# Scope of work and Technical Construction Specifications

1. **Scope of work**

The Dubré Irrigation System Irrigation Rehabilitation and Improvement Project, located in the Department of Nord, Arindisemont Acul du Nord, Commune Milot (19°39'59.84"N, 72°14'5.69"W) is as described in the drawings, specifications and other contract documents

The Project Works are divided into two parts: (1) the work required for the rehabilitation of an existing 22 year old irrigation system that diverts surface water from the Anba Lanmè River and, (2) the work required to construct structures required to add 57 hectares of land to the existing system.  The work on the existing system includes the rehabilitation of the existing river surface water diversion structure, its three mechanical hand-operated slide gates, the construction of new upstream and downstream stone masonry and gabion river bank training structures, the rehabilitation of the existing stone masonry lined feeder and primary canals, the construction of stone masonry lining on two existing secondary canals, the replacement of fabricated steel slide gates throughout the system and the clearing and channelization of three existing system drains.  The work needed to be done to add another 57 hectares of new land under irrigation command includes the provision and construction of a new Anba Lanmè River surface water diversion structure and two new mechanical hand-operated slide gates, new lined feeder, primary and secondary canals, new earthen tertiary canals, installation of new canal gates and system drainage canals.  The current system is operated and maintained by the Association of Irrigators of Dubré village (AID).

1. **Technical construction specifications**

## General

### Reference to Other Sections

Throughout these Specifications, references are occasionally made to other Contract Sections and Contract Documents. All such references are intended solely for the convenience of those using the Documents, and the absence of a reference in no manner excludes the application of every other Section in the Specifications and/or the other Contract Documents that may have any bearing upon the topic, point, issue and/or matter in question. The intention being that the Contract Documents shall be read and applied as a whole.

### Standards and Regulations to be Followed by the Contractor

It is the responsibility of the Contractor to ensure that construction and non-construction activities carried out to implement this project comply with applicable Haitian Government and any other regional government laws and regulations governing construction activities. This includes engineering design standards, environmental protection, procurement, taxes and levies, public health and safety standards regarding the safeguarding of the public, the Contractor’s own workers and site health and safety. Stated United State Government (USG) and United States Agency for International Development (USAID) rules and regulations referenced in this contract also apply to the Work and to the Contractor’s opertions and activities.

All applicable standards and equipment manufacturer’s instruction sheets, orders and circulars apply to the Work and Contractor operations.

Haitian Construction Permits, Building Codes and Structural Regulations: It is the Contractor’s responsibility to ensure that all work and all activities comply with local permitting requirements. To this end, the Contractor is responsible to obtain at his cost any such permits.

Construction methods and construction materials codes and standardsnoted in these specifications and the drawings also apply and must be closely followed and applied by the Contractor during the prosecution of the Work.

### Contractor’s General Facilities and Work Practices

#### Mobilization

Five days prior to mobilization, the Contractor shall with the engineer, meet with and schedule mobilization with the local Water User’s Association. This includes informing them of arrival and work dates, seeking their permission for access, seeking their permission for Material and Equipment Lay-Down yards, permission for use local water and electricity resources, agreed upon payments for housing space, security staff (guards), etc.

#### General Site Facilities and Operations

The Contractor is required to provide adequate toilet and washroom facilities for all staff. These facilities shall be kept clean and serviceable at all times. They may be temporary facilities or facilities arranged by the contractor with the WUA. The Contractor shall also maintain such facilities in a neat manner and prevent them from becoming a health hazard.

The Contractor is required to provide a formal project Health and Safety Plan to the engineer within 15 days of Contract execution for review and approval. Part of this Plan will be the inclusion of adequate first aid equipment on-site at all times along with at least one formally trained and certified Haiti Red Cross/Crescent Advanced First Aid Trainee. Failure of the Contractor to ensure the availability of first aid equipment and at least one trained staff person on-site at all times will result in an immediate “Stop Work‟ order being issued. All costs and time delays resulting from any such “Stop Work‟ order are entirely the Contractors responsibility.

The Contractor is to maintain a safe, healthy and tidy site office and worksite at all times and all work activities are to be performed with protective and safety equipment appropriate for the task. The Contractor is entirely responsible for workplace safety and unsafe work practices will be identified and recommendations made for revised work methods as appropriate.

#### The Site

The Site shall include the following areas:

1. All routes, roads, paths for any temporary access roads;
2. The Contractor’s temporary working and material storage areas;
3. The Contractor team’s accommodation areas.
4. The entire existing Dubre 1 (Rehabilitation Construction) Irrigation System Command Area and the existing diversion structure and area within 200 meters of this structure; and
5. The entire existing Dubre 2 (New Construction) Irrigation System Command Area and the existing diversion structure and area within 200 meters of this structure;

#### Site Office

A Site Office will be established by the Contractor at the work site. The location of the site office will be identified by the Contractor for Engineer approval. This can be a temporary trailer or some appropriate existing space in the area. The office will have a complete set of the contract documents. Contractor shall provide a desk, chair, electricity and water/wastewater utilities for the DAI/AVANSE Engineer’s Representative. The Site Office will have a parking area, proper signage, electricity, have proper water wastewater facilities for Contractor management staff and project guests. It shall be kept clean and neat at all times.

