B I D D I N G D O C U M E N T S

FOR THE PROCUREMENT OF THE REHABILITATION OF AIRSIDE PAVEMENTS AND AGL SYSTEM AT MOI INTERNATIONAL AIRPORT, MOMBASA

IPC / ICB No: KAA/OT/MIA/0036/2024-2025

PROJECT: KENYA TRANSPORT SECTOR SUPPORT PROJECT
EMPLOYER: KENYA AIRPORTS AUTHORITY

COUNTRY: KENYA

ISSUED: OCTOBER 2024

VOL III OF IV – TECHNICAL SPECIFICATIONS

PART A: CIVIL WORKS

PART B: ELECTRICAL WORKS

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The Tender/Bidding Documents for the above project consist of the following Volumes:

VOLUME I OF IV: BIDDING AND CONTRACT DOCUMENTS

PART 1 – BIDDING PROCEDURES

- **SECTION I: INSTRUCTIONS TO BIDDERS**
- **SECTION II: BID DATA SHEET**
- **SECTION III: EVALUATION AND QUALIFICATION CRITERIA**
- **SECTION IV: BIDDING FORMS**
- **SECTION V: ELIGIBILITY CRITERIA**
- **SECTION VI: AFD POLICY – CORRUPT AND FRAUDULENT PRACTICES - ENVIRONMENTAL AND SOCIAL RESPONSIBILITY**

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INTRODUCTION

00 – PRELIMINARY

SECTION 00 00 00 - PRELIMINARY

PART 1- GENERAL

1.1 Summary

This section includes the preliminaries during implementation of the project as follows:

1. Environmental, Social, Health and Safety (ESHS) Management
2. Dispute Board and their Payment Procedure
3. Safety Measures

1.2 References and Related Sections

The above preliminaries items shall be read in reference with the references and the related sections provided as follows:

1. Environmental, Social, Health and Safety (ESHS) Management
   - Appendix B of Volume I of IV of the Bidding and Contract Documents
   - Section IX Particular Conditions of Volume I of IV of the Bidding and Contract Documents
   - Sections 01 33 00.13 and 80 00 01 of this document.
   - Sections 01 52 23.13 of this document.
2. Dispute Board and their Payment Procedure
   - General Conditions of Contract
   - General Conditions of Dispute Board Agreement in Appendix A of Volume I of IV of the Bidding and Contract Documents
3. Safety Measures
   - Section VII – Works Requirements under Volume I of IV of the Bidding and Contract Documents
   - Section 01 14 23.13 - Safety Measures of this document

1.3 General

A The ESHS

B The project shall have a dispute board in place in a tripartite agreement by and between:

a) The "Employer";
b) The "Contractor"; and
c) The "Member", who is defined in the Dispute Board Agreement as being:
d)
   (i) The sole member of the "DB" and, where this is the case, all references to the "Other Members" do not apply, or
   (ii) One of the three persons who are jointly called the "DB" (or "Dispute Board") and, where this is the case, the other two persons are called the "Other Members".

The Employer and the Contractor have entered (or intend to enter) into a contract, which is called the "Contract" and is defined in the Dispute Board Agreement, which incorporates this Appendix. In the Dispute Board Agreement, words and expressions which are not otherwise defined shall have the meanings assigned to them in the Contract.

C The dispute board payments shall be in currency named in the dispute board agreement, that is further elaborated as follows:

a) A retainer fee per calendar month, which shall be considered as payment in full for:

   (i) Being available on 28 days' notice for all Site visits and hearings;

(ii) Becoming and remaining conversant with all project developments and maintaining relevant files;
(iii) All office and overhead expenses including secretarial services, photocopying and office supplies incurred in connection with his duties; and
(iv) All services performed hereunder except those referred to in sub-paragraphs (b) and (c) of this Clause.

The retainer fee shall be paid with effect from the last day of the calendar month in which the Dispute Board Agreement becomes effective; until the last day of the calendar month in which the Taking-Over Certificate is issued for the whole of the Works.

With effect from the first day of the calendar month following the month in which the Taking-Over Certificate is issued for the whole of the Works, the retainer fee shall be reduced by one third. This reduced fee shall be paid until the first day of the calendar month in which the Member resigns or the Dispute Board Agreement is otherwise terminated.

b) A daily fee which shall be considered as payment in full for:

(i) Each day or part of a day up to a maximum of two days' travel time in each direction for the journey between the Member's home and the Site, or another location of a meeting with the Other Members (if any);
(ii) Each working day on Site visits, hearings or preparing decisions; and
(iii) Each day spent reading submissions in preparation for a hearing;

c) All reasonable expenses including necessary travel expenses (air fare in less than first class, hotel and subsistence and other direct travel expenses) incurred in connection with the Member's duties, as well as the cost of telephone calls, courier charges, and faxes: a receipt shall be required for each item in excess of five percent of the daily fee referred to in sub-paragraph (b) of this Clause;

d) Any taxes properly levied in the Country on payments made to the Member (unless a national or permanent resident of the Country) under this Clause 6.

The Contractor shall pay each of the Member's invoices in full within 56 calendar days after receiving each invoice and shall apply to the Employer (in the Statements under the Contract) for reimbursement of one-half of the amounts of these invoices. The Employer shall then pay the Contractor in accordance with the Contract.

If the Contractor fails to pay to the Member the amount to which he/she is entitled under the Dispute Board Agreement, the Employer shall pay the amount due to the Member and any other amount which may be required to maintain the operation of the DB; and without prejudice to the Employer's rights or remedies. In addition to all other rights arising from this default, the Employer shall be entitled to reimbursement of all sums paid in excess of one-half of these payments, plus all costs of recovering these sums and financing charges calculated at the rate specified in Sub-Clause 14.8 of the Conditions of Contract.

If the Member does not receive payment of the amount due within 70 days after submitting a valid invoice, the Member may

(i) suspend his/her services (without notice) until the payment is received, and/or
(ii) resign his/her appointment by giving notice under Clause 7.

01 – GENERAL

SECTION 01 11 00 SUMMARY OF THE WORKS

PART1 - GENERAL

1.1 Location

The site is located at Moi International Airport on the shore of Indian Ocean in the sunny Coastal Region of Kenya. Mombasa is located approximately 450 km (by road) south east of Nairobi, on the western shores of the Indian Ocean. The airport is located 7 km to the west of Mombasa town along the Nairobi-Mombasa Road. The Airport is accessed through Magongo Road from Changamwe roundabout on Mombasa Nairobi highway via Airport Road.

1.2 Extent of works

A The Extent Works for the Kenya Transport Support Project- Rehabilitation of Airside Pavements and AGL System at Moi International Airport, Outstanding works is as outlined below.

B The descriptions given hereinafter shall be considered as outline description only; reference is to be made to the relevant specifications and drawings for a detailed description of the works.

C The proposed scope of works includes the following:

a) **Slope Stabilization Works**

i. Remedial works at Slopes Stabilization - near Outfall no. 2 by provision of prevention and stabilizing piles, gabions, drainage improvement works and cut and fill of ground to form.

ii. Surface protection works at the slopes' stabilization areas by stone pitching and vegetation cover.

iii. Slopes stabilization works for Secondary Runway Approach 15 of the Secondary Runway & Outfall no. 5 to improve the slope stability at these grounds that have recently experienced ground subsidence and slippage. This will be done by provision of prevention and stabilizing piles, stone filled gabions, drainage improvement works and cut and fill of ground to form.

b) **Rainwater Harvesting Systems**

The works include the completion of works at the 4 no tanks namely; Twin 3500m^3 tanks, General Aviation 500m^3 tank, Site Office 500m^3 tank and the Fire Station 550m^3 tank includes:

i. Construction of water inlet systems,

ii. Water washout/outlet systems,

iii. Water treatment systems,

iv. Water reticulation systems,

v. Construction of periphery fence around the Twin tanks and General Aviation Tank,

vi. Removal of asbestos roofs at the police station and fire station buildings and the construction of roof

The scope of the works shall also include the remedying of the leakage at one compartment of the Twin Tanks. These includes:

i. Investigation by use of a ferrous scan to determine the status of the joints placements.

ii. Completion of all outstanding works and remedial works to joints.

iii. Conducting water tightness tests.

iv. Reservoir testing/cleansing

v. Pressure testing of inlet works pipelines and delivery pipelines,

vi. Backfilling of the tanks and making good the areas.

c) **Drainage Improvement**

i. Construction of Taxiway M2 drainage channel in the vicinity of the Military premises

ii. Outfall 2 works - exposure of the buried outfall (by excavation and disposal) and side slopes protection

iii. Construction of reinforced concrete channels at the Slope Stabilization areas and the Twin Tank area.

iv. Outfall No 4 - Demolition and decommissioning of the existing outfall in the sections indicated. Construction of a new outfall.

d) **11 KV Electrical Cable**

(i) Supply and install underground 120mm² and 50mm² 11kv XLPE armored Copper Cable run in concealed concrete surrounded ducts buried in ground including termination at the power boards.

(ii) Construction of manholes as per electrical engineer's requirements (based on Civil Works Specifications).

(iii) Supply and installations of 12 Core Fibre optic cable including terminations.

(iv) FAT for materials/equipment supplied.

1.3 Interfaces

A The works covered under this package are subdivided into two parts as shown in Table 1 below.

TABLE 1: Interfaces

Part A	Civil Works
Part B	Electrical Works

B It is the Contractor's responsibility to undertake all the Works covered under the two packages, and to coordinate the efficient implementation of the above two packages.

1.4 Phasing of the Works

1.4.1 General

A The Contractor shall be clearly aware that significant parts of the Works are to be executed on or around airside operational areas.

B Prior to commencing the construction works, the Contractor shall submit to the Engineer for approval a detailed construction schedule which considers, but is not limited to, the following:

(i) Safety measures as specified in Section 01 14 23.13 shall be strictly adhered to.

(ii) Construction works shall be scheduled in such a way that there is no interference with the prevailing flight operations schedule. It is the Contractor's responsibility to coordinate the construction works with the Airport Operations Department.
(iii) Construction works shall be coordinated with the Fire & Rescue Department to secure continuous access of this department to all parts of the airport.
(iv) At all times, the Contractor shall ensure that the boundaries of the site are secure against entry by unauthorized persons, vehicles and/or animals.
(v) At all times, proper access by passengers and personnel to and from the airport shall be ensured.

C The tentative works schedule is as detailed in item 1.4.2 below; however, the contractual works schedule will be the one submitted by the Contractor prior to the Works and approved by the Engineer.

D Prior to commencing the construction works, the Contractor shall submit to the Engineer for approval a logistical plan in which all construction routes within and outside the airside operational areas are indicated.

1.4.2 Provisional Phasing Program

A The provisional is governed by the fact that operations at the airport need to continue during the construction period. The construction works programme shall comply with the following requirements:
(i) The construction period shall be a maximum of twelve months
(ii) The program shall be based on working 6 days a week and minimum working time 8 hours for day shift
(iii) The approved contractor's supervisor shall be equipped with two-way Radio for safe co-ordination with the ground control and the NOTAM to be issued shall advise the Pilots to power down the aircraft accordingly.
(iv) Red warning lights and plastic fences will be required to indicate hazard demarcation for trenches and works adjacent to maneuvering areas.
(v) During the construction period, the contractor will be responsible for maintaining the existing and commissioned new infrastructure in an operational condition until handed over to the client at the end of the project.
(vi) During construction the Engineer may request from the contractor for approval, a Plan of Construction Operation (PCO) for any specific activity as may necessary during construction taking into consideration airport operation constraints

1.5 Scope of the Civil Works (Part A)

A The Scope of the Civil Works is divided into the following Divisions based on the Construction Specifications Institute (CSI):
01-General Items
02-Existing Conditions
03-Concrete
31-Earthworks
32 Exterior Improvement
33-Utilities
80-Miscellaneous Items
81-Dayworks

B These sections cover the following major Civil Work items:
1. Slope stabilization works
2. Completion of Rain water harvesting works
3. Drainage improvement
4. Removal of Asbestos at the Fire Station and police Station building

SECTION 01 14 23.13 - SAFETY MEASURES

PART 1- GENERAL

1.4 General

A This section covers the requirements for safety measures, which are applicable during the execution of works at Moi International Airport.

B The Contractor shall submit to the Engineer a safety plan, addressing methods taken and persons appointed for the air operations safety, including the proposed construction periods, working hours, so that notices can be distributed to the Airport Authorities.

C At any time, when Air Operation Areas and/or Obstacle Limitation Surfaces have to be entered, the authority is the air traffic controllers and their orders must be followed.

PART 2- RESTRICTED AREAS

2.1 Air Operations Areas

A For the purpose of this Project, the term Air Operations Area shall mean any area of the airport used or intended to be used for the landing, take-off, or surface maneuvering of aircraft, including such paved or unpaved areas necessary for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron. The limits of the Air Operations Area are defined as:

1. The runway strip: an area including the runway and extending before the threshold and beyond the end of the runway or stop way for a distance of at least 60m. It is extended laterally to a distance of at least 150m on each side of the center line of the runway and its extended center line throughout the length of the strip.
2. Taxiway strip: An area extended symmetrically on each side of the center lines of the taxiways throughout their lengths to at least a distance of 47.5m from their center lines.
3. Taxi lane strip: An area extended symmetrically on each side of the center lines of the taxiplanes throughout their lengths to at least a distance of 42.5m from their center lines.

B If so required, these limits may be extended.

2.2 Obstacle Limitation Surfaces

A The following obstacle limitation surfaces are established with relation to the airport and its runway:

1. Transitional Surfaces: A complex surface along the side of the strip and part of the side of the approach surface that slopes – with a slope equals to 14.3% - upwards and outwards to the inner horizontal surface.
2. Approach Surfaces: An inclined plane or combination of planes preceding the threshold:
   (i) 60m from threshold
   (ii) Length of inner edge = 300m
   (iii) First section, slope = 2%
   (iv) Divergence = 15%
3. Take Off Climb Surface: An inclined plane or other specified surface beyond the end of a runway or clearway:
   (i) 60m from threshold
   (ii) Length of inner edge = 180m
   (iii) First section, slope = 2%
   (iv) Divergence = 12.5%

2.3 Other Restricted Areas

A Further restriction may be necessary for stockpiling materials and for the movement and parking of equipment and vehicles in the vicinity of navigational aids, or to prevent interference of the line-of- sight from the control tower.

PART 3 – LIMITATIONS OF OPERATIONS

A The Contractor shall control his operations and the operations of his Sub-Contractors and all suppliers so as to provide for the free and unobstructed movement of aircraft in the Air Operations Areas of the airport and no construction or placing of materials or equipment shall take place that will penetrate one of the Obstacle limitation surfaces.

B When the work requires the Contractor to conduct his operations within an Air Operations Area or through one of the Obstacle limitation surfaces, the work shall be coordinated with the Airport Authority at least 24 hours prior to commencement of such work. The Contractor shall not close or enter an Air Operations Area until so authorized.

C Closing an Air Operations Area or starting construction that will penetrate the Obstacle limitation surfaces, is not allowed until the necessary marking and associated lighting is in place and until the relevant Notice to Airmen (NOTAM) has been issued by Air Traffic Control (ATC).

D When the Works require the Contractor to work within an Air Operations Area of the airport on an intermittent basis (intermittent opening and closing of the Air Operations Area), the Contractor shall maintain constant communications, immediately obey instructions to vacate the Air Operations Area and obey the instructions to resume work in such Air Operations Area.

PART 4 – MARKING AND /OR LIGHTING REQUIREMENTS

4.1 Recommendations

A Recommendations of ICAO Annex 14, volume 1, fifth edition, chapters 6 & 7, shall be strictly followed. This includes, but is not limited to, the Specifications below.

4.2 Fixed Obstructions

A The Contractor shall provide danger markers and/or lights on all heaps or dumps of materials, plant, structures and other possible obstructions in the Air Operations Areas or on those penetrating the Obstacle limitation surfaces.

B These danger markers shall be flags for day-time and lights for night-time periods and shall be displayed around, on top of, or around the highest edge of the obstruction.

C Flags used to mark fixed obstructions shall not be less than 0.6 x 0.6 m and displayed at least every 15 m to mark extensive obstructions. The colour of the flags shall be orange, except where such colour merges with the background.

D Lights used to mark fixed obstructions shall be fixed low-intensity obstruction lights with a distribution of 360 degrees horizontal and 10 degrees minimal vertical. The colour of the lights shall be red, with an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which they would normally be viewed. In no case shall the intensity be less than 10cd or red light.

E Fixed obstructions penetrating or adjacent to approach and take-off surfaces shall be provided with double red obstruction lights with a transfer relay which switches over to the stand-by lamp in case of failure of the normal operating lamp.

F All obstruction markers and lights shall be kept continuously in operation, during all days between

sunrise and sunset for the markers and between sunset and sunrise for the lights.

4.3 Vehicles and Equipment

A All mobile obstructions such as equipment, plant, vehicles of the contractor, subcontractors, suppliers, visitors, etc. shall be marked in day-time and lighted in night-time while operating in the Air Operational Areas.

B All mobile obstructions will be identified by means of a flag on a staff in day time. Flags used shall be attached to and flying above the vehicle. The flag shall be not less than 0.9 x 0.9 m and consist of a checkered pattern of orange and white squares of not less than 0.3 m on each side.

C Vehicles of the Engineers staff of the Contractor, the Engineer or the Employer may, however, be equipped with flasher lights in lieu of flags for day-time operations as well. These flasher lights or flags shall be provided and fixed by the Contractor.

D All vehicles operating by night-time in the Air Operations Areas or near the Obstacle limitation surfaces shall be equipped with low-intensity yellow flasher lights. Distribution shall be 360 degrees horizontally and minimum 10 degrees vertically and the intensity shall be not less than 40cd of yellow light during night-time and not less than 200cd when used during day-time. The flash frequency shall be between 60 and 90 flashers per minute.

4.4 Closed Air Operations Areas

A The Contractor shall furnish, erect and maintain temporary closed markings and associated lighting and markers, when:

1. The Works require closing of an Air Operations Area or
2. The Works under construction or the (substantially) completed works obtain or have the appearance of a serviceable area.

B The closed markings shall be in the form of a cross. Each of the legs of the cross shall be as shown on the applicable drawings or as required by ICAO standards and regulations. The colour shall be of a single contrasting colour, either yellow or white. Marking material other than paint on the surface may be used.

C In addition to closed markings, when the closed runway or taxiway (or portions thereof) is intercepted by a usable runway or taxiway, or abuts a usable apron, danger markers shall be placed across the entrance(s) to the closed area continuously or sufficiently close so as to delineate the boundary of the closed area.

D These danger markers shall consist of conspicuous upstanding devices such as flags, cones, marker boards, drums, etc. The markers shall be at least 0.5 m in height and shall be alternately red and white or orange and white. Flags are to be in accordance with Annex 14.

E In addition to closed markings and danger markers, when the closed runway, taxiway or apron is intercepted by a usable runway or taxiway or abuts a usable apron which is used at night, danger lights shall be placed across the entrance(s) to the closed area at intervals not exceeding 4.5 metre. These danger lights shall consist of red fixed lights, as specified in Clause 4.1 D hereof.

4.5 Unserviceable Areas

A Unserviceable areas are small portions of taxiways or aprons unfit for the movement of aircraft but where it is still possible for aircraft to bypass the area safely.

B Unserviceability markers and lights shall be displayed as warning to pilots. The markers for day-time and the lights for night-time shall be as described in Clause 4.2 D.

4.6 Diverted Routes

A For temporarily displaced runway thresholds and diverted aircraft taxi routes or vehicle routes, temporary marking and lighting may be necessary.

PART 5 – COORDINATION OF CONSTRUCTION ACTIVITIES

5.1 Instructions

A When Air Operations Areas have to be entered for construction activities, surveys, inspections, etc. the following shall be adhered to.

B The Contractor shall comply with the instructions regarding movements of his lorries, plant, etc., so as to prevent interference with aircraft or related traffic. The location of haul routes shall require approval.

C The Contractor shall provide flagmen and warning signs and operate traffic control arrangements as required and shall also act accurately and shall immediately respond to the directions by Air Traffic Control.

D Vehicles, equipment, materials, etc. not actually being used for construction purposes, will be restricted from the Air Operations Areas.

E No vehicles or equipment shall be left unattended in Air Operation Areas. A driver or operator shall be continuously present in order to move the vehicle or the equipment out of the Air Operation Area, whenever necessary.

F The Contractor's attention is drawn to the fact that the operation of aircraft at the airport will at all times have priority over construction operations and that at any time it may be required to temporarily suspend work due to operating aircraft.

G Neither vehicles, equipment nor personnel shall use any active runway, taxiway, apron, or any portion of the landing area without permission. Any unauthorized use or crossings by vehicles, equipment or personnel of any active runway, taxiway or apron will be cause for banishment from the airport.

H Only those trenches for which material is on hand and ready for placing therein shall be opened. As soon as practicable after material has been placed and work approved, trenches shall be backfilled and compacted as required. In the meantime, all resulting hazardous conditions shall be marked and lighted in accordance with safety provisions herein.

I The areas in use for aircraft operations must be kept clean and free from stones, etc. to avoid damage to aircraft

5.2 Safety Officer

A In order to comply with the instructions and safety precautionary measures the Contractor shall appoint a safety officer for coordinating all safety matters in the Air Operations Areas and near Obstacle limitation surfaces.

B The safety officer shall continuously inspect the markers and lights, to determine whether they are in compliance with the instructions.

C In order to maintain constant communications with Air Traffic Control, the safety officer shall be provided with a two-way radio.

5.3 Consequences of Safety Measures

A Interruptions in the execution of the works caused by operating aircraft shall have been considered by the Contractor and are deemed to be included in his proposed method of construction and in his programme of works.

B Interruptions and delays due to aircraft operations between the hours of 6.00am and 24.00pm will not be accepted as grounds for financial claim or for extension of time.

C The costs of safety measures shall be borne by the Contractor and shall be included in the relevant unit rates.

PART 6 – CONTROL OF SMOKE, DUST AND FLYING DEBRIS

A The contractor shall take all precautions necessary to control smoke, dust and flying debris arising from any of his operations and blowing onto aircraft operation areas.

B Earthwork areas shall be watered and covered as required to limit the creation of dust.

C All vehicles used by the contractor must have clean tyres to prevent weed seeds, spoil and other debris being left on the apron or access route. Vehicles must be washed where necessary before leaving the site. Runoff water should be directed towards a pollution entrapment area e.g. grassed swale, gross pollutant trap.

D Debris should be confined to dustbins or the like in and around the buildings and if exceptionally found on or adjacent to any aircraft pavement area they should be removed as soon as possible and as directed by the Client.

E Burning of rubbish on or adjacent to the site constitutes a hazard to flight operations, and is strictly forbidden.

F The contractor shall keep the site clear of all rubbish and standing water that may attract birds to the site. Such rubbish shall be removed from the site as directed by the Client.

G The contractor shall be responsible at all times for keeping all areas of aircraft operation, roads, footpaths and all other areas within the airside area within which he is working free of mud, dust, dirt, flying debris and any other materials because of the danger of personal injuries, low visibility, ingestion into aircraft engines, tire damage or further equipment damage. The contractor shall take all necessary precautions such as mechanical sweeping to prevent such situations to occur.

H The contractor shall keep the site and his working areas generally clean, tidy and free from any loose materials. All loose material shall be fastened so that it cannot be blown away.

PART 7 - SECURITY

A Prior to the start of all works the contractor shall ensure that the boundaries of the site are secure against entry by unauthorized personnel.

B Before any work commences a security, pass shall be provided in consultation with the airport authority for all the contractors' staff. The pass system shall allow for a clear identification of the wearer and areas of access permitted for the wearer. The different areas of access shall be agreed with the airport authority and the Client.

C The contractor shall submit for approval by the airport authority all personnel and vehicles requiring access passes to the airside area. The contractor shall ensure that all entry to airside area will be gained only by production of a valid security pass.

D The contractor shall keep an updated record of all passes and submit the record to the airport authority and the Client weekly.

E All vehicles and mobile equipment the contractor wishes to use within the airside area shall be required to have a vehicle pass. The pass shall allow identification of the area of access permitted. All vehicle passes shall be clearly displayed at all times.

F The airport authority reserves the right to refuse any pass application to airside area without giving any explanation.

G All submissions for airside area access passes shall be made at least 10 days prior to the date of commencement of the pass.

H The contractor will ensure that pass system is strictly enforced throughout the contract period. Persistent non-observance of the system by any personnel will result in their removal from the site.

SECTION 01 31 13.13 PROJECT COORDINATION

PART 1-GENERAL

1.1 Summary

A This section includes administrative and engineering requirements for project co-ordination

1.2 Coordination

A The Contractor shall coordinate construction scheduling, submittals, and work of the various sections of the Project to ensure efficient and orderly sequence of installation of each item of work.

B The Contractor shall verify utility requirements and characteristics of operating equipment are compatible with building utilities, civil works and all others as required in the Contract. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C The Contractor shall coordinate space requirements, supports, and installation of civil, mechanical and electrical work which are indicated diagrammatically or in detail in Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building, pavements and any permanent installation. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E Coordinate completion and clean-up of work of separate sections in preparation for Substantial Completion and for portions of work designated for Employer's partial occupancy.

F After Employer's occupancy of premises, the Contractor shall coordinate with the Employer access to site for correction of defective work and work not in accordance with Contract documents, to minimize disruption of Employer's activities.

1.3 Responsibility for Completion of Time

A The Contractor shall be full responsible for full mobilization in line with his programme of works and shall not in any way delegate this responsibility tot the Engineer or Engineer's Representative whatever the case may be, except for issues of emergencies and safety ordered by the Engineer/Employer.

B The Contractor shall verify and confirm with the Mereological department of Government to confirm the Climate and weather expected during the construction period. Incremental weather shall be assumed to be a Force Majeure on significant deviation of at least 2.8 times the normal of 30 years events..

C The Contractor be responsible for all the facilitation of all the site meetings / inspections in terms of transport, any required eatables/eateries, water and drinks to facilitate the sooth and reasonable meetings.

SECTION 01 31 19.00 PROJECT MEETINGS

PART 1 GENERAL

1.1 Summary

A This section includes meetings to be conducted during implementation of the project as follows:

1. Preconstruction meeting
2. Site mobilization meeting
3. Progress meetings
4. Coordination meetings with other Contractors

1.2 Preconstruction Meeting

A The Engineer will schedule a meeting with the Contractor as soon as possible after the Notice of Commencement has been issued.

B Attendance Required: Employer, Engineer, and Contractor.

C Agenda

1. Distribution of Contract Documents.
2. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
3. Designation of personnel representing the parties in Contract, and the Engineer.
4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures and joint measurement submittals.
5. Scheduling.
6. Other related matters

D The Engineer will record minutes and distribute copies within five (5) days after meeting to Employer and Contractor.

1.3 Site Mobilization Meeting

A meeting will be scheduled by the Engineer at the Project site prior to Contractor site occupancy.

B Attendance Required: Employer, Engineer and Contractor

C Agenda

1. Employer’s requirements.
2. Use of premises by Employer, the Engineer and Contractor.
3. Construction facilities and controls
4. Temporary utilities
5. Survey
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for materials testing.
10. Procedures for maintaining Project record documents.
11. Inspection and acceptance of plant and equipment put into service during construction period.
12. Contractor’s safety program
13. Contractor’s Quality Control

14. Layout and sequencing of the works by the Contractor.
15. Communication procedures

D. The Engineer will record minutes and distribute copies within five (5) days after meeting to Employer and Contractor.

1.4 Progress Meetings

A A regular progress meeting will be scheduled by the Engineer every other week or as maybe necessary throughout the progress of work.

B Attendance Required: Contractor, Employer and Engineer

C Agenda
1. Comments to minutes of previous meeting.
2. Status of work
3. Field observations, problems and solutions if any
4. Coordination with other Contractors
5. Technical issues
6. Submittal
7. Administrative issues
8. Payment issues
9. Variation orders
10. Other contractual issues
11. Any other business

D Record minutes and distribute copies within five (5) days after meeting to participants, with copies furnished to Engineer, Employer representative, participants, and those affected by decisions made.

1.5 Coordination Meetings with Other Contractors/services providers

A Coordination meetings with other Contractors will be scheduled by the Engineer and Employer throughout the progress of the works.

B Attendance required: Employer, Engineer and the various Contractors involved in the ongoing activities of the Project.

C Location will be decided by the Engineer and Employer.

D Record minutes and distribute copies within five (5) days after meeting to participants, Engineer, Employer and those affected by the decisions made.

1.6 Facilitation for meetings

A The Contractor be responsible for all the facilitation of all the site meetings / inspections in terms of transport, any required eatables/eateries, water and drinks to facilitate the sooth and reasonable meetings. Any unofficial meetings required by the Contractor shall be fully facilitated in terms of any additional overtime for the attendees.

SECTION 01 32 23.01 REQUIREMENTS FOR BENCHMARKS, SETTING OUT AND LEVEL TOLERANCES

PART 1 - BENCHMARKS

1.1 General

A The Contractor shall establish a local grid covering the entire construction site, which shall match the existing local grid.

B The Contractor shall confirm the co-ordinates and levels of the Control Points as indicated on the Drawings and use those control points in setting out his works.

C At the beginning and during the construction of the works the Contractor shall establish additional benchmarks, as directed by the Engineer. These benchmarks shall be integrated with the above- mentioned grid.

D For each structure and building additional benchmarks are required.

E The benchmarks shall consist of steel or copper pipes or pins, suitable to the environment, 20 mm in diameter and cast in concrete bases of 300mm in diameter x 500 mm deep. The benchmarks shall be clearly marked and protected, throughout the duration of the works. If necessary, damaged or disturbed benchmarks shall be promptly restored.

F The accuracy of the leveling shall be such that the vertical error of closure will not exceed 10 mm for one kilometre of bench level run.

G The Engineer may authorize third parties to make use of the available benchmarks.

H Maps indicating all data related to the benchmarks and other fixed points shall be produced and distributed among responsible persons.

I All the works as well as all main features such as buildings, intersections and other facilities shall be expressed in the coordinates of the local grid. These main features as well as the precise points will be specified by the Engineer.

J The geographical coordinates of the specified main features shall be indicated on the "As Built" General Lay-out drawing.

K The Contractor's attention is drawn to the fact that the above may have to be treated as classified information.

PART 2 – SETTING OUT

2.1 Earthworks and foundations and Aggregate Bases

A On the area involved, a grid of steel pegs shall be placed at intervals of as specified in the applicable sections.

B The grid shall be placed parallel and at right angles to the centreline of the projected course.

C Extra pegs shall be placed at locations of changing grades.

2.2 Surface Courses and foundations

A On the area involved, a grid of steel pegs shall be set parallel and at right angles to the centreline

of the course to be placed.

B The grid shall have intervals not as specified in the applicable sections.

C The peg lines shall be placed approximately 0.15 metres outside the paving lane for guidance of the electronic equipment on the paver.

D The pegs shall be precisely set, so that after compaction, the finished elevations of the courses conform to the projected elevations.

PART 3 – LEVEL TOLERANCES

A In view of the permitted tolerances as defined in the relevant technical sections it must be clearly understood that these tolerances are not intended as a means for varying the final elevations of layers of materials to be placed in sequence.

B The final surface elevations, as indicated on the drawings, are to be strictly adhered to and so are the elevations of the underlying layers, determined from design layer thicknesses and final elevations.

SECTION 01 33 00.13 SUBMITTAL PROCEDURES

PART 1- GENERAL

1.1 Summary

A This section sets forth general provisions regarding submittals required from the Contractor which include:

1. Monthly Progress Reports
2. Survey Data
3. Shop Drawings
4. As-built Drawings and Final Construction Report
5. Product Data
6. Samples
7. Construction Photographs as Specified
8. Miscellaneous
9. Environmental Management Plans
10. Project Documents Management System

B Before commencement of the works, the contractor will be required to submit to the Engineer a detailed cost breakdown of unite rates buildup together with a resourced Programme of Works as a condition precedent to commencement. The Programme of Works and its supporting information is to the satisfaction of the Engineer who would give a written approval irrespective of the Conditions of Contract on Programme of Works.

1.2 Monthly Progress Reports

A The Contractor shall maintain a daily log describing the important events pertaining to the works, the working hours, the number of laborers employed, effective time of operation equipment, overtime hours, progress of work and instructions, notifications and recommendations made by the Engineer. The daily log shall at all times be available to the Engineer upon request.

B The Contractor shall submit to the Engineer four (4) copies of the monthly progress reports within seven (7) days after the end of every month indicating the progress made, construction activities, inventories of materials used and stored on jobsite, number of working days, the summary of the daily log of the month and all-important events in relation to the works.

1.3 Survey Data

A Within four (4) weeks of completion of any field survey works, two (2) copies of each drawing shall be submitted to the Engineer for review before the submission of the final drawings containing two (2) sets.

B Two (2) copies of the field data neatly bound in a folder and an electronic copy shall be submitted to the Engineer. The field data shall be signed by the field Engineer.

1.4 Shop Drawings

A The Contractor shall submit shop drawings where so required by particular sections of the specifications or as requested by the Engineer. Shop drawings shall be based upon the drawings and specifications requirements, in the approved scale, clearly showing all details for fabrication and assembly.

B The drawings shall be in two (2) copies, and submitted as soon as possible to the Engineer for review

and in any case in sufficient time to permit modifications to be made if such are deemed necessary by the Engineer. For each submission of drawings, a minimum time of two (2) weeks shall be allowed for review of the Engineer. The Engineers review of drawing shall not relieve the Contractor from any responsibility under the Contract.

C Each drawing shall be examined and commented on by the Engineer and will be returned to the Contractor, who shall then print the necessary copies of each drawing requiring no correction for distribution.

D Drawings requiring correction shall be corrected and resubmitted.

E Where drawings are inspected, the said inspection does not relieve the Contractor from his responsibility or from the necessity of furnishing material or performing work required by the drawings and specifications, which shall in the event of a dispute, take precedence over shop drawings.

1.5 As-Built Drawings

A Within one month after the issuance of the Taking Over Certificate, the Contractor shall prepare and submit 2 sets of as-built drawings and final construction report as draft. And within 15 days after the Engineer has commented the draft, the Contractor shall submit five sets of Final Construction Report and Final As-Built Drawings.

B Final As-Built Drawings of the works consist of five (5) sets in hardcopy and five (5) sets electronic copy (AutoCAD latest edition).

1.6 Product Data

A The Contractor may submit manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data in lieu of shop drawings.

B When contents of submitted literature from manufacturers include data not pertinent to submittal, clearly indicate which portion of contents is being submitted for review.

C After review, distribute as directed by the Engineer copies for record documents.

1.7 Samples

A The Contractor shall submit samples free of charge, of the plant and materials to be incorporated into the works, whenever called for by the Engineer, and all plant and materials subsequently delivered to the site for use in the works, are to be identical to the samples approved by the Engineer.

B All samples shall be delivered a minimum of two (2) weeks in advance of commencement of the works in order to give the Engineer sufficient time in which to make decisions regarding choice.

C The quantity of the samples provided shall be sufficient for the Engineer to determine whether or not the sample(s) comply with the standard required. Each sample shall be labelled indicating the generic name of the sample, the manufacturer's name and the model number, brand name and supplier's name, and any other relevant data.

D The Contractor shall accompany each delivery of samples with a transmittal voucher, listing the sample data enumerated above for each sample transmitted, and referencing each sample to the appropriate drawings, sheet and detail, and to the respective item in the Specifications and the Bill of Quantities.

E In addition to the foregoing requirements, the Contractor shall provide sample panels of various

work items, well in advance of such item commencing on site all as directed by and for approval of the Engineer.

1.8 Construction Photographs

A The Contractor shall provide record progress photographs taken at a fixed points and angle as, when and where directed by the Engineer at intervals of not more than (30) days.

B The photograph shall be sufficient in number and location to record the exact progress of works.

C Photographs shall be taken by digital camera at a resolution of minimum 3.0 megapixels.

D On all photographs the date of taking the photograph shall be automatically imprinted by the camera.

E The Contractor shall provide one (1) print of each photograph taken at a size of minimum 150 x 100 mm. All prints shall be placed in an album with a subtitle clearly representing the content of the photograph.

F All photographs shall be provided in digital format (JPEG) on CD-rom/Flash disk

G Albums and CD-roms/Flash disks to accommodate the photographs shall be supplied by Contractor.

1.9 Environmental Management Plans

A The Contractor shall submit to the Engineer his customized Environmental Management Plans for all his works. The Management Plans shall show the responsibilities and response times requirements for every action of environmental mitigation measures.

B The Contractor shall submit to the Engineer his customized Environmental and Social Impact Assessment Reports approved by NEMA for all sources of materials (quarry sites, Plant Sites, Batching Plant etc to ensure compliance with the prevailing law, acts and regulations.

C The Contractor shall ensure his health and safety, Environmental offices are fully supported with dedicated transport and office space with all authority to act as required in the Contract.

D The Contractor shall report to the Engineer all issues on EMP Monitoring Compliance for each and every moth of construction and scheduled inspections during the Defects Notification Period. The report should also be provided during the Monthly Progress meetings and confirmed with the Engineer

1.10 Project Documents Management System

A Document management system (DMS) is a system (based on computer programs in the case of the management of digital documents) used to track, manage and store documents and reduce paper. Most are capable of keeping a record of the various versions created and modified by different users (history tracking). The term has some overlap with the concepts of content management systems. It is often viewed as a component of enterprise content management (ECM) systems and related to digital asset management, document imaging, workflow systems and records management systems.

B The Contractor is expected to purchase, train and implement document management system capable of:

- Metadata Metadata is typically stored for each document. Metadata may, for example, include the date the document will be stored and the identity of the user storing it. The DMS may also extract metadata from the document automatically or prompt the user to add metadata.
- Integration Many document management systems attempt to integrate document management directly into other applications, so that users may retrieve existing documents directly from the document management system repository, make changes, and save the changed document back to the repository as a new version, all without leaving

the application.

- Capture Capture primarily involves accepting and processing images of paper documents from scanners or multifunction printers.
- Validation Visual validation registration system and important data. E.g., document failures, missing signatures, misspelled names, this can be printed on paper documents or images on paper.
- Indexing Indexing tracks electronic documents. Indexing may be as simple as keeping track of unique document identifiers; but often it takes a more complex form, providing classification through the documents' metadata or even through word indexes extracted from the documents' contents. Indexing exists mainly to support retrieval. One area of critical importance for rapid retrieval is the creation of an index topology.
- Storage Store electronic documents.
- Retrieval Retrieve the electronic documents from the storage.
- Distribution A published document for distribution has to be in a format that cannot be easily altered.
- Security Document security is vital in many document management applications. Document marking at the time of printing or PDF-creation is an essential element to preclude alteration or unintended use.
- Workflow Workflow is a complex process and some document management systems have a built-in workflow module. There are different types of workflows. Usage depends on the environment to which the electronic document management system (EDMS) is applied.
- Collaboration Collaboration should be inherent in an EDMS. In its basic form, collaborative EDMS should allow documents to be retrieved and worked on by an authorized user. Access should be blocked to other users while work is being performed on the document.
- Versioning Versioning is a process by which documents are checked in or out of the document management system, allowing users to retrieve previous versions and to continue work from a selected point. Versioning is useful for documents that change over time and require updating, but it may be necessary to go back to or reference a previous copy.
- Searching finds documents and folders using template attributes or full text search. Documents can be searched using various attributes and document content.

1.11 Miscellaneous

A. The Contractor shall submit for approval all method of work execution, manufacturer's catalogues, specification of plant and materials, details of testing and commissioning procedures, manufacturer's recommended spare lists, operating and maintenance manuals, and other technical data so required by particular sections of specifications or as directed by the Engineer. No work shall be executed before the Approval of the Engineer or Authorized Engineer's Representative

SECTION 01 45 29.13 LABORATORY REQUIREMENTS

PART 1 GENERAL

1.1 Description

A The Employer has the Laboratory on site and the Contractor shall maintain and service the laboratory office and equipment that are listed in this section. The Laboratory Equipment shall be calibrated and their calibration shall remain valid for the entire period of the execution for the works or need for any testing.

B The Contractor shall be responsible for provision of all consumables for the laboratory for the intended work to be carried out in the laboratory as required in the Specifications and best practices.

C Where there is insufficient equipment for quality control of any part of work under the scope of work of the Contractor, the Contractor shall supply and ensure the supplied equipment of the laboratory are compatible with the Employer's' laboratory equipment and facilities. Notably, the Employer's laboratory is not equipped for the testing of Concrete piles and the Contractor shall be fully responsible for the same.

D All equipment added by the Contractor to argument the Employer's Laboratory shall revert to the Contractor at the end of the need of the same.

