Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 20 00: Concrete Reinforcing.

.2 Section 03 30 00: Cast-in-Place Concrete.

1.2 REFERENCES

.1 All referenced standards to be the current edition or the edition referenced by the applicable Building Code in force at the time of building permit application, as noted on Structural Drawings.

.2 Canadian Standards Association (CSA International):

.1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA O86, Engineering Design in Wood.

.3 CSA O121, Douglas Fir Plywood.

.4 CSA 0141, Softwood Lumber.

.5 CSA O151, Canadian Softwood Plywood.

.6 CSA O153, Poplar Plywood.

.7 CSA O325.0, Construction Sheathing.

.8 CSA O437 Series, Standards for OSB and Waferboard.

.9 CSA S269.1, Falsework and Formwork

.3 American Concrete Institute (ACI):

.1 ACI 117, Specification for Tolerances for Concrete Construction and Materials.

.2 ACI 347, Guide to Formwork for Concrete.

1.3 QUALITY ASSURANCE

.1 In accordance with Section 01 43 00 – Quality Assurance.

.2 Qualifications

.1 Engage a Professional Engineer licensed in the place where the project is located to be responsible for design, installation and site review of all formwork, falsework and re-shoring.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

.1 Provide shop drawings for formwork and falsework stamped and signed by the Professional Engineer responsible for their design.

.2 Show on drawings:

.1 Formwork design data: permissible rate of concrete placement and temperature of concrete in forms.

.2 Erection sequence.

.3 Stripping and re-shoring procedure.

.4 Camber.

.5 Locations of all construction joints in slabs and walls.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Design in accordance with CSA S269.1 and CSA S269.3

.2 WSP-S accepts no responsibility for structural adequacy of formwork, falsework and re-shoring and will not review its design.

2.2 MATERIALS

.1 Formwork materials: to CSA S269.1.

.1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CSA 0141, CSA O437 or CSA-O153.

.2 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material.

.3 Form ties:

.1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm (1”) diameter in concrete surface.

.2 Form ties to be designed to act as ties and spreaders and to have a minimum working strength of 13 kN (3000 pounds).

.3 Snap ties to snap cleanly at least 25 mm (1") from concrete surface without damage to the concrete.

.4 Cone ties to be internal disconnecting type which snaps cleanly at least 38 mm (1½") from concrete surface without damage to the concrete.

.4 Form release agent: non-toxic, low VOC, chemically active agent containing compounds that react with free lime in concrete resulting in water insoluble soaps.

.5 Form stripping agent: colourless mineral oil, non-toxic, low VOC, free of kerosene, with viscosity between 15 to 24 mm^2/s (70 and 110s Saybolt Universal) at 40˚C, flashpoint minimum 150˚C, open cup.

.6 Grooves, reglets and chamfers: White pine selected for straightness and accurately dressed to size.

.2 Falsework materials: to CSA S269.1.

.3 Compressible filler: flexible polyethylene closed cell expansion joint filler to ASTM D 4819, type II.

2.3 ACCESSORIES

.1 PVC Waterstops: flexible, extruded, heat weldable, ribbed to CGSB 41-GP-35M and as follows:

.1 Tensile strength: to ASTM D638, minimum 13 MPa.

.2 Ultimate elongation: to ASTM D638, minimum 350%.

.3 Water absorption: to ASTM D570, 0.15% max.

.4 Tear resistance: to ASTM D624, minimum 50 kN/m.

.5 Low temperature brittleness: to ASTM D746, no failure at -37˚C.

.6 Width in construction joints: 100 mm (4”).

.7 Width in expansion joints: 225 mm (9”), with 31 mm (1-1/4”) O.D. centre bulb.

.2 Swellable waterstops

.1 Bentonite Waterstops - composed of 75% sodium bentonite and 25% butyl rubber, rectangular, flexible, min 200% expansion after 21 day aging.

.2 Extrudable waterstops - one part polyurethane, bentonite free, 100% expansion after 7 days.

Part 3 Execution

3.1 FABRICATION AND ERECTION

.1 Confirm to CSA A23.1.

.2 Fabricate and erect falsework in accordance with CSA S269.1.

.3 Do not place shores and mud sills on frozen ground.

.4 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.5 Fabricate and erect formwork in accordance with CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.

.6 Make formwork tight and flush faced to prevent the leakage of mortar and the creation of unspecified fins or panel outlines.

.7 Form sides of footings unless Structural Drawings and Geotechnical report allow use of earth forms.

.8 See drawings for any camber required in hardened concrete. Measure cambers relative to member supports.

.9 Obtain WSP-S approval for formed openings, slots and chases not indicated on Structural Drawings.

.10 Use internal form ties.

.11 Apply a form coating and release agent uniformly to the contact surface of formwork panels before reuse.

.12 Use 25 mm (1”) chamfer strips on external corners and 25 mm (1”) fillets at interior corners, unless specified otherwise.

.13 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated on Architectural and Structural drawings.

.14 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.

.15 Anchors and inserts not to protrude beyond surfaces designated to receive applied finishes, including painting.

.16 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

.17 Build top form on sloping concrete where required to prevent concrete from flowing out of the form. Provide vents to allow air and bleed water to escape.

.18 Do not close wall forms before reinforcing steel has been reviewed by WSP-S.

3.2 SWELLABLE WATERSTOPS

.1 Provide swellable waterstops for construction and temporary joints in exterior walls, basement walls, retaining walls, slabs supporting earth and at other locations shown where minimum required distance to concrete edge can be achieved. Do not use for expansion joints.