#### Existing Utilities and Services

Existing electricity and water services in the area may be used as temporary services for the performance of the Contract and for the Site Office as agreed upon with the local Water User’s Association and as approved by the Engineer.

The Contractor at its own expense shall arrange for a temporary and permanent potable water supply system for laborers for drinking water and cleaning water. The water provided shall be of good quality and sufficient quantity.

The temporary wastewater disposal system shall be constructed, operated and maintained by the Contractor during the project's construction period. All toilets provisioned for the contractor's workforce shall include the ability to remove wastewater from the site or properly dispose of wastewater at the site.

#### Local Weather and Farming

The Contractor shall schedule its work around the farming and irrigation schedules of the local Water User’s Association activities. If this negatively affects its schedule along with any rain or other weather delays, the Contractor should notify the Engineer of such delays in order to seek Engineer agreement that such a delay will be allowed to impact the schedule.

#### Tree Cutting / Removal

The Contractor shall not cut and/or remove any trees on the Site until permission has been granted by DAI/AVANSE. All such activities must also comply with the Project EMMP.

The Contractor shall submit to DAI/AVANSE, at least five (5) days before the commencement of construction, a written request with a detailed drawing showing the trees to be felled together with the outlines of the relevant temporary or permanent structures.

Along with the drawing the Contractor shall submit details as to when the trees must be cut to maintain the schedule.

The Contractor shall be responsible for liaising with and obtaining all necessary licenses for tree cutting. If permission to cut trees is not obtained in time the Contractor may claim for a corresponding extension of time but will not receive monetary compensation for the delay.

#### Survey Monuments, Benchmarks, Levels, References and Staking

The datum point for project co-ordinates and levels shall be the survey markers and permanent benchmarks as indicated on the Drawings.

The Contractor shall satisfy himself that the existing ground levels as indicated on the Drawings are correct. Should the Contractor wish to dispute any levels he shall submit to DAI/AVANSE a schedule of the position of the levels considered to be in error and a set of revised levels. The existing ground relevant to the disputed levels shall not be disturbed before DAI/AVANSE’s decision as to the correct levels is given.

The Contractor shall install all level and survey stations required. Such stations shall be of robust construction, protected against damage and the influence of movement that may arise from the execution of the Works. The Contractor shall check the condition and resurvey survey stations at intervals during the progress of the Works. The Contractor shall provide DAI/AVANSE with the location and description of all survey stations, the results of surveys and all calculations. Where required, it shall give adequate opportunities for DAI/AVANSE to check such stations prior to their use.

The degree of accuracy (tolerances) employed in the survey and setting out shall be such as will allow the alignment, levels and dimensions specified for the Works to be achieved. In no case shall they exceed 10 mm (vertical and horizontal controls – 95% of all measurements, six (6) seconds angle +/1). The Contractor shall ensure that all surveying equipment used for the Works is of appropriate accuracy, is properly maintained and that the equipment complies with the manufacturer’s specification for accuracy. If requested, he/she shall give adequate evidence to DAI/AVANSE that the calibration of the surveying equipment has been confirmed.

The Contractor shall set construction stakes establishing lines and grades in accordance with the Drawings and shall secure the approval of the Engineer before commencing with the work of construction. The Engineer will, if he deems it necessary, revise the line and grade and require the Contractor to adjust the stakes accordingly. The Contractor shall give the Engineer not less than forty-eight hours notice of his intention to stake out or establish levels for any part of the work in order that arrangements may be made for checking. The Contractor shall measure the staking out and the Engineer will check the measurement. The approved measurement will be the basis of payments.

The surveying and staking shall be performed in accordance with these Specifications to obtain close conformance with the lines, grades and details indicated on the drawings or established by the Engineer. The Contractor shall be responsible for the supervision of the surveying and staking personnel. Any errors resulting from the operations of the surveying personnel shall be corrected at the Contractor’s expense. The Contractor may be required to furnish to the Engineer a practicable schedule of staking priorities. This schedule shall be in the form of a progress chart, including the dates and sequence of staking requirements. The Contractor will meet and coordinate with WUA members and ensure that all staking and land work is done with their agreement.

#### Storage of Materials / Equipment

Project materials, equipment and components to be used in the construction shall be stored in such a manner as to preserve their quality and condition as directed by manufacturers, suppliers and as is understood to be best industry practices and also as presented in other sections of the Contract. The quantity of materials and components stored on the Site shall be consistent with that necessary for efficient working. Contractor shall keep a neat and tidy lay down area and keep good records of what is stored on site and in the lay down areas.