PART 2 - LABORATORY EQUIPMENTS

2.1 List of Laboratory Equipment

A The list of equipment is listed below:

Specification Ref No.	Item - Description	Unit	Quantity
01 45 29.13	**APPENDIX FOR ENGINEER'S LABORATORY FURNITURE, EQUIPMNET**		
A	**A. FURNITURE FOR THE ENGINEER'S LABORATORY**		
1	Provide and maintain one (1) approved branded desktop computer with the following: Intel Core i7 processor, 20" TFT screen display, 750 GB SATA HOO storage, 8 GB DOR RAM, DVD ±RW multi-layer drive, NIC card, 540M graphics card complete with all accessories and pre-loaded with licensed Windows 7 Ultimate 64-bit OS, latest MS Office and MS Project. The PC should have full multimedia capabilities.	Nr	1.00
2	Provide and maintain Konica Minolta page pro 1490 MF or similar approved desktop laser printer	Nr	1.00
3	Provide and maintain UPS 600VA	Nr	1.00
4	Electronic Scientific Calculator 12 figures (Casio fx-995)	Nr	4.00
5	Reams of A4 photocopying paper	Nr	20.00
6	Stapling machine size 66 or similar with 5000 staples	Nr	1.00
7	Stapling machine size 50 or similar with 5000 staples	Nr	4.00
8	Pencil sharpener (desk mounted type)	Nr	2.00
9	Heavy duty paper punch	Nr	1.00
10	Ordinary paper punch	Nr	2.00
11	Filling tray	Nr	10.00
12	Refrigerator, 75-liter capacity	Nr	1.00
13	Vacuum cleaner of approved make, minimum 1000 W power	Nr	1.00
14	900-watt 25-liter microwave oven with grill	Nr	1.00

Specification Ref No.	Item - Description	Unit	Quantity
15	Air conditioner unit, medium size	Nr	2.00
16	Writing desk, 2.2 m x 0.9 m with lockable drawers	Nr	1.00
17	Swivel chair, adjustable height, with arms	Nr	1.00
18	4-drawer lockable steel filling cabinets	Nr	2.00
19	3m² wooden book shelves	Nr	2.00
20	Drawing tables. 1.8 m x 0.9 m with drawer	Nr	2.00
21	Chairs for drawing tables	Nr	2.00
22	Typist table complete with a chair	Nr	1.00
23	Lockable cupboards	Nr	2.00
24	Soft board for wall notices, 2.0 m x 1.0 m	Nr	2.00
25	Bench for people waiting	Nr	1.00
26	Waste paper basket	Nr	6.00
27	Fire extinguishers, CO_2 type 5-liter capacity	Nr	3.00
28	First aid kit for general purposes	Nr	2.00
29	First aid kit for snake bites	Nr	1.00
30	Set of laboratory cleaning and washing up equipment	Nr	1.00
31	Set of curtains for all windows	Set	2.00
B	**B. LABORATORY EQUIPMENT**		
	Compaction Test (AASHTO T99 & T180)		
32	Compaction molds complete with base plate and extension collar 101.1.6 internal diameter by 116.43mm high	Nr	10.00
33	2.49kg compaction hammer, drop regulated to 304.8mm	Nr	2.00
34	4.536kg compaction hammer, drop regulated to 457.2mm	Nr	2.00
35	Electric vibrating Kango hammer fitted with steel tamper (BS1377) with support frame	Nr	1.00
36	Straight edge 300mm long with handles	Nr	4.00
37	Steel tamping rod (BS1377)	Nr	4.00
38	Compaction mold 152.4mm Dia x 116.43 high complete with base plate and extension collar	Nr	2.00
39	Galvanized metal tray lm x 0.5 m x 7 mm deep	Nr	4.00
40	75mm brush	Nr	2.00
41	Semi-automatic balance. 25kg capacity accurate to l0g, including weights	Nr	4.00
42	20mm BS Sieve, 300mm diameter	Nr	1.00
43	Stop clock	Nr	4.00
44	Electric oven, thermostatically controlled between 10 and 150 deg. Celsius, 0.2225 m3mln. Capacity	Nr	2.00
45	As item 106/30 but gas	Nr	1.00
46	Liquid limit divide to BS 1377	Nr	2.00
47	Cone penetrometer with gauge and automatically controlled test cup	Nr	2.00
	Density (Sand Replacement Method BS 1377)		
48	Metal containers (450mm diameter)	Nr	2.00
49	Stainless steel tray 305mm diameter	Nr	2.00
50	Metal tray 300 x 300mm square, 40mm deep with 150mm diameter hole in the center	Nr	2.00

Specification Ref No.	Item - Description	Unit	Quantity
51	Metal tray 500 x 500 mm square, SO mm deep, with 200mm diameter hole in the center	Nr	2.00
52	Steel pegs for fixing tray in position	Nr	50.00
53	Sand pouring cylinder, 150 mm diameter	Nr	3.00
54	Sand pouring cylinder, 200 mm diameter	Nr	3.00
55	Cold steel chisel 20mm x 300mm long	Nr	3.00
56	Cold steel chisel 10mm x 250mm long	Nr	3.00
57	1.5kg, 3.5kg hammers and 1 kg rubber mallet	set	1.00
58	Scoop for removing excavated material from hole, 250m long handle	Nr	4.00
59	100 mm brush, soft	Nr	6.00
60	50mm brush, soft	Nr	10.00
61	Primus gas stove	Nr	1.00
62	Calibrating can 150mm diameter x 250mm deep	Nr	4.00
63	As item 105/48 but 200mm diameter x 250mm deep	Nr	2.00
	Density (Nuclear Method AASHTO T238J)		
64	Nuclear Densometer (Troxler 3411B or similar approved) complete with hole forming device and guide	Nr	1.00
	CBR (AASHTO T238J)		
65	CRB mold, 152.4 Dia x 178mm high, complete with perforated base plate and extension collar 50.8 mm high that cab be fitted to either end of the mold	Nr	25.00
66	Perforated swell plate 150m diameter with adjustable center post of rustproof metal provided with a lock-nut	Nr	25.00
67	2.25kg split surcharge weight	Nr	25.00
68	Set of annular surcharge weights	Nr	25.00
69	Solid base plate for CBR mold	Nr	25.00
70	Static Compaction displacer discs l No.2 61.4mm, 1 No. 50.8mm and 2 No. 38.8 thick	Nr	4.00
71	Disk lifting handle	Nr	6.00
72	Linear Shrinkage mold	Nr	5.00
73	Static Compaction press, 50 tones capacity with an adjustable daylight between platens of 530 to 250mm (hydraulic or mechanical operation and hand operated)	Nr	1.00
74	Set of guards for above press	Nr	1.00
75	CRB mold, 152.4 Dia x 178mm high, complete with perforated base plate and extension collar 50.8 mm high that cab be fitted to either end of the mold	Nr	1.00
76	Penetration gauge range 0-25mm	Nr	4.00
77	Swell measurement tripod completes with gauge calibrated 0.01 divisions	Nr	4.00
78	Soaking tank for CRB molds sufficient for at least 50Moulds	Nr	1.00
	Relative Density of Aggregates (BS & 812)		
79	Wire mesh basket with apertures not greater than 6.5mm large enough to contain 2.5kg of aggregate	Nr	2.00
80	A stout watertight container ln which the basket can be freely suspended	Nr	2.00
81	Soft absorbent cloth [tea towel)	Nr	10.00
82	Shallow tray of area not less than 0.065 m2	Nr	2.00

Specification Ref No.	Item - Description	Unit	Quantity
83	An air tight container of similar capacity to the basket	Nr	2.00
84	Pycnometer of l liter capacity	Nr	4.00
85	Semi-automatic 5 kg balance accurate to 0.1 g to be of size and type to permit the basket containing the sample to be suspended in water [to be supplied with weights)	Nr	1.00
86	Hot air drier (electric)	Nr	1.00
	FLAKINESS (BS 812)		
87	Flakiness gauge	Nr	1.00
88	ACV apparatus of 150 mm internal diameter with plunger and base plate	Nr	1.00
89	Metal stamping rod 16mm diameter and 450mm to 600mm length with one end round	Nr	2.00
90	Cylindrical measure to BS 812	Nr	2.00
	LAA TEST		
91	LAA Machine as el_42-530/01 or similar	Nr	1.00
92	Spare set of abrasive charges	Nr	2.00
	Concrete: Cube and Compression Testing		
93	Concrete compression machine, to BS 1610 grade A with 300mm gauge, rectangular platens, capacity 1560kN.complete with safety guard 50, 70, 100mm distance pieces and electro-mechanical load pacer	Nr	1.00
	Concrete: Slump and Cube Manufacture (BS 1881)		
94	Slump cone, tamping rod and base	Nr	2.00
95	Concrete cube mold (150 mm cube)	Nr	20.00
96	Curing tank for cubes (Capacity 50 No.)	Nr	1.00
97	Cube Tamping rods	Nr	8.00
	Aggregates And Chippings		
98	Metal stamping rod 16mm diameter and 450mm to 600mm Set length with one end round	set	1.00
99	Beaker 250ml	Nr	2.00
100	Thermometer 0 C to + 50 C	Nr	2.00
101	Thermometer 0 C to +50 C	Nr	2.00
102	Reagent grade silica gel, 500g container	Nr	20.00
	Sieve Analysis		
103	BS Sieve 300 mm diameter in sizes 75, 63, 50, 37.5, 28, 20, 14, 10, 6.3, 5 and 4mm, plus lid and receiver	set	1.00
104	BS Steve 200 mm diameter in sizes 2, 1, 0.6, 0.5, 0.425, 0.30, 0.15 and 0.075 plus lid and receiver	set	1.00
105	Electric sieve shaker	Nr	1.00
106	BS Sieve 200 mm diameter 0.425 and 0.075mm	set	2.00
107	1m x 1m x 75mm deep galvanized metal tray	Nr	5.00
108	Riffle box with 50mm slots (BS 1377)	set	2.00
	Marshall Test ASDM D1559		
109	Specimen Mold	Nr	3.00

Specification Ref No.	Item - Description	Unit	Quantity
110	specimen extractor	Nr	1.00
111	Marshall Compactor, complete	Nr	1.00
112	Marshall testing machine complete inducting flow meter	Nr	1.00
113	Electric mixer	Nr	1.00
114	water bath	Nr	1.00
115	200mmx200mmx50mm deep steel baking trays	Nr	6.00
116	pots suitable for heating bitumen	Nr	6.00
117	spatulas	Nr	3.00
118	dial thermometers 10oc to 210oc	Nr	3.00
119	pairs of gloves for handling hot material	Nr	10.00
120	pair of rubber gloves to remove specimens from water bath	Nr	4.00
121	flat bottomed scoop	Nr	2.00
122	ladle for placing mixture in molds	Nr	2.00
123	Gyrator compactor (laboratory mix design) ELE SERVO PAC or equivalent with 100mm and 150mm diameter molds	Nr	1.00
124	Vibrator hammer complete with shanks, tampers,6 molds and 7 base plates	Nr	1.00
	Maximum S.G. Of Bituminous Paving Mixtures (ASTM D2041)		
125	Balance of sufficient capacity and sensitivity to enable maximum specific gravity of samples of uncompacted paving mixtures to be calculated to at least four significant figures, it shall be equipped with a suitable suspension apparatus to permit weighing of the samples while suspended center of the pan	Nr	1.00
126	Vacuum pump	Nr	1.00
127	Glass or metal container of at least 1,000ml capacity it shall be sufficiently strong to withstand a partial vacuum, it shall have a cover fitted with a rubber gasket and a hose connection. Fine wire mesh covers the hose prevent loss of fines. The top surfaces of the container shall be smooth and substantially plane.	Nr	1.00
	Quantitative Extraction Of Bitumen From Bituminous Mixtures ASTM D2172 And ASTM D95		
128	Water Bath for use with bowl suitable for immersing the bowl and apparatus for suspending the bowl from the center of the scale pan.	Nr	1.00
129	Oven capable of maintaining temperature at 100°C to 104°C	Nr	1.00
130	Flat pan 300mmx200mmx25mm deep	Nr	1.00
131	Balance capacity 5000g accurate to 0.2g	Nr	1.00
132	Balance capacity 5000g accurate to 1.0g	Nr	1.00
133	Small mouth graduate 1000ml capacity	Nr	4.00
134	Ignition dish 125mm capacity	Nr	4.00
135	Desiccator	Nr	1.00
136	Analytical balance	Nr	1.00
137	Centrifuge to ASTM E2172	Nr	1.00
138	Filter rings for centrifuge	Nr	150.00
139	Reflux condenser to ASTM E2172	Nr	4.00
140	Petroleum naphthalene	Nr	150.00
141	Trichlorethylene reagent grade	Nr	5.00

Specification Ref No.	Item - Description	Unit	Quantity
142	Extractor fan	Nr	1.00
	Recovery Of Bitumen From Solution		
143	Centrifuge to AASHTO T170	Nr	1.00
144	Centrifuge tubes	Nr	10.00
145	Distillation assembly to AASHTO T170	Nr	1.00
146	Water Jacketed condenser	Nr	1.00
147	ASTM low distillation thermometer with range 20oc to 300oc	Nr	2.00
148	Gas flow meter	Nr	1.00
149	Corks drilled as AASHTO T170	Nr	10.00
150	Separator funnel 125ml capacity	Nr	1.00
151	Supply of carbon dioxide	Nr	30.00
152	Flexing tubing	Nr	20.00
153	Sodium Hexametaphosphate	Nr	5.00
	Bitumen Spray Test (BS 1707)		
154	Steel tray 20 mm deep x 0.1 m2(for measuring bitumen spray quantity) including purpose made detachable handle 1.5 m long to enable trays to be picked up.	Nr	6.00
	Miscellaneous Equipment		
155	Wheel barrow	Nr	4.00
156	Dustpan brush	Nr	4.00
157	Shovel	Nr	4.00
158	Pick axe with handle	Nr	4.00
159	Metal scoop, large (150m wide)	Nr	4.00
160	Metal scoop, medium (100 m wide)	Nr	2.00
161	Garden trowel	set	4.00
162	Steel tray 0.3 x 0.3 x 0.01 deep	Nr	8.00
163	Palette knife 200mm long fade	Nr	4.00
164	Palette knife 100mm long fade	Nr	4.00
165	BS Sieve 450 diameter 37.5 mm	Nr	1.00
166	BS Sieve 450 diameter 20 mm	Nr	2.00
167	BS Sieve 450 diameter 5 mm	Nr	2.00
168	BS Sieve 450 diameter 0.6mm	Nr	4.00
169	BS Sieve 450 diameter 0.425 mm	Nr	10.00
170	BS Sieve 450 diameter 0.3 mm	Nr	4.00
171	BS Sieve 450 diameter 0.075 mm	Nr	4.00
172	Lid and receiver for all sieves from Item01 45 29.13-002-167	set	1.00
173	BS sieve brush	Nr	4.00
174	Measuring cylinder set 25ml. l00ml, 500ml, l000ml, 200ml	Nr	4.00
175	Glass jar capacity 5 liters	Nr	2.00

Specification Ref No.	Item - Description	Unit	Quantity
176	200mm x 200mm x 20mm cadmium plated or aluminum tin	Nr	2.00
177	Electronic balance capacity l000g accurate to 0.0lgm	Nr	2.00
178	Balance 2000g capacity accurate to 0.1 g (manual) including weights	Nr	2.00
179	Balance 50kg capacity accurate to l0g including weights	Nr	1.00
180	Still for producing distilled water	Nr	1.00
181	Polythene or glass 20 liters storage vessels with tap at bottom	Nr	2.00
182	Stiff broom	Nr	4.00
183	Vernier calipers, l50mm	Nr	2.00
184	Vernier calipers, 250mm	Nr	2.00
185	Pestle and mortar	Nr	2.00
186	Linear shrinkage mold (BS 1377)	Nr	2.00
187	Average least dimension gauge	Nr	2.00
188	Plastic or metal bucket including lid, 10 liters capacity	Nr	2.00
189	Polythene wash bottle (500ml)	Nr	20.00
190	A4 size clipboard	Nr	6.00
191	Thermometer range 500C to 1500(, glass (BS 593)	Nr	2.00
192	Laboratory thermometer, range 00C to 2500C (BS 593)	Nr	2.00
193	Lockable tool box containing 1 pr "mole grips" 2°150mm screw driver, 2 °300mm screw driver (1 standard and 1 Phillips head of each) adjustable spanners 200mm and 300mm 1 general purpose pliers, 1 plastic faced mallet (kg),1 set imperial spanners 14: to 15/16" 1 set metric spanners 8mm to 20mm 2 tyre pressure gauge range 0-100 p.s. i	Nr	1.00
194	Maximum and Minimum Thermometer (BS 692)	Nr	2.00
195	Rain Gauge	Nr	1.00
196	Pocket dial thermometer +50°C to 250°C accurate to +3% with 0.75m long	Nr	4.00
197	5-liter capacity steel storage containers with leak and dustproof lids for storage of bitumen samples	Nr	6.00
198	Hotplate 200mm diameter with thermostat heat control unit	Nr	2.00
199	450mm diameter x 150 mm deep basins	Nr	5.00
	Standard Specification		
	Copies of each of the following standard specifications (Latest edition). The Contractor shall supply the other standards quoted in the Contract but the cost of these shall be deemed to have been included in other rates elsewhere.		
200	BS 812	Nr	1.00
201	BS 882	Nr	1.00
202	BS 1377	Nr	1.00
203	BS 1881	Nr	1.00
204	BS 1924	Nr	1.00
205	ASTM 04.03	Nr	1.00
206	AASHTO -GDPS -3 V3	Nr	1.00
207	AASHTO HM -25 (PART I & PART II}	Set	1.00
	Consumables And Sundries Estimated (Not available in full)		
208	Paraffin	kg	50.00

Specification Ref No.	Item - Description	Unit	Quantity
209	Gas	kg.	600.00
210	Gunny sack	Nr	500.00
211	Plastic bag 900 x 450mm x 1000 gauge	Nr	500.00
212	Plastic bag 900 x 450mm x 500 gauge	Nr	500.00
213	Plastic bag 450 x 300mm x 1000 gauge	Nr	250.00
214	Plastic bag 450 x300mm x 500 gauge	Nr	600.00
215	Filter Paper 150mm diameter Watman No. 5(boxes of 100)	Nr	25.00
216	Filter Paper 450mm diameter Watman No. 5(boxes of 100)	Nr	25.00
217	Filter Paper 100mm diameter Watman No. 5(boxes of 100)	Nr	25.00
218	Trichloroethylene 205 little drum	Nr	2.00
219	Cotton waste (or drying cloths)	Nr	25.00
220	Filter Paper 270mm diameter 33MM with diameter hole incentre, Wartman No. 5 (boxes of 100)	Nr	20.00
221	Filter paper 400 mm diameter watt man No.54 (box 100)	Nr	25.00
222	Gas cylinder compatible with stove supplied under 106/31	Nr	6.00
	Other Consumables		
223	Sand for density test	KG	500.00
224	Calcium carbide	KG	5.00
225	Sodium sulphate (anhydrous salt)	KG	5.00
226	Sodium hydroxide (reagent grade)	KG	1.00
227	Potassium dichromate (reagent grade)	KG	1.00
228	Sulphury acid (concentrated)	liter	1.00

PART 3- GENERAL PROVISIONS

3.1 Provisions

A From the date of hand-over of the site until the facilities revert to the Employer, the Contractor has the obligation to maintain and service the above equipment with instructions from the Engineer:

B The listed equipment shall revert to the Employer after project completion.

C The excess consumables shall be the property of the Employer at the end of the project.

SECTION 01 52 23.13 ENGINEER'S REQUIREMENTS

PART 1 GENERAL

1.2 Description

A The Contractor shall maintain the field office, certain transport facilities, field equipment, services, and labour for the Engineer's representative and his staff as prescribed in this section. The Engineer's offices building are provided by the Employer.

B It is anticipated that the Engineer's staff could include the following compliment of on-site staff during various stages of the project:

- Engineer's Representative on Part Time basis
- Resident Engineer/Engineer's Representative
- Deputy Resident Engineer
- Assistant Engineer's
- Electrical Engineer
- Materials Engineer
- Drainage Engineer
- Assistant Engineer's for Electrical Works
- Environmental Expert
- Inspectors of Works (Earthworks, Concrete and Electrical)
- Materials Technologist
- Laboratory staff (Technicians, Technologists, Attendants)
- Surveyor/Assistant Surveyor
- Administration Staff (Secretary and others)

PART 2- FIELD OFFICES

2.2 Requirements and Provisions

A The Engineer's field office shall be required to provide fast internet connection like ISDN or DSL (or similar approved). The system shall be linked up with the local network in accordance with the requirements of the relevant authorities and to the satisfaction of the Engineer.

B The field offices comprise of 4 no. blocks within the same perimeter fence and accessed through one gate. Two blocks are for the Engineer and One is laboratory while the 4th may be used as the Contractor's offices if he so wishes. The Employer is not responsible for provision of the Contractor's offices.

C The contractor shall provide suitable sign boards indicating the project name, the Client's name, the Engineer's name and the Contractor's name as the case may be.

PART 3- GENERAL PROVISIONS

3.2 Provisions

A From the date of hand-over of the site until the facilities revert to the Employer, the Contractor has the obligation to provide the following assistance to the Engineer:

1. For cleaning and maintenance of the Engineer's field office;
2. For service to the Engineer's staff in the Engineer's field office;
3. For guarding and protecting the Engineer's field office;
4. For translations if so required;
5. For assistance in survey works and testing, as required.
6. Provision of assistant staff for the ER/RE to carry out contract obligations.

B From the date of hand-over of the site until the facilities revert to the Employer, the Contractor has the following obligations:

1. Provide and maintain a continuous supply of electric current, either from the public supply system or, when this system should be unreliable due to interruptions or excessive voltage fluctuations, by his own generating units;
2. Provide and maintain a continuous supply of running safe drinking water;
3. Provide and maintain adequate sewage disposal facilities at least 10 m from any building;
4. Provide a refuse removal service at least once daily;
5. Provide and maintain gas/electricity or cooking;
6. Maintain the office and keep the installed equipment, such as water pumps, refrigerators, air-condition units, etc. In good working order;
7. Provide for the engineer's field office and field laboratory all transparency and printing paper, photo copying paper and all further stationary as required by the engineer;
8. Make available a facility for printing/copying drawings on or near the site; costs of printing and copying required for the works will be borne by the Contractor.
9. Make provisions for coffee, tea and non-alcoholic beverages (including for all site meetings attendances)

C From commencing the execution of the Works, the Contractor shall insure all the works, persons and facilities against any damage, loss or injury as required under the Conditions of Contract.

3.3 Engineers Transportation

A For the transportation of the Engineers personnel the following number and type of vehicles will be made available by the Contractor during the complete construction period, 24 hours per day, 7 days per week. The vehicles shall be **BRAND NEW** and are to revert to the Contractor upon completion of the works.

- 4 WD Double Cab Light Delivery Vehicles: 6 No. vehicles shall have air-conditioning.

B Similar to Engineer but for transportation of the Employers' Engineering personnel

- 5 door Sports Utility Vehicle (SUV): 2 No. vehicles shall have air-conditioning.

C Maintenance, repair and fuel and operation including provision of a driver will be the Contractor's responsibility.

Description of Vehicles: All vehicles to be supplied will be **BRAND NEW**.

- 2 No.: minimum 2.4 liter 4-wheel drive "*Toyota" specifications* 5 or equivalent 5 approved, 5 5 door Sports Utility Vehicle (SUV) or similar approved, fitted with air bags, mobile telephone hands-free headset and 2-way radio approved for airport operations.
- Six No.: Minimum 2.4 litre 4-wheel drive "Toyota" specifications, or equivalent approved, twin-cab pick-up fitted with mobile telephone hands-free headset and 2-way radio approved for airport operations.

D Half of the Vehicles to the Engineers personnel provided will be supplied and maintained throughout the Defects Liability Period. All the vehicles shall be comprehensively insured and serviced.

E For transportation of Employer's supervision staff, the contractor shall provide on instruction by the Engineer Nairobi- Mombasa or vis-versa an economy class return air ticket and an accommodation allowance for accommodation in a 3-4-star hotel in Nairobi or Mombasa.

3.4 Communication, Electronic Equipment and Software

A The following electronic equipment must be made available to the Engineer (during the complete construction period) in order to perform his duties using hardware, software and modern means of communication:

1. Ten (10) mobile telephones of type to be approved by the Engineer as consumables.
2. Monthly airtime (cash reimbursable against call cards and or receipts) totally to minimum of Kshs 200,000 per month.
3. Four (4) desktop computers and Six (6) laptop computer with the following minimum specifications / or similar approved:

Desktop computers:

Operating system: Genuine Windows 11 Pro 64, Linux ready
Processor: Intel® Xeon® E3-1225 v5 with Intel HD Graphics P530 (4.3 GHz, up to 7.7 GHz with Intel Turbo Boost Technology, 8 MB cache, 4 cores)
RAM: Memory Configuration 32GB, up to 64GB ECC unbuffered DIMMs supported memory slot or similar approved.
Storage: Internal: 1.5 TB up to 4 TB SATA (7200 rpm)
Optical Storage HP Slim DVD-ROM Drive; HP Slim SuperMulti DVD-RW Drive; HP Slim Blu-ray Writer with RAID 0, 1 support, Optical drive: SATA SuperMulti DVD writer or similar approved.
Graphics: Professional 3D: NVIDIA® NVS™ 510 (26GB)
Communication features: LAN: Integrated Intel® I219LM PCIe GbE; Intel® Ethernet I210-T1 PCIe NIC (optional) WLAN: Intel® 8260 802.11 a/b/g/n/ac PCIe wireless NIC (optional); HP X530 10 GbE Dual-Port Adapter (optional); HP 10 GbE SFP+ SR Transceiver
Power supply: 400 W 92% efficient, wide-ranging, active PFC; PFC Energy Efficiency Compliance:
Software installed: Microsoft® Office professional plus 2021 or similar approved Performance Advisor; Remote Graphics Software (RGS); PDF Complete - Corporate Edition; PC Hardware Diagnostics UEFI; HClient Security Software;
Security management: Solenoid Hood Lock & Hood Sensor Security Cable with Kensington Lock and Trusted Platform Module (TPM) 1.2 (TPM module disabled where use is restricted by law)
Expansion features:
A: Ports: Front: 2 USB 3.0; 2 USB 2.0 (1 charging); 1 headphone; 1 microphone Back:4 USB 3.0; 2 USB 2.0; 2 DisplayPort 1.2; 1 DVI-I single link; 1 serial port (optional); 1 parallel port (optional); 2 PS/2; 1 RJ-45; 1 audio line-in; 1 audio line-out; 2 IEEE 1394b (optional) Internal:1 USB 3.0 and 2 USB 2.0 ports available as 2 separate 2x10(3.0 x1, 2.0 x1) and 2x5(2.0 x2) header. Supports one Internal USB 2.0 Port Kit and one USB 3.0 media card reader. Drive Bays (Internal) One 2.5"; Two 3.5", Drive Bays (External) Two 5.25"; One slim ODD
B: Slots: 1 PCIe Gen3 x16, 1 PCIe Gen3 x4 (x4 connector), 1 PCIe Gen3 x4 (x16 connector), 1 PCIe Gen3 x1, 1 PCI (optional), 1 M.2 slot PCIe Gen3
C: Warranty: Protected by HP Services, including 3 years of parts, 3 years New higher-performance architecture

Laptop computers:

Operating system: Genuine Windows 11 Pro 64, or Linux Ready
Processor: Intel® Core™ i7-2620M (2.70 GHz, 4 MB L3 cache), Processor technology: Intel® Core™ i7 with vPro technology, Chipset: Mobile Intel® QM67 Express
Memory: 32 GB LPDDR3-1600 SDRAM
Storage: 1.5 TB GB M.2 SATA TLC SSD, DVD+/-RW SuperMulti DL
Graphics: 15.6" or 14" diagonal QHD UWVA deep 1.3 + PSR WLED BrightView touch screen (2560 x 1440) NVIDIA® NVS™ 310 6GB Graphics controller NVIDIA® NVS™ 310 GPU: GF119-825 Bus Type PCI Express x16, 2.0 compliant Memory Size: 6GB DDR4 Clock: 875Mhz Memory Bandwidth: 14GB/s Connectors 2 x DisplayPort 1.2 Maximum Resolution Up to 2560 x 1600 (digital display) per display
Another feature:

Slots: 1 Express Card/54 1 Smart Card Reader 1 SD/MMC
Audio: SRS Premium Sound, Integrated stereo speakers, Stereo headphone/line out, Stereo microphone in, Integrated microphone (dual-microphone array with optional webcam. Integrated camera: 720p HD webcam, Keyboard: Spill-resistant keyboard with numeric keypad and drain

Input devices: Touchpad with on/off button, two-way scroll, gestures, two pick buttons; Pointstick with two additional pointstick buttons
Ports: 3 USB 3.0, 1 mini-DisplayPort 1.2, 1 HDMI, 1 headphone/microphone combo, 1 AC power
Keyboard: Full-sized island-style, backlit keyboard
Pointing device: Touchpad with multi-touch gestures enabled. Taps enabled as default
Communication features: Wireless Intel® 802.11a/b/g/n/ac (2x2) and Bluetooth® 4.0 Combo Intel® 802.11a/b/g/n (2x2) and Bluetooth® 4.0 Combo (Support for Miracast. Support for Intel® Pro Wireless Display (WiDi Pro).)
Power supply: 90W Smart AC adapter; HP Fast Charge, 6-cell (62 WHr) Li-Ion battery.
Operating temperature range: 41 to 95°F (5 to 45°C). Energy efficiency: ENERGY STAR® qualified; EPEAT® Gold
Software installed: Microsoft® Office Professional 2021 or similar approved

Security management: Standard: HP Protect Tools, Central Management capable, TPM Embedded Security Chip 1.2, Enhanced Pre-Boot Security, HP Spare Key (requires initial user setup), HP Disk Sanitizer, Drive Encryption for HP Protect Tools, Credential Manager for HP Protect Tools, File Sanitizer for HP Protect Tools, Smart Card Reader, security lock slot Optional: Computrace Pro for HP Protect Tools, HP Fingerprint Sensor

Warranty: HP/LENOVO/DELL Services includes a one-year standard parts and labor warranty, pick- up or carry-in, and toll-free 7 x 24 hardware technical phone support. On- site service and warranty upgrades are also available.
Network with network server for file and print serving, equipped with tape streamer, UPS and further back-up facilities suitable for above-mentioned 7 number computers and 8 laptops; One (1) high resolution digital camera (minimum 15 megapixes, 3GByet memory card with zoom features and movie mode application);

B The contractor shall make provision for the following original software for use and retained by the Employer/Engineer

1. AutoCAD Civil 3D software latest version

C All Communication, Electronic Equipment and Software shall revert to the Contractor at the end of the Contract in exception of the data within the electrical equipment which shall revert to the Employer in backups or extraction of the Hard drives of the equipment.

3.5 Housing Accommodation for the Residents Engineer and His/her Staff

Engineer's Representative Housing

A The contractor shall for the duration of the Contract, provide, furnish and equip Resident Engineer's Staff Accommodation at locations to be identified by the Engineer in the number and types indicated hereunder.

B The housing shall be provided with day and night watchmen and security lights, the cost of which shall be deemed to have been included in the rates for the houses including the provision of water and Electricity for the duration of the Contract.

C All House Furniture and Equipment. New furniture and equipment, to the approval of the Engineer.

D Payments for the Accommodation for the Engineer shall be for fully maintain and pay all rents and municipal services for houses fully furnished and equipped for the engineer (house unit) X (month) for each type. Furniture and equipment: The general description of the type of houses to be supplied is as follows:

1) Type I House

As illustrated in the Drawings (if any) or described in the Special Specifications having an internal floor area of approximately 150 m² complete with furnishings and equipment as listed below. The cost of providing the houses, furnishings, equipment, water, electrical supply, drainage and maintenance during the whole period of the Contract shall be deemed to be included in the Bill of Quantities.

Furniture

- Kitchen Table (Formica Top) 1 No.
- Kitchen Chair 4 No.
- Dining Table 1 No.
- Dining Chairs 6 No.
- Dining Chairs with arms 2 No.
- Writing Desk (3 drawer) 1 No.
- Bookshelf 1 No.
- Settee (3 cushions) 1 No.
- Easy Chairs 4 No.
- Coffee Tables 2 No.
- Sideboard 2 No.
- Beds, double with inner-spring mattress 2 No.
- Beds, single with inner-spring mattress 3 No.
- Pillows 10 No.
- Side Tables 5 No.
- Dressing Tables with mirrors 2 No.
- Dressing Table Stools 2 No.
- Chest of Drawers 3 No.
- Bedside Chairs 5 No.
- Bathroom Cabinet with Mirror 1 No.
- Bathroom Stool 1 No.
- Floor Rugs 5 No.

Equipment

- Air Conditioner 12,000 BTU/hr 4 No.
- Refrigerator min. 0.40 m2 (Electric frost-free) 1 No.
- Electric or gas cooker with 4 burners, separate grill and oven 1 No.
- Fume Hood 1 No.
- Water Filter 2 No.
- Dust Bin metal with lid (outdoor type) 1 No.
- Door Mats 2 No.
- Vacuum Cleaner (electric) 1 No.
- Ceiling Fans 3 No.
- Set of 8 pieces crockery, cutlery, Glassware 1 Set
- Set of Kitchen utensils 1 Set
- Set of Pots, pans, etc. 1 Set
- Deep-Freeze cabinet 0.40 m2 1 No.
- Water cooler / dispenser 1 No.
- Fire Extinguisher 2 No.
- Standard lamps 2 No.
- Table Lamps 2 No.
- Toilet Tissue Holders 2 No.

- Waste Baskets 5 No.
- Vacuum Cleaner (electric) 1 No.
- Mixer (Electric Portable) 1 No.
- Bedside lights 5 No.
- Wall lights 6 No.
- Pelmets and runners all windows
- Curtains all windows
- Bed sheets 20 No.
- Pillow cases 10 No.
- Blankets 10 No.
- Towel rails 2 No.

2) Type II House

As illustrated in the Drawings (if any) or described in the Special Specifications having an internal floor area of approximately 130 m² complete with furnishings and equipment as listed below. The cost of providing the house, furnishings, equipment, water, electrical supply drainage and maintenance during the whole period of the Contract shall be deemed to be included in the Bill of Quantities.

Furniture

- Kitchen Table (Formica top) 1 No.
- Kitchen Chair 4 No.
- Dining Table 1 No.
- Dining Chairs 4 No.
- Dining Chairs with arms 2 No.
- Writing Desk (3 drawers) 1 No.
- Bookshelf 1 No.
- Settee (3 cushions) 1 No.
- Easy Chairs 3 No.
- Coffee Tables 2 No.
- Sideboard 1 No.
- Beds, single with inner-spring mattress 3 No.
- Beds, double with inner-spring mattress 1 No.
- Pillows 8 No.
- Side Tables 4 No.
- Dressing Tables with mirrors 1 No.
- Dressing table stools 1 No.
- Chest of Drawers 2 No.
- Bedside Chairs 4 No.
- Bathroom Cabinet with Mirror 1 No.
- Bathroom Stool 1 No.
- Floor Rugs 4 No.

Equipment

- Air Conditioner 12,000 BTU/hr 2 No.
- Refrigerator min. 0.40 m2 (Electric frost-free) 1 No.
- Electric or gas cooker with 4 burners, separate grill and oven 1 No..
- Fire Extinguisher 2 No.
- Fire axe 1 No
- Fume Hood 1 No.
- Vacuum Cleaner (electric) 1 No.
- Mixer (Electric Portable) 1 No.
- Water Filter 1 No.
- Dust Bin Metal with lid (outdoor type) 1 No.
- Door Mats 2 No.

- Ceiling Fans 2 No.
- Set of 6 pieces crockery, cutlery, glassware 1 Set
- Set of Kitchen utensils 1 Set
- Set of Pots, pans, etc. 1 Set
- Deep-Freeze cabinet 0.40 m21 No.
- Water cooler / dispenser 1 No.
- Standard lamps 2 No.
- Bedside lights 4 No.
- Wall lights 5 No.
- Pelmets and runners all windows
- Curtains all windows
- Bed sheets 16 No.
- Pillow cases 8 No.
- Blankets 8 No.
- Towel rails 2 No.
- Table Lamps 1 No.
- Toilet Tissue Holders 1 No.
- Waste Baskets4 No.

3) Type III House

As illustrated in the Drawings or described in the Special Specifications having an internal floor area of approximately 70 m² complete with furnishings and equipment as listed below. The cost of providing the house, furnishings, equipment, water, electrical supply, drainage and maintenance during the whole period of the Contract shall be deemed to be included in the Bill of Quantities.

Furniture

- Kitchen Table (Formica top) 1 No.
- Kitchen Chair 4 No.
- Dining Table 1 No
- Dining Chairs 4 No.
- Writing Desk (2 drawers) 1 No.
- Book Shelf 1 No.
- Settee (3 Cushion) 1 No.
- Easy Chairs 2 No.
- Coffee Table 1 No.
- Sideboard 1 No.
- Beds, single with inner-spring mattresses 2 No.
- Pillows 2 No.
- Side Table 1 No.
- Dressing Table 1 No.
- Dressing Table Stool 1 No.
- Chest of Drawers 1 No.
- Bathroom Cabinet with Mirror 1 No.
- Bathroom stool 1 No.
- Floor Rugs 4 No.

Equipment

- Air Conditioner 12,000 BTU/hr 2 No.
- Refrigerator min. 0.40 cu.m (Electric frost-free) 1 No.
- Beds, single with inner-spring mattress2 No.
- Electric or gas cooker with 2 burners, separate grill and oven 1 No.
- Fume Hood 1 No.
- Water Filter 1 No.
- Dust Bin Metal with Lid (outdoor type) 1 No.

- Door Mats 2 No.
- Vacuum Cleaner (electric) 1 No.
- Ceiling Fans 2 No.
- Set of 4 pieces crockery, cutlery, glassware 1 Set
- Set of Kitchen utensils 1 Set
- Set of Pots, pans, etc. 1 Set
- Mixer (Electric Portable) 1 No.
- Water cooler / dispenser 1 No.
- Fire Extinguisher 1 No.
- Fire axe 1No.
- Standard lamps 1 No.
- Bedside lights 2 No.
- Wall lights 3 No.
- Pelmets and runners all windows
- Curtains all windows
- Bed sheets 8 No.
- Pillow cases 4 No.
- Blankets 4 No.
- Towel rails 1 No.
- Toilet Tissue Holder 1 No.
- Waste Baskets2 No.

4) Type IV House : Multiple Living Accommodation

1 block of 4 units of multiple living accommodation each unit consisting of 17m², containing two rooms with common ablution block, kitchen, dining room and external veranda all to the approval of the Engineer, as shown in the Drawings, complete with furnishings and equipment as listed below.

Furniture

- Kitchen Table (Formica Top) 1 No.
- Kitchen Chair 4 No.
- Dining Table 1 No.
- Dining Chairs 8 No.
- Sideboard 2 No.
- Beds, single with mattresses 8 No.
- Pillows 8 No.
- Side Table 8 No.
- Bedside Chair 16 No.
- Bathroom Cabinet with Mirror 2 No.
- Bathroom stool 2 No.
-

Equipment

- Electric Fan 8 No.
- Refrigerator min. 0.40 m2 (Electric or equivalent) 1 No.
- Fire Extinguisher 4 No.
- Vacuum Cleaner 1 No.
- Electric Cooker with 4 burners, separate large grill and oven 1 No.
- Water Filter 1 No.
- Water cooler / dispenser 1 No.
- Dust Bin Metal with Lid (outdoor type) 1 No.
- Door Mats 2 No.
- Ceiling Fans 2 No.
- Set of 10 pieces crockery, cutlery, glassware 1 Set
- Set of Kitchen utensils 1 Set
- Set of Pots, pans, etc. 1 Set

- Mixer (Electric Portable) 1 No.
- Wall lights 3 No.
- Pelmets and runners all windows
- Curtains all windows
- Bed sheets 32 No.
- Pillow cases 16 No.
- Blankets 16 No.
- Towel rails 3 No.
- Toilet Tissue Holder 1 No.
- Waste Baskets2 No.

Each unit shall be furnished with one bed, complete with mattress, one table and 2 chairs and one electric fan. The cost of providing the block of 4 units, furniture, equipment, water, electrical supply, drainage and maintenance during the whole period of the Contract shall be deemed to be included in of the Bill of Quantities.

E The contractor shall provide through rent for the duration of the Contract, the Engineer's housing. A description of the accommodation is given below.

- Engineer's Representative on Part Time basis
- Resident Engineer
- Deputy Resident Engineer
- Assistant Civil Engineers 2No
- Electrical Engineer
- Materials Engineer
- Drainage Engineer
- Environmental Expert
- Inspectors of Works 4No
- Laboratory Technician 2No
- Material Technologists 2 No
- Junior Support Staff:
  - Lab Attendants 6No,
  - Administrative Assistants 2No.

F Note: All staff to be approved by the Resident Engineer

3.6 Payment of Overtime for Engineer's Junior Staff

A The contractor shall be responsible for the payment of overtime for the Engineer's Junior Support staff for works undertaken beyond the normal working hours. i.e. 8.00 am to 5.00 pm. All night work shall be considered as overtime.

B When the Contractor executes permanent works outside the Engineer's normal working hours, then the payment for overtime for the Engineer's junior staff shall be reimbursed in full by the contractor to the Engineer's Representatives.

C In addition to the Engineer's junior staff, the support staff seconded to the Engineer shall also be eligible for overtime payments.

3.7 Health, Safety and Accidents

A In accordance with the laws of Kenya, the contractor shall provide for arranging awareness programme for public health education and particularly for HIV/AIDS as detailed in Additional specifications

B The Contractor shall supply to all his workers and the Engineer's Staff with Personal Protective Equipment (PPE). Personal Protective Equipment (PPE) have been developed as the preferred means of demonstrating equipment conformity with the basic health and safety requirements

(BHSRs) of the EC Personal Protective Equipment Directive (89/686/EEC). The manufacturer producing a 'technical file' for the equipment which also demonstrates that it satisfies the BHSRs. The specifications are:

- EN 340:2003 - Protective clothing - General requirements: - mark identifying the manufacturer, product identifying mark, size or size range designation, EN ### - specific Standard number, pictogram - for specific hazard protection (Figs 1 to 15), plus performance levels, where applicable, - care labeling. May include a maximum number of cleaning cycles (max ## x), - single use PPE to be marked "DO NOT RE-USE"
- EN 381-11:2002 – Protective clothing for users of chainsaws – Upper body protectors: As EN 340 plus for high visibility clothing, and if. # - class of garment (1 to 3) based on minimum, areas of visible background, retro-reflective and combined performance materials, # - retro-reflective class (1 or 2; 2 is most reflective) for materials
- EN 471:2003 - Specification for high visibility warning clothing (Amended 2007)
- EN 510:1993 - Specification for protective clothing for use where there is a risk of entanglement with moving parts
- EN 1150:1999 - Visibility clothing for non-professional use
- EN ISO 13998:2003 – Aprons, trousers and vests protecting against cuts and stabs by hand knives: As EN 340 plus - mark identifying the manufacturer, - mark identifying the product, - size designation, - mark identifying the outer surface, - performance level: Level 1 – broad bladed knives only, Level 2 – narrow bladed knives
- EN 14877:2002 - Protective clothing for abrasive blasting operations using granular abrasives: As EN 340 plus Type 1 independent of RPE, Type 2 combined with RPE, Type 3 combined with RPE and dust-tight.
- EN 343:2003 – Protection against rain Amended 2007, Corrected 2010: As EN 340 plus Resistance to water penetration class 1 to 3 (3 is best), - Water vapour resistance class 1 to 3 (3 is best). Class 1 garments must also be marked" Restricted wearing time"
- EN 465:1995 - Protective clothing against liquid chemicals. Performance requirements for chemical protective clothing with spray-tight connections between different parts of the clothing (Type 4 equipment): as EN 340 plus: date of manufacture (month and year).
- EN 466-1:1995 - Protective clothing against liquid chemicals. Performance requirements for chemical protective clothing with liquid-tight connections between different parts of the clothing (Type 3 equipment): Same as EN 465:1995 plus:
  - abrasion resistance class (1 to 6)
  - resistance to heat blocking class (1 or 2)
  - flex cracking resistance class (1 to 5)
  - puncture resistance class (1 to 5)
  - tear resistance class (1 to 5)
  - coating adhesion strength class (1 to 5)
  - resistance to permeation by liquids class (1 to 6)
  - seam strength class (1 to 5
- For American specification to comply to:
  - Eye and face protection 29 CFR 1910.133
  - Respiratory protection - 29 CFR 1910.134
  - Head protection - 29 CFR 1910.135
  - Foot protection - 29 CFR 1910.136
  - Hand protection - 29 CFR 1910.138
  - Hearing Protection - 29 CFR 1910.95

C Employees and Engineer's Staff should be trained to know:

- When PPE is necessary?
- What PPE is necessary?
- How to properly don, doff, adjust and wear PPE.
- Limitations of PPE.
- Proper care, storage, maintenance, useful life, and disposal of PPE D Foot Protection for the Engineer's Staff
- Impact penetration, compression, steel toe, etc.

- Non-skid, with slip resistant soles.
- Chemical resistant (rubber, vinyl, plastic, with synthetic stitching to resist chemical penetration).
- Anti-static
- Temperature resistant (high or low extremes).
- Electrical protection (non-conducting).
- Water resistant
- Combination shoes

3.8 Protection of the Environment

A The Contractor shall be responsible for all measures to protect the environment including and not limited to the following.

1. Compliance with national and local statutes and regulations relating to protection of the environment.
2. The Contractor will be responsible for familiarizing himself with all existing national and local legislation in this regard.
3. All construction activities shall be carried out using the best possible means to reduce environmental pollution such as noise, dust and smoke. All vehicles and plant shall be regularly serviced in accordance with the manufacturer's recommendations to ensure that they operate efficiently and without excessive noxious emissions. The Engineer will have the Authority to instruct the Contractor to temporally cease operations and/or remove from the site vehicles or plant which do not comply with this requirement, until such time that he is satisfied that best practicable means to reduce environmental pollution to a minimum are being used.
4. The Contractor shall at all times maintain all sites under his control in a clean and tidy condition and shall provide appropriate and adequate facilities for the temporary storage of all waste prior to disposal.
5. The Contractor shall be responsible for the safe transportation and disposal of all waste generated as a result of his activities in such a manner as will not give rise to environmental pollution in any form, or hazard to human or animal health. In the event of any third party being employed to dispose of waste, the Contractor shall be considered to have discharged his responsibilities under this Clause from the time at which waste leaves sites under his control, providing that he has satisfied himself that the proposed transportation and disposal arrangements are such as will not give rise to pollution or health hazard.
6. The Contractor shall be responsible for the Provision of adequate sanitary facilities for his workforce, and that of his sub-contractors at all construction and ancillary sites. The contractor shall not allow the discharge of any untreated sanitary waste to ground water or any water of ground surface watercourse.
7. All concrete and asphalt plants shall be operated and maintained in accordance with the original manufacturer's specifications and manuals, and in such a manner as to minimize
8. emissions of hydro-carbons and particulate, if in the opinion of the Engineer the operation of such plant is causing, or is likely to cause nuisance or health problems to site staff or the general public, the Contractor shall carry out such work as is necessary to reduce emissions to an acceptable level within a time-scale agreed with the Engineer.
9. The Contractor shall regularly dowse with water all exposed dirt surfaces to reduce dust levels.
10. The Contractor shall take all responsible measures, at all sites under his control to prevent spillage and leakage of material likely to cause pollution of water resources. Such measures shall include but not be limited to the provisions of bunds around fuel, oil and bitumen storage facilities and provision of oil and grease traps for servicing and fueling areas. Prior to construction of such facilities the Contractor shall submit details of pollution prevention measures to the Engineer's for his approval.
11. The Contractor shall be responsible for ensuring that exposed surfaces are re-vegetated as construction progresses all to the satisfaction of the Engineer.
12. The removal of trees shall be kept to the minimum necessary to accommodate the permanent works.
13. Prior to the removal of any trees the contractor shall inform the Engineer of the intended

operation and obtain the permission of the Engineer for the removal of the trees. If any tree is removed without permission the Contractor shall replace it with an approved tree at no additional cost to the Employer.

14. The Contractor shall ensure that fires do not start within the Site or in the environs there to as a result of the works or from the actions of his employees. The burning of waste, such as vehicle tyres causing noxious emissions is prohibited. The contractor shall have available at all times trained fire-fighting personnel provided with adequate fire-fighting equipment to deal with all fires. The contractor shall additionally at all times provide sufficient fire protection and fighting equipment locally to parts of the works which constitutes particular fire hazards.

3.9 Off Road Environmental Measures

A The Employer and the National Environmental Management Agency (NEMA) may order certain environmental measures to be carried out which are off the airport and not specifically covered under these provisions, the Contractor shall carry out such works with equipment, labour and plant provided under the contract or shall make such arrangements for specialized works to be carried out by a specialized subcontractor.

B The contractor shall be paid for all direct expenses under a provisional Sum in the Bill of Quantities and a percentage (%) for his handling costs and profits.

SECTION 01 60 00 PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.1 Related Documents

A Drawings, Contract Provisions, Special Provisions, Supplementary Conditions, and other Division 01 Specification Sections apply to this Section.

1.2 Summary

A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. This Section includes substitutions made for "or as approved by the Employer" items. B. Related Sections include the following:

i) Division 01 Section "References" for applicable industry standards for products specified.
ii) Divisions 02 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.
iii) Any other as provided in the documents to be adopted as appropriate. Any changes must be approved by the Engineer and shall be full responsibility of the Contractor.

1.3 Definitions

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor

1.4 Submittals

A. Product List: Submit a list, in tabular form acceptable to Engineer, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.

1. Coordinate product list with Contractor's Construction Schedule and Submittals Schedule.
2. Form: Tabulate information for each product under the following column headings:

a. Specification Section number and title.
b. Generic name used in the Contract Documents.
c. Proprietary name, model number, and similar designations.
d. Manufacturer's name and address.
e. Supplier's name and address.

f. Installer's name and address.
g. Projected delivery date or time span of delivery period.
h. Identification of items that require early submittal approval for scheduled delivery date.
i. Item Tag Number or similar ID if identified in the drawings,
j. Location (room number from the drawings),
k. Serial Number (once available).

3. Initial Submittal: Within 60 calendar days after the Notice to Proceed, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from the Contract requirements.
4. Engineer's Action: Engineer will respond in writing to Contractor within 15 calendar days of receipt of initial product list. Engineer R's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.
5. Updated submittal: Submit updated product list every 90 days following initial submittal. The updated list shall be submitted in approved electronic spread sheet format with additional fields as required by Engineer.
6. Completed List: Submit 10 hard copies and one electronic copy of completed product list 90 calendar days before requesting inspection for substantial completion. Include a written explanation for omissions of data and for variations from the Contract requirements.

B. Substitution Requests: Submit six copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Submit requests in the form and according to procedures required for Contract Modification proposals supplied to Contractor at the preconstruction meeting or as directed by Engineer. Do not submit requests for substitutions as "Requests for Information" (RFIs).
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified material or product cannot be provided.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Employer and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
j. Cost information, including a proposal of change, if any, in the Contract Price.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated

results.

m. Failure by Contractor to include the above requirements in the submittal may cause rejection of the submittal in its entirety.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 15 calendar days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 calendar days of receipt of request, or two weeks of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Change notice.
b. Use product specified if Engineer couldn't make a decision on use of a proposed substitution within time allocated.

C. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 working days of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 calendar days of receipt of request, or 7 calendar days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Division 01 Section "Submittals."
b. Use product specified if Engineer couldn't make a decision on use of a comparable product request within time allocated.

1.5 Quality Assurance

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.6 Product Delivery, Storage, and Handling

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
4. Comply with product manufacturers written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Store cementitious products and materials on elevated platforms.
7. Protect stored products from damage.
8. Replace products and materials damaged by the elements due to improper storage at no additional cost to the Employer. This damage can be, but not limited to, oxidization, mold, mildew, warping, and rust.

1.7 Product Warranties

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Employer.
2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Employer.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
3. Refer to Divisions 02 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Project Closeout."

PART 2 – PRODUCTS

2.1 Product Options

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. The Employer reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications to establish "salient characteristics" of products.
7. "Or as approved by the Employer": Note that products submitted under an "or as approved by the Employer" provision are considered to be substitutions. Substitutions shall follow the requirements of Section 01 33 00.13 – Submittal Procedures and Sections 2.2 and 2.3 hereunder "Product Substitutions" and "Comparable Products" respectively to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part - 2 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part - 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.

2.2 Product Substitutions

A. Timing: Engineer will consider requests for substitution if received within 60 calendar days after issuance of the Notice to Proceed. Requests received after that time may be considered or rejected at the sole discretion of the Contracting Officer.

