

**MINAS DE BENGÁ**



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**INTERNATIONAL COAL VENTURE LIMITED MOZAMBIQUE (ICVL) OPERATION**

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**Contract No. ICVL/TE/068/2019**

**Design Validation and Supervision of Construction for the Development of Tailings Storage Facilities (TSF 3) at Benga Mine, in Tete Province, Mozambique**

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**EARTHWORKS SPECIFICATION FOR THE  
CONSTRUCTION OF TAILINGS CELL 3**



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## **1.0 GENERAL DESCRIPTION**

The contract comprises the construction of the new Tailings Cell Number 3 (TC3) and its appurtenant works at ICVL's Benga Coal Mine (Benga).

## **2.0 GENERAL**

This Engineering Specification defines the requirements for setting out, clearing and grubbing, stripping, excavation, embankment construction and miscellaneous site preparation and construction works for Stage 1 of TC3.

The work covered under this Specification includes:

- TC3 embankments
- Return water and drainage ponds
- Ancillary works including:
  - Penstocks pipe and inlets,
  - Slurry delivery pipeline,
  - Spillway
  - Etc. as shown on the drawings.

## **3.0 DESCRIPTION OF SITE AND ACCESS**

The SITE of the works is located to the south of the existing Benga Coal Handling and Processing Plant, some 8 km to the east of the town of Tete in Mozambique. Primary access to the site will be through the Mine Coal Processing Plant and from the north of the Tailings Storage Facility area.

## **4.0 SITE INSPECTION**

The Contractor shall be deemed to have examined the site and surroundings and to have informed themselves fully as to the physical conditions on and below the surface, and as to any measures required to obtain access.

Where a site investigation report is provided, the Contractor may use factual information (strata descriptions and levels) as a basis to inform themselves, but opinion and interpretation in the report shall be utilised at the Contractor's risk. Should the Contractor wish to conduct further investigations, these investigations will be subject to approval by ICVL Representative and at the Contractor's expense.

## **5.0 DEFINITIONS**

- Owner - ICVL
- ICVL Representative – appointed by ICVL to manage and/or supervise the construction works
- Contractor – appointed by ICVL to carry out all or part of the works
- Engineer – TC3 design engineer (SWMoz-Svosve, Lda) appointed by ICVL

## **6.0 NATURE OF GROUND AND SUBSOIL CONDITIONS**

Generally, the site comprises a series of mostly sandstone ridgelines, separated by in-filled gullies and creeks. The ridgelines often have rock outcropping at the surface or present below a thin cover of fine, silty topsoil and colluvial soils.

Within the gullies, rock is generally present at depths between 1 and 3 m. Soils within the gullies vary but are typically sandier or clayey on the site. It should also be noted that fine silty "topsoil" materials may also be present in varying thickness in the upper 1m of the soil profile.

## **7.0 DETAILS OF CONTRACT**

The Contractor is to note that the contract period may overlap the rainy season and that adequate protection of the Works will be required. The contract shall be performed under ICVL terms and conditions.

## **8.0 SITE FACILITIES AVAILABLE**

### **8.1 WATER**

The Contractor shall make his own arrangements for the supply of potable water and water for construction purposes and for electrical power and all other services, as well as for all safety and security measures necessary for the duration of the contract. It cannot be assumed that uninterrupted electrical supply, water or telephone services are available at the site.

No direct payment will be made for the provision of water, electrical power and other services. The cost of providing all services will be deemed to be included in the rates and amounts tendered for the various items of work for which these services are required.

### **8.2 SITE ESTABLISHMENT**

The Contractor will be responsible to provide a suitable site for his site office. The Contractor must make his own arrangements for a suitable site office. The location of the Contractor's site office and other site facilities will be subject to the approval of the Engineer, as well as the approval of any Local Authority, which approval shall be obtained by the Contractor.

### **8.3 SITE FACILITIES REQUIRED**

#### **8.3.1 Power**

The Contractor must make his own arrangements concerning the supply of electrical power and all other services. No direct payment will be made for the provision of electrical and other services. The cost of providing these services will be deemed to be included in the rates and amounts tendered for the various items of work for which these services are required.

#### **8.3.2 Contractor's offices**

The Contractor shall provide, erect, on or about the Site of the Works, move and re-erect as necessary, maintain and remove at completion, ample temporary office/s for the use of his site agent and staff.

**8.3.3 Temporary sheds**

The Contractor shall provide, erect, move and re-erect as necessary, maintain and remove at completion, ample temporary sheds for the proper storage of materials and tools and for the use of the workmen and watchmen, including special weatherproof sheds for the storage of cement.

**8.3.4 Engineer's site office**

The Contractor shall provide, maintain and remove on completion, office space for the Resident Engineer on site. The office must be well insulated, air conditioned and of the semi-permanent type, with dimensions of not less than 4 m x 4 m. The furnishings shall include a desk, a drawing table, a lockable filing cabinet, a plan cabinet or hanging rack, four stackable chairs, washing facilities, and appropriate parking.

**8.3.5 Site laboratory**

The Contractor shall provide an adequate laboratory, equipment, facilities and personnel for carrying out the required quality control tests on the construction materials.

Should the Engineer at any time consider any of the facilities above to be inadequate, he shall instruct the Contractor to cease further work until such time as the Contractor has remedied the deficiency. In such cases, ICVL should have the right to indicate a third party to carry out the tests, at the contractor's expense.

**8.3.6 Sanitary Facilities**

The Contractor shall supply suitable and adequate sanitary facilities for the use of his staff and workmen. Such facilities shall be to the satisfaction of the Employer and the Engineer and shall conform to Local Authority requirements and the Minerals Act. The Contractor shall, before signing the Contract Documents acquaint himself fully with these requirements.

The Contractor shall maintain in a thoroughly clean and orderly condition, move as required and finally remove from site all such sanitary facilities and make good to the approval of the Engineer and the Employer.