#### Standby Equipment

The Contractor shall provide sufficient spares and standby equipment, in particular with respect to concrete mixing and transportation plant and dewatering plant to ensure completion of crucial operations such as continuous pouring of concrete in case of breakdown of duty equipment.

#### Bill Posting and Advertisement

The Contractor shall not undertake or allow billposting or advertising of any kind in the Working area without the written consent of DAI/AVANSE.

The Contractor shall erect a project sign in accordance to USAID branding rules and regulations as directed by DAI/AVANSE.

#### Emergency Arrangements

The Contractor shall maintain arrangements whereby he can quickly call out labor outside normal working hours to carry out any work needed for an emergency associated with the Works. DAI/AVANSE shall be provided at all times with a list of addresses and telephone numbers of the Contractor's staff who are currently responsible for organizing emergency work.

#### Management Meetings

Site meetings shall normally be held weekly but shall be called for whenever the progress of the works so requires, or when required by DAI/AVANSE. The Contractor shall be represented at all meetings by the Contractor's Representative who shall have the powers to commit the Contractor in all matters concerning the Contract and/or the Work.

Other management meetings will be held as required.

#### Site Diary

The Contractor must maintain legible set of drawings and specifications at site at all times. The Contractor must maintain a set of drawings and specifications including daily markups, notes, actual dimensions, changes that can be used in developing end of project “as built drawings” The Engineer’s Representative shall have access to this “as built” set of mark ups at all time to ensure they are being kept up every day.

The Contractor shall keep a Site diary provided by DAI/AVANSE wherein full details of all work carried out each day shall be recorded. The diary shall be available for inspection by DAI/AVANSE or DAI/AVANSE any time during normal office hours. At least the following details shall be included:

1. Location of the various works undertaken;
2. Type and quality of work achieved;
3. Equipment and plant that arrive on site;
4. Number of employees and plant working;
5. Tests carried out and results;
6. Weather conditions;
7. Accidents;
8. Visitors to the site; and
9. Interaction with local people.

#### Progress Reports

The Contractor shall submit weekly progress reports to DAI/AVANSE, on the first day of the week following the week concerned, containing at a minimum the following information:

1. Location of the various works undertaken;
2. Actual progress versus planned progress;
3. Any work delays;
4. Anticipated problems;
5. Tests carried out including results;
6. Prepared materials;
7. Supplied materials;
8. Two week look-ahead schedule;
9. Accidents, injuries and near misses; and
10. Once every 4 weeks the Contractor shall submit a revised master schedule.

#### Construction Photographs

An initial set of photographs shall be taken by the contractor at the designated locations before the commencement of the works. Photographs shall be taken each week at the designated locations and submitted with the Contractor’s monthly report. A final and complete set of photographs shall be taken after completion of the works. All photographs shall be taken with color digital cameras that will automatically record the date-month-year the photographs were taken.

### Quality Control (QC) Plan, Quality Operations

The Contractor shall have an Engineer approved written quality control plan and procedures in place prior to mobilizing to the site. The QC Plan will include:

* A Document Control Plan
* A Communications Plan
* A Material and Method Testing Plan
* A Reporting Plan
* Forms that shall be used every day and month for reporting QC to the Engineer for showing that Contract required documents and periodic actions are being carried out as directed.

The Contractor shall also name an on-site person as the Quality Control Manager/Officer whose responsibility it is to manage the QC Plan.

The Contractor's quality assurance program shall be submitted in writing to DAI/AVANSE for review and approval in sufficient detail to delineate those items to be inspected and the manner in which they are to be inspected, and shall adequately describe all construction quality control activities contemplated, including provision for adequate documentation of Contractor's performance of such quality control and inspection.

#### Standards, Testing and Other Documents

Materials shall always be transported stored, tested and installed by the Contractor according to international trade technical rules and best professional practice. Supporting documents and certificates shall attest to the origin and quality of materials. Brand names, or proven equivalent, shall be submitted by the Contractor prior to delivery, attesting to the quality of materials for desired properties including strength, bulkiness, shape, appearance and overall quality of the material. All materials used in the Works shall generally comply with American Society for Testing and Materials (ASTM) or equivalent standards unless otherwise specified by DAI/AVANSE. Where proprietary products are specified, similar products from other manufacturers will be permitted only with the approval of the DAI/AVANSE Engineer. Tests to be carried out during construction

| **#** | **Type of Work** | **Test** | **Instruction** |
| --- | --- | --- | --- |
| 1 | All Civil Works | Sample field tests of water, sand, aggregates and stone | Contractor shall supply test reports before delivery of material to the site |
| 2 | Backfilling and Compaction | Density of compacted material | Manual test in presence of the Engineer’s Representative as requested. |
| 3 | Concrete Work | Quality of cement | Cement shall comply with ASTM C 150 (AASHTO M 85). |
| 4 | Concrete Work | Concrete Slump test | For each batch prepared, slump test shall comply with ASTM C 143. Two test standards and shall be within +25 mm or + one third of the required value whichever is less |
| 5 | Concrete Work | Compressive Strength Testing | Tests shall comply with ASTM. Two sample cubes shall be tested at 7 days at two 28 days for mixes and pours on the job site. |
| 6 | Masonry Work | Block/Stone | Stone masonry works shall include materials |
| 7 | Foundations for Civil Work | Soil density test | California Bearing Ration testing may be required by the Engineer |