B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution does not require extensive revisions to the Contract Documents.
2. Requested substitution is consistent with the Contract Documents and will produce indicated results.
3. Substitution request is fully documented and properly submitted.
4. Requested substitution will not adversely affect Contractor's Construction Schedule.
5. Requested substitution has received necessary approvals of authorities having jurisdiction.
6. Requested substitution is compatible with other portions of the Work.
7. Requested substitution has been coordinated with other portions of the Work.
8. Requested substitution provides specified warranty.
9. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

C. Contractor's submittal and Engineer's review or approval of Shop Drawings, Product Data, or Samples that relate to a substitute does not by itself constitute a final approval of the requested substitution, nor does it relieve Contractor from fulfilling existing Contract requirements.

D. If a substitution offers a substantial advantage to the Employer, in terms of cost, time, energy conservation, or other considerations of merit, after deducting offsetting responsibilities the Change Proposal.

2.3 Comparable Products

A. Conditions: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, it is consistent with the Contract Documents, it will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

SECTION 01 71 14: MAINTENANCE AND PROTECTION OF AIR TRAFFIC DURING CONSTRUCTION

PART 1 – GENERAL

1.1 Summary

A. Carry out operations in a manner that will cause a minimum of interference with air traffic as indicated in the Plans for Construction Operation (PCO), any phasing plans, and shall be required to cooperate with the KCAA, Employer, the airlines, and Contractors involved in work on other projects. All work shall be completed in accordance with FAA Advisory Circular 150/5370-2F (or KCAA local advisory), General Requirements and Technical Specifications, Construction Phasing Plans, and the MIA/KAA Construction Safety Manual, latest edition.

B. Supply barricades and place, maintain, move, and store barricades as indicated in the plans.

1.2 Measurement Procedures

A Maintenance and Protection of Air Traffic shall be measured by the lump sum.

B The quantity of bucket barricades and Class A barricades to be paid for under this item shall be the number of barricades delivered to the site, placed, maintained by the Contractor and ready for operation, and accepted by the Engineer. Barricades will not be counted separately for each phase. For example, if a barricade for Phase 1 is also used for Phase 2, it will not be counted again for payment. Contractor shall provide barricades as needed for all Taxiways/Runway closure during demonstration repairs.

1.3 Payment Procedures

A. Payment for Maintenance and Protection of Air Traffic will be made at the contract unit price per lump sum. This price shall be full compensation for overall management of the traffic maintenance plan, for placing maintaining and removing flag lines, temporary barricades and closed runway markers and for incidentals not specifically listed under other pay items.

B. The accepted quantities of bucket barricades, and Class A barricades shall be paid for at the contract price per each, which price and payment shall be full compensation for furnishing and maintaining the barricades and for all labour, materials, equipment, tools, and incidentals necessary to complete the work.

C. Payment will be made under:

- Item 017114-1.1 – Maintenance and Protection of Air Traffic-per lump sum Item 017114-1.2 – Bucket Barricade--per each
- Item 017114-1.3 – Class A Barricade--per each

PART 2 – PRODUCTS

2.1 Control and Warning Devices

A. Furnish and maintain barricades along the edges of the construction area to warn the air and ground traffic to stay clear of the construction work. Place light fixtures as detailed in the plans or as designated by the Engineer. Maintain orange warning flags around all equipment, stockpiles or other areas as directed by the Engineer.

B. Omni-directional warning lights on beam, bucket and Class A barricades shall be steady burn, omni-directional, 6 or 12 Volt, with Red Lense. Lights shall be: United Safety Authority Model 630AP; TAPCO Item #2771-11; TMC Safety Products Model L-204; or as acceptable to the Authority.

C. Orange warning flags to mark equipment stockpiles or trenches shall be 20” by 20” square, tacked along

a post having a length of five (5) feet and having a minimum thickness of one (1) inch. Securely drive posts into the ground or attach to the pavement so that the top of the flag is minimum four (4) feet above ground.

D. Ensure barricade lights and flags are monitored for proper functioning and serviced as needed to maintain visibility.

2.2 Barricades

A. NOT USED.

B. Bucket Barricades. Furnish bucket barricades of the type indicated. Mark paint bucket with alternating orange and white horizontal striping and one battery operated, steady burn omni- directional red warning light (see paragraph 2.1.B) mounted on the top, center of each bucket as indicated. At the completion of the Contract, bucket barricades shall become property of the Contractor and removed from the site.

C. Class A Barricades. Furnish Class A barricades of the type indicated. Mark Class A barricades with colours, stripes, and signage patterns as indicated. Mount two battery operated, steady-burn omni-directional red warning lights (see paragraph 2.1.B) shall be mounted on the top, outer edges of each barricade as indicated. At the completion of the Contract Class A barricades shall become property of the Airport.

PART 3 - EXECUTION

3.1 Control Requirements:

The Contractor's responsibility for work areas and marking equipment is as follows:

A. Place nothing upon runways, taxiways, taxiplanes, or aprons without written approval of the Engineer.

B. No vehicle shall enter a paved surface except at predetermined locations.

C. Provide and install barricades, flag lines and other warning markers as indicated or as directed by the Engineer.

D. No private vehicles shall be allowed on the runways or taxiways at any time unless approved by the Engineer.

E. Throughout the duration of the job, immediately rectify any practice or situation that the Engineer determines to be unsafe or a hindrance to regular Airport traffic.

F. The responsibility for controlling of Contractor's employees, subcontractors and their employees with regard to traffic movement rests with the Contractor.

G. G Rebuild, repair, restore and make good at the Contractor's expense all injuries or damages to any portion of the work occasioned by the Contractor's use of these facilities before completion and acceptance of his work.

H. Submit to Engineer in writing a plan for controlling construction equipment and vehicular movements in the air operations area. This plan shall be submitted before notice to proceed is given. Include material haul roads in the plan.

I. Provide a responsible Traffic Manager whose duty it shall be to direct all traffic on or near active runways, taxiways, haul roads and highways. Paved surfaces shall be kept clear and clean at all times and specifically must be kept free from all small stones which might damage aircraft.

J. Furnish two 24-hour emergency contacts for maintenance of the barricades and barricade lighting.

K. The KCAA MIA Control Tower shall at all times have control of operations on or near active runways, taxiways and approach zones. The Contractor shall coordinate through Engineer and MIA Operations with the Control Tower to develop a communication plan that will provide for a safe crossing route without causing unnecessary radio traffic. Before entering upon or crossing any runway or taxiway, the Contractor shall receive proper clearance from the Control Tower. Arrivals and departures of airplanes are under the control of the KCAA MIA Control Tower. Emergencies and operating conditions may necessitate sudden changes, both in Airport operations and in the operations of the Contractor. Aircraft operations shall always have priority over any and all of the Contractor's operations. If runways or taxiways become required for the use of aircraft or if the Control Tower or the Engineer deem the Contractor to be too close to Airport areas used by aircraft for safety, the Control Tower or the Engineer may, at their discretion, order the Contractor to suspend his operations. Removing this may include his personnel, plant, equipment and materials to a safe distance and standing by until the runways and taxiways are no longer required for use by aircraft.

L. L Where any work is to be done on any operational runway or taxiway, notify the Engineer sufficiently in advance so that provisions can be made to close the runway or taxiway to aircraft traffic. Such work shall then be prosecuted in the most expeditious manner practicable so that the runway or taxiway can be reopened to air traffic at the earliest possible date. For additional information refer to Section "Supplementary Conditions," Material Hauling article.

M. Coordinate with the Engineer in advance any action that will require removing, relocating or adding barricades.

N. Remove all equipment and all materials that would constitute a hazard to air traffic to the designated storage area whenever work is not in progress.

O. Violations of these requirements shall be considered a violation of the Contract itself and shall be sufficient cause for halting the work without extending the time limit of the job.

3.2 Barricades

A. Place barricades as indicated or as directed by the Engineer.

B. B Upon completion of each phase of the project, remove barricades from the site.

SECTION 01 77 00.13 CLOSEOUT PROCEDURES

PART 1- GENERAL

1.1 Section Includes

1. Closeout Procedures
2. Final Cleaning
3. Spare Parts

1.2 Closeout Procedures

A The following project closeout procedure defines the responsibilities of the Contractor, the Engineer and Employer in closing the project:

1. The Contractor advises the Engineer in writing that the work has reached substantial completion and provides list of items to be completed or corrected. Closeout may be conducted by areas or portions of work if requested by the Engineer.
2. The Engineer inspects the work to determine if the work is substantially complete and issues a punch list of items to be completed and/or corrected.
3. Contractor completes and corrects punch list items and notifies the Engineer in writing that the work is ready for final inspection.
4. When the work is found acceptable under the requirements of the contract documents and the contract is fully performed, the Engineer will issue the taking over certificate as described in the contract conditions.

1.3 Final Cleaning

A Final cleaning shall be executed prior to final inspection.

B Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces.

C Clean equipment and fixtures to sanitary condition

D Replace filters of opening equipment

E Clean debris from the roofs, gutters, and drainage systems.

F Clean site; sweep paved areas, rake clean landscape surfaces

G Remove waste and surplus materials, rubbish, temporary works, and construction facilities from project and from the site.

1.4 Spare Parts

A Provide all products, spare parts, and maintenance materials required by the various sections of specifications. Unless otherwise stated, required spares and maintenance materials provided shall be sufficient, in the Engineer's opinion for two (2) years of operation after the date of acceptance listed in the taking-over certificate.

B Provide a complete listing of all products and spares provided as agreed with the Engineer.

PART 2 - PRODUCTS
Not Applicable

PART 3 - EXECUTION
Not Applicable

SECTION 01 78 23.00 OPERATIONS AND MAINTENANCE DATA

PART1- GENERAL

1.1 Section Includes

1. Format
2. Maintenance Data
3. Manual for Equipment and System
4. Instruction of Owner Personnel

1.2 Format

A Prepare data in the form of an instructional manual.

B Binders: Commercial quality, 2 ring binders with hardback, cleanable, plastic covers; 2-inch maximum ring size. When multiple binders are used, correlate data and related consistent groupings.

C Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS, list title of Project, and identify subject matter of contents.

D Arrange content by systems under section numbers and sequence of Table of Contents of Project Manual.

E Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment.

F Text Manufacturer's printed data or typewritten data on 20-pound paper.

G Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 Maintenance Data

A Table of Contents: Provide title of Project; names, addresses, and telephone numbers of the Engineer and the Contractor with name of responsible parties; schedule of products and systems, indexed to content of volume.

B For each Product or System: List names, addressed, and telephone numbers of sub-contractors and suppliers, including local source of supplies and replacement parts.

C Product Data: mark each sheet to clearly identify specific products and component parts and data applicable to installation, delete inapplicable information.

D Drawings: Supplement product data to illustrate relations of component parts of equipment and systems and to show control and flow diagrams.

E Typed text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

F Warranties and Bonds: Bind in copy of each.

1.4 Manual for Equipment System

A Each item of Equipment and Each System: Include description of unit or system and component parts. Give function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of

replaceable parts.

B Panel board Circuit Directories: Provide electrical service characteristics, controls and communications.

C Include as-installed color-coded wiring diagrams.

D Operating Procedures: Includes start-up, break-in, and routine normal operating operations and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer and any special operating conditions.

E Maintenance Requirements: Includes routine procedures and guide for troubleshooting; disassembly, repair, and reassembly instructions, and alignment., adjusting, balancing, and instructions.

F Provide servicing and lubrication schedule and list of lubricants required.

G Include manufacturer's printed operation and maintenance instructions.

H Include sequence of operation by controls manufacturer.

I Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

J Provide as-installed control diagrams by controls manufacturer.

K Provide Contractor's coordination drawings, with as-installed color-coded piping diagrams.

L Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

M Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

N Additional Requirements: As specified in individual Sections.

1.5 Instruction of Employers Personnel

A Before final inspection, instruct the Employer's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times. Provide instruction for durations specified in the individual specifications, or for such duration as necessary level satisfactory to the Engineer

B For equipment requiring seasonal operation, perform instructions for other seasons within 6 months.

C Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D Prepare and insert additional data in Operation and Maintenance Manual when need of such data becomes apparent during construction.

PART A-CIVIL WORKS

02 – EXISTING CONDITIONS

PART 1- GENERAL

1.1 Description

A This item shall consist of removing existing pavements, and all other pavement items within the limits shown on the drawings or as required by the Engineer.

B The item shall include breaking-up, removal and disposal of the pavement materials.

1.2 Related Sections

A Sections to be referred to:

1	Section 31 23 16.33	Excavation and Fill
2	Section 32 01 16.71	Cold Milling Asphalt Paving

PART 2- PRODUCTS

Not applicable.

PART 3- EXECUTION

3.1 General

A The Contractor shall obtain approval of the Engineer for his method of demolition. Every effort shall be made to remove only the pavement within the limits shown.

B Plant and equipment for pavement removal shall be of suitable types and standards.

3.2 Disposal and Stockpiling of Materials

A The Contractor shall during his inspection of the site in the Tender Period obtain further information on central dumping areas where disposal of broken up materials may take place.

B Materials shall be disposed of site. Temporary stockpiling of materials within the airport property boundary shall not be permitted.

C Broken up materials shall become property of the Contractor.

D When the Contractor is required to locate a disposal area outside the airport property boundary, he shall obtain and file with the Engineer the permission in writing from the property owner and NEMA for the use of his property for this purpose.

E Disposal of material outside the airport property boundary shall be in accordance with the requirements of the property owner and applicable laws/approvals of NEMA or similar approved.

3.3 Existing Structures, Cables, Pipes and Other Utilities

A Prior to the start of any works the Contractor shall collect all possible information on location and depth of existing structures, cables, pipes and other utilities. KAA will provide existing drawings where available. Nevertheless, it is the Contractor's obligation, whether drawings are provided or not, to ascertain location of existing services.

B All care shall be taken by the Contractor not to damage the permanent features. Any damage to these features due to pavement removal works shall be repaired at the Contractor's expense.

C Whenever any public utility is encountered and must be removed or relocated the Contractor shall advise and notify the owner and attempt to secure prompt action

03 - CONCRETE

SECTION 03 25 3 THERMOPLASTIC ELASTOMERIC RUBBER / POLYETHYLENE WATERSTOPS/WATER BAR FOR CONCRETE LIQUID RETAINING STRUCTURES

PART 1- GENERAL

1.1 Description:

A. Waterstop/Waterbar embedded in concrete and spanning contraction, control, expansion, or construction joints to create a continuous diaphragm to prevent fluid migration.

B. Non-metallic Waterstop/Waterbar for use in concrete joints subjected to acids, bases, alcohols, fuels, oils, solvents or other chemicals.

1.2 Reference Standards for Chemical Resistant Waterstops/Waterbar

A Chemical resistant Waterstop/Waterbar performance is not currently governed by standard specifications in Kenya. The American Title 40 CFR requires the use of chemical resistant Waterstop/Waterbar in all joints for secondary containment in waste structures. Suitability of a material for a specific chemical or fuel application is best determined by application specific testing.

ASTM D 471	Test Method for Rubber Property - Effect of Liquids
ACI 350.2R:	Concrete Structures for Containment of Hazardous Materials
ACI 350R:	Code Requirements for Environmental Engineering Concrete Structures and Commentary

1.3 Quality Assurance

A. Waterstop/Waterbar splicing defects which are unacceptable include, but are not limited to:

1. Use of adhesives, solvents, and free lap joints.
2. Misalignment that reduces Waterstop/Waterbar cross-section area more than 15 percent.
3. Visible porosity in the welded joint, including pinholes, charred or burnt material
4. Visible signs of splice separation when cooled splices are bent by hand at a sharp angle.
5. Edge welding.

1.4 Submittals

A. Submit manufacturer's test data for chemical resistance.
B. Submit shop drawings and fabrication drawings indicating placement of waterstop and shop fabrications.

PART 2- PRODUCTS

2.1 Manufacturer

A The Contractor shall provide manufacture details brochures detailing the manufacture process and quality control.

B The catalogue of the manufacture product for Waterstops / waterbar with all material properties shall be provided with the proposed type for approval in the project.

2.2 Chemical Resistant Waterstop / WaterbarMaterial

A. Linear Thermoplastic Elastomeric Rubber / Polyethylene Waterstop/Waterbar with high resistance to wide range of oils, solvents and chemicals

B. Chemical Resistance testing to be performed by independent ASTM certified laboratory. Important to the integrity of containment structure is the Waterbar/waterstop's performance after chemical exposure. The desired properties will be minimum as indicated in the table

Property	**Test Method**	**Unexposed Value**
Tensile Strength	ASTM D 638	1800 psi (12.4 MPa)
Ultimate Elongation	ASTM D 638	800 %
100% Modulus		ASTM D 638
Shore A Hardness	ASTM D 2240	80 units
Low Temp Brittleness	ASTM D 746	No Failure @-100C/-148F
Environmental Stress	ASTM D 1693	No Failure @500 hours

Waterstop material should show less than +/- 30% change in material properties, including weight gain after 7-day exposure to selected chemicals, per ASTM D471 Testing.

2.3 Nonmetallic Waterstop/Waterbar Shop Splice Fabrications

A. Provide factory fabricated Waterstop/Waterbar intersections, leaving only straight butt joint splices for the field.

B. Use Teflon covered thermostatically controlled Waterstop/Waterbar splicing iron at 380 deg. F to 410 deg. F for PE.

C. Waterstop/Waterbar intersections and directional changes to be miter cut and heat welded with center bulb and ribs aligned to maintain continuity.

D. Splices to be free from defects as defined in approved "Quality Assurance" approved by the Engineer.

PART 3- EXECUTION

3.1 Examination

A. Ensure steel reinforcing bars do not interfere with proper position of waterstop.

B. Clean concrete joints of dirt and construction debris prior to second pour of concrete.

3.2 Nonmetallic Waterstop/Waterbar Field Splice Fabrication

A. Weld straight butt joint splices per requirements for shop fabricated fittings.

B. Cut Waterstop/Waterbar ends with miter guide and circular saw to ensure good, full contact at joints.

3.3 Installation of Ribbed Tear Web and Ribbed Centerbulb Waterstop/Waterbar

A. Use split formwork.

B. Center Waterstop/Waterbar on joint.

C. Allow clearance between waterstop and reinforcing steel to prevent rock pockets and air voids caused by aggregate bridging.

D. At expansion joints, keep centerbulb unembedded at joint centerline. Secure Waterstop/Waterbar in correct position using wires tied through Waterstop/Waterbar eyelets to adjacent reinforcing steel.

3.1 Installation of EB Cap Seal System

A. Stake plastic board in ground at joint location.

B. Insert Speed Load through expansion board.

C. Slide smooth steel load transfer dowel into Speed Load.

D. Heat weld Waterstop/Waterbar lengths together and place on board.

3.2 Installation of Retrofit Waterstop/Waterbar

A. Prepare existing concrete by grinding away irregularities. Clean concrete to ensure good epoxy bond.

B. Apply continuous bed of epoxy to concrete 1/8" thick.

C. Embed retrofit Waterstop/Waterbar in uncured epoxy.

D. Mechanically fasten Waterstop/Waterbar to concrete using stainless steel batten bars and anchor bolts staggered 6 inches O.C. max. Use batten bars on top and bottom.

E. Tool continuous layer of epoxy over batten bars and bolts to protect from corrosion.

F. Use expansion joint filler at moving joints to minimize shear stresses.

3.3 Concrete Placement at Waterstop/Waterbar

A. Carefully place concrete without displacing Waterstop/Waterbar from proper position.

B. Thoroughly and systematically vibrate concrete around Waterstop/Waterbar to obtain impervious, void-free concrete in vicinity of joint and to maximize intimate contact between concrete and Waterstop/Waterbar.

C. After first pour, clean unembedded Waterstop/Waterbar leg to ensure full contact of second pour concrete.

SECTION 03 31 13.13 STRUCTURAL CEMENT CONCRETE, BLINDING CONCRETE AND NO FINES CONCRETE

PART 1- GENERAL

1.1 Description

A This item shall consist of either plain or reinforced structural cement concrete, and blinding concrete, prepared and constructed in accordance with this specification at the locations and of the form and dimensions shown on the drawings. This section does not describe Portland Cement Concrete Pavement.

B The concrete shall be composed of coarse aggregate, fine aggregate, portland cement, and water.

1.2 Standard Test Methods

A Testing Requirements

ASTM	C 31 making specimen in the field
ASTM	C 39 compressive strength
ASTM	C 40 impurities in sand
ASTM	C 42 field cores and beams
ASTM	C 78 flexural strength
ASTM	C 88 soundness
ASTM	C 109strength of cement
ASTM	C 117wet sieving
ASTM	C 125fineness modulus: definition
ASTM	C 131abrasion - L.A. machine
ASTM	C 136sieve analysis
ASTM	C 138yield, air content
ASTM	C 143slump
ASTM	C 174measuring cores
ASTM	C 192making specimen in the lab

B Material Specifications

ASTM A 185	steel wire fabric
ASTM A 615	reinforcing steel
ASTM A 617	steel for dowels
AASHTO M 254	coated dowels
ASTM C 33	aggregates
ASTM C 87	impurities / strength
ASTM C 94	ready-mixed concrete
ASTM C 127	spec. gravity/absorption
ASTM C 128	spec. gravity/absorption
ASTM C 150	cement
ASTM C 171	curing materials
ASTM C 172	sampling concrete
ASTM C 260	air-entraining
ASTM C 309	liquid curing
ASTM C 494	chemical admixtures
ASTM C 618	fly ash and pozzolans
ASTM D 98	calcium chloride
ASTM D 1751, 1752	joint filler

1.3 Related Sections

A Sections to be referred to:

1	Section 32 05 53.13	Construction Water
2	Section 32 13 73.13	Fuel-Resistant Concrete Paving Joint Sealant

PART 2- PRODUCTS

2.1 Materials

A Only materials in accordance with the requirements of this specification shall be used in Work. They may be subjected to inspection and tests at any time during the progress of their preparation or use.

B The source of supply of each of the materials shall be approved by the Engineer before delivery or use is started. Representative preliminary samples of the materials shall be submitted by the Contractor for examination and test.

C Materials shall be stored and handled to ensure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed therein.

F In no case shall the use of pit-run or naturally mixed aggregate be permitted.

G Naturally mixed aggregate shall be screened and washed, and all fine and coarse aggregate shall be stored separately and kept clean. The mixing of different kinds of aggregates from different sources in one storage pile or alternating batches of different aggregates shall not be permitted.

2.2 Coarse Aggregate

A The coarse aggregate for concrete shall be in accordance with the requirements of ASTM C 33.

B Coarse aggregate shall be well graded from coarse to fine and shall meet one of the gradations shown in Table 1 in this section.

Table 1: Gradation for three sizes of coarse aggregate

ASTM Sieve Size		**Percentage by weight passing**		
		1½"-No.4	**1"-No.4**	**¾"-No.4**
2”	50 mm	100	--	--
1½”	38 mm	95-100	100	--
1”	25 mm	--	90-100	100
¾”	19 mm	35-70	--	90-100
½”	12.5 mm	--	25-60	--
3/8”	9.5 mm	10-30	--	20-55
No. 4	4.75 mm	0-10	0-15	0-20

C Soundness loss shall be in accordance with ASTM C 33.

D Abrasion loss shall be less than 45 percent when tested in accordance with ASTM C 131.

E The selection of any of the gradations shown in Table 1 in this section shall be such that the maximum aggregate size used will not interfere with the reinforcement or cover to steel (if any).

F For reinforced concrete, gradation 3/4" down shall normally be used.

G For plain concrete 1" down or 1½" down may be used, unless instructed otherwise.

2.3 Fine Aggregate

A The fine aggregate for concrete shall be in accordance with the requirements of ASTM C 33.

B The fine aggregate shall be well graded from fine to coarse and shall meet the grading requirements shown in Table 2 in this section

Table 2: Requirements for Gradation of Fine Aggregates

ASTM Sieve Size		Percentage by Weight Passing
3/8”	9.5 mm	100
No. 4	4.75 mm	90-100
No. 8	2.36 mm	95-95
No. 16	1.18 mm	45-75
No. 30	0.60 mm	25-55
No. 50	0.30 mm	10-30
No. 100	0.15 mm	2-10
No. 200	0.075 mm	0-5

C Blending will be permitted, if necessary, in order to meet the gradation requirements for fine aggregate.

D Fine aggregate deficient in the percentage of material passing the No. 50 mesh sieve may be accepted, provided that such a deficiency does not exceed 5% and is remedied by the addition of pozzolanic or cementitious materials other than portland cement, as specified for admixtures, in sufficient quantity to produce the required workability as approved by the Engineer.

E The fineness modulus shall be between 2.3 and 3.1.

F Dry sieving is usually satisfactory for routine testing. However, when accurate determination of the amount of fines is desired firstly test in accordance with ASTM C 117 - washing.

2.4 Cement

A Cement shall be Portland type, originating from approved manufacturers, shipped in sealed, labelled bags or in bulk.

B The quality of the Portland cement shall be in accordance with ASTM C 150 type I or V or as instructed, and shall be accepted only upon specific approval of the Engineer based on test certificates originating from recognized laboratories. The basis for this acceptance shall be compliance with the above ASTM specification, especially a compressive strength of standard cement mortar samples at 28 days of not less than that specified when tested in accordance with ASTM C 109.

C Cement shall not be used in the work until it has passed the seven days and twenty eight days tests, except with the permission of the Engineer to avoid delay of the work.

D The tests necessary for approval are included in the item.

E Approval of a cement quality shall not waive the responsibility of the Contractor to produce concrete of the strength specified.

F Cement used shall have been manufactured at least fifteen days previous to use.

G Stale cement or cement reclaimed from cleaning bags shall not be used.

H All cement shall be subjected to a check test at any time requested by the Engineer.

I All cement shall be stored in watertight sheds on a floor sufficiently raised above ground, or in watertight silos.

J Each consignment, brand and type of cement shall be kept separate in the sheds.

K Cement which for any reason has become partially set or contains lumps or caked cement, shall be rejected.

L Whenever tests of factory or field samples subsequent to the original approved tests show that the cement does not comply with the specification, the consignment from which the sample was taken will be rejected and the Contractor shall remove it forthwith from the site at his own expense and replace it with cement of satisfactory quality.

2.5 Water

A Water shall be in accordance with section "Construction Water".

2.6 Admixture

A The use of any material added to the concrete mix shall be approved by the Engineer.

B The Contractor shall submit certificates indicating that the material to be furnished meets requirements.

C The Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications.

D Subsequent tests will be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

E Pozzolanic admixtures shall be fly ash or raw or calcined natural pozzolans meeting the requirements of ASTM C 618 with the exception of loss of ignition, where the maximum should be less than 6 percent.

F Air-entrainment admixtures shall meet the requirements of ASTM C 260 and shall be added to the mixer in the amount necessary to produce the specified air content.

G The air-entrainment agent and the water reducer admixture shall be compatible.

H Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C 494, Type A, water-reducing or Type D, water-reducing and retarding.

I Water-reducing admixtures shall be added at the mixer separately from 1air-entraining admixtures in accordance with the manufacturer's printed instructions.

2.7 Joint Material

A Premoulded joint material for expansion joints shall meet the requirements of one of the following specifications: ASTM D 994, D 1751, D 1752.

B The joint sealing filler shall meet the requirements of section "Joint Sealants".

2.8 Steel Reinforcement

A Concrete reinforcing shall consist of deformed bars of either structural (grade 40), intermediate (grade 60), or hard grade billet steel (grade 75), meeting ASTM A 615 as shown on the drawings.

B To qualify as deformed, bars shall be in accordance with the requirements of ASTM A 615.

C If no grade indicated on the drawings grade 60 (intermediate) shall be used.

D Welded wire fabric shall be in accordance with the requirements of ASTM A 185.

2.9 Calcium Chloride

A When calcium chloride is permitted by the Engineer in the concrete as an accelerator, it shall meet the requirements of ASTM D 98.

2.10 Curing Materials

A Waterproof paper, white polyethylene film, and white burlap polyethylene sheeting for curing concrete shall be in accordance with ASTM C 171.

B Liquid membrane - forming compounds for curing concrete shall be in accordance with ASTM C 309, Type 2 (all resin base).

PART 3 –EXECUTION

3.1 Concrete Proportions

A Materials for one cubic metre of structural cement concrete are as given in Table 3 in this section

Table 3: **Concrete Proportioning**

Type of Coarse Aggregate	**Minimum cement content (kg)**	**Maximum W/C-ratio (%)**	**Fine Aggregate (% of total aggregate)**	**Total Aggregate (kg)**	**Slump (cm)**
Gravel	325	0.5	34-38	1900	5 – 12.5
Crushed Stone	325	0.5	38-43	1900	5 – 12.5

B The proportions in above table are based on the use of well-graded aggregates. If it is impossible with the aggregates selected to prepare concrete of the proper consistency without exceeding the maximum net water content specified, the total weight of aggregate shall be reduced by the Engineer until concrete of the proper consistency is obtained without exceeding the maximum net water content specified.

C The Contractor shall not be compensated for any additional cement which may be required by such adjustment.

D The weights specified in table 3 were calculated for aggregates of the following bulk specific gravities:

1	natural sand and gravel	2.65 t/m³
2	crushed stone	2.70 t/m³

E For aggregates of specific gravities differing more than ± 0.02 from those given under 3.1.D, the weights given in table 3 shall be corrected. The quantities shown for cement and water shall control, and the weights of aggregates shall be varied to secure the proper yield based on absolute volumes.

F When a special mix requiring a reduction in the amount of water desired, the quantities of aggregate shall be increased to maintain the specified yield.

G Yield tests, made in accordance with specification ASTM C 138, shall be made for the purpose of determining the cement content per cubic metre of concrete.

H If at any time such cement content is found to be less than that specified per cubic metre, the batch weights shall be reduced until the amount of cement per cubic metre of concrete is in accordance with the requirements.

I The net mixing water shall be adjusted for the moisture contained in the aggregates, and for the moisture which they will absorb, in order to determine the amount of water to be added at the mixer.

J The absorption of the fine and coarse aggregates shall be determined by ASTM C 127 and C 128.

3.2 Chloride and Sulphate in mix

A The total chloride ion content of the constituents of each mix, expressed as a percentage by weight of cement in the mix, must not exceed the following percentages:

1 Prestressed concrete: 0.1
2 Concrete made with sulphate resistant Portland cement or super-sulphated cement: 0.2
3 Concrete made with ordinary Portland cement or rapid hardening cement and containing embedded metal: 0.35
4 Concrete without embedded metal: 0.50

B The total sulphate content of the constituents of each mix, expressed as SO_3 must not exceed 4% by weight of the cement in the mix.

3.3 Testing

A Testing specimen

1 From the concrete proportions for structural concrete, trial mixes shall be made and from each trial mix six cylinders shall be made and cured in accordance with ASTM C 192, and tested in accordance with ASTM C 39.
2 Normally, several trial mixes shall be prepared and tested simultaneously.
3 The six specimens of each group are to be tested at the end of 28 days. The average strength and the standard deviation of the six specimen is to be calculated for each group.
4 The test results are to be compared with the requirements under clause 3.3.B hereof.
5 Trial mixes are to be continued until a design mix can be selected that fulfils the requirements.
6 Additional specimen may be made and tested to obtain the 7-days strength results. These results may be used as an indication of the 28-days strength. The 7-days strength shall not be less than 65% of the required 28-days strength.

B Compressive Strength

1 The required characteristic design strength of the group of six tests cylinders at 28 days shall be at least 25.0 N/mm²
2 The characteristic strength is defined as $X-K \cdot S$, where: X = average of 6 tests
S = standard deviation K = 1.65 (95% value)

C Slump

1 For each trial mix, one slump test is to be carried out in accordance with ASTM C 143.
2 Results shall be within the range specified.

D Control Tests

1 Six test cylinders for compressive strength tests shall be made during each day that concrete is placed during the progress of the Works. One group of three cylinders is to be made during the first half of a days shift and a second group of three cylinders is to be made during the last portion of the days shift.
2 Each group of test cylinders shall be molded from the same batch of concrete and prepared in accordance with ASTM C 31.
3 Additional groups of test cylinder may be required at the start of the concrete works and when

the aggregate source of characteristics, or the mix design, is changed. The six test cylinders mentioned above shall be used for the 28-days test, and additional test cylinders may be prepared for the 7-days test. When a satisfactory relationship between the 7-days and the 28- days strength has been established and approved, the 7-days results may be used as an indication of the 28-days strength.

4 The characteristic compressive strength of the field-made test specimens, tested at the end of 28-days, shall be as specified at Clause 3.3B, calculated from this series of six.

5 If these strength criteria are not met, and if the structural adequacy remains in doubt, the Engineer may order tests on cores drilled from the area in question, in accordance with ASTM C 42, or he may order load tests or take other action appropriate to the circumstances.

6 If cores are drilled and tested for compressive strength, the concrete will be considered structurally adequate, if the average of 3 cores is at least 85% and no single core has a strength of less than 75% of the strength specified under clause 3.3.B hereof.

3.4 Blinding Concrete

A Blinding concrete shall be placed as working aprons at the locations shown on the drawings or as directed by the Engineer and shall be constructed in accordance with this specification.

B The concrete proportions shall be as follows:

1	cement content	150 kg/m3
2	water/cement ratio	0.65-0.75
3	ratio fine aggregate to coarse aggregate by volume	1 to 2

C The coarse aggregate shall be in accordance with clause 2.2, using 1 inch maximum size.

3.5 Construction Methods

A General

1 The Contractor shall furnish all labour, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified herein.

2 All machinery and equipment owned or controlled by the Contractor, which he proposes to use on the work, shall be of sufficient size to meet the requirements of the work and shall be such as to produce satisfactory work. All work shall be subject to the inspection and approval of the Engineer.

3 The Contractor shall employ, at all times, a sufficient force of workmen of such experience and ability that the work can be prosecuted in a satisfactory and workmanlike manner.

4 The delivery of concrete to the job shall be in such a manner that batches of concrete will be deposited without interruption.

B Proportioning and Measuring Devices

1 When standard package cement is used, the cement quantity for each batch need not be weighed but shall be equal to one or more whole sacks of cement.

2 The aggregate shall be measured separately by weight.

3 Mixing water shall be measured wither by volume or by weight.

4 If aggregates are delivered to the mixer in batch trucks, the exact amount for each mixer charge shall be contained in each batch compartment.

5 Weighing boxes or hoppers shall be approved by the Engineer and shall provide means of regulating the flow of aggregates into the batch box so that the required and exact weight of aggregates can be readily obtained.

C Mixing Conditions

1 The concrete shall be mixed at the work site in a central mixing plant or in truck mixers, The mixer shall be of an approved type and capacity.

2 Mixing time shall be measured from the time all materials, except water, are emptied into the truck. When mixed at the work site or in a central mixing plant, the mixing time shall be not less than 50 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time.

3 Any concrete mixed less than the specified time shall be discarded at the Contractor's expense.

4 The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

5 The mixer shall be operated at the drum speed as shown on the manufacturer's name plate on the approved mixer.

6 The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

7 The batch shall be charged into the drum so that a portion of the mixing water shall enter in advance of cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the frum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

8 Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks having special bodies.

9 The time elapsing from the time water is added to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when the concrete is hauled in truck mixers or truck agitators.

10 Retempering concrete by adding water or by other means shall not be permitted, except if accomplished within 45 minutes after the initial mixing operation.

11 Concrete that is not within the specified slump limits at time of placement shall be discarded.

3.6 Working Limitations

A Sufficient Light No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

B Cold Weather (not applicable) C Warm Weather

1 The Contractor shall be required to take special precautions to prevent the formation of plastic shrinkage cracks.

2 The concrete shall be placed at the lowest temperature practicable, and in no case when the temperature of the fresh concrete is higher than 32° C.

3 Concrete temperatures are to be reduced by the following methods:

a) By shading aggregate and cement stockpiles from direct rays of the sun.

b) By cooling of mixing water which can be achieved by special plant or by burying, insulating, shading or white-painting the pipe line and water storage tanks. Tank cars used for transporting water should be insulated or painted white.

c) By sprinkling forms and subgrade with cool water just prior to placing.

4 When temperature conditions are critical, concrete placement shall be restricted to the evening or night.

5 A copy of weather data shall be included in the permanent records of the job.

3.7 Forms

A Concrete shall not be placed until all forms and reinforcement have been inspected and approved by the Engineer.

B Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as designed on the drawings. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports.

C The Contractor shall bear the responsibility for their adequacy. The surfaces of the forms shall be smooth and free from irregularities, dents, sags, and holes.

D The internal ties shall be arranged so that, when the forms are removed, no metal will show in the concrete surface or discolour the surface when exposed to weathering.

E All forms shall be wetted with water or with a nonstaining mineral oil which shall be applied shortly before the concrete is placed.

F Forms shall be constructed so that they can be removed without damaging the concrete or concrete surface.

G The forms shall not be removed before the expiry of at least 30 hours from vertical faces, walls, slender columns, and similar structures; forms supported by falsework under slabs, beams, girders, arches, and similar construction shall not removed until tests indicate that at least 60% of the design strength under clause 3.3.B of the concrete has developed.

3.8 Placing Reinforcement

A All reinforcement shall be accurately placed, as shown on the drawings and shall be firmly held in position during concreting.

B Bars shall be fastened together at intersections.

C The reinforcement shall be supported by approved metal chairs.

D Shop drawings, lists and bending details shall be supplied by the Contractor when required.

3.9 Embedded Items

A Before placing concrete, any items that are to be embedded shall be firmly and securely fastened in place as indicated. All such items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The embedding of wood shall be avoided. The concrete shall be spaded and consolidated around and against embedded items.

B Exact sizes for recesses or holes in concrete slabs, beams, etc. for piping, ducting etc. have to be determined and provided by the Contractor.

C Inserts or boxes as required are to be placed in correct position before placing concrete.

3.10 Placing Concrete

A All concrete shall be placed during daylight, unless otherwise approved.

B The concrete shall not be placed until the depth and character of foundation, the adequacy of forms and false-work, and the placing of the steel reinforcing have been approved.

C Concrete shall be placed as soon as practical after mixing and in no case later than 1 hour after water has been added to the mix. The method and manner placing shall be such as to avoid segregation and displacements of the reinforcement.

D Troughs, pipes, and chutes shall be used as aids in placing concrete when necessary.

E Dropping the concrete a distance of more than 1.50 m, or depositing a large quantity at one point, will not be permitted.

F Concrete shall be placed upon clean, damp surfaces, free from running water, or upon properly consolidated soil.

G The concrete shall be compacted with suitable vibrators and shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

H Vibrators shall be manipulated so as to work the concrete thoroughly around the reinforcement and embedded fixtures and into comers and angles of the forms. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs.

I Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and shall not be disturbed after being deposited.

3.11 Construction Joints

A When the placing of concrete is suspended, necessary provisions shall be made for joining future work before the placed concrete takes its initial set.

B For the proper bonding of old and new concrete such provisions shall be made for grooves, steps, keys, dove-tails, reinforcing bars other devices as may be prescribed.

C The work shall be arranged so that a section commenced on any day shall be finished during daylight of the same day.

D Before depositing new concrete on or against concrete which has hardened, the surface of the hardened concrete shall be cleaned by a heavy steel broom, roughened slightly, wetted, and covered with a neat coating of cement paste or grout.

3.12 Expansion Joints

A Expansion joints shall be constructed at such points and of such dimensions as may be indicated on the drawings.

B The premoulded filler shall be cut to the same shape as that of the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place in such a manner that it will not be displaced when concrete is deposited against it.

3.13 Defective Work

A Any defective work disclosed after the forms have been removed shall be immediately removed and replaced.

B If any dimensions are deficient, or if any of the concrete is bulged, uneven, or shows honeycombing, which in the opinion of the Engineer cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the Contractor.

3.14 Surface Finish

A All exposed concrete surfaces shall be true, smooth, free from open or rough spaces, depressions, or projections. The concrete in horizontal plane surfaces shall be brought flush with the finished top surface at the proper elevation and shall be struck-off with a straightedge and floated.

B Mortar finishing shall not be permitted, nor shall dry cement or sand cement mortar be spread over the concrete during the finishing of horizontal plane surfaces,

C When directed, the surface finish of exposed concrete shall be a rubbed finish.

D If forms can be removed while the concrete is still green, the surface shall be pointed and wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone shall be used to finish the surface.

E When approved, the finishing can be done with a rubbing machine.

3.15 Curing and Protection

A All concrete shall be properly cured and protected. The concrete shall be cured as soon as it has sufficiently hardened by covering with an approved material.

B The work shall be protected from the elements, flowing water, and from defacement of any nature during the building operations.

C Water absorptive coverings shall be thoroughly saturated when placed and kept saturated for a period of at least 3 days.

D All curing mats or blankets shall be sufficiently weighted or tied down to keep the concrete surface covered and to prevent the surface from being exposed to currents of air. Where wooden forms are used, they shall be kept wet at all times until removed to prevent the opening of joints and drying out of the concrete.

E Traffic shall not be allowed on concrete surfaces for 14 days after the concrete has been placed, or before the concrete has developed a flexural strength of 3.8 N/mm².

3.16 Drains or Ducts

A Drainage pipes, conduits and ducts that are to be encased in concrete shall be installed by the contractor before the concrete is placed.

B The pipe shall be held rigidly so that it will not be displaced or moved during the placing of the concrete.

3.17 Filling Joints

A All joints which require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools.

B Joint filling shall not be started until final curing and shall be done only when the concrete is completely dry.

C The cleaning and filling shall be carefully done with proper equipment and in a manner to obtain a neat looking joint free from excess filler.

3.18 Protective Coating for Concrete

A The surface of the structures which will come in permanent contact with soil shall be given two coatings with an approved bituminous material, depending on the ambient temperature.

B The first coating shall not be applied before a 7 day curing period of the concrete or plaster has lapsed and the second coat at least 24 hours after the first coat.

C In case no shuttering is used and concrete is poured directly in the excavated trench or pit, plastic sheets shall be used as protection between the concrete and the soil.

3.19 No Fines Concrete

A No-fines concrete shall be classified by the prefix NF and the size of aggregate to be used. Class NF 19 means a no-fines concrete with a 19 mm nominal single size aggregate. The volume of aggregate per 50 kg of cement for each class of concrete shall be as follows:

Class	*Aggregate per 50 kg cement*

NF 38	0.33 m^3
NF 19	0.30 m^3
NF 13	0.27 m^3

B Cement shall be measured by mass or in full pockets of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows.

C The aggregate shall be moist or wetted before the cement is added. Where drum mixers are used, about 20% of the water shall be poured into the drum before the aggregate and cement are loaded. The mixing time in the drum shall be about 45 to 50 seconds.

D The quantity of water added shall be just sufficient to form a smooth grout which will adhere to and completely coat each and every particle of aggregate, and which is just wet enough to ensure that, at points of contact of aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20 liters of water for every 50 kg of cement.

E Mixing shall be done in an approved batch-type mechanical mixer, but small quantities may be hand mixed.

F No-fines concrete shall be placed in accordance with the procedure approved by the engineer. It shall be placed in its final position within 15 minutes of having been mixed.

G The concrete shall be worked sufficiently to ensure that it will completely fill the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping shall be avoided and the concrete shall not in any circumstances be vibrated.

H All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:

(i) Retaining formwork in place.
(ii) Covering exposed surfaces with sacking or other approved material kept continuously wet.
(iii) Covering exposed surfaces with plastic sheeting.

SECTION 03 31 13 REPAIR OF LEAKAGES AT THE TWIN TANKS

PART 1 – GENERAL

1.1 Description

A. The Twin Tanks labelled Compartment – B leaked after the carrying of the water tightness test. The tank is to be repaired to ensure that the tank is safe for intended purpose of Rainwater harvesting storage and if possible for sue as a carpark

1.2 Submittals

A. The Contractor with the presence of the Engineer or his representative shall mutually conduct a detailed investigation of the condition of the joints. This investigation shall include the use of X -Ray ferrous scanning, and a report of the outcome to be prepared within two weeks from the last day of completing the investigations.

B. The Contractor should make prepare shop drawings and a construction methodology illustrating his approach to treat the water leakage at the earmarked locations.

1.3 Related Sections

A. Sections to be referred to:

Section 32 05 53.13 Construction Water
Section 32 13 73.13 Structural Joints
Section 03 31 13.13 Structural Concrete, Reinforcement, and Aggregates
Section 80 00 05 Water Tightness test

PART 2 – PRODUCT

A. This item shall consist of either plain or reinforced structural cement concrete, prepared and constructed in accordance with this specification at the locations and of the form and dimensions shown in the leakage repair drawings.

B. The Concrete shall be composed of coarse aggregate, fine aggregate, portland cement, and water and a desired strength of Class 25/20 (cylindrical strength) all as prescribed under the Section 03 of the Technical Specifications and the drawings by the Engineer.

C. The use of appropriate additives shall be allowed at the Engineer's discretion for a quick harden provided that air entraining is not enhanced. The Contractor shall propose a polyurethane sealant that is appropriate for the bonding of old and new concrete pours. The sealant proposed should have a wide flexibility under any weather condition such as that in Mombasa County and to be used to the satisfaction of the Engineer to seal the gaps and joints on the interior and exterior structures.

D. The other materials to refer to the other sections within the Specifications.

PART 3 – EXECUTION

3.1 Construction Requirements

Phase 1: Leakage Investigations Works

A. The Contractor to carry out a detailed investigation with liaison with the Engineer. Investigations to include among others a detailed review of the entire structure’s joints.

B. X-Ray ferrous scans to be carried out as part of the investigations.

C. Reporting to be made after 2 weeks from the last day of the investigations.

Phase 2: Repair Methods

A. With the investigation report, a review of the repair instruction shall be made and confirmed to the Contractor.

B. Respective joints earmarked for repair shall be prepared in strict adherence to the approved sealant manufacturer requirements. This shall include but not be limited to the removal of poorly adhering materials, fines, and dirt. Existing floor and wall sealants that are loosely held shall be removed, and the sections adequately prepared for a new sealant, and concrete pour.

C. Should any reinforcement bars or dowel bars require to be replaced, modified or added, this shall be done prior to concreting works. Approvals by the Engineer are required before any modifications, cleaning and concrete works for scoping and approval.

D. For the sections with exposed concrete or misaligned, new waters bars to be placed as appropriate based on the investigations.

Phase 3: Testing of Works

A. Carry out watertightness test in a progressive manner whilst observing for any signs of leakage in accordance with the Specifications.

B. Refer to Section 80 00 05 for the water tightness methodology. However, each water fill should take up to 1/3 (one third) of the tank height, and subsequent backfilling be made in the event there are no signs of leakage identified. This process should be repeated until leakage test is done to the maximum TWL (Top Water Level).

3.2 Measurements

A. The works shall be measured on the executed, completed and approved works by the Engineer, and as stated in the drawings and the Bills of Quantities. Other works instructions shall be measured appropriately as identified in the bills of quantities.

B. All investigative work proposed solutions shall be approved by the Engineer after concurrence with the Employer as to the extent and the cost thereof.