The siting of sanitary facilities must be in an appropriate and restricted area and the use of said facilities by the general public will be strictly prohibited.

**8.3.7 Security**

The Contractor shall be responsible for the security of his personnel and Constructional Plant on and around the Site of the Works, and the Employer will consider no claims in this regard. The security guards must be provided with a two-way radio and be in constant contact with the control room of the security company and an armed response unit if necessary.

**8.3.8 Telephones**

The Contractor must make his own arrangements for communication links.

**8.3.9 Accommodation for employees**

No accommodation for employees is available on the site or mine property and the Contractor shall make his own arrangements for housing employees at his own cost. It is deemed that the Contractor has made full provision for any such accommodation.

**8.3.10 Lightning shelters**

The Contractor shall provide shelter for workers in the event of the occurrence of a thunderstorm and shall furthermore ensure that all work on the Works and its surrounds ceases for the duration of such an event.

**8.3.11 Gas Bottles**

Gas bottles shall be clearly marked as to their contents and their ownership. Any person removing gas bottles from the Site or using bottles belonging to others within the Site without permission will be evicted from the Site.

**9.0 SPECIAL FEATURES REQUIRING ATTENTION**

**9.1 PROTECTION OF EXISTING SERVICES**

**9.1.1 General**

The Contractor shall, during the execution of the Contract, take care that existing services, e.g. power lines, cables, pipelines, etc., are not damaged or interfered with.

When any such service is encountered and is likely to impede the progress of the Contract, the Engineer shall arrange as far as possible for the re-location of the service.

The Contractor shall have no claim in regard to delays occasioned by alterations to any such services other than a claim for extension of the Completion Date of the Works.

Prior to any starting of activity with the possibility of such services, the contractor must liaise with the ICVL representative for consultations and clarifications.

**9.1.2 Existing Tailings Cells (TC1 and TC2)**

Extreme care should be taken so as not to disrupt or hinder the tailings deposition and construction operations in and around TC1 and TC2. The Contractor is required to liaise, through ICVL representative, with the TC2 operator should he need to access, alter or repair any of the infrastructure of the TC2, or the new TC3 once it has been commissioned.

The Contractor is responsible for any damages to the TC1 and TC2 and their infrastructure which might be caused by the construction activities. These damages are to be repaired immediately and at the Contractor's expense.



### **9.1.3 Power Lines**

The attention of the Contractor is drawn to the Power Line to the west of TC3. The Contractor must ensure the safety of his employees when operating near all power lines. Extreme care should be taken so as not to damage the power lines during construction.

## **9.2 SETTING OUT**

The Contractor shall be wholly responsible for the setting out of the various Works in accordance with the drawings supplied. Although the Engineer may require such setting out and levels to be checked from time to time, such checking will not relieve the Contractor of full responsibility for the accuracy of such setting out and levels.

### **9.2.1 Costs**

The cost of all survey including setting out shall be deemed to be included in the scheduled rates or specifically allowed for in the Preliminary and General costs.

### **9.2.2 Base lines and benchmarks**

ICVL will supply established survey control points.

The ICVL representative will establish base lines and benchmarks, as shown on the drawings, from which the Contractor shall complete the detailed set-out for the work.

If such base lines or benchmarks are disturbed in any way by the Contractor, they will be re-established by the ICVL Representative at the Contractor's expense.

### **9.2.3 Detailed set-out**

Detailed set-out shall be carried out by suitably qualified persons to establish all lines and levels and grades necessary for earthworks construction. Full records of all field work shall be kept in accordance with good surveying practice, and field books shall be available for inspection by the ICVL Representative at any time.

### **9.2.4 Approval of set-out**

The Contractor shall be responsible for the accuracy of the detailed set-out. On completion of setting out each portion of the works the Contractor shall notify the ICVL Representative, in writing, and shall obtain approval to proceed with construction.

The ICVL Representative may elect to check the Contractor's setting out, but approval to proceed (whether or not the ICVL Representative checks the set-out) shall not diminish the Contractor's responsibility for the accuracy of the work.

## **9.3 SITE ESTABLISHMENT**

The Contractor should note that the term "Site Establishment" covers all items involved in the establishment by a Contractor of his construction camps for carrying out the Works, their maintenance and their removal

at the end of the Contract, and includes all accommodation and facilities he considers necessary for his personnel, plant, stores, etc. It also includes all movement of personnel and plant to the Site prior to starting work and from Site after completing work and leaving the Site clean and tidy and free of any obstructions. It shall also be deemed to include site sanitary arrangements, all insurances as called for in various sections of this document, all site and head office supervision and travelling expenses thereby entailed.

#### **9.4 SUPERVISION AND ENGINEER'S INSTRUCTIONS**

During the execution of the Works and until completion thereof, the Contractor shall keep on the Site one competent head representative (approved of in writing by the Engineer, which approval may be withdrawn at any time), who shall superintend the Works, receive on behalf of the Contractor instructions from the Employer and/or Engineer and be responsible for the behaviour of the Contractor's employees. The Contractor shall be required to sign a Responsible Person's form.

The Contractor shall have on Site as necessary competent agents and foremen in charge of the work in progress. The Engineer will require details of past experience of agents and senior foremen to be submitted to him for approval before they take up position on the Site.

The Contractor shall carry out and maintain the Works in strict accordance with the Contract to the satisfaction of the Engineer and shall comply with, and adhere strictly to, the Engineer's instructions on any matter within the scope of the Contract, (whether mentioned in the Contract or not), who may, in his absolute discretion, and from time to time, issue further drawings, details and/or written instructions and/or directions and/or written explanations.

#### **9.5 SITE MEETINGS**

The Engineer will hold regular weekly site and monthly progress meetings, keep and circulate minutes. The Contractor shall attend all scheduled meetings and shall ensure that all sub-contractors are represented.

