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INSTALLATION OF CIVIL WORKS
FOR UNDERGROUND DISTRIBUTION

REVISION SHEET

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0	Original Document	2002-09-23	cp/df
1	Added sections 2.1.10 and 1.3.3 and modified section 3.1 2 nd paragraph	2002-12-17	cp/df
2	Modified the specifications Removed H&S Contractor Management	2006-02-01	es/csm
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7	General specification Update	2012-05-04	kp/csm
8	General Update, Added Table 1, Update to Concrete Requirements	2016-01-18	mw/cp/se/csm
9	Backfilling, revised section 6.1.5 Updated concrete requirements, add Bagged concrete, update grounding Removed waterproofing, update backfill Requirements,	2017-03-15	cp/mw/csm
10	Inspection requirements for breaking out Duct banks, slump on site adjustments to C-XL concrete, Slump value change on C-XL and C-1 concrete, updated references, remove adding water clause from 7.2, reintroduce air entrainment for pole laterals.	2020-11-20	mw/so/mm

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1. Introduction

Hydro Ottawa requires the services of a qualified or approved contractor for the installation of civil works for its underground distribution system.

2. References

- ASTM - C131/C131M -Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine Table 7-1: Graduation Table.
- City of Ottawa – By-Laws (ottawa.ca/en/licence_permit/bylaw/a_z/index.html).
- City of Ottawa – Greening Guidelines for City Roads.
- CSA - A23.1/A23.2: Concrete Materials and Methods of Concrete Construction/ Test Methods and Standard Practices for Concrete.
- CSA - C22.2 No. 211.1: Rigid Types EB1 and DB2/ES2 PVC Conduit.
- CSA - C22.3 No. 7: Underground Systems.
- CSA - S6: Canadian Highway Bridge Design Code.
- Hydro Ottawa – PRO-MS-008.00: Contractor OHSE Management Program.
- Hydro Ottawa - DFS0002: Electrical Distribution As-Built Construction Drawings.
- Hydro Ottawa – DGD0010 – Project Coach.
- Hydro Ottawa – GQS0002: Civil Contractor Qualifications To Work On or Around Hydro Ottawa Electrical Underground Distribution System.
- Hydro Ottawa – UDS0013: Temporary and Permanent Support of Existing Duct Bank When Undercut By An Excavation.
- Hydro Ottawa – UDS0022: Protecting Electrical Distribution Plant & Support Structures from Vibrations Caused by Construction Activity.
- Hydro Ottawa – WUS0003 – Exposing Underground Cable
- Hydro Ottawa – WUS0004 – Breaking out Duct from Around Cable
- Hydro Ottawa – WUS0005 – Excavating in The Vicinity of Direct Buried Cable.
- Hydro Ottawa – WUS0008 – Installation of Split Bell Ends Around Underground Conductors
- IHSA – Utility Work Protection Code (UWPC)
- Ontario Provincial Standard Specification – OPSS 1002 Materials Specifications for Aggregates – Concrete.
- Ontario Provincial Standard Specification – OPSS 1010 Materials Specifications for Aggregates – Base, Sub-base, Select Sub-grade, and Backfill Material.
- Ottawa UCC – Guidelines for Utility Pedestals within the Road Right-Of-Way.

3. Scope

These specifications prescribe the general requirements for the installation of an underground system of ducts and cable chambers to be used for the distribution of medium and low voltage electricity.

This document excludes any standard work instructions, safety requirements, electrical work protection, or environmental requirements to facilitate the installation of the civil works.

4. Definitions

“Cable Chamber” has the meaning ascribed in Hydro Ottawa’s Conditions of Service.

“City” means City of Ottawa and the Village of Casselman.

“Civil Works” means construction and excavation up to but excluding electrical works.

“Clean Native Material” – means native material free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 50 mm in any dimension and other deleterious material.

“Contract Area” means the location, described by Hydro Ottawa, where the Contractor is responsible to perform the remediation within this area.

“Contractor” means a party in contract with the Hydro Ottawa or Third party.

“Critical Root Zone” means the area of land within a radius of 100 mm from the trunk of a tree for every 10 mm of trunk diameter, where the trunk diameter is measured at a height above grade of 1200 mm for trees of 150 mm diameter or greater, and at a height of 300 mm for trees of less than 150 mm diameter.