.2 Bentonite waterstops:

.1 Locate bentonite waterstops 75 mm (3”) clear from outside face of concrete to avoid spalling of concrete due to swelling pressure of bentonite.

.2 Butt strips together. Do not overlap.

.3 Fasten to concrete at 600 mm (2’-0”) maximum.

.3 Extrudable waterstops:

.1 Locate extrudable waterstops 100 mm (4”) clear from outside face of concrete to avoid spalling of concrete due to swelling pressure.

.2 Refer to manufacturer’s specifications for application temperature range.

.3 Refer to manufacturers specifications for recommended profile size and number of profiles suitable for particular concrete thickness.

3.3 CONCRETE EXPOSED TO VIEW

.1 Minimize formwork joints. Locate joints and ties in a uniform pattern with no ties within 300 mm (12") of an edge or joint.

.2 Make panels forming slab soffits and wall / beam faces as large as possible, and arrange symmetrically.

.3 Where grooves, reglets or chamfers are shown, locate panel form joints to be hidden behind them.

.4 Seal all joints in formwork and between formwork and concrete.

.5 Do not reuse formwork if there is any evidence of surface damage or wear, which could impair the visual quality of the concrete surface.

.6 Reuse forms only on identical sections, using the original tie holes. Clean forms and fill nail holes before reuse.

.7 Use only galvanized nails.

.8 Remove form tie plastic cones. Install concrete plugs. Recess 6 mm (1/4") and bond to concrete using a cement slurry with a bonding agent conforming to Section 03 30 00.

3.4 REMOVAL AND RESHORING

.1 Conform to CSA A23.1 and to ACI 347.

.2 Survey top of formwork and slab elevations before concrete placement, prior and after falsework removal, refer to drawing notes for detailed requirements. Submit survey data for WSP-S record.

.3 Use on-site cured cylinders (kept beside and treated as the concrete in the structure they represent) to determine in-situ strength of concrete prior to removal of falsework.

.4 Maintain falsework supporting beams and slabs until concrete has reached at least 75% of its specified strength.

.5 Maintain falsework for columns and walls until non-architectural concrete reaches at least 10 MPa and until architectural concrete reaches at least 15 MPa, but not less than 3 days.

.6 Keep falsework or reshoring in place until concrete reaches the specified design strength, but not less than 28 days. If reshoring is installed to replace falsework, strip and re-shore simultaneously so that no more than 9 m^2 of soffit is left unsupported by either formwork or reshoring at any time.

.7 Install reshores tight to structure above and below so that they do not shorten under load. Do not pre-load or lift the structure above by overtightening.

.8 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

3.5 FIELD QUALITY CONTROL

.1 Refer to Section 01 45 00 - Quality Control.

.2 Obtain field review of falsework and reshoring by the Professional Engineer responsible for that work prior to each pour. WSP-S will not field review the formwork, falsework or reshoring.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 10 00: Concrete Forming and Accessories.

.2 Section 03 30 00: Cast-in-Place Concrete.

.3 Section 04 20 00: Unit Masonry.

1.2 REFERENCES

.1 All referenced standards shall be the current edition or the edition referenced by the applicable Building Code in force at the time of building permit application, as noted on Structural Drawings.

.2 Canadian Standards Association (CSA International):

.1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 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.

.3 Reinforcing Steel Institute of Canada (RSIC):

.1 Reinforcing Steel Manual of Standard Practice.

.4 American Concrete Institute (ACI):

.1 SP-66, ACI Detailing Manual.

.5 ASTM International Inc.:

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

1.3 QUALITY ASSURANCE

.1 In accordance with Section 01 43 00 – Quality Assurance.

.2 Qualifications

.1 Welding of reinforcing steel to be performed by welders certified under CSA W186.

1.4 QUALITY CONTROL

.1 Submit in accordance with Section 01 45 00 - Quality Control.

.2 Source Quality Control Submittals:

.1 Upon request, provide WSP-S with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis.

.2 Upon request, inform WSP-S of proposed source of reinforcement material to be supplied.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's data sheets for mechanical rebar splices.

.3 Shop Drawings:

.1 Prepare shop drawings in accordance with RSIC Manual of Standard Practice unless the Contract Documents contain a more stringent requirement. Conform to ACI SP-66 Detailing Manual whenever a detail condition is not covered by any of the above.

.2 Submit plans, elevations, sections and details necessary to fabricate, place and review reinforcement without reference to structural drawings, including masonry wall reinforcement. Draw to scale not smaller than 1:50 (¼" = 1'-0").

.3 Show on drawings:

.1 Sizes, spacings and locations of reinforcement, with identifying labels.

.2 Bar bending details.

.3 Lengths and locations of all lap splices.

.4 Types and locations of mechanical splices.

.5 Placing sequence.

.6 Large scale details at areas of steel concentration (such as column / beam / wall intersections), and around cast-ins.

.7 Bar lists.

.8 Quantities of reinforcement (including all rebar added to accommodate installation).

.9 Construction joint, control joint and pour gap locations.

.10 Concrete cover.

Part 2 Products

2.1 MATERIALS

.1 Reinforcing steel: carbon steel, deformed bars to CSA G30.18., unless indicated otherwise.

.2 Weldable Reinforcing steel: weldable low alloy steel deformed bars to CSA G30.18.

.3 Cold-drawn annealed steel wire ties: to ASTM A1064/A1064M.

.4 Welded steel wire fabric: to ASTM A1064/A1064M. Provide in flat sheets only.

.5 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.

.6 Mechanical splices: to concentrically align bars and develop specified tensile strength of rebar. Threaded couplers to have plastic internal coupler thread protectors.

.7 Plain round bars: to CSA G40.20/G40.21.