10 - SPECIALTIES

SECTION 10 90 00 - HANDLING OF ASBESTOS

PART 1 – GENERAL

A. This item shall consist of the methodology of handling hazardous asbestos roof materials within the Airport premises at the Police and Fire Station buildings.

B. The Contractor shall handle the hazardous materials with care, and with approval of the Engineer that shall be in accordance to the prescribed National Environment Management Agency (NEMA) guidelines.

C. The Contractor MUST engage the services of a NEMA approved Contractor to handle the asbestos materials that includes and not limited to; removal, transport, and dumping in a NEMA approved dumping site.

D. After being furnished the new roofs construction drawings, the Contractor, must provide shop drawings, and a program of works with strict adherence to the completion timelines since the Airport facilities are operational.

PART 2 – PRODUCT

A. Not applicable

B. Requisite new roofs construction to refer to their related clauses within the Technical Specification.

PART 3 - EXECUTION

A. Before beginning the removal of hazardous asbestos materials in the occupied Police and Fire Station workplaces, the following should be adhered:

i) Post signs indicating **"ASBESTOS REMOVAL – NO ADMITTANCE"**
ii) Restrict access to the removal area to those people directly involved in the asbestos removal and site supervisors
iii) Once the NEMA approval is granted by the Engineer, and the Contractor's readiness to commence the works, the Contractor shall give a 1- month notice for the access to Fire and Police stations buildings for the Employer to vacate the premises.

B. Where removal of hazardous asbestos materials is performed in an occupied workplace or work area that is not physically separate from other areas, construct a temporary an enclosure to prevent asbestos fibres from leaving the removal area.

This enclosure shall:
i) Use 15 millimeters (6 mil) polyethylene sheeting for walls and floors.
ii) In heavy traffic or wear areas, install extra layers or utilize reinforced polyethylene sheeting.
iii) Where needed, setup temporary framing to support plastic sheeting.
iv) Where a glove bag or similar device (manufactured specifically for the purpose of removing asbestos within a small confined air space) can be used in place of a constructed enclosure.
v) Remove all moveable items from the work area.
vi) For items that cannot be moved, cover them in polyethylene sheeting taped or seal to make it airtight.
vii) Evaluate any change of emergency egress and take necessary steps to ensure requirements for firefighting, emergency exits and emergency lighting requirements are met.
viii) It should be considered, at this point, to arrange a site tour for local firefighting personnel so that they understand and agree with emergency access/egress procedures.

C. Personal Protective Equipment

i) Personal protective equipment (PPE) must be provided to all workers.
ii) For glove bag removal or minor work such as debris clean up or encapsulation of the asbestos materials.
iii) Full body covering (with tight seals at wrists and ankles) consisting of approved disposable coveralls and covers for heads and footwear
iv) Approved respirator with required HEPA filters (100 series with minimum PF of 10) Use of this equipment absolutely does require removal of any facial hair that interferes with the seal, and is subject to a fit test procedure.
v) Foot, hand and eye protection and (where necessary) hard hats
vi) For wet removal of hazardous asbestos materials:
- Full body covering, including the head, consisting of approved disposable coveralls as well as footwear
- Approved respirator with HEPA filters (minimum PF of 50), or supplied air breathing apparatus.
- Use of this equipment will also require removal of any facial hair that interferes with the seal, and is subject to a fit test procedure
- Waterproof foot and hand protection
- Eye protection and (where necessary) hard hats

D. Waste Disposal, Transportation and Dumping

After the asbestos materials have been removed, proper care must be exercised to ensure no contamination occurs in surrounding areas.

i) Place hazardous asbestos materials in polyethylene bags or other approved airtight containers of at least 0 15 mm (6mil) thickness hazardous asbestos materials that could puncture an airtight bag must be double-bagged and then placed in an approved puncture-proof container
ii) Printed asbestos warning labels must appear on the outer surface of the container
iii) The container must be wiped or vacuumed with a HEPA vacuum
iv) Never break material into smaller pieces to fit into containers unless this is performed under negative air conditions, with the capability of applying a mist when necessary to reduce fibre levels
v) All efforts should be taken to eliminate or minimize storage requirements.
vi) However, if necessary, store all waste material in a designated area with posted signage and/or caution tape, secure against accidental damage until transported to a disposal site in an appropriately licensed and enclosed vehicle
vii) Drop sheets and barriers that are to be discarded are to be wetted or HEPA vacuumed and folded in on themselves. Treat them as asbestos contaminated material.
viii) Waste materials, including discarded polyethylene sheeting, sealing tape, cleaning materials, protective clothing, vacuum bags, and other contaminated materials, are treated as any other hazardous asbestos materials for disposal purposes.
ix) The disposal yard must be compliant to NEMA approved guidelines.
x) Each transportation to the disposal yard MUST accompanied by the Engineer/or Engineer's representative.

E. Measurement

i) The measurement for the works is in tonnage (t), and shall comprises of the above methodology. The Contractor shall not make a claim for any extra payments for the above works of handling asbestos materials in relation to the removal, transporting and the dumping.
ii) Measurement mode shall utilize the weigh bridge system in the facility, with weights documentation provided as support for claim of payments.

31 - EARTHWORKS

SECTION 31 05 19 GEOTEXTILE

PART 1- GENERAL

1.1 Description

A The "Geotextile Engineering Manual" by the Federal Highway Administration and "Designing with Geosynthetics" by Robert M. Koerner provide information on design criteria and example calculations used for the design of geotextiles.

1.2 Measurement

A Measure the as-built surface area, covered by geotextile, in square meters yards. Allowance will be made for geotextile in anchor and/or drainage trenches but no allowance will be made for waste, overlaps, damaged materials, repairs, or materials used for the convenience of the Contractor.

B Geotextile installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price will include the cost of materials, equipment, installation, testing, and other costs associated with placement of the geotextile.

1.3 References

A 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 D4354 (2012)	Sampling f Geosynthetics for Testing
ASTM D4355/D4355M (2014)	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M (2015)	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M (2015)	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M (2015a)	Grab Breaking Load and Elongation of Geotextiles ASTM D4751 (2012) Determining Apparent Opening Size of a Geotextile
ASTM D4759(2011)	Determining the Specification Conformance of Geosynthetics
ASTM D4873/D4873M (2016)	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D6241(2014)	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.4 Submittals

A Submittal procedure under section 01 33 00.13 shall be followed strictly.

1.5 Delivery, Storage, and Handling

A Deliver, store, and handle geotextile in accordance with ASTM D4873/D4873M.

1.5.1 Delivery

A Notify the Contracting Officer a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.5.2 Storage

A Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 71 degrees C 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

1.5.3 Handling

A Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 Raw Materials

A A minimum of Seven days prior to scheduled use, submit manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

2.1.1 Geotextile

A The Geotextile shall be in accordance with AASHTO M 288 - Standard Specification for Geotextiles. For cohesive soils with a plasticity index greater than 7, the geotextile maximum average roll value for AOS should be 0.30 mm No. 50 sieve.

Table: Some properties for permittivity requirements

Soil to be filtered	**Minimum Permittivity**
Test Method	ASTM D4491/D4491M
Units	(1/Seconds)
Less than 15 Percent Passing 75 µm No. 200	0.5
15 to 50 Percent Passing 75 M No. 200	0.2
Greater than 15 Percent Passing 75 M No. 200	0.1

B Provide geotextile that is a non-woven pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed.

C Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges.

Table: Minimum Requirements for Protection Geotextile

Property	**Units**	**Acceptable Values**	**Test Method**
Grab Strength	N	1420	ASTM D4632/D4632M
Puncture	N	930	ASTM D6241
Trap Tear	N	555	ASTM D4533/D4533M
Mass/ Unit Area	G/m²	350	ASTM D4751
UV Degradation	%	50 at 500 HRS	ASTM D4355/D4355M

2.1.2 Thread

A A minimum of Seven days prior to scheduled use, submit proposed thread type for sewn seams along with data sheets showing the physical properties of the thread. Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 Manufacturing Quality Control Sampling and Testing

A The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. A minimum of Seven days prior to scheduled use, submit manufacturer's quality control manual. Documentation describing the quality control program shall be made available upon request. Perform manufacturing quality control sampling and testing in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with testing under ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 Quality Assurance Samples and Tests

3.1.1 Quality Assurance Samples

A Provide assistance to the Contracting Officer in the collection of quality assurance samples for quality assurance testing; assign seven days in the schedule to allow for testing. Collect samples upon delivery to the site in accordance with ASTM D4354, Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller.

B The unit size shall be considered one roll of geotextile at a frequency of one per 10,000 square meters. Identify samples with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 1 meter long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

3.1.2 Quality Assurance Tests

A The Engineer may require testing quality assurance by sending the samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified (ASTM D4355/D4355M shall not be performed on the collected samples). Geotextile product acceptance shall be based on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

3.2 Installation

3.2.1 Subgrade Preparation

A The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with provided specifications.

3.2.2 Placement

A For collection ditches, geotextile placed in the direction of flow should be wide enough to cover the entire width of the ditch. If this is not possible, the geotextile should be placed perpendicular to the

direction of flow and shingled in the down-gradient direction.

B Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

3.3 Seams

A Overlapped seams are commonly used for geotextile not placed in tension. Geotextile seams can also be produced by sewing or the application of thermal energy. Contact the geotextile manufacturer for installation instructions using thermal methods. ASTM D4886 should be referenced for heat seamed geotextiles. For geotextile placed in tension, seams should be sewn and the stitch type should be based on the manufacturer's recommendations.

3.3.1 Overlap Seams

A Seams are typically overlapped a minimum of 300 mm. The specified seam overlap should be greater than 300 mm for soft subgrades or where large amounts of differential settlement are anticipated. The maximum overlap is typically 1 meter. For soils with a CBR value of less than 1, seams are typically sewn. Refer to AASHTO M 288 for additional guidance on overlaps for soft subgrade conditions.

B Continuously overlap geotextile panels a minimum of 300 mm at all longitudinal and transverse joints. Where seams must be oriented across the slope, lap the upper panel over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.3.2 Sewn Seams

A The plans and/or specifications should indicate which seams must be sewn. Seam strength can be specified based on ASTM D4632/D4632M for applications where the geotextile will not be placed in tension. In this case, seam strength is typically measured in accordance with ASTM D4632/D4632M and is typically specified to be equal to or greater than 85 to 90 percent of the grab strength of the geotextile. If seam strength testing will be required, add seam strength as specified.

B The need for quality assurance testing needs to be determined on a site specific basis and should be based on how critical the project is and the consequences of failure.

C If the geotextile is designed to be in tension, strength testing should be required and ASTM D4884/D4884M should be used to determine seam strength. Quality assurance and quality control testing should be performed on all seams that are designed to be in tension.

3.4 Protection

A The use of staples or pins to hold geotextiles in place should not be allowed in applications where the geotextile will be located adjacent to other geosynthetic layers which could be damaged.

B The purpose of limiting exposure time prior to covering geotextiles is to minimize damage due to UV radiation and to prevent direct contact by vehicles, humans, and animals. To prevent UV degradation, exposure time of polypropylene geotextile should be limited to 14 to 28 days. Polyester geotextile is more resistant to UV degradation and may be exposed to UV radiation for at least 28 days without damage.

3.5 Repairs

A Repair torn or damaged geotextile. Clogged areas of geotextile shall be removed. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a

minimum of 300 mm 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired. Repairs shall be performed at no additional cost to the Government

3.6 Penetrations

A Construct engineered penetrations of the geotextile [as shown on the drawings] [by methods recommended by the geotextile manufacturer].

3.7 Covering

A Do not cover geotextile prior to inspection and approval by the Engineer. Place cover soil in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 1 m. No equipment shall be operated directly on top of the geotextile without approval of the Engineer with a proper method statement. Use equipment with ground pressures less than 50 kPa to place the first lift over the geotextile.

B A minimum of 300mm of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 31 00 00 Earthworks. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 2.2 m/s

SECTION 31 05 22 GEOTEXTILES USED AS FILTERS

PART 1- GENERAL

1.1 Description

A This guide specification is to facilitate the preparation and review of specifications for procurement and installation of woven and nonwoven geotextiles as filter material. It is based on field performance and the laboratory testing of a limited number of geotextiles. Geotextiles possess greatly varying engineering properties and physical characteristics. Such variations require the designer to decide which testing method and what test criteria are necessary for each application.

1.2 References

A 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 D123 (2015)	Terminology Relating to Textile
ASTM D4354 (2012)	Sampling of Geosynthetics for Testing
ASTM D4355/D4355M (2014)	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M (2015)	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M (2015)	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M (2015a)	Grab Breaking Load and Elongation of Geotextiles ASTM D4751 (2012) Determining Apparent Opening Size of a Geotextile
ASTM D4833/D4833M (2007; E 2013; R 2013)	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D4873/D4873M (2016)	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D4884/D4884M (2014a)	Strength of Sewn or Thermally \Bonded Seams of Geotextiles

1.3 Submittals

A Submittals shall be in accordance with the requirements of the specifications 01 33 00.

PART 2 PRODUCTS

2.1 Requirements

A The apparent opening size (AOS), percent open area (POA), geotextile permeability (K_g), and strength test described in the specifications that follow are physical property tests. While it is acceptable to specify minimum thickness value where it governs performance, it is inappropriate to use thickness to identify a geotextile.

B Prospective geotextile suppliers should furnish these test results before their geotextile will be considered for use, or before contract specifications are adjusted to permit the use of geotextiles whose properties are outside the limits imposed by this guide. For severe soil conditions and/or for a project using a large amount of geotextiles, the specifications should require that the applicable tests be run during construction, either at a specific frequency or upon demand of the Engineer.

C Geotextile strength requirements vary with intended use and construction procedures. Table I presents the most important geotextile strength properties. It should be noted that the strength requirements listed are only a guideline to the minimum values required for survivability. Specific

applications may require additional testing.

Table 1: Recommended Geotextile Strength Requirements in Metric Units (1)

Geotextile Use	Strength Requirements (Minimum Values)			
	ASTM D4632 Tensile (N)	ASTM D4355/D4355M Untraviolet Degradation At 500 Hours (Percent)	ASTM D4833 Puncture (N)	ASTM D4533/D4533M Tear (N)
Riprap slope Protection Filter with greater than 100 mm bedding	515	50	180	180
Riprap slope protection without bedding	900	50	360	180
Drainage trench	515	50	180	110
Slab drain	515	50	180	110
Articulated mattress or interlocking block slope protection filter	515	50	180	110
Note (1) Strength values are for the weaker principal direction				

D The AOS requirement should be specified as a range, to allow for manufacturing tolerance. It is preferable to specify a geotextile with opening as large as allowed by the design criteria. The smallest sieve opening size of the AOS range should not be smaller than the 0.125 mm sieve U.S. Standard sieve size No. 120.

Table 2: geotextile filter design criteria

Protected Soil (1) (Percent Passing 75 µm No. 200 Sieve)	**Soil Piping (2)**	**Coefficient of Permeability (3)**	
		Woven	**Non-Woven**
<5	$O_{95}/D_{85} \leq 1$	POA 10 %	$K_g \geq 5K_s$
5 to 50	$O_{95}/D_{85} \leq 1$ $O_{95} \leq$ 0.212mm No 70 US Sieve	POA 4 %	$K_g \geq 5K_s$
50 to 85	$O_{95} \leq$ 0.125mm No 120 US Sieve	POA 4%	$_{Kg} \geq 5K_s$
50 to 85	$O_{95} \leq$ 0.125 No 120 US Sieve	$K_g \geq 5K_s$	

Note:
(1). Recent experiences have indicated that O_{95} (i.e. AOS) increased with increasing relative density, GR, and it is higher for uniform soil than well graded soil of similar density and average particle size
(2). If the protected soil contains appreciable quantities of material retained on the 4.75 mm No. 4 U.S standard sieve use only the soil passing the 4.75 mm No. 4 U.S. standard sieve in selecting the O_{95} of the geotextiles
(3). K_g is the permeability of the geotextile and K_s is the permeability of the protected soil.

2.2 Geotextile Fiber

A Nonwoven geotextiles are suitable for filtering fine-grained soils whereas woven or nonwoven are suitable for well graded granular soils. Therefore, all the geotextiles with the exception of the Geogrids for Asphalt Pavement reinforcement must be non-woven.

B Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Add stabilizers and/or inhibitors to the base polymer, if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Finish the edges of the geotextile to prevent the outer fiber from pulling away from the geotextile.

2.3 Seams

A These are as required under 31 05 19 (which is an update of 31 05 22)

2.4 Securing Pins

A Secure the geotextile to the embankment or foundation soil by pins to prevent movement prior to placement of revetment materials. Other appropriate means to prevent movement such as staples, sand bags, and stone could also be used. Insert securing pins through both strips of overlapped geotextile along the line passing through midpoints of the overlap. Remove securing pins as placement of revetment materials are placed to prevent tearing of geotextile or enlarging holes. Maximum spacing between securing pins depends on the steepness of the embankment slope. The maximum pins spacing shall be equal to or less than the values listed in Table 3. When windy conditions prevail at the construction site, increase the number of pins upon the demand of the Contracting Officer. Anchor terminal ends of the geotextile with key trench or apron at crest, toe of the slope and upstream and downstream limits of installation.

Table 3 – Maximum Spacing for securing pins

Embankment (slope mV on mH)	**Spacing (m)**
Steeper than 1V on 3H	0.62
1V on 3H to 1V to 4H	1.03
Flatter than1V on 4H	1.55

2.5 Inspection, Verification and Testing

A Manufacturing and Sampling: Geotextiles and factory seams shall meet the requirements specified in TABLE 1.

B Conformance Testing: Perform conformance testing in accordance with the manufacturers approved quality control manual. Submit manufacturer's quality control conformance test results.

C Factory Sampling: Randomly sample geotextiles in accordance with ASTM D4354 (Procedure Method A). Sample factory seams at the frequency specified in ASTM D4884/D4884M. Provide all samples from the same production lot as will be supplied for the contract, of the full manufactured width of the geotextile by at least 3 m long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 1.5 m. Samples submitted for testing shall be identified by manufacturers lot designation.

D Needle Punched Geotextile: For needle punched geotextile, provide manufacturer certification that the geotextile has been inspected using permanent on-line metal detectors and does not contain any needles.

E Manufacturer Certification: Upon delivery of the geotextile, submit duplicate copies of the written certificate of compliance signed by a legally authorized official of the manufacturer. The certificate shall state that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in table I & II. All brands of geotextile and all seams to be used will be accepted on the basis of mill certificates or affidavits. Submit duplicate copies of the mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit shall attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.

PART 3 - EXECUTION

3.1 Site Preparation

A Prepare surface, on which the geotextile will be placed, to a relatively smooth surface condition in accordance with the applicable portion of this specification and shall be free from obstruction, debris, depressions, erosion feature, or vegetation. Remove any irregularities so as to ensure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low density pockets of material, shall be removed; erosion features such as rills, gullies etc. shall be graded out of the surface before geotextile placement.

3.2 Installation of the Geotextiles

A The overlapping shall comply to 31 05 19 and 31 05 20

B Place the geotextile in the manner and at the locations shown. At the time of installation, reject the geotextile if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

C All geotextiles can be damaged if stone is dropped on it from a height greater than 900 mm. Some geotextiles can be damaged with lesser drop heights. When stone is heavy and angular it may cause punctures in the geotextile even if dropped from a height of 300 mm. Tension in the geotextile must be minimized to prevent puncture.

D Perform placing of cushioning material in a manner to ensure intimate contact of the geotextile with the prepared surface and with the cushioning material. The placement shall also be performed in a manner that will not damage the geotextile including tear, puncture, or abrasion. On sloping surfaces place the cushioning material from the bottom of the slopes upward. During placement, the height of the drop of riprap material shall not be greater than 300 mm 12 inches. Uncover any geotextile damaged beneath the cushioning material, as necessary, and replaced at no cost to the project.

SECTION 31 01 50 OUTFALLS WORKS – EXPOSURE OF OUTFALL NO. 02

PART 1 – GENERAL

A. The Outfall no. 2 stilling well was covered by dumped material that comprises of a marshy and weak alluvial cohesionless soils material of Magarini Sands, with overlying clayey shales. The ground conditions are predominantly wet from the high ground water table.

B. In addition, the section has high water table that is throughout the year, thus the need for specialized excavation.

C. The Contractor is required to carry out Outfall no. 2 exposure in accordance to these specifications and instructed construction drawings.

D. The Contractor should prepare shop drawings and a construction methodology for approval by the Engineer prior to commencement of the works.

PART 2 – PRODUCT

A. Not applicable

PART 3 – EXECUTION

3.1 Construction Requirements

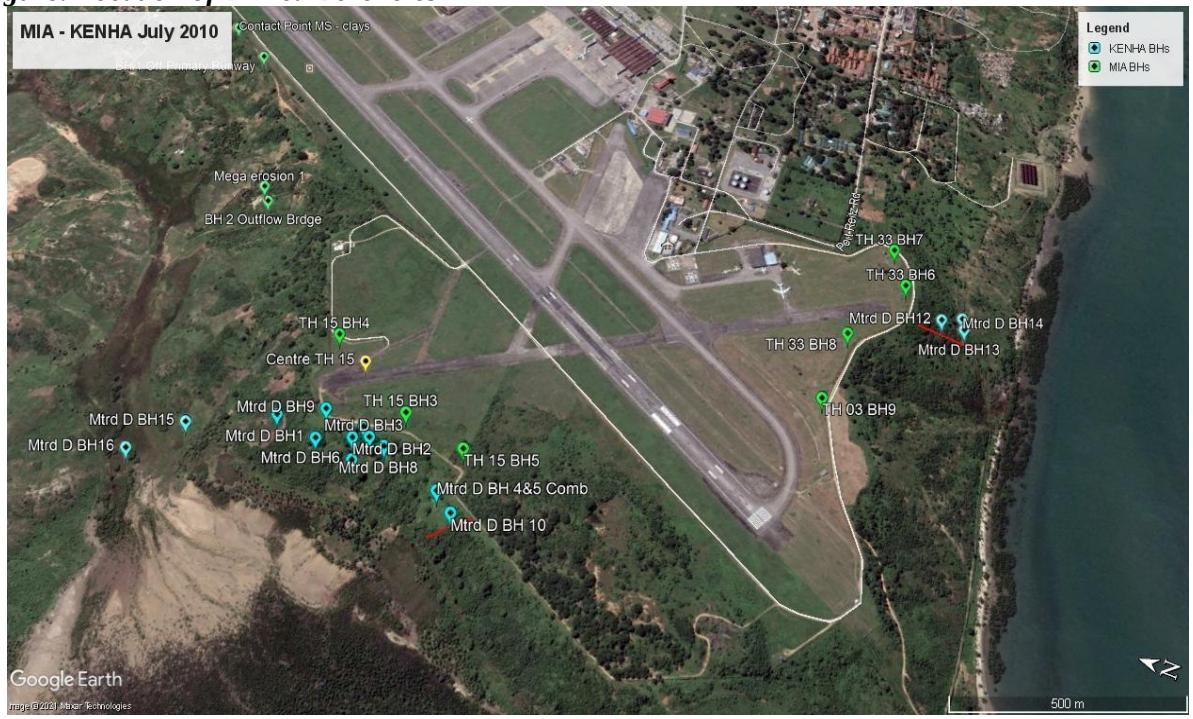
3.1.1 Factual Materials Report

A. The factual materials report of the area at Outfall no. 2 are as shown in the table below and the map"

Table: Location of Drilled Boreholes

Site	BH No	Maximum Depth Drilled (m)	Geographic Coordinates (m)		Elevation (m) asl
			Easting	Northing	
Slopes and area around out-fall 2	1	30.00	0566382.313	955508.563	55.328
	2	30.00	0565948.371	9555252.524	28.381

Figure: Location of Drilled Boreholes



B. Soil Bearing Capacities

Table: Bearing Capacity using SPT N - values

BH No.	SPT No.	Average Depth (m)	N-value	Allowable bearing Capacity, qa (kN/m²)
1	1	1.5	6	40
1	2	3	22	146
1	3	4.5	19	126
1	4	6	20	133
1	5	7.5	21	139
1	6	9	20	133
1	7	10.5	29	192
1	8	12	21	139
1	9	13.5	24	159
1	10	15	28	186
1	11	16.5	20	133
1	12	18	17	113
1	13	19.5	18	119
1	14	21	24	159
1	15	22.5	25	166
1	16	24	23	152
1	17	25.5	22	146
1	18	27	18	119
1	19	28.5	17	113
2	1	1.5	16	106
2	2	4.5	15	99
2	3	6	17	113
2	4	7.5	15	99
2	5	9	14	93
2	6	10.5	16	106
2	7	12	17	113
2	12	19.5	16	106
2	13	21	13	86
2	14	22.5	14	93

C. Bearing Capacity of Undisturbed Samples

Table: Bearing Capacity of Undisturbed Sample

BH No.	Average Depth (m bgl)	Cohesion (Kpa)	Internal Friction Angle (°)	Allowable Bearing Pressure (kN/m²)
1	21	31	19	134
2	4	47	17	164
2	11	24	24	138

D. Hydraulic Conductivity with the in-situ permeability test

Table: Hydraulic Conductivity

BH No.	Depth (m)	Material	Permeability, m/s
1	7.5	Clayey Shale	Impermeable
1	12.0	Sandy Shale	Impermeable
2	7.5	Clayey Shale	2.80x10-9
2	21.0	Sandy Shale	1.03x10-8

E. Summary of the Ground Conditions

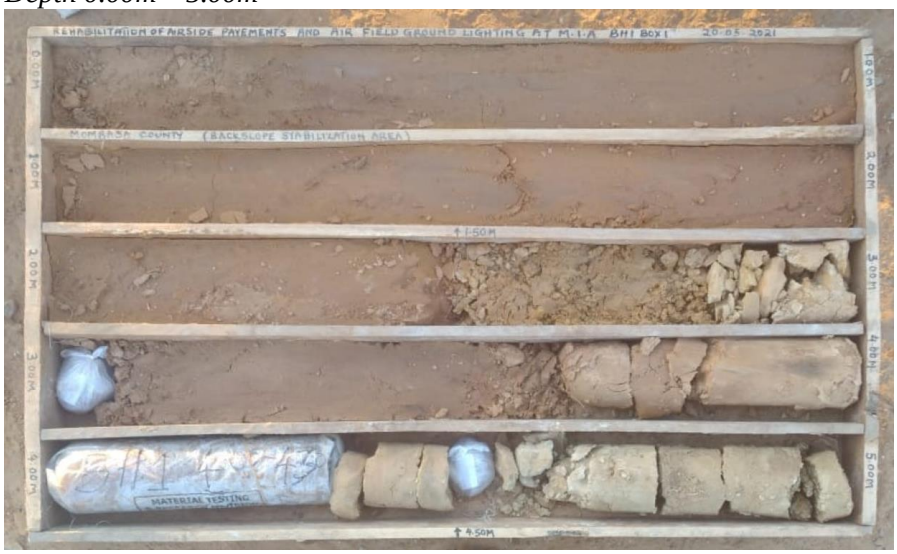
The ground structure in BH1 shows occurrence of top soil deposits of Magarini Sands overlying Clayey Shales.

In BH2 the horizons are composed of alternating residual clay and Fine Sandy Silt. The formation is open to undue settlement especially where the clay fraction is considerable in quantity. The soils in the area were established to have dumped materials with deposits of shale.

F. Photographs of Undisturbed Samples

MIA BH 1 – Drilling logs

Depth 0.00m – 5.00m

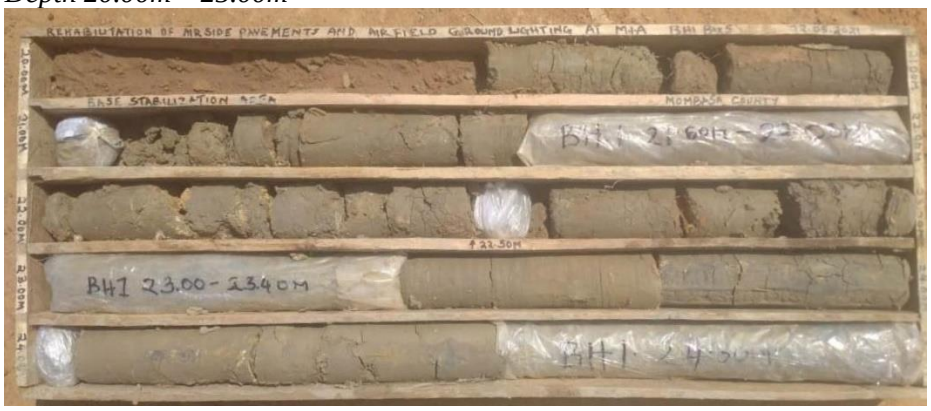


Depth 5.00m – 10.00m

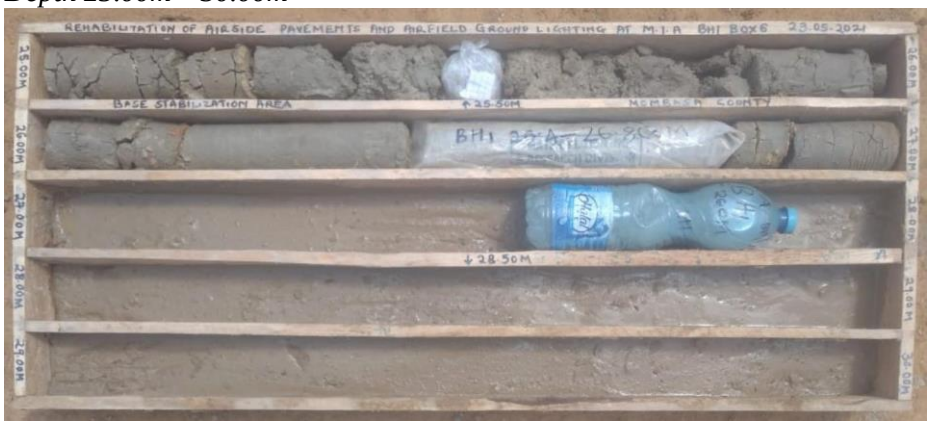
Depth 10.00m – 15.00m

Depth 15.00m – 20.00m

Depth 20.00m – 25.00m



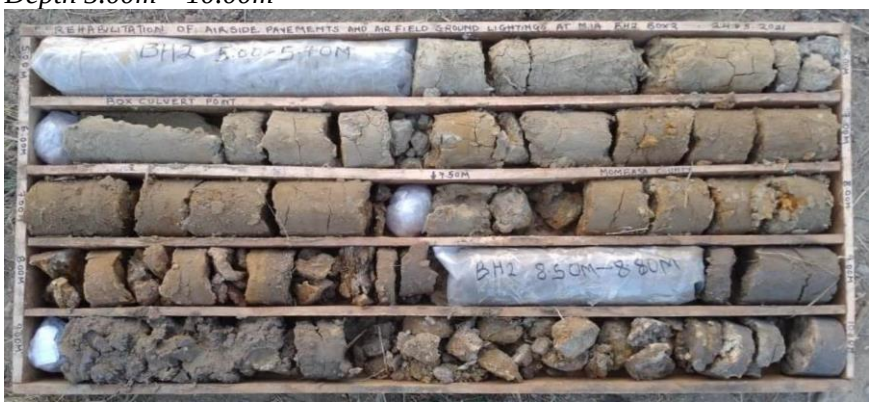
Depth 25.00m – 30.00m



MIA BH 2 – Drilling logs

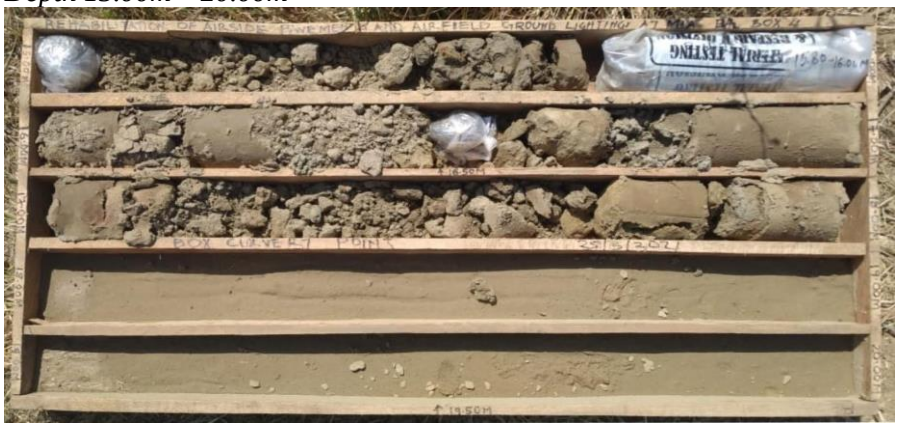
Depth 0.00m – 5.00m

Depth 5.00m – 10.00m

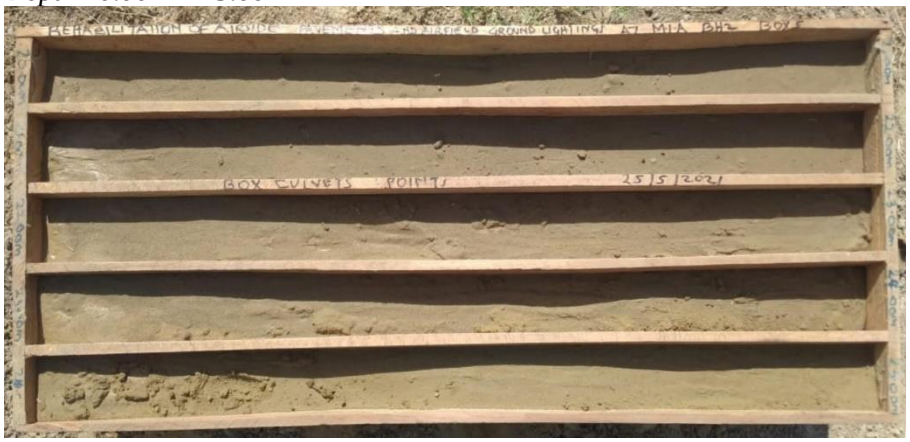


Depth 10.00m – 15.00m

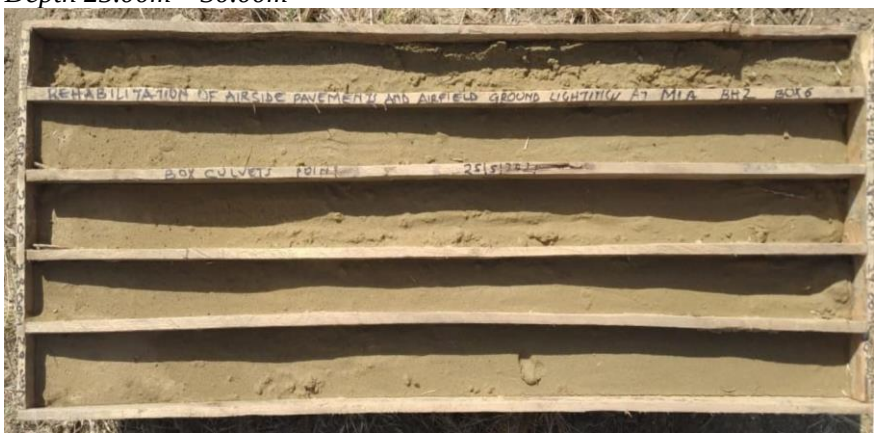
Depth 15.00m – 20.00m



Depth 20.00m – 25.00m



Depth 25.00m – 30.00m



G. Summary of Laboratory Tests

Table: Summary of Laboratory Tests

Laboratory Test Report																		
PROJECT:		**REHABILITATION OF AIRSIDE PAVEMENTS & AIRFIELD GROUND LIGHTING AT M.I.A**																**DATE: 28/07/2021**
		PLASTICITY					**GRADING**						**OEDOMETER**			**SHEAR**		
SAMPLE NO.	**DEPTH (M)**	**LIQUID LIMIT (%)**	**PLASTIC LIMIT (%)**	**PLASTIC INDEX (%)**	**LINEAR SHRINKAGE (%)**	**GRAVEL %>2mm**	**SAND % 0.006-2MM**	**SILT % 0.002-0.06MM**	**CLAY %<0.002MM**			**SPECIFIC GRAVITY %**	**COLLAPSE INDEX**	**MOISTURE CONTENT %**	**BULK DENSITY Kg/m³**	**COHESIN Kpa**	**FRICTION ANGLE Φ**	
BH 1 (BACKSLOPE STABILIZATION AREA)																		
562/21/F	3.0-4.0	NON-PLASTIC				1	88	7	4			2.64						
563/21/F	5.0-6.0	37	21	16	9	1	35	29	35			2.61	0.22	23.4	2071			
566/21/F	14.0-15.0	31	18	13	6	1	64	24	11			2.64	0.53	21.3	1984			
568/21/F	21.0-22.0	54	22	32	16	1	51	23	24			2.66	0.26	20.5	1784	31	19	
570/21/F	29.0-30.0	NON-PLASTIC				2	77	15	6			2.65						
BH 2 (BOX CULVERT AREA)																		
573/21/F	**4.0-5.0**	36	20	16	9	1	61	24	14			2.66	0.59	29	1818	47	17	
575/21/F	**11.0-12.0**	58	30	28	14	1	27	38	34			2.67	0.25	37.8	1764	24	24	
577/21/F	**15.0-16.0**	27	17	10	5	1	66	24	9			2.65	0.1	21.4	1852			
579/21/F	**23.0-24.0**	NON-PLASTIC				1	89	6	4			2.64						
580/21/F	**27.0-28.0**	NON-PLASTIC				1	95	0	4			2.62						

3.1.2 Exposure Works Methodology

A. The exposure works shall include mechanical and manual excavation. Mechanical excavation shall entail the use of specialized excavation owing to the high-water table that is throughout the year. Manual excavation shall take place within the walls of the stilling well in order not to break the concrete structures for the drainage channel.

B. The Contractor is required to commence from the downstream, to the upstream.

C. The Contractor is required to trim and form to the levels of the Construction drawings.

D. The Contractor is required to seek for a suitable dumping site to spoil the waste materials whose cost shall not be borne by the Employer.

E. The Contractor should prepare shop drawings and a construction methodology for approval by the Engineer prior to commencement of the works from an updated topographical survey.

3.3 Measurements

A. The works shall be measured net volume of the materials removed trimmed to form, hauled away to spoil. That have been executed, completed and approved works by the Engineer, and as stated in the drawings and the Bills of Quantities.

B. No extra payment shall be made to haulage to spoil.

SECTION 31 11 00.13 CLEARING, GRUBBING AND DEMOLITION

PART 1- GENERAL

1.1 Description

A This item shall consist of clearing or clearing and grubbing and the demolition and removal of structures and fences, including the disposal of all these materials, for all areas within the limits designated on the drawings or as required by the Engineer.

B Clearing shall consist of the cutting and removal of trees, stumps, brush, shrubs, anthills, logs, hedges, the removal of debris and rubbish and other loose objects or material on or projecting above the surface of the designated areas. The grubbing of stumps and roots will not be required under clearing.

C Clearing and grubbing shall consist of clearing as described above of the surface of the designated areas and the grubbing of all roots, stumps, ant nests, debris and rubbish of any nature, natural obstructions or such objects which in the opinion of the Engineer are unsuitable for the foundation of strips or pavements, or other required structures.

D Removal of structures shall consist of the demolition and removal of brickwork and concrete or steel structures, like buildings, walls, culverts, head walls, duct banks, pits, footings, foundations, etc.

E Removal of fences shall consist of the demolition and removal of existing fences, including gates, the cutting of the poles, the neatly securing of the fence material, the storage of such materials and the removal of footings and foundations.

1.2 References

A Not Applicable

1.3 Related Section

A Sections to be referred to:

1 Section 31 23 16.33: Excavation and Fill

PART 2 - PRODUCTS

A Not Applicable

PART 3 - EXECUTION

3.1 General

A The areas to be cleared or cleared and grubbed shall be staked out as per the directions of the Engineer. The clearing and grubbing shall be done at a satisfactory distance in advance of the grading operations.

B Plant and equipment for demolition and clearance work shall be of suitable types and standards.

C All spoil materials removed by clearing or by clearing and grubbing shall be disposed of by burning, when permitted by local laws, and/or by removal to approved disposal areas. Piles for burning shall be placed in adjacent open spaces where no damage to other vegetation, or other property will occur.

D The Contractor will be responsible for controlling fires in compliance with all applicable laws and regulations. He shall be particularly bound to coordinate with the Local Authorities and to follow their instructions in order to prevent the fires being misleading or dangerous. Ashes resulting from

burning shall be removed and disposed of. In no case shall any discarded materials be left in windrows or piles adjacent to or within the Site limits.

E For stripping of brush, sods, grass, topsoil etc. refer to 1 the section on Excavation and Fill of this Specification.

F The removal of existing structures and utilities shall be accomplished by the Contractor as to permit orderly progress of the work. If required, trench support and pumping shall be done.

G Any blasting necessary shall be done at the Contractor's responsibility, and the utmost care shall be taken not to endanger life or property.

3.2 Existing Structures, Cables, Pipes and Other Utilities

A Prior to the start of any clearing and/or grubbing works the Contractor shall collect all possible information on location and depth existing structures, cables, pipes and other utilities.

B All care shall be taken by the Contractor not to damage these features.

C Any damage to these features due to clearing and/or grubbing works shall be repaired at the Contractor's expense.

D Whenever any of these features is encountered and must be removed or relocated the Contractor shall advise and notify the Local Authority or owner and attempt to secure prompt action.

3.3 Clearing

A The Contractor shall clear the indicated areas of all objectionable materials and objects.

B The Contractor shall preserve and protect from injury all trees, bushes and shrubs not to be removed.

C The trees, stumps and brush that are to be removed shall be cut to a height of not more than 0.25 m above the ground.

D All cleared materials (that are not disposed of by means of burning) shall be loaded, transported and dumped in disposal areas and if so required covered with 0.3 m of soil.

3.3 Grubbing

A In areas designated to be cleared and grubbed, all stumps, roots, brush, anthills, ants-nests, buried logs, grass and other unsatisfactory objects shall be removed to a depth of at least 1 metre, if so required.

B All grubbed material (that is not disposed of by means of burning) shall be dumped in disposal areas and shall be covered with 0.3 m of soil, if so required.

C All holes remaining after the grubbing operation shall have the sides broken down to flatten out the slopes, and shall be filled with acceptable material, moistened and properly compacted in layers to the required density.

3.4 Demolition and Removal of Structures

A Any building, culvert or other structure to be removed, shall be demolished and removed, and all materials therefrom that cannot be reused shall be disposed of to spoil areas. The remnants of foundation, footings, wells, cesspools, and all such structures shall be destroyed by breaking out or breaking down, to a depth of at least 1 metre below the existing terrain level or 1 metre below finished grade level whichever is more.

B Underground services shall be disconnected before any demolition works take place. These services

shall be removed to a depth of at least 1 metre below the existing terrain level or 1 metre below finished grade level, whichever is more.

C Demolition works also include the excavation and removal of pavements necessary to clear the structures to be removed.

D All holes remaining after the removal works shall have the sides broken down to flatten out the slopes, and shall be filled with acceptable material, moistened and properly compacted as specified or instructed.

E The restoration of pavements after the removal of structures is not included in this Section.

3.5 Demolition and Removal of Fences

A Existing fences and/or gates to be removed shall be removed in such a way that the materials can be neatly stored in the indicated storage areas for possible later use.

B Wire mesh is to be cut from the poles and neatly rolled or piled up. Posts are to be cut and disposed of.

C All holes remaining after the removal works shall be treated as specified or instructed.

3.6 Disposal of Materials

A The Contractor shall during his inspection of the Site in the Tender Period, obtain approval on dumping areas where disposal of cleared materials and construction materials may take place.

B Products and materials arising from the work and to be disposed of shall become the property of the Contractor except where otherwise provided.

C Materials shall be removed from site as the work proceeds.

D Brick rubble or other hard material arising from the work may be reused after recycling, subject to the approval of the Engineer and in compliance with the specification.

E Any broken concrete or masonry which cannot be used in construction and all other materials not considered suitable for use elsewhere, shall be disposed of by the Contractor. The manner and location of disposal of materials shall be subject to the approval of the Engineer and shall not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the Site, he shall obtain and file with the Engineer, the permission in writing from the property owner for the use of his property for this purpose.

SECTION 31 22 23.13 AREA GRADING

PART 1- GENERAL

1.1 Description

A Section covers requirements for grading designated areas,

1 Outside the normal fill and excavation areas;
2 At locations and to the extent in accordance with the lines and grades as shown on the drawings or as instructed by the Engineer.

1.2 References

A Testing Requirements:

ASTM D 1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil using Modified Effort
ASTM D 2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1.3 Related Section

A Sections to be referred to:

1 Section 31 23 16.33: Excavation and Fill

PART 2 - PRODUCTS

2.1 Fill Material

A Refer to the Section for Excavation and Fill.

PART 3 - EXECUTION

3.1 General

A Total excavation / fill necessary to obtain specified graded area < 500 m3 per hectare.

B Quantities exceeding 500 m^3, to be considered as common excavation or fill.

C Disturbed or damaged adjacent areas due to Contractor's operations shall be restored at no additional cost.

3.2 Disposal of Materials

A All excavated materials shall be disposed off either:

A. In designated spoil or stockpile areas within the property boundary as indicated on the drawings or as instructed by the Engineer, or;
B. In dump areas outside the property boundary as approved by the Engineer.

B The Contractor shall obtain approval and all necessary permits and licenses for the use of dump areas outside the property boundary from the respective local authorities, taking into account environmental aspects and other requirements in force by legislation.

C Excavated materials, which have to be disposed off outside the property boundary shall become the property of the Contractor unless stated otherwise. Excavated materials to spoil shall not be temporarily stockpiled, but removed from site as the work proceeds.

D For the location and use of spoil and stockpile areas within the property boundary the Contractor shall

obtain approval from the Engineer.

E Excavated materials, which have to be disposed off or stockpiled within the property boundary shall remain or become the property of the Owner or the Employer unless stated otherwise.

F The Contractor shall set-out and clearly mark all approved spoil and stockpile areas within the property boundary. Before dumping of the excavated materials can commence the Contractor shall, at his own expense, clear said areas and take elevations in sufficient detail for submission to and approval by the Engineer.

G During the course of the grading operations all excavated materials dumped in spoil or stockpile areas within the property boundary shall be evenly spread out and compacted with all slopes dressed uniformly and properly drained.

H The surface levels of spoil and stockpile areas in its final state shall not extend more than 200 mm above the ground levels of the adjacent area unless instructed otherwise.

3.3 Surface Level Tolerances

A. Surface level tolerances shall be as per Table 1. The finished level tolerances are in relation to design levels.

B. Level deviation in excess of tolerances shall be corrected by loosening, removing or adding materials, spreading and re-compacting by sprinkling and rolling.

3.4 Compaction Requirement and Tolerances

A Compaction shall be as per Table 1 in this section

B Field densities tests shall be determined in accordance with ASTM D 1557 in combination with ASTM D 1556 or ASTM D 2922.

