/N
	1. Closed				
OA damper position	.2 Full open				
	1. Closed				
EA damper position	2. Full open				

4. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully. Pass? Y / N _____

General Conditions of Test

_____
_____
_____

5. Functional Testing Record

Seq. ID From Specs[1]	**Mode ID[2]**	**Test Procedure[3]** (including special conditions)	**Expected Response[4]**	**Pass Y/N**	**Note**
OCCUPIED	OA DAMPER OPENS				
OCCUPIED	FAN START				
UNOCCUPIED	FANS STOP				
UNOCCUPIED	DAMPERS CLOSE				
SAFETY	SF STOPS WHEN OA DAMPER CLOSES				

Record Foot Notes
[1]Sequences of operation specified in Contract Documents.
[2]Mode or function ID being tested from testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition.
[5]Record any permanently changed parameter values and submit to Owner.

END OF SECTION

Project:_____

FT-_____ DOMESTIC HOT WATER HEATER

1. Participants

Party	Participation
_____	_____
_____	

Party filling out this form and witnessing testing

_____

Date of test _____

2. Prerequisite Checklist

a. __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints, schedules, debugging, loop tuning and sensor calibrations complete.

_____ _____
Controls Contractor Signature or Verbal Date

b. __ All A/E punch list items for this equipment corrected.
c. __ Safeties and operating ranges reviewed.
d. __ Test requirements and sequences of operation attached.
e. __ Schedules and setpoints attached.
f. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
g. __ **BAS Program Review.** Review the BAS software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
h. __ Record of All Values for Current Setpoints (SP), Control Parameters, Limits, Delays, Lockouts,
Schedules, Etc. Changed to Accommodate Testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √	Parameter	Pre-Test Values	Returned to Pre-Test Values √

3. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting. Test the packaged controls and BAS readings.
NONE

4. Device Calibration Checks.
NONE

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully.
Pass? Y / N _____ __ Unit mounted securely.

6. Functional Testing Record

Proced. No. & Spec. Seq. ID[1]	**Req ID No.**[2]	**Test Procedure**[3] (including special conditions)	**Expected and Actual Response**[4] [Write ACTUAL response in brackets or circle]	**Pass Y/N & Note #**

Record Foot Notes
[1]Sequences of operation specified in Contract Documents (attached).
[2]Mode or function ID being tested, per testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition.
[5]Record any permanently changed parameter values and submit to Owner.

END OF SECTION

Project:_____

FT-_____ AIR SOURCE HEAT PUMP

1. Participants

Party	Participation

Party filling out this form and witnessing testing

_____

Date of test _____

2. Prerequisite Checklist

a. __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints, schedules, debugging, loop tuning and sensor calibrations complete.

_____ _____
Controls Contractor Signature or Verbal Date

b. __ All A/E punch list items for this equipment corrected.
c. __ Safeties and operating ranges reviewed.
d. __ Test requirements and sequences of operation attached.
e. __ Schedules and setpoints attached.
f. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
g. __ **BAS Program Review.** Review the BAS software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
h. __ Record of All Values for Current Setpoints (SP), Control Parameters, Limits, Delays, Lockouts,
Schedules, Etc. Changed to Accommodate Testing:

Parameter	**Pre-Test Values**	**Returned to Pre-Test Values √**	**Parameter**	**Pre-Test Values**	**Returned to Pre-Test Values √**

3. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting. Test the packaged controls and BAS readings.
NONE

4. Device Calibration Checks.
NONE

5. Verification of Misc. Prefunctional Checks.
Misc. site checks of the prefunctional checklist and startup reports completed successfully.
Pass? Y / N _____ __ Unit mounted securely.

6. Functional Testing Record

Proced. No. & Spec. Seq. ID[1]	**Req ID No.[2]**	**Test Procedure[3]** (including special conditions)	**Expected and Actual Response[4]** [Write ACTUAL response in brackets or circle]	**Pass Y/N & Note #**

Record Foot Notes
[1]Sequences of operation specified in Contract Documents (attached).
[2]Mode or function ID being tested, per testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition.
[5]Record any permanently changed parameter values and submit to Owner.

