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SARDAR HIGH GIRLS SCHOOL, AFGHANISTAN

Site Layout, Grading and Utility Drawings

WO-LT-0006

Specifications

Volume 2 of 2

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Addendum 1 Submittal

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ADDENDUM 1 SUBMITTAL

SARDAR GIRLS HIGH SCHOOL
KABUL, AFGHANISTAN

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EARTHWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2487	(2006e1) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2937	(2004) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as:

a. GW: Well graded gravel with or without sand
b. GP: Poorly graded gravel with or without sand
c. GM: Silty gravel with or without sand
d. GP-GM: Poorly graded gravel with or without silt or sand

e. GW-GM: Well graded gravel with or without silt and sand
f. GC: Clayey gravel with or without sand
g. GP-GC: Poorly graded gravel with or without clay and sand (or silty clay and sand)
h. GC-GM: Silty, clayey gravel with or without sand
i. SW: Well graded sand with or without gravel
j. SP: Poorly graded sand with or without gravel
k. SM: Silty sand with or without gravel
l. SW-SM: Well graded sand with or without silt and gravel
m. SC: Clayey sand with or without gravel
n. SW-SC: Well graded sand with or without clay and gravel (or silty clay and gravel).

Satisfactory materials for grading comprise stones less than 75 mm in any dimension. The liquid limit shall not exceed 35 and the plasticity index shall not exceed 12 when tested in accordance with ASTM D 4318.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; and material classified as satisfactory that is too wet or too dry, does not meet the specified density, or contains root, other organic matter, or frozen material. Notify the USAID Implementing Partner when encountering any contaminated materials.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines are non-plastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 as a percent of laboratory maximum density. Minimum degree of compaction shall be 90%, as determined by a Modified Proctor Test.

1.2.5 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials not included in the definition of "rock" with stones greater than 25 mm in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.6 Rock

Solid material with firmly cemented masses or conglomerate deposits, neither of which can be removed without drilling and blasting, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, and buried masonry. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.7 Unstable Material

Unstable material is too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.2.8 Select Granular Material

1.2.8.1 General Requirements

Select granular material consists of materials classified as GW, GP, SW, or SP where indicated. The liquid limit of such material must not exceed 35 percent when tested in accordance with ASTM D 4318. The plasticity index must not be greater than 12 percent when tested in accordance with ASTM D 4318, and not more than 25 percent by weight may be finer than 75 micrometers sieve when tested in accordance with ASTM D 1140.

1.2.9 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 25 mm or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller.

1.2.10 Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 12 when tested in accordance with ASTM D 4318.

1.2.11 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible material are a uniformly graded washed sand with a maximum particle size of 4.75 mm (no. 4 sieve) and less than 5 percent passing the 0.075 mm size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

1.3 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.3.1 Dewatering Work Plan

Submit procedures for accomplishing dewatering work using submittal procedures as specified in the the contract documents.

1.4 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-01 Preconstruction Submittals

Shoring and Sheeting Plan

Dewatering Work Plan

Quality Control Plan

Submit 15 days prior to starting work.

SD-03 Product Data

Utilization of Excavated Materials

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas.

SD-06 Test Reports

Testing
Borrow Site Testing

Within 24 hours of conclusion of physical tests, 6 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

Testing

Qualifications of the commercial testing laboratory or the Contractor's testing facilities.

1.5 Quality Assurance

1.5.1 Shoring and Sheeting Plan

Submit drawings and calculations, certified by a professional geotechnical engineer, describing the methods for shoring and sheeting of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

The Contractor is required to hire a professional geotechnical engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The geotechnical engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The geotechnical engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The geotechnical engineer shall be available to meet with the Contracting Officer at any time throughout the contract duration.

1.5.2 Dewatering Work Plan

Submit procedures for accomplishing dewatering work. The procedures shall include the method of monitoring groundwater levels near adjacent structures and at the pump station excavation, to guard against excavation submersion, excavation collapse, and settling of near by structures. The procedures are also to include the method of disposing of the groundwater.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH) and total metals (lead, chromium, arsenic, cadmium, nickel, zinc, copper, mercury, silver and selenium). Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH). Provide Borrow Site Testing for TPH from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the USAID Implementing Partner.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 75 mm minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric
Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

2.2.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.08 mm and a minimum strength of 10.3 MPa lengthwise, and 8.6 MPa crosswise, with a maximum 350 percent elongation.

2.2.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.10 mm, and a minimum strength of 10.3 MPa lengthwise and 8.6 MPa crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 920 mm deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3 MATERIAL FOR RIP-RAP

2.3.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, with a maximum particle size of 50 mm. Compose material of tough, durable particles. Allow fines passing the 75 micrometers standard sieve with a

plasticity index less than six.

2.3.2 Erosion Control Rock

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Provide fragments sized so that no individual fragment exceeds a weight of 68 kg or as approved by USAID Implementing Partner.

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph **3.13** FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated on the contract documents or from other approved areas by the USAID Implementing Partner.

Excavated material shall not be stockpiled within 4 meters of the pump station excavation and other excavations including, but not limited to trench excavations, sewer manhole excavations and greywater tank excavations.

3.1.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on the Contract Drawings. Do not excavate ditches and gutters below grades shown.

3.1.2 Shoring and Sheeting

Provide shoring, bracing, cribbing, trench boxes, underpinning and sheeting where necessary to prevent the following negative impacts:

a. Undermining of pavements, foundations and slabs.

b. Slippage or movement in banks or slopes adjacent to the excavation.

c. The shoring and sheeting plan is to include provisions to prevent these negative impacts.

3.1.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Grade the

construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.1.4 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and heave in the excavation. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, at least 0.6 meter below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.1.5 Pump Station Excavation Requirements

Excavate the pump station as shown on the plan details. Shore pump station excavation walls more than 1.5 meters high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Excavate pump station walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Where recommended pump station excavation dimensions are exceeded, provide redesign, stronger shoring, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger shoring, or special installation procedures without any additional compensation.

3.1.5.1 Bottom Preparation

Grade the bottoms of the pump station excavations accurately to provide uniform bearing and support for the slab foundation. Remove stones as directed by the geotechnical engineer.

3.1.5.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the pump station excavation, remove such material 150 mm below the required grade and replace with suitable materials as provided in paragraph **3.9** BACKFILLING AND COMPACTION.

3.1.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the pump station excavation, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph **3.9** BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the

Contractor is responsible for excavating the resulting material and replacing it without additional compensation.

3.1.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of concrete forms and/or trench shoring for the full length and width of the pump station structure footings and foundation walls as shown. Clean area of loose debris and cut to a firm surface as shown or as directed.

3.1.6 Trench Excavation Requirements

Excavate the trench as shown on the plan details. Shore trench walls more than 1.5 meters high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 600 mm plus pipe outside diameter (O.D.) for pipes of less than 600 mm inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional compensation.

3.1.6.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 75 mm or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.1.6.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, remove such material 150 mm below the required grade and replace with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.6.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional compensation.

3.1.6.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock of loose debris and cut to a firm surface as shown or as directed. Remove unstable material, loose disintegrated rock and thin

strata. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.1.7 Structural Excavation

Test pits will be performed at all locations as required by Geotechnical Engineer.

Ensure that footing subgrades have been inspected and approved by the USAID Implementing Partner prior to concrete placement.

3.2 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval.

3.3 SHORING

3.3.1 General Requirements

Submit a shoring and sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a professional geotechnical engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

3.4 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Place and grade in separate stockpiles of satisfactory, unsatisfactory, and wasted materials as specified. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material.

3.5 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond.

3.6 GROUND SURFACE PREPARATION

3.6.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 150 mm before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material.

3.6.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.7 UTILIZATION OF EXCAVATED MATERIALS

The Contractor shall dispose unsatisfactory materials removed from excavations outside the construction limits. Use satisfactory material removed from excavations in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes.

Excavated material shall not be stockpiled within 4 meters of the pump station excavation and other excavations including, but not limited to trench excavations, sewer manhole excavations and greywater tank excavations.

3.8 BURIED TAPE AND DETECTION WIRE

3.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape as shown on the construction drawings.

3.8.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance as shown on the construction drawings. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 0.9 m of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over it's entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.9 BACKFILLING AND COMPACTION

Backfill adjacent to any and all types of structures shall be compacted to at least 90 percent of maximum density as determined by Modified Proctor Test within minus 1 percent to plus 2 percent of optimum moisture content for cohesive or for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Fill material must be placed in lifts up to a maximum of 200 mm uncompacted thickness. If hand-held compaction equipment is used, the lift thickness shall be no more than 150 mm.

3.9.1 Pump Station Excavation Backfill

3.9.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the pump station excavation with select granular material or initial backfill material.

3.9.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the pump station excavation with select granular material placed in layers not exceeding 150 mm loose thickness. Each layer shall be compacted to 95 percent of laboratory maximum density, ASTM D 1557.

3.9.1.3 Backfill

Fill the pump station excavation with satisfactory material. Place backfill material and compact to 95 percent of maximum density, ASTM D 1557.

3.9.2 Trench Backfill

The Contractor shall place backfill to an adequate level to ensure stability of the line when performing the required pressure test.

3.9.2.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

3.9.2.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 150 mm loose thickness. Each layer shall be compacted to 95 percent of laboratory maximum density, ASTM D 1557.

3.9.2.3 Bedding and Initial Backfill

Place initial backfill material 150 mm under utility line and to a height of at least 300 mm above the utility pipe or conduit and compact it with approved tampers. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Compact backfill to 150 mm above the top of pipe to 95 percent of ASTM D 1557 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

a. Class I: Angular, 6 to 40 mm, graded stone, or as recommended by the pipe manufacturer, whichever is smaller.

b. Clean, coarse-grained sand classified by ASTM D 2487 as SP.

3.9.2.4 Final Backfill

Fill the remainder of the trench with satisfactory material. Place backfill material and compact to 95 percent of maximum density, ASTM D 1557.

3.9.3 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, place backfill in such a manner that the structure is not damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.10 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.10.1 Water Lines

Excavate trenches to a depth that provides a minimum cover as shown on the construction drawings from the indicated finished grade to the top of the pipe.

3.10.2 Electrical Distribution System

Provide a minimum cover as shown in the contract documents from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.11 EMBANKMENTS

3.11.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm. Place the material in successive horizontal layers of loose material not more than 200 mm in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so the fill will bond with the surface on which it is placed.

3.12 SUBGRADE PREPARATION

3.12.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a dump truck loaded with 6 cubic meters of soil or a 13.6 metric tons, pneumatic-tired roller. Operate the roller or the truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the USAID Implementing Partner a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the USAID Implementing Partner. Remove the rutting or pumping material as directed by the USAID Implementing Partner and replace with satisfactory material.

3.12.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 150 mm below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified.

3.12.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Compact each layer of the embankment to at least 90 percent of laboratory maximum density.

3.12.3.1 Subgrade for Pavements

Compact subgrade for pavements to at least 90 percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 300 mm of subgrade.

3.13 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown in the contract documents. Provide the degree of finish for graded areas within 30 mm of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph **3.12** SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.13.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until gravel is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay gravel until the subgrade has been checked and approved. Do not place gravel on a muddy, spongy, or frozen subgrade.

3.13.2 Capillary Water Barrier

Place a capillary water barrier under concrete floors and slabs directly on subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.13.3 Grading Around Structures

Construct areas within 1.5 m outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.14 TESTING

Perform testing according to Contractor's Quality Control Plan. Determine field in-place density in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D 1556. ASTM D 6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method. Check the calibration curves furnished with the

moisture gauges along with density calibration checks as described in ASTM D 6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and one (1) sand cone density for each ten (10) densities performed in accordance with ASTM D 6938. ASTM D 2937, use the Drive Cylinder Method only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the USAID Implementing Partner, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.14.1 Fill and Backfill Material Gradation

One test per 100 cubic meters stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C 136, ASTM D 422, and ASTM D 1140 when the material is granular and ASTM D 422 and ASTM D 1140 when the material is not granular.

3.14.2 In-Place Densities

a. Structural Fill Areas: One test per 230 square meters, or fraction thereof, of each lift. If more than 20% of the field density measurements yield unsatisfactory results, the testing frequency shall be subdivided and tested at a frequency of 120 square meters.

b. Non-Structural Fill Areas: One test per 460 square meters, or fraction thereof, of each lift. In every area where field density measurements yield unsatisfactory results, testing frequency shall be reduced to one test per 230 square meters.

3.14.3 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the USAID Implementing Partner.

3.14.4 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic meters of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.14.5 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.14.6 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the USAID Implementing Partner. Inspect pipes by shining a light (lamping) between manholes or manhole locations. If, in the judgment of the USAID Implementing Partner, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed without additional compensation.

3.15 DISPOSITION OF SURPLUS MATERIAL

Provide surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber as removed from the project site as directed by the USAID Implementing Partner.

-- End of Section --

SECTION 32 11 23

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2006)Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 29/C 29M	(2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and

	Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM E 11	(2004) Wire Cloth and Sieves for Testing Purposes

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 19.0 mm sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 19.0 mm sieve are expressed as a percentage of the laboratory maximum dry density.

1.3 SYSTEM DESCRIPTION

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.4 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-03 Product Data

Plant, Equipment, and Tools

List of proposed equipment to be used in performance of construction work, including descriptive data.

SD-06 Test Reports

Sampling and Testing
Field Density Tests

Certified copies of test results for approval not less than 30 days before material is required for the work.

Calibration curves and related test results prior to using the device or equipment being calibrated.

Copies of field test results within 24 hours after the tests are performed.

1.5 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor and performed by a testing laboratory approved by the USAID Implementing Partner. Work requiring testing will not be permitted until the testing laboratory has been approved. Test the materials to establish compliance with the specified requirements; perform testing at the specified frequency. The USAID Implementing Partner may specify the time and location of the tests. Furnish copies of test results to the USAID Implementing Partner within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the USAID Implementing Partner.

1.5.2 Tests

Perform the following tests in conformance with the applicable standards listed.

1.5.2.1 Sieve Analysis

Perform sieve analysis in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11. Particle-size analysis of the soils shall also be completed in conformance with ASTM D 422.

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D 4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with ASTM D 1557.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938. For the method presented in ASTM D 1556 use the base plate as shown in the drawing. For the method presented in ASTM D 6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration of the ASTM publication. Tests performed in accordance with ASTM D 6938 result in a wet unit weight of soil, and ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 6938. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as

described in paragraph Calibration of ASTM D 6938, on each different type of material being tested at the beginning of a job and at intervals as directed.

1.5.2.5 Wear Test

Perform wear tests on ABC coarse material in conformance with ASTM C 131.

1.5.3 Testing Frequency

1.5.3.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis including the 0.02 mm sieve.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Weight per cubic meter of Slag.

1.5.3.2 In-Place Tests

Perform each of the following tests on samples taken from the placed and compacted material. Samples shall be taken and tested at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 square meters, or portion thereof, of completed area.

b. Perform sieve analysis including the 0.02 mm sieve on every lift of material placed and at a frequency of one sieve analysis for every 500 square meters, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the total thickness of the base course at intervals, in such a manner as to ensure one measurement for each 500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

1.5.4 Approval of Material

Select the source of the material 30 days prior to the time the material will be required in the work. Approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted course(s).

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide ABC consisting of clean, sound, durable particles of crushed stone, crushed slag, crushed gravel, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the 4.75 mm sieve is known as coarse aggregate; that portion passing the 4.75 mm sieve is known as fine aggregate.

2.1.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.

c. Crushed Slag: Crushed slag shall be an air-cooled blast-furnace product having an air dry unit weight of not less than 1120 kg/cubic meter as determined by ASTM C 29/C 29M, and shall meet all the requirements specified below.

2.1.1.1 Aggregate Base Course (ABC)

ABC coarse aggregate shall be hard durable crushed rock. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, shall be retained on the maximum size sieve listed in TABLE 1.

2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.1.2.1 Aggregate Base Course

ABC fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Apply the specified gradation requirements to the completed base course. The aggregates shall be continuously well graded within the limits specified in TABLE 1. Sieves shall conform to ASTM E 11.

TABLE 1. GRADATION OF AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1
50.0 mm	100
37.5 mm	70-100
25.0 mm	45-80
12.5 mm	30-60
4.75 mm	20-50
2.00 mm	15-40
0.425 mm	5-25
0.075 mm	0-8

NOTE 1: Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the USAID Implementing Partner.

2.2 LIQUID LIMIT AND PLASTICITY INDEX

Apply liquid limit and plasticity index requirements to the completed course and to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area. Provide line and grade stakes as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating are the responsibility of the Contractor. Operate the aggregate sources to produce the quantity and quality of materials meeting the specified requirements in the specified time limit.

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the USAID Implementing Partner to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the base course(s), the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the base course(s), the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 31 00 00 EARTHWORK. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the base course(s). Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the base course is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

Mix the coarse and fine aggregates in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. Make adjustments in mixing procedures or in equipment, as directed, to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory base course meeting all requirements of this specification.

3.5.2 Placing

Place the mixed material on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm or less in thickness is required, place the material in a single layer. When a compacted layer in excess of 150 mm is required, place the material in layers of equal thickness. No layer shall be thicker than 150 mm or thinner than 75 mm when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than

one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

3.5.3 Grade Control

The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course and the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

The base course(s) shall be placed so that the completed section will be a minimum of 600 mm wider, on all sides, than the next layer that will be placed above it. Additionally, place approved fill material along the outer edges of the base course in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 600 mm width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of base course. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Compact each layer of the base course, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of the optimum water content determined from laboratory tests as specified in paragraph QUALITY ASSURANCE. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Continue compaction until each layer has a degree of compaction that is at least 95 percent of laboratory maximum density through the full depth of the layer. Make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Construct the compacted thickness of the base course as indicated. No individual layer shall be thicker than 150 mm nor be thinner than 75 mm in compacted thickness. The total compacted thickness of the base course(s) shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than

indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

3.5.7 Finishing

The surface of the top layer of base course shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of base course is 13 mm or more below grade, then the top layer should be scarified to a depth of at least 75 mm and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a 3.66 meter straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 15 meter intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

Completed portions of the base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

Maintain the base course in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Refer to Section 31 00 00 EARTHWORK.

-- End of Section --

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(2005; Errata 2008) Specifications for Structural Concrete
ACI 305R	(1999; Errata 2006) Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM A 184/A 184M	(2006) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 615/A 615M	(2009b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 966/A 966M	(2008) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C 1077	(2009b) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 143/C 143M	(2009) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete

ASTM C 172	(2008) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 231	(2009a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33/C 33M	(2008) Standard Specification for Concrete Aggregates
ASTM C 494/C 494M	(2008a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 78	(2009) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94/C 94M	(2009a) Standard Specification for Ready-Mixed Concrete

1.2 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-03 Product Data

Curing materials

Admixtures

Dowel

Reinforcement

Submit a complete list of materials including type, brand and applicable reference specifications.

Cementitious Materials

SD-04 Samples

Field-Constructed Mockup

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Aggregate tests

Concrete slump tests

Air content tests

Flexural strength tests

Cementitious materials

SD-07 Certificates

Batch tickets

Cementitious materials

SD-11 Closeout Submittals

1.3 DELIVERY, STORAGE, AND HANDLING

ASTM C 94/C 94M.

1.4 QUALITY ASSURANCE

1.4.1 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field shall be performed by a commercial testing laboratory which conforms to ASTM C 1077. The laboratory shall be approved in writing by the USAID Implementing Partner.

1.4.2 Batch Tickets

ASTM C 94/C 94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.4.3 Field-Constructed Mockup

Install minimum 21 square meters to demonstrate typical joints, surface finish, texture, color, permeability, and standard of workmanship. When USAID Implementing Partner determines that mockup does not meet requirements, demolish and remove it from the site and install another until the mockup is accepted. Keep accepted mockup undisturbed during construction as a standard for judging completed paving. Accepted mockup may be incorporated into final work when approved by USAID Implementing Partner.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials in concrete mix shall be 50 percent non-portland cement pozzolanic materials by weight.

2.1.1.1 Cement

ASTM C 150/C 150M, Type I or II with maximum alkali content of 0.60%. Cement certificate shall include test results in accordance with ASTM C 150/C 150M, including equivalent alkalies indicated in the Supplementary Optional Chemical Requirements.

2.1.2 Water

Fresh, clean, and potable.

2.1.3 Aggregate

2.1.3.1 2.1.3.1 Alkali Reactivity Test

Aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with ASTM C 1260. The types of aggregates shall be evaluated in a combination which matches the contractors' proposed mix design (including Class F fly ash or GGBF slag), utilizing the modified version of ASTM C 1260. Test results of the combination shall have a measured expansion of less than 0.08 percent at 16 days. Should the test data indicate an expansion of greater than 0.08%, the aggregate(s) shall be rejected and the contractor shall submit new aggregate sources for retesting or may submit additional test results incorporating Lithium Nitrate for consideration.

2.1.3.2 Fine Aggregates

ASTM C 33/C 33M.

2.1.3.3 Coarse Aggregates

ASTM C 33/C 33M.

2.1.4 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E,

water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the USAID Implementing Partner.

ASTM C 260: Air-entraining.

2.1.5 Reinforcement

2.1.5.1 Dowel Bars

Bars shall conform to ASTM A 615/A 615M, Grade 420 for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.

2.1.5.2 Tie Bars

Bars shall be billet or axle steel deformed bars and conform to ASTM A 615/A 615M or ASTM A 966/A 966M Grade 420.

2.1.5.3 Reinforcement

Deformed steel bar mats shall conform to ASTM A 184/A 184M. Bar reinforcement shall conform to ASTM A 615/A 615M, Grade 300.

