SITE INSPECTION REPORT

FINAL

Project:

SEDIMENT REPAIR AT MAPUTO SUBSTATION

Client:

MOTRACO

NOVEMBER 2022

Maputo- Mozambique
Av. 25 de Setembro Nº 2526 – 1º andar,C.P 4190
Tel: 21 32 21 85, Email: sabreu@tec.co.mz

Site Inspection Report

(FINAL)

Revision	Issue Date	Description	Prepared by	Revised and Approved by
00	08/08/22	Site Inspection Report Sediment Repair at the Maputo Substation	AM, HD	SA
01	02/11/22	Site Inspection Report Sediment Repair at the Maputo Substation	AM, HD	SA

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APPENDICES

Appendix 1 – Maputo Substation Map
Appendix 2 – Bill of Quantities
Appendix 3 – Construction Drawings

RELATED DOCUMENTS

P914_MOTRACO_Paving_Flags_Specs_TEC20221102.pdf

P914_MOTRACO_TECHN_SPECS_TEC20221102.pdf

1 INTRODUCTION

Mozambique Transmission Company (MOTRACO), hereinafter referred to as Client, invited TÉCNICA – Engenheiros Consultores, Lda (TÉCNICA) to provide consultancy services for the sediment erosion that have been observed at Maputo Substation facilities in Beluluane.

The present report is the result of the findings from site inspection, revision of documents, drawings and reports from previous studies and similar civil works executed previously.

For that purpose TÉCNICA made a site inspection with the main purpose of assessing the causes of soil erosion and sediment displacement occurring within the substation yard.

The site inspection took place on 2nd and 3rd June, 2022, attended by TÉCNICA engineers, António and Hans, under guidance of Eng. Victor from MOTRACO.

2 GENERAL FINDINGS

In the substation, three (03) distinct zones can be identified, namely: 132 kV, 275 kV and 400 kV, as illustrated in Figure 1 and Appendix 1. In the mentioned zones, it was possible to generally identify the following:

- Loss of fine soils and settlement around cable trenches;
- Differential settlement of kerbs and broken covers of cable trenches;
- Collapse of drainage ditches walls;
- Localised settlements between manholes within the substation yard.

Figure 1 *- Zoning of the Maputo Substation.*

3 FINDINGS AND RECOMMENDATIONS

3.1 Cable Trenches

3.1.1 Findings

- *Sandy material dragged into the cable trenches*

In almost all the cable trenches, there is sand that has been dragged into it. Some trenches are practically filled up with dragged sand.

Pictures 1 & 2 *– Accumulated material in the cable trench.*

At some points the accumulation of sand material is such that it covers the cables.

- *Erosion of the kerbs bearing stratum*

The joints between kerbs are unsealed and geotextile is not present, this situation allows water to flow and wash out the fines into the trenches. The highest erosion rates occur near those joints. Sometimes, the erosion of the soil beneath the kerbs (bearing stratum) is high enough to cause collapse of the kerbs.

Pictures 3, 4 & 5 *– Soils supporting the kerbs eroded, kerb collapsed (Picture 5).*

- *Differential settlement of the kerbs and settlements along the cable trenches*

Since the erosion rate beneath the kerbs is not uniform, differential settlements of kerbs occur near the unsealed joints. In addition, differential settlements occur along the cable trenches.

Pictures 6 & 7 *– Differential settlement of the kerbs (400 kV zone).*

Pictures 8 & 9 *– loss of fines and settlements.*

- Broken cable trenches cover slab

Damaged or broken cable trenches covers were found. This occurs due to age and some of them due to lack of proper reinforcement steel.

***Pictures 10 & 11** – Damaged cable trenches cover slabs.*

- Broken cover slab on cable trenches ramp crossings for heavy vehicles

Regarding the cable trench ramp crossings for heavy vehicles, the oldest cover slabs were broken due to age (Pictures 10 & 11). Most of the observed cover slabs were broken due to lack of proper reinforcement steel.

- Comments on the existing solution for some cable trenches

Regarding the existing solution for some cable trenches, it was noticed that the base of the cable trenches is uncoated, so the cables are directly laid on the soil. The storm water that may circulate inside the trenches washes the base material making the cables to sink and be covered with soil (Picture 12).

