SECTION 31 09 17

DYNAMIC PILE TESTING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. ASTM International (ASTM): D4945, Standard Test Method for High-Strain Dynamic Testing of Piles.

1.2 DEFINITIONS

A. High Strain Dynamic Testing (HSDT): Testing performed with Case-Goble Pile Driving Analyzer (PDA) to determine the drivability, pile toe and shaft friction capacity of specified piles, pile integrity and hammer performance. Gauges are attached to pile approximately 1 m below pile head and connected with cable to monitoring station on ground away from pile. Gauges consist of two accelerometers, two strain transducers, and junction box.

B. Impact Stress: Peak stress at pile head on impact from driving train as determined from measurements using pile driving analyzer.

C. Production Piles: Piles incorporated into the Work, utilizing a uniform selection of materials and workmanship, and which are determined acceptable by Contract Administrator based on observation and pile test results.

D. Test Piles: Piles constructed of same materials and workmanship, and installed as specified for production piles at locations other than for production pile locations or production pile locations.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Qualifications: Testing agency and testing instrumentation installer.
   2. Test equipment description and layout.
   3. Test procedures.
   4. Test record documents.

1.4 QUALIFICATIONS

A. Testing Agency: Independent, certified, and at least 5 years' experience in similar testing including installing instrumentation, performing testing, monitoring specified testing, analyzing data.

B. Testing Instrumentation Installer: At least 5 years' experience in installation of the test pile instrumentation.

1.5 INSTRUMENTATION PREINSTALLATION MEETING

A. Discussion to include details and scheduling of test equipment installation, testing, and test monitoring.

B. Attended by Contractor, testing agency, pile installation personnel, and Contract Administrator, and The City before starting Work specified under this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified for production piles.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 TEST PROCEDURES

A. Minimum (i) test descriptions, (ii) forms, and (iii) checklists to be used to control and document each required test.

B. Describe specific test to be performed.

C. Provide space(s) after each test description for Contractor, Contract Administrator, and testing agency to certify that successful testing, in accordance referenced standards, has been completed.

D. Contract Administrator’s acceptance required prior to commencement of respective testing.

E. Provide calibration and certification.

3.2 RECORD DATA

A. Record for each test pile driven and tested, include minimum:
   1. Dynamic Testing Report: In accordance with referenced standard for test performed.
   2. Driving record.
   3. Pile length.
   4. Number of hammer blows-per-300 mm of penetration.
   5. Resistance in blows-per-25 mm of last 300 mm of final driving.
   6. Hammer stroke, and rate of operation during driving.
   7. Unusual occurrence(s) during driving.

3.3 TEST RECORD DOCUMENTS

A. Make available to Contract Administrator at Site.

B. List of specific piles to be tested.

C. Updated versions of documentation required for testing.

D. Certifications of calibration.

E. Testing record data.

3.4 HIGH STRAIN DYNAMIC TESTING

A. Testing Equipment:
   1. Contractor: Provide dynamic monitoring equipment, including Pile Driving Analyzer (PDA), and all ancillary equipment and movable monitoring station as necessary to conduct the high strain dynamic testing and conforming to ASTM D4945.

B. Pile Driving Equipment:
   1. Use same hammer, driving system, and ancillary equipment to drive test piles and production piling. Maintain and operate driving equipment in accordance with manufacturer's instructions.
   2. If determined necessary based on results of PDA monitoring, modify pile cushion material and thickness to increase or decrease pile driving stresses. Confer with Contract Administrator on appropriate material and thickness.

C. Test Piles: Approximately 5 percent of piles will be tested. If any pile tested indicates nonconformance with specified criteria, percentage of tests stated above will be increased by Contract Administrator.

D. Test Pile Preparation: Mark entire length of each test pile at 300 mm intervals and number marks consecutively starting at pile toe for the purpose of recording penetration resistance and depth of pile penetration. Make marks and numbering clearly visible for monitoring personnel. Upon request, perform additional marks at 25 mm intervals for selected length.

E. Minimum Estimated Activity Times:
   1. Preliminary Gauge Installation: 30 minutes.
   2. Final Gauge Attachment: 30 minutes.
   3. Dynamic Monitoring per Pile Driven: 60 minutes.
   4. Removal of Gauges: 15 minutes.

F. Testing:
   1. Perform in accordance with ASTM D4945.

3.5 DAMAGED, MISPLACED, OR OTHERWISE REJECTED PILES

A. Test piles found damaged, necked, or otherwise unfit for use that are located at production pile locations shall be replaced.

B. Remove from Site and replace with conforming piles.

END OF SECTION

SECTION 31 23 19.01

DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. Comply with Division 1, General Requirements.

B. Section Includes
1. Control of groundwater and surface run-off.
2. Deep well ground water level monitoring using existing monitoring wells and depressurization.
3. Monitoring movements of existing structures.
4. Discharge of drainage water from construction Site.

1.2 SYSTEM DESCRIPTION

A. Design and Performance Requirements
1. Prevent surface run-off from entering excavations.
2. Dewater and maintain excavation dewatering activities until Total Performance is achieved.
3. Obtain the Contract Administrator's written consent prior to transferring dewatering activities to others.
4. Protect the Works from underground water pressure effects.
5. Follow requirement as per CW 2030. Further to CW 2030, work areas can receive flow of an undetermined amount from groundwater infiltration, snow melt, rainfall and other unforeseen sources.
6. Utilize as required in an optimized way and complete the existing dewatering installations in order to achieve Contract performance requirements.

B. Dewatering Discharge, including Depressurization, Requirements
1. Provide appropriate filter screens so that no soil or foundation material is removed, and solids concentration of less than 500 parts per million in the discharge water is achieved.
2. Discharge hoses for pumping from excavations shall not be laid across vehicle access roads without adequate protection over them and the hoses must be protected from freezing during winter months. Pumping equipment, if used, shall be set-up in a location and in such a way as approved by the Contract Administrator.
3. Discharge drainage water to existing storm drainage system.
4. Pumping of runoff water from excavations shall be discharged to a grass field area outside the excavation before running off into ditches.

C. Existing Dewatering Installations:
1. Sump pump installed in UV building excavations to control dewatering of main plant outlet leakage.
2. 5 monitoring piezometers installed in monitoring wells have been installed on the Site. Monitoring and protection of the piezometers and wells is included in the Contract.