END OF SECTION

PART 1 – GENERAL

1.1 INCLUDED SYSTEMS AND EQUIPMENT

.1 The following is a list of the equipment and system test requirements included in this section:
- .1 Lighting controls
- .2 General Indoor Light Levels
- .3 Baseboard Heaters

1.2 DESCRIPTION

.1 This section specifies the functional testing requirements for electrical systems and equipment. Submit specific testing strategies from the general functional testing process, requirements and testing methods definitions are described in Section 01 91 13. The test requirements for each piece of equipment or system contain the following:
- .1 The contractors responsible to execute the tests, under the direction of the CA.
- .2 A list of the integral components being tested.
- .3 Prefunctional checklists associated with the components.
- .4 Functions and modes to be tested.
- .5 Required conditions of the test for each mode.
- .6 Special procedures.
- .7 Required methods of testing.
- .8 Required monitoring.
- .9 Acceptance criteria.
- .10 Sampling strategies allowed.

1.3 PREREQUISITES

.1 The following applicable generic prerequisite checklist items are required to be submitted to the CA prior to functional testing.

__ All related equipment has been started up and start-up reports and prefunctional checklists submitted and approved ready for functional testing:

__ All A/E punch list items for this equipment corrected.

__ These functional test procedures have been submitted and reviewed by CA.

__ Safeties and operating ranges reviewed by the CA.

__ Test requirements and sequences of operation attached.

__ Schedules and setpoints attached.

__ Sufficient clearance around equipment for servicing

__ Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.).

__ Other miscellaneous checks of the prefunctional checklist and start-up reports completed successfully.

1.4 MONITORING

.1 Monitoring is a method of testing as a stand-alone method or to augment manual testing.

.2 All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the lighting controls contractor. At the CA's request, the lighting controls contractor shall trend up to 20% more points than listed at no extra charge.

.3 Hard copies of monitored data must be in columnar format with time down the left column and at least 4 columns of point values on the same page. Graphical output is a desirable option, if the system can produce it.

PART 2 PRODUCTS Not applicable

PART 3 - EXECUTION

3.1 LIGHTING CONTROLS

.1 Parties Responsible to Execute Functional Test
- .1 Electrical contractor: assist in testing sequences
- .2 CA: to witness.

.2 Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 01 91 38 shall be listed on each functional test form and checked off prior to functional testing.

.3 Functions/Modes Required To Be Tested and Test Methods

.1 The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual (demonstration), Monitoring, Either or Both
MISCELLANEOUS FUNCTIONS	
.1 All specified functions and features are set up, debugged and fully operable.	Verbal discussion of features
.2 Power failure and battery backup and power-up restart functions.	Demonstration
.3 Verify override duration setting.	Demonstration

.4 Special Procedures (other equipment to test with, etc.; reference to function ID): None.

.5 Required Monitoring:

.1 None required, though monitoring can substitute for manual testing for all functions. See section 1.4 above.

.6 Acceptance Criteria (referenced by function or mode ID) 1-9 For the conditions, sequences and modes tested, integral components (All) and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.2 GENERAL INDOOR LIGHT LEVELS

.1 This is a performance test to verify that the lighting systems can provide fixed light levels equal to the specifications.
- .1 Parties Responsible to Execute Functional Test
- .2 Commissioning authority
- .3 Contractor or A/E witness optional

.2 Integral Components or Related Equipment Being Tested: none.

.3 Prerequisites: none.

.4 Test Conditions: The test shall be performed at night, with lights on in adjacent rooms open to the tested space. Doors from the tested space shall be closed.

.5 Special Procedures:
- .1 Space should be normally furnished and wall, floor and ceiling finishes complete.

.6 Required Monitoring: None.

.7 Acceptance Criteria
- .1 Average light levels in the tested space at the workplane elevation shall not be less than 10% below nor greater than 30% above the specified light level range for the space.

.8 Sampling Strategy
- .1 At least 10% of all space zones and rooms shall be verified to be realizing proper light levels, chosen by the Owner.

.9 If 10% of the spaces in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the spaces in the 2nd sample fail, test all remaining spaces, fully at the contractor's expense.

END OF SECTION

1 GENERAL

.1 Contractor shall be responsible for submitting blank forms for the prefunctional test to the CA.

.2 Contractor may use the included sample blank forms for developing equipment specific blank test forms.

.3 Contractor shall submit a customized blank prefunctional test forms for each system included for commissioning listed in the commissioning plan and commissioning specification sections 01 91 13 and the drawings.

.4 Prefunctional testing performed on non approval forms shall not be accepted.