Table 1: Field Densities and Finished Levels

Finished Ground Level of Graded Areas in:	**Minimum Test Area (m^2)**	**Field Density (%MDD at OMC)**	**Finished Ground Level Tolerances (mm):**
Runway Safety Areas (Strip, Overrun, Blastpad)	1,000	As per Section Excavation and Fill	-20 / +20
All other Areas	1,000	As per Section Excavation and Fill	-20 / +20

SECTION 31 23 16.33 EXCAVATION AND FILL

PART 1- GENERAL

1.1 Description

A This Section specifies the general earthworks requirements, classifications of excavation, soil and geosynthetic filter fabrics, compaction requirements and construction methods for excavation and spoiling, and placing of fill, including a pioneer layer, spoiling, all of which shall conform to the dimensions and typical sections shown on the drawings.

B Where this section refers to structures, it shall mean small structures only, such as one-storey buildings and drainage structures, unless specified otherwise.

1.2 References

A Testing Requirements:

ASTM D 1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory compaction characteristics of soil using modified effort
ASTM D 2487	Classification of soils for engineering purposes
ASTM D 2922	Density of soil and soil-aggregate in-place by nuclear methods
ASTM D 4318	Atterberg Limits (LL, PL and PI)

1.3 Related Sections

A Sections to be referred to:

1	Section 31 11 00.13	Clearing, Grubbing and Demolition
2	Section 32 91 19.13	Topsoil Placement and Grading

1.4 Definitions

A “Fill": The material used for the purpose of filling a depression or raising a site to the required level, excluding the material used for topsoil, if any.

B "Subgrade": The uppermost material located in the fill structure or in unmoved excavation areas immediately below pavement constructions or under structures.

C "Formation Level": The surface level of the ground in its final shape after completion of earthworks (excavation and placing of fill), before placing structures, laying pavements or top soiling.

D “Compaction”: The densification of a soil by means of mechanical manipulation. The insitu soil dry densities expressed as a percentage of the maximum dry density (MDD) at optimum moisture content (OMC), as per the specified laboratory test method.

E “Aircraft Pavements”: Pavements where ground maneuvering of aircraft takes place, such as runways, taxiways, aprons, hangar floors, including blast pads, stopways, overruns and shoulders. Pavements intended to serve aircraft towing tractors shall be considered as aircraft pavements as well.

F “Aircraft Safety Areas”: Unpaved areas intended to protect aircraft in the event of an aircraft running off the aircraft pavements, such as the graded portion of the runway strip and taxiway strips.

G “Road Pavements”: Pavements intended to serve vehicles other than aircraft and aircraft towing tractors.

H There will be no distinction in classification of material between Soft, Intermediate and Hard material. The contractor will be required to assess the material quality and classification as only one rate for excavation and fill for all material at the Moi International Airport construction site.

1.5 General Requirements

A Material from specified excavations, acceptable for fill construction, shall be used in specified fill areas, as indicated on the drawings.

B When the volume of acceptable materials from specified excavations is not sufficient for specified fill, the deficiency shall be obtained from borrow areas/locations approved by the Engineer.

C All material declared unacceptable for fill operations and all surplus material shall be disposed of in spoil areas as instructed.

D The Engineer shall have final control over the excavation, stockpiling, placing of fill, spoiling, transport and deposition and shall determine the acceptability of material to be used in fill areas.

E All over-excavation, over-break or over-blasting beyond designated excavation limits, the Contractor shall replace in an approved manner at his own expense.

F When the Contractor's excavating operations encounter artefacts of historical or archaeological significance, the operations shall be temporarily discontinued and the Engineer shall be consulted for further action.

G All operations of the Contractor in connection with transport, deposition and spoiling shall be approved by the Engineer and the appropriate authorities.

PART 2- PRODUCTS

2.1 Soil Classification

A This classification of soil is based on suitability for use in the construction of fill under pavements and structures. The ASTM version of Unified Soil Classification System (ASTM D 2487) is used for this purpose.

B "Suitable materials" shall include materials assigned with group symbols GW, GP, GU, GM, GC, SW, SP, SU, SM, SC.

C "Unsuitable materials" shall include materials assigned with group symbols CL, ML, OL, CH, MH, OH, PT.

2.2 Materials

A Suitable materials shall be used for fill under pavement and structures.

B CL and ML materials may be used for fill under pavements and structures subject to the following conditions:

1 At a depth of 3.0 m or more below the formation level, provided that the Plasticity Index of the fill material is less than 25.
2 At a depth of 1.0 m or more below the formation level, provided that the Plasticity Index of the fill material is less than 10.

C Unsuitable materials assigned as CL, ML, OL, MH and CH may be used for fill outside (future) pavements or structures, like backfill of borrow pits, subject to the approval of the Engineer.

D Unsuitable materials, when approved by the Engineer as suitable to support vegetation, may be used for the top soiling in accordance with the Section “Topsoil placement and grading” of these Specifications.

2.3 Geosynthetic Filter Fabric

A The geosynthetic filter fabric shall be used as indicated on the drawings, both below and above the pioneer rock layer.

B The filter shall be constructed of woven polypropylene mat or non-woven sheet of continuous filaments of spun bounded polypropylene.

C The filter shall not be affected by bacteria, natural acids, salts or alkali or by ultra-violet light after exposure to direct sunlight during one month. It shall have good resistance to rot, moisture, mildew and insects and show no wet shrinkage or stretching. The size of the openings in the mat or sheet shall be determined on the basis of the subsoil that should be prevented to pass.

D The filter shall have the following characteristics: EOS < 1 , in which D(15)

EOS = equivalent opening size. In a sieve test shall be determined, what grain size of a standard sand will be allowed to pass the filter. The equivalent opening size is equivalent to the grain size of which 5 per cent in weight of the material is able to pass the filter.
D (15) = grain size from the distribution curve of the subsoil material for which 5 per cent in weight of the grains have a smaller diameter than D (15).

E The filter shall have a permeability that is greater than the permeability of the subsoil in the final situation.

F Filters made of other materials, such as polyamide, or polyester may be used, provided the filter characteristics are the same as for the polypropylene filter.

G The filter material shall be supplied to the site on rolls, properly protected during transport and storage against ultra violet light.

H The permeability of the various subsoils shall be tested in the laboratory in accordance with ASTM D653. The permeability of the filter shall be tested in the field laboratory or by the manufacturer. Certificates provided by the manufacturer, indicating amongst other things the permeability of the filter, will be acceptable, but the Engineer has the right to required tests at the site.

PART 3- EXECUTION

3.1 Equipment

A The Contractor may use any type of earth-moving, compaction and watering equipment he may desire or has at his disposal, provided the equipment is in satisfactory condition and of such capacity that the construction schedule can be maintained and that the specified quality can be obtained.

3.2 Preparatory Works

A Prior to any earthworks operations, the Contractor shall make his own survey consisting of classification and distribution, investigation of material to be excavated, preparation of the cross-sections and measurements of the existing ground surface, and shall inform the Engineer with the results.

B Such survey shall be recorded and signed as agreed by the Engineer and the Contractor and shall form the basis for quantity measurements of material to be excavated, borrowed, filled and spoiled.

C Failing such surveys and the agreements being signed by the Contractor, the surveys of the Engineer shall be final and binding upon the Contractor.

D Excavation or placing of fill in any area shall not start unless the area is completely cleared and grubbed in accordance with the Section "Clearing, Grubbing and Demolition" of these Specifications.

3.3 Protection of Works

A If it is necessary to interrupt existing surface drainage, sewers, underdrainage, conduits, utilities, or similar underground structures or parts thereof, then the Contractor shall be responsible for and shall take all necessary precautions to protect and preserve them or provide temporary replacements. The Contractor shall notify the Engineer when such facilities are encountered. The Contractor shall at his own expense satisfactorily repair and pay the cost of all damage to such facilities or structures which may result from any of his operations or from negligence during the period of the contract.

B The Contractor shall keep earthworks free of water including:

1 Arranging for the rapid removal of water either shed on to the earthworks or entering the earthworks from any source;
2 Lowering and maintaining by appropriate measures the water level in excavations, sufficiently to enable the earthworks to be constructed.
3 In carrying out these requirements the Contractor shall:
   a) Form and maintain excavation and fill areas with appropriate falls and gradient and sealed surfaces;
   b) Provide where necessary temporary watercourses, drains, pumping and the like;
   c) Discharge accumulated water and ground water into the permanent outfalls of the drainage system where practicable;
   d) Provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

C Ditches constructed on the project shall be maintained to the required cross-section and kept free from debris or obstructions. Any erosion damage shall be repaired until the Works are handed over.

D The Contractor shall be responsible for the stability of all fill structures made under the Contract and shall replace any portion which, in the opinion of the Engineer, has become displaced due to carelessness or negligence on the part of the Contractor.

3.4 Compaction Requirements

A All earthworks shall at least be compacted to a depth and to a minimum compaction rate as specified in Table 1 in this section

B The rate of compaction is expressed as a relationship in terms of a percentage between the in-situ density and the maximum dry density (MDD) at optimum moisture content (OMC).

C The in-situ soil density shall be determined in accordance with ASTM D1556 or ASTM D2922 and the maximum dry density (MDD) shall be determined by ASTM D1557 (modified proctor procedure "C") and ASTM D 698 (standard proctor procedure "C").

D Nuclear density tests as per ASTM D2922 are only allowed when a satisfactory laboratory calibration can be made and when the Contractor is authorised to operate the nuclear equipment.

E Field compaction control using sensors mounted on compaction equipment is also acceptable, provided the Contractor has established the proper correlation with test methods specified above and has demonstrated the integrity of the system to the satisfaction of the Engineer.

F Field density test shall be made at least once per lot of 2,500 m2 of compacted layer. A test lot will be approved if the average value of 4 random field density tests is above the specified compaction and no single value is more than 2% below the specified compaction. Additional field density test shall be made when, in the opinion of the Engineer, the need for further compaction control arises.

Table 1: Earthworks Compaction Requirements

Area	Applicable to compaction of Excavation Areas and Fill		Applicable to Compaction of Fill Only	
	Test Method for MDD	**Subgrade / Formation Level**	**All Fill Except Subgrade**	**Existing Ground Below Fill**
Aircraft Pavements	ASTM D 1557	95% MDD to 500 mm depth	90% MDD	90% MDD
Aircraft Safety Areas	ASTM D 1557	90% MDD at formation level		85% MDD
Road Pavements	ASTM D 1557	95% MDD to 300 mm depth		90% MDD
Small Structures	ASTM D 1557	90% MDD to 300 mm depth		90% MDD
Other Areas	ASTM D 698	85% MDD at formation level		85% MDD

3.5 Stockpiling

A Any materials to be stockpiled shall remain the property of the Employer.

B Well in advance of the earthworks operations, the Contractor shall in close coordination with the Employer identify areas for stockpiling in the vicinity of the work site.

C Material, intended to be stockpiled, shall be placed in layers of about 1m in loose depth and compacted by rolling with 3-4 passes of a suitable roller. Stockpile should be shaped to shed water and sited to avoid potentially water-logged areas. The areas adjacent to stockpile which have been disturbed by the Contractor shall be graded and put into condition acceptable for seeding or planting, if required.

D The Contractor shall ensure that he does not adversely affect the stability of excavations or fills by his methods of stockpiling material. Temporary stockpile locations on site, for acceptable material, shall be determined by the Engineer.

E Temporary stockpiling of acceptable material, re- excavation of stockpiled material, transport and deposition in fill areas shall not be measured and not be paid for separately but shall be deemed to be included in the unit rates for specified excavation items.

3.6 Excavation Classification

A This classification is based on difference in equipment, tools, use and sources and locations where the excavations take place.

B "Unclassified Excavation". Unclassified excavation shall consist of the excavation, transport and deposition of all material, regardless of its nature, which is not classified under one of the following items.

C “Muck Excavation”. Muck excavation shall consist of the excavation, transport and deposition of soils and organic matter not suitable for subgrade or for fill structures. Muck shall include peat, roots, humus, stumps or other material not satisfactory for incorporation in embankment or fill structures.

D "Rock Excavation". Rock excavation shall consist of the excavation, transport and deposition of all solid rock in ledges, in bedded deposits, in unstratified masses and conglomerate deposits that are so firmly cemented that they cannot be removed without blasting. All boulders containing a volume of more than 0.5 cubic metres will be classified as "Rock Excavation".

E "Rippable Excavation". Rippable excavation shall consist of the excavation, transport and deposition of material which cannot be excavated without ripping by a tractor mounted rippers or rooters

F “Topsoil Excavation”. Topsoil excavation shall consist of the stripping, transport and deposition of existing topsoil from areas and to the thickness as explicitly indicated on the drawings as topsoil

excavation.

G "Drainage Excavation". Drainage excavation shall consist of the excavation, transport and deposition of the materials carried out for the primary purpose of drainage and includes drainage ditches such as intercepting, inlet, outlet, or any other type explicitly shown on the drawings as drainage excavation.

H "Borrow Excavation". Borrow excavation shall consist of the excavation, transport and deposition of approved material required for the construction of fill or for other portions of the work in excess of the quantity of acceptable material available from specified excavations on the site. Borrow material may be obtained from areas within or outside the airport property.

3.7 Excavation Construction Methods

A If not specified otherwise, the excavation item(s) shall include excavation, transport of the material and deposition in fill or spoil areas.

B Where excavation reveals a combination of suitable and unsuitable materials, as specified in Clause 2.1 the excavation shall be carried out in such a manner that both materials are excavated separately.

C Except in locations where it is to be left in place as instructed by the Engineer, the existing topsoil shall be stripped from all areas of excavation and from all areas to be covered by fill structures, to depths as instructed by the Engineer.

D Requirements for stripping of the existing topsoil are specified in Section “Topsoil placement and grading” of these Specifications.

E Muck, peat, matted roots or other selected subsoil which is not acceptable for subgrade shall be excavated to the depth as instructed by the Engineer.

F The cuts and the top of the areas under pavements (subgrade) and outside pavements in excavation shall be formed to the lines and levels as indicated on the drawings and compacted as specified in Clause 3.2 of this Section.

G Rock, loose rock, boulders and other material unacceptable for subgrade shall be excavated to an extra depth of minimum 250 mm below the top of the subgrade (the formation level) or as instructed by the Engineer.

H The extra depth, that results due to rock removal or excavation of other unacceptable material, shall be refilled with approved fill material, obtained from the specified excavation and shall be compacted as specified.

I All loose or protruding rocks on the back slopes of the cuts shall be barred loose, or otherwise removed to the line of finished grade or slope.

J Blasting, when necessary, will be permitted only when the operations are approved by the Engineer, all permissions are obtained (appropriate authorities) and proper precautions have been taken for the protection and safety of all persons, the work and the property. All damage done to the work or property shall be repaired at the Contractor's expense. Any approval given will not relieve the Contractor of his responsibility in blasting operations.

K Areas within the airport property where borrow excavation takes place shall be indicated in the drawings. They will only be available after a written agreement from the Engineer has been obtained.

L When sources for borrow excavation are outside the airport property, it shall be the Contractor's responsibility to locate the source and obtain the required permits, subject to the approval of the Engineer.

M The Contractor shall notify the Engineer sufficiently in advance of the beginning of borrow excavation so that necessary measurements and tests can be made.

N All borrow pits shall be opened up to expose the vertical face of various strata of acceptable material, to enable obtaining a uniform product. All work involved with clearing, stripping and removal of unacceptable materials from borrow pits shall be performed by the Contractor at his own expense. Borrow pits shall be excavated to regular lines to permit accurate measurements and shall be drained and left in a neat and presentable condition with all slopes dressed uniformly.

O All suitable material from drainage excavation shall be placed in specified fill areas and unsuitable material shall be used, for top soiling purposes or disposed of, as instructed.

3.8 Fill Construction Methods

A If not specified otherwise, placing of fill item shall include the spreading, watering, disking, mixing, aerating, grading, (re)compaction and levelling of material delivered from specified excavations, intended for construction of the fill structures, except spoiling.

B All roots, debris, large stones, muck, peat, existing topsoil or other yielding or objectionable materials that would cause interference with the compaction of fill shall be removed from the area to the extent and to the depth as specified in Section "Clearing and Grubbing "of these Specifications.

C Except in locations where it is to be left in place as instructed by the Engineer, the existing topsoil shall be stripped from areas to be covered by fill structures, according to requirements specified in Section "Topsoil placement and grading" of these Specifications.

D The area shall then be surface compacted as specified in Table of this Section.

E In fill areas, layer placement shall begin in the lowest portion of the fill structure. As placement progresses, layers shall be constructed approximately parallel to the finished pavement grade line.

F Fill structures shall be constructed with acceptable material, as specified, placed in successive horizontal layers of not more than 200 mm in loose depth, for the full width of the cross section, unless otherwise approved by the Engineer.

G The grading operations shall be conducted, to produce a soil structure as shown on the typical cross section or as directed. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the fill structure.

H Stones or fragmentary rocks larger than 100 mm in their greatest dimension shall not be allowed in the top 150 mm of the fill structure.

I The material in the layers shall be within ± 2% of the optimum moisture content before rolling to obtain the specified compaction. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer may be required. Should the material be too wet to permit proper compaction or rolling, all work on all of the affected portions of the fill structure shall be delayed until the material has dried to the required moisture content. Sprinkling of dry material to obtain the proper moisture content shall be done with approved equipment that will satisfactorily distribute water. Sufficient equipment to furnish the required water shall be available at all times.

J Compaction areas shall be kept separate and no layer shall be covered by another layer until the proper density is obtained. Rolling operations shall be continued until all layers are compacted to not less than the specified compaction.

K Any areas inaccessible to a roller shall be compacted by mechanical tampers.

L During construction of fill the Contractor shall route his equipment at all times, both when loaded and when empty, over the layers as they are placed and shall distribute the traffic evenly over the entire width of the fill.

M Fill operations shall be suspended at any time when satisfactory results cannot be obtained because of

adverse weather or other unsatisfactory conditions in the field.

N Tests shall be taken at specified intervals. Based on these tests the Contractor shall make corrections and adjustments in work method or moisture content in order to achieve the specified compaction.

O Any area found to lack the required compaction shall be further re-compacted or watered and/or scarified, or otherwise manipulated as the Engineer may instruct, until the specified compaction is obtained.

3.9 Spoiling

A The Contractor shall during his Site inspection in the Tender Period, contact the Employer to obtain information regarding the destination of unacceptable materials and surplus materials. These materials remain the property of the Employer unless the Employer transfers his ownership to the Contractor.

B Unacceptable materials and surplus materials that are released by the Employer shall become the property of the Contractor. They shall not be spoiled or stockpiled on site and shall be removed off the airport property.

C The Contractor shall make his own arrangements with other public agencies, the municipality or private companies or landowners for the spoiling of unacceptable and surplus materials that became his property.

D Topsoil material, if required, shall be stockpiled at approved locations, further specified in Section "Topsoil placement and grading" of these Specifications.

E The surface elevation of spoil areas shall not extend above the surface elevation of adjacent area. The spoil material shall be placed/spoiled and compacted to a reasonable density as instructed by the Engineer. All spoil areas shall be graded to allow positive drainage of the area itself and of adjacent areas. If required, the spoil area and adjacent area shall be put into condition acceptable for seeding or planting.

3.10 Tolerances

A In those areas upon which any pavement construction is to be placed, the top of the subgrade shall not vary from the design levels by more than 15 mm. The finished levels shall be determined by taking levels in a grid of 10 by 10 metre or less. A lot will be accepted for grade if not more than 10 percent of the measurements exceed the specified tolerance, but are less than 20 mm.

B In areas outside pavement constructions the top of the formation shall not vary from the design levels by more than 25 mm. The finished levels shall be determined by taking levels in a grid of 20 x 20 metres or less. A lot will be accepted for grade if not more than 10 percent of the measurements exceed the specified tolerance, but are less than 40 mm.

C The size of a lot shall be between 2,500 – 5,000 m^3.

D Any deviation in excess of the above tolerances shall be corrected by reshaping and re-compaction of the material.

3.11 Pioneer Layer

A An initial layer, known as a pioneer layer consisting of rock fill material, shall be constructed over a weak roadbed where selected material is used to provide a stable platform for the construction of subsequent layers.

B This rock fill shall be constructed across water-logged or soft clayey ground exhibiting excessive movement under normal compaction equipment and haulage trucks, and such conditions preclude the effective compaction of the bottom fill layers, in particular in the vicinity of the runway extension.

C The maximum size of rock which may be used in rock fill is 200 mm. The engineer may prescribe that 5% of the oversize material shall be bladed off after the material has been dumped, and it shall be disposed of as required. The compacted layer shall not contain any rock fragments the largest dimension of which exceeds the thickness of the compacted layer.

D This layer shall be constructed by successive loads of suitable coarse material being dumped and spread in a uniform layer with a thickness just sufficient to provide a stable working platform for constructing the further fill layers which are to be compacted to a controlled density.

E Light hauling equipment shall be used, and, where necessary, end tipping for placing the material and the layer shall be compacted by light compaction equipment being used, which will give the most effective compaction without the roadbed being overstressed.

G The compacted volume of material used may be determined by 70% of the loose volume in trucks being taken as an alternative to taking cross-sections before and after construction.

H Rock fill shall be brought up in layers not exceeding 600 mm and every effort shall be made to fill the voids with the finer material to form a dense, compact mass.

I Each (rock) layer shall be levelled and smoothed with suitable grading equipment and by distribution of spalls and finer fragments of rock.

J Density requirements will not apply to portions of fill structure constructed of materials which cannot be tested in accordance with specified methods (like rock fill).

3.12 Roadbed Preparation

A Any part of the roadbed which is classified as being suitable for use in situ, save that it fails to meet density requirements, shall be scarified, watered and compacted to a percentage of modified AASHTO density. The type of compaction and the depth of compaction shall be as directed by the engineer. If necessary, roadbed material may have to be temporarily bladed off to windrow in order to achieve the necessary depth of compaction.

B Where any additional material has to be imported to obtain the required level and layer thickness, and where the thickness of the layer of imported material would be less than the specified layer thickness after compaction, then the roadbed material shall be scarified, the necessary imported material placed, and this combined material mixed and compacted to the full specified depth of the layer. The imported material shall be measured and paid for under "Cut and borrow to fill"

3.13 Gravel Wearing Course

A The gravel wearing for the re-aligned perimeter fence road course shall comply with the following specifications:

PARAMETER	LIMIT	
	TYPE 1	TYPE 2
Maximum size, mm	37.5	37.5
Oversize index (I_o) (maximum), %	5	0
Shrinkage product (S_p)	100 - 365	100 - 240
Grading coefficient (G_c)		16 - 34
CBR at □ 95% modified AASHTO Compaction	16 - 34	
(soaked value) (minimum), %	15	15
I_o =	Oversize index (per cent retained on 37.5 mm sieve) Linear shrinkage x (per cent passing 0.425 mm sieve)	
S_p =	(Per cent passing 26.5 mm - per cent passing 2.0 mm) x per cent passing 4.75 mm/100	
G_c) =		

B The gravel wearing course shall be compacted to 95% of modified AASHTO density.

3.13 Grading

A The existing service road running parallel to Runway 03/21 and Taxiway-A shall be re-graded with the bituminous milling waste and other excavations materials (gravel) to all weather and to tie into the taxiways and runway shoulder edge levels.

B This re-grading shall be maintained by the contractor in a safe trafficable condition. Whenever required by the engineer, the grading shall be done by means of self-propelled road graders to provide a smooth riding surface free from corrugations. All potholes shall be repaired immediately.

C The engineer may also instruct the contractor to water the temporary deviations to keep down dust or to facilitate the proper blading of the surface. All drainage works shall be maintained in a good working order.

SECTION 31 23 33.13 TRENCHING AND BACKFILL

PART 1 - GENERAL

1.1 Description

A. Section covers requirements for trenching,

1 Consisting of excavation in any material and backfill of trenches with sand and suitable fill material, compaction and disposal of surplus material and restoring ground surface to its original state;
2 For the purpose of laying underground cabling, water mains and sewage lines;
3 At locations and to the extend and details as shown on the drawings or as instructed by the Engineer.

1.2 References

A. Not Used

1.3 Related Section

A. Sections to be referred to:

1	Section 31 23 16.33	Excavation and Fill
2	Section 32 11 16.19	Selected Fill, Drainage Layer
3	Section 31 32 13.16	Cement Soil Stabilization for Backfill
4	Section 03 31 13.13	Structural Concrete and Blinding Concrete

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 Excavation

A trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed.

B Graders, scrapers or bulldozers shall not be used to excavate the trench.

C The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, trenches shall be excavated to a minimum depth of 0.75 m below finished grade for AFL and RC cables and 1 m for HV, LV, water mains and sewage lines.

D When rock excavation is encountered, the rock shall be removed to a depth of at least 0.8 m below finished grade. Rock excavation shall consist of the removal of boulders and detached rock ½ cubic metre in volume or greater, and of all rock in place in ledges or masses which can be removed only by the use of bars and sledges or by blasting.

E Before any rock is removed the Engineer shall have the opportunity to obtain the necessary data to determine the quantity.

F he Contractor shall excavate all trenches to a width not less than 0.3 m. The trench shall be widened, as directed by the Engineer, where more than two cables are to be installed parallel in the same trench.

G At all times during construction, the trenches shall be kept free of standing water.

3.2 Excavation Near Existing Facilities

A These trenches shall be excavated manually in order to avoid damages to existing cables and utilities.

B Any damage to existing cables or utilities shall immediately be reported to the Engineer and the relevant Authorities, and shall be promptly repaired or replaced by the Contractor at his own expense and in a manner and with materials as required by the Engineer or the Authorities.

C If the Authorities require that the repair of damaged cables or utilities shall be carried out by their own workmen or by other Contractors, then the Employer shall be entitled to recover from the Contractor the cost thereof or may deduct the cost from any payment due or that become due to the Contractor.

D Special attention shall be paid to the sections of existing cables, which have to remain in use or be re-used for intermediate power supply upon completion of the works. Therefore, the Contractor shall determine the exact location of these cables, whether indicated on the drawings or not, before starting any of his operations in a particular area.

3.3 Backfill, Protection and Disposal of Surplus Material

A The cables to be laid on a first layer of backfill of sand or earth free from clay or silts or particles larger than 4 mm, to a depth of at least 0.1 m or as indicated on the drawings. The next layer or layers shall contain all cables as shown on the drawings and shall be of the same material. The above-described layers shall be lightly to moderately compacted.

B The remainder of the backfill shall not contain particles larger than 30 mm diameter and shall be placed in layers not exceeding 0.2 m and shall be compacted to the density as required for embankments in unpaved areas and paved areas in the relevant sections.

C Protective cement concrete tiles shall be used for all trenches or certain trenches, to be minimum 40 mm thick and of a uniform size and placed covering cables with an overwidth of 100 mm, and over the full trench length as indicated on the drawings, on top of the layers of sand fill, containing the cables. The tiles shall be pre-fabricated; the concrete shall be structural concrete in accordance with the requirements of the Section for Structural Concrete and Blinding Concrete.

D After the first layer of this backfill, a vividly coloured polythene identification tape such as ”Heptape”, or a plastic net such as "Plyage" or similar shall be placed 0.3 m above the cables for the full width of the trench, colour is to be “Red”.

E The tolerance of backfill is +25 / -25 mm.

3.4 Bedding

A Wherever the use of fine granular material is specified in this section for the bedding of culverts, it shall mean sand or other cohesionless material, all of which shall pass through a 6,70 mm sieve and not more than 10% of which shall pass through a 0,15 mm sieve.

B Selected Granular Material, Selected Fill Material and Common Fill Material shall be as specified the other specifications and drawings.

3.5 Separation Distances between Utilities

A Separation distances between cables and utilities in the same trench conform to the requirements as shown on the drawings.

3.6 Cleaning of Site

A. All areas disturbed by the trenching, storing of dirt, cable laying, pad construction, and other work shall be restored to its original condition. The restoration shall include any necessary top soiling, seeding or planting

SECTION 31 36 00 WIRE MESH GABIONS [AND MATTRESSES]

PART 1 - GENERAL

1.1 Description

A. This guide specification covers the requirements for the procurement and installation of steel wire mesh gabion and mattress units used as a measure of protection against erosion forces of stream flow in water courses and slope instability.

B. The work under this specification includes furnishing, assembling, filling and tying open wire mesh rectangular compartmented gabions [and mattresses] placed on a prepared surface of [filter material] [geotextile], [geotextile and filter materials], as specified, and in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

C. Gabions [and mattresses] are wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable, monolithic structures. Gabions [and mattresses] shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid, which is produced separately from the base. The supply to the jobsite of unassembled individual wire mesh components (panels) forming gabions [and mattresses] will not be permitted.

D. Definitions of terms specific to this specification and to all materials furnished on the jobsite, with the exception of the rock to fill the baskets and the filter material, shall refer and be in compliance with ASTM A975 for double twisted wire mesh Gabions[and Revet mattresses], or with ASTM A974 for welded wire fabric Gabions[and Gabion Mattresses]. [For ease of reference, the term "mattress" will be used in this specification in place of Revet mattress and/or Gabion mattress, where the statement is of general nature and it is not specific to the double twisted or welded wire mesh products.]

E. Payment will be made for costs for filter material, including furnishing, hauling, placing, and maintenance of the filter layers until placement of the gabion [and mattress] cover is completed and accepted. No payment will be made for excess thickness of filter layers or for material required to replace material lost by rain wash, wind erosion, or otherwise, except for additional filter material ordered in writing

1.2 Measurement

A. The Engineer will measure the quantity of geogrid in square meters. The Engineer will not measure geogrid when the contract indicates that the geogrid are incidental to the work being performed or when no separate bid item for geogrid is listed in the proposal. The Engineer will not measure providing the geogrid manufacturer’s representative for payment and will consider it incidental to the geogrid work.

1.3 References

A. 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 A313/A313M (2013) Standard Specification for Stainless Steel Spring Wire
ASTM A370 (2016) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A428/A428M (2010; R 2014) Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A641/A641M (2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A764 (2007; R 2012) Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A809 (2008; R 2013) Standard Specification for Aluminum-Coated (Aluminized) Carbon Steel Wire

ASTM A853 (2004; R 2010)	Standard Specification for Steel Wire, Carbon, for General Use
ASTM A856/A856M(2003; R 2014)	Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire
ASTM A90/A90M (2013)	Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A974 (1997; R 2011)	Standard Specification for Welded Wire Fabric Gabion and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)
ASTM A975 (2011)	Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly (Vinyl Chloride) (PVC) Coating)
ASTM B117 (2016)	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C136/C136M (2014)	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C33/C33M (2016)	Standard Specification for Concrete Aggregates
ASTM D1499 (2013)	Filtered Open-Flame Carbon-Arc Type Exposures of Plastics
ASTM D2240 (2015)	Standard Test Method for Rubber Property - Durometer Hardness
	ASTM D412 (2015a) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D5312/D5312M (2012; R 2013)	Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM D638 (2014)	Standard Test Method for Tensile Properties of Plastics
ASTM D746 (2014)	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D792 (2013)	Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM G152 (2013)	Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

1.4 Definitions

1.4.1 Rate of Aggressiveness

A. The determination of the rate of aggressiveness (non-aggressive, moderately, or highly aggressive) shall be made on a project-to-project basis, due to the many variables involved and the lack of criteria of general validity. It is normally recommended for the choice to be based on all the available data and on the experience of existing gabion structures in similar environments.

1.4.2 Double Twisted Wire Mesh Gabions [and Mattresses]

A. Classified according to the wire coating, which is applied prior to manufacturing the mesh. Coating styles are as follows:

Style 1: Wire mesh made from wire which is zinc coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for:

Permanent: Gabion [or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unaltered over time.

Temporary: Gabion [or mattress] structures, for works in moderately aggressive environments, depending on the minimum design life of the structure.

Style 2: Wire mesh made from wire which is coated with Zn-5Al-MM before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from Zn-5Al-MM coated wire. Style 2 for the wire coating is normally recommended for:

Permanent: Gabion [or mattress] structures, for works installed in moderately aggressive environments.

Temporary: Gabion [or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

Style 3: Wire mesh, lacing wire, and stiffeners as Style 1 and overcoated with PVC. Fasteners shall be of stainless-steel wire. Style 3 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

Style 4: Wire mesh made from wire which is aluminum-coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from aluminum-coated wire. Style 4 for the wire coating is very seldom used in the gabion industry. Its life expectancy shall be adequately documented to guarantee its consistency and reliability.

1.4.3 Welded Wire Fabric Gabions [and Mattresses]

A. Classified according to wire coating styles as follows:

Style 1: Welded wire fabric made from wire which is zinc coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for temporary gabion [or mattress] structures, for works in non-aggressive or non-polluted environments.

Style 2: Welded wire fabric which is made from uncoated wire and the fabric is subsequently zinc-coated after fabrication. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 2 for the wire coating is normally recommended for permanent gabion [or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unchanged over time

Style 3: Welded wire fabric made from wire which is coated with zinc-5 percent aluminum- mischmetal alloy (Zn-5Al-MM) before being welded into fabric. Spiral binders, lacing wire, and stiffeners are also produced from zinc-5 percent aluminum-mischmetal alloy (Zn-5Al-MM) coated wire. Style 3 for the wire coating is normally recommended for:

Permanent Gabion [or mattress] structures, for works installed in moderately aggressive environments.

Temporary: Gabion [or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

Style 4: Welded wire fabric made from wire which is aluminum-coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are also produced from aluminum-coated (aluminized) wire. Style 4 for the wire coating is very seldom used in the gabion industry. Its life expectancy shall be adequately documented to guarantee its consistency and reliability.

Style 5: Welded wire fabric, spiral binders, lacing wire, and stiffeners as Styles 1, 2, 3, or 4, and overcoated with PVC. Style 5 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

1.5 Submittals

A. Submittal procedure under section 01 33 00.13 shall be followed strictly.

1.6 Quality Assurance

A. Furnish samples of materials used to fabricate the gabions or mattresses to the Engineer 60 days prior to start of installation. Samples will be tested in accordance with specification and either ASTM A974 or ASTM A975 depending on which system is being furnished by the Contractor. The Engineer

reserves the right to test additional samples to verify the submitted test records at the Project's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

1.7 Delivery, Storage, and Handling

A. Gabions [and mattresses] shall be delivered with all components mechanically connected at the production facility with the exception of the mattress lid, which is produced separately from the base]. All gabions [and mattresses] are supplied in the collapsed form, either folded or bundled or rolled, for shipping. Bundles are banded together at the factory for ease of shipping and handling. [Mattress bases and lids may be packed in separate bundles].

1 Mattress lids may be supplied either as individual units (bundled) or in roll form. Lacing wire shall be shipped in coils with a diameter of the coil approximately 0.60 m. Fasteners shall be shipped in boxes. Preformed stiffeners shall be shipped in bundles.
2 Deliver gabions [and mattresses] to the jobsite labeled in bundles. Labels show the dimensions of the gabions [or mattresses] included, the number of pieces and the color code.

PART 2-PRODUCTS

2.1 Materials

A. Double Twisted Wire Mesh Gabions [and Mattresses] type 3 or Welded Wire Fabric Gabions [and Mattresses] type 5

B. The use of the most appropriate Style for the wire coating in double twisted and welded wire gabions [and mattresses] is determined by the minimum required design life of the structure in relationship with the aggressiveness of the surrounding environment (air and water quality)

2.1.1 Double twisted wire mesh Gabions [and Mattresses]

A. Double twisted wire mesh gabions [and mattresses] shall be Style 3 manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion [and mattress] sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A975 (Tables 1, 3, 4, 5, 6, and Sections 9). Gabions [and Mattresses] shall meet the following test requirements:

1 Metallic Coating: The coating weights shall conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].
2 PVC for Coating: The PVC coating shall show no cracks or breaks after the wires are twisted in the fabrication of the mesh. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:
   - Specific Gravity: In the range from 1.30 to 1.35 N/m³, when tested in accordance with test method ASTM D792
   - Tensile Strength: Not less than 20.6 MPa when tested in accordance with test method ASTM D412
   - Modulus of Elasticity: Not less than 18.6 MPa when tested in accordance with test method ASTM D412
   - Hardness: Shore "D" between 50 and 60, when tested in accordance with test method ASTM D2240
   - Brittleness Temperature: Not higher than -9 degrees C, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.
   - Resistance to Abrasion: The percentage of the weight loss shall be less than 12 percent
   - Salt Spray Exposure and Ultra Violet Light Exposure: The PVC shall show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC shall show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C 145 degrees F,

when tested in accordance with practice ASTM D1499 and ASTM G152

- Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test: After the salt spray test and exposure to ultraviolet light, the PVC coating shall not show cracks nor noticeable change of color, or blisters or splits. In addition, the specific gravity, tensile strength, hardness and resistance to abrasion shall not change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values

3 Wire Tensile Strength: The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with Test Methods and definitions ASTM A370, shall be in accordance with the requirements of [ASTM A641/A641M (Style 1)], [ASTM A809 (Style 4)], and [ASTM A856/A856M (Style 2)], for soft temper wire.

4 Mesh Strength and Panel to Panel Joint Strength: The minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A975 Section 13.1, shall be as shown in Table 1. The strength values reported in kN/m are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. The same number of wire revolutions or ring spacing shall be used in the field installation. Pleating the based panel to obtain internal panels is prohibited.

Table 1: Minimum Strength Requirements of Mesh and Connections

Test Description	**Gabions, metallic coated**	**Gabions, PVC coated**	**[Revet mattresses] (metallic and PVC coated)**
Tensile strength parallel to twist	51.5 kN/m	42.3 kN/m	33.6 kN/m
Tensile strength perpendicular to twist	26.3 kN/M	20.4 kN/M	13.1 kN/M
Connection to selvedges	20.4 kN/m	17.5 kN/m	10.2 kN/m
Panel to panel (using lacing wire or ring fasteners)	20.4 kN/m	17.5 kN/m	10.2kN/m
Punch Test	26.7 kN	23.6kN	17.8 kN

2.1.2 Welded Wire Fabric Gabions [and Mattresses]

A. Welded wire fabric gabions[and mattresses] shall be Style 5 manufactured with a welded wire mesh composed of a series of longitudinal and transverse steel wires arranged substantially at right angles to each other, and welded together at the points of intersection by electrical resistance welding to form fabricated sheets. Gabion [and mattress] sizes, wire diameters, mesh opening sizes, physical properties of the PVC for coating, and tolerances shall comply with the requirements of ASTM A974 (Tables 1, 2, 3, and Sections 9). Gabions [and Mattresses] shall meet the following test requirements:

1 Metallic Coating: The coating weights shall conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].

2 PVC for Coating: PVC adhesion test shall be PVC coating shall show no cracks or breaks after the wires are twisted in the fabrication of the mesh. The initial properties of the PVC coatingon the wire and welded wire fabric shall have a demonstrated ability to conform to the following requirements:

- Adhesion: The PVC coating shall adhere to the wire such that the coating breaks rather than separates from the wire, in accordance with test method ASTM A974 Section 13.3;
- Mandrel Bend: The PVC-coated wire when subjected to a single 360 bend at -18 degrees C 0 degrees F around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating;
- Specific Gravity: In the range from 1.20 to 1.40 N/m3, when tested in accordance with test method ASTM D792;
- Tensile Strength: Not less than 15.7 MPa when tested in accordance with test method ASTM D638;
- Modulus of Elasticity: Not less than 13.7 MPa at 100 percent strain, when tested in accordance with test method ASTM D638;
- Hardness: Shore "A" not less than 75, when tested in accordance with test method ASTM

D2240;

- Brittleness Temperature: Not higher than -9 degrees C, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.
- Resistance to Abrasion: The percentage of the weight loss shall be less than 12 percent;
- Salt Spray Exposure and Ultra Violet Light Exposure: The PVC shall show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC shall show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C, when tested in accordance with practice ASTM D1499 and ASTM G152;
- Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test: After the salt spray test and exposure to ultraviolet light, the PVC coating shall not show cracks nor noticeable change of colour, or blisters or splits. In addition, the specific gravity, tensile strength, hardness and resistance to abrasion shall not change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values.

3 Wire Tensile strength: The tensile strength of the wire used for the welded wire fabric, spiral binders, lacing wire and stiffeners shall be soft medium in accordance with ASTM A641/A641M (Style 1), ASTM A856/A856M (Style 3), and ASTM A809 (Style 4) or hand drawn in accordance with ASTM A853 (Style 2). The cross-sectional area of the test specimen shall be based on the diameter of the metallic coated wire. All the wires used in the fabrication of gabions [and mattresses] must use the same temper wire in accordance with given order.

4 Weld Shear Strength: Minimum Average Shear Value: The minimum average shear value in Newtons pounds-force shall be 70 percent of the breaking strength of the wire or as indicated in the table as follows, whichever is greater, when tested in accordance with ASTM A974 Section 13.4. Typical minimum average shear strengths as specified are as follows:

Table 2: Minimum average shear strength values for the welded mesh

Wire diameter, mm	Min. Av. Shear Strength, N	Min. Shear Strength, N
2.20	1300	1000
2.70	2100	1600
3.05	2600	2000

B. The material shall be deemed to conform with the requirements for weld shear strength if the average of the test results of the first four specimens or if the average of the test results for all welds tested comply with Table 2.

C. Panel to Panel Joint Strength: The minimum strength of the joined panels, when tested as described in ASTM A974 Section 13.5, shall be as follows:

Table 3: Panel to panel joint strength for welded gabions

Test Description	Gabions, metallic coated (kN/m)	Gabions, PVC coated (kN/m)	[Revet mattresses] (metallic and PVC coated) (kN/m)
Connection to selvedges	20.4	17.5	10.
Panel to panel (using lacing wire or ring fasteners	20.4	17.5	10.

D. The strength values reported in kN/m are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire used. The same number of wire revolutions shall be used in the field installation.

2.1.3 Testing

A. Test records made within one year by certified laboratories to determine the acceptability of the fastening system. Samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records shall be submitted at least 60 days in advance to the Engineer for approval. The Engineer reserves the right to test additional samples to verify the submitted test records at the Project's expense. When the first test results indicate that the fasteners do not meet the

specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.3 Stone Fill

A. For gabions [and mattresses], the ability to function properly depends upon their stability, which is partly depending upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions [or mattresses]. The rock has also to withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Rock to fill gabions [and mattresses] shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

B. Delivery: Deliver rock to the work site in a manner to minimize its reduction in sizes (breakdown) during the handling of the rock, and place and secure within the assembled and interconnected gabion [or mattress].

C. Sources: The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. The inclusion of more than 5 percent by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in Table 4.

D. Properties: Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure..

E. Stone Quality: Stone fill, crushed stone, shall meet the quality requirements of ASTM C33/C33M, and freezing and thawing requirements of [ASTM D5312/D5312M][COE CRD-C 144] for the region of the United States in which the structure will be constructed.

F. Gradation: Gradation of stone for gabions shall be performed every 1000 tons placed under this contract in accordance with ASTM C136/C136M. Sizes of rock to fill gabions and mattresses are chosen on the basis of the mesh sizes, the structure's thickness, and within the limits shown in Table 4 Within each range of sizes, the rock shall be large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of 5 percent oversize rock by weight, or 5 percent undersize rock by weight, or both.
   - Oversize Rock: In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each gabion compartment[and two or more layers of rock within each mattress compartment dependent upon the height of the mattress].
   - Undersize Rock: In all cases, undersize rock shall be placed within the interior of the gabion or mattress compartment and shall not be placed on the exposed surface of the structure. There shall be a maximum limit of 5 percent undersize or 5 percent oversize rock, or both, within each gabion[or mattress] compartment. The required rock gradation is reported in Table 4.

Table 4 Required rock gradation for gabions [and mattresses

Type of Structure	**Thickness/Height (mm)**	**Rock Sizes (mm)**
[Mattresses]	170	75 -130
[Mattresses]	230	75 -130
[Mattresses or] Gabions	300	100 - 200
Gabions	500 or higher	100 -200

2.1.4 Filter Material

A. The material shall meet the quality requirements of ASTM C33/C33M for the region in which the structure is located. The gradation test shall be performed in accordance with ASTM C136/C136M. Filter material shall consist of sand and gravel or crushed stone, well graded between the prescribed limits and the Filter fabrics shall meet the provisions of Section 31 05 22 Geotextiles Used as Filters.

PART 3-EXECUTION

3.1 Foundation Preparation

A. After excavation or stripping, to the extent indicated on the drawings or as directed by the Engineer, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the Engineer shall inspect the prepared foundation surface, and no material shall be placed thereon until that area has been approved.

3.2 Filter Placement

A. Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Engineer, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods, which will tend to segregate particle sizes, will not be permitted. Any damage to the foundation surface during the filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

3.3 Assembly and completion

A. The assembly and completion shall be in accordance with the Manufacture requirements.

SECTION 31 62 13 PILING WORKS

PART 1 – GENERAL DESCRIPTION

A. This item shall consist of piling in accordance with the provisions of this special specification and in reasonably close conformity with the Drawings and or/as directed by the Engineer.

B. This item shall include construction of reinforced concrete piles cast in bored holes drilled with the use of special equipment. It shall include the excavation and drilling of holes, furnishing and placing of temporary and/or permanent steel casing and all other incidentals necessary for the execution of work. Pile construction shall be at locations, dimensions and lengths indicated on the drawings, in accordance with this Specification and /or as directed by the Engineer.

C. The Contractor shall without added compensation, increase the pile lengths to provide for fresh heading and for such additional lengths as maybe necessary to suit the Contractor's method of operation.

PART 2 – PRODUCTS

2.1 Description

A. This item shall consist of either plain or reinforced structural cement concrete, and blinding concrete, prepared and constructed in accordance with this specification at the locations and of the form and dimensions shown on the drawings.

B. The Concrete shall be composed of coarse aggregate, fine aggregate, Portland cement, and water and a desired strength of Class 30/20 all as prescribed under the Section 03 of the Technical Specifications and the drawings by the Engineer.

C. The use of appropriate additives to assure mix consistency shall be allowed at the Engineer's discretion provided that air entraining is not enhanced. A retarder of proven adequacy and approved by the Engineer shall be used to ensure that early hardening of concrete during tremie operations will not occur.

D. Casings which are required to be incorporated as part of the permanent work shall conform to AASHTO Ml 83 (ASTM A-36) or JIS G3101 (SMA 400W).

E. Liner plates for deep foundation piles shall conform to JIS G 3101 (SS330) or approved equivalent.

F. The contractor shall be required to undertake comprehensive survey and prepare shop drawings before commencement of construction of the works.

PART 3 – EXECUTION

3.1 Construction Requirement

A. All reasonable precautions shall be taken to prevent damage to existing structures and utilities. The measures shall include but are not limited to, selecting construction methods and procedures that will prevent excessive caving of the bored hole, monitoring and controlling the vibrations from the driving of casing or sheeting or drilling of the pile.