3. 2 depressurization wells, one duty and one stand-by have been installed in the excavations between the secondary clarifiers. The duty and standby wells are each equipped with a 40 HP pump of capacity 230 m3/h.
4. The depressurization wells are covered with a temporary weather proof enclosure located at the well heads. Well head enclosure to be maintained and rebuilt at different elevation if required by back filling works.
5. The well head enclosure contains access doors, two (2) - VFD's and associated appurtenances (1-VFD for each 40HP pump) connected to temporary generators supplied under Bid Op 601-2015 until July, 2016.
6. Depressurization well power source is not supplied after July 2016. Temporary generators (duty / standby) shall be supplied and installed by the Contractor prior to March 1, 2017 to ensure operation of the depressurization system. Contractor to supply, supply fuel and generator maintenance including periodic start-up and other regulatory requirements.
7. Existing Depressurization wells have been installed under previous contracts to control groundwater levels between the elevations of 224.5 and 226.0 to protect excavations as per previous works
8. Refer to Drawings for existing Site storm drain system.
9. Include Works for Manholes 1 and 3 as described in construction documents and as part of the construction scope and phase appropriately at the start of the Works for utilization as required during dewatering.

1.3 SUBMITTALS

A. Shop Drawings
   1. Submit Water Control Plan that includes:
      a. Proposed dewatering equipment, method and standby equipment and power supply.
      b. Proposed methods for water discharge
      c. Propose means available for Site flooding protection
      d. Review depressurization system and soil characteristics for protection of excavations below existing excavations level (ex: BNR sump wells, encasement of piping below slabs).
      e. Submit Water Control plan to the Contract Administrator for review at contract award and revise as required at least 10 days before any new excavation.
   2. Dewatering Discharge Approval
      a. Groundwater Dewatering approval from Manitoba Conservation has been obtained by The City and will be made available to the successful Contractor. In the event that the groundwater dewatering is required, follow requirements described in the license. Request additional information or approval if required.
   3. Depressurization volumes:
      a. Record volume of water pumped on a daily basis via flow meter (supplied by others) and submit to Contract Administrator.
   4. Monitoring Observation Wells
      a. Submit water elevation records on spreadsheet for 5 existing well monitoring piezometers daily during possible high water season between March 1 and July 31 or during seasonal events as determined by flooding, storm, nearby water bodies impacting ground water elevation or as determined by Contract Administrator on the base of outside observations. Submit water elevation records weekly otherwise.
      b. Monitoring Movement bench marks

c. Submit weekly records.
d. Accuracy of measuring systems including markers and measurement instrument to be in accordance with Section 3.3.

1.4 SITE CONDITIONS

A. Soils Report
1. Refer to Appendix for geotechnical information.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Dewatering Equipment
1. Pipes, hose, pumps, electrical generators, and other equipment.
2. Pumps and generators with effective muffling devices to keep noise levels at or below background noise levels.
3. For groundwater depressurization only, utilize existing dewatering and depressurization equipment as described in Section 1.2. All other equipment necessary for surface dewatering shall be supplied by the Contractor.

PART 3 EXECUTION

3.1 DEWATERING SYSTEMS

A. Supply and Install dewatering equipment and continuously dewater excavations to maintain dry working conditions.

B. Standby power and equipment
1. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

3.2 MONITORING and operation of GROUNDWATER WELLS

A. Operate a full depressurization system for the safety and integrity of the Works

B. Measure water levels observed in each existing observation well two times daily between March 1 and July 1and weekly whenever any event, including but not limited to flood, storms, changes in water surface elevation of nearby water bodies, may have caused a change in the groundwater elevation and provide to the Contract Administrator.

C. Depressurization wells have been installed under Bid Op.333-2014 to control groundwater levels between the elevations of 224.5 and 226.0. As defined in these documents, the Contractor shall monitor the groundwater levels and operate the depressurization wells as necessary to maintain the specified groundwater elevations and as directed by the Contract Administrator.

3.3 MOVEMENT MONITORING BENCH MARKERS

A. Install and maintain markers to monitor horizontal and vertical movements of existing structures as directed by the Contract Administrator.

B. Movement monitoring benchmarks installed for monitoring movement during pile installation may be used for this purpose. Monitor movement in x,y, and z directions.

3.4 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. The Contractor shall not discharge water containing residual chlorine into water courses. Provide testing and dechlorination to demonstrate no chlorine residual in discharged water.

3.5 PROTECTION OF PROPERTY

A. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 31 61 13

PILE FOUNDATIONS, GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 31 Earthwork that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. Manitoba Building Code (MBC)

C. CSA International
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
   2. CAN/CSA A23.3, Design of Concrete Structures.
   3. CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.
   4. CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
   5. CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.4 QUALITY ASSURANCE

A. Installation of driven H-Piles and cast-in-place Concrete friction piles shall be inspected by the Contract Administrator.

B. Storage and Handling Requirements:
   1. Store materials off ground in dry location and in accordance with Manufacturer's recommendations in clean, dry, well-ventilated area.
   2. Replace defective or damaged materials with new.

C. Develop Construction Waste Management Plan related to Work of this Section.

D. Sub-surface investigation report: when site conditions differ from those indicated, submit written notification to Contract Administrator and await further instructions.

E. Submit schedule of planned sequence of construction to Contract Administrator for review, as specified.

F. Equipment:
   1. Submit prior to pile installation for review by Contract Administrator, list and details of equipment for use in installation of piles.
   2. Impact hammers: submit Manufacturer's written data as specified.

G. Quality assurance submittals:
   1. Test reports: submit three (3) copies of certified installation test reports for piles from Geotechnical Consultant, indicating compliance with Construction Documents for specified performance characteristics and physical properties.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with Section 01 61 00, Common Product Requirements.

B. Protect piles from damage due to excessive bending stresses, impact, abrasion or other causes during delivery, storage and handling.

C. Replace damaged piles as directed by Contract Administrator.

1.6 EXISTING CONDITIONS

A. Sub-surface investigation report is bound into Specification.

B. Notify Contract Administrator in writing if subsurface conditions at site differ from those indicated and await further instructions from Contract Administrator.