Part 3 Execution

3.1 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice.

.2 Stagger mechanical splices 750 mm (2'-6") unless otherwise noted on drawings.

.3 Weld reinforcement in accordance with CSA W186 where indicated.

.4 Ship bundles of bar reinforcement, clearly identified in accordance with bar lists.

.5 Provide standard hooks at ends of all hooked bars.

.6 Substitute different size bars only if permitted in writing by WSP-S.

3.2 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by WSP-S.

.2 When field bending is authorized, bend without heat, applying slow and steady pressure. Use tools which will limit bend radii to the values given in CSA A23.1.

.3 Replace bars which develop cracks or splits.

3.3 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CSA A23.1/A23.2.

.2 Remove all loose scale, dirt, oil or other coatings which would reduce bond.

.3 Ensure cover to reinforcement is maintained during concrete pour.

.4 Turn ends of tie wire towards the interior of concrete.

.5 Support bars, chairs and spacers:

.1 Provide sufficient support bars, chairs, carriers and side form spacers as necessary to secure against displacement of reinforcement and maintain concrete cover before and during concrete placement. Support devices contacting surfaces exposed to the exterior to be non-corroding. Bars which are not shown on Structural Drawings and whose only function is supporting other reinforcing in lieu of other supporting devices to be considered accessories.

.2 Use bar supports for beams and slabs.

.3 Use side form spacers for walls and columns.

.4 Use plastic or plastic tipped bar supports and spacer with colour to match concrete for exposed concrete surfaces.

.6 Do not splice reinforcing at locations other than shown on placing or structural drawings without WSP-S written approval.

.7 Do not cut reinforcement without WSP-S written approval.

.8 Unless otherwise noted on drawings, stagger alternate mechanical couplers 750 mm (2'-6") apart.

.9 Do not field weld reinforcement except where indicated or authorized by WSP-S.

.10 Obtain WSP-S field review of all reinforcing materials and placement before pouring concrete.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 10 00: Concrete Forming and Accessories.

.2 Section 03 20 00: Concrete Reinforcing.

.3 Section 05 12 23: Structural Steel for Buildings.

1.2 REFERENCES

.1 All referenced standards to be the current edition or the edition referenced by the applicable Building Code in force at the time of building permit application, as noted on Structural Drawings.

.2 Canadian Standards Association (CSA International):

.1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA A283, Qualification Code for Concrete Testing Laboratories.

.3 CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.3 ASTM International Inc.:

.1 ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

.2 ASTM C920 – Standard Specification for Elastomeric Joint Sealants

.3 ASTM D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

.4 Canadian General Standards Board (CGSB):

.1 CGSB-51.34, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

1.3 QUALITY ASSURANCE

.1 In accordance with Section 01 43 00 – Quality Assurance.

.2 Qualifications

.1 Concrete supplier to have a valid “Certificate of Ready Mixed Concrete Production Facilities” issued by the relevant Ready Mixed Concrete Association.

1.4 QUALITY CONTROL

.1 Submit in accordance with Section 01 45 00 - Quality Control.

.2 Minimum two weeks prior to starting concrete work, provide valid certificate from plant delivering concrete.

.1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.

.3 For concrete with high volume of supplementary cementing materials (HVSCM concrete, as defined in CSA A23.1), perform trial mixes to ensure that the required properties are achieved.

.4 Minimum four weeks prior to starting concrete work, provide proposed quality control procedures on following items:

.1 Hot weather concrete.

.2 Cold weather concrete.

.3 Curing;

.4 Finishing.

.5 Protection.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meeting: convene pre-installation meeting one week prior to beginning concrete works. Ensure key personnel to attend.

.2 Batch Logs: keep record of each batch delivered to site.

.3 Concrete Delivery Slips: Keep all concrete delivery slips ("driver's tickets") on site until building is completed. Record on delivery slip where concrete was placed, including time and date.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Minimum 2 weeks prior to starting concrete work, submit all concrete mix designs, and indicate where each concrete mix is to be used.

.3 Minimum 2 weeks prior to placing concrete, submit drawings showing proposed locations of all construction and control joints (including wall control joints and slab on grade sawcut joints) for WSP-S review and approval.

.4 Minimum submission requirements for each concrete mix design shall include the following:

.1 Minimum specified compressive strength at 28 day (or at the time specified on drawings).

.2 Maximum aggregate size.

.3 Aggregate type (if not normal density).

.4 Concrete density range, wet and dry (if not normal density).

.5 CSA exposure class.

.6 Cement type (if not type GU).

.7 Percentage and type of supplemental cementing materials.

.8 Maximum water/cementitious materials ratio.

.9 Assumed method of placement of concrete.

.10 Maximum time from batching to placing concrete (if retarding admixtures are used).

.5 Concrete pours: provide accurate records of all concrete pours marked on a set of Structural Drawings.

.6 On completion of the works, provide written report to WSP-S certifying that the concrete in place meets performance requirements established in Part 2 - Products.

Part 2 Products

2.1 DESIGN CRITERIA

.1 To CSA A23.1/A23.2, Alternative 1 – Performance, and as described under Mixes and on Structural Drawings.

2.2 PERFORMANCE CRITERIA

.1 Concrete supplier to meet the concrete performance criteria established by WSP-S and to provide verification of compliance.

2.3 MATERIALS

.1 Portland cement: to CSA A3001.

.2 Cementitious hydraulic slag: to CSA A3000.

.3 Fly ash: to CSA A3001, Type CI.

.4 Water: to CSA A23.1.

.5 Aggregates: to CSA A23.1/A23.2. Do not use recycled concrete as aggregate.