#### Samples

Where required, the Contractor shall submit for DAI/AVANSE's approval samples and test reports of proposed materials and manufactured articles, and such samples shall be kept by DAI/AVANSE for reference.

#### Unsuitable Materials

If any materials or articles brought onto the Site are found to be of inferior quality or in any way unsuitable, such materials or manufactured articles shall forthwith be removed from the Site at the Contractor's expense and as directed by the Engineer.

#### Submittals

Contractor shall within 15 days of contract signing submit for Engineer review and approval the following deliverables as Submittals.

1. Construction Schedule (five days after Contract signing);
2. Performance Bond (five days after Contract signing);
3. Insurance Documentation (five days after Contract signing);
4. Local Construction Permits (five days after Contract signing);
5. Health and Safety Plan;
6. Quality Control Plan;
7. Project Signs (2);
8. Permanent Project Markers;
9. Mechanical Gate Fabrication Plan (dimension schedule (5), materials, welding specification, painting specification, plan to allow Engineer inspection in Port au Prince of completed gates prior to shipping);
10. Slide Gate Fabrication Plan (dimension schedule (57), material specification, shop drawings (2- one for a mechanical gate and one for slide gate) welding specification, painting specification, schedule-plan to allow Engineer inspection and approval of all completed gates in Port au Prince prior to shipping to Cap Haitien);
11. Cement;
12. Reinforcing Steel; and
13. Gabion Rock.

All submittals shall be made using a standard cover sheet provided by the Engineer to the Contractor. Submittals shall include as required:

1. Manufacturer’s Product Information (Make, Model #, Date of Manufacture, Use recommendations, transport and storage instructions, installation instructions, etc.) Contractor shall demonstrate to the Engineer’s satisfaction that such materials and/or equipment meet stated specification requirement;
2. Non-material Deliverables: Must meet the definition as defined in these specifications or other Contract Documents; and
3. Any work carried out with unapproved materials or under unapproved method statements or operational plans may be unacceptable and may require replacement at the expense of the Contractor;

### Health & Safety (H&S) Plan and Site and Operational Security

The Contractor shall have an Engineer approved written Health & Safety Plan with procedures in place prior to mobilizing to the site. The H&S Plan will include:

1. A Health and Safety Policy
2. A list of each individual project construction activity, a Risk Assessment for each and Contractor Plan to mitigate each risk;
3. A H&S Training Plan for all staff;
4. Personal Protective Equipment (PPE) List for each staff person
5. A H&S Reporting Plan
6. Forms that shall be used every day and month for reporting H&S activities to the Engineer for showing that Contract required documents and periodic actions are being carried out as directed.

The Contractor shall also name an on-site person as the Health & Safety Program Manager/Officer whose responsibility it is to manage the H&S Plan. The Contractor shall provide PPE for every staff person at his/her expense. The Contractor is responsible and liable to ensure that all Contractor staff and all site visitors are trained in H&S operations and are using proper PPE.

The Contractor shall be responsible for the protection and the security of the Site, and all work, materials, equipment, and all existing or completed facilities thereon, against vandals and other unauthorized persons. The Contractor is also responsible to ensure the safety and security of all people who may visit the site.

### Environmental Management and Monitoring Plan (EMMP)

The Contractor shall conform and comply with the DAI/AVANSE USAID/HAITI approved EMMP and the Government of Haiti Laws on Protection of Environment and other relevant legislation. The Contractor shall comply with all current environmental laws and regulations, be they national or local, related to the following, but not limited to:

1. Noise;
2. Vibration;
3. Air pollution;
4. Water contamination;
5. Solid waste disposal;
6. Liquid waste disposal;
7. Sanitary conditions;
8. Avoidance of Nuisance

The Contractor shall also:

1. At all times ensure that all existing stream courses and drains within, and adjacent to, the site are kept safe and free from any debris and any excavated materials arising from the Works;
2. Ensure that chemicals and concrete agitator washings are not deposited in the watercourses;
3. Ensure that all water and waste products arising on the Site shall be collected, removed from the site via a suitable and properly designed temporary drainage system and disposed of at a location and in a manner that will cause neither pollution nor nuisance;
4. Provide adequate precautions to ensure that no spoil or debris of any kind are allowed to be pushed, washed down, fallen or be deposited on land adjacent to the Site;
5. Provide adequate precautions to ensure that no undue noise or vibrations are allowed to be distributed to land adjacent to the Site;
6. Not burn debris or other materials on the site without the permission of the Engineer;
7. Implement when required by the Engineer dust suppression measures that shall include but not be limited to effective water spraying to dampen dust during the delivery and handling of all raw sand and aggregate and other similar materials when dust is likely to be created during dry and windy weather.

