TECHNICAL SPECIFICATION FOR
Design, Fabrication and Installation of a
61.0 m VHF Tower
Cape North, Nova Scotia
47º- 00'- 40'' N
60º- 25'- 36'' W
Project # F6839-145057
Contract # F5211-140388

Canadian Coast Guard
P.O. Box 1000
Dartmouth, Nova Scotia
B2Y 3Z8

PROJECT NO. F6839-145057
DATE: November, 2014

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Section 01010
Summary of Work

1.0 General

The work covered under this specification consists of a new VHF Tower System for Cape North, Nova Scotia. The work to be done under this Specification shall include all labor, materials and equipment necessary to complete the design, fabrication and installation to the full extent of the Specification and Drawings. The specification is for a 30 year performance life. Work shall include but not be limited to the following:

- Engineering design, supply and installation of a 61.0 m guyed VHF tower structure, guys, guy hardware, foundations and anchors, wave guide bridge, lighting system, antennas, antenna/tower interface, above grade ground system and ice guards components and all other materials required to meet the terms of this contract.
- Tower and anchor layout in accordance with approved engineering drawings. Actual layout shall be subject to the approval of Owner prior to commencement of any work.
- All materials used on this project are to be of specification grade, meaning complete dimensional, manufacturing, technical/engineering specifications and standards information must be available for all materials to ensure "fit for use" compliance.
- Contractor is to receive all materials for the project on behalf of the Owner as required and to ensure and be responsible for safe keeping until completion inspection.
- Supply and installation of auxiliary facilities such as ladders, safety rails, and platforms.
- Supply and installation of all antennas, including transmission lines, in accordance with the Owners and manufacturer's instructions and specifications. Contractor is responsible to interface appropriately the antenna systems and transmission lines to the tower.
- Supply and installation of all in-tower connectors for all lines as specified by owner.
- Supply and installation of line hangers, ground kits and necessary hardware. All hangers shall be heavy duty and constructed of stainless steel material.
- Antennas are to be installed as specified. Contractor shall ensure that the antennas do not interfere with the guy wires. Specified antennas locations are not to be changed and final location to be approved by Owner prior to installation.
- Contractor will be responsible for arranging all snow clearing requirements. Snow clearing will be based on actual rates and in addition to base costs.
- Supply and installation of all required obstruction markings **(LED DOLs and Beacon required)**.
- Supply and installation of the complete tower grounding systems (ground riser, bus bars, lightning rod, wiring etc.) and grounding connection points at the tower base and guys. Contractor will also provide copper ground bus bars at the base of the tower and building entrance. Owner shall approve locations prior to installation. The existing buried ground system (Appendix E) shall remain in place and reused to ground the new tower. Contractor shall ensure each tower leg, each guy anchor and new sections of the waveguide bridge are connected to the existing ground system in a manner to be approved by Owner prior to installation.
- Contractor shall measure the resistance to ground at a point near all anchors, the tower base and the transmission line entrance to the building. A report with readings shall be submitted to the Owner.
- The safe dismantling and disposal of the existing tower including antennas and antenna systems, transmission lines, guys and anchor systems. Salvage items as directed by Owner.
- Clean up of site following completion of all work.

- Contractor shall be responsible for checking all material against the material list and protection of the material until it is installed and accepted by Owner.
- Transportation of all materials and equipment to the site.
- Access to the site is by a narrow, gravel-surfaced road 7.2 km in length, or by helicopter.
- All antenna orientation, optimization, testing, and system commissioning. Contractor shall coordinate all work with Owner and provide report.
- Contractor is responsible for testing of Tx lines and antennas.

2.0 Definitions

"Owner" means: Fisheries and Oceans Canada, Canadian Coast Guard (CCG)

"Engineering Consultant" means: for this project, to be determined at a later date.

"(Tower) Design Engineer" means: Contractor's Design Engineer of Record.

3.0 Site

3.1 Before tendering it is recommended that the Contractor familiarize themselves with the remote location, scope of work, site restrictions, short construction season and temporary measures required to complete work as specified. No after claim will be allowed for any work or material necessary for proper execution and completion of the contract.

3.2 Site is located at 47º- 00'- 40" N (Latitude) and 60º- 25'- 36" W (Longitude), at the Canadian Coast Guard site in Cape North, Nova Scotia. The site elevation is 415 metres above sea level.

3.3 Any dimensions given in this Specification or appended drawings are approximate and are for guidance only. Exact dimensions and layouts to be determined by the Contractor in the field.

4.0 Site Access

4.1 The site is accessible by a narrow, gravel-surfaced road 7.2 km in length, or by helicopter.

5.0 Completion Schedule

5.1 All work on the project shall be completed within the time indicated in the tender document.

5.2 Tender submission shall include a schedule of all Contractors activities including design, fabrication, transportation and installation. Design and fabrication to be substantially completed by March 31, 2015. Installation to be completed by August 15, 2015.

6.0 Existing Site Conditions

6.1 Contractors should note that there are restrictions at this location with regard to:

- the available space
- location of cable trenches

- location of overhead power conductors
- location of building and existing tower
- location of other substation equipment
- access to anchors (guy lanes will be cleared of trees and brush)

It shall be the Contractor's responsibility to locate and protect all buried cables and other underground or overhead structures. Any damage to such structures shall be the responsibility of Contractor. Where unknown services are encountered, Contractor to log location and advise Owner immediately.

7.0 Existing Soil Conditions

7.1 Geotechnical reports are in Appendix D. The Contractor is reminded that the intention of these reports is to provide data applicable to borehole and test pit locations. Any interpolation or assumptions made relative to any locations other than the borehole and test pit locations, is the responsibility of the Contractor.

Contractor is to advise the owner if any discrepancies exist between the Geotechnical reports and actual excavations.

8.0 Work Commencement

8.1 Contractor is to provide an updated detailed schedule and commence work immediately upon award of contract and after review and approval of all submittals.

8.2 The weather conditions, short construction season and site remoteness may require the use of longer work days and additional work force to complete the project within the scheduled completion date.

8.3 The Contractor is to make every effort to ensure sufficient material and equipment is delivered to site at the earliest time possible upon award of the contract.

9.0 Site Operations

9.1 Arrange for sufficient space adjacent to project site for conduct of operations storage of material etc. Exercise care so as not to obstruct or damage public or private property in area. Do not interfere with normal day-to-day operations at site. All arrangements made for space and access shall be made by the Contractor. All arrangements for security shall be made by the Contractor.

9.2 At completion of work restore area to its original condition. The Contractor must repair damage to ground and property. Remove all construction materials, residue, excess etc., and leave site in a condition acceptable to Owner.

10.0 Project Meetings

10.1 Owner will arrange and give notice of all project meetings. Contractor is responsible for any expenses related to attending these meetings.

10.2 All project meetings will take place at site of work unless otherwise directed by the Owner.

10.3 Prior to commencement of work there will be a Project "Kick-Off" Meeting. The Contractors Project Manager (at their own expense), the Owner and the Engineering Consultant will be in attendance. Assume meeting to be in Dartmouth, NS.

Data and an agenda will be distributed prior to the meeting and the following agenda discussed at the initial meeting;

- Introduction of all key personnel participating in the meeting and the project and names of responsible individuals.
- Establishing limits on work hours, access, movements, security on site, etc.
- Organizational arrangement of the contractor's forces and personnel as well as those of the sub-contractors and material suppliers.
- Chain of command, channels and procedures for communication.
- Detailed work breakdown structure (WBS) of the construction schedule, including sequence of critical work.
- Contract documents, including distribution of required copies of original documents and amendments.
- Processing of shop drawings and other data submitted as directed by the Engineering Consultant.
- Processing of bulletins, field decisions, and change orders.
- Site procedures for Occupational Health and Safety, First Aid, security, quality control, housekeeping and other related matters.
- Other items as required

10.4 Owner will be responsible for recording minutes and distribution.

10.5 Contractor to have a responsible representative present at all job meetings and to the maximum extent possible, this should be the same person.

11.0 Protection of Materials and Equipment

11.1 Store all materials and equipment to prevent theft or damage. Repair or replace all material or equipment damaged in transit or storage to the satisfaction of and to no cost to the Owner.

12.0 Documents Required on Site

12.1 Contractor to maintain on site one copy of the following:

- Health and Safety Plan
- First Aid Kit
- Contract drawings and specifications
- Addenda
- Reviewed shop drawings
- Change Orders
- Other modifications to Contract
- Field test reports
- Copy of approved work schedule
- Manufacturers Installation and Applications Instructions

- Contact information for Owner and Engineering Consultant
- Other items as requested

13.0 Taxes and Permits

13.1 Contractor to obtain all Federal, Provincial and Municipal permits and pay all applicable taxes.

END OF SECTION

Section 01050
Site Layout

1.0 Site Layout

1.1 Establish at the site, by means of iron bars or wooden stakes, the location of the structure center, anchors and wave-guide bridge. All locations are to be approved by Owner.

1.2 Layout additional reference points, batter boards or offsets as required for the construction of anchors and foundations.

1.3 Survey not available at this time. Contractor to design appropriate guy radius and assume no rises/drop more than 3 meters. Approximate tower layout is indicated on the enclosed site survey. Contractor is responsible for tower design including guy radius for each anchor to suit site specific elevations when available. Contractor to ensure that the layout and guy radius is in accordance with the design drawings.

1.4 Establish guy anchor working points to suit the actual ground elevations.

1.5 No foundation work shall begin until the layout has been checked and approved by the Owner.

1.6 All alignment and layout verification to be completed by Contractor using trained personnel and appropriate survey equipment.

2.0 Tolerances

2.1 Elevations to underside of base plates +/-12mm on self supporting towers. Guyed tower base plates shall be level.

2.2 Location of guy working points +/- 2° off resultant line of action of anchor shaft. Lateral location +/-150mm, out of theoretical guy-tower plane.

2.3 Horizontal alignment of anchor bolts +/-2mm.

2.4 Horizontal dimensions from centre of tower to guy working points and anchors +/- 150mm, except when fixed terminations require more accurate location of guy working points. In this case the tolerance shall suit the Contractors requirements for accurate measurement of guy cutting lengths and be approved by in advance by Owner/Engineer.

2.5 Concrete dimensions: not less than the dimensions specified.

END OF SECTION

Section 01300
Submittals

1.0 General

1.1 The Contractor shall submit for review one complete set of stamped/sealed drawings in PDF format. The review period by the Owner shall be two (2) weeks. After successful review, each submitted drawing will be returned to the Contractor either "Reviewed" or "Reviewed as Noted". There after no change shall be made to the drawing without the permission of the Owner. The Professional Engineer, responsible for the design, shall seal all drawings submitted to the Owner and must be registered to practice with Engineers Nova Scotia. The design engineer of record shall have a minimum of five years experience designing towers of a similar nature.

1.2 The Contractor, at no additional cost to the Owner, shall make any changes in the drawings which may be required, consistent with this Specification and shall submit revised copies for review in the manner herein set out. The review does not relieve the Contractor from responsibility for ensuring that his complete work meets all the requirements for the drawings and Specifications contained herein. Items submitted are to be complete, in final form and ready "for construction". Incomplete submissions will be returned. The Contractor shall ensure that the tower design, including guy location, does not interfere with the operation of the antenna systems.

1.3 Any work done prior to the return of the reviewed drawings shall be at the Contractor's own risk. The Owner or his representative may issue a stop work order if any site work is started prior to approval of engineering drawings. Any costs associated with this shall be the Contractor's responsibility.

1.4 Drawings of the work produced by the Contractor and all rights and privileges associated therewith shall become the exclusive property of the Owner who will be free to make any use or reuse of said drawings which in the opinion of the Owner is reasonable and/or required in the Owner's interest.

2.0 Contract Submission

2.1 The Tenderer shall include the following documentation with the tender submission:

a. Breakdown of Costs as per FORM OF TENDER.
b. List of subcontractors proposed for: steel fabrication, galvanizing, painting and tower erection.
c. List and description of previous projects completed which are of a similar nature.
d. Resume (CV) and tower related experience of the Project Manager and Tower Engineer of Record. Tower Engineer to have a minimum of five years experience designing similar structures. Confirm registration or eligibility for registration with Engineers Nova Scotia. Resume (CV), qualifications, and tower experience of the potential site foreman. Site foreman to have a minimum of five years experience as foreman working on towers of similar size.
e. Preliminary design drawing complete with leg, diagonal and horizontal sizes, anticipated tower base and anchor loads, guy sizes and anchor radius.
f. Detailed work schedule including all project milestones for design, fabrication, transport and installation.
g. Overview of Health and Safety Plan.

2.2 Questions pertaining to any of the above or other items in the specification documents MUST be addressed to the Contracting Officer for this project as indicated in the Tender documents.

3.0 Drawings

3.1 All drawings shall be a minimum of 280 mm x 430 mm (11”x17”) and include a graphic scale bar. Larger sizes will be permitted only if prior written approval is given by the Owner. The Contractor shall make every effort to provide consistent sized drawings which optimize the amount of information shown. The Contractor shall provide a Table of Contents listing all drawing titles with a sequential numbering system. All drawings shall be bound in bindered pdf format sets.

3.2 All drawings shall have a title block, which clearly shows the Project Name and Location, Owners Name (Canadian Coast Guard), design engineer, date, revision number, and a description of the drawing content. All drawings must be approved and stamped by a Professional Engineer licensed in the Province of Nova Scotia, prior to submission. The drawings are also to be stamped with the design firms Permit to Practice Engineering Seal. **Unsealed drawings will not be reviewed.**

4.0 Contract Technical Submission

4.1 On acceptance of the Tender, the Contractor shall submit for review:

4.1.1 Copies of all Quality Control and Quality Assurance programs in place relating to, governing and demonstrating the ability to complete the work in question, including but limited to, the tower painting process, steel fabrication process and the tower steel galvanizing process. Details of all material handling procedures are to be included.

4.1.2 Details with regard to the steel supplier and fabrication company and their CWB certification number.

4. 1. 3 Sealed drawings which include:

- Structural profile drawing showing the sizes of legs, web members and bolts. The elevations at which the member sizes changes shall be clearly shown. Antenna orientation, size, type and center of radiation shall be clearly indicated. The drawing shall include all pertinent design information including design standard, ice loading, wind loading, bearing pressure, soil conditions, elevation difference from base and any special design factors. A copy of this drawing shall be submitted on a CD in AutoCAD format (unless other wise discussed with owner).
- A detailed plan of the tower clearly showing the attachment position and size of all attachments including (but not limited to), TX lines, ladders, lifeguards, obstruction lighting and tech cables, safety devices and anticlimbs in relation to the leg and web members and antennas.
- Detailed drawings showing the following:
    a) Details of tower sections.

b) Details of each different leg and web member and their connections.
c) Details of lighting and ground fault interrupters.
d) Details of TX Line placement.
e) Details of all required ice guards.
f) Details of attachment of all antennas.
g) Details of anti-climb devices.
h) Details of grounding bars.
i) Details of all torque triangle members and their connections and splice details.
j) Description of materials, i.e. grades of steel, bolts, steel capacity, etc.

- Details of guy assemblies, including:
  a) Make, type, diameter, breaking strength, cross sectional area, weight, etc.
  b) Make, size and description of all guy assembly hardware, including ultimate capacity.
  c) Preformed guy grips: Make, type, length, diameter, number and size of wires and a note indicating that grip lay shall be the same as the guy lay.
  d) Mechanical or pressed sleeves: physical dimensions such as length and diameter.
  e) Turnbuckles: Make, ultimate capacity, diameter, take up.
  f) Bridge sockets: Make, size and take up.
  g) Initial design tensions and pulse charts over a range from –30º C to +30º C in 5ºC increments.
  h) Details of all antenna mounts and connections. These shall include plan view drawings showing the position, **azimuth and elevation** of each antenna in relation to tower legs and web members. These details shall be to scale and accurately reflect position of the antenna relative to the tower face and mounts.
  i) Details of supports for all TX lines and conduit, present and future, including material details.
  j) Details of any special members.
  k) Details of the climbing ladder, safety fall arrest rail and trolley system.
  l) Tower profile, anchor radius, anchor drop off, etc.
  m) Details of the tower base foundation and guy anchors, showing all dimensions and steel reinforcement or rock anchor details. Drawings shall show concrete strength. Where rock bolts are used, installation and testing procedures shall be clearly indicated on the drawings. Generic copies of typical foundations are not adequate.
  n) Manufactures detailed Bill of Materials showing quantities, part number, drawing reference number, weight, mark number, etc.
  o) Design details related to wind and ice loading, design standard, etc.
  p) Details with regard to any special design assumptions.
  q) Any other drawings or diagrams required in order to make clear the work intended or show its relation to adjacent work of others.
  r) All vendor data sheets for antennas, tx lines, ground kits, lighting systems, and all other third party products proposed for use.

4.2 On acceptance of the Tender, the Contractor shall submit for review sealed design calculation report which includes:

- Reference design standard.
- All design loadings.
- All foundation analysis and calculations.
- All tower computer analysis input and output.
- All tower member capacity calculations.
- Any other information requested by Engineering Consultant.

4.3 Contractor shall maintain and update the work schedule. Each revision shall be submitted to the Owner/Engineering Consultant for review.

5.0 As Built Drawings

5.1 Upon completion of all work, and prior to release of contract holdback, the Contractor shall issue a full set of As Built drawings, which reflect any and all changes from the original contract drawings. These drawings shall be stamped AS BUILT DRAWINGS and shall be sealed by a Professional Engineer in accordance with the requirements of this specification. Submit a full set of drawings (with Tower Engineer's stamp) on CD in PDF format and two (2) copies of the stamped paper versions in binders including **ALL** product data on the lighting system and controller, antennas, Tx lines, etc. Binder to have cover page with the Project Name and Location, Owners Name (Canadian Coast Guard), design engineer, Manufacturer, Installer and date of completion. A tower profile photo should also be included.

5.2 As built drawings shall show actual antenna arrangement including azimuths and elevations, anchor radius and drop, leg azimuth, etc.

5.3 As part of the final submission, a set of tension and pulse charts will be submitted for temperature range of –30º C to +30º C in 5ºC increments based on actual guy lengths, radius and anchor elevations.

5.4 All As-built submissions to be bound in a binder format.

6.0 Inspection Reports

6.1 The Contractor is to submit two (2) copies of all quality control test reports required by this specification immediately upon completion of testing.

7.0 Safety Plan

7.1 The Contractor is to submit two (2) copies of their project and site specific Safety Plan, including, climbing safety, rescue techniques, rigging procedures, equipment maintenance and inspections, general work site safety, hazardous material safety (WHMIS), site security, public safety etc. and emergency response plans, for review prior to commencement of work on site.

END OF SECTION

Quality Control

Section 01400

1.0 Shop Factory Inspection

1.1 Contractor's and all sub-contractor's facilities are subject to inspection at any time by the Engineering Consultant or a qualified inspection firm appointed by the Owner. This can include, review and audit of Quality Control and Quality Assurance procedures, fabrication processes, materials handling processes, galvanization processes, painting processes, welding processes, workmanship and inspection of tools and equipment. Contractor will make associated documentation, procedures, drawings, specifications and mill test reports available to facilitate this work.

1.2 Co-operate in permitting access to all places where work is being done or stocked prior to shipment.

1.3 Inspection shall not relieve the Contractor of his responsibility but is a precaution against oversight or error. Defective material and workmanship wherever found at any time prior to final acceptance of the work will be rejected regardless of previous inspection.

1.4 As part of shop inspection be prepared to assemble part (or complete) tower section(s).

1.5 Contractor shall ensure proper measures are taken to ensure the delivery of undamaged materials to site.

2.0 Foundation Inspection

2.1 The foundation placement is subject to inspection during the following project stages:

- Testing of rock bolts
- Pre-pour inspection of rebar prior to concrete placement for gravity anchors and tower base footing.
- Concrete placement
- Grouting

2.2 The Contractor shall advise the Owner **ONE WEEK** in advance of these activities. Every effort shall be made to allow completion of these activities within one full day on site. The Owner shall have an independent testing firm obtain and test a minimum of three (3) concrete cylinders, per batch, as per the latest industry standards, for compressive strength for each structural anchor and base footing. An independent CSA certified testing firm shall conduct sampling and testing. This testing by the owner does not relieve the Contractor of their responsibility for ensuring concrete quality assurance.

3.0 Completion Inspection

3.1 A completion inspection is to be carried out by the Owner. The purpose of this inspection is to ensure that the work is completed as per the project specifications and industry standards. The completion inspection does not relieve the Contractor of his responsibility to execute the work in a quality fashion as per the project specifications and industry standards. The Contractor must ensure that his quality control personnel perform a complete inspection of the works prior to their crew leaving the site. It is expected that the contractor has made a thorough check of all bolts, hardware, TX lines, tension and alignments as per requirements

of CSA S37 standard latest edition and reviewed the contract for full completion. The Contractor is to inform the Owner by letter that the installation is completed and is ready for inspection. The Contractor shall have sufficient crew on site during the inspection to correct deficiencies. Contractor to advise Owner ONE WEEK in advance to completion of the tower to permit scheduling of this inspection.

3.2 All costs incurred by the Contractor during the acceptance inspection shall be at the Contractor's expense.

3.3 All work must be completed and satisfactory prior to the completion inspection. Any deficiencies should be reported prior to the inspection teams' mobilization to site. **The Contractor will be responsible for the costs of all repeat completion inspections necessitated by work, which is considered by the Owner to be incomplete or deficient.**

3.4 Any adjustments to the tension, twist or alignment shall be made by Contractor in consultation with the owner to ensure affects on signal coverage can be reviewed and monitored.

3.5 After any adjustment measures are carried out to the tower, the Contractor shall, as required, under the direction of the Owner, re-orient any antennas.

3.6 An as-built tension pulse charts with actual measured guy lengths, radii and anchor elevations along with initial design guy tensions, must be provided prior to the inspection.