1.7 SCHEDULING

A. Provide schedule of planned sequence of driving to Contract Administrator for approval, not less than two weeks prior to commencement of pile driving.

PART 2 PRODUCTS

2.1 MATERIALS

A. Material requirements for piles are specified in Sections 03 05 10, Cast-in-Place Concrete – Short Form, 03 20 00, Concrete Reinforcing and 05 12 00-01, Structural Steel Framing.

2.2 EQUIPMENT

A. Impact hammers: provide Manufacturer's name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions.

B. Non-impact methods of installation such as augering, jacking, vibratory hammers or other means: provide full details of characteristics necessary to evaluate performance.

C. Hammer:
   1. Hammers to be selected on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.
   2. Driveability analysis to include, but not be limited to, following: hammer, cushion, and cap block details; static soil parameters; quake and damping factors, total soil resistance, blow count, pile stresses and energy throughput at representative penetrations.
   3. When required criteria can not be achieved with the proposed hammer, use larger hammer and take other measures as required.

PART 3 EXECUTION

3.1 PREPARATION

A. Protection:
   1. Protect adjacent structures, services and work of other sections from hazards due to pile driving operations.
   2. Arrange sequencing of pile driving operations and methods to avoid damages to adjacent existing structures.
   3. When damages occur, remedy damaged items to restore to original or better condition at own expense.

B. Ensure that ground conditions at pile locations are adequate to support pile driving operation and load testing operation.
   1. Make provision for access and support of piling equipment during performance of Work.

C. Pre-boring of holes may be acceptable to facilitate pile alignment control and prevent damage to adjacent structures.

D. Ensure electrical grounding attachments are secured to provide an electrically continuous circuit to pile cap over and to grounding grid.

3.2 INSTALLATION

A. Leads: construct pile driver leads to provide free movement of hammer.
   1. Hold leads in position at top and bottom, with guys, stiff braces, or other means approved by Contract Administrator to ensure support to pile while being driven.
   2. Length: provide sufficient length of leads to ensure that use of follower is unnecessary.

3. Swing leads:
   a. Obtain approval from Contract Administrator prior to using swing leads.
   b. Method to be approved by Contract Administrator.

B. Followers:
   1. Obtain approval from Contract Administrator prior to using followers.
   2. Provide followers of such size, shape, length and mass to permit driving pile in desired location to required depth and resistance.
   3. Provide followers with socket or hood carefully fitted to top of pile to minimize loss of energy and prevent damage to pile.

C. Steel H-Piles to be driven to refusal as determined by Geotechnical Consultant.

D. Installation of each pile will be subject to approval by Geotechnical Consultant.
   1. Contract Administrator will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration or refusal used to determine load capacity.
   2. Contract Administrator to approve final driving of all piles prior to removal of pile driving rig from site.

E. Drive each pile to practical refusal in bedrock.
   1. Do not overdrive to cause damage to piles in bedrock.
   2. Contract Administrator will determine refusal criteria for piles driven to rock based on type of pile and driving equipment.

3.3 APPLICATION / DRIVING

A. Use driving caps and cushions to protect piles.
   1. Piles with damaged heads as determined by Contract Administrator will be rejected.

B. Hold piles securely and accurately in position while driving.

C. Deliver hammer blows along axis of pile.

D. Do not drive piles within5 m of masonry or concrete which has been in place less than 14 days.

E. Restrike already driven piles lifted during driving of adjacent piles.

F. Remove loose and displaced material from around piles after completion of driving, and leave clean, solid surfaces to receive foundation concrete.

G. Cut off piles neatly and squarely at elevations required.

H. Remove cut-off lengths from site on completion of work.

3.4 OBSTRUCTIONS

A. Where obstruction is encountered that causes sudden unexpected change in penetration resistance or deviation from specified tolerances, proceed as directed by Contract Administrator.

3.5 REPAIR AND RESTORATION

A. Pull out rejected piles and replace with new piles.

B. Remove rejected pile and replace with new, and if necessary, longer pile.

C. Remove/leave rejected pile and fill hole as directed by Contract Administrator.

D. No extra compensation will be made for removing and replacing or other work made necessary through rejection of defective piles.

3.6 FIELD QUALITY CONTROL

A. The Contractor shall provide Field Quality Control to be approved by Contract Administrator:

B. Independent Field Quality Control will be performed by Geotechnical Consultant

C. Provide assistance, as required, in instrumentation process during initial set-up and during testing.

D. Make allowance for probable interruption in driving for:
   1. Changing/modifying hammer, cap, cushions, or other equipment;
   2. Replacing/adjusting of transducers and accelerometers;
   3. Assessing of monitored results.

E. Replace/adjust hammer and modify cap, cushions, and other equipment, as directed by Contract Administrator.

F. Measurement:
   1. Maintain accurate records of driving for each pile, including:
      a. Type and make of hammer, stroke or related energy.
      b. Other driving equipment including water jet, driving cap, cushion.
      c. Pile size and length, location of pile in pile group, location or designation of pile group.
      d. Sequence of driving piles in group.
      e. Final tip and cut-off elevations.
      f. Other pertinent information such as interruption of continuous driving, pile damage.
      g. Record elevation taken on adjacent piles before and after driving of each pile.
   2. All measurements, observations and calculations associated with pile driving analyzer and wave equation analysis.
   3. Provide Contract Administrator with three copies of records.

3.7 CLEANING

A. On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

SECTION 31 62 13

CAST IN PLACE CONCRETE PILES

PART 1 GENERAL

1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

1.2 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 31 Earthwork that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions..

1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. Manitoba Building Code (MBC)

C. CSA International
   1. CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
   2. CAN/CSA A23.3, Design of Concrete Structures.
   3. CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.
   4. CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

D. Geotechnical Report: Appendix A.

1.4 INSPECTION AND TESTING

A. Installation of cast-in-place Concrete friction piles shall be inspected by the Contract Administrator.

B. Storage and Handling Requirements:
   1. Store materials off ground in dry location and in accordance with Manufacturer's recommendations in clean, dry, well-ventilated area.
   2. Replace defective or damaged materials with new.