#### **9.6 WATCHING AND LIGHTING**

The Contractor must programme his work in such a way that the Site is secure at all times. The Employer reserves the right to suspend work if, in his opinion, this requirement is not being complied with and, further, to make secure the area and recover any costs involved in labour and materials from monies due to the Contractor.

The Contractor shall make provision in the nature of temporary works as may be required for the purpose of ensuring the safety of adjoining works and property and for the protection of all persons or animals. He shall be responsible for all damage, injuries and accidents that may occur through his omission of any necessary provision in this respect.

The Contractor shall make full provision for all watching and lighting necessary for the protection of all persons, animals, vehicles, etc., from injury by reason of the Works. He shall provide ample warning signs,

guard rails, etc., around open trenches, stacks of material, excavated materials, debris or the like, and shall provide walkways over trenches wherever required for the convenience of the public.

The Contractor shall provide and maintain all necessary temporary protection of finished and/or existing work liable to be damaged during the progress of the works by properly covering up, isolating, etc., as required. The Contractor shall be responsible for any damage which may occur and shall make good the same at his own expense.

Fires will only be allowed in such places as are approved by the Engineer. Any workmen lighting fires in an unauthorised place shall immediately be removed permanently from site.

#### **9.7 CLAIMS FOR INJURY OR DAMAGE**

The Contractor shall notify the Engineer immediately of the receipt by him of any claim for compensation in respect of any damage arising out of his execution of the Contract and if, at the expiry of ninety (90) days from the date of receipt of such claim the Contractor cannot satisfy the Engineer that the matter has been settled, the Employer reserves the right to have the claim investigated and adjudicated by the Engineer and to settle the claim where considered necessary, any costs incurred by the Employer thereby to be recovered from the Contractor by deduction from any monies due to the Contractor.

#### **9.8 SAMPLES OF MATERIAL**

Samples of materials to be used upon the Works shall, when required, be submitted at the Contractor's expense to the Engineer for approval before use, and any material brought on to the Works which, in the opinion of the Engineer, does not meet the standard of the sample so submitted or is considered by him in any way unsuitable for its designed purpose, shall be removed immediately once instructions to that effect have been given.

#### **9.9 MEASUREMENT AND PAYMENT**

Measurement of completed work will be made monthly in accordance with the General Conditions of Contract.

#### **9.10 ADVANCE PAYMENTS ON MATERIALS**

The Employer reserves the right to pay for principal or major materials supplied and delivered to Site but not installed. Any payments of this nature must be completely secured by means of a legally accepted Waiver of Lieu.

This payment will only be considered if there is a substantial discount, or alternatively beneficial advantages to the Employer.

Should the Employer consider paying for principal materials on Site then the Contractor / Supplier has the opportunity to price any items in the schedule of quantities to show the discount the Contractor will pass, alternatively, the benefit such payment has towards the Employer.

**9.11 CONTRACTOR'S PLANT, TOOLS AND SCHEDULES FOR MANPOWER**

The Contractor's plant and tools shall be of modern design and construction, suitable for the duties required of them. They shall be in sound working condition and shall be sufficiently ample in capacity or number to enable the work to be carried out efficiently and expeditiously. Should the Engineer be of the opinion that the plant used by the Contractor is insufficient or in any way unsuitable for carrying out the Works in a manner or at a rate commensurate with his requirements, he shall have the right to call upon the Contractor to provide such additional or approved plant and tools as may, in his opinion, be necessary to attain these requirements.

**9.12 LOCAL AUTHORITY, PROVINCIAL OR GOVERNMENT ADMINISTRATION, ETC**

The Contractor shall acquaint himself with all and any standards and requirements laid down by a Local Authority, Provincial or Government Administration, etc., for the work about to be executed, and shall abide by such standards and requirements throughout the duration of the Contract.

**9.13 MAINTENANCE PERIOD- DEFECTS LIABILITY PERIOD**

Refer to the General Conditions of Contract and Contract Data and Special Conditions of Contract.

The maintenance period shall be twelve (12) months, commencing from the date of issue of the Certificate of Completion, with the exception of those items indicated thereon, for which the maintenance period will commence on the date of rectification.

**9.14 CLEANING OF SITE ON COMPLETION**

On completion of each section of the Works, or if directed by the Engineer on completion of any portion of the Works, the Contractor shall remove surplus materials, construction plant and equipment not to be used at, or near, the same location during later stages of the work.

In the event of the Contractor's failure to comply with the above, the same may be accomplished by the owner at the Contractor's expense.

**9.15 INCLEMENT WEATHER CONDITIONS**

An extension of Contract completion time for delays due to inclement weather will only be considered when it can be proved that weather conditions were adversely abnormal for the time of year during which site construction works took place and that these weather conditions impacted the critical path of the construction programme.

When considering the claim, the Engineer shall give due consideration to the circumstances pertaining such as amount and intensity of rainfall, when compared to those circumstances statistically anticipated to pertain during the Contract period.

Programme completion times should make allowance for those conditions likely to pertain from the Commencement Date of the Works, which date must be stated by the Engineer prior to the date of signing of the Contract Documents.

Delays will **not include consequential delays** but only take into account those periods of actual interruption due to the primary cause of the delay.

#### **9.16 OTHER CONTRACTORS ON SITE**

The Contractor is to take cognisance of the fact that other Contractors may be working in the area at the same time as construction of the works is taking place. No claims for delays due to other Contractors operations will be considered.