.6 Admixtures: not to contain chlorides.

.7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2. Minimum compressive strength: 40 MPa at 28 days.

.8 Non premixed dry pack grout: composition of non metallic aggregate and Portland cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 40 MPa at 28 days.

.9 Curing/sealing compound: to CSA A23.1/A23.2 and ASTM C309, Type 1, Class B, water based acrylic, compatible with surface hardener where hardener is used.

.10 Pre-moulded joint fillers: min.12 (1/2") bituminous impregnated fiber board to ASTM D1751.

.11 Joint Sealants: to AST C920, class 100/50.

.12 Evaporation reducer: water based polymer liquid forming continuous monomolecular temporary film on fresh concrete surface.

.13 Penetrating sealer: water based, clear water repellent, at least equivalent to AT&U Type 1b as specified in Alberta Infrastructure and Transportation Publication B388.

.14 Vapour barrier: 10 mil polyethylene to CAN/CGSB-51.34.

.15 Rigid insulation: extruded polystyrene boards per ASTM C578, structural grade, compressive strength 40 psi (275 kPa).

.16 Control joint filler: semi-rigid filler to protect against slab edge breakdown:

.1 For conventional sawcuts in interior slab: two component epoxy urethane.

.2 For conventional sawcuts in exterior slabs: two or multy component polyurethane based elastomeric.

.17 Crack Filler: low viscosity epoxy resin.

2.4 CONCRETE MIXES

.1 Use ready-mix concrete. Proportion concrete in accordance with CSA A23.1, Alternative 1 - Performance Method for Specifying Concrete.

.2 Set performance characteristics of concrete in plastic state in coordination with all trades involved.

.3 Meet performance criteria of concrete in hardened state as shown on Structural Drawings and provide verification of compliance.

.4 Use water-reducing agent in all concrete.

.5 Do not use admixtures containing chlorides.

.6 Supplementary cementing materials (SCM):

.1 Conform to CSA A23.1.

.2 Follow slag and fly ash manufacturers' directions for proportioning and mixing of concrete.

.3 Use a minimum of 15% SCM for concrete that is not architecturally exposed.

.4 Do not use concrete with more than 40% of SCM when ambient temperature is forecast to be below +10°C at the time of concrete pour and during the seven days after the pour, except for footings, walls and columns.

.5 Reduce W/C ratio to 0.45 where using more than 40% of SCM in concrete for slabs and other horizontal finished surfaces, in order to reduce bleed water and to increase rate or strength gain.

.6 For HVSCM concrete, reduce W/C ratio and comply with additional curing and protection requirements specified in CSA A23.1, including Annex K.

Part 3 Execution

3.1 PREPARATION

.1 Provide advanced notice as indicated on drawings to allow WSP-S field review of reinforcing prior to placing of concrete/closing of wall forms.

.2 Obtain WSP-S written approval before placing concrete.

.3 Obtain written approval of each foundation bearing surface by the Departmental Representative before placing concrete.

.4 Remove water and disturbed soil from excavations before placing concrete.

.5 Before placing slab-on-grade, confirm that subgrade and backfill meet specifications and are free of frost and surface water.

.6 Provide vapour barrier under all slabs placed on the ground including slabs-on-grade and framed slabs.

.1 Lap minimum 150 mm at joints and seal.

.2 Seal all punctures before placing concrete.

.3 Use patching material at least 150 mm larger than puncture and seal.

.7 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.

3.2 INSTALLATION/APPLICATION

.1 Set sleeves, conduits, pipe hangers, weep hole tubes, drains and other inserts and openings as indicated or specified elsewhere.

.2 Refer to Typical Details and Drawing Notes for placing guidelines, maximum size and minimum spacing of sleeves, embedded pipes and conduits.

.3 Check locations and sizes of sleeves and openings shown on Structural Drawings with Architectural, Mechanical and Electrical Drawings. Notify WSP-S of any discrepancies.

.4 Provide composite sleeving drawings showing sleeves required by all trades. Obtain WSP-S approval for any required sleeves and openings which are not shown on Structural Drawings.

.5 Set anchor rods using templates under supervision of appropriate trade prior to placing concrete. Locate each anchor rod group to within 6 mm (1/4") of required location.

.6 Refer to Section 03 10 00 for construction joint requirements.

3.3 PLACING CONCRETE

.1 Place concrete in accordance with CSA A23.1.

.2 Delivery and place concrete with minimum re-handling.

.3 If concrete is pumped or placed pneumatically, control discharge velocity to prevent separation or scattering of concrete mix ingredients.

.4 Place concrete in a continuous operation without cold joints. If cold joints develop inadvertently, notify WSP-S to obtain instructions for required remedial work.

.5 Where higher strength concrete needs to be puddled in slabs above columns and walls, place adjacent lower strength slab concrete within 30 minutes of pouring the puddled concrete.

.6 Do not overload forms.

.7 Cast slabs with a top surface that is level or sloping as required by the Drawings. Allow for cambering where required.

.8 Concrete exposed to view:

.1 Exposed surfaces to be dense, even, uniform in colour, texture and distribution of exposed aggregate.

.2 Defects such as honeycombing, voids, loss of fines, visible flow lines, cold joints or excessive bug holes may be cause for rejection at the discretion of the Architect.

.9 Maintain accurate records of all poured concrete including extent, date and location of each pour, concrete mix used, ambient air temperature, test samples taken and falsework removal date and mark on a set of Structural Drawings.

3.4 FINISHING CONCRETE

.1 Finish concrete to CSA A23.1/A23.2.