4.0 In-Service Inspection

4.1 Not less than six (6) months and not more than one (1) year after the completion inspection, the Owner shall re-inspect the tower. The purpose of this inspection is to re-inspect the tower alignment and guy tensions, review satisfactory completion of any previously noted deficiencies and to conduct a general review of the tower condition. At this time the Contractor shall have a minimum crew of two present and carry out any adjustments necessary to ensure the structure meets the requirements of CSA S37 standard. All costs incurred by the Contractor during this inspection shall be at the Contractor's expense.

4.2 Owner to advise Contractor at least **TWO WEEKS** in advance of the inspection in order to facilitate scheduling.

4.3 Any adjustments to the tension, twist or alignment shall be made by the Contractor in consultation with the owner to ensure affects on signal coverage can be reviewed and monitored.

4.4 After any adjustment measures that are carried out on the tower, the Contractor shall, as required, under the direction of the Owner, re-orient any antennas.

5.0 Conformance Letter

Upon completion of the installation stage of the project the Contractor is to provide the Owner with a Conformance Certification Letter stating that the tower has been designed, fabricated and installed as per the Project Specifications.

END OF SECTION

Temporary Facilities

Section 01500

Temporary Facilities

1.0 Access

1.1 Access to the tower site is available as described in section 01010. When appropriate, maintain this access during the construction period. Contractor is responsible for providing their own site office and accommodations.

1.2 The owner must approve any temporary roads planned. A plan for remediation must be included.

1.3 If authorized to use existing roads for access to the project site, maintain such roads for the duration of the Contract and make good damage resulting from Contractor's use of roads.

1.4 Any damages as a result of Contractor's activities to existing roadways, property, and adjacent property shall be returned to original condition at Contractors expense.

2.0 Sanitary Facilities

2.1 Provide sanitary facilities for work force in accordance with regulations and ordinances.

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

3.0 Power

3.1 Contractor will be granted access to limited facility power supply for routine operations. However, this supply is not to be used for high demand requirements or to power any site trailers or similar equipment. Contractor will be responsible for own power supply for this application.

3.2 Connect to power supply in accordance with Canadian Electrical Code once the building power is provided by Owner.

4.0 Drainage

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

4.2 Do not pump water containing suspended materials into waterways, sewer or drainage systems.

4.3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements and any other applicable Federal or provincial requirements.

END OF SECTION

Safety Requirements

Section 01545

1.0 Summary

1.1 This section describes specific safety requirements to be observed and enforced during the scope of this work.

1.2 Inclusion of these safety requirements shall not constitute a relief of the Contractors responsibility but is a precaution against oversight and errors.

1.3 The Contractor is solely responsible for safety procedures necessary to; meet the requirements of these specifications and to ensure the safety of workers and the general public.

2.0 Construction Safety

2.1 Provide all workers, including sub-trades, with adequate and appropriate safety regulations prior to commencement of their duties. Ensure all workers comply with all safety regulations required by Federal and Provincial Regulations, Worker's Compensation Board and municipal statutes. Take all precautions and provide all required protection to ensure the safety of the general public and the workers in accordance with the current edition of the Occupational Health and Safety Act and Regulations applicable for construction projects and all applicable regulations such as but not limited to The Canada Labour Code, The Provincial Workers Compensation Regulations, Health and Welfare Canada Safety Code 6.

2.2 In the event of conflict between any provisions of the above authorities the most stringent shall govern.

2.3 Provide health and safety protection required by the manufacturer's printed literature and ensure that all workers are trained in the safe use of health and safety equipment and the handling of materials. Ensure that at least one-person remains on site at all times who is properly trained in the first aid aspects required to deal with emergency situations that may arise. The safety person should be trained in the proper use of climbing harnesses and rescue equipment.

2.4 A first aid station must be maintained on site, available to workers at all times.

2.5 Protect all utilities and services against damage or interruption. Any claims resulting from damage will be the Contractor's responsibility. The possible location of any underground cables must be established and marked prior to any excavation.

2.6 Post "NO SMOKING" signage where flammable materials are being used. Do not allow use of spark producing equipment during application of flammable materials. Ensure that at least one site person is trained to deal with emergency situations that may arise due to fire.

2.7 Take all required precautions, including those recommended by the manufacturers printed instructions, to protect persons and property, including vehicles from over-spray of materials.

2.8 Contractors' Safety Plan shall incorporate the following;

a) Continuous attachment at all times while on the tower. No unattached climbing will be permitted at any time
b) Use of CSA approved; full body harness, belts, lanyards, trolleys, safety hats, safety boots, safety vest, and other equipment used to complete the job.
c) Only experienced personnel with previous training and demonstrated experience working on similar structures and heights to work on the project.
d) Not allowing personal to use equipment winches for transport of personnel.
e) The ability for any worker to discuss issues that they feel affects workers safety.
f) Tailgate/job assessment forms to be completed daily and made available upon request.

3.0 Fire Safety

3.1 Comply with the latest requirements of standard for Building Construction Operations FCC, No. 301, (Latest Edition) issued by the Fire Commissioner of Canada.

4.0 Falsework and Scaffolding

Design and construct all falsework as per CSA S269.1 (latest edition) and scaffolding as per SAS 269.2 (latest edition).

5.0 Overloading

Ensure no part of the work is subject to load(s) which endanger safety or will cause permanent deformations.

6.0 Construction Site Safety

The Contractor shall prepare a written project/site specific **Construction Safety Plan** outlining all procedures and safe work practices which must be followed by all personnel working on the construction site. This plan is to be developed in conjunction with all subcontractors who will be working on site. It is the Contractor's responsibility to become familiar with all safety laws and regulations applicable to the type of work to be undertaken. These safety laws and regulations shall be addressed in the safety plan as clear and specific safety rules, procedures and work practices. The Contractor shall ensure that all of his workers and his sub-contractors, as well as any other authorized persons working or circulating in the construction work area, have been briefed and are familiar with the safety rules and measures indicated in the Safety Plan and understand that these measures are mandatory at the construction site. Regular Site Safety Meetings and daily tailgate/job assessment meetings shall be held and minuted by the Contractor.

6.1 Signage and Barriers

The contractor is to maintain necessary signage to ensure workers, people accessing the site and the general public are aware of any hazards or potential hazards. Barriers are to be provided as required by regulation to ensure access to work by the general public is restricted.

6.2 The Safety Plan must be placed on the Construction Site in a common area visible to all workers and other persons accessing the site. All employees are to be advised of the Safety Plan. The Safety Plan shall also address the means to communicate the intent to all persons.

6.3 Submission of a Safety Plan to the Engineering Consultant and Owner does not relieve the Contractor of any legal obligations for the provision of construction safety as specified by Federal and/or Provincial Safety Acts or Regulations.

6.4 Contractor shall ensure compliance with the Safety Plan. The Owner or authorised representative reserves the right to demand removal of any person(s) not complying. Any person removed shall not be permitted reentry to the site.

6.5 Provide Safety Plan immediately upon award of contract. The Safety Plan shall be submitted to the Owner for review prior to commencement of work. Work shall not be allowed to begin until safety plan has been submitted. Revise Safety Plan as required for changes in work procedures or when directed by Owner, Safety Officer or authority.

7.0 Hazardous Products

7.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials, and regarding labeling and provision of material safety data sheets acceptable to Labour Canada and Health and Welfare Canada.

7.2 Deliver copies of WHMIS data sheets to Owner on delivery of materials.

7.3 All data sheets must be posted on site in a common area visible to all workers and subcontractors.

7.4 Make all efforts to select and use materials (ie. adhesives, solvents, cleaners etc.) for the type and nature of work being performed which are the least hazardous products available, of low VOC content or low toxicity type products and emitting low noxious odours. Select products known to be friendly to the environment and to human health. Communicate this intent to all subcontractors, suppliers and manufacturers.

7.5 Where the use of hazardous and toxic products can not be avoided

.1 Advise Owner before hand of the product(s) intended for use. Submit WHMIS data sheets as per requirements above.

.2 Schedule in conjunction with the Owner, to carry out the work during “Off Hours” where workers and employees have left the site.

END OF SECTION

Environmental Protection

Section 01561

1.0 Summary

1.1 This section describes environmental protection requirements to be observed and enforced during the progress of the Work.

1.2 Inclusion of these environmental requirements shall not constitute a relief of the Contractor's responsibility but is a precaution against oversight or errors.

1.3 The Contractor is solely responsible for all environmental protection procedures deemed necessary by the Contractor to meet the requirements of these Specifications. Contractor shall comply with all applicable Federal, Provincial and Municipal regulatory requirements.

1.4 Contractor is fully responsible for all costs associated with required remediation occurring from contractors work on site.

2.0 Fires

2.1 Fires and burning of rubbish on site are not permitted.

3.0 Disposal of Waste

3.1 Do not bury rubbish or waste materials on site.

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

4.0 Pollution Control

4.1 Control emissions from equipment and plant to governing authorities' emission control requirements.

4.2 Prevent dust and debris from demolition operations and other extraneous materials from contaminating air beyond application area by providing temporary enclosures.

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

4.4 Contractor is to ensure all equipment is in good repair and no fuels or fluids are leaking from it. Equipment in disrepair will be removed from site. Basic petroleum spill clean up equipment must be on site.

4.5 No maintenance, beyond that of a required daily routine nature shall be performed on equipment while on site. No refueling to be completed within 30 m of a water body.

4.6 No bulk storage of fuel or hazardous products will be permitted on site.

4.7 Work should be scheduled to avoid periods of heavy precipitation. Erosion control structures (temporary matting, geotextile filter fabric) are to be used, as appropriate, to prevent erosion and silt runoff during the construction phase.

4.8 Construction waste material such as pre-treated wood must be disposed of in an appropriate manner and shall not be incinerated onsite. Construction waste material such as aluminum, steel, iron, etc should be recycled through a metal recycler.

4.9 All exposed soil should be minimized by limiting the area that is exposed at any one time and by limiting the time that any one area is exposed. Stockpiled soil must be covered and/or dyked to prevent erosion or silt runoff from leaving the site.

4.10 All spills or leaks should be promptly contained, cleaned up and reported to the CCG at 1-800-565-1633 and notification given to the Project Engineer handling the job.

4.11 Any and all stipulations of federal, provincial, or municipal authorities must be strictly followed.

4.12 During the constructional and operational phases of the project, limit or prohibit any activities on any of the surrounding wetland/bog (i.e. Heavy Equipment).

4.13 During Constructional phase of the project, target areas for excavation should be limited to areas that are not considered a wetland/bog.

5.0 Drainage

5.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water at all times.

5.2 Do not pump water suspected of containing suspended materials into waterways, sewer or drainage systems.

END OF SECTION

Materials and Equipment

Section 01600

1.0 Summary

1.1 This Section describes requirements to be observed during the progress of the Work for materials and equipment.

2.0 Submittals

2.1 Within five working days of written request by the Owner, submit following information for any and all materials and products proposed for use:

.1 name and address of the manufacturer and suppliers.
.2 trade name, model and catalogue number.
.3 performance, descriptive and test data.
.4 manufacturer's installation or application instructions.
.5 evidence of arrangements to procure.
.6 conformance to applicable standards.

3.0 Supply and Use

3.1 Use new material and equipment unless otherwise specified.

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

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

4.0 Manufacturer’s Instructions

4.1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

4.2 Prior to use of a product or material, notify Owner in writing of any conflict between these specifications and manufacturer's instructions. Owner will designate which document is to be followed.

5.0 Conformance

5.1 When material or equipment is specified by standard or performance specifications, upon request of Owner, obtain from manufacturer an independent testing laboratory report stating that materials or equipment meets or exceeds specified requirements. Trace-ability of all materials is to be performed.

6.0 Substitution

6.1 Owner is not obligated to consider any substitutes or changes after contract award. Contractor is responsible for all costs associated with reviewing requested changes.

6.2 Proposals for substitution after Contract Award must include all documentation and information required as part of this contact and statements of respective cost differences of items originally specified and proposed substitutions.

6.3 Should proposed substitution be accepted either in part or in whole, contractor will assume full responsibility and costs when substitution affects other work on project and pay for design or drawing changes required as result of substitution.

6.4 Amounts of credits arising from approval of substitutions will be determined by the Owner and the Contract Sum will be reduced accordingly. No substitutions will be permitted without prior written approval from Owner.

END OF SECTION

Clean Up

Section 01710

1.0 Clean Up

1.1 Upon completion of the work, or sooner if ordered by the Owner, remove all temporary structures and clear away all rubbish, equipment, surplus and waste material remaining on or about the site, and attributable to this Contact, and place the site in a neat and tidy condition.

1.2 Under no circumstances will burning of construction refuse be allowed on the Owner's site. Remove all waste materials from the site to an approved dumping area as designated by local authority.

1.3 If the Contractor fails to clean up the site and restore to an acceptable condition, the Owner shall initiate completion of the work and deduct for same from monies due to the Contractor.

END OF SECTION

Excavating and Backfilling

Section 02220

1.0 Definitions

1.1 Excavation Classes: Only two classes will be recognized, rock excavation and common excavation.

1.2 Rock excavation is defined as excavation of materials from solid masses of igneous, sedimentary or metamorphic rock, which, prior to its removal, was integral with its partner mass, and boulders or rock fragments having individual volume in excess of 1 cubic metre.

1.3 Common excavation is defined as excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense tills, hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy equipment.

2.0 Requirements of Regulatory Agencies

2.1 The Contractor shall adhere to Municipal, Provincial and Federal Codes where blasting is required. The Contractor to provide a minimum of **ONE-WEEK** notice to Owner prior to any blasting operation.

2.2 The Contractor shall adhere to Municipal, Provincial and Federal requirements relating to the safety of excavations and protection of workmen.

3.0 Measurement

3.1 The Contractor shall make his own computations of the amount and nature of all excavations required.

3.2 If soil conditions are inconsistent with the reported conditions indicated in the Geotechnical reports or drawings, report this immediately to the owner.

4.0 Materials

4.1 Backfill Material:

.1) Granular Backfill: Pit run natural or blend sand or gravel consisting of clean hard durable particles free from clay lumps, cementation or organic material, having less than 10% by mass passing a #0.075mm sieve, capable of being compacted to the degree specified herein and meeting the approval of the Owner.

.2) Common Backfill: selected materials from excavation, suitable to the Owner for the use intended, free from frozen materials, cinders, ashes, sods, organic materials, refuse and other deleterious substances.

5.0 Shoring and Bracing

5.1 Contractor is responsible for ensuring that all excavation work is performed in strict accordance with all Federal, Provincial and Municpal regulations. Provide and set all shoring, bracing, etc. necessary to prevent the caving in of excavating sides. Shoring shall be placed so as to be independent of all foundations and shall remain in place until forms have been and approval given to proceed with backfilling.

6.0 Pumping and Drainage

6.1 Provide all pumping and drainage required to control ground and surface water during excavation and construction of sub grade work.

7.0 Excavation

7.1 Strip top soil from within limits of excavation and stockpile as directed for spreading after backfilling.

7.2 Excavate to at least the depth shown on the drawings and to a width sufficient to perform the work properly.

7.3 Bottoms of all excavations shall be level, kept free of water and cleaned of all loose material and debris before concrete is poured. All foundations shall rest on undisturbed earth or rock. **The front face of all anchors, not anchored to rock shall bear against undisturbed soil.**

7.4 Should the bearing capacity at levels indicated be found inadequate by the Owner, the Owner may order the excavation to be carried down to a proper bearing. Such work shall be classified as additional work and cost thereof shall be determined on the basis of unit price quoted. Bearing levels are to be verified by Owner prior to proceeding with work.

7.5 When excavations are carried down to a greater depth than shown on the drawings without the Owner's written approval, the foundations shall be carried down to the excavated depth at the Contractor's expense. The method of deepening the foundation must be approved by the Owner.

8.0 Rock Excavation

8.1 All rock excavations shall conform to alignments, profiles, and cross sections shown on the drawings. Carefully scale down all slopes and remove all rock, boulders and fragments, either on or outside the excavated area, liable to roll or slide down the side slopes of cut sections.

8.2 Excavated rock shall be disposed off the site or as directed by the Owner.

9.0 Blasting

9.1 Blasting operations shall be undertaken only with the explicit written permission of the Owner. Blasting will only be considered when a machine operated buster cannot be used.

9.2 The supply, transportation, storage and use of all explosives and accessory equipment used for blasting shall be in accordance with regulations of the authority having jurisdiction. The Contractor shall be responsible for all necessary precautions and cost to prevent damage to surroundings, including responsibility for arrangements, and all costs involved in temporary removal and replacement of utilities.

10.0 Backfilling

10.1 Do not proceed with backfilling operations until the Owner has inspected and approved work in place. Provide **48 hours** notice to the Owner.

10.2 Backfill spaces excavated and not occupied by parts of substructure or other permanent works with specified material placed up to the surface or surrounding ground.

10.3 Place backfill materials in uniform layers not exceeding 200mm loose thickness and simultaneously on sides of structure so that loading is equalized.

10.4 Compact each layer to following percentages of corrected maximum dry density in accordance with ASTM D698-78.

(a) Common Backfill 95%
(b) Granular Backfill 100%

10.5 Place backfill so as to prevent the accumulation of water around foundations or anchors.

11.0 Restoration

11.1 Upon completion of work dispose of any spoils neatly on the site by berming the anchors and the tower base and “feathering-out” excess materials.

11.2 Replace top-soil over excavated areas.

11.3 Restore areas affected by equipment outside the area of work to the condition which existed prior to commencement of work.

11.4 Remove surplus material and debris from the site to an area authorized for such disposition by those authorities having jurisdiction.

END OF SECTION

Rock Anchors

Section 02350

1.0 General

1.1 Description

This section covers the design and installation of anchors to rock for transfer of shear and tension foundation loads.

1.2 Design

The minimum number of rock bolts to be installed at one anchor shall not be less that two. Alternatively single rock bolts in certain applications may be approved by the Owner provided there is a comprehensive testing program implemented by the Contractor in accordance with the requirements of this section.

2.0 Products

2.1 Rock Bolts (Anchors)

Rock bolts shall be Williams Rock Bolts with expanding shield or approved equivalent. The shield shall be designed to provide even bearing around the hole and to develop the full ultimate tensile strength of the bolt. The shell type to suit rock conditions indicated in Geotechnical Report. Two nuts shall be supplied and installed to secure the anchor weldment. The second nut shall act as a locking nut and be of adequate quality for that purpose.

2.2 Grout

Use Grout recommended by Rock Bolt Manufacturer. Grout shall be high early strength expanding type, with expansion of 3% to 4% prior of the gel stage. Grout shall have a minimum compressive strength of 40 MPa.

3.0 Execution

3.1 Holes

Drill holes to the diameter and length recommended by the rock bolt manufacturer for the bolt diameter to be used. Take care to ensure diameter is accurate and the hole is straight. Clean the hole before inserting the bolt.

3.2 Bolt Placement

Tap bolt into position taking care not to damage the threaded end. Set expansion shield torquing bolt to value recommended by the manufacturer.

3.3 Testing

3.3.1 Establish and submit to Owner a test procedure and all testing shall be carried out by the Contractor according to the manufacturer's instructions, and in the presence of the Owner. Note that some bolt installations may, as part of the installation process, require tensioning of the bolt. This may constitute the required load test if approved by the Owner.

3.3.2 The contractor shall accurately record torquing and tension values for each bolt, along with the duration of the test. This information shall be submitted to the Owner for review.

3.3.3 Any bolt slippage shall be reported and a plan for resolution submitted.

3.3.4 The Contractor shall provide written confirmation of recent calibration of the jacking system from an independent testing firm.

3.3.5 The Contractor shall provide conversion charts issued by the jack manufacturer to convert pressure indicated to pounds of tension force.

3.4 Grouting

Insert flexible grout tube to the bottom of the drill hole. Pump in grout (mixed in accordance with the manufacturer’s instruction), slowly withdrawing the grout tube while maintaining pressure on the grout pump until grout is visible at the surface. Grouting to be conducted in presence of the Owner. Adequate notice of at least 5 days to be provided for inspection.

3.5 Protection

Thoroughly protect the rock bolts above and below grade (minimum of 600 mm) by hot dip galvanizing to the requirements of CAN/CSA-S37 and the standards specified therein. In addition, when the bolt is backfilled and below grade, apply a heavy bituminous, corrosion resistant compound.

3.6 Follow manufacture’s instructions with regard to curing and protection prior to any backfilling of the anchor.

END OF SECTION

Cast in Place Concrete

Section 03300

1.0 General

1.1 Reference Standards

The design and installation of concrete shall be in accordance with the latest version of the referenced standards and codes.

.1) Design, install and reinforce foundations and anchors to CAN/CSA 3-A23.1 except where specified otherwise.

.2) Perform formwork and cast-in-place concrete work to CAN/CSA 3-A23.1, except where specified otherwise.

.3) Perform reinforcing work to CAN/CSA 3-A23.1and welding of reinforcing to CSA W186, except where specified otherwise.

.4) Cure and protect concrete work to CAN/CSA -A23.1, except where specified otherwise.

1.2 Test Reports

.1) Contractor to facilitate execution to allow testing and sampling procedures to be performed in accordance with CSA A23.2 by Owner. Concrete cylinders shall be tested for each anchor and the tower base.

.2) Confirmation of air content and slump shall be obtained for each load of concrete delivered to the project. The Contractor shall be responsible for the proper completion of the concrete. All costs associated with the testing of concrete supplied to the project shall be the responsibility of the Owner.

.3) If inspection or test results indicate that concrete materials do not meet the requirements of this specification, such materials shall be rejected and removed from the site. The Contractor shall be responsible for all costs, including testing and additional Engineering inspections associated with concrete removal and replacement.

.4) The Contractor shall notify the Owner at least **ONE WEEK** prior to placing concrete.