#### **9.17 APPLICABLE STANDARDISED AND PARTICULAR SPECIFICATIONS**

The following South African National Standards (previously South African Bureau of Standards) Standardised Specifications for Civil Engineering Construction shall apply (not included in this document). The Contractor shall obtain his own copies of the SANS specifications.

|                |                           |
|----------------|---------------------------|
| ■ SANS 1200 A  | General                   |
| ■ SANS 1200 C  | Site Clearance            |
| ■ SANS 1200 DA | Earthworks (Small Works)  |
| ■ SANS 1200 DE | Small Earth Dams          |
| ■ SANS 1200 DK | Gabions and Pitching      |
| ■ SANS 1200 GA | Concrete (Small Works)    |
| ■ SANS 1200 L  | Medium Pressure Pipelines |
| ■ SANS 1200 LB | Bedding (Pipes)           |
| ■ SANS 1200 LD | Sewers                    |
| ■ SANS 1200 LE | Stormwater Drainage.      |

#### **10.0 VARIATIONS AND ADDITIONS TO STANDARDISED/ PARTICULAR SPECIFICATIONS**

The following are variations or additions to the standardised or particular specifications.

##### **10.1 SITE CLEARANCE**

###### **10.1.1 Scope (SANS 1200C, Sub-Clause 1.1)**

No site clearance will take place without the written approval of the Engineer. The Engineer reserves the right to determine which areas will be cleared, viz: The Engineer may rule that no site clearance is necessary. Payment for site clearance will only be for the areas specified by the Engineer in writing.

###### **10.1.2 Materials (SANS 1200C, Sub-Clause 3.1)**

###### **10.1.2.1 Disposal of Materials**

Material from the borrow area clear and grub exercise is to be placed in a neat stockpile(s) all as indicated on the drawings or as directed by the Engineer. The disposal area shall be within the fenced area or, as specified in the Schedule of Quantities.

Existing fencing wire shall be neatly wound into rolls or coils and all such wire, together with all fence posts, gates and other material from structures shall be stacked at designated sites within the contract area or as directed by the Engineer.

**10.2 CONSTRUCTION (SANS 1200C, SUB-CLAUSE 5.1)**

**10.2.1 Areas to be cleared and grubbed**

The Contractor shall ensure that the general shape, profile and levels of the area(s) are not materially altered during clearing and grubbing operations (maximum 50 mm).

**10.3 EARTHWORKS**

This section has been replaced by Particular Specification PA – Specification for Excavations, Earthworks and Under Drainage.

**10.4 GABIONS AND PITCHING**

**10.4.1 Stone (SANS 1200DK, Sub-Clause 3.1)**

No weathering tests will be required.

**10.4.2 Pitching (SANS 1200DK, Sub-Clause 3.2.1.2)**

The type of pitching to be constructed will be cement grouted light pitching or ordinary ungrouted pitching in terms of Table 4.

**10.4.3 Source of material**

All stone for gabions shall conform to size and mass of stone for gabions and be obtained by the Contractor. The rate for gabions is to be inclusive of supply, loading, haulage and placing.

**11.0 TSF FOUNDATION PREPARATION**

**11.1 SCOPE OF WORK**

The work covered under this Specification includes earthworks and rock foundation preparation for construction of the Stage 1 of TC3.

**11.2 SUMMARY OF REQUIREMENTS**

The technical requirements for construction shall be as shown on the drawings, unless varied by instruction of the Engineer by reason of the conditions encountered. These requirements summarise and augment the requirements contained in the Subsections following and elsewhere in this Specification. In the event of a clear conflict of meaning between this Subsection and other Subsections and Sections, this Subsection shall take precedence.

**11.3 GENERAL**

The work of this Specification Section shall consist of all labour, materials and equipment, and performance of all work necessary for excavation and foundation preparation and treatment, including surficial soil compaction, within the spillway, dams, embankments and other areas.

Foundation treatment may be required for rock and weathered rock, if necessary, within foundation areas of the spillway and other areas as necessary to eliminate and correct local pockets, cavities and irregularities in the exposed bedrock surface.

The Contractor shall strip all topsoil in all construction areas as shown on Drawings and/or as directed by Engineer and in accordance with this Specification.

The Contractor shall submit the proposed methodology for excavation, including the sequences and stages to ensure that the stability of adjacent natural or cut slopes or of the completed work is not at risk, and the works are carried out in dry condition. The Contractor shall not commence excavation of any part of the work until the proposed methodology and construction sequence have been reviewed and approved by the Engineer.

The Contractor shall carry out all excavation work in accordance with the Drawings and Specifications, using ground support and water control measures required for safe and effective operation.

#### **11.3.1 Classification of excavated materials**

If the excavated material is found suitable for construction, it shall be excavated, loaded and delivered to designated areas within the embankment construction works. If unsuitable, it shall be excavated, loaded, hauled and dumped in designated waste areas.

#### **11.3.2 Borrow excavation**

Borrow excavation shall consist of all excavation required at designated borrow areas, whether on this site or elsewhere on the Mine, to obtain material suitable for construction of the dams, embankments and spillways. The borrow excavation shall be carried out in an orderly and efficient manner, to efficiently use the material resources available and to minimize ponding of water on material to be used as fill. Temporary and permanent cuts shall be made with safe and stable side-slopes.

Upon completion of the Work, the borrow area shall be reinstated by shaping the area to smooth surfaces conforming to adjacent topography, with safe and stable side-slopes, graded and ditched such that drainage is adequate.

#### **11.3.3 Road and trench excavation**

Excavations for access roads and trench shall include excavation of all overburden and bedrock materials to obtain the required grades.

The excavated materials shall be disposed of in the designated waste areas or used as embankment fill as approved by the Engineer.

#### **11.3.4 Rock excavation by blasting**

The delivery, storage, site transport and use of explosives for rock excavation shall comply with Australian Standard (AS) 2187, Explosives – Storage, Transport and Use.

The Contractor shall take all necessary precautions to maintain regular and stable excavation surfaces, in accordance with the boundaries, dimensions, lines and grades shown on the Drawings. Controlled blasting techniques such as pre-split and cushion blasting shall be implemented, to minimize fracturing of the rock. Pre-split blasting is the detonation of final line holes before the detonation of production holes. Hole spacing for pre-split holes is typically less than for production holes.