B. All foundation excavation in which bored piles are to be constructed shall be completed before any drilling begins unless otherwise approved by the Engineer. Where bored piles are to be installed in conjunction with embankment placement, it shall be constructed after the placement of the fill unless shown on the Drawings. Other excavations shall not be carried out close to boreholes for piles not concreted, nor close to piles, which have been cast recently, which could be damaged by the adjacent work.

C. General Methods and Equipment: Excavation for bored piles shall be earned out by mechanical methods; blasting and compressed air method shall not be used unless permitted by the Engineer. Excavation shall be performed through whatever materials are encountered to the dimensions and elevations shown on the Drawings or ordered by the Engineer. The methods and equipment shall be suitable for the intended purpose and materials encountered. Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed. Mineral Slurry may be used in the drilling process to prevent caving during drilling of holes and the placement of concrete.

The stability of excavations for bored piles shall be maintained where necessary by:

i) Temporary Casings or Permanent Casing

The bottom of casings shall be kept sufficiently deep (into the freshly cast concrete) to prevent the inclusion of soil into the casing.

The casings, whether temporary or permanent shall be free from significant distortion, shall be free from internal projections, and encrusted concrete, which may prevent proper formation. The inside of casings shall be cleaned and all loose materials removed before placing concrete.

Temporary casing, when used in drilling operations, may be left in place or removed from the hole as concrete is placed. The bottom of the casing shall be maintained to not more than 1.5m or less than 0.3m below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer. Separation of the concrete during withdrawal operations shall be avoided by vibrating the casing.

ii) Excavations

The bottom elevation of the bored pile shown on the Drawings may be adjusted during construction if the Engineer determines that the foundation materials encountered during drilling is unsuitable or differs from what was assumed in the design of the drilled shaft.

The Contractor shall take soil samples or rock cores when required by the specification or as directed by the Engineer to determine the character of the material directly below the shaft excavation. The Engineer will inspect the samples or cores to determine the final depth or required shaft exaction.

Excavations shall not be carried out close to piles which have been executed but not concreted, or close to piles which have been cast recently and which contain concrete which would be damaged by adjacent work.

Excavation materials which are removed from the hole excavation and any drilled fluid used shall be disposed of in accordance with the special provisions or as directed by the Engineer.

iii) Slurry

The slurry to be used in drilling process shall be mineral slurry. The slurry shall have both a mineral grain size that will remain in suspension with sufficient viscosity and gel characteristic to transport material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. The level of the slurry shall be determined at a height sufficient to prevent caving of the hole.

The mineral slurry shall be premixed thoroughly with clean fresh water and adequate time allotted for hydration prior to introduction into the drilled hole. Adequate slurry tanks will be required when specified or as directed by the Engineer. No excavated slurry pits will be allowed when slurry tanks are required on the project without written permission of the Engineer. Adequate de-sanding equipment will be required when specified or as directed by the Engineer. Steps shall be taken as necessary to prevent the slurry from “setting up” in the shaft excavation,

such as, agitation, circulation and adjusting the properties of the slurry.

Sand content shall not exceed 4 percent (by volume) at any point in the shaft excavation as determined by the American Petroleum Institute sand content test.

Test of determine density, viscosity and Ph values shall be done during the drilling to establish a consistent working pattern.

Prior to placing concrete in the bored pile, slurry samples shall be taken from the bottom and at intervals not exceeding 3 meters for the full height of slurry. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be eliminated. The mineral slurry shall be within specification requirements immediately before placement of bored pile concrete.

D. Reinforcing Steel Cage and Subsequent Concrete Works

The reinforcing steel cage as shown on the Drawings plus the cage stiffener bars, spacers, centralizer and other necessary appurtenance shall be completely prefabricated and placed as a unit immediately after the shaft excavation is inspected and accepted and prior to shaft concrete placement.

Prefabricated reinforcement cages for piles shall be marked and fitted with spacers to ensure that the cage is correctly oriented and positioned within the pile. When concrete is place by tremie methods, temporary hold down devices shall be used to prevent uplifting of the steel cage during concrete placement.

i) Concrete Placement, Curing and Protection

Concrete shall be place as soon as possible after the reinforcing steel cage has been installed and permission of the Engineer has been obtained. Concrete shall be placed without interruption until the complete pile is concreted. Placement shall continue after the shaft is full until good quality concrete is evident at the top of the shaft. Concrete shall be cast in place through a tremie or concrete pump.

Concrete deposited in water shall have a minimum cement content of 400kg/m3 of concrete. The slump of the concrete shall be maintained between 10 and 20cm. To prevent segregation, the concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump- bucket, or other approved means, and shall not be disturbed after being placed.

The concrete mix shall be of such design that concrete remains in workable plastic state throughout the placement period. Temporary casings which are in contact with the bored pile concrete and which are not withdrawn before the initial set of the concrete has occurred shall be left in place. When the top pile elevation is above ground, the portion of the pile above ground shall be formed with a temporary or permanent casing when specified.

For at least 48 hours after pile concrete has been placed, no construction operations that would cause soil movement adjacent to the shaft, other than mild vibration, shall be carried out unless permitted by the Engineer.

ii) Construction Tolerances

The following construction tolerances shall be maintained in the construction of bored piles:

1) The bored pile shall be within 50 mm of the plan position in the horizontal plane at the plan elevation for the top of the shaft.
2) The vertical alignment of the drilled hole shall not vary from the plan alignment by more than 10 mm per meter.
3) After all the pile concrete is placed, the top of the reinforcing steel cage shall be no more than 150 mm above and no more than 75 mm below plan position.
4) The top elevation of the pile shall be within 25 mm of the plan top of pile elevation.

5) The bottom of the shaft excavation shall be normal to the axis of the pile within 60 mm per meter of pile diameter.
6) When casing is used, its outside diameter shall not be less than the shaft diameter shown on the Drawings. The diameter of cast in-site piles shall be at least 97% of the specified diameter.

E. Boring and Working Records

Bored pile records shall be kept by the Contractor and a signed copy handed to the Engineer at the end of each day of drilling. Pile records shall take the form given in the below.

Daily Record for Slopes Stabilization Reinforced Concrete Piles						
Pile Record Sheets for Each Pile						
	Block Number		Drawing Number			
General	Pile Ref. No.		Pile Día		Level of Base	
			Under Ream Día			
	Ground Level		Cut off level		Concrete Level	
Drilling	Date Started		Date Completed		Air Temp	
	Error in Position on plan		Error in Plumb		Depth Bored	
Obstructions Natural Unnatural	Type		Depth Encountered		Penetration Time	
	Type		Depth Encountered		Penetration Time	
Steel mains Steel links or Helix	No. of Bars		Diameter		Length	
	Centers of Bars/Pitch		Diameter		Cover to All Steel	
Concrete	Date Started		Date Completed		Concrete Temp.	Quality
	Mix		Slump		Supplier	
Borehole soil and Rock Excavation	Depth of soil	Description	Depth of Rock	Description of Rock	Depth of Rock Augured	Depth of Rock Chiseled
Casing	Depth of Temporary Casing					
	Depth of Encountered					
Water	Depth to Strong Flow		Details of Strong Flow		Details of Remedial Measures	
	Depth to Strong Flow					

Table 1: Boring and Work Records Form

3.2 Testing

A. The completed bored pile shall be subjected to non-destructive testing to determine the extent of any defects that may be present in the pile. Integrity- testing method to be adopted shall be cross hole sonic logging integrity testing in accordance with ASTM D 6760, subject to the approval of the Engineer.

3.3 Reporting

A. The testing shall be carried out by the Contractor using an engineer with specialized experience in this field and shall be approved and work under the Engineer's. Prior to integrity testing all apparatus shall be calibrated to ensure that precise and reliable data be obtained. Certificate of calibration shall be submitted unless otherwise waived by the Engineer.

B. `The Contractor shall submit a report on the integrity testing containing vital information necessary for the pile evaluation, prescribed in ASTM D5882. Such report shall be submitted within seven days after the completion of each test.

C. If and when necessary, as determined after evaluation of the integrity of the pile subjected to the test, the Engineer may require further test or dictate pile repair or replacement, depending on the seriousness of the defect that may be established for piles that need to be repaired, the Contractor shall submit for the approval of the Engineer, remedial measures he intends to implement. Otherwise, a new pile to be constructed adjacent to the failed test pile.

D. For rejected piles, the Contractor shall make a proposal for review and approval of the Engineer. Such proposal shall include the necessary design calculations, the methodology he intends to implement, equipment and other items as may be necessary. Approval of these proposals however does not relieve the Contractor of contractual responsibilities for any defects as a result of the proposals. The cost of further tests required, remedy and measures and replacement of rejected piles shall be borne by the Contractor

3.5 Method of Measurement and Payment

A. Measurement under this item shall be the sum of the actual lengths in meters of piles cast and left in-place in the completed and accepted work. Measurements will be from the pile tip to the bottom of the pile cap or pier coping or as shown on the drawings.

B. Portions of piles cast deeper than the required through over-drilling will **not be measured for payment**.

C. The accepted quantities as determined above shall be paid for at the contract unit price in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing and placing all materials, including all labor, equipment, tools, reinforcement, steel caging, and incidentals and reporting necessary to complete the work and as further stated in the Bills of Quantities.

D. The payment shall be deemed to include full compensation for all additional materials and work not shown on the Drawings or specified, which are necessary to complete the work and to be measured against the prescribed Bill Items. These include the other composite slope stabilizing measures such as stone filled gabion boxes, mattresses, stone pitching, vegetation covering etc.

E. The payments for tests shall be as instructed by the Engineer. Other tests measurement under this item e.g. (Pile integrity test and or load dynamic test) shall be the number of piles tested and accepted. Any incidentals not otherwise described hereto are considered subsidiary to the work item and shall not be paid for separately.

32 – EXTERIOR IMPROVEMENTS

SECTION 32 05 43.13 AVAILABILITY OF MATERIALS

PART 1- GENERAL

1.1 Description

A. The Contractor shall be clearly aware of the fact that supply of fine and coarse aggregate for fill, base course, asphalt and structural concrete, etc. is entirely his responsibility.

B. For as far as materials are required in excess of those from suitable specified excavations, the Contractor shall make his own arrangements to acquire land for quarries and borrow areas at his own expense.

C. Long hauls to reach acceptable quarries may be necessary to obtain high quality aggregates.

D. In addition to other sections of this Specification, areas within the project boundary fence will not be available for quarries or borrow unless a written agreement from the Engineer is obtained.

E. Material taken from these quarries or borrow pits within the site may be free of charge.

F. Calcareous materials such as limestone, etc shall not be used in combination with brackish or salt construction water.

SECTION 32 05 53.13 CONSTRUCTION WATER

PART 1-GENERAL

1.1 Description

A. Section includes: supplying suitable water for use in:

1 Existing sub-grade - moistening and compaction;
2 Embankment and fill layers - moistening and compaction;
3 Aggregate base courses - moistening and compaction;
4 Cement treated base courses and soil cement - mixing and curing;
5 Portland cement concrete and mortar - mixing and curing.

B. Sourcing and supplying suitable water shall be the Contractor's responsibility.

C. Acquiring suitable water: no payment for purchase and hauling or for any other provisions.

2.2 References

A. Testing Requirements:

AASHTO T 26	Quality of Water to be used in Concrete ASTM C 109 Compressive Strength of Hydraulic Mortars
ASTM C 191	Time of Setting of Hydraulic Cement by Vicat Needle B Material Specification Requirements:
ASTM C 150	Portland Cement

2.3 Related Sections

A. Sections to be referred to:

1	Section 03 31 13.13	Structural Concrete and Blinding Concrete
2	Section 32 13 13.26	Portland Cement Concrete Pavement

PART 2- PRODUCTS

3.1 Construction Water

3.1.1 Quality

A. Water for embankment, fill layers, sub-grades and aggregate base courses:
a) clear, free from injurious amounts of oil, sugar, acid, clay, silt, strong alkalies or vegetable matter;
b) pH value : ≥ 5.
c) In addition, brackish water may be used for the same work items, but with: salinity: < 1,0 %, provided that, aggregates used shall not contain water soluble solids exceeding 3 % by weight.

B. Water for soil cement and cement treated base courses:
a) clear, free from injurious amounts of oil, sugar, acid, clay, silt, strong alkalies or vegetable matter;
b) salinity : < 0.5 %;

d) pH value : > 5;
e) chlorides : maximum 5,000 ppm (mg/l);
f) sulphate : maximum 3,000 ppm (mg/l).

C. Water for Portland cement concrete and mortar:

a) fresh, clear, free from injurious amounts of oil, acid, alkali, sugar, deleterious mineral or organic matter;
b) salinity : < 0.2 %;
c) pH value : > 5;
d) no impurities in sufficient amounts to cause discoloration of the concrete.

D. In addition:

a) Water for non-reinforced or mass Portland cement concrete:
- chlorides : maximum 2,000 ppm (mg/l);
- sulphate : maximum 1,000 ppm (mg/l).

b) Water for reinforced Portland cement concrete:
- chlorides : maximum 1,000 ppm (mg/l);
- sulphate : maximum 500 ppm (mg/l).

c) Water not to contain impurities in sufficient amounts to cause:
- change in time of setting for Portland cement: > 25 %,
- as initial setting time according to ASTM C 191;
- reduction in compressive strength of mortar: > 10 %,
- according to test method ASTM C 109 for the types of cement and for the ages shown in Table 3 of ASTM C 150,
- as compared to same tests executed and results obtained with distilled water.

E. Water known to be of potable quality may be used without testing.

F. Related Sections

Figures for chlorides and sulphate content in water for concrete mentioned in Clause 2.1.A.3 are indicative. For total allowable chloride and sulphate content in concrete mixes, refer to the respective paragraphs in the Sections for:

1 Portland Cement Concrete Pavement;
2 Structural Cement Concrete and Blinding Concrete

PART 3 – EXECUTION

3.1 Construction Water

A Before start of the works, Contractor to submit to Engineer for approval a source and supply of water, its suitability, composition and intended application.

B Contractor to ensure for adequate and continuous water supply and storage during period of construction.

SECTION 32 31 13.53 HIGH-SECURITY CHAIN LINK FENCES AND GATES

PART 1 -GENERAL

1.1 Description

A This item covers the requirements for furnishing materials and constructing fences and gates in accordance with the details included herein and shown on the drawings.

B The type of fence to be erected shall be chain-link fencing as shown on the applicable drawing.

C The contractor shall include all supplementary parts necessary or required for a complete and satisfactory installation within the true meaning and intent of the drawings.

D All runs of the fence shall present the same general appearance and the product of one manufacturer only will be accepted, except for items which do not influence the appearance of the completed fence.

E No used, rerolled, or open seam steel shall be permitted.

F The posts and supports shall be constructed in accordance with the details included herein and/or as shown on the drawings or as directed by the Engineer.

G Included in the item are connections to buildings or existing fences and the provision of electrical grounds.

1.2 References

A. General requirement

ICAO Annex 14 – Volume 1 : Chapter 9.10, page 9-15 BMaterial Requirements:
ASTM A 121 Metallic-Coated Carbon Steel Barbed Wire ASTM A 153Zinc Coating (hot-dip) on Iron and Steel hardware ASTM B 117 Practice for Operating Salt-Spray Apparatus
ASTM F 1043 Strength and Protective Coating on Steel Industrial Chain Link Fence Frame Work
ASTM F 1083 Pipe, Steel Hot-Dipped Zinc-Coated Welded for Fence Structures
ASTM G 152 Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
ASTM G 153 Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non- Metallic Materials
ASTM G 154 Operating Fluorescent Light Apparatus for UV Exposure of Non-Metallic Materials
ASTM G 155 Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
Fed. Spec. RR-F-191/3 Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)

1.3 Related Section

A. Sections to be referred to:

1. Section 03 31 13.13 - Structural Concrete and Blinding Concrete

PART 2 – PRODUCTS

2.1 Materials

A. The fabric shall be a woven with a 9-gauge PVC-coated steel wire in a 50 mm mesh and shall meet the requirements of ASTM F 1043, Class 2b.

B. Barbed wire shall be 2-strand twisted 2.5 mm thick zinc-coated steel wire with 4-point barbs of 2 mm zinc-coated steel wire and shall conform to the requirements of ASTM A 121, Class 3, Chain Link Fence Grade. The barbs shall be spaced approximately 120 mm. The minimum weight of zinc-coating shall be 150 gram per square metre. The wires shall be spaced as shown on the drawings or as directed by the Engineer.

C. Wire fabric ties and wire ties shall be 3 mm galvanized steel wire and PVC coated. Tension wire shall be 4 mm galvanized steel wire and PVC coated.

D. Line posts, rails and braces shall conform to the requirements of ASTM F 1043 or ASTM F 1083 as follows:

1. Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.
2. Roll Formed Steel Shapes (C-Sections) shall conform to the requirements of Group IIA, and be galvanized in accordance with the requirements of F 1043, Type A.
3. Hot-Rolled Shapes (H Beams) shall meet the requirements of Group III, and be galvanized in accordance with the requirements of F 1043, Type A.
4. Aluminum Pipe shall conform to the requirements of Group IB.
5. Aluminum Shapes shall conform to the requirements of Group IIB.
6. Vinyl or polyester coated steel shall conform to the requirements of ASTM F 1043, Paragraph
7. 7.3 Optional Supplemental Colour Coating.
8. Composite posts shall conform to the strength requirements of ASTM F 1043 or ASTM F 1083. The strength loss of composite posts shall not exceed 10 percent when subjected to 3,600 hours of exposure to light and water in accordance with ASTM G 152, ASTM G 153, ASTM G 154, and ASTM G-155.

E. Posts, rails, and braces furnished for use in conjunction with aluminum alloy fabric shall be aluminum alloy or composite.

F. Posts, rails, and braces, with the exception of galvanized steel conforming to F 1043 or ASTM F 1083, Group 1A, Type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B 117 as follows:

- External: 1,000 hours with a maximum of 5% red rust.
- Internal: 650 hours with a maximum of 5% red rust.

G. The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Fed. Spec. RR-F-191/3.

H. Gate frames shall consist of galvanized steel pipe and shall conform to the specifications for the same material under Clause 0. Gates may be filled with security mesh fence welded to the pipes or consist of top and bottom rails with vertical bars. The fabric shall be of the same type material as used in the fence.

I. Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A 153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

J. Zinc-coating on gates, gate posts, supports, fittings and other structural steelware shall be of a minimum weight of 450 gram per square metre.

K. Concrete shall be in accordance with Section Structural Concrete and Blinding Concrete, using 25 mm maximum coarse aggregate.

PART 3- EXECUTION

3.1 General

A. The fence shall be constructed in accordance with the requirements of the Engineer and as specified herein, with new materials and all work shall be performed in a workmanlike manner satisfactory to the Engineer.

B. Prior to the beginning of the work, the Contractor shall locate the position of the work by establishing and marking the fence line. At locations of small natural or drainage ditches where it is not practical for the fence to conform to the general contour of the ground surface, the Contractor, when directed, shall use longer posts and strands of barbed wire stretched thereon to span the opening below the fence, vertical clearance between wire shall not be more than 0.15 m.

C. The new fence shall be permanently tied to the terminating points or existing fences whenever required by the Engineer.

D. The finished fence shall be plumb, taut, true to line, and ground contour, and complete in every detail.

E. When directed, the Contractor shall be required to stake down the chain-link fence at several points between the posts.

F. To keep stock on adjoining property enclosed at all times, the Contractor shall arrange the work so that construction of the new fence will immediately follow removal of existing fence.

G. The unfenced section shall be of such length that the livestock can be kept in the proper field. The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence.

H. Openings in the fence shall be guarded when livestock is in the adjoining property.

3.2 Clearing Fence Line

A. The site of the fence shall be sufficiently cleared of obstructions, and surface irregularities shall be graded so that the fence will conform to the general contour of the ground.

B. The fence line shall be cleared to minimum width of 1 metre on each side of the center line of the fence.

C. This clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions which will interfere with proper construction of the fence. The clearing must be within the airport boundaries.

D. Stumps within the cleared areas of the fence line shall be grubbed or excavated.

E. The bottom of the fence shall be placed at a uniform distance above the ground as specified by the Engineer.

F. As directed by the Engineer, existing fences which coincide with, or are in a position to interfere with the new fence location shall be removed by the Contractor as a part of the construction work.

G. Holes remaining after stump and post removal shall be refilled with suitable soil, gravel, or other material subject to the acceptance of the Engineer and shall be properly compacted with tampers.

H. The work shall include the handling and disposal of all material cleared, excavated or removed, regardless of the type, character, composition, or condition of such material encountered.

I. Performance of the work under this clause shall be considered as a subsidiary obligation of the Contractor covered under the item "Chain-Link Fence".

J. Grading operation exceeding fill or excavation layers of 0.15 m thickness shall not be considered as normal grading.

K. If so ordered by the Engineer, fill or excavation exceeding the 0.15 m shall be carried out by the Contractor.

3.3 Installing Posts and Supports

A. All posts shall be spaced as shown on the drawings.

B. Line and corner posts and supports shall be set in concrete bases as shown on the drawings. The top of the base shall be slightly above the ground surface, trowel finished, and sloped to drain.

C. Holes of full depth and size for the concrete bases for posts shall be provided.

D. The concrete bases shall be allowed to cure for 7 days before top rails, tension wire and fabric are installed.

E. Should rock be encountered at a depth less than the planned footing depth, a hole 50 mm larger than the greatest dimension of the posts shall be drilled to a depth of 300 mm.

F. After the posts are set, the remainder of the drilled hole shall be filled with grout, at Contractor's expense.

G. If top rails are required, an expansion coupling shall be placed at approximately 30 metres intervals to take care of expansion and contraction of the rail.

H. All corner and support posts etc. shall be braced as shown on the drawings.

I. Support posts shall be set at approx. 100 metres intervals and braced as shown on the drawings.

3.4 Installing Barbed Wire and Tension Wire

A. All barbed wire and tension wire shall be placed on the side of the posts away from the airport or as directed by the Engineer, at the height indicated on the plan.

B. The wire shall be carefully stretched and hung without sag and with true alignment. Care shall be taken not to stretch the wire so tightly that it will pull up corner, support and gate posts.

C. All wires shall be fastened securely to each post by fasteners or clips designed for use with the posts furnished.

D. The wires shall be wrapped around end, corner and gate posts, and the ends of all horizontal wires shall be tied with snug, tight twists.

E. The wires shall be secured to each post to prevent slipping out of line or becoming loose.

F. Splices in barbed and tension wire shall be permitted if made with an approved galvanized bolt-clamp splice.

G. The bottom tension wire shall clear the ground by not more than 0.1 m at any place.

3.5 Electrical Grounds

A. Where a power line/cable passes over or under the fence, electrical grounds shall be constructed.

B. The electrical grounds shall be installed 10 m before and 10 m after the point of crossing.

C. The electrical grounds shall be accomplished with a copper clad rod 2.4 m long and a minimum of 15 mm in diameter driven vertically until the top is 150 mm below the ground surface.

D. A solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded.

E. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction.

3.6 Installing Fabric

A. The chain link fabric shall be installed by a method as recommended by the supplier.

B. Standard chain-link fence stretching equipment shall be provided for stretching the fabric before tying it to the wire or rails and posts.

C. Stretching operations shall be repeated about every 30 metres.

3.7 Installing Gates

A. The gates shall be hung on gate fittings to match the existing. They shall be attached in such a manner that the gate cannot be lifted off the hinges.

B. Gates shall be so erected as to swing in the direction indicated or as directed by the Engineer and shall be provided with gate stops.

C. All hardware shall be thoroughly secured, properly adjusted, and left in perfect working order.

D. Hinges and diagonal bracing in gates shall be adjusted so that the gates will hang level.

3.8 Connection with Existing Fence

A. Wherever the new fence joins an existing fence, either at a corner or at the intersection of straight fence lines, a corner post with a brace post shall be set at the junction and braced the same as shown on the drawings.

B. If the connection is made at other than the corner of the new fence (e.g. to a building), the last span of the old fence shall contain a brace span.

3.9 Cleaning up Site

A. The Contractor shall remove from the vicinity of the completed work all tools, equipment, etc. belonging to him or used under his direction during the construction.

SECTION 32 91 19.13 TOPSOIL PLACEMENT AND GRADING

PART 1- GENERAL

1.1 Description

A. This Section specifies sources and requirements for topsoil material and construction methods for the topsoil works, such as obtaining topsoil material, stockpiling, preparing the ground surface for topsoil application and spreading topsoil material on prepared areas and at the locations shown on the drawings or as directed by the Supervisor.

1.2 Definitions

A. Topsoil- Topsoil is the surface soil with a mineral base suitable for plant growth.

B. Subsoil- Subsoil is the undisturbed strata lying immediately below the topsoil.

C. Plastic Limit - The plastic limit of the soil is water content at which the soil consistency changes from being brittle to plastic.

D. Organic matter- Decomposed remains of plants or animals no longer distinguishable.

1.3 Standard Test Methods

A. The following test method apply:

ASTM D 1140	Test Method for Amount of Material in Soil Finer Than 75-mm (No. 200) Sieve
ASTM D 2974	Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D 4972	Test Method for pH of Soils
ASTM D 5268	Specification for Topsoil Used for Landscaping Purposes

PART 2 – PRODUCTS

2.1 Material Sources

A. Naturally occurring topsoil, upper layer of an in situ soil profile, usually darker in colour, more fertile than that below (subsoil) and which is a product of natural biological and environmental processes.

B. The selected subsoil, deposits of mixture of soils and organic matter suitable for plant growth, located in deeper layers of the soil profile.

C. All top soil shall be obtained from sources within the limits of the construction site, unless specifically approved by the Supervisor.

2.2 General Material Requirements

A. Topsoil shall be a layer with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stone (50 mm or more in diameter), clay lumps or similar objects.

B. Brush or other vegetation which will not be incorporated with the soil during handling operations shall be cut and removed.

C. Ordinary sods and herbaceous growth such as grass and weeds are not to be removed but shall be thoroughly broken up and intermixed with the soil during handling operations.

D. The topsoil or soil mixture obtained from sources off site, unless otherwise specified or approved,

shall have a pH range of approximately 5 pH to 7 pH (ASTM D 4972).

E. The organic matter content shall be neither less than 2% nor more than 20% (ASTM D 2974).

F. There shall be 20–60% sand content and 35–70% silt and clay content (ASTM D 1140).

G. The topsoil material may be ended by the Contractor with approved materials and methods to meet the above specifications.

2.3 Inspection and Tests

A. The Supervisor shall be notified in due time of the source of topsoil to be furnished by the Contractor.

B. The topsoil material shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth end the extend to which stripping and/or excavation will be permitted.

C. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed depths, for testing purposes as specified.

PART 3- EXECUTION

3.1 Equipment

A. Suitable equipment necessary for proper preparation and treatment of ground surface, stripping of topsoil, and for the spreading of all required materials shall be available, in good condition, and approved by the Supervisor before the various operations are started.

3.2 Obtaining Topsoil Material

A. When suitable topsoil material is available on the site, the Contractor shall remove this material from the designated areas and to the depth as instructed by the Supervisor.

B. When suitable topsoil material is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the Supervisor. The Contractor shall notify the Supervisor sufficiently in advance of operations in order that necessary measurements and tests can be made.

C. Sites should be surveyed prior to stripping so that depths and distribution of topsoil material can be identified.

D. Prior to the stripping of naturally occurring topsoil from designated areas, any vegetation, briers, stumps, and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the Supervisor. Heavy sod or other cover, which cannot be incorporated into the topsoil by disking or other means, shall be removed.

E. Topsoil should never be stripped or laid when it is wetter than the Plastic Limit (PL), and preferably not when the moisture content is wetter than the PL less 3%. The PL can be assessed in the field as the minimum moisture content at which the soil can be rolled and moulded into thin thread approximately 3mm in diameter without breaking or cracking.

F. Topsoil should not be stripped during, or shortly after, heavy rain.

G. The selected subsoil excavation, as another source of topsoil material, shall meet the requirements of Section “Earthworks” of these Specifications.

3.3 Stockpiling

A. Ideally, topsoil material should not be stockpiled but, if this is unavoidable, topsoil heaps should be

as low and as narrow as possible, maximum heap height 1 m.

B. Topsoil material should be loosely dumped and stockpiles should be shaped to shed water and sited to avoid potentially water-logged areas.

C. The areas adjacent to stockpile which have been disturbed by the Contractor shall be graded and put into condition acceptable for seeding or planting, if required.

D. If topsoil material has to be stored for more than 6 months, it is advisable to seed the stockpile with a deep rooting grass legume seed mixture to maintain structure and aeration, to minimize weed colonization and to stabilize the stockpile.

3.3 Preparing the Ground Surface

A. Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the Supervisor, to a minimum depth of 50 mm to facilitate bonding of the topsoil to the covered subsoil.

B. The surface of the area to be topsoiled shall be cleared of all stones larger than 50 mm in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting.

C. Areas, which are too compact to respond to these operations, shall receive special scarification.

D. Grades on the area to be topsoiled as shown on the drawings shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and properly compacted condition to prevent, insofar as practical, the formation of low places or pockets where water will stand.

E. The physical and chemical characteristics of all material within the rooting depth should be such that plant roots will thrive in it.

3.4 Spreading Topsoil Material

A. The topsoil shall be evenly spread on the prepared areas, already tilled and smooth-graded, to a depth as indicated on the drawings. Spreading shall not be done when the ground or topsoil is excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

B. After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (50 mm or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor.

C. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cult packer or by other means approved by the Supervisor.

D. The compacted topsoil surface shall conform to the required lines, grades, and cross sections.

E. Any topsoil or dirt falling upon roads or other pavements as a result of hauling or handling and placing of topsoil shall be promptly removed.

SECTION 32 91 19.19 -GEOGRID FOR SLOPE STABILIZATION

PART 1- GENERAL

1.1 Description

The product Geo grid / or Basetex 1000/100 has the intended use of soil reinforcement or uses of the construction product, in accordance with the applicable harmonized technical specification, as foreseen by the manufacturer. The product's use is in construction of earthworks, foundations and retaining structures, and stabilization of the unstable slopes behind Threshold 15 of the Secondary Runway 15/33.

1.2 Measurement

The works shall be measured per square metre of the materials installed vertically and anchored at the reinforced concrete tie beams, and per square metre of the material spread out on the ground surface.

1.3 References

- EN13251:2014
- EN13254:2014
- EN13255:2014
- EN13257:2014
- EN13265:2014

PART 2 – PRODUCTS

2.1 Product Specification

The soil stabilization geo-grid requires to meet the following guidelines for its approval, and application.

<table>
<tr><th colspan="4">Performance Related Physical Properties of the Geotextile</th><th>Technical Specification</th></tr>
<tr><th colspan="2">Essential characteristic</th><th colspan="2">Performance</th><td rowspan="11">• EN13251:2014
• EN13254:2014
• EN13255:2014
• EN13257:2014
• EN13265:2014</td></tr>
<tr><th>Product characteristic</th><th>Unit of characteristic</th><th>Declared Value</th><th>Tolerance</th></tr>
<tr><td>Tensile Strength (EN ISO 10319)</td><td>kN/m</td><td>MD – 1050,0
CMD – 105,0</td><td>-50,0
-5,0</td></tr>
<tr><td>Elongation at Maximum Load (EN ISO 10319)</td><td>%</td><td>MD – 10,5
CMD – 10,5</td><td>±3,5
±3,5</td></tr>
<tr><td>Static Puncture (CBR test) (EN ISO 12236)</td><td>kN</td><td>10,0</td><td>-3,0</td></tr>
<tr><td>Dynamic Perforation Resistance (cone drop test) (EN ISO 13433)</td><td>mm</td><td>26mm</td><td>+12mm</td></tr>
<tr><td>Tensile creep (EN ISO 13431)</td><td>kN/m</td><td colspan="2">Long term creep rupture strength at a design life of 120 years and 20ºC in soil temperature is 634kN/m</td></tr>
<tr><td colspan="2">Dangerous substances (National Regulations in force in EU Member States)</td><td colspan="2">Less than required by national regulations in EU Member States</td></tr>
<tr><td colspan="4">Durability Statement (EN 13251, Annex B)</td></tr>
<tr><td colspan="4">The minimum working life is assumed to be 100 years in natural soils with a pH value between 4 and 9 and in soil temperatures less than 25°C, when covered within 1 day. (Rep No 10/19868 & 10/15350/LH)</td></tr>
</table>

PART 3: EXECUTION

The Contractor shall place the geo-grid, and affirm the soils on the vertical fall on the front side of the reinforced concrete pile. The Contractor shall also place the geo-grid on steep slopes as may be directed by the Engineer. The geo-grid should be anchored on concrete structure.

SECTION 32 92 19.19 GRASSING

PART 1 - GENERAL

1.1 Description

A. This item shall consist of sowing seed or planting grass on the areas shown on the drawings or as directed by the Engineer, in accordance with this specification.

B. These areas have usually been provided with topsoil.

1.2 References

Not Applicable

PART 2 - PRODUCTS

2.1 Grass Type

A. The seed or grass used for sowing or planting shall be Dhub grass (Cynoden Dactylon) or Bahama grass or as instructed by the Engineer.

B. Tall, quick growing or Tussock grasses shall not be used without the consent of the Engineer.

PART 3 - EXECUTION

3.1 General

A. The Contractor shall as far as practical arrange his operations in such a manner, that grassing of the areas as described can take place in the proper season.

3.2 Seeding

A. After grading of the areas to be grassed has been completed, the top shall be loosened and worked to a depth of 50 mm.

B. Grass seed shall be sown at such a rate as is necessary to ensure that the grass will form a thick and homogeneous mat.

C. The seed shall be raked and properly covered.

D. After the seed has been properly covered, the seed bed shall be immediatly compacted by means of an approved lawn roller, weighing 60 - 100 kg/m width for clay soils (or any soil having a tendency to pack) and weighing 225 - 300 kg/m width for sandy or light soils.

E. Contractor may propose alternate methods of seeding such as Hydro-seeding.

3.3 Planting

A. Individual planting shall be at max 0.25 m centres measured parallel and at right angles to the edge of the pavement or at such distances as is necessary to ensure that the grass will form a thick and homogeneous mat.

B. If the soil is not moist when the grass is being set, water shall be applied until the soil is moist and in workable condition.

3.4 Maintenance of Grassed Areas

A. The Contractor shall protect grassed areas against traffic or other use and he shall mow and water as

necessary and otherwise maintain grassed areas in a satisfactory condition until provisional hand-over of the areas or until such time as specified.

B. Surfaces gullied or otherwise damaged following seeding or planting shall be repaired by regrading and reseeding or replanting.

C. It shall be the Contractor's responsibility to ensure that the seed is sown at the necessary rate, that watering is sufficient for the grass to take root, and that a good stand of grass is established, uniform in colour and density to the satisfaction of the Engineer.

D. If at the time of the completion of the works it is not possible to make an adequate determination of the colour, density and uniformity of the grassed areas, acceptance and payment for the unaccepted portions shall be withheld until such time as these requirements have been met.

33 - UTILITIES

SECTION 33 42 16.13 PRECAST CONCRETE PIPE CULVERTS

PART 1 - GENERAL

1.1 Description

A. This item shall consist of reinforced concrete pipe, for direct burial of the types, classes, and dimensions required on the drawings, furnished and installed at locations designated on the drawings and profiles, in accordance with this specification.

B. The item shall include common excavation, backfill and disposing of surplus excavation, furnishing and installing all trench bracing, shoring and sheathing, grading, pumping and temporary stream diversion required for the installation of the reinforced concrete pipe and all treatment and fittings required to complete the pipe culvert as shown on the drawings, and the material for and the making of bedding, of all joints, including all connections to existing drainage pipes and structures.

C. The construction of headwalls, inlets and outlet structures, pits etc. are not included in this scope.

1.2 Test Methods and Specifications

The following testing and material requirements apply.

A. Standard Test Methods: ASTM C 497 Testing concrete pipes

B. Standard Material Specifications: Reference to clause 2 (Materials).

PART 2 - PRODUCTS

2.1 Materials

The pipe shall meet the requirements shown on the drawings and specified below:

A. Reinforced concrete pipe shall be in accordance with the requirements of ASTM C 76, Class V - Wall B, to meet the D-crack load of 140 N/M/mm diameter, accompanied by a factory certificate, tested as per ASTM C 497.

B. Rubber gaskets for concrete pipes shall be in accordance with the requirements of ASTM C 443.

C. Portland cement for mortar shall be in accordance with the requirements of ASTM C 150, type I.

D. Sand for mortar shall be in accordance with the requirements of ASTM C 144.

E. Bituminous material for treatment shall be RC 250 or MC 250, to ASTM D 2028 or ASTM D 2027 respectively.

F. Structural concrete for pipe bedding/cradle and blinding concrete shall be as per Section 03 31 13.13, Structural Concrete and Blinding Concrete.

PART 3 - EXECUTION

3.1 Equipment

A. All equipment necessary and required for the proper construction of culverts and drains shall be on the project in first class working condition and shall have been approved by the Engineer before construction is permitted to start.

B. The Contractor shall provide poker vibrators and hand tampers and pneumatic tampers to obtain the required compaction of the pipe concrete bedding/cradle material and the subgrade/backfill material, as specified.

C. The Contractor shall provide appropriate hoisting equipment to handle the pipe while unloading and placing it in its final position without damage to the pipe or disturbance to the trench.

3.2 Excavation

A. The width of the pit or trench for the structure shall be sufficient to permit satisfactory jointing of the pipe and/or pouring of concrete and thorough compaction of the concrete bedding material under and around the structure, but it shall not be less than the external diameter of the pipe or structure plus 0.25 m on each side.

B. Trench or pit walls shall be approximately vertical.

C. Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 0.15 m.

D. The excavation for pipe lines or culverts that are placed in embankment fill shall not be made until the embankment has been completed to a height of 0.3 metre above the top of the pipe or culvert.

E. The Contractor shall do such trench or pit bracing, sheeting, or shoring necessary to perform and protect the excavation and the structure as required for safety and conforming governing laws, and perform all grading and pumping, if necessary, to prevent water running into the trench and to keep the trench dry.

F. The bracing, sheating, or shoring shall be removed by the Contractor after placing of the structure.
Removal shall be done in such a way that it will not disturb the structure.

G. In order to work under dry conditions, it may be necessary to divert streams temporarily. Contractor shall carry out all such excavation and backfill operations as may be necessary in accordance with the specification

3.3 Placing Pipe

3.3.1 General

A. Proper facilities shall be provided for lowering the pipe when it is to be placed in a trench. The pipe shall be laid carefully and true to lines and grades on a structural concrete bed which is uniformly firm throughout its entire length.

B. Any pipe which is not in true alignment, or which shows any undue settlement after being laid, or is damaged, shall be taken up and re-laid or replaced without extra compensation.

C. The laying of the pipe in the finished trench shall be started at the lowest point and laid upgrade.

D. The bed of the pipe shall be such, that at least the lower quarter of the pipe shall be in continuous contact with the bed.

3.3.2 Concrete Pipes

A. The Engineer shall inspect all pipes before they are laid, and reject any section that is damaged by handling or is defective to a degree which will materially affect the function and service of the pipe. In any case, the pipes shall be accompanied by a load test certificate from the pipe manufacturer as per ASTM C 497. If necessary, the engineer may ask for a new load test of pipe specimens at contractor's expense.

B. When bell and spigot pipe is used, the bell shall be laid upgrade.

C. If tongue and groove pipe is used, the grooved end shall be laid upgrade.

D. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform.

E. When bell and spigot pipes are used, spaces for the pipe bells shall be dug in the pipe subgrade to accommodate the bells. These spaces shall be deep enough to ensure the same depth of concrete bedding is provided under the bells and that the bells do not bear the load of the pipe. They shall not be excessively wide in relation to the longitudinal direction of the trench.

F. When the pipes are laid, the barrel of each section of pipe shall be in contact with the quadrant-shaped bedding throughout its full length, exclusive of the bell, to support the entire load of the pipe.

3.4 Pipe Joints

A. Pipe joints may be of the bell and spigot type or the tongue and groove type. The pipe shall be gasket jointed.

SECTION 33 46 26.13 FRENCH DRAIN

PART 1 - GENERAL

1.1 Scope

A. This item shall consist of a drainage layer of clean dust free crushed aggregate, perforated PVC pipes or other material approved by the Engineer and a filter.

B. This item shall include any type of excavation and disposing of surplus excavation, grading, cleaning and restoration of site required for the installations of the french drain.

1.2 Materials

A. Drainage Layer

1. The drainage layer shall be from crushed rock sources that fulfil the gradation requirements as per table1 below

Table 1: Aggregate Grading Drainage Layer

ASTM **Sieve Size**		**Percentage by Weight Passing Sieve**
¾ inch	(19 mm)	100
½ inch	(12.5 mm)	70 – 100
3/8 inch	(9.5 mm)	40 – 65
No. 4	(4.75 mm)	20 – 45
No. 8	(2.36 mm)	17 – 30
No. 200	(75 □m)	0 – 3

2. The permeability tested using a constant head permeability apparatus shall be at least 300 m day.

3. Coefficient of uniformity > 3.5 and non plastic (Cu = D60 / D10).

B. Pipes

1. The pipes shall be perforated PVC pipe diameter. min. 0.150 m or equal material up to the approval of the Engineer.

2. Perforated PVC pipe shall conform to the requirement of ASTM D1785, schedule 80.

3. Fittings for PVC pipe shall conform to the requirement of ASTM D2467.

4. Pipes without slots or perforations required for conveying ground water from the subsoil drainage proper to the point of discharge, shall be PVC pipes of the types specified above.

C. Filter

1. The filter shall be constructed of woven polypropylene mat or nonwoven sheet of continuous filaments of spun bounded polypropylene.
2. The filter shall not be affected by bacteria, natural acids, salts or alkali or by ultra-violet light after exposure to direct sunlight during one month. It shall have good resistance to rot, moisture, mildew and insects and show no wet shrinkage or stretching. The size of the openings in the mat or sheet shall be determined on the basis of the subsoil that should be prevented to pass.

3. The filter shall have the following characteristics: $\frac{EOS}{D(15)} < 1$,

Where,

EOS = equivalent opening size. In a sieve test shall be determined, what grain size of a standard sand will be allowed to pass the filter. The equivalent opening size is

equivalent to the grain size of which 5 per cent in weight of the material is able to pass the filter.

D (15) = grain size from the distribution curve of the subsoil material for which 5 per cent in weight of the grains have a smaller diameter than D (15).

4. The filter shall have a permeability that is greater than the permeability of the subsoil in the final situation.

5. Filters made of other materials, such as polyamide, or polyester may be used, provided the filter characteristics are the same as for the polypropylene filter.

6. The filter material shall be supplied to the site on rolls, properly protected during transport and storage against ultra violet light.

7. The permeability of the various subsoils shall be tested in the laboratory in accordance with ASTM D653. The permeability of the filter shall be tested in the field laboratory or by the manufacturer. Certificates provided by the manufacturer, indicating amongst other things the permeability of the filter, will be acceptable, but the Engineer has the right to required tests at the site.

D. Rodding Eyes

1. Rodding eyes for subsoil drainage systems shall be constructed in accordance with the details shown on the drawings or in positions as instructed by the engineer.

SECTION 33 47 13.23 GROUTED STONE PITCHING

PART 1 - GENERAL

1.1 Description

A. Section covers the requirements for constructing: Grouted Stone Pitching,
- consisting of a layer of stones or crushed rock, grouted with cement mortar; on a prepared sub- grade at inlets and outlets of culverts or at slopes and bottom in ditches, gutters, etc.;
- at locations and in accordance with the lines, grades, dimensions and details as shown on the drawings or as instructed by the Engineer;
- including excavation, provisions for temporary stream diversion and pumping for keeping working areas dry, grading, compaction, disposal of surplus material and restoring ground surface to its original state.

1.2 Related Sections

A. Sections to be referred to, related to this Section:
- Construction Water
- Earthworks

1.3 References

A. Testing Requirements:

ASTM C 109 - Compressive Strength of Hydraulic Cement Mortars BMaterial Specification Requirements:
ASTM C 91 - Masonry Cement
ASTM C 144 - Aggregate for Masonry Mortar ASTM C 150 - Portland Cement
ASTM C 270 - Mortar for Unit Masonry

1.4 Submittals

A. Product: Cement.

B. Compliance: ASTM C 150.

C. Product Data: Submit product data, including manufacturer's product specification sheet of specified product.

D. Samples: Submit selection and verification samples for final approval by Engineer.

E. Quality Assurance Submittals: Submit the following:
- Test Reports: Certified test reports showing compliance with specified physical requirements, or;
- Certificates: Product certificates signed by manufacturer stating, that materials comply with specified physical requirements.

1.5 Delivery, Storage and Handling

A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Delivery: In bulk, or; deliver materials to site in manufacturer's original, undamaged, unopened bags with identification labels intact.

C. Storage and Protection:

- store materials at temperature conditions recommended by manufacturer and protect same from extended UV exposure and against moisture;
- consignments stored for more than 2 months from date of manufacture: not to be used, to be discarded and removed from site.

PART 2 - PRODUCTS

2.1 Materials

2.1.1 Pitch Stone

D. Pitch Stone to be sound, hard and durable natural stone or crushed rock with at least one flat surface with:
- minimum square size of: **100 mm**;
- maximum square size of: **200 mm**;
- thickness of: **100 - 250 mm**, or not more than the thickness of the grouted stone pitching layer, whichever is less.

2.1.2 Cement Mortar

Portland Cement, Type: I

A. Aggregate:
- Natural sand or Manufactured sand, obtained from crushing stone or gravel;
- Grading: according to par. 4.1 of ASTM C144.

B. Composition of Mortar: 1 (one) part cement : 2.5 - 3.0 parts of sand by weight.

C. Physical Requirement: average compressive strength (3 cubes) according to ASTM C 109/C 109M: after 7 days: > 3.5 MPa (reference ASTM C 91 and C 270, Type N).

PART 3 - EXECUTION

3.1 Preparing Sub-grade

A. Excavation shall be made to the required width and depth, and the sub-grade upon which the item is to be built shall be compacted to a firm uniform grade.

B. All soft and unsuitable material shall be removed and replaced with suitable approved material.

C. The Contractor shall perform all grading and pumping to prevent water running in and to keep the excavated pits dry.

D. When indicated on the drawings or instructed by the Engineer a layer of subbase material, having a compacted thickness of 100 mm, shall be placed to form a sub-grade.

E. The underlying course shall be checked and accepted by the Engineer before placing operations are started.

F. Performance of works under this item such as excavation, removing unsuitable material and replacing with suitable approved material, pumping and compacting sub-grade, shall be considered as a subsidiary obligation of the Contractor, covered under the item Grouted Stone Pitching.

3.2 Placing

A. The stones shall be bedded in the foundation in straight rows with each stone perpendicular to the finished surface. The stones shall be set in close contact, their flat surfaces up and their longest

dimension at right angles to the center-line of the gutter and ditch.