C. Develop Construction Waste Management Plan related to Work of this Section.

D. Sub-surface investigation report: when site conditions differ from those indicated, submit written notification to Contract Administrator and await further instructions.

E. Submit schedule of planned sequence of construction to Contract Administrator for review, as specified.

F. Quality assurance submittals:
   1. Test reports: submit three (3) copies of certified installation test reports for piles from Geotechnical Consultant, indicating compliance with Construction Documents for specified performance characteristics and physical properties.

1.5 ACCEPTABILITY

A. Section 03 05 10, Cast-in-Place Concrete – Short Form, shall apply to piles.

1.6 FIELD RECORDS

A. Record the following information for each pile placed.

B. Pile sizes, lengths and location of piles.
   1. Final bearing and cut-off elevation.
   2. Soil Conditions.
   3. Date and time concrete placed and concrete test results.
   4. Reinforcing details.

C. Submit 3 copies to the Contract Administrator.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete: as specified in Section 03 05 10, Cast-in-Place Concrete – Short Form.

B. Reinforcement: steel, as specified in Section 03 20 00, Concrete Reinforcing.

C. Bond Breaker: material, such as rigid fibrous glass insulation, that is sufficiently strong to withstand backfilling of soil against it, but much weaker than the backfilled soil.

PART 3 EXECUTION

3.1 DRILLING

A. Carry out excavation for piles after site clearing and stripping is completed.

B. Excavate pile shaft to dimensions shown on Drawings and clean hole.

C. Special excavation procedures necessary due to sloughing, caving, or soil water may require procedures such as casing of the hole. The extent of such work procedures shall be

determined from a study of the geotechnical report and Contractor's own knowledge of the area. This work shall constitute part of the Contract. Have casing on site at time of drilling.

D. Dispose of excavated materials as directed by Contract Administrator.

E. Inspect pile excavation prior to placing of concrete. Remove loose material, foreign matter and water. If water not removable, then tremmie concrete as required.

F. Do not drill adjacent piles within five (5) shaft diameters until 48 hours has elapsed from installing the first pile.

3.2 PILE INSTALLATION

A. The requirements of Section 03 05 10, Cast-in-Place Concrete – Short Form for concrete and reinforcement placement shall apply except that a free fall of concrete may be the length of the pile.

B. Use a suitable method of holding the reinforcement in proper position during concrete placement.

C. Place concrete within two hours of completing cleaning of the pile base.

D. Reinforcement not extending the full length of the pile need not be placed until concrete has reached the bottom level of the vertical steel.

E. Have two working vibrators on site prior to commencing work, each of sufficient length to vibrate to depth required. Vibrate concrete as placing proceeds for full length of pile shaft.

F. Vibration may be carried out during removal of casing.

G. Withdraw casing immediately upon completion of concreting. Top up concrete displaced by casing withdrawal. Ensure top of pile is fully compacted/vibrated and adequately finished.

H. Clean all concrete from projecting reinforcing steel and dowels.

3.3 TOLERANCES

A. Refer to Drawing General Notes

B. Concrete Cut-off Elevation: plus 25 mm to minus 75 mm.

C. If tolerances are exceeded and result in excessive eccentricity, propose corrective construction to compensate. Submit proposal for review and approval by Minister prior to proceeding.

3.4 DEFECTIVE PILES

A. The Contract Administrator may reject any pile that does not meet the specified tolerances.

B. Replace rejected with new piles as directed, at no additional cost. Cut off rejected piles 600 mm below the design cut-off elevation or as directed by Contract Administrator.

END OF SECTION

SECTION 31 62 13.23

PRESTRESSED CONCRETE PILES

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Canadian Standards Association (CSA):
      a. A23.1, Concrete Materials and Methods of Concrete Construction.
      b. A23.2, Test Methods and Standard Practices for Concrete.
      c. A23.4, Precast Concrete – Materials and Construction
      d. A3000, Cementitious Materials Compendium.
      e. G30.18-M, Carbon Steel Bars for Concrete Reinforcement.
      f. S269.3, Concrete Formwork.
   2. ASTM International (ASTM):
      a. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      b. A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

1.2 DEFINITIONS

A. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

B. Dynamic Monitoring: Monitoring performed with Case-Goble Pile Driving Analyzer (PDA). Gauges are attached to pile approximately 1 metre below pile head and connected with cable to monitoring station on ground away from pile. Gauges consist of two accelerometers and two strain transducers.

C. Elevations: Referenced to Benchmark located at existing Administration Building for all piles. Benchmark: Northing 5517633.414, Easting 636968.196, Elevation 234.059.

D. Fixed Leads: Leads that are pinned to crane boom at top and equipped with hydraulic spotter at bottom capable of spotting pile to its correct position and maintaining alignment during driving. Degree of rigidity and strength acceptable will be subject to review of Contract Administrator.

E. Impact Stress: Stress transferred to pile head at impact from driving train, as determined from measurements using Pile Driving Analyzer.

F. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering subsurface or physical condition.

G. Termination Criterion: Penetration resistance of a predetermined number of blows per 25 mm and to continue driving pile would be impractical.

H. Rated Hammer Energy:
   1. Diesel Hammers: Product of rated stroke times ram weight.
   2. Air Hammers: Rated energy from manufacturer's literature.

I. Representative Test Cylinder: A test cylinder made from same concrete pour, and cured under same conditions at same location as piles.

J. Set: Pile penetration in mm per blow.

K. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

L. Termination Penetration Resistance: Penetration resistance (blow count) at which driving may be terminated, as established by Contract Administrator.

M. Transferred Hammer Energy: Energy transferred to pile head from driving train impact, as determined from measurements using Pile Driving Analyzer.

1.3 DESIGN REQUIREMENTS

A. Design 300, 350, and 400 mm diameter hexagonal prestressed, precast concrete piling, with individual piles capable of sustaining:
   1. Axial Compression (SLS):
      a. For 300 mm diameter piles, 555 kN plus dead weight of pile.
      b. For 350 mm diameter piles, 780 kN plus dead weight of pile.
      c. For 400 mm diameter piles, 1050 kN plus dead weight of pile.
   2. Handling and driving stresses.

B. Coordinate the manufacturing of the piles and installation for the hammer used. Pile driving hammer selection shall consider result of wave equation analysis.