“Granular A” means aggregates consisting of crushed rock composed of hard, uncoated, fractured fragments, produced from rock formations or boulders of uniform quality, or a mixture of crushed gravel, sand and fines composed of hard, durable, uncoated particles, produced from naturally formed deposits, or crushed slag produced from iron blast furnace or nickel slag. Granular A aggregates may also consist of a blend of any combination of: natural aggregates, reclaimed Portland cement concrete, and reclaimed asphalt pavement material. The final blend shall not contain more than 30% percent by mass of asphalt coated particles as determined by percent of asphalt coated particles, LS 621.

“Hydro Ottawa” or “HOL” means Hydro Ottawa Limited.

“Ready Mix Concrete” means concrete that was mixed at a concrete plant and not on the construction site.

“Work” means the whole of the activities, services, materials, equipment, software, matters and things required to be done, delivered or performed by the Contractor in accordance with the terms of the Contract.

5. General Conditions

5.1. Reinstatement

The permanent reinstatement of **public** roadway and sidewalk surfaces is to be done by the Contractor. The Contractor shall be responsible for the maintenance of the cuts until they have been reinstated. During this time the contractor shall ensure that the trench grade is kept reasonably close to the surrounding grade so that vehicles and pedestrians can negotiate the cuts at normal speed and without hazard.

- The reinstatement work shall be carried out in accordance with current road authority bylaws and standards.
- Hydro Ottawa, the road authority, and the Contractor prior to starting excavation shall inspect all areas of proposed work. This is to ensure that in order to make known to all parties the limits of the proposed work and the existing conditions of the affected municipal surfaces. Reinstatement of

municipal surfaces outside the established limits shall proceed only after approval by Hydro Ottawa.

- All reinstatement of public roadways and walkways done by the Contractor shall be subject to inspection and approval by the road authority Engineer or their duly authorized representative. Only after this approval will Hydro Ottawa accept an invoice for this work.

The permanent reinstatement of **private** driveways and walks, lawns, gardens, etc. whether or not they are located on public or private property, shall be done by the Contractor, who shall maintain these areas until they have been restored to their original condition or better and to the satisfaction of the party involved. All such reinstatement shall be included in the Contractor's unit prices.

Where sod must be removed, it shall be handled and replaced carefully. If the original sod is unsuitable for re-use, new sod of the type removed shall be used. Topsoil shall be kept separate from other excavated material so that it can be replaced properly. When excavating through a lawn, the excavated material shall be placed on a tarpaulin or canvas to prevent damage to the lawn. If there is a possibility of ruts being formed by moving heavy equipment over a lawn or newly seeded area, a runway of planks shall be laid.

All permanent asphalt reinstatement of driveways and walks shall be done with hot mix and rolled with an acceptable roller to provide quality and appearance equal to or better than the original.

If any repair of the service conductor on the Customer's Property is required and Hydro Ottawa is responsible for such repair, Hydro Ottawa shall reinstate outdoor surfaces with sand, gravel, and/or soil. It is the Customer's responsibility to repair/replace vegetation (e.g., shrubs, trees, lawn, gardens, etc.), hard surfaces, obstacles (e.g., decks, fences, patios, sheds, pools, play structures, etc.), foundations unless there is a written agreement that provides for different level of reinstatement.

After a job on a public road right-of-way has been completed, and before the Contractor moves the work force away from the area, the road authority inspector shall be called to the site to verify the job has been cleaned up satisfactorily.

5.2. Protection of Trees and Construction Activities Around Trees

The Contractor shall abide by legislative (federal, provincial, or municipal) requirements on tree protection, working around trees, and guidelines when installing civil works around trees. Where legislative direction is not in place, the Contractor shall meet the following requirements.

- a. During excavation activities, the Contractor shall ensure that all equipment stays within the confines of the work area so as not to disrupt any turf or tree roots unnecessarily. The storage of equipment and vehicles around any trees within the right of way is prohibited.
- b. The Contractor shall remove all excavated material immediately and not place it on grass or near trees for any length of time. This also applies to imported material, *i.e.* topsoil.
- c. The contractor shall reinstate all disturbed turf to its original state immediately upon completion of work.

- d. The Contractor shall protect all trees whose critical root zone are within 5 metres of the work area by installing snow fence outside of the tree's critical root zone and by protecting the trunk of the trees with wood lath fence to a height of 2400 mm.
- e. The Contractor shall not store fuel within the critical root zone of any tree, and exhaust fumes from all equipment must not be directed towards any tree's canopy.
- f. The Contractor shall take all steps necessary to avoid mechanical damage when operating raised dump boxes or large excavating equipment in proximity to trees, which overhang the road allowance.
- g. Hydro Ottawa may require the Contractor to place ductwork by tunnelling or boring under large diameter tree roots.