2.1.6 Curing Materials

2.1.6.1 White-Burlap-Polyethylene Sheet

ASTM C 171, 0.10 mm thick white opaque polyethylene bonded to 0.31 kg per meter (1.0 meter) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

ASTM C 309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound shall be magnesium fluosilicate which, when mixed with water, seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.1.7 Joint Fillers and Sealants

Provide as specified in Section 03 15 14.00 10 EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS. New joints shall match existing alignment.

2.2 CONTRACTOR-FURNISHED MIX DESIGN

Contractor-furnished mix design concrete shall be designed in accordance with ACI 211.1 except as modified herein, and the mix design shall be as specified herein under paragraph entitled "Submittals." The concrete shall have a minimum flexural strength of 4.48 MPa at 90 days. The concrete may be air entrained. If air entrainment is used the air content shall be 5.0, plus or minus, 1.5 percent. Maximum size aggregate for slip forming shall be 38 mm. The minimum cementitious factor is 335 kg per cubic meter and slump shall be 25 mm to 75 mm (or less when slip form is used).

If the cementitious material is not sufficient to produce concrete of the flexural strength required it shall be increased as necessary, without additional compensation under the contract. The cementitious factor shall be calculated using cement, Class F fly ash or GGBF slag, or a combination of the two. The mix shall use a cement replacement (by weight) of 25%-35% Class F fly ash, or 40%-50% GGBF slag, or a combination of the two. In the combination, each 5% of Class F fly ash shall be replaced by 8% GGBF slag.

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construct forms to be removable without damaging the concrete.

3.1.2 Coating

Before placing the concrete, coat the contact surfaces of forms except existing pavement sections where bonding is required, with a non-staining mineral oil, non-staining form coating compound, or two coats of nitro-cellulose lacquer. When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed.

3.1.3 Grade and Alignment

Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.2 REINFORCEMENT

3.2.1 Dowel Bars

Install bars accurately aligned, vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Before installation thoroughly grease the sliding portion of each dowel. Dowels must remain in position during concrete placement and curing.

3.2.2 Tie Bars

Install bars, accurately aligned horizontally and vertically, at indicated locations. For slipform construction, insert bent tie bars by hand or other approved means.

3.2.3 Setting Slab Reinforcement

Reinforcement shall be positioned on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Reinforcement, when placed in concrete, shall be free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. The laps at splices shall be 300 mm minimum and the distances from ends and sides of slabs and joints shall be as indicated.

3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.3.1 Measuring

ASTM C 94/C 94M.

3.3.2 Mixing

Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 29.4 degrees C, reduce mixing time and place concrete within 60 minutes. Additional water may be added to bring slump within required limits as specified in Section 11.7 of ASTM C 94/C 94M, provided that the specified water-cement ratio is not exceeded.

3.3.3 Placing

Follow guidance of ACI 301, except as modified herein. Do not exceed a free vertical drop of 0.90 m from the point of discharge. Place concrete continuously at a uniform rate, with minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 3 m of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3.4 Vibration

Immediately after spreading concrete, consolidate concrete with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs 150 mm or more in thickness. Limit duration of vibration to that necessary to produce consolidation of concrete. Excessive vibration will not be permitted. Vibrators shall not be operated in concrete at one location for more than 15 seconds. At the option of the Contractor, vibrating equipment of a type approved by the USAID Implementing Partner may be used to consolidate concrete in unreinforced pavement slabs less than 150 mm thick.

3.3.4.1 Vibrating Equipment

Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount units on a frame that is capable of vertical movement and, when necessary, radial movement, so vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. Clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane shall not exceed 750 mm. Distance between end of vibrating tube and side form shall not exceed 50 mm. For pavements less than 250 mm thick, operate vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 50 mm from subbase, and top of vibrator a few mm below pavement surface. Vibrators may be pneumatic, gas driven, or electric, and shall be operated at frequencies within the concrete of not less than 8,000 vibrations per minute. Amplitude of vibration shall be such that noticeable vibrations occur at 450 mm radius when the vibrator is inserted in the concrete to the depth specified.

3.3.5 Cold Weather

Except with authorization, do not place concrete when ambient temperature is below 5 degrees C or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 18 and 27 degrees C. Methods of heating materials are subject to approval of the USAID Implementing Partner. Do not heat mixing water above 74 degrees C. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306.1.

3.3.6 Hot Weather

Maintain required concrete temperature in accordance with Figure 2.1.5 in ACI 305R to prevent evaporation rate from exceeding 0.98 kg of water per square meter of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305R.

3.4 PAVING

Pavement shall be constructed with paving and finishing equipment utilizing fixed forms.

3.4.1 Consolidation

The paver vibrators shall be inserted into the concrete not closer to the underlying material than 50 mm. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment shall be vibrated with a hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete.

3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 200 mm.

3.4.3 Required Results

The paver-finisher shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface. Multiple passes of the paver-finisher shall not be permitted. The equipment and its

operation shall produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), shall be applied to the concrete surface during paving and finishing.

3.4.4 Fixed Form Paving

Forms shall be steel, except that wood forms may be used for curves having a radius of 45 m or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 200 mm or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.4.5 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement.

3.4.6 Placing Dowels and Tie Bars

Dowels shall be installed with alignment not greater than 1 mm per 100 mm. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 15 mm and a vertical tolerance of plus or minus 5 mm. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. Dowels and tie bars in joints shall be omitted when the center of the dowel tie bar is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness.

3.4.6.1 Contraction Joints

Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal basket assemblies. The dowels and tie bars shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable anchors.

3.4.6.2 Construction Joints-Fixed Form Paving

Installation of dowels and tie bars shall be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

3.4.6.3 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the hardened concrete. Holes approximately 3 mm greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded

in the drilled holes using epoxy resin injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars shall be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway shall be constructed, and the bent tie bars shall be inserted into the plastic concrete through a 0.45 to 0.55 mm thick metal keyway liner. Tie bars shall not be installed in preformed holes. The keyway liner shall be protected and shall remain in place and become part of the joint. Before placement of the adjoining paving lane, the tie bars shall be straightened, without spalling the concrete around the bar.

3.4.6.4 Expansion Joints

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times. Transverse and longitudinal surface tolerances shall be 6 mm in 3 m.

3.5.1 Side Form Finishing

Strike off and screed concrete to the required slope and cross-section by a power-driven transverse finishing machine. Transverse rotating tube or pipe shall not be permitted unless approved by the USAID Implementing Partner. Elevation of concrete shall be such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with two screeds which are readily and accurately adjustable for changes in pavement slope and compensation for wear and other causes. Make as many passes over each area of pavement and at such intervals as necessary to give proper compaction, retention of coarse aggregate near the finished surface, and a surface of uniform texture, true to grade and slope. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. During the first pass of the finishing machine, maintain a

uniform ridge of concrete ahead of the front screed for its entire length.

3.5.1.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 6 mm. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.1.3 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished, pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template.

3.5.1.4 Longitudinal Floating

After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats. Use floats that are not less than 3.65 m long and 150 mm wide and stiffened to prevent flexing and warping.

3.5.2 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, USAID Implementing Partner representative, and a representative of the facility owner shall inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. Any type of transverse texturing shall produce grooves in straight lines across each lane within a tolerance of plus or minus 13 mm of a true line. The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the surrounding area.

3.5.2.1 Burlap Drag Finish

Before concrete becomes non-plastic, finish the surface of the slab by dragging on the surface a strip of clean, wet burlap measuring from 0.91 to 3 m long and 600 mm wider than the width of the pavement. Select dimension of burlap drag so that at least 0.91 m of the material is in contact with the pavement. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks.

3.5.2.2 Brooming

Finish the surface of the slab by brooming the surface with a new wire broom at least 450 mm wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 2 mm in depth. Broomed surface shall be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

3.5.2.3 Wire-Comb Texturing

Surface texture transverse to the pavement center line shall be applied using a mechanical wire comb drag. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores shall be 2 to 5 mm deep, 1.5 to 3 mm wide, and spaced 10 mm apart.

3.5.2.4 Surface Grooving

The areas indicated on the drawings shall be grooved with a spring tine drag producing individual grooves 6 mm deep and 6 mm wide at a spacing between groove centerlines of 50 mm. These grooves shall be cut perpendicular to the centerline. Before grooving begins, the concrete shall be allowed to stiffen sufficiently to prevent dislodging of aggregate. Grooves shall not be cut within 150 mm of a transverse joint or crack.

3.5.3 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of 3 mm. When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Remaining edges shall be smooth and true to line.

3.5.4 Repair of Surface Defects

Follow guidance of ACI 301.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 5 degrees C for the full curing periods.

3.6.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 300 mm. Make sheeting not less than 450 mm wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or

replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing shall take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats shall be at least 4 liters of undiluted compound per 20 square meters. Compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.6.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener shall not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

The Contractor's approved laboratory shall collect samples of fresh concrete in accordance with ASTM C 172 during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C 31/C 31M.

3.7.2 Consistency Tests

The Contractor's approved laboratory shall perform concrete slump tests in accordance with ASTM C 143/C 143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 16 cubic meters (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams and cylinders are made.

3.7.3 Flexural Strength Tests

The Contractor's approved laboratory shall test for flexural strength in

accordance with ASTM C 78. Make four test specimens for each set of tests. Test two specimens of each set at 7 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than 3.79 MPa. If the ratio of the 7-day strength test to the specified 28-day strength is less than 65 percent, make necessary adjustments for conformance. Frequency of flexural tests on concrete beams shall be not less than four test beams for each 38 cubic meters of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, shall be removed and replaced with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C 231 on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

Surface testing for surface smoothness and plan grade shall be performed as indicated below by the Testing Laboratory. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the USAID Implementing Partner within 24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the USAID Implementing Partner upon conclusion of surface testing.

3.7.5.1 Surface Smoothness Requirements

The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall be within the tolerances specified when checked with a 4 meter straightedge: 5 mm longitudinal and 6.5 mm transverse directions for roads and streets and 6.5 mm for both directions for other concrete surfaces, such as parking areas.

3.7.5.2 Surface Smoothness Testing Method

The surface of the pavement shall be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

3.7.6 Plan Grade Testing and Conformance

The surfaces shall vary not more than 18 mm above or below the plan grade line or elevation indicated. Each pavement category shall be checked by the Contractor for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

3.7.7 Test for Pavement Thickness

Measure during concrete placement to determine in-place thickness of concrete pavement.

3.7.8 Reinforcement

Inspect reinforcement prior to installation to assure it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.9 Dowels

Inspect dowel placement prior to placing concrete to assure that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Dowels shall not deviate from vertical or horizontal alignment, after concrete has been placed, by more than 3 mm per 300 mm.

-- End of Section --

SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2008) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 143/C 143M	(2008) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2007a) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 31/C 31M	(2008) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled

PVC Expansion

ASTM D 5893	(2004) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The USAID Implementing Partner shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.3 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-03 Product Data

Concrete

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control

Copies of all test reports within 24 hours of completion of the test.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 5 degrees C and is falling, or is already below that point. Placement may begin when the air temperature reaches 2 degrees C and is rising, or is already above 5 degrees C. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.4.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 35 degrees C at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of **210 kg/cm2** at 28 days. Maximum size of aggregate shall be 37.5 mm.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 50 mm plus or minus 25 mm where determined in accordance with ASTM C 143/C 143M.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615/A 615M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, **14 mm** thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C 920 or ASTM D 5893.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 50 mm nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3 m. Radius bends may be formed with 19 mm boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 3 m with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 32 11 23 AGGREGATE BASE COURSE.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 m. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily

repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 3 mm in any 3 m long section. After forms are set, grade and alignment shall be checked with a 3 m straightedge. Forms shall have a transverse slope of 20 mm per meter with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 3 mm. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 8 mm from the testing edge of a 3 m straightedge. Permissible deficiency in section thickness will be up to 6 mm.

3.4 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 1.5 m on center, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 3 m or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in

contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

3.4.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 3 mm blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.4.2 Sidewalk Expansion Joints

Expansion joints shall be formed with **14 mm** joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3 mm, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. Joints shall be sealed as specified in Section 03 15 14.00 10 **EXPANSION, CONTRACTION, CONSTRUCTION JOINTS, AND WATERSTOPS IN CONCRETE FOR CIVIL WORKS**.
The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.4.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.5 CURB JOINTS

Curb joints shall be constructed at right angles to the line of curb and gutter.

3.5.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m nor greater than 4.5 m in length.

a. Contraction joints shall be constructed by means of 3 mm thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the

joint and prior to finishing.

3.5.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb. Expansion joints shall be provided in curb directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Joints shall be sealed as specified in Section 03 15 14.00 10 **EXPANSION, CONTRACTION, CONSTRUCTION JOINTS, AND WATERSTOPS IN CONCRETE FOR CIVIL WORKS**. Expansion joints and the top 25 mm depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.6 CURING AND PROTECTION

3.6.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on site and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.6.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 150 mm. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.6.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 300 mm when a continuous sheet is not used. The curing medium shall not be less than 450 mm wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.6.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.6.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7 FIELD QUALITY CONTROL

3.7.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.7.2 Concrete Testing

3.7.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 190 cubic meters of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than **40 kg/cm2**.

3.7.2.2 Air Content

Determine air content in accordance with ASTM C 173/C 173M or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the USAID Implementing Partner. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.7.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 190 cubic meters, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.7.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section.

3.7.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.8 SURFACE DEFICIENCIES AND CORRECTIONS

3.8.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm, the deficient section will be removed between regularly scheduled joints, and replaced.

3.8.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 6 mm. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.8.3 Appearance

Exposed surfaces of the finished work will be inspected by the USAID Implementing Partner and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 32 17 23.00 20

PAVEMENT MARKINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Markings, Waterborne

1.2 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-03 Product Data

Paints for roads and streets

Equipment

SD-06 Test Reports

Paints for roads and streets

Certified reports from sampling and testing made in accordance with paragraph entitled "Sampling and Testing" prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-07 Certificates

Paints for roads and streets

Construction equipment list

SD-08 Manufacturer's Instructions

Paints for roads and streets

Submit manufacturer's Material Safety Data Sheets.

SD-11 Closeout Submittals

Warranty

1.3 DELIVERY AND STORAGE

Deliver paints and paint materials in original sealed containers that plainly show the designated name, specification number, batch number,

color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site, only in areas approved by the USAID Implementing Partner, for maintaining materials at temperatures recommended by the manufacturer. Make available paint stored at the project site or segregated at the source for sampling not less than 30 days prior to date of required approval for use to allow sufficient time for testing. Notify the USAID Implementing Partner when paint is available for sampling.

1.4 WEATHER LIMITATIONS

Apply paint to clean, dry surfaces. Unless otherwise approved, apply paint only when the air and pavement surface temperatures are at least 2.7 degrees C above the dew point. Apply paint only when the air and pavement temperatures are above 5 degrees C and less than 35 degrees C for oil-based materials or above 10 degrees C and less than 43 degrees C for water-based materials. Maintain paint temperature within these same limits.

1.5 EQUIPMENT

Machines, tools, and equipment used in the performance of the work shall be approved by the USAID Implementing Partner and maintained in satisfactory operating condition. Submit construction equipment list for approval by the USAID Implementing Partner.

1.5.1 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

1.5.2 Paint Application Equipment

1.5.2.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of paint to pavement surfaces. Paint applicator machine shall be acceptable for marking small street and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1.6 WARRANTY

Provide manufacturer's standard guarantees and warranties.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified herein.

2.1.1 Paints for Roads and Streets

FS TT-P-1952, color shall be yellow.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

3.1.1 Early Painting of Rigid Pavements

Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

3.2 APPLICATION

3.2.1 Testing for Moisture

Apply pavement markings to dry pavement only. Do not commence painting until the pavement is sufficiently dry and the pavement condition has been approved by the USAID Implementing Partner.

3.2.2 Rate of Application

3.2.2.1 Nonreflective Markings

Apply paint evenly to the pavement surface to be coated at a rate of 2.5 plus or minus 0.10 square meter per liter.

3.2.3 Painting

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

3.3 FIELD TESTING, INSPECTION, AND DEMONSTRATIONS

3.3.1 Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

3.3.2 Surface Preparations and Application Procedures

Surface preparations and application procedures will be examined by the USAID Implementing Partner to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.

3.3.2.1 Surface Preparation Demonstration

Prior to surface preparation, demonstrate surface preparation using the proposed methods and equipment. Prepare areas large enough to determine cleanliness and rate of cleaning.

3.3.2.2 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. The test stripes shall be long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 15 meters long.

3.3.2.3 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the USAID Implementing Partner 30 days prior to proceeding with the work.

3.3.2.4 Level of Performance Demonstration

The USAID Implementing Partner will be present for the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the USAID Implementing Partner, the test stripe shall be the measure of performance required for this project. Work shall not proceed until the demonstration results are satisfactory to the USAID Implementing Partner.

3.4 TRAFFIC CONTROL AND PROTECTION

Place warning signs near the entrance and exit of the work site for alerting approaching traffic of construction activities and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

-- End of Section --

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

1.2 SYSTEM DESCRIPTION

Refer to the fence details on the Contract Drawings.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Fence Assembly
Gate Assembly
Gate Hardware and Accessories

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.5 WARRANTY

Provide manufacturer standard performance guarantees and warranties.

PART 2 PRODUCTS

2.1 GENERAL

Provide fencing materials that conform to the requirements of the fence details on the Contract Drawings.

2.2 ZINC COATING

Ferrous-metal components and accessories, except as otherwise specified, must be hot-dip galvanized after fabrication.

Provide galvanizing repair material that is cold-applied zinc-rich coating

conforming to ASTM A 780.

PART 3 EXECUTION

3.1 GENERAL

Final grading and established elevations must be complete prior to commencing fence installation.

3.2 EXCAVATION

Excavations for post footings must be in virgin or compacted soil and of minimum sizes as indicated on Contract Documents.

Space footings for line posts 3048 millimeter on center maximum and at closer intervals when indicated.

Bottoms of the excavations must be approximately 75 millimeter below the bottoms of the posts. Set bottom of each post not less than 915 millimeter below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Soil from excavations must be spread uniformly adjacent to the fence line or on areas of the project site, as directed by the USAID Implementing Partner.

When solid rock is encountered near the surface, the Contractor must drill into the rock at least 305 millimeter for line posts and at least 457 millimeter for end, pull, corner, and gate posts. Drill holes at least 25.4 millimeter greater in diameter than the largest dimension of the placed post.

If solid rock is below the soil overburden, Contractor must drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

3.3 SETTING POSTS

Remove loose and foreign materials from holes and the soil moistened prior to placing concrete.

Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.

Posts set into sleeved holes in concrete must be grouted in with an approved grouting material.

Posts set in concrete construction must be set vertically, with tops aligned and held in position until concrete has set.

3.3.1 Earth

Provide concrete bases of dimensions indicated. Compact concrete to eliminate voids, and finish to a dome shape. In bedrock, set posts with a minimum of 25.4 mm of grout around each post. Work grout into hole to

eliminate voids, and finish to a dome shape.

3.3.2 Concrete Slabs and Walls

Set posts into zinc-coated sleeves, set in concrete slab or wall, to a minimum depth of 305 mm. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections into sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

3.3.3 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 305 mm below top of fence, and a diagonal truss rod and truss tightener used as a tension member.

3.4 CONCRETE STRENGTH

Provide Concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Fabric and wires must not be stretched or gates hung until the concrete has attained its full design strength.

Samples and test concrete must be taken to determine strength as specified.

3.5 TOP RAILS

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.6 CENTER RAILS

Center rails must be one piece between posts, set flush with posts on the fabric side, using special offset fittings where necessary.

3.7 BRACE ASSEMBLY

Contractor must provide bracing assemblies at end and gate posts, and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension.

Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.8 TENSION WIRE INSTALLATION

Install tension wire by weaving them through the fabric and tying them to each post with not less than 3.9 millimeter galvanized wire or by securing the wire to the fabric with 3.5 millimeter ties or clips spaced 610 millimeter on center.

3.9 FABRIC INSTALLATION

Provide Fabric in single lengths between stretch bars with bottom barbs

placed approximately 38 millimeter above the ground line. Pull fabric taut and tie to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed.

Fabric must remain under tension after the pulling force is released.

3.10 STRETCHER BAR INSTALLATION

Thread stretcher bars through or clamped to fabric 102 millimeter on center and secured to posts with metal bands spaced 381 millimeter on center.

3.11 GATE INSTALLATION

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.12 TIE WIRES

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.13 FASTENERS

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.14 ZINC-COATING REPAIR

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.15 TOLERANCES

Provide posts that are straight and plumb within a vertical tolerance of 6.35 millimeter after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 12.7 millimeter deviation from the established centerline between line posts. Repair defects as directed.

3.16 SITE PREPARATION

3.16.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing. Establish a graded, compacted fence line prior to fencing installation.

3.17 FENCE INSTALLATION

Install fence on prepared surfaces to line and grade indicated. Secure fastening and hinge hardware in place to fence framework by peening or welding. Allow for proper operation of components. Coat peened or welded areas with a repair coating matching original coating. Install fence in accordance with fence manufacturer's written installation instructions

except as modified herein.

3.17.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 3.048 m on center. Provide gate posts spaced as necessary for size of gate openings. Do not exceed 152.4 m on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 0.26 rad or more, or for abrupt changes in grade.

3.17.2 Bottom Tension Wire

Install bottom tension wires before installing chain-link fabric, and pull wires taut. Place tension wire within 203 mm of respective fabric line.

3.18 ACCESSORIES INSTALLATION

3.18.1 Post Caps

Design post caps to accommodate top rail. Install post caps as recommended by the manufacturer.

3.19 CLEANUP

Remove waste fencing materials and other debris from the work site.