Cushion or trim blasting is the detonation of final line holes after the detonation of production holes. Hole spacing for cushion blast holes is typically less than for production holes.

Excavation plans submitted to the Engineer for approval shall be prepared by a Blasting Specialist who has had at least 10 years' experience with blast design and who has been approved by the Engineer. The plans shall include descriptions of blasting patterns, charge densities and other blasting techniques. The Contractor shall advise the Engineer at least 6 hours in advance of each blast.

The Contractor shall provide the following information prior to each blast

- Number, diameter, depth, and orientation of drill holes for blasting
- Location and blasting pattern shown on plan and cross-section drawings
- Type, density, weight and specific power and dimensions of the charge
- Quantity of explosives and maximum weight per delay
- Distribution scheme of delays, indicating blasting sequence and micro-delay intervals proposed for each group of holes
- Type and source of ignition.

#### **11.3.5 Vibration control**

Vibrations induced by blasting shall not alter the natural state of rock beyond the excavation limits, nor the previously grouted rock, fills or concrete of any permanent structure. The Contractor shall demonstrate a proactive approach to minimizing blast-induced damage.

If the Contractor can demonstrate in the blasting plan that the proposed charges will not induce damage to adjacent structures, or if site conditions and construction sequencing indicate that damage will not result, the Contractor may proceed following approval by the Engineer. However, if it appears that damage could result, the Contractor shall establish peak particle velocity vibration monitoring devices to verify that the vibrations do not exceed acceptable limits, in accordance with AS 2187.2-1993, Appendix J, and as directed by the Engineer.



**11.3.6 Protection of excavated surfaces**

As the excavation progresses and prior to slope protection works, the Contractor shall remove any loose rock blocks and fragments such that the excavated surface is composed of firm, stable material. Blasting of such blocks may be required.

The Contractor shall promptly initiate temporary and permanent slope protection works. The safety of workers is paramount in implementing these slope stabilization works.

**11.3.7 Designated waste areas**

The Contractor shall dispose of materials within approved limits of designated waste areas within the basin of the various TSF cells, in compacted horizontal layers, starting at the lower section of the designated waste area and proceeding upslope. Excavation material shall not be dumped down any natural slope. Minimum compaction for waste materials shall consist of four passes of a Caterpillar D-6 bulldozer or similar per 500 mm maximum lift thickness of loose material. Slopes shall be shaped no steeper than 2H:1V.

The Contractor shall continuously monitor and evaluate stability conditions of the designated waste areas, and shall take preventative measures to ensure stability, as required.

Upon completion of the work, the designated waste area shall be shaped to match the adjacent topography, and bladed smooth.

**11.3.8 Quality Control**

The Contractor shall be responsible for developing and maintaining quality control testing to ensure that the Work is constructed in accordance with the Drawings and Specifications.

The Engineer may also carry out testing for confirmatory purposes. The results of such tests shall be provided to the Contractor. However, the Engineer's tests do not constitute part of the Contractor's quality control program.

**11.4 FOUNDATION PREPARATION AND TREATMENT**

**11.4.1 General**

Stockpile or dispose of excavated materials at locations shown on Drawings or as directed by Engineer.

Perform any necessary blasting operations in a careful manner so as not to cause damage to rock foundations for the spillway structures or by creating new fractures in surrounding rock zones.

If, in opinion of Engineer, any damage to a rock foundation has occurred, Contractor shall repair damage to satisfaction of Engineer at no additional cost to Owner.

Schedule foundation preparation such that required fill may be placed immediately after preparation of the foundation.

#### **11.4.2 Foundation dewatering**

Contractor shall furnish, install, maintain, and operate all necessary pumps, dewatering wells, or other suitable equipment and construct all necessary facilities for removal of water from the various parts of the Project Site and for maintaining excavations, foundations, and other parts of the work free from water as required for construction.

Prior to beginning any work of this Specification Section, Contractor shall submit to the Engineer for review a plan showing his proposed equipment and method for removal of water from excavations.

The plan may be placed in operation upon acceptance, but nothing in this Specification Section shall relieve the Contractor from full responsibility for the adequacy of the water removal equipment, facilities, and operations.

Contractor shall furnish all materials, equipment, appurtenances, and facilities as required for the furnishing, installing, and removing of all excavation and foundation dewatering equipment, structures, and facilities.

The Contractor's method of removal of water from excavations and foundations shall be subject to review and acceptance by the Engineer. Dewatering methods may include, but are not limited to, well points, dewatering wells, sumps, trenches, and/or culverts.

Excavations shall be kept free from water at all times. Dewatering shall be stopped only when authorized by the Engineer. Adequate dewatering equipment shall be maintained at the Project Site at all times to handle emergency situations.

#### **11.4.3 Earth foundation preparation**

When rough grading has been completed, the remaining surficial soils shall be inspected by the Engineer prior to compaction. Any unsuitable materials such as organic matter, topsoil, soft clay, etc. shall be removed as directed by Engineer.

If the surface layer of the foundation soil has a moisture content greater than two (2) percent above the Optimum Moisture Content in accordance with the Standard Proctor maximum dry density (AS 1289), these soils shall be scarified to a depth between 200 mm and 300 mm and allowed to dry out to the required moisture content.

If the moisture content of the remaining surface soils is between minus one (-1) percent and plus two (+2) percent of the Optimum Moisture Content, the soils shall be compacted by a minimum of six (6) passes of a 8-10 vibratory or at least 12 tonne static sheep foot or padfoot vibratory (or equivalent equipment acceptable to Engineer). Hauling and spreading equipment will not be considered as compaction equipment.

If the foundation soils are granular in nature, they shall be compacted by at least four (4) passes of a 10-tonne drum-weight vibratory smooth drum roller (or equivalent equipment acceptable to Engineer) before fill placement.