It was also observed that the kerbs that compose the lateral structure of the trenches are made by a standard precast concrete and a cast in-situ concrete wedge, as shown on the As-Built drawing presented on Figure 2.

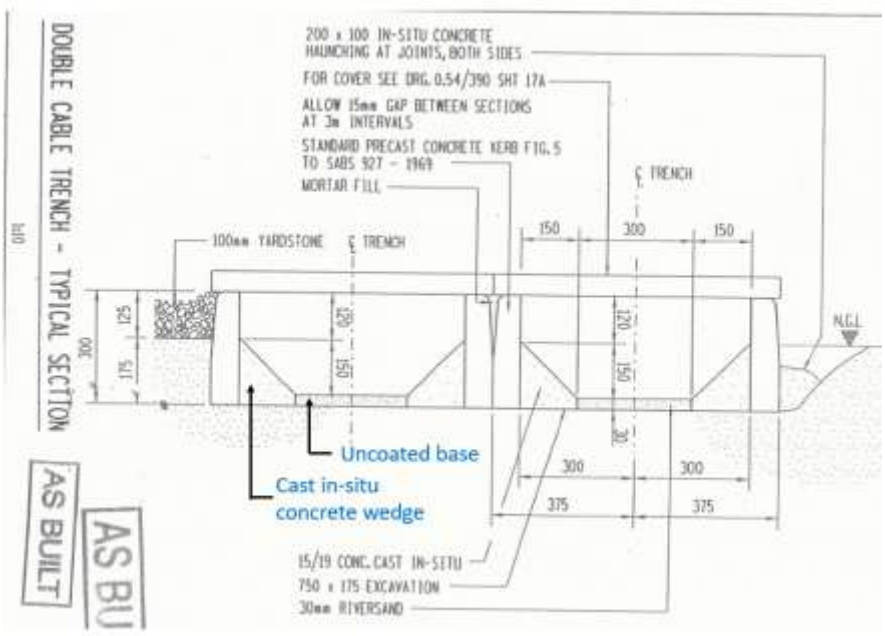


Figure 2 *- As-Built drawing of the cable trenches (from MOT/MAP/035, Sheet 16B).*

In these conditions, as there is no solid connection between the precast and the cast in-situ pieces, with variation of temperature and differential settlements those cast in-situ concrete pieces (wedges) are prone to break and separate (Picture13) causing general instability of the trench.

Pictures 12 & 13 *– Cables covered with soil and separation between the cast in-situ concrete wedge and the precast concrete kerb (400 kV zone).*

3.1.2 Solutions

3.1.2.1 For the cable trenches structure in general

Regarding the encountered problems, it is recommended to rebuild the cable trenches, which comprises the following works:

- Substitution of the broken kerbs with reinforced precast concrete kerbs as per the attached drawings;
- Cleaning of the trenches, levelling and compaction of the base, and placement of a 100 mm thick layer of river sand on the base;
- Placement of geotextile for filtration along the external perimeter of the trenches;
- Substitution of the broken slab covers.

For construction details, refer to Appendix 3.

3.1.2.2 For the trenches cover slabs within the traffic zones of heavy vehicles

Regarding the broken cover slabs of the trenches within the traffic zones of heavy vehicles, the following solution is recommended:

- Substitution of the broken slab covers by the ones with proper reinforcement steel, as shown on Appendix 3.

3.2 Between Manholes

3.2.1 Findings

- Localised settlements between manholes

Within the substation yard, localised settlements between manholes can be found. This may be due to damaged drainage pipes in the manhole alignments.

***Pictures 14 & 15** – Localised settlement between manholes, 400 kV zone.*

- Comments on the presumptive existing solution for the sub-soil drain

On a previous site inspection done in 2015 on some storm water drainage system and inspection boxes, it was found that the slotted pipes that make the connection between inspection boxes were not involved in geotextile.

As per the As-Built drawings, apparently a trench was excavated to insert the tubes, and then geotextile was placed on the walls of the trench and subsequently backfilled with rock fill (Figure 3).