2.0 Products

2.1 Materials

.1) Lumber: plywood and wood formwork materials to CSA CAN-A23.

.2) Reinforcing steel: Grade 400 MPa, deformed bars to CSA G30.12 unless indicated otherwise.

.3) Cement: to CSA A5-93, normal (type 10), sulphate resistant (type 50).

.4) Water, fine aggregates, normal weight coarse aggregates: CSA A23.

.5) Chemical admixtures: to CSA A266.2.

.6) Non-shrink grout: premixed compound consisting of non-metallic aggregate, cement, and water reducing and plasticizing agents capable of developing minimum compressive strength of 50 Mpa (7000 psi) at 28 days.

2.2 Concrete Mixes

.1) Except where indicated or specified otherwise use concrete mix designed to produce minimum compressive cylinder strength at 28 days of 30 Mpa for tower foundation and 25 Mpa for anchors.

.2) Slump, unless noted otherwise, shall be 75mm +/-25mm.

.3) All concrete exposed to exterior temperatures and weather in its final use shall contain an air-entraining agent. Total air content to be as specified in CSA Standard A23, for the particular size of aggregate being used. The air-entraining agent shall be compatible with the water reducing agent.

.4) The maximum size of coarse aggregate shall be 40mm.

.5) If the air temperature is 5 C° or less, the temperature of the concrete, at the time of placing, shall be between 15° C and 30° C.

3.0 Workmanship

.1) Place all anchors against an undisturbed front face.

.2) Ensure that reinforcement and inserts are not disturbed during concrete placement.

.3) Do not place concrete against any surface which is less than 5° C. Remove all snow and ice before placing.

3.1 Formwork

.1) Design all formwork in accordance with CSA Standard A23.

.2) Withdraw all nails and thoroughly clean and repair all form materials before reusing.

.3) Provide a 20mm chamfer on all exposed corners.

.4) Take all precautions necessary to maintain the safety of the structure before and after forms are removed.

.5) Take care that the concrete is not chipped or cracked while removing the forms. Pedestal forms to remain in place a minimum of 48 hours. **All formwork is to be completely removed.**

3.2 Reinforcement

.1) Clean all reinforcement of any loose scale, dirt, or other coatings which would destroy or reduce the bond. Reject bars with kinks or bends not shown on the drawings. Thoroughly clean all forms before installing reinforcement. Fabricate, detail and install all reinforcing steel as per Reinforcing Institute of Canada "Manual of Standard Practice" latest edition.

.2) Do not field cut, bend or displace any reinforcement to permit placing weldments or anchor bolts either before or after concrete is placed unless approval is given by the Owner.

.3) All reinforcement shall have a minimum of 75mm concrete cover.

3.3 Joints

.1) Construct all joints as detailed on the drawings.

.2) Clean the face of the joints of dirt and then saturate with water before placing new concrete.

3.4 Grouting of Base Plates

.1) Use In-Pact pre-blended non-shrink dry pack grout as manufactured by C.C. Chemicals Ltd. or approved equal. All grout should be installed according to the manufacture's instructions.

.2) Edges of grout should be tapered off at 45° to give a neat transition between base plates and concrete pedestals.

3.5 Curing and Protection of Concrete

.1) Provide effective means of maintaining the temperature of concrete in place at a minimum of 10° C and a maximum of 30° C for three days after placing. When the mean daily temperature is forecasted to be less than 5° C, provide protection for newly placed concrete by means of suitable enclosures or raised coverings, insulation and heat.

.2) Insulation must be protected to prevent loss of effectiveness due to moisture.

.3) The use of calcium chloride to accelerate curing is prohibited.

3.6 Placement of Concrete

.1) Consolidation of concrete should be performed by internal or immersion type vibration. Consolidation of the concrete by rods or shovels will not be permitted.

END OF SECTION

Tower Structure

Section 05020

1.0 General

1.1.1 The design, supply and erection of the tower shall be in accordance with the latest version of the following codes and standards:

- CSA-S37	Antennas, Towers and Antenna Supporting Structures
- CSA B33.4	Galvanized Steel Tower Bolts and Nuts
- ASTM A325	High Strength Bolts for Structural Steel Joints
- CSA CAN3-A23.3	Design of Concrete Structures
- CSA W59	Welded Steel Construction
- CAN/CSA-G40.20	General Requirements for Rolled or Welded Structural Quality Steel
- CAN/CSA-G40.21	Structural Quality Steels
- CAN/CSA-G164	Hot Dip Galvanizing of Irregularly Shaped Articles
- CAN/CSA-S16.1	Limit States Design of Steel Structures
- CAN/CSA-B72	Installation of Lightening Rods
- CAN/CSA-C22.1	Canadian Electrical Code, Part 1
- CAN/CSA-G4	Steel Wire Rope for General Purpose and Mine Hoisting and Mine Haulage
- CSA-CAN3-G12	Zinc Coated Steel Wire Strand
- CSA W47.1	Certification of Companies for Fusion Welding of Steel Structures
- W47.1S1	Supplement No.1-M1989 to W47.1-1983
-Z259.2	Fall Arresting Devices, Personnel Lowering Devices and Life Lines
- Z259.1	Fall Arresting Safety Belts and Lanyards for the Construction and Mining Industries

- Canada Labour Code
- Health and Welfare Canada Limits of Exposure to Radio-Frequency Fields at Frequencies from 10 kHz-300 kHz, Safety Code 6
- Provincial Occupational Health & Safety Act and Regulations
- National Building Code of Canada
- Transport Canada Standard TP382 – Standards Obstruction Markings
- Canadian Coast Guard Safety Requirements

1.2 Tower Design

1.2.1 The tower should have a maximum serviceability response (tilt and/or twist) of less than 2.0 degrees under working loads. Tower to be designed to require no torsion resistors.

1.2.2 Design Ice Load: The tower shall be designed with loading consideration of 70 mm of radial ice on all exposed surfaces, including members, guys and all attachments, and antenna components. The density of the ice shall be taken as 900 kg/m^3.
Design Spec. & Loading: S37-01, q=1284 Pascal, Rime load = 150 mm rime + 50 mm glaze on guys
Ice load = 50 mm glaze on guys and tower

1.2.3 Design Wind Load: Use Site Specific Wind Data contained in Appendix C.

1.2.4 The loading imposed on the tower by transmission lines and auxiliary lines – feeder lines, attached to it shall be based on the actual dimensions of the lines as determined from the manufacturer's specifications.

1.2.5 If the projected area of the face mounted feeder lines are less than the projected area of the structural members on that face, they shall not be considered as part of the new projected face area, A_s, but shall be considered as a linear attachment outside the C_d calculation for the mast. Subject to the foregoing, should a feeder line arrangement on one face be duplicated on one other face, they shall not be considered as part of the net projected face area, A_s, but shall be considered as a linear attachment outside the C_d calculation for the mast.

1.2.6 If the projected area of face mounted feeders exceeds the projected area of the structural members on that face or if the feeders are duplicated and symmetrically arranged on all faces, the projected area of face mounted feeders shall be considered as part of the net projected face area, A_s, for the purposes of calculating the drag factor, C_d, for the mast and feeders.

1.2.7 The value of C_d shall be taken as 1.5 for flat feeders and 1.0 for round feeders.

1.2.8 Shielding of the transmission lines by the tower members, other feeders or attachments may be considered. When feeder lines are mounted on the inside of one face of the tower, shielding of the leeward lines may be considered, following the procedures outlined in "User's Guide – NBC 2005 – Structural Commentaries (Part 4 of Division B)" Commentary I, Figure I-28 Poles, rods and wires.

1.2.9 Loading from auxiliary facilities and attachments such as ladders, fall arrest rails, feeder line supports, etc. must be considered in a similar fashion as that of the transmission lines and feeders outlined above.

1.2.10 The tower shall be of complete knock down, guyed, lattice design incorporating bolted angle sections. "All-welded" tower sections and welded round leg members are not acceptable.

1.2.11 Tower design to include a wave guide bridge assembly as required to elevate and protect (from falling Ice etc.) transmission lines from the tower base point to the building transmission line entrance. Wave guide bridge to tie into existing where possible.

1.2.12 The foundation designs shall be based on the conditions contained in the Geotechnical Report contained in Appendix 'D'.

1.2.13 Secondary members may be used to reduce the unbraced length of a leg or bracing member. They are not considered to directly resist the applied loads.

1.2.14 In determining unbraced length, a member which is considered to provide lateral support to a compression member shall be capable of resisting a force, either in tension or compression, acting perpendicular to the axis of the corresponding radius of gyration and equal to the percentage of the maximum capacity in the compression member given below. A different value may be used where indicated by suitable analysis. This force need not be applied simultaneously with primary design forces for conventional lattice towers.

Percentage of Axial Compressive Capacity for Lateral Support

L/r of Compression Member	% of Axial Capacity
0 to 60 1.5	1.5
61 to 100 2.0	2.0
101 to 200 2.5	2.5

If the angle between the leg and the main diagonal of a K-brace panel is less than 25º, the forces given by the table noted above may not be adequate. For these cases an analysis shall be completed taking into account eccentric and secondary stresses and member deformations.

1.2.15 The factored resistance of the member and its connections in tension shall not be less than one third of the factored compression resistance unless erection and other forces have been considered.

1.2.16 The unbraced length, L, for any cross sectional axis of a member shall be taken as the distance along the axis of the member between the points at which it is intersected by the axes of the members providing support for that axis. The unbraced length may vary for different cross sectional axes of the member. Secondary members which do not directly resist the applied loads may be used to reduce the unbraced length of a member.

1.2.17 The slenderness ratio of a member is L/r, where r is the radius of gyration of the member on the axis perpendicular to the unbraced length under consideration.

1.2.18 The effective length factor, K, modifies the unbraced length, L, to take into account the structural configuration, including the rotational restraints and end connections.

1.2.19 The effective slenderness ratio, KL/r, is the ratio of the effective length, KL, to the corresponding radius of gyration, r.
The maximum effective slenderness ratio for compression member shall be:

a. 120 for leg members;
b. 200 for main members carrying design compression forces, other than leg members;
c. 240 for secondary members

The maximum effective slenderness ratio for tension only members, and components of built up members not in tension under initial loading conditions, shall be 300 unless other means are provided to control flexibility, sag, vibration, slack and other similar effects.

1.2.20 The w/t ratio of an angle member in compression shall not exceed 25, where w is the effective leg width and t is the nominal leg thickness.

1.2.21 The Design Engineer accepting responsibility for the tower structure shall

a. Have a minimum of five (5) years design experience as it relates to guyed and self-support towers.
b. Be registered or eligible for registration with the Engineers Nova Scotia.

c. Seal all drawings issued that relate to the tower.

2.0 Antennas and Transmission Lines

2.1 The tower structure shall be designed for the antenna systems contained in Appendix B. All antennas are leg mount. All specified future antennas, lines and mounts should be incorporated into the tower design.

2.2 All future antennas, lines and mounts should be incorporated in the tower design.

2.3 All new antennas shall be leg mounted to the tower at the azimuths indicated.

2.4 All transmission lines shall be new 22mm (7/8") Andrew's Heliax LDF5-50 Coaxial Cable or approved equal, with VSWR of 1.13, operating in the frequency of 156 MHz range. All lines shall be supplied complete with connectors, hoisting grips, hangers, ground kits and other necessary hardware.

2.5 Transmission line connectors and end terminations (Type N) top and bottom, are to be supplied and installed by the Contractor.

2.6 The Contractor shall supply and install all new transmission lines as noted above. All lines will extend into the building three meters.

2.7 The Contractor shall be responsible for the installation of all systems as per the manufacturers' recommendations. All antenna / tower interface hardware not supplied by the antenna manufacturers shall be the responsibility of the tower contractor. It shall be the Contractors responsibility to determine any additional material required to mount the antennas to the tower structure. This shall include all antenna struts, mounts, special attachments, bolts, etc. The Contractor shall liaise with the antenna manufacturers or suppliers to obtain adequate information required to design proper mounting interface components.

2.8 The contractor shall be responsible for the installation of all lines and antenna systems, including line hangers, ground kits, connectors, power dividers, hoisting grips, threaded rod, and other necessary hardware. Installation shall be in accordance with the manufacturers recommendations. Line hangers shall be placed at a maximum distance of 762 mm centre to centre. All transmission lines shall be grounded with approved non-braided, solid copper grounding kits.

2.9 The Contractor shall design, supply and install new mounts for all antennas. All antenna mounts, mount hardware and line hangers shall be heavy duty hot dip galvanized or stainless steel. Materials prone to rust or corrosion are not acceptable.

2.10 The antenna elevations are referenced from ground level to the bottom of the antenna. Deviations from these centers of radiation greater than 0.5 m must be reported to the Owner.

2.11 Antenna assembly and installation must be completed in accordance with the manufacturers' instructions and acceptable industry standards. Antennas or antenna components damaged

accidentally prior to full acceptance by the Owner shall be replaced at the Contractors expense. Replacement will be completed so as not to delay project completion.

2.12 A hoisting grip shall be installed and used to facilitate transmission line installation as recommended by the manufacturer of the transmission line. The hoist grip shall be connected to the tower after final placement of the line. The connection shall be made using a suitable galvanized connector. Connections may be made to secondary members such as transmission line support brackets, redundant horizontals, antenna mount members, or on primary members where special allowance has been made for such a connection.

3.0 Transmission Line Grounding

3.1 Ground kits shall be Andrews' or approved equivalent and constructed of solid copper wire and meet or exceed the requirements of the transmission line manufacturer. Ground assembly is to be installed with provided tapes and methods included in the ground kits. All transmission lines shall be grounded in accordance with manufacturers recommendations but minimally at the antenna attachment elevation, at 60 m intervals (where applicable), at the tower base and at the building TX line entrance. Connect the terminal end of the ground kit conductor to predrilled purpose specific holes in the tower steel or ground bar as is appropriate to the specific installation. The holes shall be located so as not to weaken the structure. The connection surface must be free of paint providing a good metal-to-metal contact.

3.2 The connection point on the tower shall be lower than the connection point on the transmission line. The ground line shall run from the lower end of the taped connection. Ground kit lines are to be installed to eliminate any bends or turns in the grounding wire.

4.0 Materials

4.1 All steel CSA G40.21M – 350W u/n. Preference shall be given to the use of structural steels with improved resistance to brittle fracture. A36 modified steel is not acceptable. All materials to be used in the tower shall be new and in accordance with the requirements of CSA Standard S37.

4.2 Use of material sections less than 5 mm in thickness will not be permitted on primary or secondary structural members. Sections used for attachment or support of auxiliary facilities may be permitted subject to review by the Engineering Consultant.

4.3 Hollow sections will not be permitted on primary or secondary structural members which include tower legs, horizontals and diagonals.

4.4 Test Certificates

Two copies of mill test certificates for each lot of steel received from the mill by the Contractor shall be forwarded to the Owner. These certificates shall record results of tests indicating the following:

i) Yield Strength
ii) Ultimate Tensile Strength

iii) Percent Elongation
iv) Chemical Composition.

4.5 Mill Certificates may be requested to be forwarded to the Owner by the Contractor, at least two (2) weeks prior to the commencement of fabrication of structures incorporating the related material.

4.6 All guys shall be one continuous length Bridge Strand or Guy Strand (Grade 180) and guy attachment assemblies unless otherwise approved by the Owner. Cut ends of strand shall be capped with a stainless steel hose clamp or ear clips.

5.0 Connections

5.1. Connections in the shop may be bolted or welded. All site connections shall be bolted.

5.2 Make all welded connections in conformance with CSA Standard W59.1. Use only low hydrogen electrodes or processes of equivalent rating. All weld designs shall be clearly indicated on the design drawings.

5.3 Make all bolted connections with high strength bolts clearly marked A325 conforming to A.S.T.M. Standard Specification A325. Place a hardened washer in under the bolt element (nut or bolt head) turned in tightening the bolt. Tighten all bolts by the turn of the nut method as specified in CSA Standard S16.

5.4 Power wrenches may be used in installing bolts, provided they are of the adjustable type capable of cutting-out at a pre-selected torque value.

5.5 After the tower has been complete, check all bolted connections, including those on miscellaneous metal work, and retighten all loose bolts. Exercise care that bolts adequately tightened are not subjected to additional rotation of the turned element. All damaged nuts or bolts to be replaced.

5.6 The minimum resistance of a splice shall not be less than the maximum design force in the member, and where practical should equal the design resistance of the member. The splice shall provide sufficient stiffness to ensure continuity of the member. For splices which transfer compression by bearing, the mating surface shall be finished to bear. The splice shall have a minimum tensile resistance equal to the maximum tensile force, but not less than 33% of the compression resistance of the member. For flange forces in tension, the effects of prying action shall be taken into account.

6.0 Workmanship

6.1 General

Workmanship and finish throughout shall be equal to the best modern practice for this class construction. All members shall be in accordance with the drawings and shall be straight and true as per CSA S37. All like parts shall be interchangeable. All punched holes must be accurately located so that the structure can be erected with a minimum of “drifting”. The ends of members shall be clipped as required to facilitate assembly. In any bending or reworking of any material, methods employed shall ensure that the physical properties of the material are not impaired.

6.2 Marking

Each separate member shall be distinctly identified by a number assigned to that member. Each member shall be clearly marked with its member number to facilitate erection and traceability. All like parts shall have the same number.

6.3 Punching

Punching shall be done by methods designed to ensure accuracy. The centre of any hole shall, in no case, be displayed more than1.5mm from its position shown on the drawings. Plugging or welding mis-punched holes will not be allowed. Punches and dyes shall be sharp and true and all punch holes shall be round, true to size, and free from ragged edges and burrs. Where applicable, punching performed on bent members, shall be done after bending to avoid distortion of holes.

6.4 Welding

All welding shall be performed in accordance with CSA Standard W59 latest revision and shall be undertaken by a fabricator fully approved by the Canadian Welding Bureau to the requirements to CSA Standard W47, latest revision. Provide copy of CWB Certification to Owner.

6.5 Handling of Material

Materials shall be handled and stored in the plant and on the job site in such a manner that no damage shall be done to the materials of any existing building or structure. Special care shall be taken to ensure that galvanizing, priming, or painting is not damaged during handling and erection of materials. Storage of materials on the site will be the responsibility of the Contractor.

7.0 Galvanizing

7.1 All materials, structural steel, pipe and fittings, including bolts, nuts and washers shall be hot dip galvanized to the requirement of CSA S37 and the standards specified therein. Galvanizing applied to structural members is to have a minimum mass of Zinc coating of 610 g/m² (2 oz/ft²) equivalent to a thickness of 87 μm (3.40 mils). Galvanizing applied to bolts, nuts and threaded fasteners is to have a minimum mass of Zinc coating of 460 g/m² (1.5 oz/ft²) equivalent to a thickness of 65 μm (2.54 mils).

7.2 All materials shall be completely fabricated before galvanizing. No galvanizing shall be permitted on assemblies after being bolted. No machine or shop work shall be allowed after galvanizing (except the tapping of nuts).

7.3 Before galvanizing, the steel shall be thoroughly cleaned of all paint, grease, rust, scale or other materials that will interfere with proper binding of the zinc with the steel as per the requirement of CSA S37-01 and the standards specified therein.

7.4 Test for thickness and uniformity of coating shall be made, on at least 10 members, throughout the galvanization process and from time to time on as many samples as may be considered necessary by the Owner. Such tests shall be conducted in full accordance with the requirements of CSA S37 and the standard recording results of the foregoing tests shall be forwarded to the Owner by the Contractor. The Contractor shall engage an independent testing firm to complete this work. All costs are to be included in the tender price.

7.5 The Contractor shall field paint all steel members of the tower where the galvanized finish has been scrapped or chipped during erection in the field. This shall be done using Zinkrich paint, as supplied by the Zinkrich Company, 42 Broadway, New York, New York, U.S.A. or Galvicon or an approved equal. Steel members that have a slightly damaged finish shall be given three coats of Zinkrich Paint applied according to the manufacturer's printed instructions.

7.6 Contractor shall warranty all galvanizing work for a period of not less than three (3) years.

8.0 Painting

8.1 The tower shall be painted by a qualified painting facility subject to audit and approval by the Owner in 7 equal and alternating bands of International Orange (#12197) and White (# 17875) in accordance with latest edition of Transport Canada, Canadian Aviation Regulations, TP 382/621.9 – Standards Obstruction Marking.

All anchor shaft below assemblies to be coated with a heavy bituminous compound.

8.2 All surfaces of the tower are to be painted with exception of an area of the leg splice plates connection mating surfaces, thus to ensure a good electrical connection for grounding purposes

Care shall be taken to ensure galvanized members are kept clean and free of all oils and contaminates during material handling process.

Surface Preparation – Galvanized steel must be cleaned prior to blasting in accordance with SSPC-SP-1 – "Solvent Cleaning"

8.3 **Light Sweep blast all surfaces** in accordance with SSPC-SP-7 to remove any chromate treatment, or poorly adhered zinc salts that may be present to increase mechanical bonding through increased roughness. Care should be taken to remove as little zinc as possible while maintaining desired roughness. After sweep blasting, the coating system should be applied ideally the same day and a max of one day.
SPECIFICATION FOR ABRASIVE SWEEP-BLASTING

- Blast pressure - 300kPa maximum.
- Media grade 0.2 to 0.8 mm
- Media type(<5 mhos hardness) – clean silica and slags, alumina, limestone.
- Angle of blasting to surface 30-60°
- Distance from surface 300-600mm
- Nozzle type minimum – 10mm venturi type.
- Grit should not be recycled.

Coating System to be water based Acrylic (no Alkyds are acceptable)

8.4 To be applied as per manufacturers specifications.
Primer: Aqualux 523-613 @ 2.5 – 3.5 mils dft (or approved equivalent)
Finish: Aqualux 522-121white & 522-126 Orange @ 2.5 – 3.5 mils dft (or approved equivalent)

8.5 All paints must meet ASTM performance requirements for abrasion resistance, hardness, fading, flexibility and salt-spray resistance. Paint products must not contain Lead (pb) in their composition.