.5 Contractor shall make necessary modifications to forms as noted by the CA.

2 FORMS

.1 The following sample forms are attached at the end of this section:
- .1 Power Distribution System Pre-functional Checklist.
- .2 Lighting and Lighting Control Pre-functional Checklist.

END OF SECTION

PC-___ POWER DISTRIBUTION SYSTEM

__ Entire Building

Associated checklists: _____

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.___ List attached.

_____ _____ _____ _____
Electrical Contractor Date General Contractor Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____ _____ _____ _____
Commissioning Agent Date Owner's Representative Date

2. Documentation submitted and approved: [All]

__ manufacturer's cut sheets
__ installation and checkout manual and plan
__ written copy of all control parameters, settings
__ written copy of all control parameters, settings and setpoints
__ performance data
__ design criteria

__ O&M manual

- ***Documentation complete as per contract documents.... ___ YES ___ NO***

3. Model verification

[Contr = _____]

	As Specified	As Submitted	As Installed
Service Entrance Switchboard			
Manufacturer			
Model No.	n/a	n/a	
Serial No.			
Transformers			
Manufacturer			
Model No.			
Serial No.			
UPS			
Manufacturer			
Model No.			
Serial No.			
Motor Starters			
Manufacturer			
Model No.			
Serial No.			
Panelboards			
Manufacturer			
Model No.			
Serial No.			

- ***The equipment installed matches the specifications for given trade___ YES ___ NO***

4. Physical Installation Checks

4.1. Checks

Check if Okay. Enter comment or note number if deficient.

Check	**Y / N**	**Contr.**
General installation		
General appearance good, no apparent damage		
Equipment labels affixed		
Wiring Devices		
Receptacle properly grounded		
Cover plate installed		

Check	Y / N	Contr.
Service Entrance Switchboard		
Terminal phasing identified		
Cable phase identified correctly		
Cable connection complete		
Code required clearances met		
Proper grounding		
Drip hood installed		
Owner's metering installed		
Door covers installed		
Interior and exterior cleaned		
Dry Type Transformers		
Terminal phasing identified		
Cable phase identified correctly		
Vibration isolators installed		
Cable connection complete		
Adequate clearance		
Proper ventilation		
Proper grounding		
PET lug installed		
Enclosure type 3R		
Cleaned		
Motor Starter		
Copper busing		
Cable phase identified correctly		
Adequate clearances		
Properly grounded		
Auxiliary contacts		
BAS components installed		
Control wiring diagrams included		
Control transformer		
Cleaned		
Panelboards		
Filler piece in place		
Cable phase identified correctly		
Cable lugs bolted to MRT (manufacturer's recommended torque)		
Bus bolts torqued to MRT		
Properly grounded		

Check	Y / N	Contr.
Spare breakers installed		
Panel directory typed and complete		
Hinged door and front cover installed		
Breaker lock on devices installed		
Breaker bolts torqued to MRT		
Cleaned		
UPS		
Installed per drawings		
Neutral and ground conductors properly sized and configured		
Battery polarity correct		
Painted circuit boards properly configured		
Wire connections complete and tight		
Notes:		

- ***The checklist items of Part 4 are all successfully completed for given trade:***

..... ___ YES ___ NO

5. Operational Checks (These augment manufacturer's list. This is not the function performance testing.)

5.1. Checks

Check if Okay. Enter comment or note number if deficient.

Check	Y / N	Contr.
Wiring Devices		
Receptacle polarity tested		
GFCI Tested		
Voltage drop tested within tolerances		
Service Entrance Switchboard		
Insulation resistance measured		
Breaker switch opens and closes circuit properly		
Main breaker field set points adjusted		
Voltage and current measured within acceptable limits		
Dry Type Transformer		

Check	Y / N	Contr.
Taps set correctly		
Ventilation operating		
Voltage and currents measured within acceptable limits		
Motor Starters		
H.O.A. switches operate as intended		
Voltage and current measured within acceptable limits		
UPS		
Input voltage and phase rotation correct		
Cooling system operational		
Bypass switch operates as intended		
Confirm transfer from normal to battery power		
Confirm run time at full load		
Notes:		

- ***The checklist items of Part 5 are all successfully completed for given trader:***

..... ___ YES ___ NO

END OF SECTION

PC-___ LIGHTING AND LIGHTING CONTROL SYSTEM

Associated checklists: _____

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.___ List attached.