.2 Cooperate with any trade applying finishes to concrete surfaces and provide surfaces which will ensure adequate bond. Provide chases and reglets where required.

.3 Finishing Flatwork:

.1 Protect concrete during finishing process. Use evaporation reducer during severe drying conditions.

.2 Provide final finish in accordance with proposed use and as follows:

.1 Wood float finish with brooming for: exterior exposed slabs.

.2 Powered steel trowel finish for: interior exposed slabs. Do not trowel air entrained concrete.

.3 Steel trowel exposed interior concrete floors at least twice.

.3 Surface Tolerances:

.1 Concrete surface tolerance to CSA A23.1, F-Number method.

.2 Unless otherwise noted, conform to finish tolerance Class A.

.4 Finishing Formed Surfaces:

.1 Completely fill holes left by through-bolts with grout.

.2 Do not patch surfaces until instructed in writing by WSP-S.

.3 Concrete exposed to view:

.1 Provide smooth-form finish.

.2 Rub exposed sharp edges with carborundum to produce 3 mm (1/8") radius edges unless otherwise indicated.

.4 Architectural Concrete:

3.5 CONCRETE CURING AND PROTECTION

.1 At a minimum cure and protect concrete in accordance with CSA A23.1

.2 Extend curing and protection period until concrete has reached following strength levels for structural safety:

.1 Framed slabs and beams: 75% of specified 28 day strength.

.2 Columns, walls, piers and footings: 50% of specified 28 day strength

.3 For concrete containing supplementary cementing materials, curing and protection times may need to be extended beyond those outlined by CSA A23.1 to achieve the required structural properties.

.4 Cure slab surfaces immediately after finishing is completed. Unless otherwise noted or required, use a curing compound compatible with applied finishes.

.5 Concrete exposed to view:

.1 Protect during construction period from wear, damage, marking, discolouration, staining and becoming coated with concrete leakage.

.2 Unless rejected, repair damage and remove marks and stains to the approval of the Architect.

.6 Do not load concrete until sufficient strength is developed.

.7 Cracks in Slabs-on-Grade:

.1 Extensive cracking of slabs-on-grade or cracks in excess of 3 mm (1/8”) in width may be cause for rejection of slab or portion of slab at the Architect’s discretion.

.2 Protect edges of cracks in slabs-on-grade from breakage.

.3 Exposed slab on grade: Unless slab is rejected, repair cracks that are over 0.4 mm (0.016") wide:

.1 Fill cracks with a sand-cement grout after concrete is at least 120 days old.

.2 Seven days later, cut out top 20 mm (3/4") of crack for a width of 5 mm (3/16") and fill with control joint filler.

3.6 PENETRATING SEALER

.1 Concrete to receive penetrating sealer to be at least 28 days old.

.2 Surfaces to be treated with the sealer to be dry and free of dirt and other contaminants.

.3 Completely remove all curing compounds before the sealer application.

.4 Follow manufacturer’s recommendations for coverage rate and application procedure.

.5 Do not apply in inclement weather or if ambient air temperature or concrete surface temperature is less than 5°C or more than 38°C.

3.7 GROUTING UNDER BASE PLATES AND BEARING PLATES

.1 Grout under base plates and bearing plates using procedures in accordance with manufacturer's recommendations.

.2 Provide 100% contact over grouted area.

.3 Grout column base plates and beam bearing plates as soon as steelwork is completed.

.4 Do not add load on steelwork until grouting is completed and grout strength has reached at least 20 MPa.

3.8 INSPECTION AND TESTING:

.1 An independent Inspection and Testing Agency (certified under CSA A283 with category to suit testing provided) will be appointed to carry out inspection and testing of concrete and concrete materials and check conformance with applicable Standards and Contract documents.

.2 Assist the Inspection and Testing Agency in its work. Notify as to the Work Schedule and provide safe access to the work area as required. Provide concrete samples.

.3 The Agency will submit reports covering the work inspected and the testing performed. The reports will include the Supplier's mix design numbers, locations in structure to which the tests relate and comments on abnormal results and conditions. The reports will be provided not later than five working days after the testing is completed.

.4 Sampling, storing, curing and testing of concrete will be in accordance with CSA A23.1/A23.2.

.5 The Agency will review all submittals pertaining to concrete mix designs and certification of plant, equipment and materials.

.6 The Agency will measure slab surface tolerances (flatness and levelness) using the F-Number system in accordance with ASTM E1155M. Measurements to be made a maximum of 72 hours after every slab pour.

.7 Compressive Strength Testing:

.1 One test is required for each 100 cubic meters of placed concrete, but not less than one test for each concrete mix placed each day. At least 3 tests are required for each class of concrete used.

.2 A group of three cylinders for each test will be provided, Location of concrete placement will be recorded for each cylinder set. One specimens will be tested at 7 and one at 28 days. The third specimen will be tested at 56 days if the required strength at 28 days is not achieved.

.3 If the final concrete strength is specified at 56, 90 or 120 days, a group of four cylinders will be provided. One specimen will be tested at 7 and one at 28 days, with the third specimen tested at the time the final concrete strength is specified. If the required strength is not achieved at the time specified, the fourth specimen will be tested 28 days later.

.4 One additional cylinder will be provided for each concrete mix during cold weather concreting. The specimens will be cured on site adjacent to and under the same conditions as the work they represent, and will be tested prior to form removal.

.5 If standard on site cured cylinders are used to determine concrete strength prior to removal of formwork, they will be kept adjacent to and under the same conditions as the work they represent.

.6 If pull out tests are used to determine concrete strength prior to removal of formwork, the Inspection and Testing Agency will supply, locate and test pull out inserts. The inserts not to be located on surfaces exposed to view.