B. The pattern of the stones shall break joints satisfactorily, so that no continuous joints are formed.
There shall be no interstices exceeding 30 mm in width.

C. The stones shall be rammed thoroughly until the surface is firm and conforms to the finished surface in grade, alignment, and cross section.

D. Any sections having an irregular or uneven surface shall be taken up and re-laid satisfactorily. Rejected material shall be removed from the work.

3.3 Grouting

A. After the stones have been rammed into place and the surface is satisfactory, the spaces or voids between and around the stones shall be filled with grout.

B. The grout shall be poured and broomed into the spaces between the stones, this operation being continued until the grout remains flush with the top of the stones.

C. The grout shall be of such consistency that it will flow readily in to the spaces between the stones, but it must not be so wet that the solid matter separates from the water.

3.4 Weep Holes

A. Weep holes shall be constructed as shown on the drawings or indicated by the Engineer.

3.5 Backfill

A. After the grout has set sufficiently, the spaces adjacent to the structure shall be backfilled to the required elevation with approved fill material and compacted by mechanical equipment to at least 90% of the MDD at OMC, as determined by ASTM D 1557, Procedure ‘C’.

3.6 Cleaning and Restoring of Site

A. After the backfill is completed the Contractor shall remove all tools, surplus material, dirt, and rubbish from the site.

SECTION 33 47 13.26 CONCRETE LINING

PART 1 - GENERAL

1.1 Description

A. This item shall consist of Portland cement concrete ditches, on a prepared bed constructed in accordance with this specification at the specified locations and in accordance with the dimensions, lines and grades as shown on the drawings or as required by the Engineer.

B. The item shall include common excavation, backfill, disposing of surplus excavation, grading, reinforcement, jointing, pumping and cleaning and restoration of site required for the installation of the concrete lining.

1.2 Reference

A. ASTMD 1557 - Laboratory Compaction – Modified effort

PART 2 - PRODUCTS

A. Concrete, reinforcement, joint filler and premoulded joint material shall be in accordance with the requirements of sections Structural Cement Concrete and Joint Sealants.

B. Sub-base material shall be in accordance with the requirements of the relevant section.

WATERSTOPS

2.1 PVC Waterstops

A. PVC waterstops shall be of the shapes and sizes shown on the drawings with eyelets spaced 300 mm apart on both sides. The waterstops shall be free from porosity or other imperfections and shall comply with requirements of CKS 389 specification.

B. The PVC waterstops must be easily joined on site by heating the ends to be joined together. The resultant joint must have a minimum strength of 11.2 MPa in tension at 23Degree Centigrade. Full details of the recommended jointing procedures and special tools required are to be supplied for approval. Right angles, tee junctions and other intersections must be joined in the manufacturer's workshops in properly constructed jigs to the approval of the Engineer, and shall have a minimum tensile strength 11.2 MPa in tension at 23Degree Centigrade

C. Waterstops are to be packed in as long sections as manufacture will allow.

2.2 Rubber waterstops

A. Shall be of the shapes and sizes shown on the drawings shall comply with CKS388 specification and shall meet the following requirements:

B. The waterstop shall contain not less than 70 % natural rubber by volume, shall be precision moulded, and shall have the following properties at $20°C$

- Minimum tensile strength : 20,5 MPa
- Minimum elongation of break : 450 %
- Hardness (as determined by BS 903) 60-70 BS degrees
- Maximum water absorption by weight after 2 days at 70°C: 5 %
- Minimum tensile strength after ageing 5 % of initial tensile strength (48 hours at 70°C and 2.0 MPa of oxygen)
- Minimum elongation after ageing 75 % of initial elongation at break (48 hours (48 hours at 70
  °C and 2.0 MPa of oxygen)
- Maximum compression set by constant deflection method - % of original deflection: 20 %

C. Joints in straight lengths and between straight lengths and intersection pieces shall be properly vulcanised in accordance with manufacturer's instructions and by using the special equipment

D. Right angles, tee junctions and other intersections shall generally be moulded as one unit by the manufacturer.

2.3 Installation

A. Waterstops are to be installed so that they are securely held in their correct position whilst concrete is placed. The concrete must be fully and properly compacted around the waterstops to ensure that no voids or porous areas remain. Where reinforcement is present, adequate clearances are to be left between this and all waterstops. No holes are to be made through any waterstops.

B. Before any concrete is cast around a waterstop, the waterstop shall be thoroughly cleaned of all dust, grease, dry mortar or other foreign matter.

PART 3 - EXECUTION

3.1 Construction Methods

Not used

3.2 Preparing Sub-grade

A. Excavation shall be made to the required width and depth, and the sub-grade upon which the item is to be built shall be compacted to a firm uniform grade.

B. All soft and unsuitable material shall be removed and replaced with suitable approved material.

C. The Contractor shall perform all grading and pumping to prevent water running in and to keep the excavated pits dry.

D. When indicated on the drawings, a layer of subbase material, having a compacted thickness of 100 mm, shall be placed to form a sub-grade.

E. The underlying course shall be checked and accepted by the Engineer before placing and spreading operations of the blinding concrete are started.

F. Performance of the work under this item, such as excavation, removing unsuitable material and replacing with suitable approved material, pumping and compacting subgrade, shall be considered as a subsidiary obligation of the Contractor.

3.3 Placing

A. The forms for and the mixing, placing, finishing, and curing of concrete shall be in accordance with the relevant section.

B. The concrete shall be tamped and spaded until it is consolidated and laitance entirely covers and forms the top surface. The surface of the concrete shall be floated smooth.

C. Before the concrete is given the final finishing, the surface shall be tested with a 3 metre straightedge, and any irregularities of more than 6 mm in 3 metres shall be eliminated.

D. The concrete lining shall be reinforced with welded wire fabric of 6 mm diameter at 200 mm centres in both directions.

E. The concrete shall be placed with dummy grooved joints not more than 7.5 metres apart, except where

shorter lengths are necessary for closures, but no section shall be less than 1.20 metres long.

F. Expansion joints of the type called for in the drawings shall be constructed to replace a dummy groove at spacings of approximately 30 metres.

G. When the lined ditch is placed next to concrete pavement, expansion joints in the lined ditch shall be located opposite expansion joints in the pavement.

H. When a lined ditch abuts a pavement or other structure, an expansion joint shall be placed between the lining and the pavement or other structure.

I. Weep holes shall be constructed as shown on the drawings or indicated by the Engineer.

J. Forms shall not be removed within 24 hours after the concrete has been placed.

K. Minor defects shall be repaired with mortar containing 1 part cement and 2 parts fine aggregate.

L. The operations of depositing, compacting and finishing the item shall be conducted so as to build a satisfactory structure.

M. If any section of concrete is found to be porous, other than minor defects which may be plastered or is otherwise defective, it shall be removed and replaced by the Contractor without additional compensation.

3.4 Backfilling

A. After the concrete has set sufficiently, the spaces adjacent to the structure shall be backfilled to the required elevation with approved fill material and compacted to at least 90% of the MDD at OMC, as determined by ASTM D 1557, method D.

3.5 Cleaning and Restoration of Site

A. After the backfill is completed the Contractor shall remove all tools, surplus material, dirt, and rubbish from the site.

SECTION 33 49 13.23 BOX CULVERTS, HEADWALLS AND WINGWALLS

PART 1 - GENERAL

1.1 Description

A. This item shall consist of reinforced concrete box culverts, headwalls and wingwalls on a working apron of blinding concrete, constructed in accordance with this specification at the specified locations and conforming to the lines, grades, and dimensions shown on the drawings or as instructed by the Engineer.

B. The item shall include common excavation, backfill, and disposing of surplus material, furnishing and installing all trench bracing, shoring and sheeting, grading, pumping and temporary stream diversion required for the installation and all treatment materials and fittings required to complete the structure as shown on the drawings, and the material for and the making of all joints, all connections to existing drainage and structures and cleaning and restoration of site.

1.2 References

A. Test Methods and Specifications
The standards referred to in PART 2 (Products) shall apply.

PART 2 - PRODUCTS

A. Concrete for structures shall be structural cement concrete and for working aprons shall be blinding concrete in accordance with the requirements of the specification section 03 31 13.13

B. Reinforcement steel shall be in accordance with the requirements of the specification section 03 31 13.13

C. Rubber gaskets for joints shall be of the type as specified on the drawings and shall conform to ASTM C443 M.

D. Bituminous material for treatment shall be RC 250 or MC 250.

PART 3 - EXECUTION

3.1 Equipment

A. All equipment necessary and required for the proper construction of the structure shall be on the project in first class working condition and shall have been approved by the Engineer before construction is permitted to start.

B. The Contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the subgrade and the backfill as specified.

3.2 Excavation

A. The width of the pit or trench for the structure shall be sufficient to permit satisfactory placing of the structure and/or pouring of concrete and thorough tamping of the bedding material under and around the structure.

B. Excavated material not required or not acceptable for backfill shall be disposed of.

C. Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 0.15 m.

D. Where a firm foundation is not encountered at the design grade, due to unsuitable material, this soil

shall be removed and replaced with approved fill material for the full trench width. The Engineer shall determine the depth of removal. The fill material shall be compacted to provide adequate support.

E. The Contractor shall do such trench or pit bracing, sheeting, or shoring necessary to perform and protect the excavation and the structure as required for safety and conforming governing laws, and perform all grading and pumping, if necessary, to prevent water running into the trench and to keep the trench dry. The bracing, sheeting, or shoring shall be removed by the Contractor after placing the structure. Removal shall be done in such a way that it will not disturb the structure.

F. In order to work under dry conditions, it may be necessary to divert streams temporarily. Contractor shall carry out all such excavation and backfill operations as may be necessary.

3.3 Placing Concrete and Reinforcement

A. The reinforced structural cement concrete for the structure shall be in accordance with the relevant specification.

B. Where indicated on the drawings a working apron of blinding concrete shall be made of minimum 50 mm thickness.

C. Reinforcement shall be placed as indicated on the applicable drawings and shall be approved before concrete is poured.

D. Provision shall be made to keep the reinforcement and shuttering firmly in place and for the proper bonding of previously and newly poured concrete.

E. The work shall be arranged so that a section commenced on any day shall be finished during daylight of the same day. Sections may be between contraction joints.

3.4 Protection

A. The surfaces of reinforced concrete which will come in contact with soil shall be given two coatings with an approved bituminous material, depending on the ambient temperature.

B. The first coating shall not be applied before a 7 day curing period of the concrete has elapsed and the second coat at least 24 hours after the first coat.

C. In case no shuttering is used and concrete is poured directly in the excavated trench or pit, plastic sheets shall be used as protection between the concrete and the soil.

3.5 Backfilling

A. After a structure has been completed, the areas around it shall be filled with approved material, in horizontal layers not to exceed 0.2 m in loose depth, and compacted to the density as required for fill in unpaved areas and paved areas, as per section 02321, Earthworks.

B. Backfill shall not be placed against any structure until permission is given.

3.6 Connections

A. Where the drawings call for connections to existing or proposed structures, these connections shall be watertight and so made that a smooth uniform flow line will be obtained throughout the system.

3.7 Weep Holes

A. Weep holes shall be constructed where shown on the drawings.

3.8 Cleaning and Restoration of Site

A. After the backfill is completed the Contractor shall remove all tools, surplus material, dirt, and rubbish from the site.

B. For paved areas, the Contractor shall restore all disturbed areas to their original condition.

3.9 Inspection

A. Prior to final approval, a thorough inspection shall be performed.

B. Any indication of defects in material or workmanship, or obstruction to flow in the system, shall be further investigated and corrected.

C. Defects due to the Contractor's negligence shall be corrected by the Contractor without additional compensation and as directed.

SECTION 33 49 13.23 MANHOLES, INLETS, PITS, ETC.

PART 1 - GENERAL

1.1 Description

A. This item shall consist of manholes, catch basins, inlets, gullies, inspection pits, collection pits, pump-pits and connection pits, septic tanks, soak-away pits, oil and grease separators, drainage channels, frames, fittings and animal screens, perforated drainage pipes etc., in accordance with this specification, at the specified location and in accordance with the lines, grades, and dimensions shown on the drawings or required by the Engineer.

B. The item shall include common excavation, backfill and disposing of surplus excavation, the furnishing and installation of all bracing, shoring and sheathing, grading and pumping required for the installation of the structure, all treatment and fittings required to complete the structure, as shown on the drawings, including all connections and cleaning and restoration of site.

1.2 Reference

A. ASTM, AASHTO and other standards as specified in part 2 of this section,

PART 2 - PRODUCTS

2.1 Manholes, Inlets, Pits etc

A. Concrete Brick shall be in accordance with the requirements of ASTM C 55, Type II, Grade S.

B. Mortar grout and similar work shall be composed of 1 part of Portland cement and 2 parts of mortar sand, by volume.
- Portland cement shall be in accordance with the requirements of ASTM C 150, Type I.
- Sand shall be in accordance with the requirements of ASTM C 144.
- Water shall be in accordance with section Construction Water.

C. Plain and reinforced concrete used in structures, connection of pipes with structures, and the support of structures or frames shall be in accordance with the requirements of the relevant section.

D. Oil and grease separators shall be made either of concrete/cast iron combination, steel or glass fibre reinforced polyester. This depending on type, size and manufacturer. Covers of separators shall be gas tight.

E. The casting of frames, covers, grates and screens shall comply with one of the following requirements:

a) *Gray iron castings shall meet the requirements of AASHTO M 105.*

b) *Malleable iron castings shall meet the requirements of AASHTO M 106.*

c) *Steel castings shall meet the requirements of AASHTO M 103.*

d) *Structural steel for grates and frames shall meet the requirements of AASHO M 94.*

e) *Cast iron frames, covers and grates shall be capable of withstanding the following minimum static loads:*
- *900 KN, class F according to German standard DIN 1229, when installed in pavements subjected to aircraft load.*
- *600 KN, class E according to German standard DIN 1229, when installed in pavements subjected to vehicle load.*
- *250 KN, class C according to German standard DIN 1229, when installed in side walks and other areas not subjected to significant load.*

f) *Adequate bolts shall be used for locking. The grating shall be suitably seated by means of gaskets attached into the frame.*

F. Castings or structural steel units shall be to the dimensions shown on the drawings and shall be designed to support the loads specified.
   - Each frame and cover or grate shall be provided with fastening members to prevent it from being dislodged by traffic but which allow easy access to the structure.
   - All castings shall be thoroughly cleaned and given two coats of approved bituminous paint.
   - All structural steel units shall be galvanized after fabrication to meet the requirements of AASHTO M 111.

G. Steps or ladder bars shall be galvanized steel and shall meet the requirements of AASHTO M 111. The steps shall be of the size, length, and shape as shown on the drawings.

H. Rubber gaskets shall be in accordance with the requirements of ASTM C 443.

I. Bituminous treatment material shall be RC 250, MC 250 or equivalent.

2.2 Perforated Pipe for Drainage

A. Perforated pipe for sub-surface drainage shall be manufactured from polypropeen as per DIN 4262-1 or Equivalent EURONORM. The perforated pipes shall be corrugated and surrounded by polypropylene fibres. The T-joints and connections shall be of the same material.

B. The perforated pipe shall meet the requirements of DIN 4262-1/ EURONORM

C. The surrounding fibres shall meet the requirements of DIN 4262-1/ EURONORM

D. The diameter of the pipe and connections shall be as shown on the applicable drawings.

PART 3 - EXECUTION

3.1 Equipment

A. All equipment necessary and required for the proper construction of the structures shall be on the project in first class working condition and shall have been approved by the Engineer before construction is permitted to start.

B. The Contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the subgrade and the backfill as specified.

3.2 Excavation

A. The Contractor shall do all excavation of sufficient size to permit the placing of the structure.

B. Excavated material not required or acceptable for backfill shall be disposed of.

C. Common excavation shall not be done below the required depth. When this is done, the trench or pit shall be backfilled with approved material and compacted to the specified density, at the Contractor's expense.

D. Boulders, logs, or any other objectionable material encountered in excavation shall be removed.

E. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Supervisor. Seams or crevices shall be cleaned out and grouted. Loose and disintegrated rock and thin strata shall be removed.

F. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation.

G. Excavation to final grade shall not be made until just before the concrete or reinforcing steel is to be

placed.

H. Where a firm foundation is not encountered at the design grade, due to unstable soil, this soil shall be removed and replaced with sand or with approved granular material. The Engineer shall determine the depth of removal of unstable soil and the amount of backfill necessary. The backfill shall be compacted and shaped to a firm but slightly yielding condition to form the bed for the structure.

I. The foundation of the structure shall be controlled and compacted to the depth and density specified by the Engineer.

J. Where indicated on the drawings, working floors of blinding concrete thick 50 mm shall be made.

K. The Contractor shall do such trench or pit bracing, sheating, or shoring necessary to perform and protect the excavation and the structure as required for safety and conforming governing laws, and perform all grading and pumping, if necessary, to prevent water running into the trench and to keep the trench dry.

L. The bracing, sheeting, or shoring shall be removed by the Contractor after placing at the structure. Removal shall be done in such a way that it will not disturb the structure.

M. In order to work under dry conditions, it may be necessary to divert streams temporarily. Contractor shall carry out all such excavation and backfill operations as may be necessary.

3.3 Brick Structures

3.3.1 Foundations

A A prepared foundation shall be constructed for all brick structures after the excavation is completed and accepted.

B The base shall consist of reinforced concrete in accordance with the relevant specification.

C The foundation shall be built to the correct elevation and shall be finished to reduce possible resistance to flowing water.

3.3.2 Laying Bricks

A All bricks shall be clean and thoroughly wetted before laying so that they will not absorb any appreciable amount of additional water at the time they are laid.

B All bricks shall be laid in freshly made mortar.

C Mortar that is not used within 45 minutes after water has been added shall be discarded.

D Retempering of mortar shall not be permitted.

E An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it which can be readily closed by the laying of the brick.

F All bed and head joints shall be filled with solid mortar.

G End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint.

H Bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar.

I No broken or chipped bricks shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges.

J Full bricks shall be placed at ends or corners and the bats shall be used in the interior of the course.

K In making closures, no piece of brick shorter than the width of a whole brick shall be used and wherever practicable, whole brick shall be used and laid as headers.

3.3.3 Joints

A Joints shall not be less than 6 mm nor more than 12 mm and whatever width is adopted shall be maintained uniform throughout the work.

B All joints shall be finished properly as the laying of the brick progresses.

C When nails or line pins are used, the holes shall be immediately plugged with mortar when the nail or pin is removed.

3.3.4 Finishing

A Upon completion of the bricklaying the walls shall be plastered inside and outside.

B The plaster shall be not less than 12 mm thick, troweled to a smooth dense surface so as to provide a continuous unbroken shield.

C The plaster shall be cured with a curing compound applied at the rate of spread as specified by the manufacturer.

3.4 Concrete Structures

A Concrete structures shall be built on prepared foundations, in accordance with the dimensions and forms indicated on the drawings.

B The concrete construction shall be in accordance with the requirements of the relevant specification.

C The reinforcement shall be placed as indicated on the drawings and shall be approved by the Engineer before the concrete is poured.

D All invert channels shall be constructed and shaped accurately so as to be smooth, uniform, and cause minimum resistance to flowing water.

E The interior bottom shall be sloped downward towards the outlet.

3.5 Inlet and Outlet Pipes

A Inlet and outlet pipes shall extend through the walls of the structures for a sufficient distance beyond the outside surface to allow for connections but shall be cut off flush with the wall on the inside surface, unless otherwise directed.

B For concrete structures, the mortar shall be placed around these pipes so as to form a tight, neat connection.

3.6 Placing and Treatment of Castings, Frames, Fittings and Screens

A Castings, frames, fittings and screens shall be fixed in the positions indicated on the drawings or as directed by the Engineer, and shall be set true to line and to correct elevation.

B If frame or fittings are to be set in concrete or cement mortar, all anchor or bolts shall be in place

and positioned before concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

C The Contractor shall make allowances for the placing of frames, anchor bolts, brackets and other embedded items in the concrete or brickwork.

D When frames or fittings are to be fixed upon previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface in order that the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the drawings or as directed and approved by the Engineer.

E All units shall be set firm and secure.

3.7 Installation of Steps

A The steps shall be installed as indicated on the drawings.

B The steps shall be set in concrete and shall be fixed and secured in position before the concrete is poured.

C When the steps are installed in brick masonry they shall be fixed as the masonry is being built.

D The steps shall not be disturbed or used until the concrete or mortar has hardened for at least 7 days.
After this period has elapsed, the steps shall be cleaned.

3.8 Protection of Surfaces

A The surface of the structures which will come in permanent contact with soil shall be given two coatings with an approved bituminous material, depending on the ambient temperature.

B The first coating shall not be applied before a 7 day curing period of the concrete or plaster has lapsed and the second coat at least 24 hours after the first coat.

C In case no shuttering is used and concrete is poured directly in the excavated trench or pit, plastic sheets shall be used as protection between the concrete and the soil.

3.9 Backfilling

A After a structure has been completed, the area around it shall be filled with approved material, in horizontal layers not to exceed 0,2 m in loose depth and compacted to the density as required for embankments in unpaved areas and paved areas.

B Backfill shall not be placed against any structure until permission is given by the Engineer.

C The backfill shall be placed on all sides of the structure at the same time and to approximately the same elevation.

3.10 Connection to Existing Structure

A Where the drawings call for connections to existing or proposed structures, these connections shall be watertight and so made that a smooth uniform flow line will be obtained throughout the system.

3.11 Installation of Perforated Pipes

A The perforated pipe shall be installed in the pervious drainage layer at locations and elevations as shown on the applicable drawings. The perforated pipes shall be provided with T-junctions and

other accessories and connected to the drainage structures, or outfalls as indicated on the applicable drawings and as directed by the Engineer.

B The perforated pipes shall be carefully backfilled with the drainage layer material . Precaution shall be taken to prevent damage or collapse of the pipe before the backfill is completed.

3.12 Cleaning and Restoration of Site

A After the backfill is completed the Contractor shall remove all tools, surplus material, dirt, and rubbish from the site.

B For paved areas, the Contractor shall restore all disturbed areas to their original condition.

3.13 Inspection

A Prior to final approval of the drainage system, a thorough inspection shall be performed.

B Any indication of defects in material or workmanship, or obstruction to flow, or poorly constructed joints in the system, shall be further investigated and corrected.

C Defects due to the Contractor's negligence shall be corrected by the Contractor without additional compensation and as directed.

80 – MISCELLANEOUS ITEMS

SECTION 80 00 01 ENVIRONMENTAL MANAGEMENT PLAN

PART 1: GENERAL

1.1 EMP Principles

Environmental management Plan (EMP) is developed as a tool to facilitate integration of proposed impact mitigation measures into the project implementation and operation thereafter. The plan is guided by the defined project objectives along with the overall corporate strategies and policies on environment management. The Kenya Airport Authorities (KAA) has an established Environmental Division whose responsibilities encompass providing advice to the Management on environmental management with key focus on ensuring projects and operations comply with the local regulations as well as the international environmental safeguards including ICAO guidelines. Specific responsibilities of the Environmental Division include

(i) Ensuring that KAA adheres to established environmental safeguards,
(ii) Advise KAA on environmental principles in projects and operations,
(iii) Integrate local and international guidelines in new projects and into operations at all times.

In view of the above responsibilities, the key observations relative to the works during the proposed rehabilitation works include;

(i) The works are confined within the airport grounds implying no direct interaction with the surrounding communities and economic activities are anticipated. Delivery of construction materials, however, may have limited effects to the external social and environmental setting along the transit routes,
(ii) There exist direct linkages of the pavements to the external environment through pollutant transportation from point sources and lack of appropriate connection to the nearest open drains. This includes discharge of contaminated surface runoff into open drains and grounds subsequently to the outfalls,
(iii) Drainage system around the southern end of the airport grounds could provide a pathway of pollutants from airport to the external environments. Likewise, the zone neighbouring to the north and west could discharge into the airport grounds,
(iv) Aerial emissions from construction works (concrete, earth works, material management and machinery operations) will have direct implications with settlements to west of the airport grounds. The emissions may also be associated with greenhouse gas emissions leading to climate change,
(v) Waste materials from the works including construction debris and scrap will need a planned handling.

1.2 EMP Implementation

Management of impacts arising from the rehabilitation works is based on established actions with clear responsibilities, defined timeframes and cost estimates as well as appropriate monitoring indicators. Specific actions have been defined covering the construction and post-construction phases of the project. While appreciating the benefits of this rehabilitation works that are being enhanced through the design, this EMP addresses the negative aspects that require preventive measures through the works.

1.3 Management Actions

1.3.1 Waste Management

Potential Linkages

(i) Aesthetic pollution around the airport,
(ii) Soil contamination at points of waste generation (materials storage and preparation areas, work campsites, etc.),

(iii) Blockage of surface drains at various locations around the airport grounds (earth and debris entering open drainage systems) from the construction works,
(iv) Potential attraction of birds by wastes around the airports, specifically wastes emanating from the construction works,
(v) Potential non-compliance with the established waste management plan for the airport during the construction and post-construction.

Management Action (Construction)
(i) The Contractor to provide waste holding bins in all work areas,
(ii) All wastes generated from the construction works to be handled following the established waste management plan for the airport,
(iii) ALL FODs to be removed to the landside after every working shift for the safety of the aircrafts and handled in accordance with the waste management plan.

Management Actions (Post-Construction)
(i) Review the Waste Management Plan for the airport for adoption and application by all operators, stakeholders and airport users,
(ii) Coordinate operators into a harmonized solid waste collection, storage and off-site transfer and disposal in accordance with the waste management plan,
(iii) Undertake annual airport wide waste audit to ensure compliance with the waste management plan,
(iv) General waste materials to be disposed off to approved public disposal sites (Kibarani OR Mwakirunge dumping areas),
(v) Hazardous and special wastes are undertaken in accordance with the airport's waste management plan.

1.3.2 Drainage Management

a) Potential Linkages
(i) Potential blockage of open drains with debris, earth and scrap at the work areas,
(ii) Discharging waste materials at the outfalls into the external drainage systems, Potential flooding arising from disrupted surface and sub-surface drainage systems,
(iii) Potential disruption of the works from external entry of surface runoff from the neighbouring residential and commercial areas,
(iv) Noted inflow of contaminated surface runoff from the neighbouring estates, potentially polluting internal runoff leading to soil contamination and risks to people's health. This is specifically anticipated during the medium to long term operations of the airport,
(v) Discharge of pollutants from internal point sources comprising oil/grease, polluted leachate, solid residuals, etc., to external drainage system,
(vi) Potential reducing carrying capacity of external drains by design and maintenance to accommodate run-off from the airport grounds,
(vii) Risks posed to the airport and the neighbouring areas from inadequate sub-surface drainage (erosion and landslides)

b) Management Actions (Construction)
(i) Consider a cutoff drain along the northern end of the airport grounds and divert external runoff from the airport grounds during and after the construction,
(ii) All drainage outfalls should be installed with grit traps and oil interceptors as part of the rehabilitation works. This include interception of pavement dirt and particulate matter,
(iii) Drain out all low lying ponding sections as part of the rehabilitation works to prevent risks of sub-surface erosion.

c) Preventive Measures (Post-Construction)
(iv) Provide all internal drains with grit traps and oil interceptors at the respective point sources before

discharging into the main drains. The Operators should be involved in this regard,

(v) Liaise with the Mombasa City County and other Stakeholders on upgrading and maintenance of the external drainage systems around the airport grounds with a view to enhancing the carrying capacity and structural suitability,

(vi) Ensure operators respects drainage systems through established compliance audit schedules

1.3.3 Removal of Vegetation Cover

a) Potential Linkages

There is notable ground cover at the airport comprising mainly of grass, with scattered short trees on the landside. Among the impacts include the following;

(i) Limited clearance of bushes for drainage construction at the outfalls. All drains and outfalls are within the airport grounds and hence insignificant vegetation disruption,

(ii) Potential attractants to birds from grass cover and insects' proliferation on the airside.

b) Management Actions (Construction)

(i) Reintroduce grass cover around the construction areas upon completion of the rehabilitation works,

c) Management Actions (Post-Construction)

(ii) Maintain all wooded vegetation short (select indigenous deep rooted species)

(iii) Liaise with neighbouring landowners on planting trees that are also safe to airport operations,

(iv) Maintain grass short within the airside for safety,

(v) Ensure the grass do not habour bird attractants into the airport's airside to the extent possible.

1.3.4 Health and Safety

a) Potential Linkages

(i) Potential occupational health and safety risks to the workers,

(ii) Potential safety risks to aircrafts and passengers from the construction works,

(iii) Elevated occupational and health noise levels to receptors (workers) during the construction and travelers, operators and neighbourhoods (during operations),

b) Management Actions (Post-Construction)

(i) All safety requirements as established are adhered to at all times,

(ii) Ensure the constructor applies all safety requirements and necessary information for both workers and airport users,

(iii) Close and monitor all loose illegal entries into the airport grounds during and after the construction

(iv) Enhance security surveillance during the construction,

(v) Develop a social communication strategy for a harmonious co-existence with the local communities,

(vi) Establish key social linkages of the proposed works and airport operations thereafter,

(vii) Initiate social education to the public on safety aspects associated with the airport operations for enhanced appreciation,

(viii) Involve the local communities in maintaining the drainage outfalls for enhanced ownership and responsibility,

(ix) Initiate a process of occupational health and safety measures including air quality measurements, noise measurements and fire safety audits, etc.,

(x) Consider a buffer zone (~50m) between the airport ground and the neighbouring residents for enhanced airport safety. This might require necessary acquisition of the land following appropriate consultations with stakeholders,

(xi) Install a double secured fence is recommended around the airport grounds,
(xii) Consult with local authorities on land use compatibility in the area for enhanced safety of the airport and its users,
(xiii) Aircraft related noise effects to the neighbouring residents be addressed
(xiv) Control land use practices along the landing approach funnel for safety of the aircrafts and passengers. Support for other relevant arms of the National and County Governments will be necessary. Certain investments may be involved in this exercise.

1.3.5 Emissions

a) Potential Linkages

Emissions are expected to comprise of CO_2, CO, NO_X, SO_X, HCl and PM. Key sources will include the following;

(i) Emissions from construction and other public and ground support vehicles (GSV) accessing the airport grounds,
(ii) Emissions from construction equipment and operations ground support equipment (GSE)
(iii) Emissions from power back-up generators,
(iv) Indirect power supply associated with non-renewable energy sources (may not be quantified)

b) Management Actions (Construction)

(i) To the extent possible, avoid threshold displacement options. In this regard, maximize on the low traffic hours for the works in order to make available the full length of the runway hence reducing the need for enhanced fuel application by the aircrafts on reduced runway length,
(ii) Ensure only controlled application of on-board auxiliary ground power support for the aircrafts at the aprons. May consider application of electric ground power support equipment where possible,
(iii) Impose emissions levels control requirements for construction vehicles and other public and ground support vehicles entering the airport and adhere to the standards at all times,
(iv) Impose emissions levels control requirements for construction equipment and operations ground support equipment and adhere to the standards at all times.

1.3.6 Construction Material Sites

a) Potential Linkages

(i) Degradation of the materials sources (mainly quarries) and the land surrounding the material sites and the access roads by delivery construction trucks. This applies whether the Contractor directly sources the materials or outsourcing arrangements,
(ii) Vegetation removal at material sites and access paths,
(iii) Aerial emissions (dust particulate matter, engine exhaust emissions) into the neighbourhoods of the material sites, as well as transit routes to the airport,
(iv) Elevated noise levels to the neighbouring areas from the extraction machinery,
(v) Potential risks to road safety associated with materials delivery trucks,
(vi) Aesthetic obstructions by materials holding points within the airport grounds.

b) Management Actions (Construction)

(i) Engage material site owners to ensure material extraction or sale agreements have clear responsibilities outlined for compliance during and after the works. This will ensure appropriate monitoring liabilities throughout the construction works between the Contractor(s), Landowners or other parties involved in the process,
(ii) Consult operators in the airport on the most acceptable location for material holding yards to avoid unnecessary operational inconveniences,
(iii) Material extraction methods should not pose safety risks to the communities neighbouring the

material sites. Necessary information and awareness shall be furnished to the neighbourhood at all times,

(iv) Materials shall always be covered while on transit and maintained so at the site of construction to prevent dust emissions,

(v) Driver safety and road courtesy shall always be ensured by truck drivers delivering materials and other vehicles associated with the construction works.

(vi) Materials debris shall be removed for safe disposal upon completion of the works.

1.3.7 Compliance

In order to ensure full compliance with necessary environmental and social requirements, the following will be necessary;

(i) An intensive supervision will be necessary,

(ii) In this regard, the contractor will need to be provided with the environmental management plan as well as the legal provisions as outlined in this report.

(iii) The environmental division will also need to develop a legal register to enable evaluate the level of compliance at all times,

(iv) A completion report will be prepared at the conclusion of the rehabilitation works,

(v) The rehabilitated facilities will be included in the annual environmental audit of the airport thereafter.

PART 2: MANAGEMENT ACTIONS RESPONSIBILITIES MATRIX

Item	Item Description	Management Actions	Responsibility and Cost Estimate (KShs.)	Remarks
1	Waste Management	**Immediate Actions (Construction):** • Provide waste collection bins at all the rehabilitation work areas, • Removal of all wastes to the landside after every working shift • Adopt established Waste Management Plan for the airport	• The Airport Manager/Engineer, • Contractor • Supervision Consultant **Costs be part of the project costs**	• There is need for collective decision by the all the players to ensure provisions of necessary provisions with respect to drainage and linkages to the pavements. • Integration of the waste management plan will facilitate the implementation of a waste requirements for the works • The linkages between waste management, the pavements and drainage systems should be appreciated at all times.
		Management Actions (Post-Construction) Adopt provisions of the Waste Management Plan for the airport	▪ The Airport Management ▪ Operators **Cost dependent on waste volume from the construction works**	
2	Drainage Management	**Immediate Actions (Construction):**	• Airport Manager,	

Item	Item Description	Management Actions	Responsibility and Cost Estimate (KShs.)	Remarks
		• Maintain clear all surface and sub-surface drains • Drains from point pollution sources installed with interceptors, • Improve capacity of outfall drain channels discharging from the airport grounds. • Install ALL drainage outfalls with grit traps and oil interceptors	• Airport Engineer) • Contractor, • Supervision Consultant **Costs be part of the project costs**	• Drainage is a facility that should reach all parts of the airport. • All operators should be provided with drainage link to all operation points
		Management Actions (Post-Construction) • Engage operators on their effluent handling during the construction as well as post-construction periods, • Effluent discharge guidelines • Drainage monitoring	• Airport Manager	• Monitoring of the status of the drains and related facilities should be scheduled into the airport maintenance programme. • Enhanced efforts are required to protect the drainage outfall areas.
3	Vegetation Cover	**Immediate Actions (Construction):** • Grassing and vegetation • Collective participation on the airside • Establish community liaison for improved tree planting.	• Airport Manager • Contractor • Construction Supervisor **Costs as per the BoQ**	• There is no presence of trees at the airport for safety reasons. However, the southern end are characterized with marine based vegetation • Introduction of trees into the airport ground should take into consideration of safety risks from birds. • The outfall area should be planted with shrubs and short tree species but with deep roots to hold the soils together.
		Management Action (Post-Construction) • Maintain wooded vegetation short and deep rooted, • Enhance community liaison for vegetation maintenance.	• Airport Manager • Environmental Division **~KShs. 100,000 annually in collaborated tree planting**.	
4	Social, Health and Safety	**Immediate Actions (Construction):** • Provide all construction workers with appropriate PPEs and application ensured at all time while	• KAA (Safety Division) • Airport Manager • Contractor • Security Agents	• There should be extra safety and security precautions during

Item	Item Description	Management Actions	Responsibility and Cost Estimate (KShs.)	Remarks
		working, • All the workers be provided with basic training and awareness on aviation safety aspects of the airport, especially the airside, • Application of health safety requirements during construction • Linkages with surrounding communities, • Close illegal entries • Security during construction,		the construction period, • The airport has a established OHS policies and procedures to guide the requirements
		Management Action (Post-Construction) • Enhance coexistence with surrounding communities (implement KAA's CSR strategy as part of the construction works), • Involve communities on external drainage maintenance,	• KAA (Safety Division) • KAA Corporate Office • Airport Management • Security Agents • Local Leadership.	• A comprehensive strategy on social issues is required at the KAA policy level to guide on social interactions. • KAA has established noise maps for the airport
		• Undertake occupational and environmental health and safety audits for the construction works. • Apply noise maps to indicate aircraft noise treads during the construction works. ▪ Influence land use trends around the airport Address noise related issues.	**No direct cost estimates. Other costs are as per the BoQ**	• BUT occupational noise and vibrations conditions need to be established • A budget line needs to be developed for this item.
5	Material Sites	**Immediate Actions (Construction):** • Contractor to prepare Environmental impact assessment reports on material sites if direct extractions • If outsourced materials supplies, the Contractor to demand suppliers provide Due Diligence on materials sites including restoration plans, • Safety precautions during material extractions and transportation by the Contractor, • Control of waste material	▪ Contractor ▪ Material site land owners, ▪ KAA (Corporate Office), **No costs estimates at this stage**	Material sites have not been identified and confirmed at the time of this assessment.

Item	Item Description	Management Actions	Responsibility and Cost Estimate (KShs.)	Remarks
		handling at the airport grounds,		
		Management Action (Post- Construction) • All material sites be decommissioned and rehabilitated • Monitoring		
6	Compliance	**Continuous** • Contractor's work plan based on this EMP, • Prepare the project's completion report showing extent of EMP integration • Compliance monitoring • Material site rehabilitation plan and completion report • Project completion report • Environmental audits, • Legal register.	• Airport Manager, • Contractor, • Material sites landowners • NEMA **No direct costs estimates**	6

PART 3: PREVENTIVE ACTIONS

Issue No.	Environmental Issues	Preventive Actions	Timeframe
1	**Drainage** • Transportation of pollutants to external drainage systems • Risks to aircraft safety • Potential water Logging from inadequate drainage	Comply with drainage designs	During construction
		• Provide oil/grease interception at the sources and drainage outfalls as necessary, • Provide grit traps at the sources and drainage outfalls as necessary	During construction
2	**Health and Safety** • Potential Risks to the construction workers • Potential safety risks to the aircrafts and passengers	• Close liaison with KCAA and KAA in regard to operations • Define safety limits and sensitize construction workers accordingly • Issues appropriate precautions to the contractor teams even during nocturnal periods,	During Construction
		• Enhance signage around the construction areas • Enhance communication at all times to the Contractor teams as well as other relevant stakeholders	During Construction
		Provide basic safety precautions and security awareness to the Contractors workers	Upon Commencing of the construction works and continuous
3	**Waste Management**	Provide suitable temporary and safe holding areas for construction wastes to await disposal in line with the waste management plan	During Construction

	• Potential scattering construction debris in inappropriate locations • Problem handling rubber residuals in runway striping's • Plastic materials from parts and facilities • Residual cables and wires • Earth removed from limited excavations • Sanitary waste disposal	Isolate debris with rubber residuals for special handling (preferably burying in landfills)	During construction
		• Move debris to approved disposal grounds • May apply part of the crushed debris for earth roads within the airport grounds	During Construction
		• Channel construction wastewater into the drains (ensure no solid materials or other pollutants are discharged) • Install drains from pavements with grit traps and collection chambers.	During construction
		Provide a mobile toilet for the workers while at construction area and remove while not at work (the terminal is far for the workers' needs)	For the works duration
4	**Material Sites** • Dust emissions, • Safety to the neighborhoods, • Noise and vibrations • Wastes disposal • Potential land degradation	• Undertake environmental impact assessment for the materials sites before extraction and provide a management plan including rehabilitation, • Isolate material sites using a fence from the rest of the area for safety of residence, • Install safety precautionary signage around the material sites • Integrate site rehabilitation responsibilities into the lease agreement with landowners, • Rehabilitate all material sites upon closure to acceptable standards,	Upon commencing of the works
		Control pollutants during material extraction, e.g. dust emissions, solid waste disposal, land cover degradation	During material extractions
		• Adopt commercial materials sources to let Suppliers carry the responsibility • Supplier to prove due diligence at material sources	During construction
5	**Material Haulage and Storage** • Potential risks to road safety • Dust emission • Potential conflict with airport users	• Truck drivers to observe due care along the delivery routes and within the airport grounds, • Truck Drivers to be of good conduct due to sensitivity of the airport grounds	All times construction
		• Delivery trucks should be covered to prevent dust along the delivery route • Adopt temporary dedicated security towards materials delivery trucks in to the airport.	During Construction
		• Material storage areas should be identified early and isolated to avoid conflict with airport operations • Location of the material storage be easily accessible by the delivery trucks and also in- house mode of transfer	During Construction
		All dry materials (sand, aggregate, etc.) shall be stored in closed structures or covered to avoid any dust.	During Construction
6	**Emissions**	Materials maintained conditions.	covered
		Pavement stripping to be done if possible under wet conditions to prevent dust	At all times during construction

	• Dust from materials' handling • Dust at material sources • Emissions from working machines	emissions	
		All equipment to be maintained at high working condition (hydrocarbon residuals, CO_2, etc.).	At all times during construction
		Open burning of wastes (off-site) be discouraged as a source of aerial emissions (particulate matter and smoke)	At all times during construction
		Contractor(s) to maintain material delivery trucks to prevent exhaust fumes.	At all times during construction
		• Maintain materials extraction sites dump to reduce dust emissions (if done by Contractor) • Contractor(s) may seek commercial materials supply BUT ensure due diligence from suppliers (maintained trucks),	At all times during construction
7	**Noise and Vibrations** • Work equipments (limited to the work areas as receptors are located a distance away) • Aircraft landing, taxiing and take-off activities	• Contractor will confine equipment noise to the work areas • Contractor(s) will maintain equipments at high operational conditions to reduce emission, • The construction project will have no control over other aviation operations with respect to noise levels. • Plan the construction work such as it will not significantly influence additional noise from aviation operations.	During work hours

PART 4: CONCLUSIONS

It is noted that the proposed rehabilitation works will not have significant impacts to the external environmental and social setting. However, it is also observed that;

(i) All the works will be confined in-house with little or no interaction with the neighbourhood. In this regard, discharge of dust and particulate matter into the neighbouring areas are insignificant while emissions directly associated with the works will be relatively low,

(ii) There are various operators providing services with Moi International Airport including support ground aircraft services, catering, ground maintenance, cargo handling, security, travel agents and airline managements. There is, however, no clear guidelines on the procedures for handling environmental related aspects such as the use of common pavements and discharge controls into open surface drainage systems,

(iii) Moi International Airport has established a Waste Management Plan for solid refuse and wastewater. There are, therefore, defined solid waste holding stations and spills discharges with direct linkages to the pavements and drainage sections. The Construction works and operations thereafter have full access to these stations,

(iv) Equally, the Airport has developed Noise Maps for Aircrafts operations (LTO) though it does not cover parked and taxiing aircrafts as well as occupational noise aspects. The noise maps are able to give indications of baseline noise levels along the flight corridors for the landing and take-off cycles,

(v) Defects developing on then pavements are to a large extent associated with drainage status of the airport ground. High water table, failed drainage provisions of the airport and compromised drainage outfalls are among factors affecting the drainage efficiency within and around the airport grounds leasing to weakening of the pavement foundations and loss of soils through landslides,

(vi) It is noted that there is significant discharge of sewage and surface runoff from the neighbouring residential estates (surface and sub-surface flows) that needs to be intercepted. This runoff is apparently not designed for in the current airport plan and is creating evidence of ponding at various

locations and permanent wet areas on the northern end a short distance from the runway. This could be contributing to the weakening runway foundation and other pavements,

(vii) The airport surface drainage systems are generally inadequate in terms of reaching key areas requiring draining, isolation of pollution point sources and the carrying capacity of the existing drains system. The network also seems to have suffered serious structural failures from blockages, collapsing sub-surface drainage components and increasing storm water flows,

(viii) The drainage outfalls pass through geologically delicate ground (steep slopes of red un-cohesive soils that have been exposed through vegetation clearing by the squatting communities) and do not seem to have capacity to accommodate maximum hydraulic flows from the airport grounds. The land is, therefore, highly damaged during heavy storm water from surface erosion and land slips,

(ix) There are notable social related issues linked to the airport grounds including encroachments by neighbouring residents, solid waste disposal into the grounds, vandalism of installations (drains, lighting systems and fences) and occupation of the drainage outfall areas to the western side.

(x) While the rehabilitation works do not have direct interactions with the neighbourhoods, the construction works may generate significant wastes comprising of milled asphalt concrete, waste concrete debris, obsolete machine parts, timber, scrap metal, packaging materials, etc. that will require safe disposal,

(xi) Due to small land area available for the airport operations, the rehabilitation works could pose a safety concern to the aircraft operators, passengers and the construction workers,

(xii) Assuming the Contractor will direct source for construction materials, the materials sites are privately owned, but the potential implications (dust, emissions, noise, safety, vegetation removal, etc.) of material extraction are likely to affect their entire neighbourhoods,

PART 5: RECOMMENDATIONS

The following recommendations have been found appropriate in addressing the above observations;

(i) The Contractor(s) shall be advised to ensure minimal interference with the neighbouring communities with respect to their safety at all times such as to include control of dust and other emissions and elevated noise levels among others,

(ii) Review the drainage capacity and coverage such as to include the low lying sections of the airport grounds, yards under various service providers, workshops areas and waste holding stations around the grounds as discussed in this report. The Construction activities should utilize these stations for waste movement to the extent possible,

(iii) Drainage designs should provide oil/grease traps and grit chambers for all drains, specifically at workshops and machine service areas, waste holding areas, the apron, pavement receptions and discharge points to the outfalls. The interceptors and grit chambers will be cleaned on regular basis and the materials safely disposed off,

(iv) Stabilize the drainage outfall areas by designing wider drains, construction of concrete drains OR improved firm gabions on strong bases pillars as discussed in the design proposal. Then re-vegetation with deep rooted but short indigenous trees and allowing grass and short shrubs is recommended to hold the soil together,

(v) Management of wastes generated in the pavement rehabilitation and drainage construction will be the responsibility of the contractor. External dumping shall be on approved grounds while in-house re- use (e.g. filling of the gullies at the outfalls) shall be with approval from KAA's Environmental Division,

(vi) Air quality and noise are aspects inseparable between the construction activities and routine airport operations. While advising the Contractor to ensure minimal emissions and noise levels, it would be recommended that KAA's Environmental Division to initiate air quality surveys around the airport ground and the immediate surroundings in the long term,

(vii) Emissions of Greenhouse Gasses from the construction equipment, ground accessing vehicles (GAV) and ground support equipment (GSE) as well as aircrafts during the construction period and

post construction will need to be worked out based on the aircraft mix for MIA by a Climate Change Expert. In this regard, appropriate data and trends for aircraft, ground support vehicles and ground support equipments will be necessary. This include respective LTO schedules and associated fuel loads,

(viii) The encroachments and conflicting settlements around the airport are not directly related to the proposed rehabilitation works. However, the implications on the gains from the rehabilitation call for medium to long term interventions, especially through Corporate Social Responsibility (CSR). A CSR Strategy has been established for KAA to enhance co-existence with the society in the short term. For long term safety solutions, it will be necessary to initiate collaborations through appropriate channels on safety issues relating to the encroaching land use features with a view to acquiring a safety buffer all around the airport,

(ix) Rehabilitate all materials sites upon completion of the proposed works. In this regard, appropriate agreements between the contractor and materials site owners will be necessary to facilitate apportionment of rehabilitations responsibilities.

