MOKOLO AND CROCODILE WATER AUGMENTATION PROJECT PHASE 2 (MCWAP-2)

TENDER NO 054/2024/PMID/MCWAP2/RFB

PART C3.1
SPECIFICATION

SECTION 17

RESERVOIR MEMBRANES AND LINERS

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SECTION 17

RESERVOIR MEMBRANES AND LINERS

17.1 SCOPE

This Section covers the manufacture, supply, transport, store, installation and testing of geomembranes, liners and geocells in raw water reservoirs. The primary functionality of the lining is seepage control. The functionality is specifically not multi-layer polluted water control.

The embankment construction and concrete structures are done by others. The surface preparation for the liner installation forms part of the embankment construction.

This specification module, Section 17, is a project specification that shall be read in conjunction with SANS 1526: Thermoplastics polyolefin sheeting for use as a geomembrane and Code of Practice SANS 10409: Design, selection and installation of geomembranes. The design and selection of the geomembranes are the responsibility of the Employers designer. The installation and testing is the Contractors responsibility.

17.2 SUPPORTING SECTIONS

The following Specification Sections shall be read in conjunction with this Section 17:

- Section 1 – General;
- Section 8 – Dealing with Water;
- Section 16 – Embankment Construction; and
- Section 48 – Tests on Completion.

17.3 DEFINITIONS AND ABBREVIATIONS

17.3.1 Definitions

For the purpose of this Section, the definitions and abbreviations given in the Sections listed above in Clause 17.2, SANS 1526, SANS 10409 as well as the following shall apply:

a) **“Installation”** Specialist contractor experience in installing geomembranes on reservoirs.

b) **“Contractor”** Sub-contractor to the main Contractor.

c) **“Liners”** Thermoplastic polyolefin sheeting used to waterproof a reservoir / dam.

d) **“Membranes”** Thermoplastic polyolefin sheeting used as geomembranes. The functionality of the geomembrane could be waterproofing, filtering or draining.

e) **“Geocells”** means cellular confinement systems made of a specified material to form a honeycomb-like cell structure when expanded. These cells can be filled with a variety of selected material to provide the appropriate erosion protection.

17.3.2 Abbreviations

AIA	:	Approved Inspection Authority
ASTM	:	American Society for Testing and Materials
BoQ	:	Bill of Quantities
CQC	:	Construction Quality Control
FTB	:	Film Tearing Bond
GRI	:	Geosynthetic Research Institute
HDPE	:	High Density Polyethylene
MQC	:	Manufacturing Quality Control
SANS	:	South African National Standard
UV	:	Ultra violet

17.3.3 References

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

17.4 MATERIALS

17.4.1 Requirements for polyolefin geomembranes

Further to SANS 1526: Sub-clause 4.1.1 only HDPE complying with GRI Test Method GM13 shall be used. Geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm to 3.0 mm. Both smooth and textured geomembrane surfaces are provided for.

The geomembrane functionality and dimensional requirements are indicated on the drawings. The installation contractor shall sign off on the final ordering of material from a roll width and length perspective. The planning of the panel installation depends on this. The Employer design selects the type of material and minimum thickness. The installation contractor selects the roll width and length to align with the planned panel installation.

The geomembrane manufacturer shall provide with each roll of HDPE material delivered to site the compliance certification together with a report of the test results in terms of GRI GM-13 Clause 10. No payment shall be made prior to receipt of the above documentation. Tables 1(b) and 2(b) of GM-13 provide the testing methods, testing frequency and acceptance criteria. Non- compliant material shall not be delivered to Site.