Wherever possible, the Contractor shall consult with the owner's arborist to minimize tree related conflicts. Where tree damage does occur, it must be reported immediately to the owner's arborist.

Where tree removal is required, Hydro Ottawa and its Contractor shall consult with the tree owner prior to its removal unless there is an immediate safety reason.

5.3. Control of Vehicular and Pedestrian Traffic

All federal, provincial, and municipal laws and regulations shall be met to ensure safe traffic control in/or around the work site.

5.4. Rock Removal Measurements

The term "rock" refers to any solid rock or boulder that may be adequately removed only by the use of quarrying methods recognized and approved by Hydro Ottawa. For measuring rock, the following will be used:

- The maximum butt diameter of a pole plus 150 mm.
- The diameter of a duct plus 25 mm. The width of duct bank as specified plus 50 mm.
- The outer dimensions of a cable chamber plus 300 mm.
- The outer dimensions of a transformer base plus 460 mm.

Ducts are measured from one end of the duct run to the other along its centre-line in linear metres.

Trenches are measured from pole to pole, pole to duct, duct to cable chamber, etc., along the centre-line in linear metres.

Pole risers include the specified conduits on the pole; the ninety-degree bends at the base of the pole, and the concrete encasement.

Hydro Ottawa shall measure the total area of reinstatement in the field upon the completion of the work, in the presence of the successful contractor, as a basis for payment.

5.5. Shoring

It is the responsibility of the contractor to provide adequate shoring for all excavations and meet all Ministry of Labour requirements. The contractor is to have on site engineer approved drawings describing the type of shoring to be used and method of installation.

5.6. As-Built

The contractor shall provide Hydro Ottawa with digital as-built drawings as per Hydro Ottawa's DFS0002: Electrical Distribution As-Built Construction Drawings. Payments will be based on this as-built information. Site visits will be made by Hydro Ottawa to verify dimensions submitted. If major errors are found, charges will apply as stated in the above noted standard.

6. Construction Specifications

6.1. Ducts - Concrete Encased

6.1.1. Location

The construction general lay-out drawings show the number of ducts and their approximate location. No cut or excavation shall be made until the exact location of the trench has been given to the contractor in the field by Hydro Ottawa. The contractor shall set stakes or lines to indicate this location. The locations of proposed plant may be adjusted by Hydro Ottawa to eliminate conflicts with driveways, walks and other utilities.

All ducts shall be grey, black, or red in colour. Grey duct is the normally used unless the alternate colours are approved for the specific project by Hydro Ottawa.

6.1.2. Excavation

The trench shall be of a minimum width to allow for the indicated duct installation and to accommodate trench shoring as required under the Occupational Health and Safety Act. Cuts in roadways and sidewalks shall be performed in such a manner and with such type of equipment as to avoid breaking the surrounding pavement.

In all cases where the excavated material is not to be re-used for the backfilling of the trench, such material will be loaded immediately and removed from the site.

6.1.3. Grading

Whenever possible and unless specified otherwise, there shall be a minimum of 760 mm cover from the top of the concrete envelope to the finished grade, except where the duct enters the manholes, in which case the cover maybe greater. If depth of minimum cover may not be achieved due to rock or other obstructions, the installer shall obtain direction and approval from Hydro Ottawa's Inspector.

The bottom of the trench shall be graded so that the duct run will have a rise or fall of at least 2.5 mm/m toward the next manhole or from the high point in

the section toward the manholes. In all cases, the ducts shall have no sags or depressions in which water may accumulate.

In cases where fill is required to bring the bottom of the trench to the proper grade, special care must be taken to ensure that this fill is thoroughly tamped. Where the depth of the fill exceeds 150 mm, Granular A must be used.

Where possible, no ducts shall be laid or concrete placed until the trench has been opened between termination points of the duct run. Where this is not possible, test holes shall be opened at points along the line of the proposed ducts so that the nature and location of obstructions may be determined. The final line of grade can thus be laid out. In all cases, Hydro Ottawa shall approve the grade before ducts are laid or concrete placed.

6.1.4. Laying of Ducts

Additional duct banks that are adjacent/longitudinal to an existing duct run shall be constructed allowing 85 mm between the new duct and the existing concrete envelope.