SECTION 80 00 02 SUMP PUMPS

PART 1 - GENERAL

1.1 Description

A This guide specification covers the requirements for automatic, electric-motor-driven, centrifugal, wet-pit and submersible sump pumps.

B Remove information and requirements not required in respective project, whether or not brackets are present.

C Motors are covered are LOW-VOLTAGE MOTORS

1.2 References

A. 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. The pump manufacture specifications shall prevail.

B. ASTM A53/A53M(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.3 Submittal Requirements

A Shop Drawings
- Connection Diagrams
- Control Diagrams
- Fabrication Drawings
- Installation Drawings

B Product Data
- Manufacturer's Catalog Data
- Pump Performance Curve
- Spare Parts List
- Special Tools
- Wet-Pit Sump Pumps
- Submersible Pumps
- Accessories

C Test Reports
- Hydrostatic Leak
- Static Heads
- Pump Flow Capacity

D Certificates
- Manufacturer's Certification of Bearing Life
- SD-08 Manufacturer's Instructions
- Manufacturer's Installation Instructions
- Vibration Specifications

PART 2 - PRODUCTS

A Concrete for structures shall be structural cement concrete and for working aprons shall be blinding concrete in accordance with the requirements of the specification section 03 31 13.13

B Reinforcement steel shall be in accordance with the requirements of the specification section 03

31 13.13

C Rubber gaskets for joints shall be of the type as specified on the drawings and shall conform to ASTM C443 M.

D Bituminous material for treatment shall be RC 250 or MC 250.

PART 3 - EXECUTION

3.1 System Requirements

A. Provide pump and motor with vibration levels conforming to ISO 1940-1 unless otherwise noted.

B. Show details of connection of cables and pump motors on connection diagrams for sump pumps.

C. Submit control diagrams for sump pumps showing motor starters, relays, or any other component necessary for safe operation.

D. Indicate the sump pump size, type, and efficiency rating on fabrication drawings.

E. Ensure installation drawings for sump pumps are in accordance with the manufacturer's recommended instructions.

F. Submit manufacturer's catalog data for sump pumps showing performance data including; pump performance curve, indicating brake horsepower, head liter per minute gpm, and NPSH. Also include equipment foundation data and equipment data.

G. Provide manufacturer's installation instructions and vibration specifications.

3.2 Equipment

A. Wet-Pit Sump Pumps.
1 Cast-iron, carbon-steel, or concrete cast-in-place sumps or basins should be dimensioned on the drawings or specified herein. Capacities for each pump of the simplex or duplex unit range from 150 to 3800 liter per minute; total dynamic heads range from 3 to 40 meter
2 The number of pump units required should be indicated on the drawings or specified herein (one duty one standby alternative operations).
3 Construct and furnish pumps in accordance with the applicable requirements of ISO 2858 and ISO 5199 standards and those specified herein.
4 Include with the simplex pump unit a vertical, submerged, volute, centrifugal pump mounted below a coverplate; a vertical, flexible-connected, solid-shaft motor; a motor and bearing-support housing attached to the coverplate; pump-support and shaft-housing pipe; discharge pipe; and automatic controls.
5 Avoid contact between dissimilar metals. Where such contact cannot be avoided, protect joints between dissimilar metals against galvanic corrosion by plating, organic-insulation coatings, gaskets, or other suitable means.

B. Pump Selections
1 Where parallel pump operation is indicated, select pumps with characteristics specifically suited for the service without unstable operation
2 Provide a pump unit that delivers, at rated speed, not less than the specified liters per minute against the specified or indicated discharge head while the liquid level is not more than 300 millimeter above the datum elevation of the pump. Use the level of the entrance eye of the impeller as the datum elevation. Include in the calculations of the the discharge head, both the friction head of the system piping external to the pump unit and the static head measured from a point of reference on the sump to the highest point in the system. Base ratings on pumping clear, fresh water at a temperature of 20 degrees C 68
3 Ensure pump seals, lubricant, and electrical insulation are suitable for service in liquids up to 60

degrees C

C. Pump Casing: Provide cast iron pump casing. Provide a volute and discharge nozzle of the pump casing cast as one piece. Construct casing with a bolted plate to permit inspection and removal of the impeller. Ensure casing can withstand a hydrostatic pressure of not less than 1-1/2 times the design shutoff head of the pump

D. Bearings and Lubrication: Bearings and Lubrication: Furnish antifriction ball- or roller-bearings with full provision for the mechanical and hydraulic, radial, and thrust loads imposed. Seal and permanently grease or oil lubricate bearings.
   1 Furnish one or more antifriction ball- or roller-bearings in the motor and bearing support housing above the cover-plate surface, with full provision for the mechanical and hydraulic radial and thrust loads imposed. Provide sealed and grease lubricated bearings that have an L- 10 rating of not less than 80,000 hours in accordance with ABMA 9 or ABMA 11. Ensure the shop drawings bear the manufacturer's certification of bearing life. Provide bearings manufactured from vacuum-processed or degassed-alloy steels.
   2 Provide sleeve type intermediate shaft bearings. Ensure center distance between any two bearings on the shaft does not exceed 1370 millimeter for pumps operating between 1,700 and 1,800 revolutions per minute (rpm) or 1520 millimeter for pumps operating at 1,200 rpm or less. Provide sleeve bearing not less than 2 times the shaft diameter and locate near the lower extremity of the shaft.
   3 Provide heavy-duty bronze or bronze-backed, babbitt-lined sleeve bearings. Provide appropriate nonferrous piping and fittings to permit individual lubrication of the intermediate and lower bearings from above the sump coverplate. Provide means to prevent the pumped fluid from entering the lower bearing. Include a suitable seal or a system wherein a partial vacuum developed below the bearing by the impeller rotation induces a positive flow of lubricant into the bearing. Fit bearings with a centralized grease lubricator that is manually or electrically operated from a single point
   4 Supply potable water through a piping system containing a pressure regulator, a solenoid, and a backflow preventer. Provide plastic, nonmetallic composition, elastomer, or nonferrous metal for all wetted components

E. Impeller: Provide cast iron or bronze impeller, enclosed or semi-open, with vanes on back shroud. Refer to paragraph BEARINGS AND LUBRICATION for additional requirements. Ensure impeller is dynamically balanced.

F. Strainer: Protect intake with a large cast-iron, slotted intake strainer with an effective free area sufficient to prevent cavitation and degradation of efficiency. Ensure strainer has a free area of at least four times the cross-sectional area of the suction casing.

G. Pump Shaft: Construct the pump shaft of ground and polished AISI Type 304 or 316 corrosion-resistant steel with hardened wearing surfaces at intermediate shaft-bearing locations. Hardened surfaces may be overlays of 500 Brinell, Deloro Stellite, Wall Colmonoy, or similar proprietary metals, or plasma-spray-applied ceramic materials of not less than 900 Brinell hardness. Ensure means for external adjustment of the clearance between the impeller and the inner surfaces of the volute section.

H. Flexible Couplings: Connect the pump shaft to the motor shaft through a flexible coupling. Provide a tire shape or a solid-mass serrated-edge disk shape flexible member made of chloroprene material and retained by fixed flanges. Provide flexible coupling that acts as a dielectric connector, that does not transmit vibration or end thrust, and that permits up to 4-degree misalignment under normal duty.

I. Support Pipe: Provide a wrought-iron or steel support pipe concentric with the pump shaft that connects the pump to the sump cover plate. Provide support-pipe flanges that are machined and doweled to ensure proper alignment of the pump and shaft whenever the pipe is disassembled and reassembled in the field

J. Discharge Pipe: Furnish a discharge pipe running from the pump-discharge outlet to the sump cover plate as an integral part of the pump unit. Arrange the discharge pipe to preclude discharge piping

beyond the pump assembly from imposing loads which would tend to cause shaft misalignment. Provide black steel or wrought iron pipe, with wall thickness not less than that specified in ASTM A53/A53M for Schedule 40 pipe. Ensure discharge pipe is gastight through the sump cover plate. Ensure discharge end of the pipe terminates in a screwed or flanged connection in accordance with the manufacturer's standard practice.

K. Liquid-Level Control: Provide a simplex unit with a float mechanism to provide automatic operation of the pump unit when the liquid in the sump rises to a predetermined level. Provide a means of adjustment, such as float-rod stops, to allow for variation in the start and stop level-control points. Provide AISI Type 304 or 316 corrosion-resistant steel float and stem. For all other parts of the fluid-level-sensing mechanism below the cover plate, provide bronze, brass, or material of equivalent resistance to the corrosive effects of sea water. Provide stilling tubes where indicated

L. Motor and Power Cord: Provide permanently sealed, oil-filled, and watertight motor and that is manufacturer's standard construction for the service. Fit the motor space with watertight expansion provisions to accommodate temperature normal to specified duty. Ensure motor seals remain watertight under any pressure developed in the volute and under a sump-level static head of not less than 9100 millimeter 30 feet of water. Ensure circuits for three phase motor provide overload protection.
   1 Provide single phase motors with automatic-reset thermal-overload protection.
   2 Provide waterproof, internally grounded, oil-resistant, Type SO chloroprene power cord, with three-prong plug of indicated length.

3.3 Installations

A Alignment

1 Before attempting alignment, demonstrate that the pump does not have any load/force imposed by the piping system. Minimum alignment values (below) are for pump and driver at normal running temperatures. Compensate values for thermal growth. Correct limited movement of the pump or driver (commonly known as bolt-bound) to ensure alignment capability. Ensure hold down bolts are not undercut in order to perform adjustment.

2 Ensure shims are commercially die-cut, without seams or folds, and are made of corrosion resistant stainless steel. Do not use more than four shims at any single point.

3 Pump and driver may have an intermediate shaft, spacer, or spool piece (sometimes called a jackshaft) Based on the motor nominal operating speed. Align the pump and driver to the following minimum specifications:

4 Provide final alignment settings as part of the final test data.

B Field Quality Control: Perform PT&I tests and provide submittals as specified in Section

1 Vibration Analyzer :

- Use a FFT (Fast Fourier Transform) analyzer to measure vibration levels. Provide an FFT analyzer with the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz-10 KHz (300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.
- Use an accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) with the FFT analyzer to collect data. Ensure the mass of the accelerometer and its mounting has minimal influence on the frequency response of the system over the selected measurement range.

2 Pump Acceptance

- Ensure vibration analysis verifies pump conformance to specifications. Ensure vibration levels are not more than 1.9 mm/sec at 1 times run speed and at pump frequency, and 1 mm/sec .04 in/sec at other multiples of run speed.
- Perform tests, including hydrostatic leak checking of piping and operation of equipment, in accordance with manufacturer's instructions.
- Operate pumps against static heads indicated, and verify pump-flow capacity.
- Provide final test reports to the Engineer. Provide reports with a cover letter/sheet clearly

marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition

- Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

SECTION 80 00 03 CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL)

PART 1 - GENERAL

1.1 Description

A. This guide specification covers the requirements for chlorine feeding machines for the treatment of water or sewage..

1.2 References

B. 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. The pump manufacture specifications shall prevail.

ASME B16.1 (2015)	Gray Iron Pipe Flanges and Flanged Fittings ASME B16.11 (2011)Forged Fittings, Socket-Welding and Threaded
ASME B16.3 (2011)	Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5 (2013)	Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME BPVC SEC VIII D1 (2010)	BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASTM A106/A106M (2014)	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A153/A153M (2016)	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A53/A53M (2012)	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated, Welded and Seamless
ASTM A587 (1996; R 2012)	Standard Specification for Electric-Resistance-Welded Low- Carbon Steel Pipe for the Chemical Industry
ASTM B88 (2014)	Standard Specification for Seamless Copper Water Tube
ASTM B88M (2013)	Standard Specification for Seamless Copper Water Tube (Metric) ASTM D1785 (2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM F441/F441M (2013; E 2013)	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

1.3 Submittal Requirements

A. Shop Drawings: Installation Drawings

B. Product Data: Material and Equipment and Framed Instructions

C. Test Reports: Testing

D. Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 Chlorine Feeding Machine

A Design the machine for the treatment of water by the application of chlorine [gas] against a positive head of 40m mm using the facility's [water supply system for operation of the machines under a variation in pressure from 5m minimum to 60 m head. The chlorine-feeding system consists of controls and devices necessary for a complete operating system including a chlorine

pressure gauge or other device that indicates loss of chlorine pressure, a chlorine pressure-reducing valve, a meter with rate-of-flow, injector, pressure-relief valves, water-pressure gauges, water strainers, backflow preventer and water-pressure regulator if required. Provide each chlorine-feeding machine with means for [direct cylinder mounting] [wall mounting] [floor mounting on a panel or in a cabinet] and design so that the chlorine gas feed rate control is under pressure when the machine is in operation. [Mix chlorine gas with liquid after being measured through the meter. The chlorine feeding machine must function accurately regardless of normal variations in pressure in the chlorine cylinders. In case of failure of the chlorine supply, the machine must be the type that is automatically protected against flooding or damage so that under operating conditions it is not possible for water to get back into the chlorine inlet line or dry-gas control parts. Parts subject to contact with chlorine must be made of materials resistant to the action of chlorine at the pressures and concentrations that could be encountered. Construction must be as simple as practicable to provide reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

B Capacity: Each chlorine-feeding machine must be capable of delivering chlorine to ensure a residual chlorine of 0.3% in 24 hours and capable of continuous operation at rated capacity.

C Chlorinator Controls: Provide [fully automatic] / [semiautomatic] [program control] /[manually-adjusted] type chlorine-feeding machine. Fully automatic machines must be capable of receiving standard 4-20 mA control signals. Fully automatic controls consist of devices with accessories to adjust continuously the rate of chlorine feed automatically in direct proportion to flow and chlorine residual [to compensate for changes in the chlorine demand of the water being chlorinated. The controls must require no manual attention other than adjustment of the required chlorine residua. Semiautomatic controls consist of devices with accessories to start and stop the chlorine-feeding machine automatically with the starting and stopping of the waterbeing chlorinated or with a timer mechanism. Program control consists of a device with accessories to change the chlorine feed rate of the machine automatically according to a predetermined cycle. Manual controls consist of adjustment and indicating devices for regulating the chlorine dosage manually. Manually adjusted types must be capable of receiving standard 4-20 mA control signals by the addition of an automatic control device.

D Provide cylinder connections for attaching standard chlorine cylinders to the chlorine-feeding machines. Connections include flexible metal tubing, an auxiliary valve for each chlorine cylinder, a manifold for connecting cylinders to each chlorine-feeding machine, and other necessary fittings, unless the machine is direct cylinder-mounted.

E Switchover Valves: Supply two or more mechanically operated or loss of chlorine supply-operated automatic gas switchover valves to automatically regulate chlorine gas pressure]and install [in the gas header] [directly on the chlorine cylinders]. The switchover valves must be of suitable size and equipped with filters [and traps]. Factory set the switchover pressure.

F Chlorine Pressure Gauges: Chlorine pressure gauges when supplied, must be of the diaphragm type with the Bourdon tube and diaphragm compartments filled completely with suitable oil. Construct the gauge on the line from the chlorine tank to indicate accurately the pressure of chlorine gas as supplied from the gas tank to the chlorine feeder.

G Chlorine Pressure-Reducing Valves: Chlorine pressure-reducing valves must function to reduce the pressure of the gas and maintain the pressure constant for any given setting of rate of feed regardless of changes in the cylinder pressure.

H Vacuum and Chlorine Relief: Vacuum and chlorine relief shall be provided to limit the vacuum within the chlorine-feeding machines and provide for the release to a suitable vent to the outside atmosphere of any chlorine gas pressure build-up in the parts of the machine, normally under vacuum, through improper functioning of the equipment. A vacuum sealing valve which will seal off the system when excessive vacuum is present may be substituted for the vacuum relief valve.

I Chlorine-Metering Devices: Chlorine-metering devices in sufficient number shall be furnished to cover properly the range specified. The chlorine feed rate control system shall maintain the feed

rate within 4 percent of the indicated rate.

J Injectors: Injectors shall be provided with the chlorine-feeding machines to receive all chlorine and solution water and to discharge the resulting solution to the points of application. The chlorine solution shall be introduced into the watermain by means [of a hard rubber or plastic injection nozzle] of a suitable diffuser tube inserted into the main through a corporation cock].

K Alarm Actuators: Each chlorine-feeding machine shall be equipped with alarm actuators to indicate loss of vacuum and excess vacuum. Alarm actuators shall be provided for low chlorine gas pressure and high chlorine gas pressure, unless the chlorine-feeding machine is direct-cylinder mounted.

L Pressure-Relief System: Each evaporator shall also be equipped with a chlorine pressure relief system located downstream of the gas outlet. The relief system shall have the following features:
- Rupture disk with 1.7 MPa minimum rating.
- Pressure switch protected by a diaphragm seal and actuated at 137.9 kPa.
- Self-reseating pressure relief valve with manufacturer's standard pressure rating, set for a pressure compatible with the respective rupture disk rating figure.

2.2 Piping

A Water Piping: Water piping shall be galvanized steel conforming to ASTM A53/A53M or copper tubing conforming to ASTM B88M ASTM B88. Malleable-iron unions and fittings for installation of steel pipe shall conform to ASME B16.3.

B Cylinder Connections: Cylinder connections shall be flexible metal tubing of required size cadmium-plated copper. Flexible cylinder connector assembly shall be installed with lead-gasketed, naval-bronze fittings.

PART 3 - EXECUTION

3.1 Examination

A After becoming familiar with all details of work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 Installation

A. Submit 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. 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.

3.3 Chlorine-Feeding Equipment

A The chlorine feeding machines, [the evaporators] and all equipment appurtenances shall be installed in accordance with CI Pamphlet 1 and CI Pamphlet 6 so as to provide a complete and integrated system in accordance with the instructions of the manufacturer [and under the direct supervision of the manufacturer's representative].

B Pipe, Tubing, Hangers, and Supports The installation of pipes and tubes shall be in accordance with Manufacturers requirement.

3.4 Manufacturer's Field Service

A. Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.5 Framed Instructions

A. Post framed operating instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.6 Testing

A After installation of the chlorine-feeding machine [and evaporators] is complete, operating tests shall be carried out to assure that the chlorine-feeding installation operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

B Submit test reports in booklet form showing 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.

3.7 Field Painting

B. Equipment which did not receive a factory finish shall be painted as specified by the manufacture. Factory painted items requiring touching up in the field, shall be thoroughly cleaned of all foreign material and shall be primed and topcoated with the manufacturer's standard factory finish provided it does not discolour in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Coating shall be not less than 0.05 mm thick.

3.8 Operating and Maintenance Manuals

A. Submit 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.

B. Submit complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the instructions gas pipe layout, liquid chlorine pipe layout, dilution liquid pipe layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

3.9 Field Training

A. Conduct a field training course for designated operating staff members. Training shall be conducted by the manufacturer's representative and provided for a total period of 12 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

SECTION 80 00 04 SPECIFICATION DWS 1940: DESIGN, MANUFACTURE, SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF PACKAGE WATER TREATMENT PLANT

1. SCOPE

A. This specification covers the design, manufacture, supply, delivery, installation, commissioning and maintenance for a 12 months and 24 months guarantee period of the package water treatment plant consisting of filter units, chemical dosing equipment, associated pumps, pipeworks, valves and other ancillary equipment for the treatment of potable water.

2. INTERPRETATIONS

2.1 Supporting specifications

A Where this specification is required in a project, project drawings and the project specification shall form part of the contract document.

B Reference is made to the latest issues of the following standards:

DWS 1130	Design, manufacture and supply of steel pipes, specials and fittings for duties up to 4.6 Mpa design pressure.
DWS 1131	Lining and coating of steel pipes and specials.
DWS 2510	Valves.
DWS 1930	Supply, installation and commissioning of water treatment plant equipment. Section 3 Specifications for electrical equipment.
SABS 1200	As applicable.
SABS 241	Water for domestic supplies.
SABS 533	Black polyethylene pipes for the conveyance of liquids.
SABS 558	Cast iron surface boxes, manhole and inspection covers and frames.
SABS 664	Cast iron gate valves for waterworks.
SABS 746	Cast iron pipes and pipe fittings for use above ground in drainage installations.
SABS 763	Hot-dip (galvanised) zinc coating.
SABS 1024	Welded steel fabric for concrete reinforcement.
SABS 044	Welding.
SABS 0142	Wiring of premises.
BS 1247	Manhole step irons.
BS 4504	Circular flanges of pipes, valves and fittings (PN designated).
BS 4994	Design and construction of vessels and tanks in reinforced plastics.
BS 4999	General requirements for rotating electrical machines.
IEC 144	Degrees of protection of enclosures for low-voltage switchgear and control gear. Act 6/1983 Machinery and occupational safety act.

3. MATERIALS AND EQUIPMENT

3.1 Selection against corrosion

A In a water treatment plant the very corrosive nature of the environment and the substances in contact with the materials and equipment requires that special attention shall be given to the selection of materials and equipment capable of withstanding corrosion due to these circumstances.

B Any material or equipment showing signs of corrosion during the Maintenance Period shall be rejected and replaced by the Contractor at his own expense with material or equipment resistant to corrosion as shown by a re-test.

3.2 Guarantee

A. All equipment shall be guaranteed against faulty design, materials and workmanship for a period of two (2) years from the date of final completion. During this period the contractor shall attend to and rectify, at his own cost, any defects which can be attributed to faulty design, materials and workmanship. Normal wear and tear shall be excluded.

3.3 Information and technical data at tendering

A. Full information and technical data on all materials and equipment offered, shall be supplied at the tendering stage. Manufacturer's pamphlets and catalogues shall be edited and clearly marked so as to describe the particular equipment offered.

4. PLANT REQUIRED AND DELIVERIES

A The Contractor shall be responsible for off-loading all the material and equipment at the site as well as the storing of such material in a depot indicated by the Engineer.

B No delivery shall take place on Saturdays, Sundays or statutory non-working days unless special arrangements have been made with and agreed to by the Engineer. The Contractor shall be solely responsible for obtaining transport permits and clearance from road or rail authorities for the transporting and delivery of materials and equipment as well as the compliance with the requirements of such bodies.

C The Contractor shall be responsible for the supply, delivery, installation and commissioning of the following:

(a) The treatment unit together with all the mechanical equipment, valves, pumps, interconnecting pipework and electrical work necessary for the correct functioning of the whole.
(b) Chemical dosing apparatus, including a chlorinator and/or all the other treatment equipment required to ensure that the treated water is potable in conformity with SABS 241.
(c) All electrical equipment on the distribution side of a power supply point.
(d) Any other equipment included in the quotation by the Contractor.

5. FILTER

A The multimedia sand filter can be manual and automatic in operation.

5.1 Filter media

A The grading and the depth of the filter bed shall be such, that the turbidity of the filtered water shall be less than 1 NTU and the turbidity of the settled water being up to 6.5 NTU.

B Backwashing of the filter should take place not more than once daily.

5.2 Pipework

A The requirements for the pipework are as follows:

(a) Pipework shall be steel or uPVC or HDPE.

- The steel pipes, specials and fittings shall be manufactured in accordance with Specification DWS 1130.
- Steel pipework shall be epoxy lined and coated in accordance with Specification DWS 1131.
- The uPVC pipes, specials and fittings shall comply with SABS 533 Part 2 (latest issue).

(b) Pipe diameters not specified shall be determined by the Contractor to suit equipment offered and shall conform to the required flow rates.
(c) Pipework shall be adequately supported by brackets or other suitable methods. Additional support shall be provided if required by the Engineer.

5.3 Flow meters

A Flow meters shall be supplied and installed in the filtered water stream as well as the backwash water pipeline to indicate the filtered and backwash water flow rate.

B An integrator is required for each flow meter.

5.4 Valves

A Valves supplied shall be suitable for class NP 16 uPVC or Steel piping as provided in the specialist design.

B All power operated valves shall be provided with a handwheel or other acceptable control for manual operation.

C All metallic valves supplied shall be in accordance with the Standard BS Specification for the Supply of Valves, AND all related..

D The Technical Schedules included in this document shall be completed at the time of tendering.

6. PIPING FOR CHEMICALS

A. All piping to be used for the transfer of diluted chemicals shall be either class NP 16 uPVC or rubber suitable for handling highly corrosive solution/suspensive, e.g. ferric chloride. Diameters of piping shall be sized by the Contractor to suit the required flow rates. The minimum pipe diameter shall be 25 mm.

B. All piping shall be properly supported/fixed. For piping along walls, ceilings, floors, etc. AVS-PE pipe clamps or equal approved shall be used.

C. All components of valves shall be from suitable plastic materials.

D. Installation of these valves into pipelines shall be by means of unions facilitating easy removal.

E. Handles of valves shall be so positioned that the handle is in line with piping when open and at right angle to the line of piping when closed.

F. Galvanised mild steel piping may be used for the supply of service water if approved by the Engineer.

7. ELECTRICAL INSTALLATION

A All electrical installation shall conform the SABS 0142 or similar approved.

8. TOLERANCES

A Tolerances are to be such that the equipment performs within the requirements of this specification.

9. FINAL COMPLETION

A On final completion all work in terms of the contract shall be completed. A certificate of completion will then be issued.

10. MAINTENANCE OBLIGATION

A The Contractor shall maintain all equipment provided in a good working order during the maintenance period, and shall specify in his tender the number of routine maintenance visits to be undertaken.

B The maintenance period shall commence on the day following the final completion, as agreed to by the Engineer.

C The Employer reserves the right to undertake any emergency repair work during the maintenance period without the prior consent of the Contractor. The Engineer has the right to decide whether the emergency exists and shall notify the Contractor accordingly. Should this emergency repair work be caused by poor material, faulty workmanship or neglect on the part of the Contractor, the Employer may deduct the cost of the repair work from the outstanding retention money owing to the Contractor.

11. OPERATION AND MAINTENANCE MANUAL

A Five comprehensive copies of operation and maintenance instructions in the form of hard covered manuals with a rear pocket enclosing prints of relevant as-built drawings shall be supplied.

B All manuals shall be supplied prior to handover/acceptance of equipment. The Completion Certificate will neither be issued nor will the corresponding payment be made until the above manuals and drawings have been supplied.

C Operating instruction shall include -

- index;
- pre-start check list;
- step by step description of the approved procedures for all modes of operation of equipment;
- description of required safety checks.

D Maintenance manual shall include -

- index;
- details of routine and regular maintenance work which the manufacturer considers necessary to maintain equipment in satisfactory running order;
- instruction for the repair or replacement of warn or damaged parts;
- schedules of routine testing of electrical equipment (as recommended by specific suppliers);
- spare parts list;
- particular technical data of equipment;
- preference list, including local agents for supply and repairs of specific equipment; and
- all schematic wiring diagrams pertaining to technical equipment.

E The Contractor shall, in addition to supplying the above information, undertake to instruct departmental staff and satisfy himself that they are capable of operating all equipment when it has been commissioned.

12. TESTING

A. On completion of the installation and as soon as convenient for the client, but not later than five weeks after completion, the complete works shall be started up, tested, and commissioned to the satisfaction of the Engineer.

SECTION 80 00 05 SPECIFICATION DWS 1810: SPECIALIST SERVICES

1. SUPPORTING SPECIFICATIONS

A Reference is made to the latest issues of the following standards:

SABS 110	Sealing compounds for the building industry, two-component, polysulphide base.
SABS 298	Mastic asphalt for damp-proof courses and tanking.
SABS 745	Bituminous roofing.
SABS 952	Polyolefin film for damp-proofing and waterproofing in buildings.
SABS 021	Waterproofing of buildings.
CKS 388	Rubber waterstops.
CKS 389	Flexible polyvinyl chloride waterstops.
BS 903	Methodes of testing vulcanized rubber.
BS 1763	Thin PVC sheeting.
BS 2499	Hot applied joint sealants for concrete pavements.
ASTM	Specification C156, C309, C494 and D1752.

U.S. Federal specification HH-F-341f.

2. JOINT FILLERS AND SEALERS

2.1 Filler sheeting

A Expansion joints shall be formed and filled with a resin bonded cork conforming to the U.S. Federal Specification HH-F-341f (Type II Class B) and ASTM specification D1752.

2.2 Joint sealants

3.2.1 Horizontal joints

A The sealer shall be hot-poured rubber-bitumen compound complying with BS 2499, type A1, used in conjunction with a compatible bitumen based primer to give added bond strength.

3.2.2 Vertical and inclined joints

A The sealer shall be a bituminous putty, Expandite "Plastijoint" or similar. The putty shall not slump in joints 40 mm wide and 25 mm deep at 82 C and shall comply with the BS 2499 extension set A primer approved by the manufacturer shall be used in conjunction with the putty.

3.2.3 Horizontal, vertical or inclined joints

A The sealer shall be a polysulphide liquid polymer conforming to the SABS 110 and shall be supplied in conjunction with primer strictly in accordance with the manufacturer's recommendations and instructions.

B The success of using this sealer depends entirely on correct application. The Contractor shall ensure that he follows all instructions and carries out every phase of the work correctly. He shall be held responsible for any defects in jointing that might apparent either during construction or during the maintenance period.

3. EXPANSION JOINT CONSTRUCTION

A Where shown on the drawings expansion joints shall be formed in conjunction with the designated waterstop by the use of filler sheeting strip to create the required gap which unless otherwise stated shall be 12 millimetres in widths. The strip shall be fastened to the end shutter in such a way that

on removal of the shutter the strip will adhere to the concrete previously cast. After the adjacent concrete has been cast and cured for the prescribed period the filler sheeting can be raked out to the required depth to provide a cavity for the sealing compound.

B As an alternative, the cavity for the sealing compound may be formed by strips of soft board fastened to the end shutter on both sides of the filler sheets. The soft board can be raked out after curing of the concrete as described above.

C The formed cavity shall be dry before placing the sealing material and all dust, scale, grit, earth and loose stones shall be removed. Before sealing with bituminous putty and approved bituminous primer recommended by the manufacturer of the sealing material shall be brushed or sprayed into the cavity and on the surface of the concrete on either side of the joint to a width of a least 20 millimetres. The primer shall be allowed to dry completely but in no case for less than 12 hours before sealing.

D Rubber bitumen compound shall be heated to the required temperature immediately prior to application but in no case above a temperature of 190.During heating and prior application the the compound shall be continuously stirred. Heating shall be carried out indirectly through an oil sealed jacket using high flash point oil.

E The tins bituminous putty shall be heated in boiling water for at least 30 minutes prior to application. It shall be well caulked down into the cavity to fill be crevices, ensuring good contact with the sides of the joint, using a heated caulking iron. Sufficient excess material shall be applied to leave the seal lighty protruding above the surface of the concrete lining. The seal shall be neatly finished by cutting away the excess material along the joints by means of a heated knife.

4. WATERPROOFING OF BASEMENTS AND FLOORS

4.1 Mastic asphalt

A The mastic asphalt used shall comply with the requirements of SABS 298, and shall be applied strictly in accordance with clause 3.4.2 and 3.4.3 of SABS 021.

5. WATERPROOF MEMBRANES

A The membrane material shall be supplied in rolls of a length and width as large as practicable for purposes of manufacture, transport and handling on site such as to exclude all transverse joints and minimise field jointing.

B Any material delivered to site which does not conform to the specification will be rejected and shall be removed and replaced by the Contractor at no cost to the Department.

5.1 PVC Sheeting

A PVC sheeting shall comply to BS 1763.

B The PVC sheeting shall have a minimum thickness of 1,5 mm and shall be supplied in rolls of a width such as to keep field jointing to a minimum.

C All joints shall have a minimum tensile strength equal to 90 % of the original tensile strength of the sheets. Splices shall be made with minimum overlaps of 150 mm and shall be hot vulcanized or glued together with a approved mastic. The strength of the splices shall be 2,68 N per mm width in peel. After ageing the splice shall retain a minimum of 90 % of the original strength of the sheeting.

D Where required as a waterproof membrane for earth embankments, the sheeting shall be laid with a 10 % slack to provide for settlement. Under no circumstances shall the sheets be punctured or otherwise damaged during installation or during backfilling.

5.2 Roofing felt

A Roofing felt for the waterproofing of concrete roofs shall be a glass fibre base bituminous roofing felt complying to SABS 745, type 100 and applied in accordance with clause 6.1.3.2 of SABS021 or similar approved.

5.3 Polyethylene sheeting

A With carbon black pigment: The polyethylene sheeting shall conform to SABS 952 and shall contain carbon black as specified in clause 3.2.

B With other pigment:

- The polyethylene sheeting shall conform to SABS 952 or similar approved
- The polyethylene sheeting shall have a minimum thickness of 250 micrometres and shall be supplied in rolls of a width such as to keep field jointing to a minimum.
- All joints shall have a minimum tensile strength equal to 90 % of the original tensile strength of the sheets. Jointing shall be effected by the proof welding technique as specified by the manufacturers.
- Under no circumstances shall the sheets be punctured or otherwise damaged during installation or backfilling.

6. CONCRETE ADDITIVES AND CURING COMPOUNDS

A. The following types of additives and curing compounds shall be acceptable to the Engineer.

6.1 Additives

A. Air Entraining Agents shall comply to the requirements of ASTM C 250 and Water Reducing Admixtures shall comply to ASTM C 494, Type A. The additives shall preferable be free of chlorides.

6.2 Curing agents

A. Curing agents shall be membrane forming compound complying to the requirements of ASTM C 309 adn ASTM C 156 types 1, 2 and 3. The white pigmented type 2 is preferred.

8.1 Roller-shutter doors

A Roller-shutter doors shall be manufactured from minimum 1,2 mm thick heavy galvanised steel interlocking slats. The guids, angle bottom rail, brackets, bearings etc. shall be of the heavy duty type and the roller assembly shall consist of a seamless steel tube and heavy duty steel spindle all suitably treated and painted for protection against corrosion and housed in a 1,0 mm thick pressed galvanised sheet iron casing with removable panels for maintenance and lubrication. The roller-shutter doors shall be gear operated with suitably located stout cranking handles.

8.2 Sliding doors

A These shall be in the sizes specified. Top hung type manufactured from 1,6 m thick galvanised pressed steel sections supplied, delivered to site and erected complete including all necessary tracks, handles, stays, bolts, hasps and staples and pelmets etc. or similar approved type.

8.3 Jack-knife doors

A These shall be in the sizes specified as "Macmill" double panel type, hinged in center across full width, manufactured from minimum 1,6 mm thick galvanised pressed steel sections, supplied, delivered to site and erected complete with all guides, springs or counter-weights, bolts, handles etc. or similar approved type.

9. TEST ON CONCRETE WATER RETAINING STRUCTURES FOR WATERTIGHTNESS

A After completion of construction and when all concrete in contact with water is at least 28 days old, all concrete water retaining structures shall be tested for watertightness.

B Immediately any part of the Works is ready for testing for watertightness, water shall slowly be let into the structure. Should any noteworthy leak be observed during the filling, the structure shall immediately be emptied and the leak traced and repaired to the satisfaction of the Engineer, where after the test may be resumed.

C When the structure is full and no visible leak is apparent, the inflow shall be stopped and the water level accurately recorded and again recorded 24 hours later.

D Concurrently with this test the Contractor shall carry out an evaporation loss test by providing a steel tank 600 mm x 600 mm x 450 mm deep, filling with 300 mm of water, and accurately measuring the drop in water level during 24 hours. This drop in water level shall be regarded as a measure of the evaporation loss, and shall be used to calculate the probable evaporation loss in the structure being tested.

E Should the water level in the structure have dropped by not more than 4 mm plus the calculated evaporation loss, the structure shall be accepted as watertight.

F Watertightness of reservoir roofs shall be tested by thoroughly hosing water over the roof and the roof shall be considered watertight if there is no leakage after 2 hours.

10. STERILIZATION

A After completion of the test for watertightness, all structures in contact with filtered water shall be sterilized.

B Filtered water channels in the filter gallery shall be sterilized by hosing down all internal surfaces, pipes and fittings with water uniformly chlorinated to a chlorine content of 20 mg1-1, allowing the chlorinated water to drain down into the wash water tank.

C The wash water tank shall be filled with water to a depth of 300 mm and this water shall be uniformly chlorinated to a chlorine content of 20 mg1-1. The chlorinated water shall then be sprayed by means of an air pump and fire hose with fire nozzle over all internal surfaces including the roof, piping, fittings and ladder. After the last person has left the tank, a quantity of chlorinated water shall be poured over the access ladder. The tank shall then be filled with water while further chlorine is added till chlorinated water with a chlorine content of 20 mg1-1 starts flowing into the clear water reservoir after which the wash water tank will be drained via the scour.

C The clear water reservoir shall be filled to a depth of 300 mm with water uniformly chlorinated to a chlorine content of 20 mg1-1. The chlorinated water shall then be sprayed, as in the case with the wash water tank, over all internal surfaces including pipes, fittings and the ladder. After the last person has left the reservoir, a quantity of the chlorinated water shall be poured over the access ladder. The chlorinated water shall then be allowed to fill the outlet pipe up to the high lift pumphouse after which all water shall be drained via the scours.

D Should it be necessary after the above procedure has been carried out for any person to enter any of the sterilized structures, the sterilizing process shall be repeated for that structure.

E If re-entry is due to any reason for which the Contractor is responsible, the repetition of the process will be carried out at the Contractor's expense.

F During all stages the Contractor will be held responsible for safeguarding the health of his employees.

11. MEASUREMENT

A The unit of measurement for jointing materials shall be the square metre of each thickness and type of filler sheeting. Distinction and separate measurement shall be made between faces as divided by the waterstop. For the purpose of measurement the center of the waterstop shall be accepted as the demarcating line.

B The unit of measurement for expansion joint sealing shall be the linear metre of each type of sealant applied.

C The unit of measurement for waterproof membranes shall be the square metre of each type installed.

D No measurement for payment shall be made under this Section for jointing and joint sealing when the work described in this Section is deemed to be subsidiary obligation of the Contract in terms of another Section of the Specification.

PART B-ELECTRICAL WORKS

MOI INTERNATIONAL AIRPORT

ELECTRICAL INSTALLATION

11KV XLPE CABLES AND TERMINATION KITS

E16108 11KV XLPE CABLES AND TERMINATION KITS-

1. SPECIFICATION FOR 11 KV XLPE CABLES

PART 1: GENERALS

1.1 Description

The scope of works shall include the following:

i. Supply and install underground 120mmsq and 50mmsq 11kv XLPE armoured Copper Cable run in concealed concrete surrounded ducts buried in ground including termination at the power boards
ii. Construction of man holes as per Civil engineer's requirements
iii. Supply and installations of 12Core Fibre optic cable including terminations
iv. FAT for materials/equipment supplied

This specification is for single/three core, stranded copper conductors, cross – linked polyethylene insulated, lead sheathed, un-armoured, PVC outer sheathed power cables for operation up to and including 11000 volts to sheath and 11000 volts between conductors.

The cables shall be used for interconnection between the Substations A, B, C and D and all other substations on the Airport Ring and also for completion of the Commercial Ring.

1.2 Service Conditions

The cables in these specifications shall be suitable for both outdoor and indoor use, fully exposed under the following tropical atmospheric conditions:-

A. Altitude Range: 100mm above sea level

B. Ambient Temperatures:
- maximum 40ºC
- minimum 5ºC
- Average 26ºC

C. Humidity:
- Maximum 95%
- Minimum 50%
- Average 87%

1.3 System Characteristics
- System voltage: 11kV
- Short circuit current: 25KA
- Rated Voltage: 11KV
- Frequency: 50Hz

1.4 Design and Manufacture

The cable shall be designed, manufactured and tested in accordance with IEC 60502/BS6622

1.4.1 Conductor Details

The Conductor shall be metal-coated copper in accordance with IEC 60228 specifications, compact round single and three cores.

Conductor nominal sectional area shall be as per contract drawings and schedules
Conductor shape Compact round stranded
Thickness of insulation 3.4 mm

1.4.2 Insulation

The insulation shall be dry cured cross-linked polyethylene (XLPE) uniformly blended and dispersed.

Nominal average insulation thickness not less than 3.4mm excluding conductor screen and insulation screen.

Minimum thickness at a point shall not be less than 90% of the nominal average thickness

1.4.2 Screening

Shall consist of conductor screening and insulation screening. Shall be supplied over each individual core for three-core cable. Material shall consist of non-metallic, semi conducting material for conductor screening and consist of non-metallic part for insulation.

Interface between screen and insulation shall be smooth. Nominal thickness of conductor screen, not less than 0.8mm.

1.4.4 Laying up

For the core cable, the screened cores shall be laid up together with filler to form a compact circular assembly and lapped with a binder tape so designed to ensure continuous contact between core screens.

1.4.5 Inner Covering and Filler

Shall be extruded and shall be XLPE material.

1.4.6 Metallic Sheath

There shall be a lead alloy sheath extruded over the cable core. The sheath shall be impervious to moisture, reasonably close fitting and free from defects. The lead alloy sheath shall comply with the requirement of BS 60801/IEC 1000-4.

1.4.7 Serving (Over sheath)

Extruded over-sheath shall be of black polyvinyl chloride (PVC).

1.4.8 Embossing of PVC

The cable shall be clearly and permanently embossed with the following information throughout the length of the over-sheath. Letters and figures shall be raised and consist of upright block characters.

Minimum size of characters not less than 15% of average overall cable diameter.

(i) 11,000 VOLTS XLPE POWER CABLE
(ii) Year of manufacture
(Example: 11000 VOLTS XLPE POWER CABLE, 2021)

1.4.9 Metallic Sheath

Shall be extruded lead alloys complying with BS 60801 specification and shall be impervious to moisture, reasonably close fitted and free from defects. Nominal thickness of the sheath shall not be less than 1.9mm.

1.4 Inspection and Testing

Conductor resistance test, high voltage test and insulation resistance test shall be done in accordance with the requirements of IEC60502.

Cable shall be subjected to inspection and witnessing of routine tests in accordance with the requirements of IEC 60502.

1.5 Packing

The cable shall be coiled on wooden (or steel) drum carefully lagged in suitable lengths. The wooden drums shall be made from treated timber resistant to termite attacks. The drum shall be of robust construction and shall have a distinguishing number branded or neatly chiselled on the outside of one flange and labelled to show the description of the cable and size, length and the total weight.

2. SPECIFICATION FOR HEAT SHRINKABLE TERMINATIONS KITS

2.1 Scope

This specification covers the design, manufacture, testing and delivery of Heat Shrinkable Kits for terminations of 11kv single core and three core cables at indoor switchgear (circuit breaker) and power transformer cable end box.

2.2 Conformity with Specifications

The Heat Shrinkable kits shall be of Raychem terminations type or equivalent and shall conform in all respects with the requirements of British Standards or IEC Standard.

2.3 Operating Conditions

The Heat Shrinkable kits shall be suitable for outdoor/indoor use fully exposed under atmospheric conditions specified below:-

A. Altitude Range; 100mm above sea level

B. Ambient Temperatures:
   - Maximum 40ºC
   - Minimum 5ºC
   - Average 26ºC

C. Humidity
   - Maximum 95%
   - Minimum 50%
   - Average 82%

D. Installation Area
   Moi International Airport. Maximum Humidity is 95% and the atmosphere is polluted with cement and coal dust some corrosive effect but with low isokerannic level.

2.4 Design

The Heat Shrinkable kits termination shall be designed to accept single core or three core XLPE copper cables for termination in switchgear and transformer for the sizes specified in the contract documents or as indicated in the Substations.

2.5 System Characteristics

- Nominal System Voltage 11kv
- Highest Voltage 12kv

- Basic insulation level 95kv
- Frequency 50Hz

2.6 Identification

Each kit shall have marked on the manufacturers name or trademark, the year of manufacture and the kit reference. The marks shall be visible after assembly of fittings shall be imprinted and impressed.

2.7 Inspection and Tests

The Heat Shrinkable kits shall be subjected to inspection and witnessing of routine tests in accordance with the requirement of British Standards at the manufactures works before dispatch by Inspection Engineers appointed by the Client.

2.8 Certificate of Compliance

The Sub-Contractor shall submit for approval, Manufacture's certificate giving results of all tests in accordance with the requirements of British Standards or IEC Standards before the kits are packed for dispatch.

Summary KAA's Requirements

No	Description	Units	120mm²	50mm²
1	Cable type	Cu/XLPE/SC/SWA/PVC		
2	According to regulation	BS 6622		
3	Rated voltage (U)	(kV)	11kV	
4	Voltage to neutral (Uo)	(kV)	6.35kV	
5	Material of conductor	Copper		
6	Nominal cross-section area of conductor	(mm²)	120mm²	50mm²
7	Number of cores/conductors	3 Core		
8	Material of insulation	XLPE		
9	Identification of cores	Red-Yellow-Blue		
10	Thickness of insulation	(mm)	3.4	
11	Screen size	(mm²)	16mm²	16mm²
12	Armouring type	Round galvanised steel wires SWA		
13	Material of cable sheath	PVC	3.5	3.5
14	Thickness of cable sheath	(mm)	3.5	3.4
15	Overall diameter (Approx.)	(mm)	67	52
16	Permissible operating temperature of conductor	(°C)	90	90
17	Permissible temp.in emergency overload	(°C)	130	130
18	Permissible short-circuit temperature up to 5 sec.	(°C)	250	250
19	Permissible final temperature of copper screen	(°C)	250	250
20	Nominal short-circuit current for 1 second of conductor	(kA)	17.2	17.2
21	Nominal short-circuit current for 1 second of screen	(kA)	3.3	3.3
22	Conductor DC resistance at 20 °C	(Ohm/km)	0.153	0.387
23	Net weight of cable	(kg/km)	9300	5050
24	Minimum bending radius of cable	(mm)	1005	950

2.9 Surge Protections Devices in the LV Panels

There are three (3) types of SPDs:

Type I: The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage. It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors. Type 1 SPD is characterized by a 10/350 µs current wave.

Type II: The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltage in the electrical installations and protects the loads. Type 2 SPD is characterized by an 8/20 µs current wave.

Type III: These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads. Type 3 SPD is characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

The protective devices should be connected directly to earthing and bonding bars.

Each surge protection device must be equipped with a trip alarm to be connected to EPMS. If required according to manufacturer documentation, the surge protection device must be accompanied by a short circuit protection device.