.7 If maturity tests are used to determine concrete strength prior to removal of formwork, the Inspection and Testing Agency will develop strength-maturity relationship curves, provide and install temperature sensors into fresh concrete and interpret readings in accordance with ASTM 1074,

.8 Air Entrainment Testing:

.1 One standard test for air content in plastic concrete will be conducted for each 100 cubic meters of each air entrained concrete mix.

.2 One standard test per ASTM C457 will be conducted to determine air void spacing factor in hardened concrete for each 100 cubic meters each air entrained concrete mix.

.9 Testing for Reservoirs:

.1 Carry out testing in accordance with ACI-350.1 – Testing Reinforced Concrete Structures for Watertightness.

.2 Plug all drains, shut all necessary valves and test hydrostatic pressure relieve valve.

.3 After concrete has reached specified strength and before application of any coating or lining,, fill the pool slowly to maximum level over several days using water between 5 and 15°C.

.4 Restore water level if down after first 3 days, and let stand for the next 7 days.

.5 Read water surface elevation at 24 h intervals, at 4 points 90° apart.

.6 Place a floating, calibrated, transparent, watertight open container in the pool to account for evaporation and precipitations. Partially fill with water and measure levels at the same 24 h intervals.

.7 Calculate leakage rate. It should meet the HST-050 leakage criteria as defined in by ACI-350.1

.8 If leakage does not meet that criteria, locate and repair any defective areas.

.9 Repeat testing after repairs, until a satisfactory result is achieved.

.10 Inspection and testing by the Agency will not augment or replace the Contractor's quality control nor relieve him of his contractual responsibility.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 The Work of this Section shall consist of the labor, materials and equipment required for furnishing and installing new underground fiber optic cabling between buildings as well as fiber optic cabling within the buildings as part of a complete and operating communications cabling system.

Part 2 Products

2.1 FIBER OPTIC TERMINATIONS

.1 Fiber Optic Patch Panels

.1 Provide a wall mounted patch panel in each building near metering equipment. Location and quantities are dependent on metering network topology.

.2 Each patch panel must;
- a. Accommodate MTP/MPO to LC modular cassettes
- b. Provide adequate space for fiber port labeling
- c. The termination connector modules shall provide standard LC Duplex connectors for user interface

.3 Provide patch panels and MTP termination modules for 100% of installed fiber cabling.

2.2 FIBER OPTIC CABLES

.1 Acceptable Manufacturer: Superior Essex, Corning, Seimon or pre-approved equal.

.2 Fiber Optic Backbone Cable

.1 Pre-terminated Single-mode (OS1) fiber optic cable.
- a. Shall at minimum meet TIA-568-C.3 performance standard
- b. Non-Armoured Plenum Distribution type construction
- c. Strand Count: 6.
- d. MTP/MPO style high-density modular factory termination on both ends
- e. Shall have staggered 12 strand breakout length of 915mm

(36") on both ends for patch panel terminations

f. Enclosed in CSA FT-6 (OFNP) rated thermoplastic jacket.

g. Jacket color: Yellow

h. Polarity (Method A/B/C) shall be clearly identified and documented.

i. Maximum attenuation: 0.5dB/Km @ 1310nm and 0.5dB/Km @ 1550nm.

j. Minimum pull strength of 2670 N (600 lbf) for cables with more than 12 fibers, and a minimum pull strength of 1335 N (300 lbf) for cables with less than or equal to 12 fibers.

k. Support a bend radius of 10 times the cable outside diameter when not subject to tensile load, and 20 times the cable outside diameter when subject to tensile loading up to the cable's rated limit.

l. Provide 3 meters of additional length on each end of each fiber trunk for service loop.

m. Approved fiber glass core source manufactures: Corning, OFS C.

.3 Fiber Optic Cable Shipping Requirements

.1 All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

.2 Top and bottom ends of the cable shall be available for testing on the shipping reel.

.3 Both ends of the cable shall be sealed to prevent the ingress of moisture.

.4 Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:

a. Cable Number, Gross Weight

b. Shipped Cable Length in Meters, Job Order Number

c. Manufacturer Product Number, Customer Order Number

d. Date Cable was Tested, Manufacturer Order Number

e. Cable Length Markings, Item Number

i Top (inside end of cable)

ii Bottom (outside end of

cable)

.5 Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:
a. Manufacturer Cable Number, Manufacturer Product Number
b. Manufacturer Factory Order Number, Customer Name
c. Customer Purchase Order Number
d. Mark for Information Ordered Length
e. Maximum Billable Length, Actual Shipped Length
f. Measured Attenuation of Each Fiber Bandwidth Specification (for lengths > 1000 m)

4. The cable manufacturer shall provide installation procedures, cable pull ratings, and technical support concerning the items contained in this specification.

3 Execution

3.1 INSTALLATION

.1 General

.1 All cable and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All cable and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).

.2 New fiber optic cables shall be installed in cable trays or conduit raceways. Cables shall not be bundled or tied in conduits, or cable trays.

.3 All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, network equipment, mechanical equipment access doors and covers, switches or electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser at a later time by maintaining a working distance from these openings. All cable shall be installed to allow for simple installation and removal of cables in the future.

.4 All cables running outside the building shall be rated for outside plant installation.

.5 All fiber optic cables shall be marked at all pull boxes, cabinets, and terminations. Each cable run between terminating locations shall be one continuous cable (no splices or connections).

.6 The Contractor shall install cable in such a manner as to prevent stretching, kinking or sharp bends. Cable damaged during installation or not passing required testing shall be removed and replaced at no additional cost to Owner.