## EARTHWORK

### Cleared Materials

The Contractor shall remove or otherwise dispose of all trees, stumps, roots, topsoil, vegetable matter and other objectionable material from the areas shown on the Drawings or as directed by DAI/AVANSE.

All cleared and excavated material shall be disposed of in spoil tip areas as directed by DAI/AVANSE. Depending on its nature and quality the material shall either be: stockpiled for re-use, disposed of by burning, disposed of by earthfilling. Material intended for re-use in the Permanent Works shall be stockpiled separately from all other materials. The Contractor shall dispose of all shrubs, bushes and other vegetable and combustible material by stockpiling followed by controlled burning as approved by the Engineer.

The Contractor shall be responsible for the disposal of surplus excavated material off site but no excavated material suitable for re-use in the Works shall be removed from the site except on the direction, or with the permission of the Engineer.

### Excavation

Excavation shall be carried out to the lines, levels, slopes and dimensions as shown on the Drawings or as directed by DAI/AVANSE. Any excavation in excess of such dimensions or instructions shall be made good with suitable, well-compacted material or concrete as directed by DAI/AVANSE. Excavated material from trenches and/or structure locations shall be piled in places as directed by the Engineer. Any remaining material left over from backfilling operations shall be stockpiled and saved as directed by the Engineer for possible use in other earthwork operations on the project.

Excavated material from the drains shall be placed far enough away from the drains that the material cannot erode back into the drain over time.

### Shoring

The Contractor shall provide wooden or some other form of shoring in excavated areas exceeding 1.2 meters as directed by the Engineer. Shoring works also shall be approved by the Engineering

### Protection of Adjacent Structures

In the event that excavation is within two meters or less from an existing structure, the Contractor shall provide measures to protect the existing structure from foundation and/or other damage caused by reduction in bearing capacity during construction.

### Water on Site / Dewatering

The Contractor shall not allow water to lie in any part of the Works unless required to do so under the Contract. Water arising from or draining into the Works shall be drained or pumped to an approved disposal point. Any drainage sumps or silt traps required shall, where practicable, be sited outside the area excavated for the Permanent Works.

The Contractor shall provide, install, maintain and operate all necessary pumping and other equipment for dewatering the various parts of the Works in order to keep the excavations, foundations and other parts of the Works free from water as required for constructing each part of the Works.

The Contractor shall take all necessary precautions to prevent any adjacent ground from being adversely affected by any dewatering process.

The Contractor shall be responsible for and shall repair at his own expense any damage to the foundations or any other part of the Works caused by failure or inadequacy of dewatering operations.

**Planning for Dewatering**: The Contractor shall meet with the Engineer and develop a dewatering plan for all excavation and structural placement activities in the canal system and in or near to the River. The Contractor shall provide a plan and include equipment to be used for the Engineer’s approval. The Contractor also may need to develop a plan that includes partially damming the river to as to divert water away for construction activities. This will also be part of the dewatering plan.

### Structural Earthwork, Preparation / Grading / Filling

Prior to placing any permanent material, the formation must be thoroughly dewatered, cleaned and prepared as approved by the Engineer. No work which may be required above subgrade formation level shall be executed until the prepared subgrade formation has been approved by the Engineer.

All unsuitable material shall be removed from proposed X-section formation. Such materials shall include but not be limited to all topsoil, sod, loam and rock fragments with a dimension in excess of 75 mm except in the area of river training works where rock fragments with a dimension not exceeding 150 mm shall be accepted.

The formation surface shall be levelled and well compacted to ensure the dry density of the subgrade formation material is maintained to original earth. All soft spots shall be excavated to a firm base and the voids backfilled with suitable granular material placed in thin layers and compacted to prevent erosion of loss of formation shape.

Where the slope of the existing ground is greater that 1 (vertical) to 3 (horizontal) or where directed by the Engineer, horizontal terraces in steps not greater than 0.5 m in height and 1 (vertical) to 1.5 side slopes shall be cut into the existing ground before placing fill material.

Any blinding layer or prepared surface which is damaged before being covered shall be repaired at the expense of the Contractor and to the satisfaction of the Engineer.