Duct runs shall be constructed such that the duct run falls towards the cable chamber for drainage.

Forms constructed of tight form lumber and adequately braced, shall be used for the sides of the duct run. Only separators that have been approved by Hydro Ottawa shall be used. Zoombord, a cardboard forming material specifically designed for formwork, may also be used in place of the plywood forming.

Bell forms shall be used for duct entrances into manholes, and these entrances shall be finished smooth immediately after removal of the forms.

To prevent floating and misalignment of ducts the ducts shall be tied together every 1500 mm with No. 18 AWG steel wire. The concrete must be carefully vibrated around and between the ducts to eliminate all voids. Care should be taken when vibrating between ducts to ensure any couplings do not come apart. To avoid separation of aggregates do not over-vibrate between the ducts.

Construction joints in the duct run are to be avoided. Hydro Ottawa shall approve the length of the duct run to be poured and shall be the maximum possible length depending on field conditions.

If work on a duct section must be stopped for any reason, the exposed end of the section must be covered immediately with burlap or tarpaulin to prevent dirt, etc., from falling in on the fresh concrete. On continuing the work, the face of the concrete must be thoroughly washed down before any new concrete is placed.

If freshly placed concrete is to be left unguarded, it shall be covered in a manner satisfactory to Hydro Ottawa.

6.1.5. Backfilling

All backfilling must be done in conformity with the applicable municipal, provincial and federal regulations, and as further detailed in this specification and on Hydro Ottawa drawings. In no case shall rock or broken

concrete be used as backfill. When installing ducts under hard surfaces (concrete, asphalt or brick pavers) only Granular A material is to be used. Under soft surfaces (sod), Clean Native Material may be used only when approved by the Hydro Ottawa inspector. All backfill material used shall be as specified in Section: 7.4-Backfill.

Where concrete encased ducts are being installed in a new residential subdivision, as part of a multi utility joint-use trench, clean sand backfill may be used if the following conditions are met;

1. Duct bank is not installed under hard surfaces,
2. Duct bank is not in the core area,
3. Duct bank is not installed along a collector or arterial road, and;
4. There is no three phase circuits installed in the ducts

In order to obtain the most efficient compaction, the material in the trench shall contain at least 7% moisture by weight before compaction. It shall be placed and compacted in approximately 150 mm lifts with appropriate compacting equipment. All granular materials shall be compacted to a degree of compaction not less than 95% of standard proctor density. Confirmation of compaction may be required by the contractor and is at the discretion of the Hydro Ottawa inspector.

6.1.6. Pole Risers

Pole risers shall be placed at the same time as the ninety-degree bends. They shall be placed straight and in line with the edge of the pole. If more than one riser is to be installed, they shall be placed so their tops are even with one another. If the intended cable pole is not straight, or is deteriorated, Hydro Ottawa shall be notified.

The concrete shall extend above grade 760 mm. All forms shall be removed after the concrete has set.

6.1.7. Primary Service Ducts

Primary service ducts shall be concrete encased and shall be installed in the exact position indicated by Hydro Ottawa. Their position is normally indicated by an appropriate mark on the face of the building or by a stake. These ducts shall be connected to sleeves at the building wall. If no sleeves exist, the building wall is to be core drilled with 127 mm diameter holes and steel sleeves installed to extend the service ducts to the inside of the building wall. Where no building exists or the duct entry is on private property, the ducts are to be extended to the property line and capped. Care should be taken to ensure that there are no obstructions to prevent access to the capped ducts at a later date.

6.1.8. Cleaning and Testing

Before the job will be accepted, the contractor must test each duct, by passing through it first with a brush then a mandrel of suitable diameter to be supplied by Hydro Ottawa. Table 1 provides the diameter specifications with both the brush and mandrel for various diameters of duct. An 8 mm polypropylene rope is to be placed in each duct. This rope is to be supplied and installed by the contractor. The ducts shall be cleaned of all extraneous matter that might affect the pulling of the cable. The Hydro Ottawa inspector must be present when the ducts are being tested. Except as noted, the contractor will be required to supply the rods or other suitable means for cleaning and testing the ducts in the above mentioned manner.