8.6 All paint shall be applied in shop conditions as per manufacturers instructions, evenly spread and free from all marks, stains, defects and flaws. No painting shall be done when the temperature is lower than 10º C and humiditys above 50%. No painting shall be done in damp weather. No painting shall be done when the tower metal is hot enough to cause paint blister and produce a porous coating. No coat of paint shall be applied until the previous coat is thoroughly dry as per manufactures recommendations. Where painting or priming is done in the shop, any areas damaged during transit or erection shall be cleaned and touched up with new Zinc rich primers and/or paint as required.

8.7 The Contractor shall be responsible for damage done by paint spraying or dripping on the Owner's or other's property.

8.8 Contractor shall warrant all painted items for three (3) years for 90 % coverage. Any damage to the paint from normal environmental conditions prevalent at the site shall be repaired by the Contractor at no cost to the Owner in a manner approved by the Owner.

8.9 The Contractor shall be responsible for damage done to the tower's paint during shipping and erection.

9.0 Erection

9.1 The tower shall be erected in a manner that will not bend, scrape, distort, or injure the component parts of the galvanizing.
Upon award of contract, Contractor is to provide a detailed Erection Plan to include the use of gin poles, winches, cranes and erection equipment.

9.2 The use of iron sledges for hammering or driving any members will not be tolerated. All hammering is to be done with wooden mauls or hammers of plastic, lead or other soft material.

9.3 Every failure of the material to join together properly shall be reported to the Owner.

9.4 Upon completion of erection, the tower shall be inspected by the Contractor for member damage. Any damaged or missing items, including nuts, bolts, etc., shall be replaced.

9.5 The Contractor shall be responsible to ensure that no members of the tower are over stressed during erection. Any members damaged during erection shall be replaced. The Contractor shall be responsible for any damages done to the work of others, or to adjoining structures and property during erection.

9.6 The guy tensions shall be adjusted to within + 15% and –5% of the stipulated design tensions noted in the design drawings and as per the requirements of CSA S37. The tension calculations shall consider the ambient temperature at the time of adjustment. Full consideration of anchor location with respect to the tower base must be incorporated into the calculation of correct guy tensions. It shall be the Contractor's responsibility to obtain accurate measurements pertaining to elevation differences between the tower base and guy anchors.

9.7 The Contractor shall use a three-transit set up to complete final adjustment of vertical alignment and twist and to ensure it meets the requirements of CSA S37 for vertical alignment and twist.

9.8 Contractor is responsible for establishing temporary obstruction lighting in accordance with Transport Canada requirements.

10.0 Cathodic Protection of Anchor Shafts

All anchor shafts are to be protected from deterioration and/or corrosion by a properly installed cathodic protection system designed by the Contractor. Anodes to be zinc or magnesium and to last the performance life of the tower.

END OF SECTION

Auxiliary Facilities

Section 05121

1.0 General

1.1 The following facilities shall be considered to be an integral part of the tower contract and shall be supplied and erected as such. In mounting any of these auxiliary facilities, care shall be taken that the structural members of the tower are not weakened by the drilling of holes or any other means.

1.2 Ladder – The tower shall be equipped with a climbing ladder (outside climb preferred) complete with a CSA approved fall arrest rail centered in the ladder. The ladder shall be a separate assembly bolted to the tower and shall conform to the latest version of CSA S37. Provide an unobstructed climbing path and maintain the required climbing radius as per CSA S37.

1.3 Transmission Line Supports – Hangers shall be provided to support the transmission lines at the elevation of all antennas. Lines are to be supported and restrained at centers suitable to the manufacturer's requirements and TX lines are to be installed on the outside face of the tower. Use of wrap lock/ tie wrap devices to secure TX lines is not acceptable. The maximum spacing between supports is 760 mm. Location of Transmission lines will be submitted to Owner for approval.

1.4 Ice Protection

.1) All horizontal runs of transmission lines shall be protected from falling ice in a manner approved by the Engineering Consultant.
.2) Three U-Bolt clips are to be spaced 300 mm apart, directly above the grounding connection and guy markers on each guy.
.3) All obstruction lights shall be protected by ice shields.
.4) All antennas are to have ice guards locating above of sufficient size to completely shield the antenna from falling ice and as per drawings. Ice guards are to be installed at 45 degree angles to tower to cause shedding of ice away from the tower.

1.5 Turnbuckles and Shackles

.1) Turnbuckles and shackles shall be manufactured from AISI 1035 steel, heat treated, and shall be hot dip galvanized in accordance with the requirements of the latest version of CSA S37. The minimum turnbuckle length shall be 457 mm. Provide full articulation at anchor ends of each turnbuckle by means of shackles.
.2) Install all turnbuckles so as to provide a minimum of 250 mm of take-up for future adjustment. Provide a locking device for each turnbuckle. The locking device shall consist of vinyl coated cable or an approved equivalent.
.3) All guy hardware including turnbuckles and shackles to be Crosby Brand (Heavy Duty Grade) or approved equivalent.

1.6 100% Terminations

Bridge sockets shall be sized to provide a minimum of 1220 mm of adjustment. The sockets shall be installed so as to provide a minimum of 760 mm of take-up for future adjustment. The bridge sockets shall be made of heat treated steel. Contractor is to provide details of other 100% terminations.

1.7 Anti-climb Devices

.1 The tower is to be provided with a locked, Anti-climb device approved by the Owner. The Anti-climb should incorporate a framed, heavy gauge expanded wire mesh cage bolted flush to the tower face using round headed hardware that cannot be used as a step or hand hold. The panel should be approximately 2.5 m high with the lower edge positioned approximately 3 m above grade. Access should be prevented from both outside and inside the tower. Contractor is to submit drawings of the anti-climb system including specification sheets on the wire mesh and gauge thickness for approval by the Owner.

.2 The anti-climb shall be hinged on two faces, the climbing face and the transmission line face. Operable panels shall been framed, hinged on one vertical side, with a combined latching mechanism with a lock on the opposite vertical edge. A locking mechanism requiring removable hardware such as long steel rods to open access panels is not acceptable.

.3 The trap door in the horizontal anti-climb should easily open up to allow safe access to the tower.

.4 Barbed wire will not be permitted as part of the anti-climb.

1.8 Guy Markers

.1 Each guy shall be equipped with yellow vinyl guy markers located at the anchor end of each guy. Install such that markers extend to mark at a point 4 m above the ground.

.2 Guy markers shall be approximately 2 m in length and vandal resistant. Field drill 25 mm holes at 200 mm spacing to render these useless for other purposes.

.3 Contractor shall submit shop drawings for Owner approval.

1.9 Fall Arrest Safety Device

.1 The Contractor shall design, supply and install a CSA approved Fall Arrest Rail to meet CSA S37 and the latest version of CSA Z259.1and CSA Z259.2. Rail system is to be Miller type trolley compliant or approved equivalent.

.2 The fall arrest rail shall be free from obstructions for the complete height of the tower.

.3 The fall arrest rail shall be supported at spans not more than 1 m. Any extension beyond the top of the tower must be structurally supported for the entire height.

.4 Proper manufactured stop hardware is to be installed at the top of the fall arrest rail to prevent accidental dislodging of the trolley from the rail.

.5 The fall arrest system shall be supplied complete with two new CSA approved trolleys (including fall back compliance) that will be turned over directly to the

owner. Trolleys shall be supplied with permanently attached lock safe swivel clips for attachment to front D ring of CSA Approved full body harness.

.6 Cable fall arrest systems are not acceptable.

2.0 Waveguide Bridge

2.1 The waveguide bridges shall be supplied and installed as per approved design drawings and tie into the existing bridge Designs must incorporate continuous waveguide bridge ice protection from the tower to the equipment shelter.

2.2 This ice protection shall incorporate a peaked roof of solid plate construction located above the standard channel support for the waveguides, cables and conduit. Design must allow easy access to TX lines without removal of bridge hardware.

2.3 Transmission lines must be protected by the waveguide bridge at all times.

2.4 The waveguide bridge must be independent of and not directly connected to the tower structure or the building.

2.5 The waveguide bridge can be supported on a post located in the centre or two sides of the assembly, except the support closest to the building which must consist of two posts located on the outside of the assembly.

2.6 The waveguide bridge shall be designed to carry all initial and proposed waveguides, cables and conduits as indicated on the antenna and transmission line schedule.

2.7 The waveguide shall be supported on cable hangers connected to a trapeze style support system of stainless steel threaded rod or galvanized bar hangers and two levels of horizontal trapeze angles suitable and elevated to run directly into the waveguide window.

2.8 The Contractor shall provide a suitable adjustable plate extension to the bridge to protect the lines between the bridge and the building and the bridge and the tower. This plate must taper to the full width of the waveguide window or waveguide ladder on the tower.

2.9 Unistrut or Cantruss sections are not acceptable for use on the waveguide bridge or the tower itself.

END OF SECTION

Lighting and Power Supply

Section 16500

1.0 General

1.1 Contractor is responsible to verify requirements for obstruction lighting as per Canadian Aviation Regulations 621.19/TP382. The tower height shall be based on the highest intended projection of the structure. Lights to be LED. Beacon shall be on a circuit independent of mid level obstruction lights.

1.2 All required equipment is be supplied, as specified, by Contractor.

The complete wiring system and lighting fixtures shall be of a waterproof type using COREFLEX CABLE or an approved equal, rigid fittings, and cast-iron or aluminum, type junction boxes.

1.3 All wiring shall be in accordance with CSA requirements, and type RA- 90-40C wire shall be used throughout the installation. Wires shall be routed in to a junction box or fixture, and shall be routed down the tower from the top of the junction box or fixture.

1.4 Tower obstruction lighting shall be wired so that lamps in each double obstruction fixture will be on opposite side of a three wire circuit. Circuits are to be wired in a flip flop fashion and controlled by a photocell as the base of the tower.

1.5 The obstruction lamps shall be 130 volts long life, type 116 A21-TS or equivalent.

1.6 Lighting system to have a control system that is capable of remote monitoring and signalling operation.

2.0 Auxiliary Power Outlet

2.1 A weatherproof power receptacle shall be located at the intermediate and top elevation of the tower. The AC outlets will be complete with a GFI and will be on separate circuits. 120V, 20 amp.

3.0 Permits and Temporary Lighting

3.1 The Contractor shall obtain an electrical installation permit from the appropriate agency and submit to the Owner evidence that the lighting installation has been inspected and approved by the said agency.

3.2 When required by Transport Canada, the tower Contractor shall make arrangements to provide temporary tower lighting until the tower is accepted, and the permanent power supply is available. These arrangements will be subject to the final approval of the Owner.

4.0 Ice Protection

4.1 The Contractor shall install ice protection for all lights and lighting systems.

5.0 Cable Attachment

5.1 The Contractor shall adequately secure the cables at distances not exceeding 750mm. Use of wrap-lock/tie wrap device to secure cables is unacceptable.

6.0 Shop Drawings

6.1 The Contractor shall submit shop drawings clearly indicating all elements of the lighting system.

7.0 Termination of Wire and Hook Up

7.1 The Contractor shall terminate all wiring inside the building, in the existing electrical panel. The Contractor shall attach conduit to ceilings and walls so as to avoid conflict with existing equipment. All conduit shall be installed in a neat manner.

END OF SECTION

Electrical Antenna

Section 16785

1.0 General

1.1 Scope of Work

.1 Work under this section relating to the antenna:
(Only new materials are to be used except for antenna #1. Existing VHF-DF antenna may be reused.)

.1 Supply and installations of all antennas.
Refer to Appendix B. Antennas #3, #4, #5, #6, #7 shall be new. Existing antenna #1 shall be reused. Removal of antenna #1 from existing tower and installation on new tower shall be done in a manner and timing to be approved by the Owner prior to its relocation.

.2 Supply and installation of new continuous Andrew LDF5-50 Heliax transmission cable, or approved equivalent, from the new antennas to the transmitting equipment in the existing equipment building. Terminate into N type female connector both ends.

Contractor is responsible for all testing, and reporting for the lines and antennas.

All transmission lines shall be new 22mm (7/8″) Andrew's Heliax LDF5-50 Coaxial Cable or approved equal, with VSWR of 1.13, operating at a frequency of 156 MHz (+/- 5MHz). Written verification of this must be submitted to the Engineering Consultant for each line prior to installation. Use of spliced lines is unacceptable.

.3 Supply all grounding material to properly ground all TX lines minimally at the top, tower mid point, bottom of tower and building entrance.

.4 Contractor is responsible for a full line and antenna system sweep.

.5 Contractor shall provide own testing equipment for sweep test.

.6 CCG shall provide on site Technician to provide sweep specifications.

1.3 Antenna Specifications

Refer to Appendix B

Notes:

1. All antenna elevations referenced to bottom of antenna
2. All antennas to be 1/4 wavelength spacing.
3. All antennas to have suitably designed ice guard protection designed by Contractor. Antenna surface shall be black anodized to increase melting of ice cover in sunlight.
4. Frequency range from 138 MHZ to 174 MHZ

2.0 Execution

2.1 Electrical Bonding

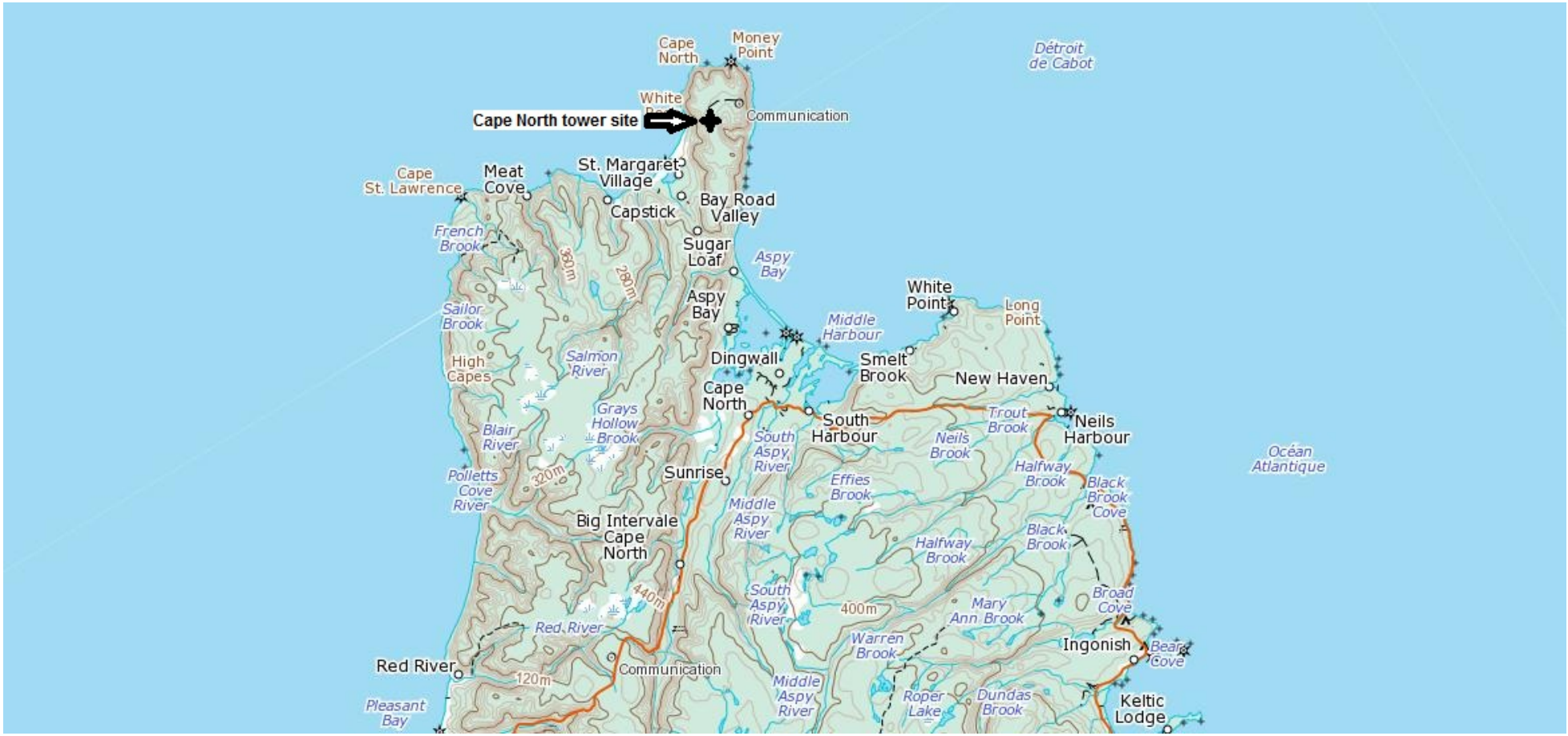
.1 Special care shall be taken to ensure continuity of required electrical connections and proper bonding of electrical conduits, etc., upon initial assembly and throughout antenna structure life when subjected to salt spray conditions in coastal installation.

END OF SECTION

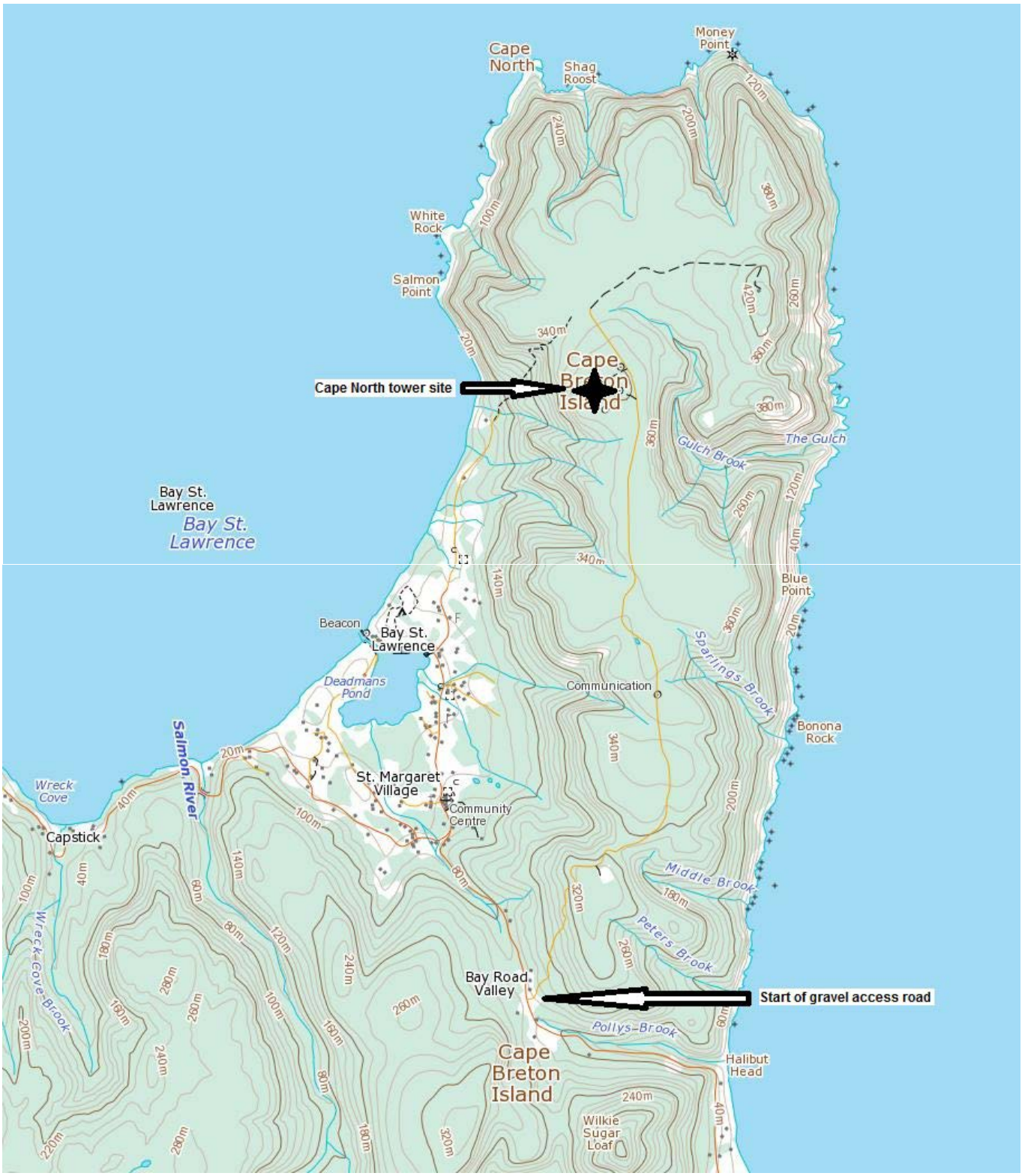
Appendix A

Site Location Maps

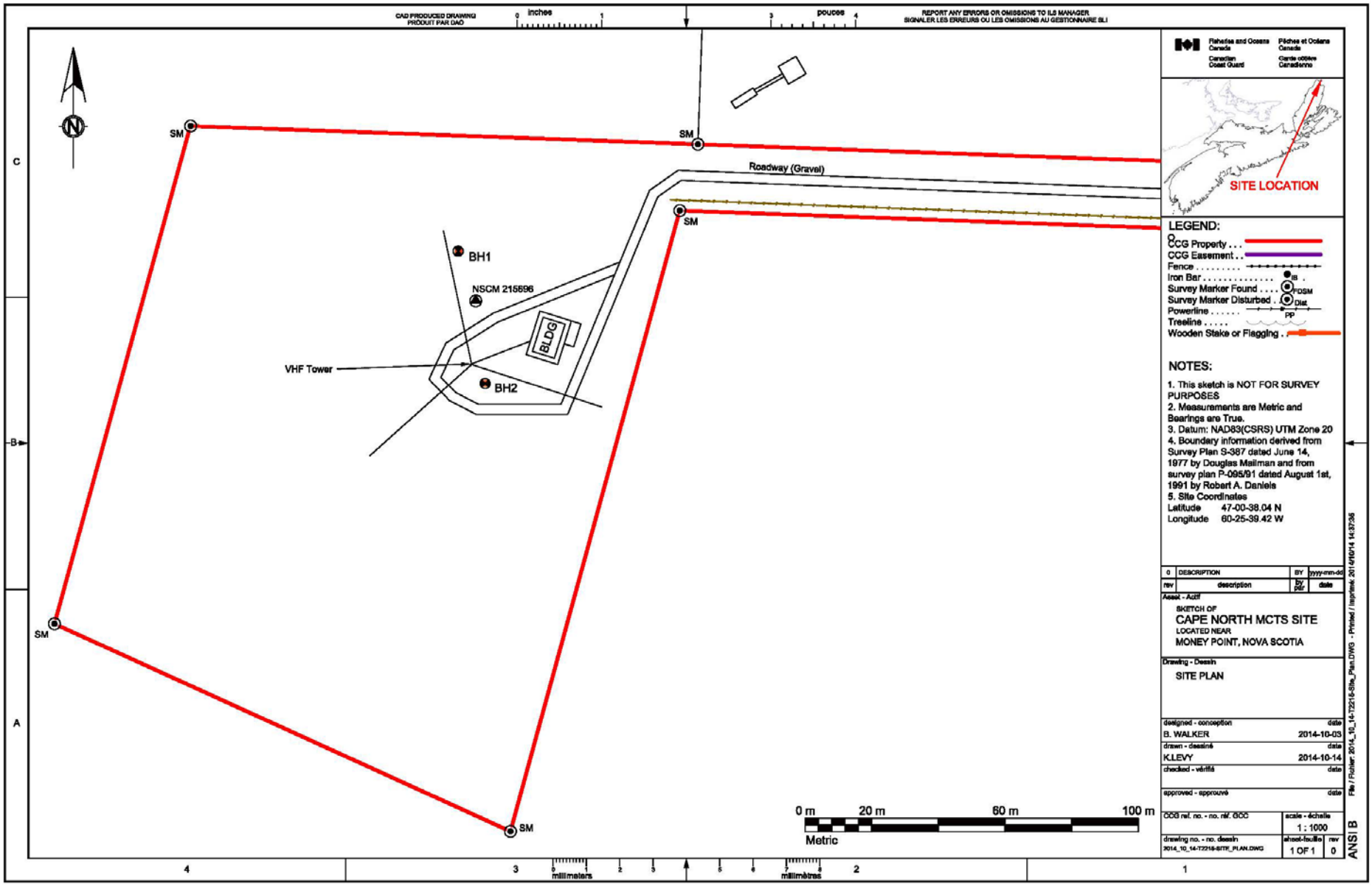
General location of Cape North tower site