Engineer shall approve foundation areas prior to placing overlying materials.

#### **11.4.4 Rock foundation preparation**

In subgrade areas consisting of bedrock, the Contractor shall remove all loose and objectionable materials using appropriate excavation tools and equipment to obtain a surface suitable for placement and compaction of the bedding layer material, to the satisfaction of the Engineer. This shall include the use of hand excavation methods to clean out local pockets, cavities, and irregularities in the exposed bedrock surface. Local pockets, cavities, and irregularities in the exposed bedrock surface shall be backfilled with select embankment fill material conforming to the requirements of the overlying fill zone, to create a uniform surface. Said select embankment fill material shall be compacted using mechanized or hand operated equipment, or by hand using a steel rod or other suitable device, as directed by the Engineer.

The Contractor shall be required to eliminate all bedrock overhangs in the foundation preparation areas sufficiently to allow subsequent fill placement and compaction, to the satisfaction of the Engineer.

Engineer shall approve all foundation areas prior to placing fill materials or concrete.

#### **11.4.5 Protuberances**

The Contractor shall remove or eliminate all angular subgrade protuberances and oversized materials within the foundation preparation areas, which in the opinion of the Engineer, are likely to inhibit proper fill lift placement.

### **12.0 EMBANKMENT FILLING**

#### **12.1 SCOPE OF WORK**

The work covered under this Specification includes filling for construction of Stage 1 embankments for TC3.

#### **12.2 EMBANKMENTS (SANS 1200DA, SUB CLAUSE 5.2.3.1)**

Embankments shall be constructed by obtaining selected soil from excavations, approved borrow pits or stockpiles and forming it to the dimensions and elevations given on the drawings.

Material forming the embankment shall be compacted in layers not exceeding 300 mm after compaction to form durable embankments of good, regular appearance with all cross-sections having the minimum sizes detailed on drawings and having side slopes not steeper than specified. The sides of the embankments and fill must be compacted to hard durable faces. Any spoil resulting from this operation is to be removed and disposed of at no extra cost.

The unit of measurement for embankment and fill construction shall be the design cubic metre of placed material after compaction, trimming and forming to the specified dimensions. Contractors will not be paid for embankments and fill constructed in excess of the dimensions specified. The Engineer will decide on acceptance or rejection of embankments and fill which are oversized.

The Contractor is to allow in his rate for forming and compacting an oversized embankment/fill, cutting back and compacting the sides of the embankment/fill to the correct size.

In general, the preferred source of borrow material, subject to quality approval by the Engineer, will be excavated material from the basins of TC3 and the return water dams/sumps.

### **12.3 BACKFILLING (SANS 1200DA, SUB CLAUSE 5.2.3.2)**

#### **12.3.1 Backfilling where compaction is not required**

The unit of measurement for all backfill shall be the nett design cubic metre of consolidated material placed.

#### **12.3.2 Backfilling where compaction is required**

Backfilling to foundations and trench extensions shall be paid for under the items provided in the Schedule of Quantities and shall be carried out by replacing excavated material with either:

- Selected excavated material in loose 300 mm layers, each layer being thoroughly compacted, rammed and consolidated before the succeeding layer is placed or such other ways as may be directed by the Engineer. In areas where specified compaction densities are required for backfill then the identical testing and approval procedures required for the embankments will be enforced. Only sand replacement testing may be done near concrete foundations.
- Selected material with the addition of 12% cement by mass and sufficient water to obtain a consistency to permit the compaction by means of concrete vibrating equipment ("soilcrete")
- Loose selected material as shown on the drawings.

Any defects caused due to subsidence of the backfilling, as a result of improper workmanship shall be made good at the Contractor's expense. At the ground surface, the filling shall be banked to a height of about 100 mm above the level of the adjacent ground surface to allow for any settlements and before completion of the works, and, if necessary, again before expiry of the maintenance period or at such other times as the Engineer may direct, all refilled excavations shall be examined and dressed and, where depressions have occurred, these shall be made good by refilling and ramming with suitable material at the Contractor's expense.

The unit of measurement for all backfill shall be the nett design cubic metre of compacted material placed.

#### **12.3.3 Backfilling to over-excavation**

Backfilling to over-excavation below the required levels or depths necessary to achieve the required depth or to obtain a suitable bottom is to be carried out to the instructions and satisfaction of the Engineer and entirely at the Contractor's expense.

**12.4 HAULAGE (SANS 1200DA, SUB CLAUSE 5.2.5)**

The Contractor shall at his own cost construct and maintain temporary haul roads as required along the route designated by the Engineer.

If the Contractor chooses, for reasons of his own, to transport material by a different route, the measurement of distance for transport will be along the routes designated by the Engineer.

In the case of borrow pits, the Contractor shall be restricted to the routes designated by the Engineer.

Free haulage of material excavated from a borrow pit, excavation, etc. or cutting shall be limited to within the designated area.

Overhaul is that portion of the total haulage beyond the designated area and is measured separately.

The unit of measurement for overhaul in the case of compacted fill or placed material shall be the cubic metre - kilometre being the product of distance measured in kilometres to the nearest tenth of a kilometre and the cubic metres of compacted or placed (whichever is applicable) material transported. However, in the case of cut to spoil, or stockpile the unit of measurement for overhaul shall be the cubic metre-kilometre being the product of the distance measured in kilometres to the nearest tenth of a kilometre and the cubic metre of undisturbed in situ material transported.

**12.5 TOLERANCES (SANS 1200DA, SUB CLAUSE 6)**

All embankments, excavations, trenches, fill areas, trenches, etc, shall be neatly trimmed to the required widths, cross-sections and levels as specified on the drawings and specifications. Where not stated the tolerance is to be within  $\pm 25$  mm.