1.4 SUBMITTALS

A. Action Submittals:
   1. Details on Methods, Sequence, and Procedures:
      a. Pile forming system.
      b. Pile casting and curing.
      c. Pile extension, if required, formwork, casting and curing.
      d. Prestressing and tension release.
      e. Handling and transport.
   2. Design calculations and Shop Drawings for items listed below:
      a. Piles, including reinforcement.
      b. Pile extension, if required, including reinforcement.
      c. Anchorage devices.
      d. Anchoring stresses.
      e. Handling and transport stresses.
      f. Storage support point locations.
      g. Pile pickup points.
   3. Show that steel layout and details conform to those shown on Drawings.

4. Drawing giving an identification number and fabrication length for each pile, prior to pile manufacture.

B. Informational Submittals:
1. Schedule of planned sequence of driving no less than two (2) weeks prior to start of pile driving.
2. Installer qualifications.
3. Manufacturer's Certification of Compliance: Manufactured products.
4. Certified Test Results: Concrete mix design, including certified minimum 28-day compressive strength.
5. Mill Certificates: Prestressing steel, spirals, nonprestressed reinforced steel, pile anchorage steel, and all other embedded items.
6. Hammer selection analysis using wave equation theory.
7. Certification of Calibration:
   a. Pressure gauge for measuring air pressure (for air hammers) or chamber pressure (for closed and diesel hammers). Include:
      1) Correction data for hose losses if air pressure gauge is located away from hammer.
      2) Chart for closed end diesel hammers that equates bounce chamber pressure to other equivalent stroke of energy.
   b. Jacking System: Calibration curves used in prestressing.
8. Methods and materials for casting and curing concrete during cold weather.
9. Method(s) to align and maintain pile alignment, including type of leads to be used with details on methods and equipment to be used to measure alignment.
10. Manufacturer's product specifications and maintenance manuals for pile hammer and auxiliary equipment.
11. Complete Pile Hammer Data Sheet, attached to this Specification section.
12. Daily Log and Record: At end of each working day, for every pile installed that day.

1.5 QUALIFICATIONS

A. Shop Drawings: Prepared, stamped and signed by an engineer registered in the Province of Manitoba.

B. Piling Installer: Minimum of 5 years of past successful experience on ten projects of precast concrete pile installation.

C. Pile Manufacturer: CPCI certified. Provide proof of certification as part of Manufacturer's Certification of Compliance.

1.6 SITE CONDITIONS

A. Soils Report
1. Refer to Information Available to Bidders.
2. Notify the Contract Administrator in writing if subsurface conditions differ from those indicated.

B. Existing Utilities and Services
   1. Known underground services and utilities are indicated on Drawings. No guarantee is given of completeness or accuracy.
   2. Notify the Contract Administrator in writing of any significant discrepancies.
   3. Record locations of underground utilities encountered.
   4. Repair damage to existing services and utilities resulting from work under this Section at no cost to The City.
   5. Utilize suitable safety procedures for work near utilities.

C. For pile extensions, if required, comply with requirements of CSA A23.1, Cold-Weather Protection. Verify that concrete has attained specified compressive strength before backfilling.

1.7 STORAGE AND HANDLING

A. Do not subject piles to fracture by impact, bending stresses, abrasion, or other injury during delivery, storage, and handling.

B. Replace damaged piles to satisfaction of Contract Administrator.

C. Lift piles only at approved pickup points, by means of a bridle or slings attached to pile at marked pickup points.

D. Store piling on substantial and unyielding foundations.
   1. Blocking: Sufficient to ensure that stored or stacked members will be supported at designated pickup points, plus one intermediate row of supports between each pickup point.
   2. Bearing Points of Tiered Members: Locate one above other.
   3. Tiering of piles more than four high, or storage of materials or equipment on piles, is not permitted.

1.8 SEQUENCING AND SCHEDULING

A. Complete foundation excavation and earthwork prior to beginning Work under this section.

PART 2 PRODUCTS

2.1 PILE ORDER LENGTHS

A. Order Lengths: Establish from cutoff elevations shown on Drawings.

B. Supply full length piles and provide suitable equipment for installation of full length piles without cutting or splicing. Provide sufficient pile length above cut-off elevations so that reinforcement or prestressing strands exposed after cut-off are of sufficient length for anchorage into supported structure.

C. Do not splice piles without written permission from Contract Administrator. Where approved, submit design details of splice stamped and signed by an engineer registered in the Province of Manitoba to Contract Administrator for review.

2.2 MATERIALS

A. Concrete: Class of Exposure S-3 in accordance with CSA A23.1.
   1. Minimum Compressive Strength:
      a. 35 MPa at 28 days.
      b. 30 MPa at transfer of prestress.
      c. If the pile designer considers 30MPA at transfer to be unnecessary, 20MPa at transfer of prestress will be allowed provided that a stamped letter from the pile designer is submitted identifying that the such deviation from the previous clause of this specification is acceptable.

B. Aggregates:
   1. Coarse aggregate: CSA A23.1; rough and angular gravel or crushed stone.
   2. Fine aggregate: CSA A23.1; natural sand.

C. Prestressing Strands: Bright, seven-wire, stress-relieved, nominal diameter shown, ASTM A416, Grade 270.

D. Reinforcing Steel:
   1. Dowels and Reinforcing Steel: CSA G30.18.
   2. Spiral Steel Reinforcing: ASTM A1064.

E. Grout: non-metallic, non-gas-liberating, non-shrink hydraulic cement grout, with minimum strength of 35 MPa at 7 days.

2.3 FABRICATION

A. Forms:
   1. Steel or Wood: Arrange for ample working room and easy access for proper placing, compacting, and finishing of concrete for piles.
   2. Of rigid design and construction for removal without damage to completed piles.
   3. Free of dents, creases, and other irregularities.
   4. Design and align forms so that they will not restrict longitudinal movement of casting when prestress force is transferred.
   5. Thoroughly clean and oil prior to each use.
   6. Form top end of piles to details shown.
   7. Chamfer pile corners.

B. Placement of Reinforcement: Install prestressing strands and all mild steel reinforcing before concrete is placed. Keep strands and reinforcing clean from form oil, dirt, rust, grease, and other substances harmful to bond.