At the direction of Hydro Ottawa, some or all ducts may require flat line rope instead of the 8 mm polypropylene rope. Flat line rope shall be supplied by Hydro Ottawa

Table 1: Wire Brush & Mandrel Diameter Coordination with Duct Size

Duct Diameter	Wire Brush Diameter	Steel Mandrel Diameter
76 mm [3"]**	70 mm [2.75"]	70 mm [2.75"]
89 mm [3.5"]**	82 mm [3.25"]	82 mm [3.25"]
102 mm [4"]	95 mm [3.75"]	89 mm [3.5"]*
125 mm [5"]**	121 mm [4.75"]	121 mm [4.75"]

*Mandrel size as per UZS0001

**Non-standard duct sizes

6.1.9. Breaking-out existing Ducts with Cables

Before any work is to be done on an existing Hydro Ottawa duct bank, the position of all cables in the duct bank are to be verified by the Hydro Ottawa inspector. Before work is started on an existing Hydro Ottawa duct bank, the Hydro Ottawa inspector shall be satisfied that the work will be done safely and Hydro Ottawa plant will be protected. The Hydro Ottawa inspector may be required to stay on site or may allow work to proceed without their presence. The Hydro Ottawa representative shall verify that the appropriate Work Protection is in place as per IHSA UWPC. (Isolate as many cables as possible and obtain Hold-offs on all other energized cables.) The contractor shall understand and acknowledge the extent of their electrical work protection before work is commenced.

A wide breaker point is to be used to break out the concrete around the ducts to avoid any possible puncturing of the cables. After removal of the concrete, the ducts are to be broken by hand methods using a small sledgehammer. As soon as it is feasible, a steel cable guard is to be placed in the duct, over the cable, to protect the cable from any possible damage. At no time should cables be left unprotected. Exposed cables are to be placed in split duct as soon as possible or otherwise protected as specified by the Hydro Ottawa Inspector. See standard work method WUS0004 "Breaking Out Duct From Around Cable."

6.2. Structures (Manholes, Transformers Bases, Underground Vaults, & Hand Holes)

6.2.1. Location

The construction general lay-out drawings show the type of cable chamber structure (hand hole, manhole or transformer vault) and its approximate location. The contractor shall provide wooden templates of the size and shape of the outside of the structure walls when required by Hydro Ottawa for the accurate location of a structure. No excavation is to be undertaken until the exact location has been determined by Hydro Ottawa. No expandable foam is to be used to temporarily block ducts during structure construction.

6.2.2. Excavation

In all cases where the excavated material is not to be re-used for backfilling, such material will be loaded immediately and removed from the site.

The excavation shall be of minimum dimensions to allow for the installation of the indicated structure. Cuts in roadways and sidewalks shall be performed in such a manner and with such type of equipment as to avoid breaking the surrounding pavement.

The contractor shall provide an excavation suitably shored or sloped in accordance with local safety requirements, de-watered and excavated true to line and grade.

In the case of a cast in place structure, no formwork shall be placed until the size and depth of the excavation have been approved by Hydro Ottawa.

For precast structures, a minimum clearance of 150 mm shall be provided on all sides between the shoring and sides of the excavation and the exterior walls of the structure. No bracing shall obstruct the placing of the structure.

All loose material shall be removed from the bottom of the excavation and it should be finished to required grade with a minimum of 76 mm of compacted Granular A. Where ground condition requires considerable over excavation of the base, Granular A should be placed in 150 mm lifts until final grade is reached, each lift being compacted to achieve 95% standard Proctor density. If in clay, a bedding of 150 mm minimum of Granular A is required.

6.2.3. Manhole Sump

Sumps are to be installed in all manholes or transformer vaults. Wherever possible, they should be located at the sidewall directly below the chimney.

6.2.4. Grounding

Manholes: One continuous piece of 2/0 stranded bare copper wire 7m long to be installed through wall of the structure with 1m inside manhole. The remainder of the wire is to be placed under the adjoining duct structure or under the manhole below the gravel base. If, during the excavation for a manhole or transformer vault, a water main or water service is uncovered, Hydro Ottawa may, at its discretion, run a grounding connection to it. Only Hydro Ottawa will install this connection and the Contractor must be prepared to coordinate his operation with this work without claiming any additional payment.

Hydro Ottawa manhole frames are not grounded.

Hydro Ottawa switching, transformer or other energized equipment chamber frames shall be grounded.

All customer owned manhole frames are to be grounded.

6.2.5. Backfilling

All backfilling must be done in conformity with the regulations of the road authority. The backfill shall consist of material as specified in Section: 7-4-

Backfill. All backfill shall be placed and compacted in approximately 150 mm lifts using appropriate compacting equipment. All granular material shall be compacted to a degree of compaction not less than 95% of standard proctor density. In order to obtain the most efficient compaction, the material in the excavation shall contain at least 7% moisture by weight before compaction. Conformation of compaction may be required by the contractor and at the discretion of the Hydro Ottawa inspector. Clean Native Material may not be used.