-- End of Section --

SECTION 32 96 00

TRANSPLANTING EXTERIOR PLANTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 580/A 580M	(2008) Standard Specification for Stainless Steel Wire
ASTM D 6155	(2006) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

1.2 RELATED REQUIREMENTS

Section 02 41 00 DEMOLITION and Section 31 00 00 EARTHWORK applies to this section for requirements, with additions and modifications herein.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-01 Preconstruction Submittals

Landscape Contractor's License & Tree Relocation References

SD-02 Shop Drawings

Transplanting Plan

SD-03 Product Data

Mulches Topdressing
Ground Stakes
Composted Derivatives
Rotted Manure
Organic Mulch Materials
Staking Material
Ground Stakes

1.4 QUALITY ASSURANCE

1.4.1 Landscape Contractor's License & Tree Relocation References

Contractor shall be a professional tree moving company and have a minimum of 10 years tree relocation experience. Submit 3 references of tree relocation work in the past 5 years.

1.4.2 Transplanting Plan

A transplanting plan shall be submitted showing existing and proposed locations of transplanted material. The plan shall also delineate methods, dates, and times for root pruning, digging, balling, removing, storing, transporting, planting, watering, and maintenance to ensure survivability.

1.4.3 Pre-Installation Meeting

Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Require attendance of parties directly affecting work of this section. Review conditions of operations, procedures and coordination with related work. Agenda shall include the following:

a. Tour, inspect, and discuss conditions of planting materials.

b. Review planting schedule and maintenance.

c. Review required inspections.

d. Review environmental procedures.

1.5 DELIVERY OF MATERIALS

1.5.1 Soil Conditioners Delivery and Storage

Soil conditioners shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil conditioners may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries. Store in dry locations and away from contaminants.

1.6 INSPECTION OF MATERIALS

Materials shall be inspected for compliance with paragraph PRODUCTS and paragraph PLANT MATERIAL IDENTIFICATION. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 40 mm diameter shall be rejected. Topsoil that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be removed from the job site. The USAID Implementing Partner reserves the right to refuse any unacceptable plant material. All rejected plant material shall be removed from the job site on the day of rejection.

1.7 HANDLING OF PLANT MATERIALS

Materials shall not be dropped from vehicles. Plant material shall be transported without scarring trunks or deforming crown branching. Materials found to be in unacceptable condition shall be replaced at no additional cost to the USAID Implementing Partner.

1.8 TIME LIMITATION

The time limitation from digging, removing, transporting, to installing transplanted plant material shall be the same day. The time limitation between installing the plant material and placing the mulch shall be a maximum 48 hours. If project conditions prevent the Contractor from

transplanting and installing plant material on the same day, plant materials shall be boxed or heeled in as required. Plant material shall be maintained and protected by the Contractor.

1.9 GUARANTEE

Transplanted plant material shall have a guarantee period of 365 days. All plants that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period, shall be replaced in kind in relation to size and species during the planting season as approved by the USAID Implementing Partner.

1.10 TRANSPLANTED PLANT MATERIAL TIME AND CONDITIONS

Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

1.10.1 Transplanting Conditions

All transplanting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to all transplanting operations, proposed transplanting times shall be submitted for approval. The installing site for the plant material shall be prepared and excavated in accordance with paragraph SITE EXCAVATION, prior to removing the plant material. If project conditions prevent the Contractor from transplanting and installing plant material on the same day, plant material shall be boxed or heeled in as required. Plant material shall be maintained by the Contractor until a suitable planting time.

1.10.2 Underground Utilities

The location of underground utilities and facilities at both the removal and installing sites shall be verified and marked. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

1.10.3 Protecting Existing Vegetation

When there are established lawns at either the removal or installing sites, the turf shall be protected during the operation. Existing trees, shrubs, and plant beds at the installing sites that are to be preserved shall be barricaded and protected from damage by a tree barricade or other measure. Damage to existing plant material shall be mitigated by the Contractor at no additional cost to the USAID Implementing Partner. Damage shall be assessed by a certified arborist or other approved professional.

1.10.4 Protection of Plant Material to be Transplanted

Contractor shall protect plant material slated for transplanting that is not transplanted at the beginning of construction operations. Prior to construction operations, Contractor shall tag plants to be transplanted with plastic or vinyl tape tied to the plant caliper. Plants to be transplanted shall be protected from root compaction and any other damage with barrier of metal poles a maximum of 2.5 meters on center with plastic fluorescent netting at a minimum of 6 meter diameter from outside of the plant's trunk prior to the start of any construction operations. Where tree drip lines are greater than 3 meters from the tree's trunk, locate barrier fencing at the drip line of the tree. Plastic tape and barrier

fencing shall not be removed until transplanting operations are ready to begin and instructed by the USAID Implementing Partner. Contractor shall water and prune plant material as necessary to keep healthy and vigorous, particularly when water is shut off. Contractor shall be responsible for watering existing plant material to be transplanted from the start of construction operations until the maintenance period is over or until regular water service is in working order. Outside storage locations shall be continually shaded and protected from the wind. Bare root plants shall be heeled in. Plants stored on the project shall be protected from any drying at all times covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.

1.10.5 Protection of Plant Material During Transplanting

Plant material shall be protected during transplanting to prevent desiccation and damage to the branches, trunk, and root system. Branches of shrubs, palms, vines shall be protected by tying-in. Exposed branches shall be covered during transport. Plant material shall be undamaged, vigorous and healthy with a well-branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after transplanting. Plant material showing desiccation, abrasion, sun scald injury or structural branching damage shall be replaced at no cost to the USAID Implementing Partner.

PART 2 PRODUCTS

2.1 TOPSOIL

Topsoil to be placed around root balls of transplanted material at new planting site shall match topsoil of existing site where material is transplanted from. Soil conditioners may be added to topsoil to bring into compliance.

2.2 SOIL CONDITIONERS

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners shall be nontoxic to plants.

2.2.1 Sand

Clean and free of materials harmful to plants.

2.2.2 Perlite

Horticultural grade.

2.2.3 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having the following properties:

2.2.3.1 Particle Size

Minimum percent by weight passing:

4.75 mm screen	95
2.36 mm screen	80

2.2.3.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.2.3.3 Biobased Content

Minimum 100 percent.

2.2.4 Vermiculite

Horticultural grade for planters.

2.2.5 Rotted Manure

Well rotted horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.3 MULCHES TOPDRESSING

Free from noxious weeds, mold, pesticides, or other deleterious materials.

2.3.1 Inert Mulch Materials

Recycled porcelain, concrete, stone, or other recycled material complying with ASTM D 6155. All materials shall be approved by the USAID Implementing Partner.

2.3.2 Organic Mulch Materials

Organic mulch materials shall be from site when available. Biobased content shall be a minimum of 100 percent. Wood cellulose fiber shall be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch shall contain a minimum of 100 percent post-consumer recycled content. Wood-based hydraulic mulch shall contain a minimum of 100 percent recycled material.

2.3.3 Recycled Organic Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 65 mm by 65 mm screen. It shall be cleaned of all sticks a minimum 25 mm in diameter and plastic materials a minimum 75 mm length. The material shall be pretreated to retard the growth of mold and fungi.

2.4 STAKING AND GUYING MATERIAL

2.4.1 Staking Material

2.4.1.1 Tree Support Stakes

Rough sawn hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes shall be minimum 50 mm square or 64 mm diameter by 2.4 m long, pointed at one end.

2.4.1.2 Ground Stakes

Wood or 100 percent post-consumer recycled content plastic, 0.91 m long.

2.4.2 Guying Material

2.4.2.1 Guying Wire

12 gauge annealed galvanized steel, ASTM A 580/A 580M.

2.4.2.2 Guying Cable

Minimum five-strand, 5 mm diameter galvanized steel cable.

2.4.2.3 Hose Chafing Guards

New or used 2 ply 19 mm diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.4.2.4 Flags

White surveyor's plastic tape or 12.70 mm diameter PVC pipe, 150 mm 300 mm long, fastened to guying wires or cables.

2.4.2.5 Turnbuckles

Galvanized or cadmium-plated steel with minimum 75 mm long openings fitted with screw eyes. Eye bolts shall be galvanized or cadmium-plated steel with 25 mm diameter eyes and screw length 38 mm, minimum.

2.4.2.6 Deadmen

100 by 200 mm rectangular or 200 mm diameter by 900 mm long, wood material.

2.4.2.7 Metal Anchors

a. Driven Anchors

Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
50 mm	75 mm
75 to 150 mm	100 mm
150 to 200 mm	150 mm
200 to 250 mm	200 mm
250 to 300 mm	250 mm

b. Screw Anchors

Steel, screw type with welded-on 75 mm round helical steel plate, minimum 10 mm diameter, 375 mm long.

2.5 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water may be supplied by an existing irrigation system or by collected storm water or a graywater system.

PART 3 EXECUTION

3.1 PLANT MATERIAL PREPARATION AND HANDLING

3.1.1 Plant Material Preparation

Plant material designated for transplanting shall be watered thoroughly several days before root pruning, digging or moving. Broken or interfering growth shall be pruned. Large canopy and specimen plant material shall be wire balled and burlapped. Mark north side of plants prior to excavation. Relocate in new location with north facing same direction.

3.2 SITE PREPARATION

3.2.1 Protection

Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

3.2.2 Finish Grade and Topsoil

The Contractor shall verify that finish grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK, prior to the commencement of the transplanting operation.

3.2.3 Layout

Relocate plant material as shown on drawings. Plant material locations may be adjusted to meet field conditions, only with USAID Implementing Partner approval. Provide on-site locations for excavated rock, soil, and vegetation.

3.3 SITE EXCAVATION

3.3.1 Plant Pits

Plant pits shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits shall be dug a minimum of 2 times the diameter of the root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well-aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used. Pits shall be dug immediately before plants are placed in the pit.

3.4 INSTALLATION

3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient top soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at

which it was grown. The root system shall be spread out and arranged in its natural position. Damaged or girdled roots shall be removed with a clean cut. The beginning of the root flare shall be visible at soil level when the tree is planted, since it is critical not to plant the tree too deep. The following shall be performed:

a. Plumb plant materials and backfill half of the hole with topsoil.

b. Prior to backfilling, all metal, wood, and synthetic products shall be removed from the ball or root system avoiding damage to the root system. Biodegradable burlap and tying material shall be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball.

c. Water the hole to collapse air pockets.

d. Backfill and gently firm topsoil.

e. Clear soil mounded against trunk.

f. An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 100 mm height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.4.2 Watering

A regular watering schedule shall be established. Slow deep watering shall be used. Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated. Run-off and puddling shall be prevented. Watering of other plant material or adjacent areas shall be prevented.

3.4.3 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity. When required the following staking and guying procedures shall apply:

3.4.3.1 One Bracing Stake

Trees 1200 to 1800 mm high shall be firmly anchored in place with one bracing stake. The bracing stake shall be placed on the side of the tree facing the prevailing wind. The bracing stake shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly to the stake with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. A chafing guard shall be used when metal is the guying material.

3.4.3.2 Two Bracing Stakes

Trees from 1800 to 2400 mm height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Chafing guards shall be used when metal is the guying material.

3.4.3.3 Three Bracing or Ground Stakes

Trees over a minimum 2400 mm height and less than a maximum 150 mm caliper shall be held firmly in place with 3 bracing or ground stakes spaced at equal intervals around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over a minimum 75 mm diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

3.4.4 Deadmen or Earth Anchors

Trees over a minimum 150 mm caliper shall be held firmly in place with wood deadmen buried a minimum 900 mm in the ground or metal earth anchors. Multi-strand cable guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used.

3.4.5 Flags

A flag shall be securely fastened to each guy line between the tree, stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

3.5 FINISHING

3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area shall be raked and smoothed while maintaining the earth berms.

3.5.2 Placing Mulch

The placement of mulch shall occur a maximum of 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 75 mm uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.5.3 Pruning

Pruning shall be accomplished by a certified arborist. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Broken branches shall be removed.

3.6 MAINTENANCE

Provide landscape construction maintenance to include irrigation equipment cleaning and adjustments, mowing, fertilizing, watering, weeding, pruning and stake and guy adjusting for all newly installed landscape areas unless indicated otherwise.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Turf areas containing ruts or dead turf, as a result of work under this contract, shall be graded smooth and sodded with the same species. All pavements and facilities that have been damaged from the transplanting operation shall be restored to original condition at the Contractor's expense.

3.7.2 Backfill Removal Site Plant Pits

The Contractor shall ensure that all remaining holes from the removal site have been backfilled with on-site soil, tamped to 90 percent compaction, leveled and finished to meet existing grade after settling. Adjacent trees, shrubs, vines and groundcover destroyed by transplanting or construction operations shall be replaced in kind in relation to size and species.

3.7.3 Clean Up

Excess and waste material shall be removed from both removal site and the installed site and shall be disposed offsite at an approved landfill, recycling center, or composting center. Separate and recycle or reuse the following landscape waste materials: nylon straps, wire, ball wrap, burlap, and wood stakes,. Adjacent paved areas shall be cleared.

3.8 PLANT ESTABLISHMENT PERIOD

The establishment period for transplanted materials will commence on the date that inspection by the USAID Implementing Partner shows that the transplanted plants furnished under this contract have been satisfactorily installed and shall continue for a period of 365 days.

-- End of Section --

SECTION 33 11 00

WATER DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C500	(2009) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2009) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 94/C 94M	(2009a) Standard Specification for Ready-Mixed Concrete

ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F 441/F 441M	(2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

UNDERWRITERS LABORATORIES (UL)

UL 262	(2004) Standard for Gate Valves for Fire-Protection Service
UL 312	(2004; Rev thru Jun 2009) Check Valves for Fire-Protection Service

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-8	(2000) Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 Inch)

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water distribution mains of high density polyethylene (HDPE) pipe, SDR as indicated on the Drawings. Provide water main accessories, gate valves and check valves as specified and where indicated.

Above ground piping shall be either schedule 80 CPVC, Schedule 40 Steel, or Class 52 ductile iron pipe (DIP) and painted in accordance with the manufacturers recommendations.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-03 Product Data

Piping Materials

Water distribution main piping, fittings, joints, valves, and coupling

Valve boxes

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on joints. Include information concerning gaskets with submittal for joints and couplings.

SD-06 Test Reports

Bacteriological

Test results from commercial laboratory verifying disinfection

SD-07 Certificates

Water distribution main piping, fittings, joints, valves, and coupling

Lining

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

Warranties

SD-08 Manufacturer's Instructions

Delivery, storage, and handling

Installation procedures for water piping

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, and valves free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material at the Contractor's expense with no additional compensation. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

1.4.2.1 Miscellaneous Plastic Pipe and Fittings

Handle Polyvinyl Chloride (PVC) pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing

materials that are not to be installed immediately under cover out of direct sunlight.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

2.1.1.1 Ductile-Iron Piping

a. Pipe and Fittings: Pipe, AWWA C151/A21.51, Thickness Class 52. Fittings, AWWA C110/A21.10 or AWWA C153/A21.53. Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the specified joints. Pipe and fittings shall have cement-mortar lining, AWWA C104/A21.4, standard thickness.

b. Joints and Jointing Material:

(1) Joints: Joints for pipe and fittings shall be mechanical joints.

(2) Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets, AWWA C111/A21.11.

2.1.1.2 High Density Polyethylene (HDPE)

a. Where shown, HDPE pipe is to be smooth wall, with the SDR as indicated on the Drawings. All joints are to be butt joint thermal weld, or flanged, as required.

2.1.1.3 Polyvinyl Chloride (PVC) Plastic Piping

a. Where shown, PVC pipe is to be schedule 80.

b. Joints and Joint Material: Joints for pipe shall be glued or flanged, as required.

2.1.1.4 CPVC Pipe

Where indicated on the Drawings, CPCVC pipe shall be Schedule 80 and shall be manufactured from a Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a minimum Cell Classification of 23447 per ASTM D 1784. The pipe shall be manufactured in strict compliance to ASTM F 441/F 441M, consistently meeting the Quality Assurance test requirements of this standard with regarding to material, workmanship, burst pressure, flattening, and extrusion quality. This pipe shall carry the National Sanitation Foundation (NSF) seal of approval for potable water applications.

a. Pipe shall be solvent weld joints or flanged, to be installed in accordance with the manufacturers recommendations.

2.1.1.5 Steel Pipe

Where indicated on the Drawings, steel pipe is to be Schedule 40 and have a working pressure in accordance with ASTM A 53/A 53M.

a. Pipe joints of 50 mm and less are to be screwed.

b. Pipe joints of greater than 50 mm are to be flanged.

2.1.2 Valves and Other Water Main Accessories

2.1.2.1 Gate Valves on Buried Piping

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be nonrising stem type with double-disc gates and mechanical-joint ends or push-on joint ends as appropriate for the adjoining pipe, (2) AWWA C509 shall be nonrising stem type with mechanical-joint ends or resilient-seated gate valves 80 to 300 mm in sizes, and (3) UL 262 shall be inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 1035 kPa, and shall have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have 0-ring stem seals , except for those valves for which gearing is specified, in which case use conventional packing in place of 0-ring seal. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair. Where a post indicator is shown, the valve shall have an indicator post flange; indicator post flange for AWWA C500 valve shall conform to the applicable requirements of UL 262.

2.1.2.2 Gate Valves in Valve Pit(s) and Aboveground Locations

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be outside-screw-and-yoke rising-stem type with double-discgates and flanged ends, (2) AWWA C509 shall be outside-screw-and-yoke rising-stemtype with flanged ends, and (3) UL 262 shall be outside-screw-and-yoketype, shall have double-disc or split-wedge solid or one-piece type gate and flanged ends, and shall be designed for a hydraulic working pressure of 1035 kPa. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves 150 mm size shall have solid-wedge gates or solid or one-piece type gates where indicated. Provide valves with handwheels that open by counterclockwise rotation of the valve stem.Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair.

2.1.2.3 Check Valves

Swing-check type, AWWA C508 or UL 312. Valves conforming to: (1) AWWA C508 shall have iron or steel body and cover and flanged ends, and (2) UL 312 shall have cast iron or steel body and cover, flanged ends, and designed for a working pressure of 1035 kPa. Materials for UL 312 valves shall conform to the reference standards specified in AWWA C508. Valves shall have clear port opening. Valves shall be spring-loaded. Flanges shall be Class 125 conforming to ASME B16.1. Valves shall be of one manufacturer.

2.1.2.4 Air Relief Valves

Air relief valves shall be of the size shown and shall be of a type that will release air. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

2.1.2.5 Valve Boxes

Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast iron of a size suitable for the valve on which it is to be used and shall be adjustable. Cast-iron boxes shall have a minimum cover and wall thickness of 5 mm.Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 135 mm. Cast-iron box shall have a heavy coat of bituminous paint.

2.1.2.6 Tracer Wire for Nonmetallic Piping

Provide bare copper or aluminum wire not less than 2.5 mm in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

2.2 PAINTING OF ABOVEGROUND EXPOSED PIPE AND FITTINGS

Aboveground exposed PVC and CPVC pipe and fittings shall be painted in accordance with Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Line

Where water piping is required to be installed within 1 m of existing structures, the water pipe shall be sleeved as required in Paragraph "Casting Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

Terminate the work covered by this section at a point approximately 1.5 m from the building, unless otherwise indicated. Do not lay water lines in the same trench with fuel lines or electric wiring.

a. Water Piping Installation Parallel With Sewer Piping

(1) Normal Conditions: Lay water piping at least 3 m horizontally from a sewer or sewer manhole whenever possible. Measure the distance edge-to-edge.

(2) Unusual Conditions: When local conditions prevent a horizontal separation of 3 m, the water piping may be laid closer to a sewer or sewer manhole provided that:

(a) The bottom (invert) of the water piping shall be at least 450 mm above the top (crown) of the sewer piping.

(b) Where this vertical separation cannot be obtained, the sewer piping shall be constructed of AWWA-approved water pipe and pressure tested in place without leakage prior to backfilling. Approved waste water disposal method shall be utilized.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Sewer Piping or Sewer Manholes: No water piping shall pass through or come in contact with any part of a sewer manhole.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00.

3.1.1.3 Pipe Laying and Jointing

In accordance with pipe manufacturer's instructions. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall not be less than 800 mm.

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.1.1.5 Penetrations

Pipe passing through walls of valve pits and structures shall be in accordance with the Contract Drawings.

3.1.2 Installation of Gate Valves

a. Gate valves shall be installed in accordance with AWWA C509 at all locations as shown on the Drawings and in accordance with the details shown on the Drawings.

3.1.3 Special Requirements for Installation of Water Mains

3.1.3.1 Installation of Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

a. Jointing: Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.

b. Allowable Deflection: The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

c. Pipe Anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Thrust blocks shall be in accordance with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks shall be as indicated. Use concrete, ASTM C 94/C 94M, having a minimum compressive strength of 15 MPa at 28 days.

3.1.4 Installation of Water Service Piping

3.1.4.1 Water Main Connections to Service Lines

Connect service lines to the main as indicated. Connect service lines to HDPE water mains in accordance with UBPPA UNI-B-8 and the recommendations of AWWA M23, Chapter 9, "Service Connections."

3.1.5 Disinfection

Prior to disinfection, obtain USAID Implementing Partner's approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain USAID Implementing Partner's approval of the proposed method for disposal of waste water from hydrostatic testing. The USAID Implementing Partner will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.

3.2.2 Special Testing Requirements

For pressure test, use a hydrostatic pressure 375 kPa greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 50 mm in diameter, hydrostatic test pressure shall be not less than 800 kPa. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

SECTION 33 16 15

WATER STORAGE STEEL TANKS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE/SEI 7-05	(2005; R 2006) Minimum Design Loads for Buildings and Other Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2004) Hypochlorites
AWWA B301	(2004) Liquid Chlorine
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C652	(2002) Disinfection of Water-Storage Facilities
AWWA D103	(2009) Factory-Coated Bolted Steel Tanks for Water Storage

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

INTERNATIONAL CODE COUNCIL (ICC)

IBC	(2009) International Building Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2009) Drinking Water System Components - Health Effects

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10	(2007) Near-White Blast Cleaning

1.2 SYSTEM DESCRIPTION

1.2.1 Design and Construction Standards

The design, fabrication, and erection of the elevated tank shall be in

accordance with the applicable requirements of AWWA D103 except as modified herein. Earthquake design shall be in accordance with IBC using the following spectral values: S_s = 1.28 g and S_1 = 0.51 g and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Sloshing effects of stored liquid shall be designed in accordance with ASCE/SEI 7-05. No additional thickness for corrosion allowance will be required. Design metal temperature shall be 38 degrees C. The elevated tank shall be designed for a basic wind speed of 142 km/hour in accordance with ASCE/SEI 7-05. The elevated tank shall be designed for a snow load of 720 Pa.