If required for construction operations, fill material shall be comprised of material that is similar in character and type to the native soils in and around the construction activity. It will have the ability to be compacted to form a stable layer as directed by the Engineer. The material shall be sufficiently mixed to produce a homogeneous fill. The material shall not have an organic content of more than 5% by weight and all unsuitable foreign material shall be excluded from the fill. No piece of fill material with a dimension exceeding 100 mm will be permitted within 300 mm of the formation level and no piece exceeding 75 mm will be permitted within 150 mm of the formation level.

The fill material shall be placed in layers parallel to the formation level and shall be built up evenly over the whole area of the work. Sufficient slope shall be maintained at all times to ensure adequate drainage.

Fill material shall be compacted in such a manner as to ensure maximum density of the material. The material shall be placed in layers of compacted thickness not exceeding 150 mm unless otherwise directed by the DAI/AVANSE Engineer. Unless otherwise specified, the layers of fill material shall be compacted throughout to achieve a dry density of at least 95% of the maximum dry density.

Backfill behind retaining walls shall, if shown to include filter material shall be uncompacted crusher run or river gravel with 85% of material 20 mm or larger.

All fill material left over at the end of the work shall be either removed or stockpiled as directed by the Engineer. All stick piled material shall be shaped and placed in a neat manner so as to be easily accessible by the WUA members and to not pose an erosion issue that would result in sediments running into the river, canals, and/or drains.

## CONCRETE WORK AND FORMWORK

## MASONRY

## GABIONS

Gabions shall consist of rectangular wire mesh formed containers filled with rock. Gabions will be non-raveling double twisted wire mesh, consisting of two wires twisted together in two 180 degree turns. They shall have uniform square or rectangular pattern and a resistance twist at each intersection. Gabions shall be provided by the Contractor as baskets or mattresses, as shown in the construction drawings. Baskets shall have a height of 300mm or greater. Mattresses shall have a thickness of 300mm or less.

Baskets and mattresses shall be fabricated within a dimension tolerance of plus or minus 5 percent, except that the mattress height shall be within 10 percent.

### Materials

Gabions shall be fabricated, assembled and installed in accordance with the nominal wire sizes and dimensions found in Tables 1 and 2. Wire for fabrication and assembly shall be hot-dipped galvanized. The wire shall have a minimum tensile strength of 60,000 psi. Galvanized steel wire shall conform to ASTM A 641, Class 3, Soft Temper. Alternate fasteners for use with wire mesh gabions, such as ring fasteners, shall be formed from wire meeting the same quality and coating thickness requirements as specified for the gabions. All fasteners shall meet the closing requirements of the gabion manufacturer or be approved by the Engineer.

**Table 1, Gabion Baskets, Height 12, 18, or 36 Inches; Length as Specified**

| **Type of Wire** | **Mesh Size Inches** | **Wire Diameter Inches** | **Total Diameter Inches** | **Galvanized Coating Oz./SF** |
| --- | --- | --- | --- | --- |
| Woven Mesh | 3 ¼ x 4 ½  3 ¼ x 4 ½ | 0.118  0.105 | 0.118  0.145 | 0.80  0.80 |
| Selvage |  | 0.153  0.132 | 0.153  0.172 | 0.80  0.80 |
| Lacing and Internal Connecting Wire |  | 0.086 | 0.126 | 0.70 |
| Spiral Binder |  | 0.105 | 0.145 | 0.80 |

**Table 2 Gabion Mattresses, Height 6, 9, or 12 Inches; Length as Specified**

| **Type of Wire** | **Mesh Size Inches** | **Wire Diameter Inches** | **Total Diameter Inches** | **Galvanized Coating Oz./SF** |
| --- | --- | --- | --- | --- |
| Woven Mesh | 2 ½ x 3 ¼ | 0.086 | 0.126 | 0.70 |
| Selvage |  | 0.105 | 0.145 | 0.80 |
| Lacing and Internal Connecting Wire |  | 0.086 | 0.126 | 0.70 |
| Spiral Binder |  | 0.105 | 0.145 | 0.80 |

### Rock Requirements

Rock shall be sized to at least 85 percent of the rock particles, by weight, within the predominant rock size range shown in Table 3.

1. **Table 3, Rock Requirements**

| **Gabion Basket or Mattress Height** | **Predominant Rock Size Inches** | **Minimum Rock Dimension Inches** | **Max. Rock Dimension Inches** |
| --- | --- | --- | --- |
| 18 or 36 Inch Basket | 4 to 8 | 4 | 9 |
| 12 Inch Basket or Mattress | 4 to 6 | 3 | 8 |
| 6 or 9 Inch Mattress | 3 to 6 | 3 | 6 |

Prior to delivery to the site, the Contractor shall inform the Engineer in writing of the source from which the rock will be obtained, and provide a sample by which the material was determined by the Contractor to meet the requirement.