_____	_____	_____	_____
Electrical Contractor	Date	General Contractor	Date

Prefunctional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

_____	_____	_____	_____
Commissioning Agent	Date	Owner's Representative	Date

2. Documentation submitted and approved: [All]

__ manufacturer's cut sheets
__ installation and checkout manual and plan
__ full written sequences and list of all control strategies
__ written copy of all control parameters, Settings and setpoints
__ O&M manual
__ performance data
__ operating manual
__ completed control drawings
__ design criteria

- ***Documentation complete as per contract documents.... ___ YES ___ NO***

3. Model verification

[Contr = _____]

	As Specified	As Submitted	As Installed
Manufacturer			
Model No.			
Serial No.	n/a	n/a	

- ***The equipment installed matches the specifications for given trade.. ___ YES ___ NO***

4. Physical Installation Checks

Check if Okay. Enter comment or note number if deficient.

Check	Y / N	Contr.
Layout and locations match drawings		
Luminaires connected to lighting circuits		
Separate conduit systems provided for dimming control wire and cable		
Control devices installed and wired		
Notes:		

- ***The checklist items of Part 4 are all successfully completed for given trade***

  ___ ***YES*** ___ ***NO***

5. Optional Checks (These augment manufacturer's list. This is not the functional performance testing)

All field-installed temperature, relative humidity, CO, CO_2 and pressure sensors and gages, and all actuators (dampers and valves) shall be calibrated using the methods and tolerances given in the "Calibration and Leak-by Test Procedures" document. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed *in* a packaged unit at the factory with calibration certification provided need not be field calibrated. All calibrations shall be fully documented, including initial and final readings, offsets etc., on prefunctional checklist or other suitable forms.

Check	Y / N	Contr.
Controls turn on/off light as intended		
Dimming control operates as intended		
Notes:		

- ***The checklist items of Part 5 are all successfully completed for given trade***

  ___ ***YES*** ___ ***NO***

-- END OF LIGHTING AND LIGHTING CONTROLS PREFUNCTIONAL CHECKLIST --

END OF SECTION

1 GENERAL

.1 Contractor shall be responsible for submitting final Functional Test Procedures forms to CA for approval.

.2 Contractor may use included sample forms for developing final procedures.

.3 Contractor shall submit forms for each system intended to be commissioned as listed in commissioning plan and specification section 01 91 13.

.4 Blank forms shall be submitted well in advance of any scheduled test for review and approval.

.5 Contractor shall make the necessary modifications to the blank forms as instructed by the CA.

2 FORMS

.1 The following form is attached at the end of this Section:
- .1 Power Distribution System
- .2 Lighting and Lighting Controls.

END OF SECTION

Project:_____

FT-_____ POWER DISTRIBUTION SYSTEM

1. Participants

Party	Participation
_____	_____
_____	

Party filling out this form and witnessing testing

_____

Date of test _____

2. Prerequisite Checklist

a. __ All system functions for this and all interlocking systems are operable per contract documents.

_____ _____
Electrical Contractor Signature or Verbal Date

b. __ All A/E punch list items for this equipment corrected.
c. __ Safeties and operating ranges reviewed.
d. __ Test requirements and sequences of operation attached.
e. __ Schedules and setpoints attached.
f. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
g. __ **Packaged Control Program Review.** Review the packaged control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.
h. __ Record of All Values for Current Setpoints (SP), Control Parameters, Limits, Delays, Lockouts,
Schedules, Etc. Changed to Accommodate Testing:

3. Sensor Calibration Checks.

NONE

4. Device Calibration Checks.

NONE

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully.

Pass? Y / N _____

__ Unit mounted securely. __ Unit accessible for servicing. __ No unusual noise or vibration

6. Functional Testing Record

Proced. No. & Spec. Seq. ID[1]	**Req ID No.[2]**	**Test Procedure[3]** (including special conditions)	**Expected and Actual Response[4]** [Write ACTUAL response in brackets or circle]	**Pass Y/N & Note #**

Record Foot Notes

[1]Sequences of operation specified in Contract Documents (attached).

[2]Mode or function ID being tested, per testing requirements section of the project Specifications.

[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.

[4]Include tolerances for a passing condition.

[5]Record any permanently changed parameter values and submit to Owner.

END OF SECTION