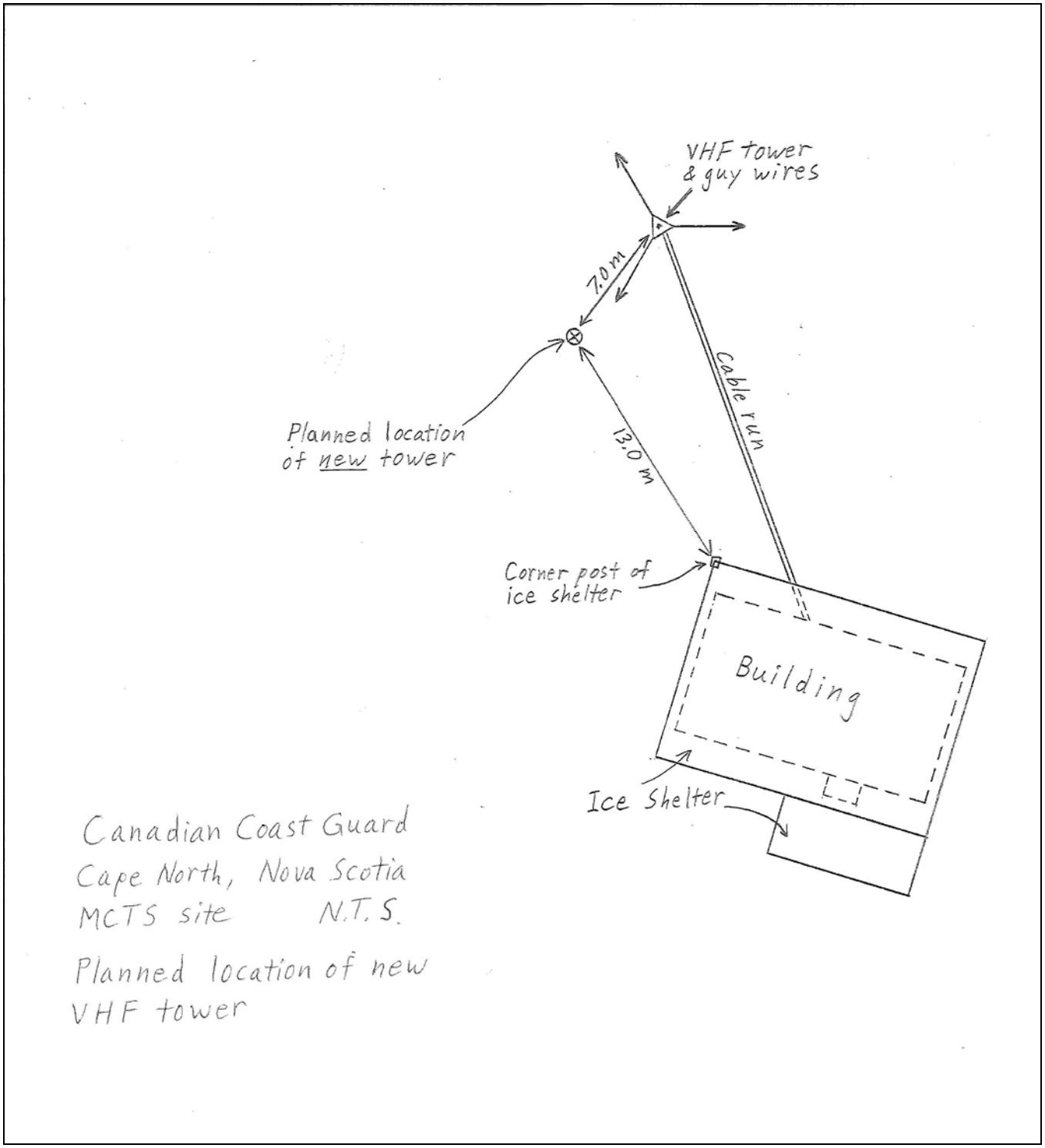
Cape North tower site in northern Cape Breton Island, Nova Scotia



Cape North tower site and access road



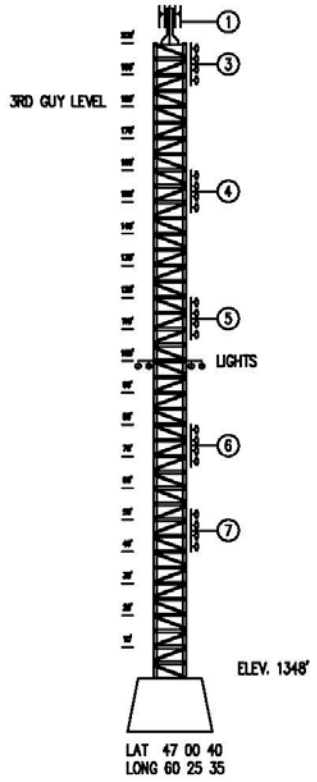
Site property map



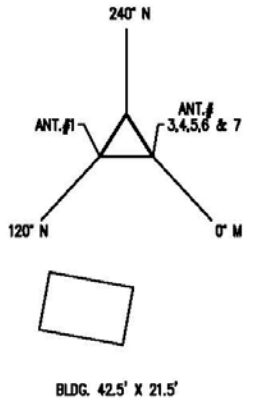
New tower location by existing tower and building

Appendix B

Tower Profile



ANT.#	DESCRIPTION	ORIENTATION	CABLE TYPE	ANT. HT. CL.
1	VHF-DF ANT.		EUPEN 7/8"	205' (1 GN)
2				
3	210C4 ANT. CH.16 1/4~	AZ 0° MAG	EUPEN 7/8"	190'(2 GN)
4	COMPROD 874-70 DSC 1/4~	AZ 0° MAG	EUPEN 7/8"	150'(3 GN)
5	210C4 ANT. HD CH.24 1/4~	AZ 0° MAG	EUPEN 7/8"	110'(4 GN)
6	210C4 ANT. HD CH.19 & 23 1/4~	AZ 0° MAG	EUPEN 7/8"	80' (1 WH)
7	210C4 ANT. HD 1/4~ SPARE	AZ 0° MAG	EUPEN 7/8"	46' (2 WH)



NO.	LOC	REVISION	DATE	BY	APPR.
J		REVISED TO DATE	SEPT.28/05	JM	
I		REVISED TO DATE ANTENNA #4 REPLACED	JULY 23/04	PJ	
F		REVISED TO DATE ANT. #7 ADDED	AUG.1/01	JM	
E		TOP MOUNTED HD210C4 (INTRAC) REMOVED	MAY 23/00	JM	
D		REVISED TO DATE VHF-DF ADDED	JUNE 26/95	JM	
C		REVISED TO DATE #93-62	JULY 28/93	JM	
A		ORIGINAL ISSUE	APR.22/88	PETE O.	

TELECOMMUNICATIONS AND ELECTRONICS BRANCH

CAPE NORTH, N.S.
200' SUPPORT TOWER
ANTENNA LAYOUT

DATE	DRAWN		CHECKED	APPR.
22/09/87	JIM MUISE			
SCALE NTS	REFERENCE	A5	DRAWING NO. MM272-019-AL	SHT. 1/1

Tower Profile

Appendix C

Site Specific Wind Pressure

Tower Coordinates: Latitude 47º - 00’ - 40” North
Longitude 60º - 25’ - 36” West
Base elevation 415 metres above sea level

Design loadings: q = 1284 Pascal
Rime load = 150 mm rime + 50 mm glaze on guys
Ice load = 50 mm glaze on guys and tower

Appendix D

Geotechnical Reports (2)

1 – 2014 letter report by BGC Engineering Inc.
Geotechnical Investigation – Proposed VHF Tower Replacement, Cape North, NS
Department of Fisheries and Oceans, Canadian Coast Guard

2 - 1979 letter and report by Maritime Testing Limited
Geotechnical Site Investigation, Cape North, Proposed Tower Site

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
1718 Argyle Street
Halifax, NS
Canada B3J 3N6
Tel: 902.474.5925
Fax: 902.474.5929

December 3, 2014
Project No: 0444-009

Bruce Walker, Project Engineer
Department of Fisheries & Oceans
Canadian Coast Guard
Marine and Civil Infrastructure
PO Box 1000
Dartmouth, Nova Scotia, B2Y 3Z8

Dear Mr. Walker,

Re: Geotechnical Investigation – Proposed VHF Tower Replacement, Cape North, NS
Department of Fisheries and Oceans, Canadian Coast Guard

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) conducted a geotechnical engineering investigation at the site proposed for the installation of a new VHF Tower in Cape North, Nova Scotia. The assignment was completed for the Department of Fisheries & Oceans, Canadian Coast Guard (CCG).

The project includes the installation of a new 200 ft. (60 m) high VHF Tower which will replace the existing, active tower installed around 1979. Based on information provided by CCG, the new tower will be offset by approximately 7 m from the existing tower, with guy wire supports similarly offset. The proposed site layout is shown on Drawing 01, attached to this letter.

1.1. Objective and Scope of Work

The purpose of the geotechnical investigation was to assess the subsurface conditions at the project site. Following assessment of the investigation BGC were to provide geotechnical recommendations to assist with the design and installation of the new VHF tower foundation and guy wire supports.

The proposed scope of work provided in BGC's proposal (dated August 8, 2014) to CCG included a site reconnaissance to gain some preliminary insight into the potential subsurface stratigraphy at the site.

Following the proposal submission, CCG provided BGC with the geotechnical site investigation report (MTL, 1979) prepared by Maritime Testing Limited (MTL) for the existing tower site design. The MTL site investigation consisted of three (3) geotechnical boreholes advanced through the overburden materials and bedrock, near each of the three existing guy anchor supports. The MTL borehole logs (provided in the 1979 report) were reviewed by BGC prior to conducting the site investigation. Based on BGC's review of the MTL borehole locations and logs, BGC proposed a revised field scope of work consisting of 1 to 2 boreholes (within project budget allowing one day of drilling) and an overview of the subsurface data presented in the MTL report. This revised scope of work was approved by CCG in October 2014.

BGC's scope of work completed for the geotechnical investigation included the following components.

- Completion of a geotechnical investigation, including one (1) geotechnical borehole.
- Determination of the borehole location using a handheld GPS unit.
- Logging and sampling of collected split spoon samples and retrieved rock core from the borehole.
- Completion of laboratory compressive strength testing of a representative rock core sample.
- Review of the subsurface data presented in the 1979 MTL geotechnical report.
- Preparation of a geotechnical letter report including:
    - Site plan showing the borehole location,
    - Borehole log,
    - Discussion on soil and groundwater conditions encountered at the proposed site; and,
    - Geotechnical engineering recommendations for design and construction of the tower foundation and guy wire supports consisting of rock anchor installations.

2.0 SITE DESCRIPTION

The project site is located along a public road (Road #6014) off of Bay Saint Lawrence Road in Cape North, Victoria County, Nova Scotia. The site is cleared in the area of the proposed replacement tower and there is road access to the site.

The following sections provide additional detail with respect to the site description. Selected photos taken at the project site during the field investigation are included in Appendix A.

2.1. Existing Development

The existing infrastructure at the project site includes a 60 m high VHF tower with three (3) guy wire supports located approximately 41 m from the centre of tower. The existing VHF Radio building is located approximately 20 m northeast of the existing tower.

2.2. Geological Setting

The Surficial Geological Map of Nova Scotia (NSDNR Map ME 1992-3) describes the surficial geology in this area as fragmented rock consisting of angular blocks and finer interstitial debris; overlain by a thin, discontinuous veneer of till.

The geological mapping indicates that bedrock in the Cape North area is described as meta-sedimentary rocks belonging to the Money Point group (Keppie, 2000). Rock types of this group can include semipelitic schist, pelitic schist, calcsilicate rocks and rare marble.

2.3. Topography

Limited site survey data was available for preparation of this letter. Based on the MTL borehole elevations shown on the Canadian Coast Guard Base Pier Design Drawing D-20-247 dated May 1979 (Drawing D-20-247, 1979) and our site observations, the topography is sloping at approximately 3 - 5% from south to north.

A Nova Scotia Control Monument (NSCM) is located north of the existing tower base. According to the Drawing D-20-247 (noted above), an assumed elevation of the NSCM is 30.5 m (100 ft) was used by MTL (1979). For this report, BGC has also assumed an elevation of 30.5 m such that the elevations could be compared between this report and the one conducted by MTL (1979). The actual elevation of the NSCM monument described above is 408.329 m, as provided by CCG.

Based on the NSCM monument El. 30.5 m, the topographic relief within the limits of the site varies from approximate elevation (El.) 32 m on the southern portion of the site to EI. 28 m on the northern portion of the site.

2.4. Vegetation

Ground surface cover at the project site consists mainly of exposed granular fill with sparse, thin vegetation growth. The vegetation consists of thin grass growth and small shrubs. There is larger tree growth along the perimeter of the site. The typical site vegetation is shown in Photo 1.

3.0 SITE INVESTIGATION PROCEDURES

3.1. Geotechnical Investigation

In accordance with the project's RFP (Geotechnical Services Replacement of VHF Tower, Cape North, dated July 25, 2014), the geotechnical investigation was completed as per CSA Standard S37-13, Antennas, Towers and Antenna-Supporting Structures, Appendix L (CSA, 2004).

The BGC geotechnical investigation was conducted October 4, 2014 and consisted of one (1) geotechnical borehole advanced at the existing VHF tower site. The location of the borehole, identified as BH-BGC14-01, is shown on Drawing No.1 attached (Photo 1 attached, also shows the borehole location). The borehole was completed using a CME 55 truck-mounted hydraulic

drill rig provided by Lantech Drilling and was advanced to a depth of approximately 10.4 m below ground surface.

As previously noted, a preliminary review of the 1979 MTL borehole logs was carried out by BGC prior to the site investigation. The review showed that the least favorable bedrock conditions for rock anchor support existed at the borehole BH3 location. Based on this information, BGC proceeded to drill one borehole at the proposed guy wire support in this location to confirm the presence or absence of unfavorable bedrock conditions. The geotechnical properties of the bedrock at this location could then be used to develop design parameters for use in anchor design.

3.2. Logging and Sampling

The boreholes were advanced through the overburden using a 100 mm dia. solid stem auger and Standard Penetration Test (SPT) with a 50 mm dia. split spoon sampler through the overburden material. The SPTs were performed to evaluate the relative density of the overburden soils, to obtain samples and to determine the SPT N-value profile throughout the overburden soils.

The split spoon soil samples were logged by BGC staff in accordance with the Unified Soil Classification System (USCS). Field descriptions of the soil samples included: apparent moisture content, relative density, colour, strength, composition and other pertinent details. Split spoon soil samples were sealed in doubled plastic bags to preserve the in-situ field condition of the soil as well as possible.

All retrieved core (NQ core – 63.5 mm) was carefully logged and then placed in core boxes for transportation and storage. Rock core samples were logged in the field by BGC staff in accordance with the International Society for Rock Mechanics (ISRS) recommended methods. The rock descriptions included: type, weathering, intact strength, colour, grain size and texture. Rock Quality Designation (RQD) and fracture spacing was also be measured and recorded in the field. Select rock core samples were preserved in the field by wrapping with Saran wrap.

3.3. Laboratory Testing

Rock core specimens (preserved in the field) were sent to a geotechnical soils testing facility for Unconfined Compressive Strength (UCS) testing on one (1) representative bedrock sample. The UCS test was conducted in accordance with the latest editions of applicable American Society for Testing and Materials (ASTM) standards. The result of the UCS test is noted in the borehole log.

4.0 SUBSURFACE STRATIGRAPHY

The subsurface conditions encountered in the BGC borehole included compact to dense, silty SAND (Glacial Till) with cobbles and boulders overlying granitic gneiss bedrock. Bedrock was encountered at a depth of approximately 2.8 m below ground surface.

Table 1 provides a stratigraphic summary of the thickness and elevation of each of the geologic units logged at the borehole location. In addition, the subsurface conditions described on the 1979 MTL borehole logs (BH1 to BH3 logs) are summarized in the table.

Details on the subsurface conditions encountered during the BGC investigation are provided in the subsections below, photographs provided in Appendix A and the borehole log included in Appendix B.

Table 1: Subsurface Stratigraphy Summary (BGC and MTL Records)

Borehole ID	Approx. Ground Surface El.[1] (m)	Rootmat Thickness (m)	Approx. Thickness of Overburden Material (m)	Approx. Bedrock Depth (m)	Approx. Bedrock El. (m)	Observed Groundwater El. (m)	Borehole Depth (m)
BH-BGC14-01	28.2	0.05	2.75	2.8	25.4	24.6	10.4
BH1	31.6	0.2	2.5	2.7	28.9	29.5	8.8
BH2	31.9	0.2	1.3	1.5	30.4	30.4	6.8
BH3	28.6	0.2	1	1.2	27.4	27.1	5

Notes:
1. Ground surface elevation at BGC borehole location based on an assumed benchmark elevation of 30.5 m at the existing NSCM located at the project site. It is inferred the MTL also used the same benchmark and elevation for determination of BH1 to BH3 ground surface elevations.

4.1. Ground Surface Cover

The ground cover at the borehole location consisted of an organic rootmat layer underlain by topsoil. The ground surface cover was approximately 50 mm thick.

4.2. Glacial Till

Glacial Till was encountered underlying the ground surface cover at the BGC borehole BH-BGC14-01. The Till consisted of light to greyish brown, poorly graded, SAND (fine and medium grained) with cobbles and boulders. Some gravel and trace silt were also observed within the Till. Photo 2 shows the Glacial Till.

The gravel particles collected in the split spoon apparatus were predominantly angular and sub-angular. Observations of shallow earth cuts, located near the project site, confirmed the presence of the sand Till with angular gravel, cobbles and boulders (See Photo 3).

SPTs were carried out to approximately 1.8 m below ground surface, where SPT refusal was encountered. The refusal was inferred as contact with cobbles or boulders. The SPT N-values recorded in the Glacial Till were 22 and 73. It is inferred that the SPT blow counts were elevated by the presence of the gravel, cobble and boulder content in the Till. Based on the SPT N-values and observations of the drilling performance, the Glacial Till is inferred to be a in a compact to dense state of relative density. The Till was observed in a moist condition.

Refusal with the solid stem auger was encountered at a depth of approximately 2.8 m below ground surface; this was inferred as contact with weathered bedrock. Based on sample return from the borehole (from split spoons and augering) and auger refusal met, the likely Till extends to approximately 2.8 m below ground surface at the BH-BGC14-01.

The MTL borehole logs (MTL, 1979) show that the overburden soil encountered was comprised of a medium dense, silty sand, cobbles and boulders, varying from 1.2 – 2.7 m thick. The MTL findings correlate well with BGC's observations of the soil, with the exception of boreholes BH2 and BH3 where the overburden was thinner at 1.3 m and 1 m thick, respectively.