C. Prestressing:
   1. Tension prestressing reinforcement to approved jacking load.

2. When two or more strands are tensioned simultaneously, provide means to obtain equal tension in all strands.
3. Determine pretensioning force by elongation based on load-elongation curve of strand.
4. Initial Prestress:
   a. Not exceed 70 percent of ultimate strength of strands.
   b. Consider loss of prestress due to initial stress transfer and creep in achieving minimum effective prestress.
   c. Stressing strands to 75 percent of ultimate strength will be allowed provided that a stamped letter from the pile designer is submitted identifying that the proposed deviation from the rest of this specification is acceptable.
5. Jacks:
   a. Equip with accurately calibrated hydraulic pressure gauges and observable reading dial of at least 150 mm or clear digital display.
   b. Certify calibration curve of each jack.
   c. Measure elongation at completion of stressing and at time of placing concrete.
   d. Conform to strand manufacturer's elongation tables.

D. Casting:
1. Methods and materials for casting and curing concrete during cold weather below 5 degrees C will be subject to prior approval by Contract Administrator.
2. Perform in a continuous nonstop operation from start to finish.
3. In a horizontal position on level, tight platforms constructed to prevent settlement during casting and curing operations.
4. Casting in tiers will not be permitted.
5. Compact concrete by internally vibrating, supplement by spading and rodding, during placing.
6. Thoroughly work concrete around reinforcement and into corners of forms uniformly over length of pile.
7. Vibration: Sufficient to cause concrete to flow and settle into place.
8. Avoid displacement of reinforcement, enclosures, and prestressing steel.
9. Point piles with a 1:2 grout, filling all cavities or irregularities, immediately upon form removal.
10. Surfaces:
    a. Free from pockets, porosity, or excessive honeycomb:
       1) Surface honeycomb of greater than 12 mm shall be repaired.
       2) Honeycomb extending to plane of reinforcing will be cause for rejection.
    b. Finish piling exposed to view above ground line.
11. Marking: Casting date and location of pickup points on each pile.

E. Curing:
1. Water Curing: Continuously wet piles after casting for 10 days if portland cement is used, and not less than 3 days if high-early-strength cement is used.
2. Steam Curing:
   a. Recording Thermometers: Supply, arrange and calibrate to record a continuous 24-hour record of temperature of enclosure, and to be available for inspection during curing process.
      1) Accuracy: To within plus or minus 3 degrees C.
      2) Locate thermometers at intervals not to exceed 15 m.

b. Start as soon as practical after casting of piles.
   1) First 2 Hours: Do not raise temperature of concrete above 38 degrees C.
   2) After First 2 Hours: Concrete temperature may be raised to a maximum of 65 degrees C in increments not to exceed 14 degrees C per hour.
   3) At Maximum Temperature: Maintain continuously until concrete has attained a minimum compressive strength of 30MPa as determined from representative test cylinder breaks.
c. After concrete has attained required strength, cool concrete to air temperature by reducing heat applied in increments of not more than 10 degrees C per hour.
d. After removal from casting bed, protect pile as necessary to avoid cooling at a rate greater than 11 degrees C per hour.

3. Remove side forms any time 24 hours after concrete is placed, provided air temperature surrounding piles is maintained at or above 10 degrees C for remaining required curing time.

F. Transfer of Prestress:
1. Do not commence release of prestressed reinforcement until representative test cylinder breaks indicate that concrete has attained required minimum compressive strength at transfer of prestress.
2. Before removing jacks from pretensioning reinforcement, relieve stress at jack by gradual release before cutting reinforcement.
3. Burn off exposed pretension steel flush with concrete surface.
4. Protect exposed ends with an epoxy coating intended for such purpose.

G. Do not subject piles to any handling stress until breaks from representative test cylinders show a strength of at least 30 MPa.

H. Tolerances:
1. Ends: Plane surfaces perpendicular to axis of pile with a maximum tolerance of 10 mm per m transversely.
2. Maximum Sweep:
   a. 3 mm in any 3 m of its length.
   b. 8 mm in any 10 m of its length.
3. Cross-Section: Within minus 5 mm to plus 10 mm.
4. Pile Head: Plus or minus 1/2 degree from a true right-angle plane.
5. Location of Reinforcing Steel:
   a. Main reinforcement cover minus 3 mm, plus 5 mm.
   b. Spacing of spiral plus or minus 10 mm.
6. Failure to maintain pile dimension tolerances and reinforcing location tolerance will be cause for rejection of pile.

2.4 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 m^3 or fraction thereof of concrete placed in the precast work in accordance with CSA A23.1 and CSA A23.2.

B. Test and record concrete strengths.

PART 3 EXECUTION

3.1 GENERAL

A. Ensure that ground conditions and any buried utilities to remain in place at pile locations are adequate to support pile driving operation.

B. Ensure access and egress to pile locations is adequate for equipment.

C. Do not commence pile installation until excavation in the area is complete.

D. Survey and locate each pile.

E. Record the condition of existing structures adjacent to pile locations prior to commencing pile installation.

F. Protect adjacent structures, shoring, services, from damage due to pile driving operations. If damage occurs, make good damaged items at no cost to The City.

G. Provide access to all portions of Work for review by Contract Administrator and any inspection and testing personnel hired by The City.

H. Provide and install temporary ramps, bridges, mats, platforms, and railing as required.

3.2 PRE-BORING

A. Pre-bore slightly oversized holes for piles up to 3 m below grade at all pile locations to allow for setting up of piles, and to reduce ground vibration and potential ground heave in large pile groups. Do not pre-bore below Elevation 222.500 m.

B. Remove pre-bore tailings and dispose of off-site.

3.3 PILE DRIVING EQUIPMENT

A. Pile Driving Hammer and Driving System:
   1. Select hammer based on wave equation analysis, including but not limited to, consideration for pile cushion, hammer cap block, soil parameters, damping factors, blow count, pile stresses.
   2. Capable of continuous operation at all fuel and/or trip valve settings.
   3. Size and type to consistently deliver an effective dynamic energy sufficient to drive pile to required ultimate pile capacity and minimum toe elevation.
   4. Air hammer shall have compressor/boiler capacity at least 10 percent greater than manufacturer’s minimum requirement.
   5. Air Hammer Calibrated Pressure Gauge: Furnish and position on hammer side of all valves, no more than 30 m of hose away from hammer inlet and located for easy observation.
   6. Closed End Diesel Hammer Calibrated Pressure Gauge: Furnish and position near ground level for easy observation.