6.2.6. Construction of Cast in Place Structures

6.2.6.1. Construction Joints

The concrete for the walls and roof of all manholes shall be placed in one continuous operation so as to avoid any construction joints.

Construction joints will be permitted in transformer vault structures, as indicated on the relevant drawings. However, the number of construction joints shown is intended as a maximum. If the contractor's technique of construction permits, construction joints should be avoided. Any construction joint must be provided with a key and "Durajoint", (or equivalent) water stop. In any case, the Contractor must have their proposed method of construction approved by Hydro Ottawa.

6.2.6.2. Floors

The floor shall be a separate pour of reinforced concrete; wood trowel finished, and shall slope uniformly at 4 mm/m to the sump.

A layer of 150 mm of Granular A will be placed on the bottom of the excavation before placing the concrete floor.

6.2.6.3. Walls

For the construction of reinforced concrete walls, the contractor shall furnish and place the necessary inside and outside forms, which shall be smooth and of such construction that they will not be forced out of position or shape by the process of placing the concrete. Inside forms shall be of approved material and design. Inserts shall be placed in the forms as shown on the relevant drawing.

The concrete shall be thoroughly tamped or spaded as it is placed. All inside surfaces shall be smooth and free from voids. All necessary pointing shall be done immediately after removal of forms.

All concrete supplied for the manhole walls shall be vibrated

6.2.6.4. Roof

For the construction of the reinforced concrete roof, the forms shall be smooth and of such construction that they will not be forced out of position or shape by the process of placing the concrete.

The concrete shall be thoroughly tamped, vibrated, or spaded as it is placed. All necessary pointing shall be done immediately after removal of forms.

The frame for the indicated openings shall be set so that the respective covers will conform to the finished grade.

The roof form in roadway structures shall remain in place for at least one week after the concrete has been placed, and no traffic shall be allowed over the structure during this same period.

6.2.6.5. Chimney

The chimney is the opening extending from the manhole ceiling to the top of the cover frame at surface grade. The part from the top of the manhole roof to the bottom of the cover frame shall be circular in shape and constructed of concrete. All manhole frames are to be bolted.

6.2.6.6. Formwork Removal

As per CSA A23.1 Clause 6.5.3.5 Formwork removal "Formwork shall be left in place until concrete has attained sufficient strength to support its own weight adequately, together with the construction loads likely to be imposed."

The minimum recommended stripping time of formwork for vertical surfaces is 24 hours, providing the curing is in accordance with CSA A23.1 Clause 6.5.3.5 Note 2.

6.2.7. Placement of Pre-cast Structures

6.2.7.1. Placement

Pre-cast structures shall be installed in the presence of a Hydro Ottawa Inspector.

6.2.7.2. Bedding

Bedding to be 150 mm of 15 mm clear stone. If in solid rock, a bedding of 75 mm of 15 mm clear stone can be used.

6.2.7.3. Finishing

All debris and dirt must be removed from the structures after they are placed.

6.3. Maintenance\Rebuild

Prior to commencement of any work on or in an existing Hydro Ottawa manhole, the Contractor and the Hydro Ottawa Inspector shall inspect the interior of the structure to ensure that all cables are clear of the work area. Any required cable rearrangement is to be done by Hydro Ottawa only. If cable relocation is not possible, suitable protection will be required as instructed by the Hydro Ottawa inspector. It is the Contractor's responsibility to ensure that all arrangements have been made prior to the start of any work. All duct entries through the existing walls shall be core drilled. Suitable cable protection will be required on the inside wall surface of the manhole. Where a manhole roof and/or wall section is to be rebuilt, a

false roof is to be built inside the structure. The false roof is to be of sufficient strength to support the weight of men working on it and debris falling from the roof section being worked on. A removable section must be provided in the false roof at least 820 mm x 820 mm to allow for access to the cables. Under no circumstances is the false roof to be supported on any cables.

6.4. Abandonment

When a manhole is to be abandoned in place, the roof is to be removed and the walls are to be broken out to the road sub grade. All duct entries are to be plugged with concrete. The cavity and excavation is then to be backfilled with Granular A compacted to 95% standard Proctor density or non-shrink backfill, in such a manner that settlement will not occur.