4.3. Bedrock

Weathered bedrock was observed at a depth of 2.8 m (El. 24.6 m) below ground surface at borehole BH-BGC14-01. However, it can be reasonably inferred that the bedrock elevation is actually higher at this location. Borehole BH3 found bedrock at a depth 1.2 m (El. 27.4 m) and SPT refusal was encountered at a depth of 1.4 m and 1.8 m in BH-BGC14-01. Therefore, there is potential that augering carried out between the depths of 1.8 m and 2.8 in BH-BGC14-01 was performed through a zone of extremely weak, highly weathered bedrock.

For preparation of the geotechnical recommendations provided herein, BGC have interpreted the zone between 1.8 – 2.8 m depth as competent soil; this is considered conservative for the tower foundation and rock anchor design. Shallower bedrock was encountered in 2 of the 3 MTL boreholes (El. 27.4 m to 30.4 m)

Intact, weathered bedrock was encountered between depths of approximately 2.8 m to 3.2 m below ground surface at the borehole BH-BGC14-01 location (See Photo 4). The weathered bedrock consisted of grey, medium to coarse grained granitic gneiss.

Based on field observations, the estimated rock strength classification (Table 3.5 - CFEM, 2006) was determined to be weak (R2) and the weathering grade was determined as highly weathered (W4). Rock Quality Designation (RQD) values were measured and determined to vary from approximately 50 - 55%. RQD is calculated by dividing the aggregate of intact core segments greater than 100 mm in length by the total core recovery length.

More competent, granitic gneiss bedrock was encountered below the weathered bedrock zone at a depth of approximately 3.2 m (El. 25 m) below ground surface. The granitic gneiss bedrock was also medium to coarse grained, but was moderately to slightly weathered (W3 to W2). Between depths of 3.2 and 4.3 m (El. 25 m to El. 23.9 m) the bedrock RQD is approximately 55%.

A zone of highly fractured, extremely weak (R0) bedrock, surrounded by thin inclusions of more competent bedrock, was encountered between depths of approximately 4.5 m to 5.9 m (El. 23.7m to El. 22.3 m) (See Photo 5). The estimated percentage of highly fractured, R0 rock encountered is 50 – 60% of the total core recovered through the 1.4 m long zone. The bedrock RQD was approximately 10% through this zone of fractured rock.

Below a depth of 5.9 m (El. 22.3 m), the bedrock quality improves to good to very good, with RQD values ranging from 60% to 90% (the BGC borehole log shows a plot of RQD with depth). The bedrock core is shown in Photo 6.

The bedrock logging recorded two predominant joint sets plus one random joint set. The two predominant joint sets are dipping at approximately 30 degrees and 45 degrees to the core axis. The random jointing is dipping steeply at 0 to 20 degrees to the core axis.

Based on BGC's field observations, the estimated bedrock strength is medium strong to strong (R3 to R4). An unconfined compressive strength (UCS) carried out on a representative intact bedrock specimen (sampled between depths of approximately 6.85 m to 7.15 m) showed an UCS of approximately 74 MPa. This UCS result correlates to a rock strength of strong (R4). MTL reports that the "intact" bedrock recovered was moderately strong.

4.4. Groundwater

Upon completion of drilling, the groundwater level was measured at a depth of approximately 3.6 m (El. 24.6 m) below ground surface in the borehole. Following the measurement, the borehole was bailed "dry" and left to recharge for approximately 1 hour. After approximately 1 hour, the groundwater level was measured at a depth of approximately 4.5 m (El. 23.7 m). According the MTL logs, groundwater was measured at 1.5 m and 2.1 m below ground surface at boreholes BH1 and BH2, respectively.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

Based on the results from the site investigation and site data reported by MTL, a footing placed on undisturbed Till or Bedrock will be suitable foundation support at the centre of the proposed VHF tower. Resistance to tensile forces will be provided by guy wires with rock anchors installed into competent bedrock. The approximate layout of the proposed tower and guy supports are shown on Drawing 01.

As previously noted, BGC did not investigate the proposed foundation location. BGC understands that MTL recommended that the existing foundation be founded on bedrock, due to the shallow bedrock encountered during the MTL investigation. The 1979 design drawing (Drawing D-20-247, 1979) for the existing tower shows the foundation base was to be founded on either undisturbed soil or bedrock. Based on the subsurface data available to BGC and a recommended foundation burial depth of 1.5 m for frost protection, the new tower foundation could be founded on either undisturbed Glacial Till or weathered Bedrock.

The following sections provide geotechnical engineering recommendations for the design and construction of the tower foundation, and the guy wire anchor supports. The discussion, narrative and recommendations presented in this section are given for the guidance of the project's structural designer.

It is recommended that experienced geotechnical personnel be present to inspect the excavations for foundations, to verify the subgrade preparation, and to monitor the rock anchor installation including the drilling and grouting activities.

5.1. Foundation Subgrade Preparation

All rootmat, topsoil and any other deleterious materials should be removed to expose an undisturbed Glacial Till foundation subgrade. The Glacial Till observed on-site contains some cobbles and boulders up to 600 mm in size which are mainly angular in shape. There is potential that excavations will result in an irregular subgrade surface, due to the large, angular boulders found in the Till. To provide a level bearing surface and help protect the Till subgrade from deterioration due to wet conditions, it is recommended that a 300 mm thick layer of granular material be placed at the base of footing. The granular fill should meet NSTIR Type 2 specifications and be compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD). The Type 2 granular fill below footing level should extend a minimum 1 m beyond the footing perimeter.

For foundation(s) on Bedrock, subgrade preparation should include removal of surface water, soil, and loose or broken rock fragments from the bedrock surface. Bedrock surface irregularities should be filled and elevated to the foundation bearing grade with a "mud mat" consisting of lean concrete.

5.2. Foundation Design

It is important that the tower footing be provided with a minimum cover of 1.5 m for frost protection. The depth of burial conforms to recommendations provided in the Canadian Foundation Engineering Manual (CFEM, 2006). Geotechnical parameters assumed for the compacted foundation backfill material include a unit weight of 20 kN/m^3 and an angle of internal friction of 36 degrees.

BGC has conducted bearing capacity and settlement evaluations based on the findings of the site investigation. The subsurface data presented in the MTL 1979 report was used to support the BGC data in assigning geotechnical parameters for the evaluations. The measured SPT N-values (from the BGC borehole) were correlated with available empirical relationships (Terzaghi and Peck, 1967) to estimate the angle of internal friction of the overburden soil. Based on the relationship, a friction angle of 36 degrees was selected for use in bearing capacity and settlement evaluations. Engineering judgment was applied in assigning the parameters, particularly within the foundation's zone of load stress influence.

In accordance with CSA Standard S37-13 document, the geotechnical evaluations and development of foundation bearing resistance recommendations were completed using Ultimate Limit States (ULS) design. For completeness of this report, evaluations were also carried out in accordance with Serviceability Limit States (SLS).

5.2.1. Foundations on Soil

Footing(s) placed on undisturbed Glacial Till, or the prepared Type 2 granular fill subgrade (Section 5.1), can be designed for a SLS of 200 kPa and a ULS of 550 kPa. The ULS bearing capacity has taken into an account a bearing resistance factor of 0.5 (ULS). These soil bearing resistances are a function of footing width and are limited to a maximum footing size of 3 m.

The total and differential settlement associated with the SLS bearing resistance should be less than 25 mm and 19 mm, respectively. The majority of this settlement is elastic and should occur immediately with the application of the load. The expected long term settlement will be minimal due to the cohesionless nature of the encountered subgrade materials and depths to bedrock.

5.2.2. Foundations on Bedrock

Footing(s) placed on bedrock or the prepared "mud mat" (Section 5.1), can be designed for a ULS of 2100 kPa and 2700 kPa for a 1 m and 2 m wide footing, respectively. The SLS of footings placed on bedrock is 700 kPa,

5.2.3. Drainage and Backfill

It is recommended that surface water be directed away from foundation locations. This can be conducted by intercepting surface water through construction of drainage swales up-gradient of the foundation locations, and directing water away from the site. This can also be conducted by grading the site, such that surface water is shed away from foundation locations.

The foundation backfill material should consist of a free draining, granular material with particle sizes less than 75 mm such as NSTIR Type 2 fill. The granular material should be in 300 mm thick lifts and be compacted to a minimum 95% of the 100% of the SPMDD.

5.3. Rock Anchor Design Recommendations

Tensile forces developed from over-turning and uplift will be resisted by the guy wires with rock anchor supports. BGC understands that rock anchors were installed for the existing tower (Drawing D-20-247, 1979). Drawing D-20-247 shows that the design included a combination of vertical mechanical rock anchors (Williams type) and grouted anchors.

At this time, BGC have limited information on the loading and type of anchor that will be used for the project. BGC have assumed that pre-tensioned grouted rock anchors will be designed for this project.

5.3.1. Rock Anchor Embedment

Based on BGC's findings of borehole, BH-BGC14-01, poor quality bedrock was encountered between depths of approximately 2.8 m (i.e., inferred bedrock surface) and 5.9 m below ground surface. Similar bedrock conditions were reported by MTL (MTL, 1979), where the upper 1.5 – 2 m of the bedrock stratum was highly fractured with RQD values of 20 – 40%. Below 5.9 m depth in the BGC borehole, the bedrock quality improved with RQD values ranging from 60 - 90%.

Based on the available subsurface data, the upper bedrock stratum is fragmented with inclusions of weak, and extremely weathered bedrock. Therefore, is not considered to be a satisfactory zone for development of grout/bedrock bond. BGC recommends that these highly fractured, upper bedrock zones be penetrated during drilling to reach a "competent" rock mass level at all anchor locations, where the anchor bond zone should be started. This will involve penetration of approximately 3.1 m of fractured rock at the proposed anchor site (adjacent to BH-BGC14-01) and an estimated 1.5 – 2 m at the other two (2) proposed anchor locations. The bond zone should be started at a depth of 6 m below ground surface at the anchor locations.

BGC recommends that geotechnical engineering personnel be present to observe the rate of drilling of the anchor hole and perceived quality of the bedrock and to confirm the design embedment depth and our overall understanding of the geologic conditions.

5.3.2. Rock Grout Bond Strength

Design guidelines for the establishment of working grout/bedrock bond stress for anchors have been prepared by Littlejohn and Bruce (1977) and by Wyllie (1992). Littlejohn and Bruce indicates that the ultimate bond stress can be taken as 10% of the UCS of bedrock test specimens from zones of 100% bedrock core recovery in competent bedrock. Core recovery from the BGC borehole varied from 80 – 100% below depth 5.9 m. Similar core recovery was noted on the MTL borehole logs throughout the borehole depth.

Based on BGC's field observations and laboratory strength testing, the estimated bedrock strength is medium strong to strong. UCS values of 25 - 100 MPa would typically be achieved in laboratory testing of intact rock specimens of medium strong to strong bedrock (R3 to R4). The bedrock strength test conducted showed a UCS of 74 MPa.

As noted above, the ultimate bond stress in competent rock can be determined from Littlejohn and Bruce based on UCS test results on specimens sampled from 100% core recovery. Full (100%) bedrock core recovery throughout the entire borehole depth was not achieved below competent rock mass level in any of the boreholes discussed herein. However, BGC considers the use of Littlejohn and Bruce design criteria as an acceptable approach for computing the bond stress, provided the lowest estimated bedrock strength of medium strong (i.e. UCS of approximately 25 – 30 MPa) is applied. Accordingly, an ultimate bond stress of 3.0 MPa could be utilized in the rock anchor design. Applying a factor of safety of 3 to the ultimate bond value yields a recommended working (allowable) bond stress of 1.0 MPa.

BGC recommends a minimum compressive strength of the grout mix of 35 MPa at 28 days which is compatible with the anticipated minimum bedrock compressive strength of medium strong (typical range of UCS 25 – 50 MPa.).

5.3.3. Uplift Capacity

The capacity of an anchor in tension depends upon the combined weight of the rock in the cone and the rock strength along the surface of the cone. Methods developed by Wyllie (1992) is suggested for the anchor uplift capacity computations.

The cone of influence surrounding the group of anchors originates at the base of the anchors and extends to the bedrock surface at approximately 40 degrees (estimated for good quality rock). Therefore, there is significant overlap of influence for the individual rock anchors. A bedrock unit weight of 15 kN/m^3 can be used for computing the uplift capacities.

To minimize excessive stress that could fracture rock around the anchors, it is common practice to achieve minimum spacing between the anchors. A commonly used criterion for determining the minimum spacing required between anchors is the lesser of 3 times of the diameter of the bond zone or 1.2 m (Wyllie, 1992).

Rock anchors should be installed in a vertical orientation due to the unfavorable bedrock jointing (joints at 30 – 45 degrees) for potential pullout of the "cone of influence".

5.3.4. Bedrock Resistivity

BGC submitted a bedrock sample (collected from 6.85 – 7.15 m depth) from BH-BGC14-01 to RPC (of Fredericton, NB) to carry out a pH level and Sulfate concentration testing. The testing was performed to assess the corrosion potential of the bedrock on the rock anchors.

The testing yielded a pH of 9.3 and Sulfate concentration of less than 10 mg/Kg (i.e., <10 PPM). According to the FHWA NHI-09-087 (U.S. Federal Highway Department), Table 2-4, maximum permissible levels of soluble salts (e.g., sulfates) have been established in AASHTO

Bridge Construction Specifications for metallic reinforcements in soil. According, the AASHTO specification, the maximum permissible level of Sulfate is 200 PPM; therefore, there is very low potential that bedrock at the proposed site will have corrosive impact on the anchors.

6.0 CLOSURE

We trust that this report meets your current requirements. Please do not hesitate to contact the undersigned at (902) 474-5925 if you require additional information.

Yours sincerely,

BGC ENGINEERING INC.
per:

ISSUED AS DIGITAL DOCUMENT. SIGNED HARDCOPY ON FILE WITH BGC ENGINEERING INC.

Robert Cholock, P.Eng.
Project Engineer

ISSUED AS DIGITAL DOCUMENT. SIGNED HARDCOPY ON FILE WITH BGC ENGINEERING INC.

Scott Munro, M.Sc.E., P.Eng.
Senior Geotechnical Engineer

Reviewed by:

Edward Carey, P.Eng.
Senior Geotechnical Engineer

RC/EC/gc/md

Attach:
Drawing 1 – Geotechnical Site Plan
Appendix B: Photographs
Appendix C: Borehole Log
Appendix D: Laboratory Testing

LIMITATIONS OF REPORT

BGC Engineering Inc. (BGC) has prepared this document for the account of the Department of Fisheries and Oceans, Canadian Coast Guard. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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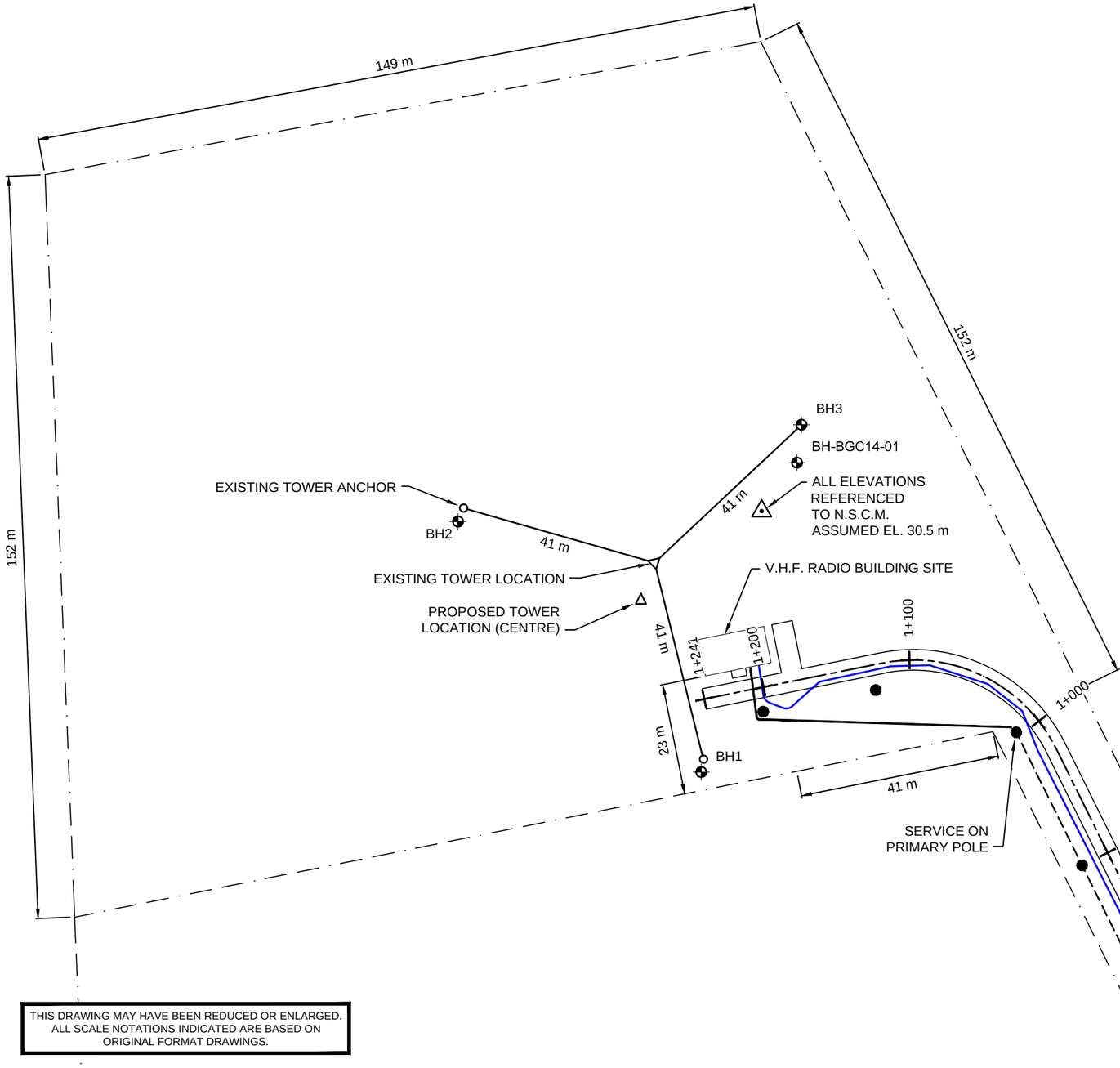
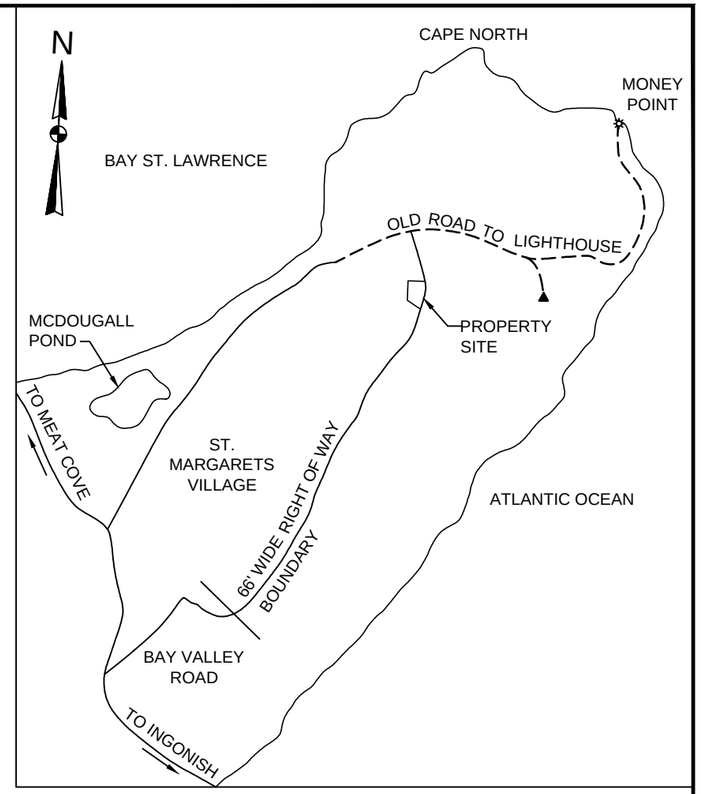
DRAWINGS





SCALE 1:1,000

10 0 10 20 30

METRES

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

LEGEND

BGC BOREHOLE

NOTES:

1. ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE NOTED.
2. THIS DRAWING MUST BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED "GEOTECHNICAL INVESTIGATION - REPLACEMENT VHF TOWER, CAPE NORTH, NS, DEPARTMENT OF FISHERIES AND OCEANS, CANADIAN COAST GUARD," AND DATED OCTOBER ??, 2014.
3. ~~BASE TOPOGRAPHIC DATA BASED ON ____ PROVIDED BY ___, DATED ___. CONTOUR INTERVAL IS __ ft.~~
4. ~~PROJECTION IS ___.~~
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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: DFO, CCG

PROJECT: GEOTECHNICAL INVESTIGATION - REPLACEMENT VHF TOWER, CAPE NORTH, NS

TITLE: GEOTECHNICAL SITE PLAN

PROJECT No.: 0444-009

DWG No.: 01

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APPENDIX A
SITE PHOTOGRAPHS

Photo 1: Shows the drill-rig setup at borehole BH-BGC14-01.

Photo 2: Shows the Glacial Till sampled from depth of 1.22 – 1.53 m below ground surface. Poor recovery apparent in split spoon apparatus.

Photo 3: Shows earth-cut, with angular gravel, cobble and boulder particles at surface.

Photo 4: Shows zone of weathered bedrock.

Photo 5: The core to 5.8 m depth is shown.

Photo 6: Shows the core retrieved in the borehole from approx. 2.8 m to 10.4 m depth. The borehole depth of 5.9 m is indicated by the Red Arrow on Photo.