1.2.2 Welding

Qualification of welding procedures shall be in accordance with Section 6 of AWWA D103 and Section 05 05 24 TANK WELDING, STRUCTURAL. Field welding is to be kept to a minimum and only used after acceptance by the manufacturer and USAID Implementing Partner.

1.2.3 Design Requirements

The elevated tank shall have a working storage capacity of 65,000 L. The elevation of the high-water level of tank and bottom of the tank shall be in accordance with the Contract Drawings. The range between high and low water levels shall be approximately 1.2 m. The tank shall have a sidewall height of 6.1 m, maximum, and the diameter shall not exceed 3.8 m. The tank shall have a flat bottom, with vertical side sheets or as approved. The tank may have a supported cone roof or self supporting dome roof as approved. The tower supporting the tank shall be constructed as shown on the Contract Drawings. The elevated tank shall be of bolted construction.

1.2.4 Sizing and Design

Sizing and design of elevated tank shall be in accordance with Section 4 of AWWA D103.

1.2.5 Coatings Certification

Coating materials for interior applications and all other materials which will be in normal contact with potable water shall conform to NSF/ANSI 61. Certification by an independent third-party organization that all interior coatings and materials, that come in contact with potable water, comply with NSF/ANSI 61 shall be provided.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Tank Installation

Detail and erection drawings, before proceeding with any fabrication. Complete drawings with details of steel, pipe, pipe supports, and concrete work, and of the assembling of items required for the total installation. Use standard welding symbols as recommended by the American Welding Society. Details of welded joints referenced on the drawings shall be included.

SD-03 Product Data

System Description
Tank Accessories
Coating System

SD-06 Test Reports

Tank Installation
Testing of Valves and Piping

Each coating manufacturer's technical data, application instructions, Material Safety Data Sheets (MSDS), and certificate for compliance for VOC content.

Copies of the following test results:

a. Manufacturer's mill test reports for plate material.

b. Mill and shop inspections by a commercial inspection agency.

c. After acceptance of the structure, the radiographic film and test segments.

d. At the conclusion of the work, a written report prepared by the Contractor covering the hydrostatic test and certifying that the work was inspected in accordance with Section 9 of AWWA D103.

SD-07 Certificates

System Description
Coating System

Certification by an independent third-party organization that all interior coating and materials that come in contact with the potable water comply with NSF/ANSI 61.

A certificate signed by a registered professional engineer, providing the following information:

a. Description of the structural design loading conditions used for the design of entire tank.

b. Description of the structural design method and codes used in establishing the allowable stresses and safety factors applied in the design of the tank.

c. A statement verifying that the structural design of the tank has been checked by experienced engineers specializing in hydraulic structures.

d. A statement verifying that the detail drawings of the tank have been checked by experienced engineers specializing in hydraulic structures to determine that they agree with the design calculations in member sizes, dimensions, and fabricating process as prescribed by applicable ACI and AWWA standards.

Warranty

1.4 EXTRA MATERIALS

Furnish 10 percent more bolts than required. Furnish 5 gasket repair kits.

1.5 WARRANTY

Provide manufacturer's standard guarantees and warranties.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver paint in unopened containers with unbroken seals and labels showing designated name, specification number, color, directions for use, manufacturer, and date of manufacture, legible and intact at time of use. Handle and store water storage tank systems, components, and parts to prevent distortions and other damage that could affect their structural, mechanical, or electrical integrity. Replace damaged items that cannot be restored to original condition. Store items subject to deterioration by exposure to elements, in a well-drained location, protected from weather, and accessible for inspection and handling.

PART 2 PRODUCTS

2.1 Acceptable Manufacturers

a. United Industries Group, Inc.

b. Columbian Tec Tank

c. Or approved equal

2.2 MATERIALS

Provide materials conforming to the following requirements:

2.2.1 Steel

Section 2 of AWWA D103.

2.2.2 Shop Fabrication

Section 7 of AWWA D103.

2.2.3 Pipe and Valves

Section 33 11 00 WATER DISTRIBUTION, and in accordance with the Drawings.

2.3 ASSEMBLIES

2.3.1 Tank Accessories

Section 5 of AWWA D103 and as specified below.

2.3.1.1 Manholes, Roof Openings, and Pipe Connections

Section 5 of AWWA D103 represents the minimum requirements. Number, type, location, and size of manholes, roof openings, and pipe connections shall be as shown on the Contract Drawings.

2.3.1.2 Overflow

The overflow for the tank shall consist of an overflow weir and outside drop pipe, adequately supported and capable of discharging at a rate of 4.5 L/second. The top of the weir shall be 10 mm below the high water elevation. Overflow pipe shall be steel, ASTM A 53/A 53M or equal, and shall terminate 300 to 600 mm above grade and shall be fitted with a flapper valve or screen to prevent ingress of animals and insects.

2.3.1.3 Vent

Vent shall be welded to the cover plate of the center manhole on the roof. Vent will be tank manufacturer's standard type mushroom vent with aluminum bird screen. The free area of the vent shall be sized 50 percent in excess of the 4.5 L/second overflow rate or 6.75 L/second. Screening for vent shall conform to Section 5.7.2 of AWWA D103 which ensures fail-safe operation in the event that screen frosts over and the bottom of the screen shall be sufficiently elevated for snow consideration in the area.

2.3.1.4 Liquid Level Indicator

A liquid level indicator with stainless float and target board shall be installed as shown on the Drawings and in accordance with the manufacturer's instructions.

2.3.1.5 Ladders and Safety Devices

Ladders and safety devices shall be provided in accordance with Sections 5.4 and 5.5 of AWWA D103. Location of ladders shall be as shown on the drawings. Sections 5.4 and 5.5 of AWWA D103 represent the minimum requirement. In addition, safety cage, rest platforms, roof ladder handrails, and other safety devices shall be provided.

2.3.1.6 Coating for Bolted Tanks

Coating system shall be in accordance with AWWA D103, Section 10.6 and interior coatings shall be NSF/ANSI 61 approved. Interior and exterior coatings are to be thermally cured epoxy applied in a minimum of two coats, with a dry film thickness of 180 microns, minimum. Prior to coating the metal tank panels, the panels shall be abrasive blast cleaned to meet SSPC SP 10 standards.

2.3.2 Tank Anchors

The manufacturer shall be responsible for providing a system to attach the tank to the platform of the tower.

The following requirements shall be met:

a. An adequate number of anchors designed to prevent overturning of the tank when empty shall be installed. Anchor bolts nominal diameter shall not be less than 25 mm, plus a corrosion allowance of at least 6 mm on the diameter.

b. The anchor bolts shall be a right angle bend, hook, or plate washer. The anchors shall resist the computed uplift.

c. Attachment of anchors to the shell shall not add significant localized stresses to the shell. The method of attachment shall

consider the effects of deflection and rotation of the tank shell. Anchors shall not be attached to the tank bottom. Attachment of the anchor bolts to the shell shall be through stiffened chair-type assemblies or anchor rings of adequate size and height.

2.4 CHLORINE

AWWA B300 for hypochlorites or AWWA B301 for liquid chlorine, mixed with water to give the solutions required in AWWA C652.

PART 3 EXECUTION

3.1 TANK INSTALLATION

Tank installation shall be in accordance with the following requirements:

3.1.1 Shop Welding

Section 6 of AWWA D103 and Section 05 05 24 TANK WELDING, STRUCTURAL.

3.1.2 Erection

Section 8 of AWWA D103.

3.1.3 Inspections and Testing

Tank inspection and testing shall be in accordance with Section 9 of AWWA D103.

3.2 PIPING INSTALLATION (EXCEPT FOR OVERFLOW PIPING)

3.2.1 General Guidelines

Where details of fabrication or installation are not shown on the drawings, installation shall conform to Section 1 and 3 of AWWA C600.

3.2.2 Testing of Valves and Piping

After the elevated tank has been erected and the valves and piping installed, and before field painting is begun, the valves and piping shall be hydrostatically tested in accordance with Section 4 of AWWA C600. Replace with sound material any defective material disclosed by the pressure test; the test shall be repeated until the test results are satisfactory.

3.3 COATING OF TANK

Tank coating system shall be shop-applied by the tank manufacturer. The tank manufacturer shall supply a touch up kit complete with instructions to repair any damages that may result from shipment or erection in the field.

3.3.1 Bolted Tanks

The tanks shall have a coating system applied to both the interior and exterior surfaces in accordance with Section 10 of AWWA D103. Color shall be as approved.

3.4 DISINFECTION

The elevated tank and connecting lines thereto shall be disinfected with chlorine before being placed in operation.

3.4.1 Tank

The elevated tank shall be disinfected in accordance with AWWA C652. After the chlorination procedure is completed and before the storage facility is placed in service, the USAID Implementing Partner will collect samples of water in properly sterilized containers for bacteriological testing from the full facility in accordance with Section 7 of AWWA C652. The tank will not be accepted until satisfactory bacteriological results have been obtained. After coating system has been inspected, approved, and cured, rinse tank with potable water.

3.4.2 Piping

The valves and piping shall be disinfected in accordance with Section 33 11 00 WATER DISTRIBUTION.

3.5 INSTALLATION OF LEVEL SWITCHES

Level switches, as described in Section 43 21 39 WELL PUMPS are to be installed in the water tank as indicated on the Drawings. The switches are to be pole-mounted, and are to be accessible from the hatch of the water tank.

3.6 INSPECTION AND REPAIR

Prior to tank repair job, perform a detailed inspection of the structure and submit report by a certified inspector.

-- End of Section --

SECTION 33 20 00

WATER WELLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA A100	(2006; Errata 2007) Water Wells

ASTM INTERNATIONAL (ASTM)

ASTM A 53	(2004) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120

1.2 SYSTEM DESCRIPTION

The well shall be located as shown on the Contract Drawings, and be constructed in accordance with these specifications. The well shall be installed in such a manner to prevent aquifer contamination from drilling operation and equipment, intra- and inter-aquifer contaminationand vertical seepage of surface water adjacent to the well into the subsurface.

1.2.1 Abandonment of Wells

If the Contractor fails to construct a well of the required capacity, or if the well is abandoned because of loss of tools, or for any other cause, abandon the hole as specified in paragraph WELL DECOMMISSIONING/ABANDONMENT.

1.3 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Installation Diagrams

Provide an as-built installation diagram for the completed well. The diagram shall be prepared by the geologist supervising the well installation operations.The diagram shall be submitted within 10 working days of the completion of the well.

SD-03 Product Data

Well Installation Plan

A plan as specified in paragraph WELL INSTALLATION PLAN describing the drilling methods, sampling, and well construction and well development 30 calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. The plan shall be approved and signed by an experienced geologist as specified in paragraph QUALIFICATIONS.

Well Material

Provide catalog data, and name of supplier, for well screens (to include the screen slot size), casing, riser pipe, filter pack material, bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, dedicated sampling equipment, pumps, and chemical specifications on drill lubricants, tracers, disinfecting agents, and drill fluid additives, if used. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

Qualifications

Provide qualification documentation for key personnel.

SD-06 Test Reports

Provide the following test reports:

Survey Maps and Notes

Provide surveyed location and elevation of the well.

Well Development Records

Provide a well development record within 10 working days of development completion.

Decommissioning/Abandonment Records

Provide a well decommissioning record, for each well, or test hole abandoned, within 10 working days of the completion of the abandonment procedure.

Project Photographs

Before, during, and after completion of the work, take photographs of each well installation site. Photographs shall also be taken of any rock that is cored at the site.

Filter Pack

Provide a filter pack material test results; including sieve and chemical analyses, within 10 working days after completion of the bore hole.

Tests

Provide test Reports within 24 hours of the conclusion of each test.

SD-07 Certificates

Air line and gauge

Drilling mud

1.4 QUALITY ASSURANCE

1.4.1 Well Installation Plan

Incorporate the following requirements into the Contractor's Well Installation Plan and follow them in the field. The plan shall include, but shall not be limited to, a discussion of the following:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal, and soil/rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, air line and gauge, tailpiece (if used), filter pack and filter pack gradation, bentonite or drilling mud, drilling fluid additives (if used), drilling water, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Forms to be used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, state well registration forms, and well abandonment records.

e. Description of contamination prevention and well materials and equipment decontamination procedures.

f. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. The maximum frost penetration for the site shall be included in this description.

g. Description of well development methods to be used.

h. List of applicable publications, including national and local regulations and standards.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning/abandonment procedures.

k. Description of well capacity testing techniques.

l. Description and discussion of geophysical techniques to be employed at the site.

m. Description of permanent pump to be installed, and discussion of pump operating tests to be employed at the site.

n. Description of specific methods to be employed to control potential

contamination or pollution arising from well installation activities.

1.4.2 Qualifications

A geologist with at least 3 years experience in soil and rock logging, and well installation, shall be on site and responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities.

The driller shall be licensed and have a minimum of 3 years of experience drilling wells.

The Contractor shall have a minimum of 3 years of well installation experience.

1.4.3 Sampling

1.4.3.1 Samples and Records

The Contractor shall collect and provide a sample of material taken from each three meters of drilling and at every significant change of formation. Approximately two-liters of representative sample shall be obtained from each sampling interval.

Immediately after retrieval, samples shall be split into two halves (one liter each). One half of each sample shall be placed on a flat surface. The other half shall be placed in sample bags which allow water to drain out. Sample bags shall be securely closed to avoid spillage and contamination, and clearly labeled with the following information:

a. Name or number of the production well
b. Depth interval represented by the sample
c. Date and time taken

Sample bags shall be labeled clearly, either directly on the bag or on an attached tag, using ink, pencil, or other medium that is resistant to moisture and sunlight. The label shall not be readily removable from the container. The Contractor shall be responsible for the safe storage of formation samples until such times as they are accepted by the USAID Implementing Partner.

The Contractor shall obtain additional samples as requested by the USAID Implementing Partner in water-bearing formations for analysis by a laboratory or screen manufacturer.

1.4.4 Observation Wells

After completion of the pump well an observation well at least 45 mm in diameter shall be drilled to the target water bearing stratum, at an appropriate location near the pump well. The observation well shall be used in conjunction with the yield test of the test hole and capacity test of the pump well. After final acceptance of the pump well by the USAID Implementing Partner, the observation well shall be abandoned as specified in paragraph WELL DECOMMISSIONING/ABANDONMENT.

1.5 DELIVERY, STORAGE, AND HANDLING

Store and maintain well materials in a clean, uncontaminated condition throughout the course of the project. Filter pack material shall not be

allowed to freeze before installation.

1.6 SITE CONDITIONS

Access to each well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the work, is the responsibility of the Contractor. If clearing, or relocation is necessary, the Contractor, and the USAID Implementing Partner shall agree on a suitable clearing or relocation plan.

PART 2 PRODUCTS

2.1 WELL CASING

Surface casing shall be supplied, installed, and properly cemented by the Contractor to a depth of 10 meters to prevent loose overburden from sloughing in. The steel surface casing shall be new material and shall have the following minimum specifications:

a. Minimum O.D. 400 mm
b. ASTM A 53, Grade B mild steel, or ASTM D 1785 Schedule 80 PVC
c. 6.35 mm wall thickness

Casings to be used in the well described in these specifications shall be as follows:

a. I.D. 200 mm
b. ASTM D 1785 Schedule 80 PVC

Casing centralizers shall be located every 20 meters on the well casing. The casing centralizers shall be installed in such a way to allow a 35-50 mm tremie tube for gravel pack to be placed to the bottom of the well.

Casing pipe sections shall be connected by flush threads or bell and spigot joints. The Contractor shall provide the opportunity for the USAID Implementing Partner to observe and photograph the joints before they are placed into the well.

No materials shall be used in the work until they have been duly inspected and approved by the USAID Implementing Partner.

A PVC end cap shall be secured to the bottom of the casing to seal the bottom of the well.

2.2 WELL SCREENS

The USAID Implementing Partner shall determine the depth position of the sections of well screen after the log is completed.

a. The well screen shall be slotted Schedule 80 PVC design. The screen shall be constructed with sufficient strength as defined by the manufacturer for a depth of at least 5 meters above static water level. The Contractor must submit screen specifications and manufacturer name, address and contact phone number to the USAID Implementing Partner for approval before notice to proceed can be given.

b. The slot size of the screen shall be determined based on aquifer characteristics.

c. The screen sections should be 1.5 meter or 3 meter sections.

2.3 FILTER PACK

Filter Pack: Clean, uniform 2.36 mm to 170 mm sized silica sand (8-12 U.S. standard sieve size) with less than 3 percent silt or clay size material (passing the No. 200 U.S. standard sieve) or Standard Ottawa Sand or approved equal.

2.4 CEMENT GROUT

The grout shall consist of Halliburton "light" cement or approved equivalent and about 1 meter of neat cement placed at the bottom of the cemented interval. The "light" cement shall be mixed at 41 liters of water per 25 kg sack of cement. The neat cement shall be mixed at 22 liters of water per 25 kg sack of cement.

PART 3 EXECUTION

3.1 EXAMINATION

Verify the location and elevation of the well to be installed.

Verify that all drill holes have been drilled at the correct locations and to the correct size, depth and orientation prior to well construction.

Verify the location of utility lines, pipelines and other features located in the vicinity of the well installation.

3.2 PROTECTION OF EXISTING STRUCTURES

Protect existing structures and facilities during drilling, construction, development and testing of the well.

3.3 GENERAL INSTALLATION REQUIREMENTS

Furnish all labor, equipment, materials, power supplies and incidentals required to install complete, fully functional, ready-for-operation wells as specified herein and shown on the Drawings.

The wells are to be completed in conformance to ANSI/AWWA A100-06 for Water Wells.

3.3.1 Drilling of Hole

The Contractor shall drill the well at the location designated on the Contract Drawings. The Contractor is responsible for verifying all Utility Locates at the well drilling site within 50 meters of the borehole location.

The well shall be drilled in accordance with the Specifications and may be drilled using the "reverse circulation" or direct rotary method. The borehole diameter shall be a minimum of 375 mm.

The Contractor shall be required to provide all tools, labor, and other machinery and appliances of whatever description necessary and adequate for the construction, development, test pumping, and completion of the well in a workmanlike manner.

3.3.2 Well Measurement

All measurements for depth shall be taken from an established point on the ground surface at the well site. The Contractor shall verify measurements with the USAID Implementing Partner.

3.3.2.1 Well Plumbness and Alignment

The completed production well shall be sufficiently plumb and straight so that there will be no interference with installation, alignment, operation or future removal of the permanent pump. The Contractor will be required to set the casing in the well sufficiently straight and plumb to permit the pump to be installed in such a manner that the pump will operate correctly, and will not be damaged due to casing alignment issues. The well shall not be out of plumb more than 1 degree at any depth.

After the casing is set, the USAID Implementing Partner may require (at Contractor's expense) that the well casing is straight and plumb within 1 degree at all depths. This may require a continuous deviation survey measuring both vertical angle and azimuth.

3.3.3 Drilling Fluid

The mud program should be designed and maintained to promote efficient drilling and keep the drill hole open. In addition, an emphasis should be made to minimize circulation of drilled solids.

3.3.4 Filter Pack

The filter pack material is to be as determined by the filter pack material test results. Filter pack will be placed at the depths shown in the drawings. The filter pack shall be introduced into the annulus between the well screen and the well bore wall in such a manner that it is readily known how much volume is in the hole. It shall be placed using tremie pipe(s).Water will be pumped with the filter pack material to facilitate placement.

Prior to filter packing the Contractor shall add chorine to the drilling fluid in the hole sufficient to break down polymer viscosity, at least of 10% chlorine bleach per barrel of hole volume. One meter of fine sand shall be placed on top of the filter pack, prior to cementing.

3.3.5 Cementing of Casing

The Contractor shall seal the annular space between the casing and the drill hole with cement/bentonite above the filter pack. The cement/bentonite must extend from the top of the filter pack to the ground surface. The method and adequacy of the cementing must be approved by USAID Implementing Partner. Following the placement of the cement/bentonite, there shall be no tools placed in the well for a period of 24 hours to allow the cement to cure. The cement/bentonite shall be placed using a tremie pipe.

3.4 WELL DEVELOPMENT

Well development is the process of removing the mud filter cake on the borehole wall and cleaning and enlarging the passages in the filter pack and water producing formations. Development will be performed with air lift surging, either conventional and/or reverse, at the discretion of USAID

Implementing Partner. The contractor shall furnish all necessary equipment and materials for proper development of the well. At any time during development the USAID Implementing Partner may choose to switch to another development method (i.e. water jetting). Tools and materials required for these development alternate methods should be on-site or readily available.

If, during surging USAID Implementing Partner determines that the equipment chosen by the contractor is insufficient to the development task, additional equipment will be brought in by the contractor at their expense to properly complete the task. Development shall be considered complete when essentially mud-free and sand-free water is obtained from the pump discharge. The Contractor shall remove any accumulated sediments from the well bore with a bailer at the completion of development.

3.5 PUMPING TESTS

The Contractor shall supply a test pump capable of pumping up to 10 L/second from a pump setting depth of approximately 30 meters and a total dynamic head of 50 meters. The pumping unit shall be complete with controls and appurtenances and shall be capable of being operated without interruption for a period of 72 hours. The test pump will be powered by an electrical generator supplied by the Contractor.