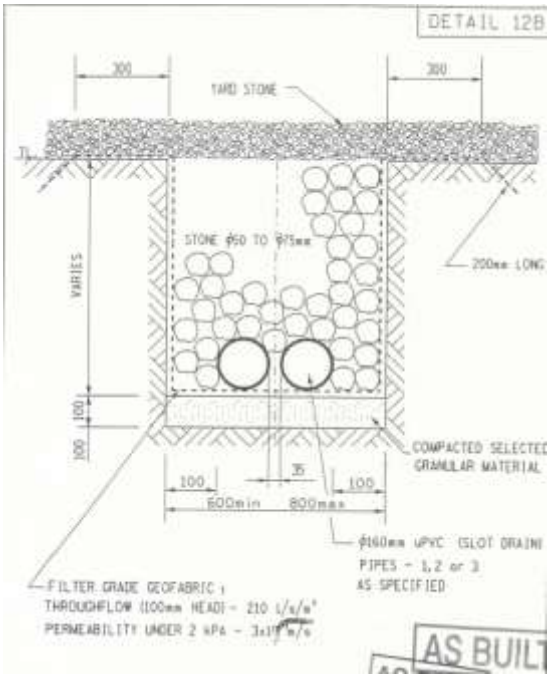


***Figure 3** - As-Built drawing of the sub-soil drain (from MOT/MAP/035, Sheet 12B).*

We suspect that the backfill material of the trench was made with sand material and a superficial layer of rock fill material, instead of only rock fill. This needs to be confirmed during reparation works.

It may be also the case of the connection between the geotextile blankets not being properly overlaid, allowing soil material to be washed when the storm waters flow in the direction of the perforated tubes.

3.2.2 Solutions

- Verify if the geotextile are well placed
- Verify the occurrence of damaged pipes
- Removal and replacement of all damaged drainage pipes including geotextile, as per the construction drawings.

3.3 Drainage Ditch

3.3.1 Findings

- Intrusion of fines;
- Collapse of the masonry walls due to lateral earth pressure.




Pictures 16, 17, 18 & 19 *– Collapsed walls, intrusion of fines (275 kV Zone).*

3.3.2 Solutions

In order to avoid the collapse of the drainage ditches walls and the intrusion of fines, the following solutions are proposed:

- Rebuilding of the collapsed drainage ditches with braced walls;
- Building of bracings where no collapse of the walls occurred yet;
- Placement of geotextile for filtration between the soil and the backside of the masonry walls.

The elements of proposed bracings (Picture 20) consist of two rows of 10cm thick blocks, softened, and placed along the longitudinal alignment of the ditches. About these blocks, two rows of 15 cm thick blocks are laid (up to the top of the trench), equally smoothed, arranged transversely to the alignment of the ditch. In the lateral zones of the base of these elements, finishing is carried out with mortar, with a curved shape, in order to allow the flow of the water without causing the deposition of fines. The spacing between the axes of the bracing elements is 5.0 m.