### Foundation Preparation

The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundations. When fill is required, it shall consist of clean locally available sand and gravel as approved by the Engineer. Gabions and bedding shall not be placed until the foundation preparation is completed, and the subgrade surfaces have been inspected and approved by the Engineer. Compaction of bedding or filter material will be required as directed by the Engineer

### Assembly and Placement

Unless otherwise specified in the construction plan, the assembly and placement of gabions shall be in accordance with the following procedures:

Assembly: Rotate the gabion panels into position and join the vertical edges with fasteners for gabion assembly. Where lacing wire is used, wrap the wire with alternating single and double half- hitches at intervals between four 100mm and 12mm. Where ring type fasteners are used for basket assembly, install the fasteners at a maximum spacing of 15mm. Use the same fastening procedures to install interior diaphragms where they are required as directed by the Engineer. Interior diaphragms will be installed to assure that no open intervals are present that exceed three .9m.

Placement: Place the empty gabions on the foundation and interconnect the adjacent gabions along the top, bottom, and vertical edges using lacing wire, spiral fasteners, or ring fasteners. Wrap the wire with alternating single and double half-hitches at intervals between 100mm and 12mm our (4) to six (6) inches. Ring fasteners shall not be spaced more than 30mm apart. Spirals are screwed down at the connecting edges, then each end of the spiral is crimped to secure it in place. Lacing wire will be used as needed to supplement the interconnection of welded mesh gabions, and the closing of lids.

Interconnect each layer of gabions to the underlying layer of gabions along the front, back, and sides. Stagger the vertical joints between the gabions of adjacent rows and layers by at least one-half of a cell length.

### Filling and Backfilling Operation

After adjacent empty woven wire gabion units are set to line and grade and common sides properly connected, they shall be placed in straight line tension and stretched to remove any kinks from the mesh and to gain a uniform alignment. Staking of the gabions may be done to maintain the established proper alignment prior to the placement of rock.

Internal connecting cross-tie wires shall be placed in each unrestrained gabion cell greater than 45mm in height, including gabion cells left temporarily unrestrained. Two internal connecting wires shall be placed concurrently with rock placement, at each 30mm interval of depth. These cross-ties will be placed evenly spaced along the front face and connecting to the back face. All cross-tie wires shall be looped around two mesh openings and each wire end shall be secured by a minimum of five 180 degree twists around itself after looping.

The gabions shall be carefully filled with rock, either by machine or hand methods, maintaining alignment, avoiding bulges, and providing a compact mass that minimizes voids. Machine placement will require supplementing with hand work to ensure the desired results. The cells in any row shall be filled in stages so that the depth of rock placed in any one cell does not exceed the depth of rock in any adjoining cell by more than 30mm. Along the exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat, compact placement with a uniform appearance.

The last layer of rock shall be uniformly overfilled 3 to 5mm for gabions and 3mm for gabion mattresses to allow for rock settlement. Lids shall be stretched tight over the rock fill using only approved lid closing tools. The use of crowbars or other single point leverage bars for lid closing is prohibited. The lid shall be stretched until it meets the perimeter edges of the front and end panels. The gabion lid shall then be secured to the sides, ends, and diaphragms with spiral binders or lacing wire wrapped with alternating single and double half-hitches in the mesh openings. Ring fasteners spaced not more than 30mmapart may be used for lid closure.

Any damage to the wire during assembly, placement and filling shall be repaired promptly in accordance with the manufacturer's recommendations or as directed by the Engineer or replaced with undamaged gabion baskets. Backfilling of gabion excavation shall be carried out in 30mm layers with each layer compacted to 90% soil compaction density.

## METAL FABRICATION

This section relates to the fabrication of all miscellaneous metal, gates, railings, fasteners and other metal deliverables in the project and includes instructions on material supply, cutting, welding, painting and placement. A listing of applicable regulatory requirements follows:

AISC, "Specifications for the Design of Cold-Formed Steel Structural Members."

AWS, "Structural Welding Code, D1.1."

SSPC, "Steel Structures Painting Council."

### Submittals

All steel and cast iron and all steel fasteners, all welding rods, all primers and all paint submittals shall include product data including brand names, name of producing foundry, drawing profiles, fabrication and installation directions. Submittals shall indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

Submit certification that manufactured products (including bolts, nuts and washers) that meet or exceed specified requirements. Certification numbers must appear on product containers for bolts, nuts and washers and the numbers shall correspond to the identification numbers on the Manufacturer's Certificate. The Manufacturer's symbol and grade markings must appear on bolts, nuts and washers.