17.4.2 Requirements for Geocells

The geocells cellular confinement system shall be manufactured from a laminated polypropylene, slit-film woven tape such as Kaytech's 'Multi-CellTM' or similar approved and shall have the following properties:

PROPERTY			UNITS	VALUE	TEST METHOD
Mass/Panel		Height 75mm	kg	4.5	SANS 10221-88
Parent Product		Laminated Polypropylene Slit-Film Woven Tape			
		Thickness	mm	0.65	SANS 10221-88
Tensile Strength	Parent	Tensile Strength	kN/m	26	SANS 10221-88
		Elongation	%	21	
	Seam	Tensile Strength	kN/m	4	
		Elongation	%	12	
Cell Size		Side	mm	200 x 200	
		Diagonal	mm	280 x 280	
Panel Size		Packaged	mm	450 x 750	
		Expanded	mm	10 000 x 5 000	

Notes:

Where products are tested under other test methods, the methods and results should accompany the tender.

The geotextile must be stable in the presence of chemicals typically found in a landfill and should be resistant to attack from these chemicals.

All geotextiles should be stable at a temperature of 100ºC.

17.4.3 Geomembrane Delivery to Site and Storage

Refer to Sub-clause 8.3 of SANS 10409 in this regard.

17.5 CONSTRUCTION QUALITY CONTROL (CQC)

17.5.1 General

Refer to Sub-clause 8.1 and 8.2 of SANS 10409 in this regard. A CQC plan shall be prepared by the installation contractor and submitted to the Engineer for approval, before installation commences.

17.5.2 Access to Records

A daily record shall also be kept of the progress of the work and any other record that the Engineer may from time to time require.

All the above records shall be available at all times during the progress of the work for inspection by the Engineer, and a copy of the preceding day's test records shall be deposited with the Engineer daily.

17.5.3 Format of Records

The format of the construction records shall be based on Annexures A to I of SANS 10409.

17.5.4 Tests on completion

An Electric Leak Location Survey (ELLS) shall be undertaken by a third party (i.e. independent of the Employer, Engineer, Contractor(s) and product supplier(s) to locate flaws and confirm containment performance in the installed geomembrane (GM), after the GM has been covered by sand, soil and then geocells or any combination thereof.

Over and above the testing required by SANS 10409, a water tightness test is required as part of the “wet” commissioning of the functionally completed systems. Refer to Specification Section 48 for the detail of this testing.

The installation contractor shall provide for the scheduling of this water tightness testing as per the Construction Programme of the Contractor. The testing can be done per compartment when the design allows for it.

17.6 GEOMEMBRANE / GEOCELLS INSTALLATION

17.6.1 General

Refer to Clause 9 of SANS 10409.

17.6.2 Additional information and clarifications

17.6.2.1 Sub-Clause 9.1.1.2

Add the following note:

Note: Refer to Specification Section 16 for the planar flatness requirements of the supporting surface.

17.6.2.2 Sub-Clause 9.2.1.3

Replace the note under this sub-clause with the following:

Note: Appropriate allowances should be made for thermal contraction and expansion of the geomembrane. The allowance shall take in account the lining material temperature at installation (Not ambient temperature) and the expected default operational lining material temperature when submerged. The lining material temperature shall be recorded when doing the closure weld and allowing the slack. This shall form part of the quality record data pack.

This note is also relevant to sub-clause 9.2.6.5.

17.6.2.3 Sub-Clause 9.2.4

Replace this clause with the following:

The installation contractor shall install field panels as indicated on a layout drawing prepared as part of the installation planning. (see annex C for an example of a layout drawing). If the panels are deployed in a location other than that indicated on the planned layout drawing, the revised location shall be noted in the field (on the panel layout drawing) and the changes incorporated into a final "record" drawing on completion.

17.6.3 Installation of Geocells

The geocell cellular confinement system must be protected from prolonged exposure to direct sunlight after being delivered to site.

The geocell cellular confinement system shall be placed as a protection layer over the HDPE lining. Where the geocell cellular confinement system is being placed onto the geomembrane, it shall be deployed by hand so as not to damage the geomembrane in any way. Special care shall be taken by the Installer to prevent damage of the geomembrane. The tensioning frame of the geocell cellular confinement system shall be expanded and held in place with sandbags to prevent wind uplift. No stakes of any sort are to be used to restrain the geocell cellular confinement system.