.7 The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, and too much jacket removed at point of termination.

.8 Minimum bend radius and maximum pulling tension for all cables shall be maintained during and after installation. Install cable in accordance with manufacturer's ratings and instructions.

.9 Cables shall not be installed near power sources or other items where interference could develop. Cables shall not be placed within 12 inches of light fixtures and within 3 feet of motors, transformers, copy machines, or solid state motor starters unless cable is installed in conduit. Contractor shall furnish and install a grounding conduit system where these minimum clearances cannot be maintained.

.10 Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.

.11 Along the shortest possible route run square (horizontal and vertical) to the building lines. Bundle similarly routed cables together and attach by means of clamps or distribution rings. Cable dress and attachment shall minimize obstruction to future installations of equipment, or other cables.

.12 Cable service loops shall be provided at both ends of backbone cable runs.

a. At the termination points, provide sufficient slack to properly dress and terminate cables at the racks and cabinets.
b. A minimum 25 foot service loop shall be maintained at each building entrance and exit.

.13 All interior fiber optic cables shall be installed in tray or conduit above accessible ceilings or in crawl spaces.

a. Install pull boxes, 12” x 12” minimum, as required to limit cable pulls to two 90 degree bends or 100 feet.

.14 Any damage to Owner's existing cabling or existing cable owned by others, caused as a result of work performed under this scope, shall be brought to the Owner's attention and repaired or replaced within 48 hours.

.15 Contractor shall use only cable lubricants recommended by the manufacturer for use with the specific cable construction.

.16 Should a cable become kinked, skinned or stretched during installation, the cable shall be removed and replaced at no additional cost to the Owner. Splicing at points other than those specified will not be acceptable.

.17 Terminate cables to complete metering network.

3.2 FIBER OPTIC CABLE TESTING

.1 Fiber Optic Cable Test Equipment:

.1 Cable tester will be NRTL certified for TIA/EIA TSB95.

.2 Cable testers will be Optical Power Meter and High Resolution Optical Time Domain Reflectometer (OTDR). The cable tester will be NRTL certified for compliance to latest TIA/EIA Standard 568B performance requirements at 850,
1300 and 1550 nm.

.3 Testers will have been calibrated at least one year prior to use on this project. Contractor to provide proof to Owner if requested.

.4 All testing equipment (OTDR, Light Loss, Splicer etc.) will be owned by the Contractor. Contractor must prove ownership of equipment if requested.

.2 Cable segments and links will be tested from both ends of the cable for each of the construction phases. (Verify that cable labeling matches at both ends).

.3 The system will not be considered certified until the tester has acknowledged that the performance of the physical layer of the system has been fully tested and is operational at the completion of the installation phase.

.4 Testing Procedures:

.1 Perform each visual and mechanical inspection and electrical test.

Certify compliance with test parameters and manufacturer's written recommendations. Test optical performance with optical power meter capable of generating light at all appropriate wavelengths.

.2 Prior to testing, all connectors will be properly cleaned with an approved product manufactured specifically for this purpose.

.3 Prior to beginning testing, confirm that all testing equipment is fully charged or operating on building power. If the test equipment power levels drop below 50%, recharge unit or continue testing with a different (fully charged) tester.

.4 Initially test optical cable with a light source and power meter utilizing procedures as stated in TIA TSB-140, ANSI/TIA/EIA-526-7, ANSI/TIA/EIA-526-14A, OFSTP-14A Optical Power Loss Measurements of Installed Multi-mode Fiber Cable Plant and ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss in installed Single-Mode Fiber cable plant.

.5 Measured results will be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with Optical Time Domain Reflectometer (OTDR) to determine cause of variation. Correct improper splices and replace damaged cables at no charge to the Owner.

.5 Single-Mode Fiber Optic Cables:

.1 Tested bi-directionally for length and attenuation at both the short and long wavelengths for Single-Mode fiber (1310 and 1550 nm). This Tier 1 testing shall be completed as specified in TIA TSB-140.

.2 Single-mode fibers will be dual wave length and provide attenuated wavelength of the 1310 nm and 1550 nm. 850 nm for single-mode fiber will not be acceptable under any circumstances.

.6 All cables will be tested after termination using a cable certification tester that contains the test equipment manufacturer’s most current version of firmware.

.7 Test all fiber optic cable segments end-to-end from the fiber optic backbone patch panel in C-13 Control Room to each fiber optic backbone patch panel in each metering network end point.

.8 Broken or faulty strands will not be accepted. Any cable not fully functional with all strands usable will be replaced at no cost to the Owner.

.9 Upon completion of testing, all connectors will be capped with a product

made for that specific function by the connecting hardware manufacturer to prevent the contamination of the fiber from construction debris or other foreign objects.

.10 Test Results:

.1 The test results information for each link will be recorded in the memory of the field tester upon completion of the test. The tester will be capable of storing test data in either internal or external memory. The external media used will be left to the discretion of the user.

.2 Test results saved by the tester will be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.

.3 The test results information for each link will be recorded in the memory of the field tester upon completion of the test. The tester will be capable of storing test data in either internal or external memory. The external media used will be left to the discretion of the user.

.4 Test results saved by the tester will be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.

.5 Optional formats of data reporting are: comma separated variable (.csv), Portable Document File (.pdf) or compatible, plain text (.txt), or hypertext markup language (.html/.htm).

.6 Test results will include the following:

a. Location of fiber pull i.e. (Equipment Room # to Control Room #)
b. Patch panel # and location
c. Connector type
d. Distance
e. Wavelength tested
f. Technician who performed the testing

.11 The Departmental Representative reserve the right to observe testing and/or randomly sample completed links for conformance to project specifications.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 20 00: Concrete Reinforcing.