When a manhole is to be removed by others, Hydro Ottawa shall verify the manhole is electrically safe and indicate known designated substances (see GDG0010 – Schedule D9) before Hydro Ottawa transfers the abandoned structure to others for removal.

7. Material Specifications

7.1. Concrete - Mixtures

7.1.1. Ready-Mix Mixture Requirements for Concrete used in Cast in Place Cable Chamber

Concrete used in the construction of cable chamber structures is to be 'High Performance Concrete.'

Concrete designated as 'High Performance Concrete' shall meet the following criteria.

- a. An exposure class of C-XL as per CSA A23.1/A23.2.
- b. Chloride ion penetrability of <1000 coulombs within 91 days
- c. A waterproof additive, such as Xypex Waterproofing (or equivalent) is to be mixed into the concrete at 2%.
- d. A superplasticizer additive.
- e. Air entrainment of 5-8% as specified in CSA A23.1/A23.2 Table 4.
- f. Minimum compressive strength shall be of 50 MPa at 56 days test.
- g. Target slump shall be no less than 100mm
- h. Maximum water/cement ratio of 0.4.
- i. Aggregate size shall be 14 – 20 mm.
- j. For outside temperatures between 4°C and -7°C, a manufacturer recommended amount of cold weather mix additive, such as WeatherMix or equivalent, shall be added. Refer to section 7.2.1 for information on cold weather concrete procedures.

In no case shall the placing temperature of high-performance concrete exceed 25°C. Ice may be required in order to keep the temperature within this limit.

Hydro Ottawa specifies a minimum slump for High Performance Concrete. Contractors at the time of ordering can specify a particular slump above this minimum that they prefer. By specifying the slump at the time of order, the concrete supplier can ensure that the concrete mix is designed for that slump.

If the concrete arrives on site below the target slump indicated on the delivery ticket, then water can be added on site to raise the slump to the target slump

Water added on the job site must meet the following.

1. Slump of the concrete shall be tested as per CSA A23.2-5C.
2. Target slump on delivery ticket shall not be exceeded
3. Batch time has not exceeded 60 minutes.
4. Specified water to cement ratio is not exceeded
5. The supplier of the concrete shall instruct the amount of water that can be added. Supplier shall guarantee on the delivery ticket that the concrete meets all performance requirements of the original batch.
6. Not more than the lesser of 16 L/m³ or 10% of the mixing water shall be added.
7. After addition of water, the mixer drum shall be turned at mixing speed for at least 30 revolutions (or equivalent time limit) after the addition of water.
8. The amount of water added and by whose authority shall be recorded on the delivery ticket.

Hydro Ottawa will not accept any concrete if the concrete supplier will not accept responsibility for it.

7.1.2. Ready-Mix Mixture Requirements for Concrete used for Cable Chamber Collars and Handholes

For collars and handholes where the amount of concrete required is too small for High performance concrete, the concrete shall meet the following criteria

- a. An exposure class of C-1 as per CSA A23.1.
- b. Chloride ion penetrability of <1500 coulombs within 91 days
- c. A waterproof additive, such as Xypex Waterproofing (or equivalent) is to be mixed into the concrete at 2%.
- d. Air entrainment of 5-8% as specified in CSA A23.1/A23.2 Table 4.
- e. Minimum compressive strength shall be of 35 MPa at 56 days test.
- f. Target slump shall be no less than 100mm.
- g. Maximum water/cement ratio of 0.4.
- h. Aggregate size shall be 14-20mm.
- i. For outside temperatures between 4°C and -7°C, a manufacturer recommended amount of cold weather mix additive, such as WeatherMix or equivalent, shall be added. Refer to section 7.2.1 for information on cold weather concrete procedures.

7.1.3. Ready-Mix Mixture Requirements for Concrete used for Duct Banks and Pole Laterals

Concrete for duct banks and pole laterals shall meet the following criteria

- a. Minimum compressive strength of 20MPa at 28 days test
- b. Maximum aggregate size shall be 10mm.
- c. Maximum slump of 120 mm.
- d. Air entrainment of 6-9% as specified in CSA A23.1/A23.2 Table 4 for pole laterals
- e. For outside temperatures between 4°C and -7°C, a manufacturer recommended amount of cold weather mix additive, such as WeatherMix or equivalent, shall be added. Refer to section 7.2.1 for information on cold weather concrete procedures

7.1.4. Bagged Concrete Mix Requirements for Minor Repairs

For minor repairs where the amount of concrete required is insufficient to make use of Ready-Mix concrete, than bagged concrete mixed on site can be used.