### Delivery, Storage, And Handling

Store steel materials and other metals, either plain or fabricated, above ground on platforms, pallets, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

### Materials

1. Steel Sections: ASTM A992, hot-dip galvanized for exterior use.
2. Steel Pipe: ASTM A53, Type S, Grade B, Schedule 40 typical unless otherwise noted. Pipe used
3. Steel Tubing: Cold formed, ASTM A500; or hot rolled, ASTM A501; seamless.
4. Cold-Rolled Carbon Steel Sheets: ASTM A653. Provide "Commercial" galvanizing, for exterior use.
5. Bolts, Nuts, and Washers: ASTM A307. Provide zinc-coated fasteners for exterior use or where built into exterior walls.
6. Drilled Anchors for Use in Concrete: Use anchors with a current ICC evaluation report appropriate to the application.
7. Welding Materials: AWS D1.1; type required for materials being welded.
8. Primers: Prime paint for ferrous metal shall be as specified in Division 09 Section "Painting" [Tnemec Series 4] or an approved equal free of chromate or lead.

### Fabrication

Verify dimensions on site prior to shop fabrication. Coordinate metalwork with adjoining work for details of attachment and fit. Be responsible for fabrication detailing and correct fitting of steel members to each other and to their supports.

Use materials of size and thickness shown or, if not shown, of size and thickness to produce strength and durability in the finished product for the utility intended.

Fabricate items with joints tightly fitted and secured. Make exposed joints butt tight, flush, and hairline.

Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.

Fit and shop assemble in largest practical sections, for delivery to site and handling through building openings.

Provide components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

### Welding

All surfaces shall be clean, free of rust, paint, and foreign matter of any kind. Burned edges to be welded shall be chipped clean and wire brushed before welding. Clamp members as required, space and alternate welds, as may be necessary to prevent warping or misalignment.

Weld Metal: Weld metal shall be thoroughly fused with the base metal along surfaces and edges of the union. Penetration shall be 1/8 inch (4 mm) minimum and shall be into the root of the joint. All gate welding shal bee continuous bead welds and no spot or tack welds shall be allowed.

Weld Quality: Welds shall present a uniform surface, free of imperfections, without undercutting or overlapping, and free from excessive oxides, gas pockets, and nonmetallic inclusions. Welds shall be made with the proper number of beads or passes to secure sound, thoroughly fused joints. Provide backup bars, temporary backup bars, or backup welds for full-penetration butt welds. Each deposit shall not exceed 1/2 inch (12 mm) of weld for each pass of bead. Preceding layers shall be cleaned by wire brushing or preening to remove scale and slag before placing new weld material.

Faulty and Defective Welding: Welding showing cracks, slag inclusion, lack of fusion, bad undercut, or other defects ascertained by visual or other means of inspection, shall be chipped out and properly replaced.

### Finish

Cleaning: Thoroughly clean mill scale, rust, dirt, grease, and other foreign matter from ferrous metal prior to galvanizing, hot-phosphate treatment, powder coating or painting.

Remove scale, rust, and other deleterious materials before applying shop coat. Clean off heavy rust and loose mill scale in accordance with SSPC SP-6, "Commercial Blast Cleaning." This is required for Tnemic primer painting.

Remove oil, grease, and similar contaminants in accordance with SSPC SP-1, "Solvent Cleaning.

Shop Priming: Shop-paint metal work except members or portions of members to be embedded in concrete, surfaces and edges to be field welded, and galvanized surfaces.

1. Immediately after surface preparation, brush or spray on primer in accordance with the paint manufacturer's instructions and [as specified Division 09 Section "Painting"] [at a rate to provide uniform dry-film thickness of 2.0 mils for each coat]. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.
2. Apply one shop coat to metal items, except apply two coats to surfaces inaccessible after assembly or erection. Change color of the second coat to distinguish it from the first.

Finish Painting: Two coats of finish metal paint shall be applied to all gates with application instructions and thicknesses of coats as recommended by the manufacturer. Color shall be bright green as approved by the Engineer.

Touch Up: Contractor shall keep primer and finish paint on site so that when gates are scratched druing transport and or during installation, they will be repair painted on site. Such touch up shall be done with three coats and as approved by the Engineer.

### Installation

Fastening to In-Place Construction: Provide anchorage devices and fasteners for securing metal work to in-place construction, including threaded fasteners for concrete inserts, through bolts, lag bolts, screws, and other connectors as required.

Conceal fastenings where practical. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Form joints exposed to weather to exclude water.

Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of metal work. Set work accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Provide temporary bracing anchors in formwork for items which are to be built into concrete or similar construction.

Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch up shop paint coat. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

Corrosion Protection: Protect dissimilar metals from galvanic corrosion by pressure tapes, coating, or isolators as acceptable to Architect-Engineer.

Grouting: Do grouting of frames, plates, sills, bolts, and similar items with nonshrink grout.

Alignment: Verify alignment of items with adjacent construction. Coordinate related work.

Handrails: Secure steel handrails with bracket. Unless otherwise noted, locate brackets 6 inches (150 mm) from ends of handrail, 6 feet (1.8 m) on center maximum, and space brackets equidistant at each handrail. Where bracket is fastened to stud wall, provide steel plate backing securely fastened to studs; toggle bolt secured to gypsum wallboard is not acceptable