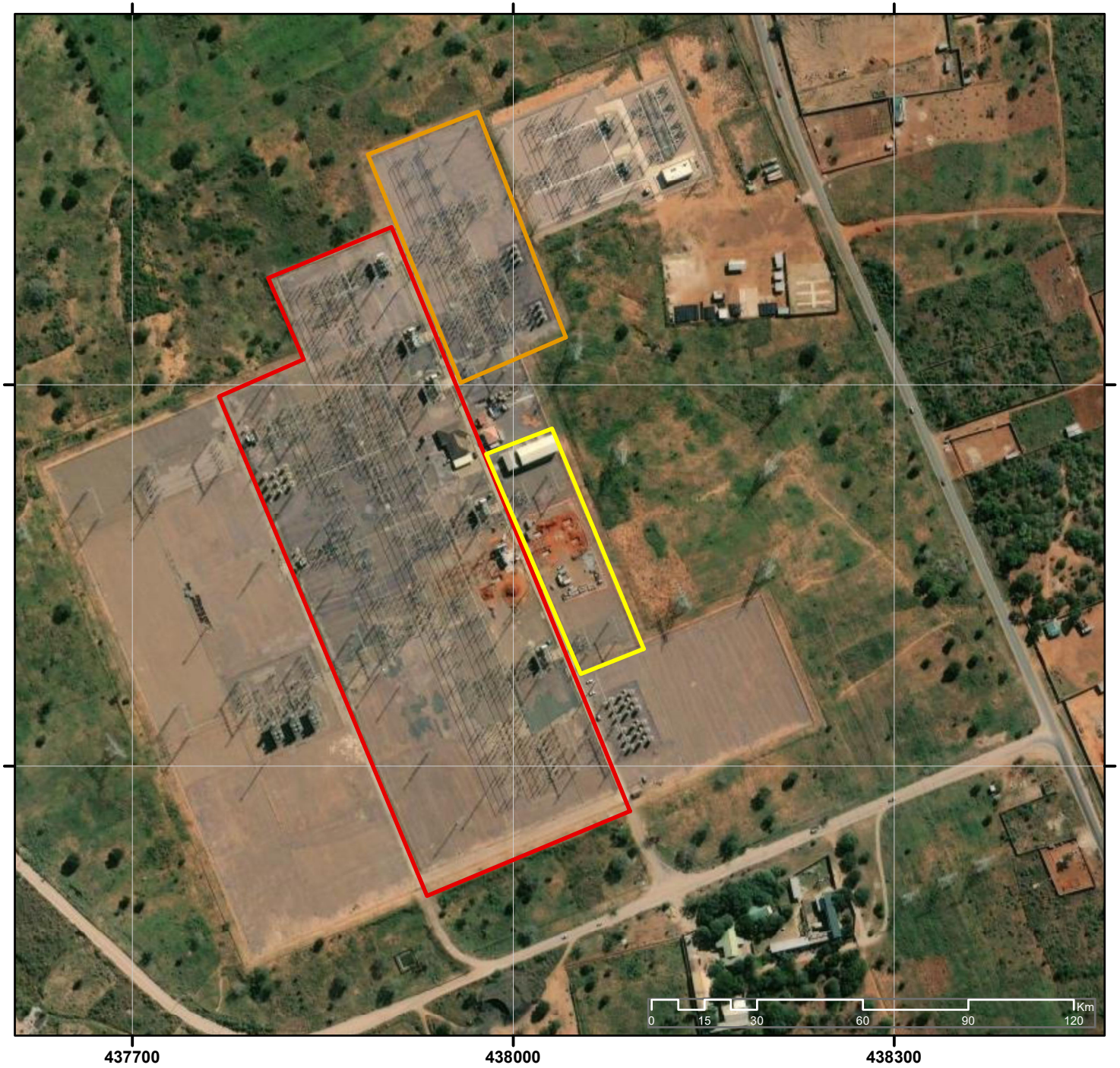
Picture 20 *– Drainage ditches with bracing elements (from previous intervention).*