Adequate cover shall be kept between construction equipment and the geocell cellular confinement system at all times. No vehicles may be driven directly over the geocell cellular confinement system until the proper thickness of cover has been placed.

All construction above the geocell cellular confinement system shall be carried out using only light construction equipment that exerts low ground pressures (such as ATV’s).

Vehicles shall not brake suddenly, accelerate quickly or make any sudden or sharp turns above any geocell cellular confinement system, even after placement of the correct thickness of cover.

17.7 GEOMEMBRANE FIELD SEAMING

17.7.1 General

Refer to Clause 10 of SANS 10409.

17.7.2 Additional information and clarifications

17.7.2.1 Sub-Clause 10.1.3

Add sub-clause 10.1.3.3.

The primary HDPE sheet welding equipment is:

- **Fusion welders (Dual hot wedge)** – Production seams

  These seams shall be produced by self-propelled dual wedge welding apparatus. The apparatus shall be equipped with gauges to monitor weld temperature. Weld temperature and machine speed shall be varied according to ambient conditions in order to maintain and demonstrate a consistent acceptable weld on slopes up to 1 in 2.5. All welding surfaces shall be kept clean and dry.

- **Extrusion welders** – Patches and closure joints (Extrusion fillet seam).

  These seams shall be produced by extruding molten resin at the edge of two overlapped sheets of geomembrane to affect a homogeneous bond. The extrusion apparatus shall be equipped with gauges to monitor extrudate temperature. Temperature and flow rate shall be varied according to ambient conditions to maintain and demonstrate a consistent acceptable weld. The extruder shall be purged of all heat degraded or cooled extrudate prior to the commencement of each seaming sequence.

The use of any other type of welding equipment shall be approved by the Engineer. The installation contractor shall provide a sufficient number of each type of welder to achieve the targeted production rates and allow for standby capacity.

Add sub-clause 10.1.3.4.

The following geomembrane test equipment shall be available on Site:

- Ambient temperature monitoring and recording;
- Geomembrane in-situ temperature monitoring apparatus;
- Vacuum box testing apparatus; (Refer to ASTM D4437 and D5641);
- Air pressure testing apparatus; (Refer to GRI Test Method GM 6); and
- Spark testing apparatus; (Refer to ASTM D6365).

The destructive testing equipment should be accessed in an accredited materials laboratory.

17.8 GENERAL DEFECTS AND REPAIR PROCEDURES

17.8.1 General

Refer to Clause 11 of SANS 10409.

17.8.2 Additional information and clarifications

17.8.2.1 Sub-Clause 11.1.2

Add the following note:

Note: A third party controller will only be used when the situation or conditions specifically requires it. The Engineer will inform the Contractor well in advance if a third party controller need to routinely sign off in terms of the CQC plan. The Engineer also reserves the right to use the AIA as third party controller as and when required. This will be as assistance to the monitoring of the Engineers representative off in terms of the CQC plan.

17.9 MEASUREMENT AND PAYMENT

17.9.1 Basic Principles

17.9.1.1 Measurement

The basic principles of measurement associated with the geomembrane and lining works are as follows:

a) Surface areas are measured perpendicular to the relevant surface as the nett square meter (m^2) covering the floor and side slopes up to the inner edge of the anchor trench. This area excludes allowance for overlaps at seams, anchoring in trenches, slack for thermal movement, waste or any other allowance. Different layers are measured individually. Partial coverage will be measured as indicated on the drawings;

b) The anchoring against concrete structures and the anchor trench at the top of the embankment are measured as linear meter (m) all inclusive;

c) For quality purposes the different types of testing and repairs are measured as type and number. Other than additional testing instructed by the Engineer, payment for these quantities is deemed to be included in the rates;

d) Safety items are measured as type and number; and

e) Preliminary and General items are to be measured as per Specification Section 1.