The Contractor shall provide two methods to measure the depth to water. The primary method shall be a pressure transducer connected to a digital data logger approved by USAID Implementing Partner. The second method may use either nitrogen pressurized air lines or a Solinst (or equivalent) water level meter. The probe and cable of the water level meter will require a PVC monitor tube set from the surface to the pump.

The well shall be "step" tested at rates of approximately 1/2, 3/4, 1 and 1.6 times the design yield (Design Yield = 6.3 L/second). The duration of the step test is 8 hours. The Contractor shall operate the pump and change the discharge rate as directed by USAID Implementing Partner. Discharge of the pump shall be controlled by a gate valve. The discharge shall be controlled and maintained at approximately the desired discharge for each step with an accuracy of plus or minus 5 percent. Pump discharge shall be measured with a magnetic flow meter and a circular orifice plate, or another methods approved by USAID Implementing Partner.

The discharge manifold shall consist of a backpressure gage, primary gate valve, sampling port and sand tester, flow meter, and an appropriate length of straight discharge pipe terminated by an orifice plate sized for the range of flow rates specified above. The backpressure gage readout shall have no greater than 0.5 bar increments. The flow meter shall be calibrated and be capable of totalizing and instantaneous measurements. The discharge shall be controlled and maintained at approximately the desired discharge for each step with an accuracy of plus or minus 5 percent. The totalizing meter shall be in liters, and gage readout for the instantaneous readout shall have no greater than 1 L/second increments. A water sampling port shall be installed on top of the discharge manifold between the flow meter and the valve. Besides sampling, the sampling port will be used to make sure that the discharge manifold pipe remains full to insure accurate flow readings.

A constant discharge rate pumping test will be conducted after recovery from the step test is complete. This constant rate test shall be conducted by pumping the well at the design rate or at maximum yield for a period of approximately 24 to 72 hours, until USAID Implementing Partner terminates

the test. At the end of the test, the pump shall be turned off and testing equipment shall remain in the hole at least 24 hours while recovery measurements are taken by an automatic data logger. During the pumping tests, water level and flow rate measurements shall be recorded manually according to the below schedule. Automatic measurements by the data logger shall be logarithmic with increasing measurement intervals.

Step Test Manual Measurements

Minutes after Rate Change	Measurement Schedule
0 - 10	Every minute
10 - 20	Every other minute
20 - 60	Every five minutes
60 - on	Every 10 minutes

24-72 Hour Test/Recovery Test Manual Measurements

Minutes Into Test	Measurement Schedule
0 - 60	As shown on the step test
60 - 240	Every 20 minutes
240 - 480	Every 30 minutes
480 - 960	Every hour
960 - 1440	Every two hours

The Contractor shall provide and install a Roscoe-Moss sand content tester (or approved equivalent) to the discharge apparatus. During the pumping tests, the water shall be periodically tested for sand content. Whenever continuous pumping at a uniform rate has been interrupted due to failure of pump operation for a period greater than one percent of the elapsed pumping time, USAID Implementing Partner shall require suspension of the test until the water level in the pumped well has recovered. For the purposes of this Contract, recovery shall be considered "complete," after the well has been allowed to rest for a period at least equal to the elapsed pumping time of the aborted test - except that if any three successive water level measurements spaced at least 20 minutes apart show no further rise in the water level in the pumped well, the test may be resumed immediately. The USAID Implementing Partner shall be the sole judge as to whether this latter condition exists.

3.5.1 Sand-Content Testing

The sand content shall be determined by averaging the results of 5 samples collected at the following times during the constant-discharge test: (1) 15 minutes after start of pumping; (2) 6 hours after start of pumping; (3) 12 hours after start of pumping; (4) 18 hours after start of pumping; and (5) 15 minutes before the end of pumping. The minimum volume of water sample collected for testing for sand content shall be the pumping rate in L/second multiplied by 300.

3.6 DISINFECTING

Contractor shall chlorinate the wells in the following manner, or an approved equal:

1. Place CMDC Sodium Hypochlorate 12-15%, or an approved equal, according to the chart below in a potable water truck tank approximately 1.5 times the Total Mix volume desired. (i.e.: for

8 cubic meter Total Mix volume, use a 12 cubic meter tank).
2. Add water to tank, filling to Total Mix volume based on the chart below.
3. Drive the truck around for approximately 30 minutes to allow mixing and TAC time.
4. Pour a minimum of 4.54 cubic meters into the well by gravity flow.
5. Leave the solution in the well.
6. Refill the empty tank truck with potable water and empty in a location as directed by USAID Implementing Partner.

3.7 TESTING FOR WATER QUALITY

After the capacity test and disinfection is complete, secure samples of the water in suitable containers, and and of sufficient quality, to have bacterial, physical, and chemical analyses made by a recognized testing laboratory. Water quality analyses shall address the parameters specified below. Expenses incident to these analyses shall be borne by the Contractor and the results of the analyses shall be furnished to USAID Implementing Partner. All sampling and analyses shall be performed following approved methods, procedures, and holding times.

Arsenic
Barium
Cadmium
Chromium
Copper
Fecal Coliform
Lead
Mercury
Selenium
Silver
Zinc
Flouride as F
Manganese as MN (dissolved and total)
Iron as Fe (dissolved and total)
Total Coliform
Total Hardness as CaCO(3)
TOC
Sulphates as SO(4)
Chlorides as Cl
Bicarbonates as HCO(3)
Carbonates as CO(3)
Nitrates as NO(3)
Alkalinity as CaCO(3)
Turbidity
pH
Temperature

3.8 TERMINATION AT TOP OF PRODUCTION WELLS

At all times during the progress of the work, the Contractor shall use reasonable precautions to prevent tampering with the well or the entrance of foreign material into it. Upon completion of the production well, the Contractor shall weld a circular plate to the top of the casing. The watertight casing of the well shall extend not less than 300 mm above the top of the concrete pad elevation.

3.9 WELL DECOMMISSIONING/ABANDONMENT

Wells completed into unconfined aquifers and unconsolidated aquifers shall be plugged, sealed and abandoned by filling the well to the static water level with drill cuttings, clean sand or clean gravel, then with clean native clays, cement or high solid bentonite grout to the ground surface. The uppermost 1,000 mm of casing shall be filled with grout or a permanent watertight cover shall be installed at the top of the casing. If casing is removed, the hole shall be filled as described above to within 1,000 mm of the ground surface. The top of the hole shall be filled with materials less permeable than the surrounding soils that are adequately compacted to prevent settling.

Dewatering wells, horizontal drains, monitoring and observation holes, percolation holes, piezometer holes, sumps, test holes and dry holes shall be plugged, sealed and abandoned either pursuant to Paragraph 3.8 or by removing all casing that was installed and by filling the hole(s) with drill cuttings, clean native clay, cement or high solid bentonite grout to within 1,000 mm of the ground surface. The top 1,000 mm of the hole shall be filled with materials less permeable than the surrounding soils that are adequately compacted to prevent settling.

-- End of Section --

SECTION 33 30 00

SANITARY SEWERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

ASTM INTERNATIONAL (ASTM)

ASTM C 443M	(2007) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2412	(2002; R 2008) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 4101	(2009) Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM F 441/F 441M	(2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	Fixed Ladders

1.2 SYSTEM DESCRIPTION

1.2.1 Sanitary Sewer Gravity Pipeline

Smooth wall high density polyethylene (HDPE), SDR of 17. Pipe joints are to be by thermal butt fusion welding.

1.2.2 Sanitary Sewer Pressure Lines

1.2.2.1 Smooth Wall High Density Polyethylene (HDPE)

Provide pressure lines of smooth wall high density polyethylene (HDPE) with the SDR as indicated on the Contract Drawings. Pipe joints are to be by butt joint thermal welding.

1.2.2.2 Schedule 80 PVC or CPVC

Where indicated on the Drawings provide Schedule 80 polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) pipe.

1.2.3 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains approximately 1.5 m outside the building to which the sewer system is to be connected. Replace damaged material and redo unacceptable work at the Contractor's expense, without additional compensation. Backfilling shall be accomplished after inspection by the USAID Implementing Partner. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the USAID Implementing Partner.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Drawings
Installation and as-built drawings, as specified.
Cast-in-place concrete manholes
Metal items
Frames, covers, and gratings
Manhole pipe penetrations

SD-03 Product Data

Pipeline Materials
Frames, covers, and gratings
Manhole pipe penetrations
Submit manufacturer's standard drawings or catalog cuts

SD-07 Certificates

Warranty

1.4 QUALITY ASSURANCE

Drawings

a. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.5.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 HDPE Gravity Sewer Piping and Fittings

Smooth wall HDPE with SDR values as indicated on the Contract Drawings. Joints are to be thermal butt fusion welded.

2.1.2 HDPE Forcemain Piping

Smooth wall HDPE with SDR values as indicated on the Contract Drawings. Joints are to be thermal butt fusion welded.

2.1.3 Polyvinyl Chloride (PVC) Plastic Piping

a. Where shown, PVC pipe is to be schedule 80.

b. Joints and Joint Material: Joints for pipe shall be glued or flanged, as required.

2.1.4 CPVC Pipe

Where indicated on the Drawings, CPCVC pipe shall be Schedule 80 and shall be manufactured from a Type IV, Grade I Chlorinated Polyvinyl Chloride

(CPVC) compound with a minimum Cell Classification of 23447 per ASTM D 1784. The pipe shall be manufactured in strict compliance to ASTM F 441/F 441M, consistently meeting the Quality Assurance test requirements of this standard with regarding to material, workmanship, burst pressure, flattening, and extrusion quality. This pipe shall carry the National Sanitation Foundation (NSF) seal of approval for potable water applications.

a. Pipe shall be solvent weld joints or flanged, to be installed in accordance with the manufacturers recommendations.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Cast-In-Place Concrete Manholes

Cast-in-place concrete manholes shall be constructed in accordance with Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.2.2 Metal Items

2.2.2.1 Frames, Covers, and Gratings for Manholes

Frames and covers shall be cast iron. Cast iron frames and covers shall be as indicated or shall be of type suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 140 kg. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.2.3 Manhole Steps

Zinc-coated steel as indicated conforming to 29 CFR 1910.27. As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to ASTM D 4101, copolymer polypropylene. Rubber shall conform to ASTM C 443M, except shore A durometer hardness shall be 70 plus or minus 5. Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 1.2 m deep.

2.3 PAINTING OF ABOVEGROUND EXPOSED PIPE AND FITTINGS

Aboveground exposed PVC and CPVC pipe and fittings shall be painted in accordance with Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.1.1 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.2 Sewer Pipe Laying and Jointing

Install HDPE sewer pipe in accordance with the manufacturer's instructions. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more

than 7.50 m apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings.

3.1.1.3 Forcemain Laying and Jointing

Install HDPE sewer pipe in accordance with the manufacturer's instructions. Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this Section.

3.1.2 Concrete Work

Cast-in-place concrete is included in Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.3 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.1.4 Miscellaneous Construction and Installation

3.1.4.1 Metal Work

a. Workmanship and finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

b. Field painting: After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of epoxy paint. Do not paint surfaces subject to abrasion.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The USAID Implementing Partner will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. The Contractor shall be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

3.2.2.1 Leakage Tests

Test lines for leakage by low-pressure air tests. Test mainlines unless directed otherwise by the USAID Implementing Partner. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leave joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

a. Low-Pressure air tests: Perform test as follows:

(1) Install test plugs in the ends of the pipe section between two manholes (upstream and downstream). Pressurize the pipe section to 27.5 kPa and hold this pressure for 5 minutes. Disconnect the air hose from the test plug, and decrease the pressure to 24 KPa. The time for the pressure to drop 3.4 kPa shall not be less than 3 minutes.

3.2.2.2 Deflection Testing

Perform a deflection test on entire length of installed HDPE pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D 2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

(1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

(2) Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4 degrees C, and shall have a surface Brinell hardness of not less than 150.

(3) Center bored and through-bolted with a 6 mm minimum diameter steel shaft having a yield strength of not less than 483 MPa, with eyes or loops at each end for attaching pulling cables.

(4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.

c. Pull-through device procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.2.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 345 kPa in excess of the maximum working pressure of the system, but not less than 690 kPa, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test. Test PVC plastic pressure lines in accordance with the requirements of AWWA C605 for pressure and leakage tests, using the allowable leakage given therein.

-- End of Section --

SECTION 33 32 13.13

PACKAGED SEWAGE LIFT STATIONS, WETWELL TYPE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

1.2 DESCRIPTION OF WORK

The work includes providing submersible sewage pumps and related work as indicated on the drawings. Provide system complete and ready for operations. Pump station system including equipment, materials, installation, and workmanship as specified herein.

The work also includes providing all piping, fittings and valves to 300 mm beyond limits of pit opening.

1.3 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Detail drawings of the control panel design, including complete, customized wiring and schematic diagrams reflecting the incorporation of the requirements stated in paragraph Pump Control System.

SD-03 Product Data

Pipe and fittings
Check valves
Gate valves
Submersible sewage pumps
Pump motor

SD-10 Operation and Maintenance Data

Submersible Sewage Pumps

Include pumps, alarms, and motors. Include all information on all equipment, alarm panel and controls, pumps and pump performance curves, and station layout. Submit operation and maintenance data in accordance with the Contract Documents.

SD-11 Closeout Submittals

Manufacturer's standard guarantees and warranties

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes and fittings free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it.

1.5 EXCAVATION, TRENCHING, AND BACKFILLING

Provide in accordance with Section 31 00 00 EARTHWORK, except as specified herein.

1.6 WARRANTY

Provide manufacturer's standard guarantees and warranties.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Provide pressure piping, and related accessories for force main piping outside the sewage wet well in accordance with Section 33 30 00 SANITARY SEWERS.

2.1.1 PVC Plastic Pressure Pipe and Associated Fittings

2.1.1.1 Pipe and Fittings

Use pipe, couplings and fittings manufactured of materials conforming to ASTM D 1784, Class 12454-B.

(1) Solvent Cement Joint: Use pipe conforming to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa working pressure and 1.38 MPa hydrostatic test pressure. Use fittings for solvent cement jointing conforming to ASTM D 2466 or ASTM D 2467. Use flanged fittings where connecting to flanged equipment.

2.1.2 Insulating Joints

Provide between pipes of dissimilar metals a rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.

2.1.3 Accessories

Provide flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required and as shown on the Drawings.

2.2 VALVES AND OTHER PIPING ACCESSORIES

2.2.1 Check Valves

PVC swing check valve with top entry cleaning design and flanged ends, designed for a hydraulic working pressure of 1.21 MPa. Disc seals tightly with a minimum back pressure. Manufacturer Asahi or equal.

2.2.2 Identification Tags and Plates

Provide valves with tags or plates numbered and stamped for their usage. Use plates and tags of brass or nonferrous material and mounted or attached to the valve.

2.2.3 Gate Valves

Flanged PVC body gate valve with polypropylene plug and position indicator. Manufacturer Asahi or equal.

2.2.4 Miscellaneous Metals

Use stainless steel bolts, nuts, washers, anchors, and supports for installation of equipment.

2.3 SUBMERSIBLE SEWAGE PUMPS

Provide submersible sewage pumps as shown on the drawings. Pumps shall be easily removed from the unit using a quick disconnect coupling or fitting. Provide submersible, centrifugal sewage pumps with pump capacity and motor characteristics as indicated herein. Design pump to operate in a submerged or partially submerged condition.

Pump	liters per second at total rated head, m H(2)O
Sanitary pump station	6 lps, 7.00 m

Pumps shall operate at optimum efficiencies to produce the most economical pumping system under the conditions encountered and shall be sized to make optimum match with the system head curve as shown. Pumps shall furnish not less than 150% of rated capacity at a total discharge head of not less than 65% of total rated head.

2.3.1 Casing

Provide hard, close-grained cast iron casing which is free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Design casings to permit replacement of wearing parts. Design passageways to permit smooth flow of sewage and to be free of sharp turns and projections.

2.3.2 Impeller

Provide non-clogging type cast-iron impeller. Make impeller with smooth surfaces, free flowing with the necessary clearance to permit objects in the sewage to pass. Fit and key, spline, or thread impeller on shaft, and lock in such manner that lateral movement will be prevented and reverse rotation will not cause loosening.

2.3.3 Shaft and Shaft Seals

Provide shaft of stainless steel. Provide mechanical seal of double carbon and ceramic construction with mating surfaces lapped to a flatness tolerance of one light band. Hold rotating ceramics in mating position with stationary carbons by a stainless steel spring. Oil lubricate bearings.

2.3.4 Bearings

Provide heavy duty ball thrust bearing or roller type bearing of adequate size to withstand imposed loads. Oil lubricate bearings.

2.3.5 Pump and Motor

Use pump and motor assembled on a single stainless steel shaft in a heavy duty cast-iron shell. Use free standing pump support legs of cast-iron providing enough clearance for the solids to get into the pump.

2.4 PUMP MOTOR

Motor horsepower must be not less than pump horsepower at any point on the pump performance curve. Fit motors with lifting "eyes" capable of

supporting entire weight of pump and motor. Motors must be suitable for operation at 50 Hz, 380 v.

2.5 PUMP CONTROL SYSTEM

Provide independant float switches for the pump ON, pump OFF, low water alarm, and high water alarm. Metal parts, if used, must be of bronze or equivalent corrosion resistant material.

2.5.1 Sewage Pump Alarm and Control Panel

Enclose alarm panel in IP 54 enclosure with a flashing red alarm light. Use alarm designed to activate under the following conditions:

a. High liquid level as sensed by float switch

b. **Low liquid level as sensed by float switch (this alarm shall de-activate the pump).**

2.5.2 Leak Sensor

The pumps shall be equipped with a leak sensor. **The pump panel shall include an alarm light indicating leak detection.**

2.5.3 Temperature Alarm

The pumps shall be equipped with a temperature alarm. **The pump panel shall include an alarm light indicating a temperature alarm. This alarm shall de-activate the pump.**

2.5.4 Electric Motor

Use hermetically sealed electric motor. Seal the power cable inside the motor end bell. Provide a neoprene covered cable with a flexible metal cover over it for its full length.

PART 3 EXECUTION

3.1 INSTALLATION

Provide pump station in accordance with drawings and requirements of the respective equipment manufacturers. Dampen and isolate equipment vibration.

3.1.1 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

3.1.2 Valves

Installation of Valves: Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation, except as otherwise indicated. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.

3.1.3 Force Main

Provide in accordance with Section 33 30 00 SANITARY SEWERS.

3.1.4 Equipment Installation

Install equipment in accordance with these specifications and the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping to avoid imposing stress on any equipment. Match flanges accurately before securing bolts.

3.2 FIELD TESTS AND INSPECTIONS

Perform all field tests, and provide all labor, equipment, and incidentals required for testing. Produce evidence, when required, that any item of work has been constructed in accordance with contract requirements. Allow concrete to cure a minimum of 5 days before testing any section of piping where concrete thrust blocks have been provided.

3.2.1 Testing Procedure

Test piping in accordance with the Section 33 30 00 SANITARY SEWERS. Test in operation all equipment to demonstrate compliance with the contract requirements.

3.2.2 Sewage Pump Lift Station

Test pumps and controls, in operation, under design conditions to insure proper operation of all equipment. Provide all appliances, materials, water, and equipment for testing. Conduct testing after all equipment is properly installed, electrical services and piping are installed, liquid is flowing, and the pump station is ready for operation. Correct all defects discovered to the satisfaction of the USAID Implementing Partner, and all tests repeated, at the expense of the Contractor, until the equipment is in proper working order.

-- End of Section --

SECTION 33 32 13.14

PACKAGED SEWAGE LIFT STATIONS, GRINDER PUMP TYPE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

1.2 DESCRIPTION OF WORK

The work includes providing submersible sewage grinder pump station and related work as indicated on the drawings. Provide system complete and ready for operations. Grinder pump station system including equipment, materials, installation, and workmanship as specified herein.

The work also includes providing all piping, fittings and valves to 300 mm beyond limits of pit opening.

1.3 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Deatiled drawings of the control panel design, including complete, customized wiring and schematic diagrams reflecting the incorporation of the requirements stated in paragraph Pump Control System.

SD-03 Product Data

Pipe and fittings
Check valves
Gate valves
Submersible sewage grinder pumps
Pump motor

SD-10 Operation and Maintenance Data

Submersible Sewage Grinder Pumps

Include pumps, alarms, and motors. Include all information on all equipment, alarm panel and controls, pumps and pump performance curves, and station layout in data for submersible sewage grinder pump station. Submit operation and maintenance data in accordance with the Contract Documents.

SD-11 Closeout Submittals

Manufacturer's standard guarantees and warranties

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes and fittings free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it.

1.5 EXCAVATION, TRENCHING, AND BACKFILLING

Provide in accordance with Section 31 00 00 EARTHWORK, except as specified herein.

1.6 WARRANTY

Provide manufacturer's standard guarantees and warranties.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

Provide pressure piping, and related accessories for force main piping outside the sewage wet well in accordance with Section 33 30 00 SANITARY SEWERS.

2.1.1 PVC Plastic Pressure Pipe and Associated Fittings

2.1.1.1 Pipe and Fittings

Use pipe, couplings and fittings manufactured of materials conforming to ASTM D 1784, Class 12454-B.

(1) Solvent Cement Joint: Use pipe conforming to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa working pressure and 1.38 MPa hydrostatic test pressure. Use fittings for solvent cement jointing conforming to ASTM D 2466 or ASTM D 2467. Use flanged fittings where connecting to flanged equipment.

2.1.2 Insulating Joints

Provide between pipes of dissimilar metals a rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.

2.1.3 Accessories

Provide flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required and as shown on the Drawings.

2.2 VALVES AND OTHER PIPING ACCESSORIES

2.2.1 Check Valves

PVC swing check valve with top entry cleaning design and flanged ends, designed for a hydraulic working pressure of 1.21 MPa. Disc seals tightly with a minimum back pressure. Manufacturer Asahi or equal.