7. Indicate location of tripping valves determining air/steam intake and cutoff, with reference to top of cap block, on Pile Hammer Data Sheet attached at end of this section.
8. Hammer shall not overstress or otherwise cause damage to the pile during installation.
9. Hammer: Adjustable and capable of low energy driving or tapping (short strokes) through soft soil strata to prevent tensile stress from exceeding net prestress in concrete pile.
10. Measuring System: Suitable for determining hammer stroke; a saximeter will be acceptable.

B. Hammer Cap block: Manufactured from stable and predictable material.

C. Helmet: Seat onto pile and bear evenly and concentrically with minimum play upon pile.

D. Pile Head: Free to rotate.

E. Pile Cushion:
1. A pad consisting of laminated wood (plywood) placed in pile driving helmet.
2. Minimum Thickness: 150 mm.
3. Place a new cushion in helmet at start of driving.
4. Replace cushion in helmet as soon as it has reached 50 percent of its original thickness, or it has begun to smoke, burn, or deteriorate.
5. Increase cushion thickness to reduce tension or compressive stresses.

F. Pile Driving Leads:
1. Fixed, with hydraulic spotter and other equipment necessary to drive piles within tolerances specified.
2. Of sufficient length so use of a follower is not necessary.
3. Straight and parallel, not deviating from a straight line by more than 10 mm over any 4 m length.
4. Easily adjustable to permit axial driving without interruption if piles deviate from required alignment.

G. Means or device suitable to indicate penetration of piles visible at a reasonable and safe distance from pile driver.

3.4 PILE DRIVING

A. Notify Contract Administrator 7 days in advance of and perform driving in presence of Contract Administrator.

B. Do not drive piles until breaks from representative test cylinders indicate minimum compressive strength specified.

C. Pile Toe Protection: In accordance with manufacturer’s instructions.

D. Do not drive piles within 10 m of structural concrete less than 7 days old and of concrete masonry units installed within prior 3 days.

E. Pile Marking: At 300 mm intervals for purpose of recording driving resistance and depth of penetration of pile.

F. Maintain hammer concentric with driving train in axial alignment on pile. Do not use hammer to limit deviation of pile during driving by exerting lateral forces or striking at angle. Where pile orientation is essential, take special care to maintain orientation during driving.

G. Impact driving may be terminated when the required ultimate capacity has been obtained.

H. Penetration resistances required to obtain ultimate capacity, as follows:

Estimated Penetration Resistance Criteria Table	
Location/Pile Size	Penetration Resistance (Blow Count for three consecutive sets)
300 mm diameter	5 blows/25 mm
350 mm diameter	8 blows/25 mm
400 mm diameter	15 blows/25 mm

I. Drive piles continuously, and without voluntary interruption, to termination penetration resistance as determined by Contract Administrator, or to termination criterion driving resistance.

J. Termination penetration resistance shall only apply after minimum toe elevation has been achieved, as determined by Contract Administrator.

K. Diesel Hammer: Throttle back hammer to operate at a reduced energy level at initial stage of impact driving to avoid potential for high tension stress in pile.

L. Remove any material forced up between piles above bottom elevation shown for foundation pit.

M. Monitor elevation of top of piles within a 5 pile diameter radius of piles being driven.

N. Redrive piles that are raised during process of driving or that become loosened by driving of piles within a 5 m radius. Redrive piles within this radius that have raised more than 10 mm. Pulling piles into alignment or position will not be permitted. No additional payment will be given for redriving of piles.

O. Driving Tolerances:
   1. Not more than 2 percent from vertical or 2 percent from inclination shown. Additionally, piles shall not be more than 50 mm out of position laterally at the top.
   2. Centroid of pile at cutoff elevation shall not vary from design position shown by more than 50 mm after driving.
   3. Piles not meeting these tolerances will be rejected.

3.5 SHORT PILES

A. Where the top of the piles is below the cutoff elevation plus the minimum length required for exposed tendons, a pile extension is required. Refer to Contract Drawings.

B. Notify the Contract Administrator prior to installing a pile extension. If proposed pile extension exceeds maximum allowable extension length, pile may be rejected.

C. No additional payment will be given for measures to remedy short piles.

D. Materials: same as prestressed concrete piles.

E. Formwork and falsework: Comply with requirements of CSA S269.3.

F. Curing: Wet cure for 10 consecutive days at a minimum temperature of 5 degrees C.

3.6 PILE CUTOFF

A. Cut at required elevation with tools that will not fracture or damage area below cut surface.

B. Cut off piles neatly and squarely at elevations indicated. Do not damage reinforcing steel and prestressing strand during chipping and cutoff operations.

C. Thoroughly clean projecting prestressing strands of concrete.

3.7 FIELD QUALITY CONTROL

A. Daily Log and Record: Document for each pile showing as a minimum:
1. Pile identification/location.
2. Weather/groundwater conditions.
3. Predrilling diameter and depth.
4. Hammer settings.
5. Date and time start and complete driving.
6. Respective depths of penetration.
7. Pile toe and cutoff elevations.
8. Driving resistance for each metre for pile tip above EL 214.000, each 100 mm for pile tip below EL 214.000, 25 mm during PDA testing.
9. Equipment used.
10. Installation method.
11. Nature and location of obstructions encountered.
12. Final pile head position (x, y, z coordinates) after cut off indicating if pile is installed within the specified tolerances.
13. Any unusual occurrences during driving.
14. Re-driving records.
15. Other pertinent pile driving behavior.

B. Dynamic Monitoring: Plan, coordinate, and accomplish in accordance with Section 31 09 17, Dynamic Pile Testing.

C. Installation of each pile will be subject to review of Contract Administrator. Contract Administrator will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration, or other criteria used to determine load capacity. Piles not meeting criteria will be rejected.

D. Damaged piles as determined by Contract Administrator will be rejected.

E. Pile extensions: Slump, air content, and standard strength tests will be made throughout progress of the Work and will be paid for by The City. Tests will be in accordance with CSA A23.1. Provide labour, concrete and other facilities for making the test specimens.