The width of the formation measured from the final staked centre line shall in no case be less than the specified dimension. The tolerance on the depth and location of soil replacement trenches shall be  $\pm 150$  mm. The average depth shall not be less than the specified depth.

**12.6 MOISTURE CONTENT AND DENSITY (SANS 1200DA, SUB CLAUSE 6.2)**

**12.6.1 General**

The standards of compaction required are shown on the drawings and the Contractor shall be entirely responsible for obtaining a density not less than the minimum specified Proctor density (hereinafter referred to as specified density).

All compacted fill material is to be placed in horizontal layers and compacted in loose layers with a compacted depth not greater than 300 mm, to a density not less than the minimum specified density. It should further be noted that a uniform moisture content (as per specification) is to be achieved throughout the loose layer prior to compaction.

All compaction shall be carried out in a direction parallel to the centre line of the earthworks, working on a predetermined pattern which shall ensure that the whole area of the layer receives a uniform compaction.

The moisture content shall unless otherwise specified be in the range between one per cent below and two per cent above Proctor optimum moisture content, (or any other range specified on the drawings or by the Engineer from time to time) whichever is applicable. Compacted layers with moisture contents outside the specified range shall be deemed to have failed regardless of the densities achieved. The required moisture content shall be distributed uniformly throughout each layer of material.

Compaction shall be carried out by means of compaction equipment to be approved by the Engineer.

#### **12.6.2 Compaction to a performance specification**

Certain specified embankments and fill will be constructed by applying a performance specification to each placed layer (hereinafter referred to as normal or performance compaction). These embankments and fill shall be formed by compacting selected material in loose layers not exceeding 250 mm in thickness by applying a minimum number of passes to be specified by the Engineer of an approved vibratory roller. The minimum number of passes will be determined on site jointly by the Contractor and the Engineer and will be based on the number of passes required to obtain a compaction of 98% Proctor density ( $\pm 2\%$ ) or any lesser density that the Engineer may specify. The Engineer reserves the right to re-execute these tests and to re-specify the minimum number of passes from time to time dependent on material variability, compactor type, moisture content, etc.

If necessary, during and/or prior to compaction water shall be provided to bring the soil to the correct moisture contents as directed by the Engineer.

The Engineer reserves the right to stop and condemn all "performance" compaction work if in his opinion the Contractor is seen not to be executing the works as described above. All such remedial works shall be for the Contractor's account.

#### **12.6.3 Preparation of pipe trench floors**

The floor of the pipe trenches shall be compacted to at least 95% Proctor density at optimum moisture content or any other specified density and moisture content that the Engineer may authorise, to a minimum depth of 150 mm. The unit of measurement shall be the design square metre of trench prepared.

### **12.7 TAKING AND TESTING OF SAMPLES (SANS 1200DA, SUB CLAUSE 7.2)**

Add in the following Sub Clause:

#### **12.7.1 Compaction Control**

The Contractor shall provide an adequate site laboratory, equipment, facilities and personnel for carrying out the required compaction tests. Should the Engineer at any time consider any of the above to be

inadequate for this purpose, he shall instruct the Contractor to cease further work on compaction until such time as the Contractor has remedied the deficiency.

The onus shall be on the Contractor to ensure the following:

- That the state of the material when placed is such that the compaction as specified in Clause 12.6.2 is obtained
- That material selected for use in compacted embankments shall be approved by the Engineer on the basis of the maximum Proctor dry density being equal to or greater than a minimum density to be specified by the Engineer.

Hence, with the objective of controlling the selection and compaction of all materials used in the various layers of fill the Contractor shall perform grading analyses, Proctor density tests on each type of material which he proposes to use including mixed or blended materials.

In addition to the tests required for his own control the Contractor shall allow for at least one density checks per 1 500 m<sup>3</sup> of material compacted per layer. The recognised method of determining the density is the sand replacement test. However, the Radio Isotope or other approved method may be used (if approved by the Engineer) for density and moisture checks, provided suitable agreement is obtained between this method and the sand replacement method and provided the necessary calibration and specified tests to these instruments are undertaken at intervals to be specified by the Engineer. If nuclear density measuring devices are used, they shall be calibrated against sand replacement tests.

If an alternative method of density determination is accepted, the sand replacement method shall be used to check every fourth density determination, and the moisture content of the sample shall be determined by oven drying as specified for the Modified AASHTO and Standard Proctor compaction methods.

To account for material variability, approved density tests will be accepted based on the following:

**12.7.1.1 Fill compacted to 100% Proctor density**

- If any one of the two density tests per 1 500 m<sup>3</sup> is below 95% then the entire layer will be re-ripped, re-watered and re-compacted.
- If any one or both of the two density tests per 1 500 m<sup>3</sup> is between 95% and 98% then two more tests will be undertaken in the layer. If the average of the four density tests is greater than or equal to 98% then the layer will be passed. If the average is less than 98% then the entire layer will be re-ripped, re-watered and re-compacted.
- If both of the two density tests per 1 500 m<sup>3</sup> lie between 98% and 102% then the layer will be passed (i.e. a range of  $\pm 2\%$ ). Tests achieving densities in excess of + 2% will not be accepted. In this case the layer will have to be re-ripped, re-watered and re-compacted.



**12.7.1.2      *Fill compacted to 98% Proctor density***

- If any one of the two density tests per 1 500 m<sup>3</sup> is below 98% then the entire layer will be re-ripped, re-watered and re-compacted.
- Any one density test will be deemed to have passed if a density of +1% to -2% is achieved. Tests achieving densities in excess of +2% will not be accepted.

**12.7.1.3      *Fill compacted to 95% Standard Proctor density***

- If any one of the two density tests per 1 500 m<sup>3</sup> is below 95% then the entire layer will be re-ripped, re-watered and re-compacted.
- Any one density test will be deemed to have passed if a density of +2% is achieved. Tests achieving densities in excess of +2% will not be accepted.