2.2.2 Identification Tags and Plates

Provide valves with tags or plates numbered and stamped for their usage. Use plates and tags of brass or nonferrous material and mounted or attached to the valve.

2.2.3 Gate Valves

Flanged PVC body gate valve with polypropylene plug and position indicator. Manufacturer Asahi or equal.

2.2.4 Miscellaneous Metals

Use stainless steel bolts, nuts, washers, anchors, and supports for installation of equipment.

2.3 SUBMERSIBLE SEWAGE GRINDER PUMPS

Provide submersible sewage pumps with grinder units as shown on the drawings. Pumps shall be easily removed from the unit using a quick disconnect coupling or fitting. Provide submersible, centrifugal sewage pumps and grinder units capable of grinding all materials found in normal domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, and wooden articles into a finely ground slurry with particle dimensions no greater than 6 mm. Pump capacity and motor characteristics as indicated herein. Design pump to operate in a submerged or partially submerged condition.

Pump	liters per second at total rated head, m H(2)O
Sanitary pump station	7 lps, 7.00 m

Pumps shall operate at optimum efficiencies to produce the most economical pumping system under the conditions encountered and shall be sized to make optimum match with the system head curve as shown. Pumps shall furnish not less than 150% of rated capacity at a total discharge head of not less than 65% of total rated head.

2.3.1 Casing

Provide hard, close-grained cast iron casing which is free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Design casings to permit replacement of wearing parts. Design passageways to permit smooth flow of sewage and to be free of sharp turns and projections.

2.3.2 Impeller

Provide non-clogging type cast-iron impeller. Make impeller with smooth surfaces, free flowing with the necessary clearance to permit objects in the sewage to pass. Fit and key, spline, or thread impeller on shaft, and lock in such manner that lateral movement will be prevented and reverse rotation will not cause loosening.

2.3.3 Shaft and Shaft Seals

Provide shaft of stainless steel. Provide mechanical seal of double carbon and ceramic construction with mating surfaces lapped to a flatness tolerance of one light band. Hold rotating ceramics in mating position with stationary carbons by a stainless steel spring. Oil lubricate bearings.

2.3.4 Bearings

Provide heavy duty ball thrust bearing or roller type bearing of adequate size to withstand imposed loads. Oil lubricate bearings.

2.3.5 Pump and Motor

Use pump and motor assembled on a single stainless steel shaft in a heavy duty cast-iron shell. Use free standing pump support legs of cast-iron providing enough clearance for the solids to get into the grinder.

2.4 PUMP MOTOR

Motor horsepower must be not less than pump horsepower at any point on the pump performance curve. Fit motors with lifting "eyes" capable of supporting entire weight of pump and motor. Motors must be suitable for operation at 50 Hz, 380 v.

2.5 PUMP CONTROL SYSTEM

Provide independent float switches for the pump ON, pump OFF, low water alarm, and high water alarm. Metal parts, if used, must be of bronze or equivalent corrosion resistant material.

2.5.1 Sewage Pump Alarm and Control Panel

Enclose alarm panel in IP 54 enclosure with a flashing red alarm light Use alarm designed to activate under the following conditions:

a. High liquid level as sensed by float switch

b. **Low liquid level as sensed by float switch (this alarm shall de-activate the pump).**

2.5.2 Leak Sensor

The pumps shall be equipped with a leak sensor. **The pump panel shall include an alarm light indicating leak detection.**

2.5.3 Temperature Alarm

The pumps shall be equipped with a temperature alarm. **The pump panel shall include an alarm light indicating a temperature alarm. This alarm shall de-activate the pump.**

2.5.4 Electric Motor

Use hermetically sealed electric motor. Seal the power cable inside the motor end bell. Provide a neoprene covered cable with a flexible metal cover over it for its full length.

PART 3 EXECUTION

3.1 INSTALLATION

Provide pump station in accordance with drawings and requirements of the respective equipment manufacturers. Dampen and isolate equipment vibration.

3.1.1 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

3.1.2 Valves

Installation of Valves: Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation, except as otherwise indicated. Make and assemble joints to check valves as

specified for making and assembling the same type joints between pipe and fittings.

3.1.3 Force Main

Provide in accordance with Section 33 30 00 SANITARY SEWERS.

3.1.4 Equipment Installation

Install equipment in accordance with these specifications and the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping to avoid imposing stress on any equipment. Match flanges accurately before securing bolts.

3.2 FIELD TESTS AND INSPECTIONS

Perform all field tests, and provide all labor, equipment, and incidentals required for testing. Produce evidence, when required, that any item of work has been constructed in accordance with contract requirements. Allow concrete to cure a minimum of 5 days before testing any section of piping where concrete thrust blocks have been provided.

3.2.1 Testing Procedure

Test piping in accordance with the Section 33 30 00 SANITARY SEWERS. Test in operation all equipment to demonstrate compliance with the contract requirements.

3.2.2 Sewage Grinder Pump Lift Station

Test pumps and controls, in operation, under design conditions to insure proper operation of all equipment. Provide all appliances, materials, water, and equipment for testing. Conduct testing after all equipment is properly installed, electrical services and piping are installed, liquid is flowing, and the pump station is ready for operation. Correct all defects discovered to the satisfaction of the USAID Implementing Partner, and all tests repeated, at the expense of the Contractor, until the equipment is in proper working order.

-- End of Section --

SECTION 33 71 02.00 20

UNDERGROUND ELECTRICAL DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318M	(2008; Errata 2008; Errata 2009) Metric Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO M 198	(2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B 3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire
ASTM B 496	(2004) Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 800	(2005) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers

ASTM B 801	(2007) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 32	(2009) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 478M	(2009) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 857	(2007) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM F 512	(2006) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C37.20.3	(2001; R 2006) Metal-Enclosed Interrupter Switchgear
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE Std 404	(2006) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V Through 500 000 V
IEEE Std 48	(2009) Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth

	Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C119.1	(2006) Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA RN 1	(2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TC 6 & 8	(2003) Standard for Polyvinyl Chloride PVC Plastic Utilities Duct for Underground Installations
NEMA TC 9	(2004) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
NEMA WC 71	(1999) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 74	(2006) Standard for 5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758-A	(2004) Customer-Owned Outside Plant Telecommunications Cabling Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644	(2002) Underground Plant Construction

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 1) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UNDERWRITERS LABORATORIES (UL)

UL 1072	(2006; Rev thru Sep 2007) Medium-Voltage Power Cables
UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 44	(2005; Rev thru Nov 2005) Thermoset-Insulated Wires and Cables
UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Apr 2009) Standard for Wire Connectors
UL 510	(2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(2004; Rev thru Oct 2009) Standard for Metallic Outlet Boxes
UL 514B	(2004; Rev thru Nov 2009) Standard for Conduit, Tubing and Cable Fittings
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 651	(2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 83	(20086) Standard for Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Rev thru Oct 2007) Service-Entrance Cables

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Precast underground structures

SD-03 Product Data

Medium voltage cable

Medium voltage cable joints

Medium voltage cable terminations

Live end caps

Precast concrete structures

Sealing Material

Pulling-In Irons

Manhole frames and covers

Handhole frames and covers

Composite/fiberglass handholes

Cable supports (racks, arms and insulators)

SD-06 Test Reports

Arc-proofing test for cable fireproofing materials

Medium voltage cable qualification and production tests

Field Acceptance Checks and Tests

Arc-proofing test for cable fireproofing tape

Cable Installation Plan and Procedure

Six copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Cable splicer/terminator

Cable Installer Qualifications

1.4 QUALITY ASSURANCE

1.4.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with ACI SP-66

e. Plans and elevations showing opening and pulling-in iron locations and details

1.4.2 Certificate of Competency for Cable Splicer/Terminator

Certification of the qualification of the cable splicer/terminator shall be submitted, for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables. The certification shall include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. The certification shall indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. The certification shall also list a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The USAID Implementing Partner reserves the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.

1.4.3 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

1.4.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the USAID Implementing Partner. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit

UL 6.

2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness shall be nominal 85 Shore A durometer, dielectric strength shall be minimum 15.75 kV per mm at 60 Hz, and tensile strength shall be minimum 25 MPa.

2.1.2 Intermediate Metal Conduit

UL 1242.

2.1.2.1 Intermediate Metal Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness shall be nominal 85 Shore A durometer, dielectric strength shall be minimum 15.75 kV per mm at 60 Hz, and tensile strength shall be minimum 25 MPa.

2.1.3 Plastic Conduit for Direct Burial

UL 651,Schedule 40 or Schedule 80 as indicated, NEMA TC 2, EPC-40-PVC or EPC-80-PVCas indicated.

2.1.4 Plastic Duct for Concrete Encasement

NEMA TC 6 & 8 and ASTM F 512, UL 651, EPC-40-PVC.

2.1.5 Innerduct

Provide corrugated polyethylene (PE) or PVC innerducts with pullwire. Size as indicated.

2.1.6 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials. Inflatable bladders may be used as an option.

2.1.7 Fittings

2.1.7.1 Metal Fittings

UL 514B.

2.1.7.2 PVC Conduit Fittings

NEMA TC 3.

2.1.7.3 PVC Duct Fittings

NEMA TC 9.

2.1.7.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit shall be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and shall conform to UL 514A.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors shall be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 12 months prior to date of delivery to the site shall not be accepted. Service entrance conductors shall conform to UL 854, type USE.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller shall be solid copper. Conductors No. 8 AWG and larger shall be stranded copper. All conductors shall be copper.

2.2.2 Conductor Material

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, shall be 600-volt, Type THWN/THHN conforming to UL 83 or Type XHHW or RHW conforming to UL 44. **Conductors shall have XLPE or EPR insulation.** Copper conductors shall be annealed copper complying with ASTM B 3 and ASTM B 8. Aluminum conductors shall be Type AA-8000 aluminum conductors complying with ASTM B 800 and ASTM B 801, and shall be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material). Type EC/1350 is not acceptable. Intermixing of copper and aluminum conductors is not permitted.

2.2.3 Jackets

Multiconductor cables shall have an overall PVC outer jacket.

2.2.4 In Duct

Cables shall be single-conductor cable.

2.2.5 Cable Marking

Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Each cable shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Conductors shall be color coded. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Conductor identification shall be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Control circuit terminations shall be properly identified. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems shall be as follows

a. 400/230, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

b. 230 volt, single phase: Black and red

2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Shall provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

b. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors shall be the circumferentially compressed, metallurgically bonded type.

2.4 LOW VOLTAGE SPLICES

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply NEMA C119.1.

2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied in accordance with the manufacturer's written instructions.

2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as covering or adhesive. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 24 months prior to date of delivery to the site shall not be accepted. Provide single conductor type cables unless otherwise indicated.

2.5.1 Cable Configuration

Provide Type MV cable, conforming to NEMA WC 74 and UL 1072 . Provide cables manufactured for use in duct or direct burial applications as indicated. Cable shall be rated as indicated with 133 percent insulation level.

2.5.2 Conductor Material

Provide concentric-lay-stranded, Class B compact round conductors. Provide soft drawn copper cables complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding.

2.5.3 Insulation

Provide ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 71.

2.5.4 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape or wire shield for each phase.

2.5.5 Neutrals

Neutral conductors of shall be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.

2.5.6 Jackets

Cables shall be provided with a PVC jacket. Direct buried cables shall be rated for direct burial. Provide PVC jackets with a separator that prevents contact when underlying semiconducting insulating shield.

2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

IEEE Std 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations shall be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations shall be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator shall be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination shall not require heat or flame for installation. Termination kit shall contain all necessary materials (except for the lugs). Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator shall consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination shall be designed for installation in low or highly contaminated indoor or outdoor locations.

2.6.3 Separable Insulated Connector Type

IEEE Std 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points.

a. 200 Ampere loadbreak connector ratings: Voltage: 15 kV, 95 kV BIL, 25 kV, 125 kV BIL. Short time rating: 10,000 rms symmetrical amperes.

b. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL, 25 kV, 125 kV BIL. Short time rating: 25,000 rms symmetrical amperes. Connectors shall have 200 ampere bushing interface for surge arresters.

c. Provide one set of three grounding elbows and one set of three feed-thru inserts. Grounding elbows and feed-thru inserts shall be delivered to the USAID Implementing Partner.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE Std 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints shall be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE Std 404. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint shall be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket shall be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice shall be packaged three splices per kit, including complete installation instructions.

2.8 LIVE END CAPS

Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. End cap shall conform to applicable portions of IEEE Std 48.

2.9 TAPE

2.9.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.9.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK

2.9.3 Fireproofing Tape

Provide tape composed of a flexible conformable unsupported intumescent elastomer. Tape shall be not less than 0.762 mm thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, and shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.10 PULL ROPE

Shall be plastic or flat pull line (bull line) having a minimum tensile strength of 890 N.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 19 mm (3/4 inch) in diameter by 3.1 m (10 feet) in length. Sectional type rods may be used for rods 20 feet or longer.

2.11.2 Grounding Conductors

Stranded-bare copper conductors shall conform to ASTM B 8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors shall conform to ASTM B 1 for sizes No. 8 and smaller. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Aluminum is not acceptable.

2.12 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE. In addition, provide concrete for encasement of underground ducts with 20 MPa minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts shall be 30 MPa minimum 28-day compressive strength unless specified otherwise.

2.13 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C 857 and

ASTM C 478M . Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable.

2.13.1 Cast-In-Place Concrete Structures

Concrete shall conform to Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.13.2 Precast Concrete Structures, Risers and Tops

In lieu of cast-in-place, Contractors, at their option, may provide precast concrete underground structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.13.2.1 General

Precast concrete structures shall have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures shall have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction shall be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have a 28-day compressive strength of not less than 30 MPa. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.13.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 0.523 rad

b. Unit Weight of Soil (Dry) = 1760 kg/m^3, (Saturated) = 2080 kg/m^3

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 915 mm below ground elevation

e. Vertical design loads shall include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact.

Live loads shall consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load shall be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads shall include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, shall be considered, along with a pulling-in iron design load of 26,700 N.

g. Each structural component shall be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design shall also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.13.2.3 Construction

Structure top, bottom, and wall shall be of a uniform thickness of not less than 150 mm. Thin-walled knock-out panels for designed or future duct bank entrances shall not be permitted. Quantity, size, and location of duct bank entrance windows shall be as directed, and cast completely open by the precaster. Size of windows shall exceed the nominal duct bank envelope dimensions by at least 305 mm vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a minimum of 150 mm from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 305 mm in diameter and 100 mm deep for precast structures.

2.13.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.13.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.

2.13.4 Handhole Frames and Covers

Frames and covers of steel shall be welded by qualified welders in

accordance with standard commercial practice. Steel covers shall be rolled-steel floor plate having an approved antislip surface. Hinges shall be of wrought steel, 125 by 125 mm by approximately 4.75 mm thick, without screw holes, and shall be for full surface application by fillet welding. Hinges shall have nonremovable pins and five knuckles. The surfaces of plates under hinges shall be true after the removal of raised antislip surface, by grinding or other approved method.

2.13.5 Brick for Manhole Collar

Brick shall be sewer and manhole brick conforming to ASTM C 32, Grade MS.

2.13.6 Composite/Fiberglass Handholes and Covers

Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass.

2.14 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

The metal portion of racks and arms shall be zinc-coated after fabrication.

2.14.1 Cable Racks

The wall bracket shall be 100 mm by approximately 38 mm by 4.76 mm channel steel, 1220 mm long (minimum) in manholes. Slots for mounting cable rack arms shall be spaced at 200 mm intervals.

2.14.2 Rack Arms

Cable rack arms shall be steel or malleable iron or glass reinforced nylon and shall be of the removable type. Rack arm length shall be a minimum of 200 mm and a maximum of 305 mm.

2.14.3 Insulators

Insulators for metal rack arms shall be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.15 CABLE TAGS IN MANHOLES

Provide tags for each power cable located in manholes. The tags shall be polyethylene. Do not provide handwritten letters. The first position on the power cable tag shall denote the voltage. The second through sixth positions on the tag shall identify the circuit. The next to last position shall denote the phase of the circuit and shall include the Greek "phi" symbol. The last position shall denote the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

2.15.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 22.4 MPa (3250 pounds per square inch); and that are two millimeter (0.08 inch) thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 77 degrees C. Provide 1.3 mm (0.05 inch) (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 778.75 N (175 pounds).

The cable tags shall have black block letters, numbers, and symbols 25 mm (one inch) high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

2.16 CABLE TERMINATING CABINETS

Cable terminating cabinets shall be hook-stick operable, deadfront construction conforming to the requirements of IEEE C37.20.3, Category A. Cabinets shall be provided with with 600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs. Provide cable terminating equipment in conformance with IEEE Std 386.

Ratings at 50 Hz shall be:

Nominal voltage (kV).....20

Rated maximum voltage (kV).....25

Rated continuous current (A).....200

Three-second short-time current-carrying capacity (kA).....10

BIL (kV).....150

2.17 SOURCE QUALITY CONTROL

2.17.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer shall test one sample assembly consisting of a straight lead tube 305 mm long with a 65.5 mm outside diameter, and a 3.175-mm thick wall, and covered with one-half lap layer of arc and fireproofing material per manufacturer's instructions. The arc and fireproofing tape shall withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode shall be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. The arc shall be directed toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Each sample assembly shall be tested at three unrelated points. Start time for tests shall be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time shall be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape shall indicate that the test has been performed and passed by the manufacturer.

2.17.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758-A and RUS Bull 1751F-644.

3.2 CABLE INSPECTION

Prior to installation, each cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. The Contractor shall then perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS. Cable shall be installed strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

Calculations and pulling plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 1525 mm outside the building and projections thereof, except that conductors shall be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Conduit shall be PVC, Type EPC-40 from the supply equipment to a point 1525 mm outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors shall have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C 309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete.

3.5.1 Cast-In-Place Concrete Structures

Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers. Provide concrete block conforming to ASTM C 139 and Section 04 20 00 MASONRY.

3.5.2 Precast Concrete Construction

Set commercial precast structures on 150 mm of level, 90 percent compacted granular fill, 19 mm to 25 mm size, extending 305 mm beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation shall additionally conform to the manufacturer's instructions.

3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices shall be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor the irons shall be a minimum of 150 mm from the edge of the sump, and in the walls the irons shall be located within 150 mm of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron shall not be located within 150 mm of an adjacent interior surface, or duct or precast

window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 150 mm clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 915 mm length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner shall be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 75 mm from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons shall have a clear projection into the structure of approximately 100 mm and shall be designed to withstand a minimum pulling-in load of 26,700 N. Irons shall be hot-dipped galvanized after fabrication.

3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 915 mm apart, and each manhole wall shall be provided with a minimum of two racks. Racks in signal manholes shall be spaced not more than 420 mm apart with the end rack being no further than 305 mm from the adjacent wall. Methods of anchoring cable racks shall be as follows:

a. Provide a 15 mm diameter by 125 mm long anchor bolt with 75 mm foot cast in structure wall with 50 mm protrusion of threaded portion of bolt into structure. Provide 15 mm steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 1192 kg per meter. Insert channel shall be steel of the same length as "vertical rack channel;" channel insert shall be cast flush in structure wall. Provide 15 mm steel nuts in channel insert to receive 15 mm diameter by 75 mm long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert shall have minimum 365 kg load rating. Provide 15 mm diameter by 75 mm long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.5.5 Field Painting

Cast-iron frames and covers not buried in concrete or masonry shall be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

3.6 DIRECT BURIAL CABLE SYSTEM

Cables shall be buried directly in the earth below the frostline as indicated to the requirements of NFPA 70 and IEEE C2, whichever is more stringent.

3.6.1 Trenching

Trenches for direct-burial cables shall be excavated to depths required to provide the minimum necessary cable cover. When rock is encountered, remove to a depth of at least 75 mm below the cable and fill the space with sand or clean earth free from particles larger than 6 mm Bottoms of trenches shall be smooth and free of stones and sharp objects. Where materials in bottoms of trenches are other than sand, a 75 mm 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil. Trenches shall be not less than 150 mm wide, and shall be in straight lines between cable markers. Cable plows shall not be used. Bends in trenches shall have a radius of not less than 915 mm.

3.6.2 Cable Installation.

Cables shall be unreeled along the sides of or in trenches and carefully placed on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position will not be permitted, except as required to pull cables through conduits under paving or railroad tracks.

Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 75 mm apart, except that communication cable shall be separated from power cable by a minimum distance of 305 mm.

Where direct-burial cables cross under roads or other paving exceeding 1.5 m in width, such cables shall be installed in concrete-encased ducts. Ducts shall extend at least 300 mm beyond each edge of any paving and at least 1.5 m beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables shall be centered in duct entrances, and a waterproof nonhardening mastic compound shall be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Damage to conduit coatings shall be prevented by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, the paving and subbase shall be restored to their original condition. Where cable is placed in duct(e.g. under paved areas, roads, or railroads), slope ducts to drain.

3.6.3 Splicing

Provide cables in one piece without splices between connections except where the distance exceeds the lengths in which cables are manufactured. Where splices are required, provide splices designed and rated for direct burial.

3.6.4 Bends

Bends in cables shall have an inner radius not less than those specified in NFPA 70 for the type of cable, or manufacturer's recommendation.

3.6.5 Horizontal Slack

Leave approximately 915 mm of horizontal slack in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections.