APPENDIX B
BOREHOLE LOG

Project: Replacement VHF Tower

DRILL HOLE # BH-BGC14-01

Location: Cape North, NS

Project No.: 0444009

Survey Method: Handheld GPS
Coordinates (m): 695,491.E, 5,209,594.N
Ground Elevation (m): 28.2
Datum: NAD83, Zone 20
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: CME55
Drilling Contractor: Lantech Drilling Services
Drill Method: Auger and Core
Core: NQ
Fluid: Water
Casing: 89 mm ***Cased To (m):*** 2.89

Start Date: 05 Oct 14
Finish Date: 05 Oct 14
Final Depth of Hole (m): 10.4
Depth to Top of Rock (m): 2.80
Logged by: JAC
Reviewed by: RC/SM

Depth (m)	Sample Type	Sample No.	Symbol	Lithological Description	Instrument Details	SPT Blows Per 150mm	Su (kPa) 50 100 150 200 / SPT (Blows/300mm) / Moisture Content & SPT N W_P% W% W_L% 20 40 60 80	Recovery %	Lab Tests and Comments	Elevation (m)
0				TOPSOIL 0.0 - 0.05 m Grass, rootmat.						28
		SPT1		SAND (SP) 0.05 - 2.80 m Fine to medium, some gravel, some cobbles and boulders, trace silt, poorly graded, compact to dense, subangular to angular, maximum particle size recovered in split spoon 35 mm, light to greyish brown, moist. [GLACIAL TILL]		6 7 15 46	●	49%		
1		SPT2				56 29 44 50	●	33%		27
		SPT3				17 R	>>●	74%		
		SPT4				26 R	>>●	16%		
2										26
3				Rock Encountered At 2.8m See BH-BGC14-01 Rock log						25
4										24
5										23
6										22
7										21
8										20
9										19
10										

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Client: DFO

Print Date: 12/3/2014

Su Symbol
◇ VANE(PEAK)
◆ VANE(RES.)
□ UCS/2
△ PP/2

NS NEW (SOIL) DFO.GDL BGC.GDT 12/3/14

All noted depths are in metres along hole.

Project: Replacement VHF Tower

DRILL HOLE # BH-BGC14-01

Location: Cape North, NS

Project No.: 0444009

Survey Method: Handheld GPS
Coordinates (m): 695,491.E, 5,209,594.N
Ground Elevation (m): 28.2
Datum: NAD83, Zone 20
Dip (degrees from horizontal): -90
Direction: n/a

Drill Designation: CME55
Drilling Contractor: Lantech Drilling Services
Drill Method: Auger and Core
Core: NQ
Fluid: Water
Casing: 89 mm **Cased To (m):** 2.89

Start Date: 05 Oct 14
Finish Date: 05 Oct 14
Final Depth of Hole (m): 10.4
Depth to Top of Rock (m): 2.80
Logged by: JAC
Reviewed by: RC/SM

Depth (m)	Sample Type	Sample No.	Symbol	Core Description	Instrument Details	Core Recovery % / RQD %	Weathering Grade	Lab Tests MPA / Strength Grade (R)	Elevation (m)
				0 to 2.80 m - See BH-BGC14-01 soil log.		20 40 60 80	1 2 3 4	50 100 150 200 250 / R1 R2 R3 R4 R5	
3		SPT5		GRANITIC GNEISS 2.80 - 3.20 m Grey, medium and coarse grained, weak (R2), highly weathered (W4). [WEATHERED BEDROCK] Between 2.80 to 3.20 m: Gravel recovered from core barrel. Iron staining on gravel particles.					25
		C1		GRANITIC GNEISS 3.20 - 10.36 m Grey, medium and coarse grained, medium strong to strong (R3-R4), moderately to slightly weathered (W3-W2), 2 joint sets plus random: 1 joint set at ~30 degrees to core axis, 1 joint set at ~45 degrees to core axis and random joint set at ~0-20 degrees to core axis, close spacing. [BEDROCK]					
4									24
5		C2		Between 3.20 to 5.80 m: Highly fractured. Below 3.25 m: Slight discoloration on joints, light grey to orangish brown. Between 4.53 to 5.50 m: Extremely weak (R0) bedrock surrounded by inclusions of medium strong (R3) bedrock. Percentage of extremely weak rock is estimated to be approximately 55% of core recovered between 4.26 and 5.80 m depth. Between 5.80 to 5.90 m: Suspected sand infill (inferred based on drill action). Gravel size rock pieces recovered from core barrel.					23
6		C3							22
7		C4		Between 6.85 to 7.15 m: Bedrock color is mottled grey, orange and white.			>>		21
8		C5							20
9				Between 8.75 to 8.90 m: Two fractures ~0-20 degrees to core axis. Below 8.83 m: Discontinuities transitioning from close to moderate spacing.					19
		C6							
10				Between 9.93 to 10.13 m: Vertical fracture approximately 0 degrees to core axis.					18
11				END OF DRILL HOLE AT 10.36 m Notes: 1. Borehole ended at 10.36 m, target depth achieved. 2. Recovery percentage of sample inferred to have been influenced by presence of gravel, cobbles and boulders. 3. SPT N-values may not be representative of actual in-situ density due to presence of gravel, cobbles and boulders. 4. Borehole grouted to surface with bentonite grout/cement mixture. 5. Water level at completion of drilling 3.65 m depth (El. 24.55 m). Bailed drill water and left to recover for 1 hour, water level at 4.54 m (El. 23.66 m) and rising.					17
12									16

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: DFO

Print Date: 12/3/2014

Symbol
UCS •
Triaxial σ_3 σ_1

NS NEW (ROCK) DFO.GDL BGC.GDT 12/3/14

All noted depths are in metres along hole.

APPENDIX C
LABORATORY REPORT

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

515 Beaverbrook
Fredericton, NB Canada E3B 1X6
Telephone (506) 460-8660
Fax (506) 460-8679

October 29, 2014
Project No.: 0444-009-01

Mr. Robert Cholock, P.Eng
BGC Engineering

Dear Mr. Cholock,

Re: Unconfined Compressive Strength Test Results

On October 5, 2014, one (1) borehole BH BGC14-01 was drilled at the Cape North VHF Tower Replacement project site. From this borehole, a rock core sample was recovered and were sent to BGC's soil and rock laboratory for Unconfined Compressive Strength (UCS) testing.

The rock core sampled from depth 6.85-7.15 m was tested on October 21, 2014 using BGC's compression frame – Accutek 250 Digital Compression Machine at a stress rate of 0.5 MPa/s.

A summary of the result is presented in Table 1 and photographs taken before and after test follow.

TABLE 1. SUMMARY OF TEST RESULTS

Borehole	Depth (m)	Rock Type	Test Performed	Density (g/cm^3)	Load at Failure (kN)	UCS (MPa)	Strength Classification
BH-BGC14-01	6.85 to 7.15	Granitic Gneiss	UCS	2.64	131.4	73.82	Strong Rock

Photo 1 – Sampled 6.85 to 7.15m, before

Photo 2 – Sampled 6.85 to 7.15m, after

Yours sincerely,

BGC ENGINEERING INC.
per:

David Oldford, P.Eng.
Geotechnical Engineer

GEOTECHNICAL
SITE INVESTIGATION

CAPE NORTH

PROPOSED TOWER SITE

Report

Submitted to

The Canadian Coast Guard

Dartmouth, N.S.

By

Maritime Testing Limited

Halifax, Nova Scotia

S1601

September 5, 1979

TABLE OF CONTENTS

REPORT

1. INTRODUCTION

Maritime Testing Limited was retained in July, 1979 by Canadian Coast Guard, Dartmouth, Nova Scotia to carry out additional geotechnical site investigation at the planned location of a tower at Cape North, Nova Scotia.

The purpose of the investigation was to determine the geotechnical conditions underlying a tower site, including design parameters for the soils and rocks, in order to facilitate the safe and economical design of a foundation and anchors for a proposed 200 foot high tower.

Previous geotechnical work was carried out at the site in June 1977 and covered in a report (Ref S1179), submitted by Maritime Testing Limited on June 9, 1977.

II. SITE LOCATION

The site is located in the Cape Breton Highlands about 2.5 miles northeast of St. Margaret's Village or 2.0 miles southwest of Morrey Point and the navigation height there is as shown in Figure 4. The site is also located aobut .2 miles northeast of the Village of Cape North. Site access is gained by the CNR right of way to a VHF tower nearby. The Military Grid Reference for the site can be taken as about 956094.

III. TOPOGRAPHY AND GEOLOGY OF THE SITE AND SURROUNDING AREA

The Cape Breton Highlands consists typically of mountain peaks, sheer cliffs and level plateaus. The tower site is located on one of the plateau areas at an approximate (interpolated) elevation of 1350 feet.

Bedrock consists of granite and allied granitic rocks belonging to the lower or middle Devonian group. The Bedrock is overlain by a thin mantle of till and boulders.

IV. SITE INVESTIGATION

A) Field Work

Three (3) boreholes were put down during the period of July 23 to July 25, 1979, near the location of the proposed anchors.

The locations of the boreholes are shown in Figure 5. Field operations were conducted from survey markers placed by others. Elevations of the boreholes were taken from a plan provided by Canadian Coast Guard, drawing number D-20-247.

The boreholes ranged in depth from 16.5 feet to 29.0 feet. Due to an inadequate water supply for drilling located at the site, water was hauled by truck from a nearby pond. The holes were drilled using a bombardier mounted, power driven, four (4) inch diameter, solid stem flight auger and B.Q. size (nominal 1½" diameter core) double tube, core barrel and diamond drill.

The amount of core recovered was recorded as a percentage of the core run.

The Rock Quality Designation (R.Q.D.) was calculated. R.Q.D. is defined as the total length of the various pieces of sound core four (4) inches and greater in length expressed as a percentage of the core run. In the core recovered the number of fractures was noted and expressed as a fracture frequency per foot. The fracture frequency indicated on the logs is only applicable to core recovered.

V. GEOTECHNICAL CONITIONS

General Soil Succession

The comments made below relate specifically to the conditions encountered during the present investigation. This section should be read in conjunction with our report MTL Report S1179 on the initial investigation carried out at the same site in June 1977.

The boreholes drilled in the present study revealed the following general conditions:

A) Root Cover

The root cover overlying the proposed tower site is shallow with a thickness of about 0.5 feet.

B) Medium Dense Silty Sand and Cobbles

Underlying the root cover is a medium dense, brown silty sand, cobbles and boulders. This material had a thickness of 8.9 feet, 4.8 feet and 3.8 feet in Boreholes 1,2, and 3 respectively.

C. Bedrock

Bedrock was encountered in the three test locations at depths of 8.9 feet, 4.8 feet and 3.8 feet.

The bedrock consists of granitic gneiss and other allied granitic rocks.

In Boreholes 1 and 2 at depths greater than 20 feet and 12 feet respectively, fracturing was limited to a minimum of about 4 fractures per foot, based on core recovery. All unrecovered core is assumed to be highly fractured and of low strength characteristics.

In all three boreholes frequent fragmented rock zones were encountered, Figures 1, 2 and 3. The fractured rock zones averaged 1 foot in thickness.

As can be noted on the borehole logs the R.Q.D. showed an increase with depth from values as low as 0 to in excess of 50. This increase in R.Q.D. to a value of at least 50 would indicate the rock to be fair, blocky and seamy.

In general the intack rock core could be considered moderately strong with the exception of Borehole 3. In Borehole 3 from the five (5) foot depth to the ten (10) foot depth the rock could be easily crushed by hand pressure, indicative of a weak strength rock, Table 1.

Occasional clayey silt seams were encountered in all three boreholes in the order of 1/2 inch in thickness.

In Borehole 2, a 6" thick claysilt seam was encountered at the 5.5 foot depth. These clayey silt seams produced an increased drill rate and accompanying discolored wash return.

The rock core showed jointing dipping at 45°.

The insitu weight of the rock can be taken as 150 pounds per cubic foot with a submerged unit weight of about 90 pounds per cubic foot.

D. Groundwater Conditions

In Boreholes 1 and 2 the groundwater table was observed to be located at seven (7) feet and five (5) feet respectively below top of ground, while field work was in progress. A standpipe was installed in Borehole 2 for future water level monitoring. Groundwater levels can be expected to vary throughtout the year. The depth to the groundwater level should be measured periodically.

VI. FOUNDATION DESIGN AND CONSTRUCTION CONSIDERATION:

It is our understanding that the proposed tower at the site will consist of three (3) tower anchors and a tower of about 200 feet in height, as shown on a drawing provided by the Canadain Coast Guard. (Drawing Number D-20-247)

A) Bearing Pressure at Tower Base

Due to the shallow depth of bedrock experienced during this site investigation and in an earlier site investigation we would recommend the tower base be founded on bedrock. Any surface irregularties in the bedrock should be satisfactorly brought up to grade by use of

for 1/10" – 20 ksf.

a lean concrete mix for backfill purposes for under slab support.

An allowable net bearing pressure of 12 kips per square foot founded on sound rock would experience settlement in the order of less than 1/50 inch.

WHAT IF 1/10" ACCEPTABLE?

A 7' x 7' concrete base founded on rock would support a base load of about 600 kips, and experience negligible settlement.

All footings should have a minimum frost protection cover of not less than 4.0 feet.

B. ROCK ANCHORS

1. The following comments are confined to a consideration of failure within the rock mass and failure of the rock/grout bond.

The cone approach or weight of rock method of design is recommended for the Cape North Site. Because of the broken, jointed and fragmented rock quality the shear strength of the rock mass is difficult to predict and should be ignored. However, a conservative approach for the shear strength of the rock mass could be to equate the rock mass to a very dense gravel layer with an angle of internal friction of 30 degrees. A contribution to uplift resistance will come from this source but the magnitude is difficult to predict.

2. Stability of the Rock Mass

If the magnitude of all the anchor loads is known precisely i.e., extreme winds and ice build ups, that have been experienced at nearby tower installations, we would suggest a safety factor of about two (2) be used.

The included angle at the apex of the cone should be taken as 90^{o} with the position of the apex no deeper than the middle of the fixed anchor in rock.

If commericially produced rock bolt anchors are used with an expandable collar located at the distal end of the anchor, the included angle at the apex of the cone should be taken as 60^{o} with the position of the apex located at the expandable collar. A safety factor no less than 2.5 should be employed for use with the expandable collar type anchor. We recommend the use of an expandable grout to surround the rock bolt.

If more than one anchor is used the position of the fixed anchor length must be considered to prevent excessive fixed anchor movement along any one plane.

Although there does not appear to be a definite set of horizontal discontinuities along which laminar failure could occur, the degree of fracturing and jointing of the rock suggests a conservative approach for the design of rock anchors .

3. Rock/Grout Bond

The E anchor/ E rock ratio would be in the order of one (1) for the rock mass underlying the Cape North site, indicating a definite non-uniform distribution of bond.

However, numerous studies indicate that a working rock/grout bond of about 145 psi can be adopted satisfactorily.

4. Fixed Anchor Length

We would suggest a minimal fixed anchor length in the rock of 10 feet, but with the actual length above the minimum depending on dead and line loading conditions.

For shorter anchors any sudden drop in rock quality along the anchorage zone and/or construction errors or inefficiencies could induce a serious decrease in the anchors capacity.

Due to the near 45^{o} jointing exhibited by the rock we would suggest that anchors are installed in vertical or near vertical positions.

We would also suggest pull out tests be performed on at least one anchor. A candidate for the test could possibly be an anchor receiving loading conditions as a result of winter prevailing winds.

If we can be of any further assistance please do not hesitate to call us at your convenience.

Respectfully Submitted,

MARITIME TESTING LIMITED

Paul Amarandos, P. Eng.

ERic Jorden, M.Sc., P. Eng.

APPENDIX

Borehole Logs

BOREHOLE LOG

Drilling Method	Logged By	Scale	Ground Level	HOLE NO.
4" Diameter Flight Auger Diamond Drill	P.M.A.	1"=5'	103.49' Datum Plan	1

Machine	Core Barrel & Bit	SITE
Bombardier Mounted Model CME55 drill	B.Q.	Cape North, Cape Breton, Nova Scotia

% Recovery	Drilling & Casing Progress	RQD	Fractures per Foot	Ground Water	Sample Type	Condition	Pen. Resist	DESCRIPTION OF STRATA (level/depth)	Graphic Log
								ROOT COVER 103.0'/0.5'	
	7/23 /79			7/26 /79	A C		5	MEDIUM DENSE, BROWN SILTY SAND and cobbles and boulders 94.6'/8.9'	
95	Core Run				C		10	BEDROCK:	
66	Core Run			Sand	C		13 15	Granitic gneiss and other allied granitic rock. Moderately fractured. Fragmented zones at depths 8.9', 13', 16', 17', 19', 21', and 28'. Six (6) inches of sand encountered at about the 13 foot depth Occasional silt-clay seams not exceeding 1/2 inch in thickness encountered at 21' and 27' depth. Rock joints dipping at about 45°.	
100	Core Run				C				
85	Core Run				C		20		
100	Core Run				C				
100	Core Run				C		25	74.5'/29'	
							30	Bottom of Borehole	

MARITIME TESTING LIMITED
Consulting Geotechnical Engineers Materials Testing Laboratories

CLIENT	Project	Figure
Canadian Coast Guard Dartmouth, Nova Scotia	S1601	1

BOREHOLE LOG

Drilling Method	Logged By	Scale	Ground Level	HOLE NO.
4" Diameter Flight Auger Diamond Drill	P.M.A.	1"=5'	104.63' Datum Plan	2

Machine	Core Barrel & Bit	SITE
Bombardier Mounted Model CME55 drill	B.Q.	Cape North, Cape Breton Nova Scotia

% Recovery	Drilling & Casing Progress	RQD 40 80 / 20 60	Fractures per Foot	Ground Water	Sample Type	Condition	Pen. Resist	DESCRIPTION OF STRATA (level/depth)	Graphic Log
	7/24 /79				A			ROOT COVER 104.1'/0.5' MEDIUM DENSE SILTY SAND and cobbles and boulders 99.8'/4.8'	
90	Core Run				C			BEDROCK: Granitic gneiss and other allied granitic rock. Moderately fractured. Fragmented zones at depths 5', 8', 10'. A six (6) inch thick silt-clay seam was encountered at the 5.5 foot depth. Rock joints dipping about 45°.	
94	Core Run				C				
98	Core Run				C				
98	Core Run				C				
95	Core Run				C			82.2'/22.4'	
								Bottom of Borehole	

5 silty clay seam

MARITIME TESTING LIMITED Consulting Geotechnical Engineers Materials Testing Laboratories	CLIENT Canadain Coast Guard Dartmouth, Nova Scotia	Project S1601 Figure 2

BOREHOLE LOG

Drilling Method	Logged By	Scale	Ground Level	HOLE NO.
4" Diameter Flight Auger Daimond Drill	P.M.A.	1'=5'	93.66' Datum Plan	3

Machine	Core Barrel & Bit	SITE
Bombardier Mounted Model CME55 drill	B.Q.	Cape North, Cape Breton, Nova Scotia

% Recovery	Drilling & Casing Progress	RQD 20 40 60 80	Fractures per Foot	Ground Water	Sample Type	Condition	Pen. Resist	DESCRIPTION OF STRATA level/depth	Graphic Log
	7/25 /79				A			ROOT COVER 93.1'/0.5' MEDIUM DENSE SILTY SAND with cobbles and boulders 89.9'/3.8'	
90	Core Run				C			5 BEDROCK: Granitic gneiss and other allied granitic rock. Moderatley fractured. Fragmented zones at depths 5.5' and 10.5', 16.0'. From 5' to 10' rock core can be easily crushed by hand pressure. Rock joints dipping at about 45°.	
83	Core Run				C				
100	Core Run				C			10	
100	Core Run				C				
100	Core Run				C			15 77.1'/16.5'	
								Bottom of Borehole 20 25	

MARITIME TESTING LIMITED Consulting Geotechnical Engineers Materials Testing Laboratories	CLIENT Canadian Coast Guard Dartmouth, Noya Scotia	Project S1601 Figure 3

Explanation of Terms
&
Symbols

EXPLANATION OF TERMS AND SYMBOLS

These pages present an explanation of the terms and symbols used on the log sheet entitled "Summary of Sampling and Laboratory Tests". The materials, boundaries, and conditions have been established only at the test hole locations and could differ elsewhere on the site.

WATER CONTENT AND ATTERBERG LIMITS

The natural moisture or water content of the soil at the time of drilling is plotted against depth, together with the plastic and liquid limits whenever determined in the laboratory. All water contents are expressed in terms of percentage of dry weight. The abbreviations and graphic symbols are defined as follows:

⊙	w	natural moisture content
⊡	w_P	plastic limit (ASTM, D424)
△	w_L	liquid limit (ASTM, D423)
	NP	non plastic soil
——→		seepage
——▼		observed water level

DEPTH

This column refers to the depth below the surface. The corresponding elevations are sometimes shown with respect to the datum given.

SOIL DESCRIPTION

Soils of different engineering classification are commonly grouped generically for ease of reference. Seepage and the water level are indicated beside the graphical representation using those symbols defined under "Water Content".

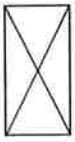
SOIL PROFILE

Soil types are designated by a modified version of the Unified Soil Classification System ("The Unified Soil Classification System", Technical Memorandum No. 3-357, Vol. 1, 1953, the Waterways Research Station, U.S.A.). Page 3 of this appendix defines these terms and symbols. Letters appearing in parentheses denote visual identifications which have not been verified in the laboratory.

SOIL SAMPLES

CONDITION — This column indicates the depth and the condition of each sample attempted.

 undisturbed

 disturbed

 not recovered or not retained

TYPE — The type of sample is indicated in this column as follows:

A auger sample
B block sample
C rock core
D drive sample
P Pitcher tube sample
U thin walled tube sample
W wash or air return sample
O other (see text)

PENETRATION RESISTANCE — Unless otherwise noted this column refers to the number of blows (N) of a 140 pound hammer dropping 30 inches required to drive a 2 inch O.D. open end sampler a distance of one foot from 0.5 to 1.5 feet into the soil. This is the standard penetration test referred to in ASTM, D1586.