The Bill of Quantities (BoQ) indicates the unit of measurement for each item. Should any item be identified for which a measurement standard has not been clearly defined, the onus remains on the Contractor to clarify this with the Engineer prior to the execution of such work.

17.9.1.2 Payment

The rates under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the items provided in Section 1 – General.

The cost of additional tests instructed by the Engineer will be paid for as daywork provided that, where the results of the tests indicate that the materials or workmanship, or both, do not comply with the applicable requirements of this Section, the cost shall be borne by the Contractor. Where the results of the tests prove compliance with this Section, the cost will be borne by the Employer.

17.9.2 Computation of Quantities

17.9.2.1 General

The surface areas and lengths will be calculated from the original levels and the dimensions of the sections, and profiles as shown on the Drawings or instructed. No surface area covered outside the specified lines and levels will be included in the measurement unless such extra work has been done on the written instructions of the Engineer.

The principles of a re-measureable contract remain.

17.9.2.2 Computation of Cross-Sections

The Engineer has prepared cross-sections for the measurement and computation of quantities.

The Contractor shall provide the Engineer and installation contractor with an “as built” survey of the embankment structure prior to installation of liners. The Contractor shall prepare the cross-sections necessary for the measurement and computation of actual quantities. The Engineer may conduct such check tests on the Contractor's cross-sections as he considers necessary to confirm their accuracy and adequacy.

17.9.3 Scheduled Items

17.9.3.1 Acceptance of surface area and access to working area

17.001 Inspection, acceptance and maintenance of surface area **Unit: m^2**

The area measured will be that ordered in writing or shown on the Drawings to be lined. The rate shall be inclusive of checking the “as built” survey information, surface acceptance inspections as well as maintaining the surface from acceptance until completion of the installation process.

17.002 Access to lining area **Unit: sum**

The lump sum amount shall include for all cost associated with the provision, maintenance, removal and repairs of access to the lining area inside the embankment. It shall be inclusive of all liner protection measures required during installation.

17.9.3.2 Geo-cells, Membranes and liners

17.003 Geotextile **Unit: m^2**

The rate includes for supply, store and installation all inclusive.

17.004 Geomembrane **Unit: m^2**

The rate includes for supply, store and installation all inclusive.

17.005 HDPE Liner **Unit: m^2**

The rate includes for supply, store, installation, ballast, overlap, slack, waste, seam welds, test and repairs all inclusive.

Note: For quality control monitoring purposes the type and length of seam welding are measured separately. For payment purposes it is regarded to be included in the rates as the installation contractor plans the optimum panel layout and the resulting length of seams.

17.006 Geo-cells for UV protection **Unit: m^2**

The unit of measurement will be a square metre of surface lined. No additional area shall be measured as overlaps.

The tendered rates shall include full compensation for procuring, furnishing and placing or applying of the Geocell system complete with soilcrete (10% by mass) or concrete (15 MPa) filling in cells, as per the relevant drawings and Schedule of Quantities, protection of geo layers below the cell system, for all labour and incidentals required for installing or applying the Geocells, complete as per the manufacturer's specifications.

17.9.3.3 Anchoring

17.007 Anchoring to concrete structure **Unit: m**

The rate includes for supply, installation and repairs, all inclusive, as per the detail provided on the construction drawings.

17.008 Anchor trench **Unit: m**

The rate includes for excavation, shaping, installation, backfill, compaction and testing, all inclusive, as per the detail provided on the construction drawings.

17.9.3.4 Safety Items

17.009 Safety ropes and buoys **Unit: Number**

The rate includes for the supply and, installation of safety ropes and buoys as per the detail provided on the construction drawings.

17.010 Warning signs **Unit: Number**

The rate includes for the supply and, installation of permanent warning signs as per the detail provided on the construction drawings.