3.6.6 Identification Slabs

Provide a slab at each change of direction of cable, over the ends of ducts or conduits which are installed under paved areas and roadways, and over each splice. Identification slabs shall be of concrete, approximately 500 mm square by 150 mm thick and shall be set flat in the ground so that top surface projects not less than 20 mm, nor more than 30 mm above ground. Concrete shall have a compressive strength of not less than 20 MPa and have a smooth troweled finish on exposed surface. Inscribe an identifying legend such as "electric cable," "telephone cable," "splice," or other applicable designation on the top surface of the slab before concrete hardens. Inscribe circuit identification symbols on slabs as indicated. Letters or figures shall be approximately 50 mm high and grooves shall be approximately 6 mm in width and depth. Install slabs so that the side nearest the inscription on top shall include an arrow indicating the side nearest the cable. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.7 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.7.1 Requirements

Depths to top of the conduit shall be in accordance with NFPA 70. Run conduit in straight lines except where a change of direction is necessary. Numbers and sizes of ducts shall be as indicated. Ducts shall have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm (18 inches) for ducts of less than 80 mm (3 inch) diameter, and 900 mm (36 inches) for ducts 80 mm (3 inches) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in structures.

3.7.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.7.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 75 mm and larger, draw a flexible testing mandrel approximately 305 mm long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For

conduit sizes less than 75 mm, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.7.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, shall be zinc-coated, rigid steel, jacked into place.Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Hydraulic jet method shall not be used.

3.7.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations shall be PVC coated and shall extend from at least 50 mm within the concrete to the first coupling or fitting outside the concrete (minimum of 150 mm from penetration).

3.7.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 65 mm, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 300 mm. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 3050 mm of conduit assembly.

3.7.7 Conduit Plugs and Pull Rope

New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 915 mm of slack at each end of unused or empty conduits.

3.7.8 Conduit and Duct Without Concrete Encasement

Provide not less than 75 mm clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 75 mm, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 6.25 mm sieve. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.7.8.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 75 mm concrete cover around ducts. Concrete encasement shall extend at least 1525 mm beyond the edges of paved areas and roads, and 3660 mm beyond the rails on each side of railroad tracks.

3.7.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 75 mm of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 65 mm, except separate light and power conduits from control, signal, and telecommunications conduits by a minimum concrete thickness of 75 mm. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring shall be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.7.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 300 mm in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.7.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.7.9.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and extend into the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.7.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. Abandon in place those no longer used ducts and cables which do not interfere with the work.

3.7.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 610 mm back into the envelope and a minimum of 610 mm beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 305 mmapart. Restrain reinforcing assembly from moving during concrete pouring.

3.7.9.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

3.8 CABLE PULLING

Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape shield shall have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.8.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.9 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

3.9.1 Cable Tag Installation

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.10 CONDUCTORS INSTALLED IN PARALLEL

Conductors shall be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

3.11 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set. Make splices in underground distribution systems only in accessible locations such as manholes,handholes, or aboveground termination cabinets.

3.11.1 Terminating Aluminum Conductors

a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.

b. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail shall have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers shall be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

c. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply inhibiting compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

3.12 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.13 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

3.13.1 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods shall be as specified elsewhere in this section. Wire shall be trained to the sides of the enclosure to prevent interference with the working area.

3.14 CABLE END CAPS

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.15 LIVE END CAPS

Provide live end caps for single conductor medium voltage cables where indicated.

3.16 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.16.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

3.16.2 Tape-Wrap

Tape-wrap metallic-sheathed or metallic armored cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap shall be in the form of two tightly applied half-lapped layers of a pressure-sensitive 0.254 mm thick plastic tape, and shall extend not less than 25 mm into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

3.17 GROUNDING SYSTEMS

Provide grounding system as indicated, in accordance with NFPA 70 and IEEE C2, and as specified herein.

Noncurrent-carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid earth ground not exceeding the following values:

Pad-mounted transformers without protective fences	5 ohms

Ground in manholes	5 ohms
Grounding other metal enclosures of primary voltage electrical and electrically-operated equipment	5 ohms

3.17.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 150 mm, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.

If the specified ground resistance is not met, an additional ground rod shall be provided in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.17.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.17.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG. Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.

3.17.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.17.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 305 mm above finished floor. Secure the conductor to the

manhole walls at intervals not exceeding 914 mm . Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.17.6 Fence Grounding

Fences shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 305 mm below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 305 mm of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 3 by 25 mm flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.18 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.18.1 Reconditioning of Surfaces

3.18.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct or direct burial cable. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

3.18.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.19 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.19.1 Concrete Slabs for Equipment

Unless otherwise indicated, the slab shall be at least 200 mm thick, reinforced with a 152 mm x 152 mm - MW19 by MW19 (6 by 6 - W2.9 by W2.9) mesh, placed uniformly 100 mm from the top of the slab. Slab shall be placed on a 150 mm thick, well-compacted gravel base. Top of concrete slab shall be approximately 100 mm above finished grade with gradual slope for drainage. Edges above grade shall have 15 mm chamfer. Slab shall be of adequate size to project at least 200 mm beyond the equipment.

Stub up conduits, with bushings, 50 mm into cable wells in the concrete

pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.19.2 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.20 FIELD QUALITY CONTROL

3.20.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.20.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Inspect for proper shield grounding, cable support, and cable termination.

(4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

(5) Inspect for proper fireproofing.

(6) Visually inspect jacket and insulation condition.

(7) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

(2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests shall be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE Std 400.2. VLF test frequency shall be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages

shall be as follows:

CABLE RATING	AC TEST VOLTAGE for ACCEPTANCE TESTING
5 kV	10kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)
25 kV	31kV rms(peak)
35 kV	44kV rms(peak)

CABLE RATING	AC TEST VOLTAGE for MAINTENANCE TESTING
5 kV	7kV rms(peak)
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)
25 kV	23kV rms(peak)
35 kV	33kV rms(peak)

3.20.1.2 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE Std 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable megohmmeter tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.20.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION 43 21 39

WELL PUMPS

PART 1 GENERAL

1.1 JOB REQUIREMENTS

Contractor shall furnish all labor, materials, tools, equipment, and perform all work and services necessary for the installation of one (1) constant speed submersible motor vertical turbine pump as shown on the Contract Drawings and as specified, in accordance with the provisions of the Contract Documents, and completely coordinated with work of all other trades.

Although not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure and complete installation. All submersible motor turbine pumps shall be from the same manufacturer.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API 5C1	(5/1999, R 8/2006) Recommended Practice for Care and Use of Casing and Tubing

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA E101	(1988) Vertical Turbine Pumps - Line Shaft and Submersible Types

1.3 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Installation

Detail drawings consisting of a complete list of equipment and materials. Detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system and control panel has been coordinated and will properly function as a unit. Show on the Drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Vertical Turbine Pump

Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions including the following:

a. Pump Speed
b. Flow vs. Head Curve
c. Efficiency Curve
d. Horsepower Curve
e. NPSHR Curve
f. Motor Efficiency vs. Load

SD-06 Test Reports

Testing

Test reports in booklet form showing all factory inspections and tests, and all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

SD-10 Operation and Maintenance Data

Vertical Turbine Pump

Six complete copies of operating manual outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the manual the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. Include in the manuals simplified wiring, layout, and control diagrams of the system as installed.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 GENERAL

2.1.1 Standard Products

Impellers shall be closed and dynamically balanced. Each impeller shall be secured to the impeller shaft with keys, taper collets or locknuts. The upper shaft bearing shall be bronze.

The suction strainer shall have a net inlet area equal to at least three (3) times the impeller inlet area. The maximum unit opening shall not be more than 75% of the minimum opening of the water passage through the bowl or impeller. The strainer shall be secured with stainless steel 302 or better fasteners.

The pump to motor coupling flange shall conform to NEMA specifications and be capable of transmitting the total torque and total thrust of the bowl assembly in either direction of rotation. A coupling guard shall be furnished, integral to the discharge head. The pump/motor interconnector case shall conform to NEMA specifications. Non NEMA frame motor adapters are unacceptable.

All components of the pump system shall be capable of operating at the pump shut-off head pressure. Refer to Contract Drawings for well pump system dimensional requirements.

The pump Contractor shall verify that the thrust bearing of the motor is not overloaded. The Contractor shall submit the "K," maximum thrust constant for the pump and thrust bearing rating for the motor. It is the responsibility of the pump Contractor to integrate the pump and motor.

2.2 PUMP AND APPURTENANCES

2.2.1 Pump Performance

The performance specifications for the pump assemblies are tabulated below. Pump to motor flange coupling must be NEMA to fit motor.

Performance Specifications

Design Points	Flow Rate lps	TDH m	Efficiency %	Frequency hz
Primary	4.5	(a)	65	50

(a) TDH to be determined in field after well installation and testing, and as approved by the USAID Implementing Partner. TDH equals the static head (difference between elevation of elevated potable water tank and elevation of the lowest drawdown within the well) plus friction losses.

2.2.2 Materials of Construction

Materials of construction shall be as follows:

PART	MATERIAL
Bearings	Thermoplastic
Pump Shaft	Stainless Steel AISI Type 316
Bowls/Cases	Stainless Steel AISI Type 316
Impeller	Stainless Steel AISI Type 316
Inlet Screen	Stainless Steel AISI Type 304
Pump Motor Coupling	Stainless Steel AISI Type 316
Fastener and Screws	Stainless Steel AISI Type 316
Cable Guard	Stainless Steel AISI Type 304

2.2.3 Water Level Indicators

Pressure Transducer: The submersible pressure transducer shall be hermetically sealed stainless steel unit with ± 0.25 % FS accuracy. The transducer shall have a 2-wire, 4-20 mA output and a repairable/replaceable sensor/cable assembly and top side indicating transmitter. Transducer shall be manufactured by In-Situ, Druck or approved equivalent. Transducer shall have a dedicated PVC tube that is accessible from inside the top of the well head. The PVC tube shall extend from the well head down below pump

alongside the motor. The PVC tube shall be perforated with four 76 mm drill holes every foot for the lowest 6 m to allow water entry. The PVC tube shall have a cap or plug on bottom.

2.2.4 Miscellaneous

Nameplates and other data plates shall be stainless steel, suitably secured to the pump and motor.

All machine bolts, nuts and capscrews shall be AISI Type 304 stainless steel of the hex head type. Hardware requiring special tools or wrenches shall not be used.

2.3 MOTORS AND APPURTENANCES

2.3.1 Submersible Motors

Performance. The minimum performance specifications for the submersible motor assembly are as follows:

Service factor above rated HP	Shall not be utilized
Voltage, VAC,	380/230 V
Phase	3
Frequency	50 Hz
Motor Size	(a)
Full Load Efficiency, min.	85 %

(a) to be determined in the field to meet the pump performance specifications in 2.2.1 PUMP PERFORMANCE and approved by the USAID Implementing Partner.

2.3.2 Construction of Submersible Well Pump Motor

Materials and methods of construction shall permit the motor to operate within the latest NEMA standards for temperature rise.

A thrust bearing of the Kingsbury type shall support all rotating and hydraulic loads of both pump and motor. Each thrust pad shall be individually tilting with the entire group self leveling and aligning. The bearing shall be bi-directional. The losses at full load shall not exceed 12 watts per 45 kg of thrust.

The frame of the pump interconnector and shaft shall conform to the latest revision of NEMA standards for submersible motors especially made for water lubrication. This motor has a NEMA flange coupling.

Windings shall be completely sealed in a stainless steel enclosure. Sand and other foreign materials shall be filtered from the water with a bronze and nickel plated brass filter. Motor leads shall be of sufficient length that the splice to the cable can be made above the pump.

2.3.3 Motor Manufacturers

Approved manufacturers: Franklin Electric, or pre-approved equivalent.

2.4 Submersible Cable

2.4.1 Conductors

One (1) continuous length of cable shall connect the submersible motor pigtails to the above ground well head junction box. An additional 1.5 meters of cable shall be housed inside the well head for splicing

This cable shall consist of three (3) individual color coded conductors. Each copper conductor shall be insulated for 600 VAC by rubber, synthetic rubber, or approved plastic insulation suitable for continuous immersion in water at well temperature. All three (3) conductors shall be enclosed in an overall jacket material that is impervious to oil and water and made from rubber, synthetic rubber, metal or other approved mechanically protective material. All filler material shall be non-hydroscopic. Jute or hemp is not acceptable.

Individual cable stranding shall meet ASTM class designations as follows:

AWG #10 or smaller - Class B - 7 strands minimum
AWG #1 through 4/0 - Class B - 19 strands minimum
AWG #9 through #2 - Class C - 19 strands minimum

The cable shall have sufficient conductor cross sectional area to meet the minimum requirements of the Insulated Power Cable Engineers Association Code of Operation in Free Air or shall meet the requirements of the motor manufacturer, as dictated by horsepower, voltage and well water temperature. A 150 mm long sample of the proposed cable shall be submitted to the USAID Implementing Partner for approval prior to installation of the submersible pump. This sample shall have the manufacturer's identifying stencil on the outer jacket.

2.4.2 Cable Support

The pump cable, water level indicator access PVC tube, and transducer PVC tube shall be secured to the riser pipe with high strength polypropylene pipe tape and 10 mm AISI Type 303 stainless steel banding. Each stainless steel band shall be protected by a nonslip, rubber, protector over the submersible cable. The spacing schedule of banding and tape is as follows:

AWG Size	Tape	SS Banding
10 or smaller	3 meter centers	30 meter centers
9 through 4	3 meter centers	9 meter centers
2 through 3/0	3 meter centers	3 meter centers

2.4.3 Mechanical Shielding

The electrical conductors shall be protected by a corrosion-resistant cable guard where they pass the pump bowls. This guard shall be secured to the pump with AISI Type 303 stainless steel bands.

2.4.4 Splices

Only one (1) splice will be permitted in the submersible cable. This splice, at the motor pigtail, shall be completed in a staggered manner so that no individual conductor splice shall be directly opposite another.

The conductors of the pigtail and power cable shall be joined with rosin

core soldered copper butt connectors. The insulating overlay shall be of rubber manufactured by 3M Company of Plymouth or shall be of submersible adhesive heat shrink insulations as made by Sigma Corporation. This insulation shall be a minimum of 30 mm in length overlay with polypropylene pipe tape and "Scotch-Kote" as made by 3M Company. The entire splice shall be banded to the riser pipe with protected stainless steel banding and polypropylene pipe tape.

Termination of the cable at the surface junction box shall be made with electrical split bolts and rubber tape for 600 VAC splices and of the manufacturers approved method for those splices above 600. Each 600 VAC surface splice shall be overlaid with vinyl and "Scotch-Kote." Wire nuts are not acceptable.

2.5 RISER PIPE AND FITTINGS

2.5.1 Pipe

The riser pipe connecting the pump to the surface shall be PVC Certanteed Certa-Lok Drop Pipe as follows:

a. Top and bottom of drop pipe string shall be fitted with stainless steel Certa-Lok Drop Pipe adapters

2.5.2 Makeup Torque

All pipe and fittings shall be secured to prevent unthreading during pump start-up. A minimum of 6.7 kg-m (10 ft-lbs) per horsepower is recommended; however, this is intended only as a guideline. Pipe torque shall be in accordance with API 5C1.

2.5.3 Pipe Lubricant

Each connection shall be coated with a pipe dope that is approved for use in water systems by the National Sanitation Foundation. Lead based doping compounds are not permissible.

2.5.4 Adapter Fittings

The Contractor shall provide all fittings to adapt the riser pipe to the well head surface plate and above ground discharge pipes. These adapters shall be of the swedge type, threaded both ends and of stainless steel material equal to or better than the specified riser pipe

2.5.5 Centralizing Spiders

Riser pipe centralizing spiders shall be installed on the downwell piping. The spiders are to be spaced at average intervals of 12 meters, however, the intervals are to be random and not evenly spaced, i.e., at 7.6 meters, 12 meters, 18 meters. Spiders shall be the equivalent of "Black Widow," the trade name of Bean Rubber Mfg. Company.

2.6 CHECK VALVES

2.6.1 Materials and Construction

Check valves in the downhole string shall be stainless steel and rated for the depth of set and extreme conditions of operating or line surface pressures. Each valve shall be threaded on both ends with a thread pattern

identical to that of the line pipe.

The outer diameter shall not be larger than the coupling diameter for the line pipe. The body of the valve shall be machined from carbon steel of tensile strength equal or greater than the line pipe. Check valves shall be manufactured by Flomatic or pre-approved equal.

2.6.2 Location

Check valve shall be set within 1.5 meters above the pump and as shown on the Contract Drawings.

2.7 KNOCKOUT VALVES

Individual knockout valves shall be placed above or be integral with each check valve. The valve bodies shall be constructed of equal or better materials than the line pipe.

The drain plug shall be replaceable and made of brass or monel. It shall be capable of withstanding the hydraulic pressure above each check.

2.7.1 Submersible Vertical Turbine Pumps

2.7.1.1 Control Equipment

Automatically controlled pumps shall have three-position MANUAL-OFF-AUTOMATIC selector switch in cover. Additional controls or protective devices shall be as indicated.

A pump low-water cutoff shall be installed in the well or on the suction pipe and shall shut the pump off when the water level in the well reaches the level shown. The control panel shall contain the display for the pressure transducer specified.

The control panel shall receive the signals from the float switches (high water alarm, well pump off, well pump on, and low water alarm) in the potable water storage tank.

The control panel shall contain a display for the flow **meter**.

Control panel is to have a IP50 enclosure and with a flashing red alarm light. Use alarm designed to activate under the following conditions:

a. Low water level as indicated by the pressure transducer**. (This alarm shall de-activate the well pump.)**

b. **Low water alarm in the potable water storage tank.**

c. High water alarm in potable water storage tank. **(This alarm shall de-activate the well pump.)**

Well pump shall shut down when the alarm activates.

2.7.1.2 Float Assembly Description

For the switches in the potable water tank, use a direct acting float switch consisting of a normally-open mercury switch enclosed in a float. use pipe mounted float assembly. Use floats molded of rigid high-density polyurethane foam, color-coded and coated with a durable, water and

corrosion-resistant jacket or clear urethane. Provide connecting cable and support pole in accordance with manufacturers recommendations. Provide a cast aluminum NEMA Type 4 junction box to connect float assembly. Use box with gasketed cover with tapped float fitting and conduit entrance pipe threaded opening. Mount floats at fixed elevations as shown. Use floats designed to tilt and operate their switches causing sequential turn-on turn-off of the well pump, when the liquid level being sensed rises or falls past the float.

2.7.1.3 Electric Motors

Submersible motors shall be designed and manufactured expressly for the intended use. Motors shall be rated 380 volts, 3 phase, 50 Hz and such rating shall be stamped on the nameplate. Submersible motors may be the wet-stator type, dry-stator type, or oil-filled stator type. Wet-stator motors shall be filled at the factory with water treated to minimize corrosion, and shall be provided with a seal to keep interchange of cooling water and water being pumped to a minimum. Windings shall be insulated with a waterproof material. Dry-stator motors shall have rotor bearings immersed in a coolant lubricant of water-oil or water-glycol mixture, or a water-grease emulsion. When the coolant is water, it may be sealed in the motor or allowed to flow through the motor, depending upon design. Stator case shall be hermetically sealed and may be filled with a solid plastic material to help dissipate heat. Oil-filled stator motors shall be completely filled with high-dielectric constant oil. A mechanical seal shall be provided between the shaft and the motor housing and shall be designed to minimize the loss of oil. An oil reservoir shall be provided to replenish the oil loss for the life of the motor. Wet-stator motors and oil-filled stator motors shall employ a system to automatically balance the liquid pressure in the motor at any depth of submergence up to the maximum allowable. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearings shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust, and shall be capable of withstanding the upthrust imposed during pump starting.

PART 3 EXECUTION

3.1 FIELD INSPECTION

The USAID Implementing Partner shall be present at the following installation inspection points. The USAID Implementing Partner shall accept or reject the installation inspection results.

1. Motor/pump models and serial number.

2. Meggering of the motor by Contractor with a 500 volt resistance megger and measurement of the motor winding resistance.

3. Placement of the airline end or water level transducer assembly.

4. Start-up.

The Contractor is responsible for notifying the USAID Implementing Partner 48 hours in advance of setting the pump and initiating start-up.

3.2 RESISTANCE READINGS

Resistance readings shall be taken on the motor with pigtail and motor with cable attached. A new motor and new cable shall have the minimum insulation resistance as measured with a 500 volt megger after one (1) minute of applied voltage. Resistance readings shall be witnessed by the USAID Implementing Partner.

1. Motor only with pigtail-ten (10) meg ohms.
2. Motor with cable attached and installed in well-two (2) meg ohms.

3.3 SUPPLIER/MANUFACTURER'S SERVICES

A supplier's and/or manufacturer's representative for the equipment specified shall be at the job site for installation assistance, inspection and certification of the installation, testing, start-up assistance, and training. These efforts by the representative shall be coordinated by the Contractor and shall be witnessed by the USAID Implementing Partner.

3.4 TESTING

3.4.1 Factory Pump Test

Factory pump performance test shall be made in conformance with AWWA E101 and the Hydraulic Institute Standards for the following:

a. Running test.

b. Witnessed running test.

c. Sample calculation from test readings.

d. Shop inspection.

e. Hydrostatic test of bowl assembly.

f. Hydrostatic test of discharge head.

Certified performance reports shall be provided to the USAID Implementing Partner for review and shall be accepted or rejected by the USAID Implementing Partner prior to shipment.

3.4.2 Field Equipment Test

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly.Each pumping unit shall be given a running field test in the presence of the USAID Implementing Partner for a minimum of 2 hours. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the USAID Implementing Partner. Provide an accurate and acceptable method of measuring the discharge flow.

-- End of Section --

SECTION 43 32 76

CHLORINATION EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

1.2 SUBMITTALS

Contractor shall submit the following using procedures as specified in the Contract Documents.