Bagged concrete shall give performances properties equal to Ready-Mix mixture requirements for Concrete used for Cable Chamber Collar Rebuilds and handholes.

An example product is Vandex Uni Mortar 1 ZSR from Euclid Chemical.

7.2. Concrete – General

Target slump can be adjusted from the above values by additives included by the Ready-Mix supplier.

Ready-mix concrete that has not been placed within a maximum of 120 minutes from the time of batching shall be rejected.

Concrete temperature shall be between 10°C and 30°C degrees, except for high performance concrete which has a maximum temperature of 25° C

Concrete shall be deposited in the forms in a manner that prevents segregation and in a location as close as practicable to its final position. Lateral movement of concrete, which can cause segregation, shall not be permitted. Note that with air-entrained concrete, significant free-fall drops can cause reductions in air entrainment. The placed concrete shall be thoroughly compacted and worked around reinforcing and ducts and into all parts of the forms.

Prior to the pouring of any concrete, the Hydro Ottawa inspector is to be notified. It is at the discretion of the inspector to determine if his presence is required at the time of the pour.

Concrete for all Cable Chambers shall be tested as per CSA A23.1/A23.2.

When concrete is to be poured at temperatures below 4°C, then the 'Cold Weather Concrete Procedures' as per clause 7.2.1 shall be used. If the temperature is below -7°C, the Hydro Ottawa Inspector is to be contacted to see if special arrangements can be made to proceed with the pour at the lower than acceptable temperatures. Contact is to be made at least 48 hours prior to the pour.

Concrete surfaces shall be cured for 3 days at a minimum temperature of 10°C, or for the time necessary to attain 40% of the specified strength in accordance with CSA A23.1 Table 19 Allowable Curing Regimes under Curing Type 1.

7.2.1. Cold Weather Concrete Procedures

For outside temperatures between 4°C and -7°C, the recommended amount of Weathermix additive or equivalent shall be used for all concrete pours

If the weather forecast anticipated a drop in temperature of below -7°C at any point in the first 48 hours after the pour, then effective means shall be provided to ensure the air temperature around the concrete is maintained at a minimum of -7°C. This temperature should be verified with the concrete supplier for their particular mix

When pouring concrete in cold weather conditions, the following should be maintained:

- The temperature of the concrete, when deposited, shall be no less than +16°C and no more than +27°C.
- Before depositing concrete on any surface, all snow and ice shall be removed, using heat when necessary.
- Concrete shall not be placed on, or against, any surface that is at a temperature less than +4°C.
- In addition to the above curing requirement in Section 7.2, Effective means shall be provided for maintaining the temperature of the concrete at all surfaces at not less than +10°C

As soon as the concrete is placed it shall be covered with clean dry straw or an insulated blanket, and then protected with a tarpaulin or polyethylene cover.

7.3. Reinforcing Steel

All reinforcing steel is to be deformed with a permissible working stress of 138×10^6 N/m². The reinforcing steel shall be unpainted and free from oil, mill or rust scale, and shall be secured and tied at each crossing with No. 18 AWG steel wire.

7.4. Backfill

The backfill shall consist of a Granular A material processed by crushing. Blending, if required, shall be carried out at the production plant. Material shall not qualify as Granular A unless it has been processed by crushing, regardless of natural particle sizes.

When requested by Hydro Ottawa representative, the contractor (at his expense) shall supply representative samples of all materials proposed to be used. Each sample shall contain no less than 23 kg.

No material shall be used until prior approval has been received from Hydro Ottawa and furthermore, any material rejected shall be removed from the site immediately.

Approved backfill of Clean Native Material may be used only when approved by the Hydro Ottawa Inspector. Even if Clean Native Material is allowed, Granular A must be placed on the sides and a minimum of 300 mm on the top of the duct run. Granular A shall meet OPSS 1010 Table 2 Gradation Requirements – Percent Passing.

7.5. Duct Technical Specifications

All ducts shall be grey, black, or red in colour. Grey duct is the normally used unless the alternate colours are approved for the specific project by Hydro Ottawa.

All ducts(s) below grade shall be constructed as per CSA C22.2 No. 211.1 unless alternate material is approved for the specific project by Hydro Ottawa. Any duct with greater than 150 mm exposure to the suns UV rays shall have UV inhibitors or shielding.