RECOVERY — This column states the proportion in percent of the sampled length that was recovered. If nothing is shown the amount of recovery was not measured.

OTHER TESTS

In this column are tabulated results of all other laboratory tests as indicated by the following symbols:

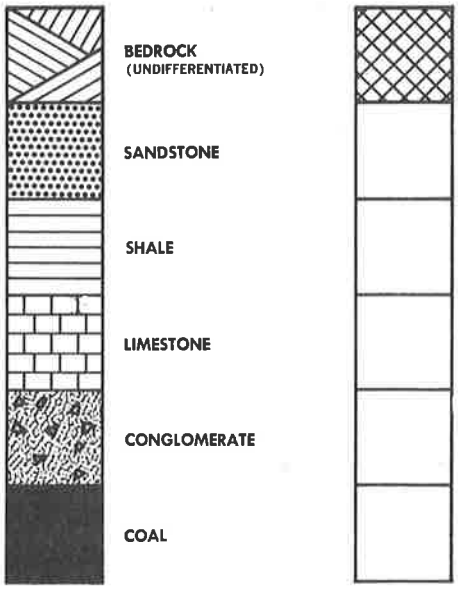
*	C	Consolidation test
	Fines	Fraction washing past #200 sieve
	G	Specific gravity
	k	Permeability coefficient
*	MA	Mechanical grain size analysis
	pp	Pocket penetrometer strength — tsf
*	q	Triaxial compression test
	qu	Unconfined compressive strength
*	SB	Shearbox test
	SO_4	Concentration of soluble sulphates
*	ST	Swelling test
	VS	Vane shear strength (undisturbed-remolded)
	ε_f	Unit strain at failure
	γ	Unit weight of soil (bulk density) — pcf
	γ_d	Unit dry weight of soil — pcf

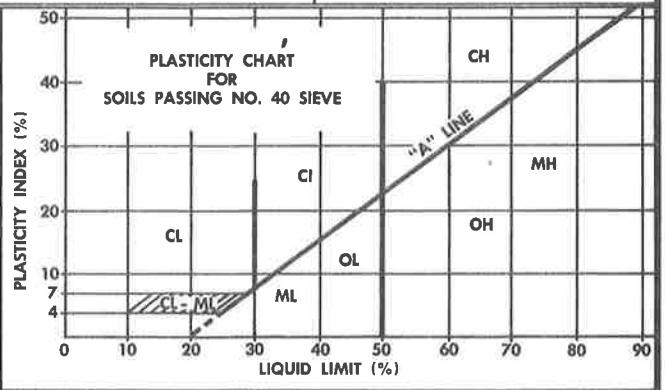
* These tests are usually summarized separately.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP		RED	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP		RED	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)	
		$W_L > 50\%$	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50\%$	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	

SPECIAL SYMBOLS

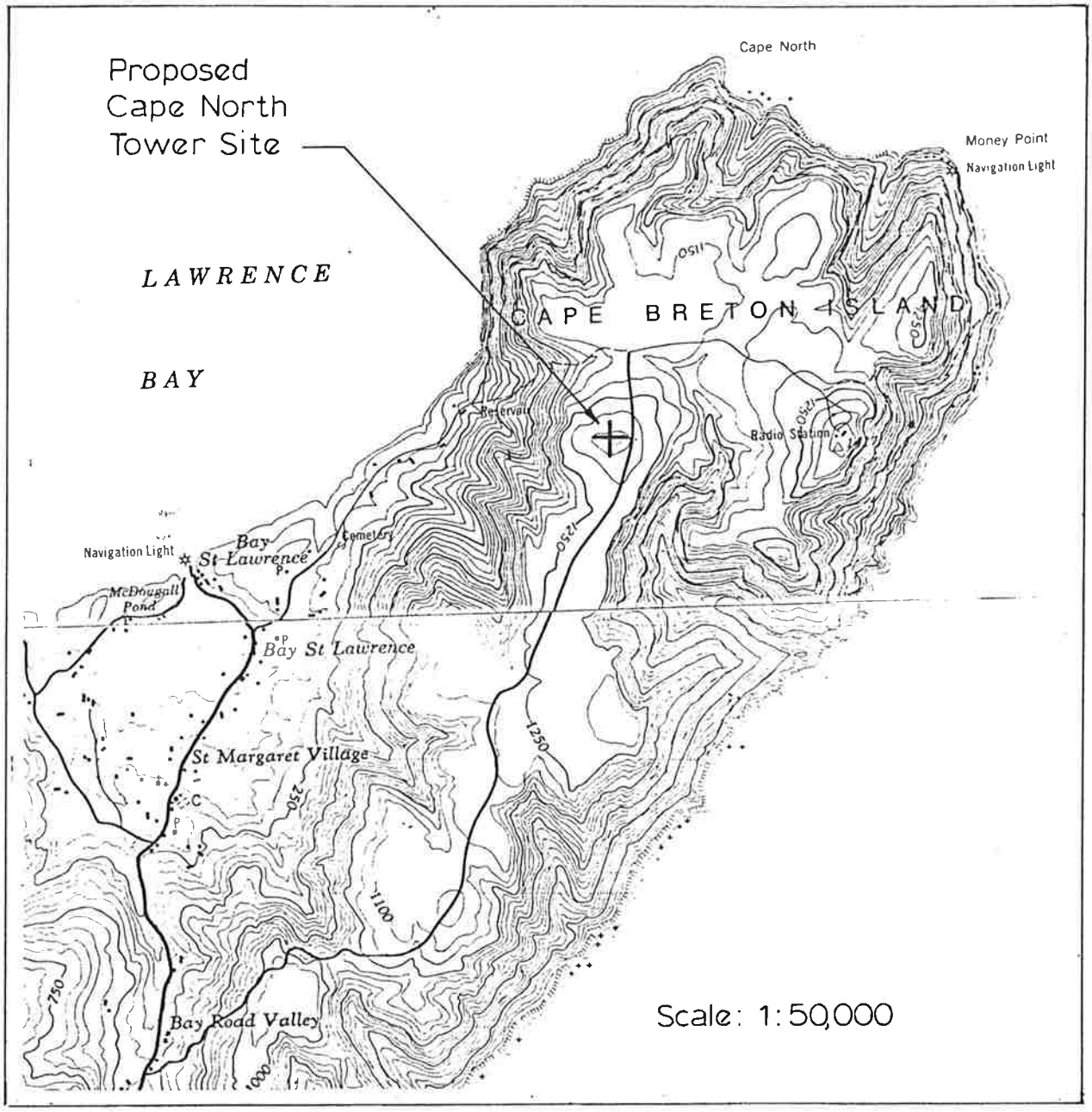




1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
2. BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.

Maritime Testing Limited

Site Location



KEY PLAN

SITE INVESTIGATION
CANADIAN COAST GUARD
PROPOSED CAPE NORTH TOWER SITE
CAPE NORTH, NOVA SCOTIA

Maritime Testing Limited
Halifax Nova Scotia

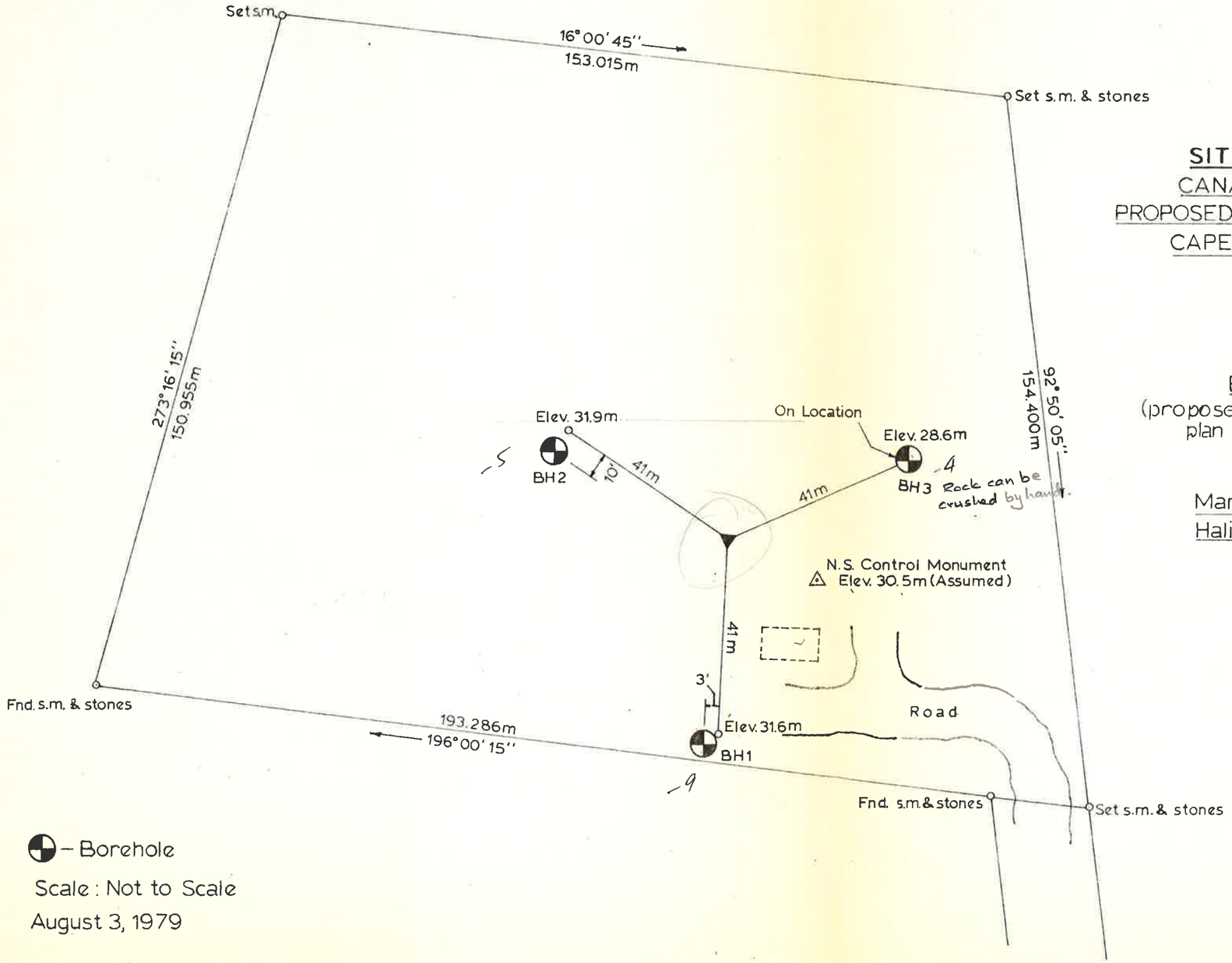
August 6, 1979
S1601

Figure: **4**

TABLE I

A SCALE OF STRENGTH, BASED ON UNIAXIAL COMPRESSIVE TESTS

Strength MN/m^2 ($1MN/m^2 = 146\ lb/in^2$)	lb/in^2	Term
$\lhd$ 1.25	$\lhd$ 182.5	very weak
1.25 to 5	182.5 to 730	weak
5 to 12.5	730 to 1825	moderately weak
12.5 to 50	1825 to 7300	moderatley strong
50 to 100	7300 to 14600	strong
100 to 200	14600 to 29200	very strong
$\rhd$ 200	$\rhd$ 29200	extremely strong



⊕ – Borehole

Scale : Not to Scale

August 3, 1979

SITE INVESTIGATION

CANADIAN COAST GUARD

PROPOSED CAPE NORTH TOWER SITE

CAPE NORTH, NOVA SCOTIA

Plan
Showing
Borehole Locations
(proposed tower location taken from plan D-20-247)

Maritime Testing Limited
Halifax Nova Scotia

S1601

Figure 5

MARITIME TESTING LIMITED
3232 BARRINGTON STREET — HALIFAX, N. S. — PH. 902-429-0849

September 13, 1979

LeBLANC ROYLE
COMMUNICATIONS TOWERS LTD.

Post Office Box # 880
514 Chardivell Road
Oakfield Ontario
L6J 5C5

ATTENTION: MR. R. ARORA, P.ENG.

Dear Sir:

RE: Geotechnical Site Investigation
Proposed Tower Site
Cape North

This letter is in confirmation of our telephone conversation of the afternoon of September 12, 1979, whereby you posed some queries with regards to the above mentioned report.

The following is our reply to those queries:

(1) The M.T.L. report S1601 has made reference to an earlier site investigation (M.T.L. report S1179) conducted in June of 1977. In this earlier report, water inflow into a test pit at the site was observed at two (2) feet below ground level. We would recommend that "the insitu weight of the rock be taken as 150 pounds per cubic foot with a submerged unit weight of about 90 pounds per cubic foot." It is our considered opinion that material located below the two (2) foot depth from existing ground surface is to be considered submerged.

(2) We would suggest a net bearing pressure not exceeding 20 kips per square foot, founded on clean bedrock. Such foundations could experience settlement in the order of 1/10 inch, at the Cape North Site.

(3) Ea is in reference to the anchor grout material and Er is in reference to the rock.

Continued ....

(4) Fixed anchor length refers to a straight shaft anchor with a nut, washer, nut combination fixed at the distal end of the shaft; i.e., two (2) inch square washer in a four (4) inch diameter hole.

(5) In reference to Paragraph 3 on Page 7 of our report S1602, we are drawing attention to the point that the effects of groups of anchors can be less than the sum of the individual anchors due to the interaction of the group as a whole.

I would draw your attention to the fact that in our report, under the section "Foundation Design and Construction Consideration", the information contained within is to be treated as considerations.

If we can be of any further assistance please write us concerning any queries relating to soil and rock parameters at the above mentioned site.

Sincerely,

MARITIME TESTING LIMITED

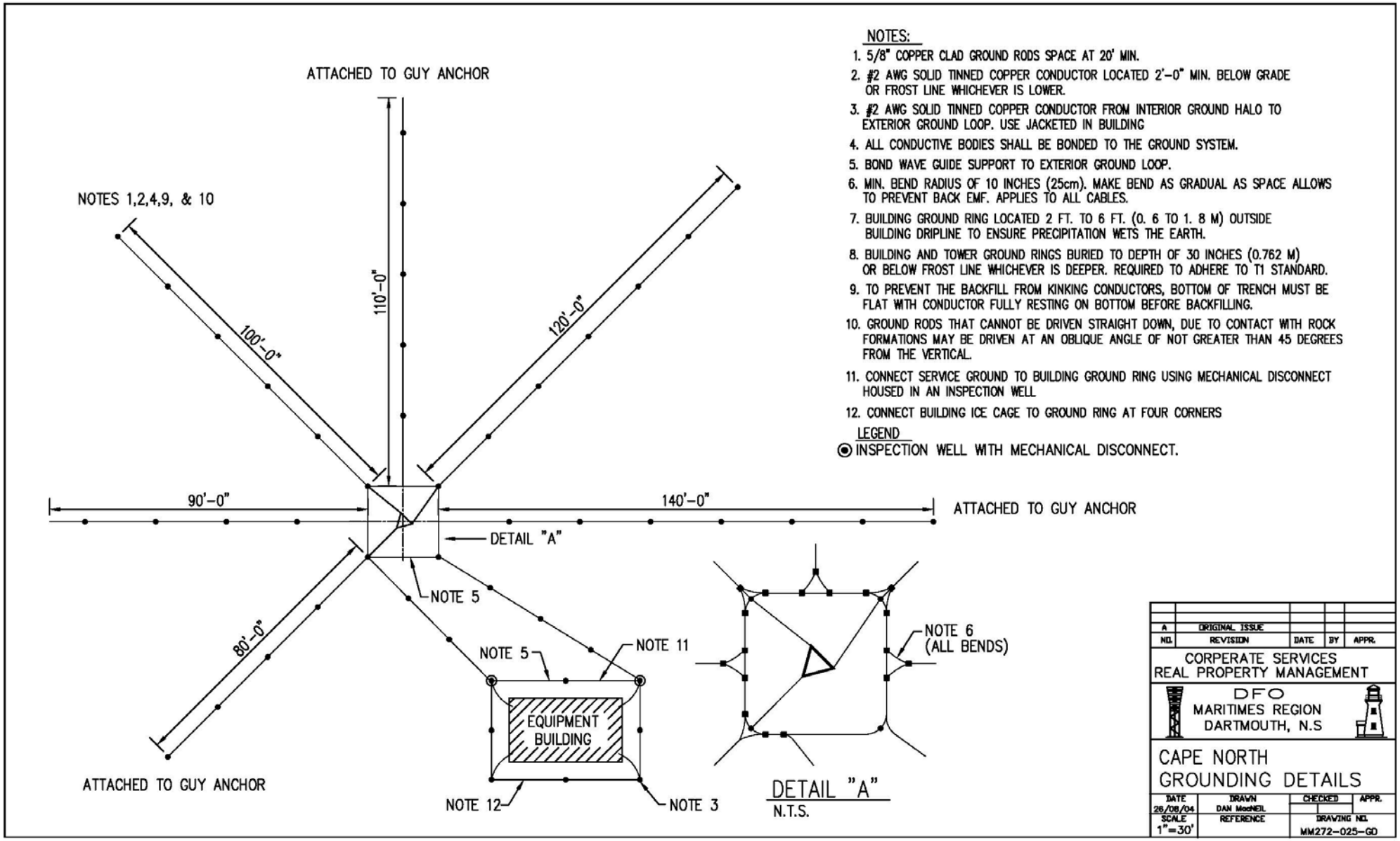
Paul Amarandos, P.Eng.

PA/sj

cc: Mr. T. Fisher
Canadian Coast Guard

Appendix E

Existing Ground System Drawing



Existing Ground System

Appendix F

Site Photos

Canadian Coast Guard (CCG) site at Cape North. The equipment building, steel ice shelter over building, waveguide bridge and VHF tower are visible.

CCG equipment building and steel ice shelter in foreground. VHF tower visible behind building.

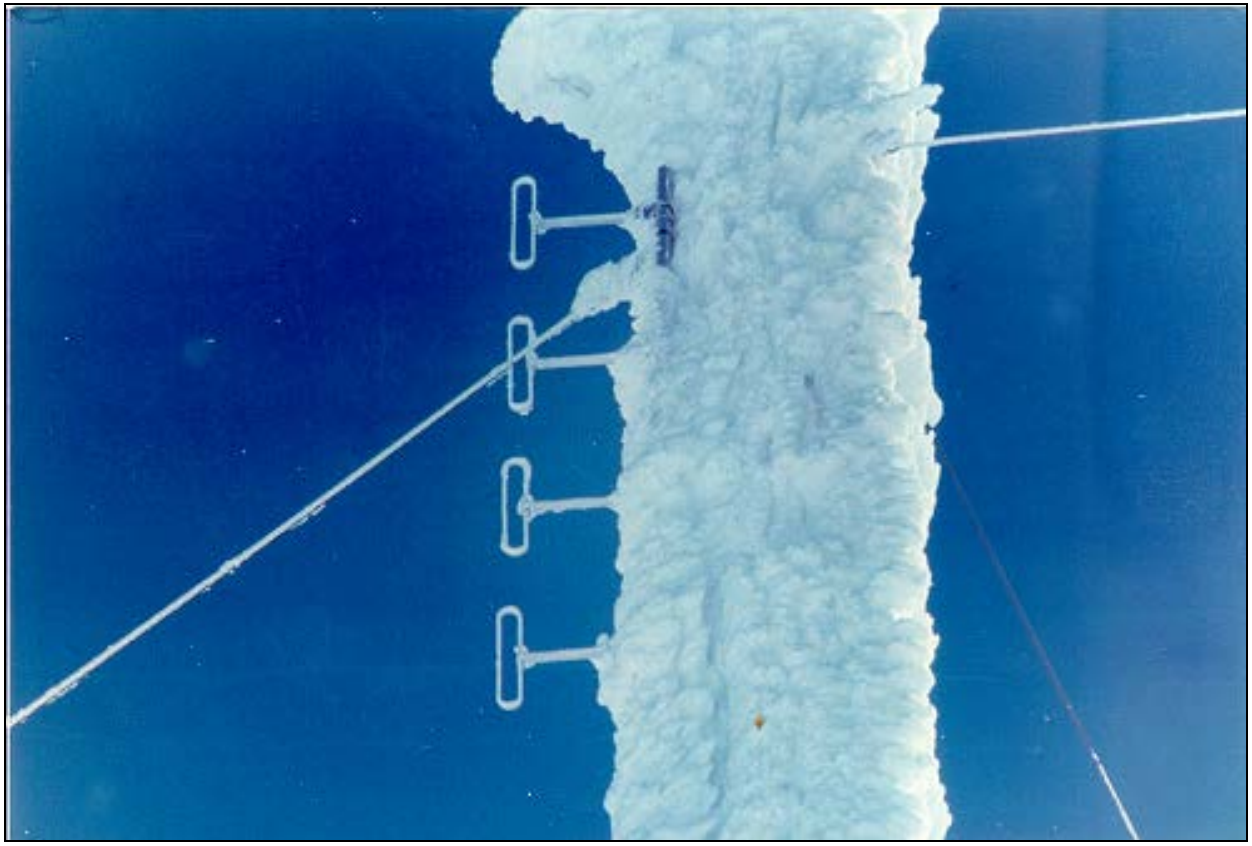
Older waveguide bridge (replaced) and western side of CCG equipment building.

CCG equipment building, ice shelter and waveguide bridge. View from vicinity of eastern guy anchor.

CCG VHF tower, waveguide bridge, ice shelter and equipment building.

CCG Cape North tower site, viewed from top of existing VHF tower. Older waveguide bridge and ice shelter visible on ground.

Base of existing VHF tower and ice protected waveguide bridge.



Severe winter conditions on VHF tower, circa 1990s.

Gravel access road 2.0 km from paved highway (5.2 km from tower site), looking east.