SD-02 Shop Drawings

Installation

Detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. **This includes the chlorine solution metering pump interfacing with the well pump control panel to receive the "pump on" signal that is to activate the metering pump.** Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Material and Equipment

A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

Six complete copies of operating manuals outlining the

step-by-step procedures required for system startup, operation and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

1.3 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.4 MAINTENANCE, EXTRA MATERIALS AND TOOLS

1.4.1 Auxiliary Equipment and Spare Parts

Furnish auxiliary equipment and spare parts as follows:

a. **One spare diaphragm for the metering pump.**

b. **Replacement cartridge check valve.**

c. **Other recommended spare parts from the manufacturer.**

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Miscellaneous Supports

Bolts, nuts, anchors, washers, and all other types of supports necessary for the installation of the equipment shall be galvanized steel, cadmium plated steel, or AISI Type 316 stainless steel.

2.2 **METERING PUMP**

a. Manual stroke length, stroke speed adjustment.

b. Rated capacity of 2.3 liters per hour at 7 bars.

c. Diaphragm is to be PTFE-faced, bonded to a composite of hypalon and fabric layers.

d. 230 V, 50 Hz, single phase.

e. Pulsafeeder Pulsatron Series E, or approved equal.

2.3 **CHLORINE SOLUTION TANK**

a. High density polyethylene (HDPE) tank, suitable for mounting the mixer (no cover required).

b. 100 liter capacity.

2.4 **HYPOCHLORITE POWDER DISSOLVING TANK**

a. HDPE tank, with cover.

b. 20 liter capacity.

c. Include a sturdy plastic paddle for manually mixing the hypochlorite powder.

2.5 **MECHANICAKL MIXER**

a. Size as recommended by the mixer manufacturer for the chlorine solution tank.

b. Materials of construction compatable with chlorine solution.

2.6 **PVC VALVES**

a. Check valves, ball valves and other miscellaneous valves shall be Asahi, or approved equal.

2.7 PIPING

All dilution water and chemical solution piping is to be Schedule 80 PVC.

2.8 ELECTRICAL WORK

Electric motor-driven equipment, and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings shall be as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Chlorine-Feeding Equipment

All components of the chlorination system are to be installed in accordance with the manufacturer's instructions.

3.1.2 Pipe, Tubing, Hangers, and Supports

The installation of pipes and tubes shall be in accordance with the manufacturer's recommendations. Installation of hangers and supports shall conform to MSS SP-58 and MSS SP-69.

-- End of Section --

SECTION 44 41 12

PACKAGED WASTEWATER TREATMENT PLANT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Recommended Standards for Wastewater Facilities, 2004 Eds, A Report of the Wastewater Committee of the Great Lakes--Upper Mississippi River, Board of State and Provincial Public Health and Environmental Managers, Published by: Health Reasearch, Inc. Health Education Services Divisions, Albany, NY 1224

ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10	(2007) Near-White Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.2 SUBMITTALS

Contractor shall submit the following using submittal procedures as specified in the Contract Documents.

SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixtures List in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Design Requirements," of this section.

Fabrication Drawings
Erection/Installation Drawings

Also, submit detailed drawings showing the layout of freeze protection systems for all exposed, normally filled pipes.

SD-03 Product Data

Submit manufacturer's catalog data and equipment and performance data for the following items:

Surface Preparation and Coating
Inlet Bar Screen

Flow Equalization Chamber
Sludge Holding Chamber
Aeration Chamber
Clarifier Chamber
Sludge Recirculation System
Scum Recirculation System
Chorine Disinfection

Submit Spare Parts Data for all components of the packaged wastewater treatment plant in accordance with the paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Submit Design Data with Manufacturer part number for the following:

Inlet Bar Screen
Flow Equalization Chamber
Sludge Holding Chamber
Aeration Chamber
Clarifier Chamber
Sludge Recirculation System
Scum Recirculation System
Chlorine Disinfection

SD-07 Certificates

Submit the following in accordance with paragraph entitled, "General Requirements," of this section.

Listing of Product Installations within Afghanistan
Safety Considerations

Submit Certificates for the following items in accordance with the applicable reference standards and description of this section.

Surface Preparation and Coating
Inlet Bar Screen
Flow Equalization Chamber
Sludge Holding Chamber
Aeration Chamber
Clarifier Chamber
Sludge Recirculation System
Scum Recirculation System
Chlorine Disinfection

Warranty

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for installing equipment components of the packaged wastewater treatment plant.

Submit the following in accordance with paragraph entitled, "General Requirements" of this section.

Preventative Maintenance and Inspection
Special Tools
Posted Instructions

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for package wastewater treatment plant including the following in accordance with paragraph entitled, "Operation and Maintenance," of this section.

Equipment Description
Assembly and Installation Procedures
Adjustment and Alignment
Checkout Procedures
Procedures of Operation
Troubleshooting

1.3 DESIGN REQUIREMENTS

Actual range in capacities may vary from that stipulated if the minimum and maximum capacities specified are included.

Furnish and install one (1) complete prefabricated carbon steel wastewater treatment plant and related equipment designed and constructed in accordance with the plans and specifications stated herein. The wastewater treatment plant will be the activated sludge type, consisting of a single train, designed for treating an average day flow of 144 m3/day and 68 kg/d BOD load.

Submit Fabrication Drawings after receiving tentative approval of the equipment and the materials list but before installation, Contractor to submit drawings covering necessary or recommended changes to accommodate the equipment offered. Show clearly on the drawings the design of the waste water treatment plant (WWTP), with dimensions, types, and thicknesses of materials, and elevation levels with reference to those elevations indicated.

Submit Erection/Installation Drawings for the wastewater treatment plant with the required equipment and accessories that are inclusive. Show clearly on the drawings the design of the base slab for the WWTP, with dimensions, reinforcement, and elevations.

Provide the following motor/pumps design data with the equipment submittals - number of motor rotor bars and stator slots; number of cooling fan blades; RPM of motor; bearings, bearing manufacturer, bearing type, bearing style and number of balls/elements; number of commutator bars and commutator brushes; SCR firing frequencies; and number of pump impellers.

Design package wastewater treatment plant in accordance with "Recommended Standards for wastewater facilities," by the Wastewater Committee of the Great Lake-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, latest edition (2004), commonly known as "Ten States Standards." Design shall be in conformance with relevant sections of AWWA, ASME, ASTM, AISC, ISO, MSS, NEMA and ICBO. The wastewater treatment plant effluent shall meet 30 mg/L BOD, 30 mg/L TSS and less than 126/100 ML e-Coli based on a 30 day geometric mean of daily samples.

1.4 PROTECTION FROM MOVING PARTS

Locate and guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts in accordance with applicable

OSHA standards and so that personnel are properly protected from injury.

1.5 NAMEPLATES

Provide the manufacturer's name or trademark on a corrosion-resistant identification plate or cast integrally, on each item of equipment, stamped, or otherwise permanently marked in a conspicuous place. Include on the pump identification plate the pump capacity in liter per minute, pump head in meter, and speed of rotation. Cast on the body of the pump the direction of rotation On the identification plate indicate all necessary information to complete identification such as the manufacturer.

1.6 FIELD REPRESENTATIVE

Contractor shall be required to provide specific instructions on the equipment, processes and systems by a Qualified Representative of the Equipment Supplier during installation, commissioning, and start-up of the wastewater treatment plant.

1.7 GENERAL REQUIREMENTS

Submit Material, Equipment, and Fixtures List of all major components including manufacturer's catalog numbers, specification and drawing reference number, warranty information, and fabrication site.

Submit Safety Considerations including information relating to load limits, speed of operation, environmental criteria (temperature and pressure limitations), and personnel hazards and equipment safety precautions for the wastewater treatment plant.

Supply three year supply of spare parts. An operator's kit with face shield and cleaning solution shall also be provided.

Provide a 90 day supply of chemicals associated with the daily operation of the treatment facility.

1.8 WARRANTY

Provide manufacturer's standard performance guarantees and warranties.

PART 2 PRODUCTS

Verify conformance of materials and equipment for wastewater treatment plant to the referenced publications or as specified Verify manufacturers regularly engaged in the manufacture of such products.

2.1 GENERAL SPECIFICATIONS

A single train shall be provided with a total of the following minimum criteria:

Minimum Equalization Chamber Volume:	41,600 L
Minimum Sludge Holding Chamber Volume:	26,500 L
Minimum Aeration Chamber Volume:	132,500 L
Minimum Clarifier Volume:	22,700 L
Minimum Chlorine Contact Chamber Volume:	3,780 L

2.2 MATERIALS OF CONSTRUCTION

All tank vessels will be fabricated of 6 mm structural grade ASTM A 36/A 36M steel plate joined by arc welding with fillets of adequate section for the joint involved. All walls will be continuous and watertight and will be supported by structural reinforcing members where required. Connections will conform to the requirements of the American Welding Society's Code and will develop the full strength of the member. All piping within the plant will be Schedule 40 steel pipe except as may be noted otherwise in other sections of the specification or called for on the plans. For example, 50 mm pipe shall have a pipe wall thickness of 4 mm, a 100 mm pipe shall have a pipe wall thickness of 6 mm, and a 150 mm pipe shall have a pipe wall thickness of 7 mm.

2.3 SURFACE PREPARATION AND COATING

2.3.1 Buried Metal Surfaces

Includes bottom and sides of tanks, up to the level of the finished grade.

2.3.1.1 Surface Preparation

SSPC SP 6/NACE No.3, Commercial Blast Cleaning

2.3.1.2 Coal Tar Epoxy Coating

Apply a prime coat of coal tar epoxy, 0.23 mm DFT. Follow manufacturer's recommended cure time prior to finish coat. Apply a finish coat of coal tar epoxy, 0.23 mm DFT. Total thickness of coating system is to be 0.46 mm DFT.

2.3.2 IMMERSED SURFACES

Includes all tanks, troughs, weirs, and other surfaces up to the walkway level.

2.3.2.1 Surface Preparation

SSPC SP 10, Near-White Blast Cleaning

2.3.2.2 High Build Epoxy

Apply a prime coat of high build epoxy, 0.13 mm DFT. Follow manufacturer's recommended cure time prior to finish coat. Apply a finish coat of high build epoxy, 0.13 mm DFT. Total thickness of coating system is to be 0.26 mm DFT.

2.3.3 Exposed Surfaces

Includes the exposed exterior surfaces of the WWTP, including the sides of the tanks above finished grade, supports, equipment mounts, handrails, grading, conduits, piping, and other surfaces.

2.3.3.1 Surface Preparation

SSPC SP 6/NACE No.3, Commercial Blast Cleaning

2.3.3.2 High Build Epoxy with Polyurethane Finish Coat

Apply a prime coat of high build epoxy, 0.13 mm DFT. Follow manufacturer's

recommended cure time prior to finish coat. Apply a finish coat of aliphatic acrylic polyurethane, 0.10 mm DFT. Total thickness of coating system is to be 6.23 mm DFT.

2.4 INLET BAR SCREEN

A bar screen will be provided at the influent port to remove any unusually large solids from the incoming raw sewage. The bar screen will be fabricated from 13 mm diameter bars spaced 25 mm apart and arranged as shown on the drawings. The bars shall be sloped to permit easy cleaning of accumulating debris. A deck will be furnished for drying this debris. The bar screen shall have the same protective coating as specified for the plant.

2.5 FLOW EQUALIZATION CHAMBER

A flow equalization chamber will be supplied with a volume designed to handle 25% to 42% of the daily design flow.

Flow control will be accomplished by pumping the plant influent to a flow control box containing an adjustable overflow broad weir and a v-notch discharge weir. The overflow broad weir will be adjustable so that a measured amount of pumped influent will discharge throughout the v-notch weir to the aeration chamber, while recycling the remaining pumped influent back to the equalization chamber.

A duplex set of equalization pumps will be furnished and installed within each chamber. Each pump will be rated at 1/2 hp 380/220 V; 3 phase; 4 wire; 50 Hz. An emergency overflow will be provided between the equalization and aeration chamber

A blower/motor unit mounted in a fiberglass housing will be supplied to meet the air requirements of the equalization chamber. Each blower unit will be capable of delivering 34 m3/hr when operating at 27.6 kPa. The motor will be 1 HP, ODP type for operating on 380/220 V; 3 phase; 4 wire; 50 Hz service. Liquid level sensors will regulate the pumps and blower/motor unit. Controls will be provided in the plant control panel.

2.6 SLUDGE HOLDING CHAMBER

The chamber will be of the aerated type. Diffuser air will be supplied by the plant blower system supplying 1.8 m3/hr of air per cubic meter of volume. The diffusers will be located parallel to and near the bottom of the tank. All piping and valves within the chamber will be factory installed. A fixed supernatant decant pipe will be provided within this chamber. Air-lift type of sludge removal will not be approved for removal of primary sludges in accordance with 10 State Standards Section 73.24.

2.7 AERATION CHAMBER

The aeration chamber will be sufficient capacity to provide a minimum of 24 hours retention of the average daily flow, and/or maximum loading of 6.8 kg BOD5 per 28.32 cubic meters of aeration tank volume. To insure maximum retention, enhance spiral rotation and eliminate short-circuiting of raw sewage, the aeration chamber will be constructed with fillets top and bottom, air diffusers will be placed longitudinally along one side of the chamber, and flow control baffles will be provided. To insure adequate circulation velocity, the proportion of chamber width to depth, in the direction of rotation will be sufficient to scour the chamber bottom and

prevent sludge filleting as well as to prevent the escape to the surface of miniscule air diffusion bubbles, causing their entrapment to provide maximum oxygenation efficiency. All aeration tanks should have a freeboard of not less than 460 mm., in accordance with 10 State Standards Section 92.323.

2.8 CLARIFIER CHAMBER

The clarifier chamber will be sized to provide a minimum of 4 hours retention, based upon the same design flow rates governing the aeration chamber, and will have proper baffling to prevent short circuiting and to provide maximum uniform retention.

The total settling volume will include the volume of the upper one-third of the sludge hopper. The bottom of the chamber will be formed into an inverted pyramidal hopper or hoppers. The flat bottom area of the hopper will in no case be greater than 0.093 square meters. The slope of the hopper walls will not be less than 1.7 vertical to 1.0 horizontal

Settled sludge will be returned from the clarifier sludge hopper to the aeration chamber by the positive sludge return system, consisting of one or more airlift pumps. The clarifier effluent will pass over the edge of the baffled effluent weir into the effluent trough and then out of the chamber. The effluent weir trough will be equipped with an adjustment to permit precise leveling of the serrated weir after plant installation.

2.9 SLUDGE RECIRCULATION SYSTEM

There will be installed within the clarifier chamber a positive sludge recirculation system consisting of at least two (2) 80 mm diameter airlift pumps in accordance with 10 State Standards Section 92.42. The airlift pump will have the recirculation capacity ranging from 0% to 150% of the average daily design flow. The airline supplying air to the pump will be equipped with a cock valve to vary the amount of air supplied to each pump, thus varying the capacity of the pump. The airlift pump will be firmly supported and equipped with a clean-out plug to allow for easy cleaning and maintenance. Discharge piping should be a minimum of 100 mm and designed to maintain a velocity of not less than 0.6 m/s when operating at normal sludge rates. Suitable devices for observing, sampling, and controlling return activated sludge flow for each settling tank hopper shall be provided in accordance with 10 State Standards Section 92.43.

2.10 SCUM RECIRCULATION SYSTEM

There will be installed within each clarifier chamber a positive scum and skimming recirculation system consisting of two (2) 50 mm diameter airlift skimming device(s). Each skimming device will be a positive airlift pump type, located in a position to skim and return floating material to the aeration chamber. The airline supplying air to the skimming device will be equipped with a valve to regulate the rate of return. The scum intake will have an adjustment assembly that will enable exact positioning of the skimmer at water level.

2.11 CHLORINE DISINFECTION

Provide a chlorine contact chamber to disinfect the treated wastewater prior to discharging from the wastewater treatment plant. The chlorine contact chamber will have minimum of 15 minutes of contact time at the design peak hourly flow. Sufficient flow baffles will be supplied to ensure

proper mixing of the chlorine solution with the plant effluent. The disinfection method shall be tablet style chlorination.

2.12 AIR DIFFUSION SYSTEM

An air distribution manifold constructed of rectangular hollow steel tubing with diffuser drop assemblies will be installed longitudinally on one side along the entire length of the plant.

Each diffuser drop assembly will be equipped with an air regulation and/or shut-off cock valve, a disconnecting union and a diffuser bar with air diffuser nozzles mounted thereon. The diffusers will be parallel to and near the base of the vessel sidewall and at the proper elevation providing optimum diffusion and mixing of the vessel contents.

Each air diffuser will be constructed with an integral air check diaphragm constructed of oxidation resistant material designed to handle a wide range of airflow. The oxygen transfer capacity of each diffuser will be such that an adequate supply of oxygen will be maintained in the aeration chamber to deliver 200% of the oxygen demand to meet treatment requirements of the design sewage load specified in Part 2.7 in accordance with 10 State Standards Section 92.332. Air piping headloss from blower outlet to diffuser shall not exceed 3.4 kPa (0.5 psi) at average operating conditions in accordance with 10 State Standards Section 92.332.

2.13 AERATION TANK BLOWER/MOTOR UNITS

To meet the air requirements of this wastewater treatment system, 2 positive displacement blower/motor unit(s) will be supplied. The blower/motor unit(s) shall be mounted on the plant or at a remote location as indicated on the plans. The blower/motor unit(s) will be capable of providing a minimum of 128 cubic meters of air per kg of BOD5 plant loading taking into account that the air temperature may reach 46 degrees C or higher and the pressure may be less than normal.

Each blower unit will be capable of delivering 156 CFM when operating at 27.58 kPa. The motor will be 5 HP, ODP type, for operation of 380/220 volt; 3 phase; 4 wire; 50 Hz service.

The blower/motor unit assembly will be mounted on a molded fiberglass base. The base structure will be adequately reinforced to support the blower/motor unit.

The blower/motor will be enclosed within a molded fiberglass weatherproof hood mounted to the base. The fiberglass-locking hood is designed for easy access to service the unit.

To help reduce blower vibration and noise, the blower/motor base will be mounted on vibration dampeners.

For easy adjustment of the V-belt drive connection between the blower and motor, the motor will be mounted on an adjustable motor mounting base. The blower will be fitted with a dry type filter/silencer at the air intake. Each blower discharge will be fitted with a check valve, and a flexible rubber discharge coupling.

For purposes of determining the blower performance and/or diffuser condition, a pressure relief valve and pressure gauge will be mounted in the air manifold. The blowers shall be provided in multiple units, so

arranged in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension with these limits in accordance with 10 State Standards Section 92.332.

Air filters shall be provided in numbers, arrangements, and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used in accordance with 10 State Standards Section 92.332.

2.14 CENTRAL CONTROL PANEL

A central control system installed within the weatherproof enclosure will be provided. The enclosure will be rated NEMA 4X-F Fiberglass. The electrical controls will consist of magnetic starters, program timers and switches necessary to automatically control all electrical devices and/or motors on the sewage treatment system.

M-O-A selector switches and magnetic starters in conjunction with the program timer will control the blower/motor. The program timers will have the capability to operate the treatment system when required as determined by the variation in the daily flow rate. Properly sized circuit breakers and fuses will protect all electrical equipment and circuitry. The control system will be designed to operate all duplex or standby equipment. The enclosure will be wired for 380/220 volt; 3 phase; 4 wire; 50 Hz incoming power.

2.15 SERVICE WALKWAYS

A service walkway will be provided to service the plant equipment. Grating panels will each consist of one-piece skid resistant steel plank. All grating panels will be constructed of 18 gauge, galvanized steel sheet. Each grating panel has a standard of 230 mm surface width and a 63.5 mm rib depth. Each panel will be supported to insure a safe uniform load carrying capacity of 390 kg/m2. On doublewide plants, the service walkways are shipped loose for field mounting by the field contractor.

2.16 SERVICE HANDRAILS

Service handrails will be provided for all tanks. Service handrails are supplied with mounting flanges for bolting into place. The rails and posts are fabricated from 38.1 mm diameter Schedule 40 steel pipe. Longer sections of hand railing are spliced to allow for easier handling and installation. Steel handrails are to be painted with as specified herein. Due to shipping limitations, handrails are shipped loose for field mounting by the field contractor.

2.17 ACCESS LADDER

Provide an access ladder, fabricated of carbon steel with 3 mm thick rails and 19 mm diameter rungs and shall be provided with rail extensions for a "walk through" design.

2.18 CATHODIC PROTECTION

Provide a sacrificial anode system for the cathodic protection of the partially buried tanks. The WWTP is to have connector lugs on the sides of

the vessels for the connection of heavy copper wire leading to the sacrificial anodes, which shall be magnesium.

2.19 GUARANTEE

Vendor will guarantee for one (1) year from the date of commissioning that the vessel and all equipment components will be free from defective materials and workmanship. Vendor will furnish replacement parts for any component considered in the opinion of vendor to be defective, whether of his or other manufacturer during the guarantee period.

2.20 OPERATIONS AND MAINTENANCE SERVICES

The Contractor is to be responsible for operating and maintaining the treatment plant for a period of one year following commissioning of the plant. During this period the Contractor is to provide a fully trained operator from the manufacturer of the WWTP to not only run the WWTP, but also train a minimum of two of the Owner's personnel on all aspects of operating and maintaining the plant. All operating and maintenance expenses, including consumables and repairs, shall be borne by the Contractor during this one year period.

PART 3 EXECUTION

Installation of the packaged wastewater treatment facility will be in accordance with the manufacturer's installation requirements.

3.1 GENERAL

Submit Preventative Maintenance and Inspection procedure for package lift stations. Procedures should include frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

Submit Special Tools that are required for maintenance and testing of the wastewater treatment plant.

Submit Posted Instructions to be posted consisting of labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the wastewater treatment plant.

3.2 TESTS

Perform Tests, including hydrostatic leak checking of piping and operation of equipment.

3.3 OPERATION AND MAINTENANCE

Submit Operation and Maintenance Manuals for wastewater treatment plant, including Equipment Description, Assembly and Installation Procedures, Adjustment and Alignment, Checkout Procedures, Procedures of Operation and Troubleshooting.

-- End of Section --