.2 Section 03 30 00: Cast in Place Concrete.

1.2 REFERENCES

.1 All referenced standards to be the current edition or the edition referenced by the applicable Building Code in force at the time of building permit application, as noted on Structural Drawings.

.2 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 W59, Welded Steel Construction (Metal Arc Welding).

.3 ASTM International Inc.:

.1 ASTM A36/A36M, Standard Specification for Carbon Structural Steel.

.2 ASTM A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) coating on Iron and Steel Products

.3 ASTM F3125/F3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPA) Minimum Tensile Strength, Inch and Metric dimensions

.4 ASTM A500, Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

.4 Canadian Geotechnical Society:

.1 Canadian Foundation Engineering Manual.

1.3 QUALITY ASSURANCE

.1 In accordance with Section 01 43 00 – Quality Assurance.

.2 Qualifications:

.1 Companies supplying and installing helical piles to have minimum 5 year experience working with this type of foundations.

.2 Company installing helical piles to be certified by the supplier.

.3 Welding to be performed by a firm certified by the Canadian Welding Bureau under the requirements of CSA W47.1, Division 1 or 2.

.4 Welders to be CWB approved.

1.4 QUALITY CONTROL

.1 Submit in accordance with Section 01 45 00 - Quality Control.

.2 Source Quality Control Submittals:

.1 Submit mill test reports showing chemical and physical properties of helical piles to be incorporated in the project.

.3 Tolerances:

.1 Maximum deviation at cut-off elevation from position on plan: 65 mm (2½")

.2 Maximum deviation from cut-off elevation: +12 mm, -50 mm (+½", -2")

.3 Maximum deviation from plumb: 2%

.4 Projection over legal boundary: zero

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

.1 Provide drawings of helical piles to be installed.

.2 Show on drawings:

.1 Helical piles types, sizes and layouts.

.2 Material specifications.

.3 Size of pile shaft and number and diameter of helical plates.

.4 Inclination.

.5 Cut off elevation.

.6 Details of attachment to structure.

Part 2 Products

2.1 MATERIALS

.1 Helical pile shafts, blades and accessories: to CSA G40.21, hot dip galvanized per ASTM A123/A123M.

Part 3 Execution

3.1 SITE CONDITIONS

.1 Determine any potential interference with existing services and protect from disruption and damage

.2 Protect existing structure from damage.

3.2 FOUNDATION CONDITIONS

.1 The Geotechnical Report is not represented as a complete description of site conditions but only as to what was found in borings at indicated locations. The Owner, Architect and WSP-S assume no responsibility for any interpretation or deduction that the Contractor may make from the data. The Contractor to establish the nature of observable conditions to his own satisfaction and has the right to obtain additional information, if necessary in his judgment.

.2 Notify WSP-S if subsurface conditions are found to differ materially from those indicated in the Contract Documents or geotechnical report.

3.3 OBSTRUCTIONS

.1 Obstructions may be encountered during installation of helical piles.

.2 All obstructions are to be confirmed by the Geotechnical Engineer, who will track and certify the time required for obstruction removal.

.3 The cost to extract and re-install foundation anchors due to obstructions will be paid by the Owner based on the time required to do the work, plus the material cost to replace the damaged piles. The method used must be acceptable to the Geotechnical Engineer.

.4 Have all the equipment required to do this work readily available for the duration of the anchor installation.

.5 Delay time resulting from not having the required equipment readily available, or from breakdown of the equipment will be at the cost of the Contractor.

.6 Repair and replacement costs for damaged equipment shall not be considered extras.

.7 The time required to extract and reinstall the anchors cannot be claimed to extend the overall construction schedule.

3.4 INSTALLATION

.1 Do not damage adjacent structures. Make good any damage caused by pile installation and operations.

.2 Hold piles securely and accurately in position while installing, and apply sufficient down pressure to advance them. Install in a smooth, continuous manner.

.3 Prevent load transfer between soil and the portion of the piles above the level of the competent soil to be used for bearing by providing bitumen coating or permanent smooth sleeves.

.4 Provide plain extension material as required to advance piles to the required depth. Extensions to be coupled to helical pier using high strength structural bolts.

.5 Monitor installation torque throughout the installation process.

.6 Terminate pile installation when the minimum installation torque and the minimum depth requirements are satisfied. Record termination torque.

.7 If the minimum torque requirement has not been satisfied at a pile's minimum depth level, the contractor has the following options:

.1 To advance the pile deeper using additional plain extension material until the specified torque level is obtained.

.2 To remove the pile and to install another pile with larger and/or more helices. This revised pile to be installed at least 900 mm (3') beyond the termination depth of the original pile.

.3 To propose installation of additional piles and submit for WSP-S review.

.8 If the maximum torque rating of a pile and/or the installing unit is reached prior to satisfying the minimum depth requirement, remove the pile and install another pile with smaller and/or fewer helices. The revised pile to be installed at least 900 mm (3') beyond the termination depth of the original pile.

.9 Cut-off piles neatly and square at elevations indicated.

.10 Touch up all cuts, drills welds and other damage to galvanizing with Zinc Rich paint in accordance to SSPC Technology Guide No. 14.

.11 Keep accurate records and submit to WSP-S at the completion of installation. Records to include:

.1 Deviation from specified location and plumb.

.2 Type of installation equipment used.

.3 Installation torque measured at 300 mm (1') increments.

.4 Bottom elevation and cut off elevation.

.5 Ground surface elevation

.6 Load testing results.

END OF SECTION 31 66 15