3.8 REJECTED PILES

A. The Contract Administrator may require one (1) or more of the following measures for each rejected pile:
   1. Pull out rejected pile and replace with new pile.
   2. Pull out rejected pile and replace with new, and if necessary, longer pile.
   3. Pull out rejected pile and fill hole as directed by Contract Administrator.
   4. Leave rejected pile in place and cut off as directed by Contract Administrator.
   5. Leave rejected pile in place, and place new pile at new location as directed by Contract Administrator.

B. No extra compensation will be given for measures to remedy rejected piles.

3.9 PROTECTION

A. Protect exposed piles from damage until pile caps or foundations of supported structures are ready to be installed.

B. Ensure that no loads are imposed on the piles except those for which they are intended, unless written permission has been obtained from the Contract Administrator.

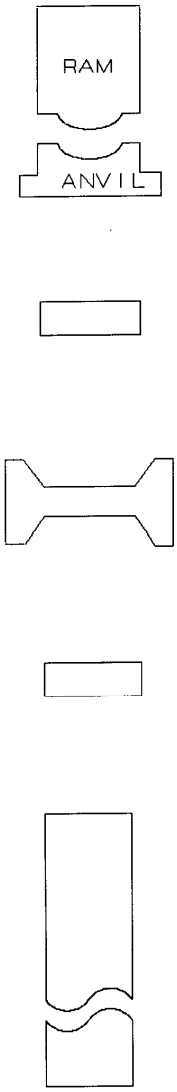
3.10 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.
   1. Hammer Data Sheet.

END OF SECTION

HAMMER DATA SHEET

Contract No.:	Structure Name and/or No.:
Project:	
Pile Driving CONTRACTOR or Subcontractor:	
County:	Piles Driven By:



Manufacturer:	Model:
Type:	Serial No.
Rated Energy: @	Length of Stroke
Modifications:	
Material:	
Thickness:	Area:
Modulus of Elasticity - E	(MPa)
Coefficient of Restitution - e	
ALL COMPONENTS	Weight:
Cushion Material:	
Thickness:	Area:
Modulus of Elasticity - E	(MPa)
Coefficient of Restitution - e	
Pile Type:	Weight/ m
Length in Leads:	
Pile Diameter:	Taper:
Design Pile Capacity:	kN
Description of Splice:	
Tip Treatment Description:	

NOTE: If mandrel is used to drive pile, attach separate manufacturer's detail sheet(s), including weight and dimensions.

Submitted By:_____ Date:_____

SECTION 31 62 18
STEEL H PILES

PART 1 GENERAL

1.1 GENERAL

A. Requirements of this Section apply only for the 66 kV Substation.

1.2 RELATED REQUIREMENTS

A. Requirements specified within this section apply to all sections in Division 31 Earthwork that are applicable to the 66 kV Substation. This section supplements requirements of other Divisions.

1.3 REFERENCES

A. Work shall be in accordance with the National Building Code of Canada 2010 and as revised by the Manitoba Buildings and Mobile Homes Act (C.C.S.M c. B93), MR 118/214, Regulation 31/2011' as amended. This is the Manitoba Building Code. References shall be the current document specified including documents referenced therein. References stipulated in the Manitoba Building Code shall be the issue of the document stipulated, including documents referenced therein.

B. The Manitoba Building Code (MBC).

C. American Society for Testing and Materials International, (ASTM).
   1. ASTM A123, Standard specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A143; Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   3. ASTM A153; Standard Specification for Zinc Coating (Hot-Dip) on Iron and Hardware.
   4. ASTM A384; Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
   5. ASTM A385; Standard Practice for Providing High Quality Zinc Coatings (Hot-Dip).
   6. ASTM A767; Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   7. ASTM A780; Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

D. Canadian Institute of Steel Construction (CISC)
   1. Handbook of the Canadian Institute of Steel Construction.
   2. CISC Manual of Standard Practice

E. Canadian Standards Association (CSA International)
   1. CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

2. CSA S16, Limit States Design of Steel Structures.
3. CSA W47.1, Certification of Companies for Fusion Welding of Steel.
4. CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
5. CSA W55.3, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
6. CSA W59, Welded Steel Construction (Metal Arc Welding).

F. The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International
   1. NACE No. 3/SSPC SP-6, Commercial Blast Cleaning.

1.4 SHOP DRAWINGS

A. Submit Shop Drawings in accordance Drawing General Notes

1.5 TEST REPORTS

A. Furnish mill test reports indicating yield and chemical analysis of steel piles if requested by Contract Administrator.

1.6 WASTE MANAGEMENT AND DISPOSAL

A. Separate and recycle waste materials.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel H piles: to CSA G40.20/G40.2, Grade 300W minimum. Size and weight as shown on the Construction Documents.

B. Welding materials: to CSA W48.

C. Steel plates: to CSA G40.20/G40.21, grade 300W minimum.

D. Exterior protective coating: Top 4 meters to be hot dipped galvanised to ASTM A153 and ASTM A384. Thickness to be as stipulated in the Drawing General Notes.

E. Pile driving shoes: Pruyn Cast Steel Points or approved equal in accordance with B8.

PART 3 EXECUTION

3.1 COATING

A. Coating to be as stipulated in the Drawing General Notes.

B. Surface preparation:
   1. In accordance with SSPC-SP 10 unless noted otherwise in coating supplier's printed instructions.
   2. Remove oil, grease, and all deleterious material, with solvents or detergents prior to preparing surface.

C. Coat top 4 metres below finished ground elevation. Coating thickness to be Z350 unless noted.

3.2 INSTALLATION

A. Install piling in accordance with Section 31 61 13, Pile Foundations, General Requirements.

B. Provide driving shoes as specified.

C. Splice pile extensions to details on Construction Documents.
   1. Align extension with driven pile when splicing.
   2. Provide full bearing of spliced parts.

D. Cut off piles squarely at required elevation.

E. Touch up scratches on uncoated surfaces.

3.3 WELDING

A. Weld to CSA W59 and CSA W59S1.

B. Welding certification of companies: to CSA W47.1 and CSA W47.1S1.

END OF SECTION