The compaction control tests shall be carried out as laid down in "Standard Methods of Testing Materials" published by the Department of Transport, Pretoria.

Field density and moisture content tests are to be carried out within twelve hours after the completion of each section of the layer. If such tests are not carried out by the Contractor within this period then the Engineer may fail a layer or section of the layer regardless of any test results which may then or subsequently be provided, and this decision shall be final.

When the compaction of any section of any layer, for which a density and moisture content is specified, is completed, the Contractor shall supply to the Engineer copies of test results whether successful or otherwise within 6 hours of determination.

The Contractor is to note that no subsequent layer is to be placed until such time as the previous layer has been approved by the Engineer in writing.

The Contractor shall maintain updated, accurate records of all compaction control tests, i.e. test data, chainage and layer elevation.

These records shall be available on site for inspection by the Engineer at all times.

Where tests reveal that the density or moisture content of any layer, at any depth, is not to specification, the Contractor shall re-rip, re-compact and re-water if necessary such material, or if the specified density cannot be obtained by further compaction of the material such material shall be removed and replaced by material capable of yielding the specified density.

All such testing and corrective work shall be undertaken at the Contractor's cost.

Tests to check the density, moisture content and particle size distribution of the compacted material and/or to check the testing procedures of the Contractor as described above, may be carried out by the Engineer.



The costs of these tests will be paid for by the Employer only if the results of the tests show that the specified density has been obtained.

The Contractor shall pay for all such tests where the results show that the specified density has not been obtained; also he shall pay for any further tests to check if the required density, moisture content and particle size distribution has been obtained after the specified corrective measures have been carried out.

### **13.0 UNDER DRAINS**

#### **13.1 GEOFABRIC**

Where shown on the drawings or directed by the Engineer subsurface pipe drainage systems shall be lined with approved geofabric prior to placing of rejects.

The type of geofabric to be used shall be as indicated on the drawings or an approved Medium grade equivalent. The Engineer reserves the right to approve the make and grade of any alternative type of geofabric considered.

The geofabric shall be stored under cover and out of direct sunlight at all times. To this end the Contractor is to satisfy the Engineer of suitable covering facilities, e.g. shed or adequate canvas covers, etc. The manufacturer's wrappings shall not be removed until just prior to use. Any geofabric exposed for more than 10 (ten) days shall not be used and shall be removed from the works if already incorporated therein.

Joining of the geofabric is to be undertaken with an approved nylon yarn as shown on the drawings or by double lines of stitching along a 150 mm lap width made by means of a "sac-up" type of portable machine obtainable from "Industrial Sewing Machines" Durban, or any approved similar machine, using Lubes M20 nylon thread obtainable from "Natal Thread Co" or an approved equivalent. Prior to backfilling/covering, the placed geofabric and stitching are to be approved by the Engineer.

The surface upon which the fabric is laid shall be even and free of protruding or sharp edged stones. The earthworks placement rates shall allow for this preparation work. Any damage caused to the fabric during installation or during placing of the rip-rap material shall render it unsuitable for use. The cost involved in replacing any and all damaged filter fabric shall be borne by the Contractor. Should the damage be sufficiently localized, the Engineer may direct the Contractor to patch the fabric. Patching shall only be carried out after the Engineer's permission has been given.

Where pipes come out of the geofabric-wrapped drain (i.e. pipes required for carrying water away from subsurface drains, but not forming a part thereof), the fabric shall be tied around the pipes with suitable nylon or other approved yarn in a manner which is satisfactory to the Engineer.

The unit of measurement for the geofabric is the square metre of geofabric installed. The price shall include the supply, protection from ultra violet light, installation, including cutting, wastage lapping and joining as

previously described. The area paid for will be the nett area installed and no additional payment will be made for any joint overlaps whatsoever.

The Contractor is to price the document on the basis of the specified type and grade of geofabric. Alternative rates utilizing equivalent geofabric types are to be submitted separately.

### **13.2 PERMEABLE MATERIAL**

Permeable material to be as used in the under drains will be rejects from the CHPP, supplied on site free of charge by Benga. The Contractor is to place the rejects to the lines and levels shown on the drawings.

### **13.3 UNDERDRAIN CONSTRUCTION**

Underdrains shall be constructed as shown on the drawings.

Excavation for the underdrains shall be to the specified tolerances. The geofabric specified in Clause 13.1 of this Specification shall be carefully and neatly laid on the ground and shall be pinned to the trench walls with 150 mm nails fitted with 30 mm diameter 2 mm thick galvanised washers placed at approximately 1m centres. (The Contractor may propose other fixing methods).

Pipelines shall be laid to straight grades between vertical bends and shall be to the routes, levels and grades indicated on the drawings.

Before placing any permeable material over the pipes, the Contractor is to obtain the approval of the Engineer.

The permeable materials shall be placed as shown on the drawings. The finished thickness of each layer of permeable material shall nowhere vary below the specified thickness.

Care should be exercised when placing the permeable materials so as not to damage the subsurface drainage pipes.


Any material placed as permeable material not conforming to the minimum requirements as set out in Clause 13.2 shall, at the discretion of the Engineer, be removed and replaced with suitable material at the Contractor's expense.

At all junctions with outfall drains or at any other section where required by the Engineer, no permeable material shall be placed until the junction has been inspected and approved by the Engineer. The Contractor shall undertake the necessary rodding and/ or water testing as required by the Engineer. All such costs shall be borne by the Contractor.

**13.4 EROSION CONTROL**

Any runnels or erosion channels greater than 50 mm deep formed during the construction or maintenance period shall be backfilled and compacted and the surfaces returned to their original condition. This shall apply to outside embankment faces, embankment crests, inside slopes, berms and canals.

The Contractor will receive no payment for repairing erosion damage.

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