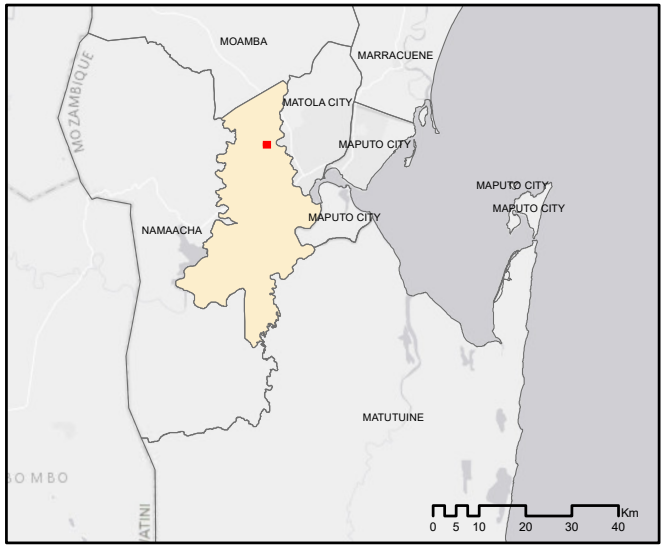
4 FINAL CONSIDERATIONS

- The scope of work presented in the present report is based on the site inspection held on 3rd June 2022. In this case it will be necessary to confirm the works and quantities prior to the commencement of the rehabilitation works.
- Regarding the works to be developed on the trenches, as handling the cables is involved, the Contractor must have special attention. This work must be coordinated with the client and all risks must be assessed and evaluated prior to the commencement of the works to avoid any injury or situation that may put in danger the life of the workers and the well-functioning of the Substation. It is advisable to have a Health and Safety officer on field to follow up the health and safety requirements and procedures for this work. The restoration of the cable trenches can be done in sections by lifting the cables with care and using wooden supports to maintain the cables lifted while the base is being prepared adequately to settle the new kerbs in replacement of the broken ones. If necessary lightweight lifting equipment can be used with proper guidance.
- The quantities on the BoQ present was made based on the quantity survey done at the areas where the problems can be visually identified. Nevertheless, it is expected that the same problems may occur in the near future on other areas of the Substation. As a preventive measure we recommend the following:
    - Inspect regularly the storm water drainage inspection boxes to see if there is any accumulation sand sediments that could indicate the occurrence of broken pipe or damage/absent of geotextile;
    - The facts observed on site proves that the solution previously adopted for the cable trenches is not the most effective. So it is advisable to make an intervention plan to verify all the trenches and evaluate the need to reconstruct the trenches using the solution recommended in the present report.

APPENDIX 1 – MAPUTO SUBSTATION MAP

LOCATION OF THE MAPUTO SUBSTATION





N
W E
S

Land Limits

- Matola Rio
- Boane District
- Maputo Province

Legend

- 400 kVA
- 275 kVA
- 132 kVA

Projection: Universal Transversa de Mercator - UTM
Datum: WGS 1982, Zone 36S
Prepared by: António Mussual
Date: 07/06/2022

tecnica
ENGENHEIROS CONSULTORES LDA.

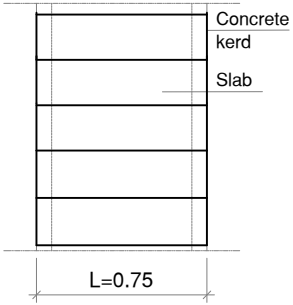
APPENDIX 2 – BILL OF QUANTITIES

CLIENT:	**MOTRACO**
PROJECT:	**Sediment Repair at Maputo Substation**
DATE:	**November 2022**

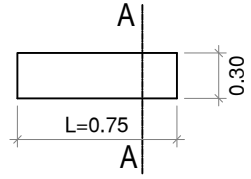
LIST OF UNIT PRICES

ITEM	DESIGNATION	UNITS	QUANTITIES	UNIT PRICE (MT)	TOTAL PRICE (MT)
1	**GENERAL**				
1.1	Mobilization including all costs associated with the mobilization of equipment, machinery and personnel	**LS**	1		
1.2	Provision for HST officer on field for Health and Safety requirements follow up	**month**	Rate Only		
2	**DRAINAGE DITCHES**				
2.1	**275 kV Zone**				
2.1.1	Excavation of the soil adjacent to the walls of the drainage ditches (0.50 m x 0.50 m)	m^3	66.02		
2.1.2	Removal of the demaged walls of the drainage ditches (0.5 m deep and 0.4 m wide)	m	24.48		
2.1.3	Rebuilding of the walls of the drainage ditches, including the bracings with blocks of 10 cm thick	m^2	12.24		
2.1.4	Placement of 200g/m2 geotextile at the backside of the drainage ditches walls	m^2	211.28		
2.1.5	Backfill of the soil adjacent to the walls of the drainage ditches (0.50 m x 0.40 m), including compaction to 95% mod AASHTO in layers of 150 mm maximum thickness. (0.50 m x 0.40 m)	m^3	52.82		
2.1.6	Placement of 50 mm crushed stone. The layer must be 100 mm thick (0.50 m x 0.10 m)	m^3	13.20		
2.2	**400 kV Zone**				
2.2.1	Excavation of the soil adjacent to the walls of the drainage ditches (0.50 m x 0.50 m)	m^3	42.00		
2.2.2	Placement of 200g/m2 geotextile at the backside of the drainage ditches walls	m^2	134.40		
2.2.3	Backfill of the soil adjacent to the walls of the drainage ditches (0.50 m x 0.40 m), including compaction to 95% mod AASHTO in layers of 150 mm maximum thickness. (0.50 m x 0.40 m)	m^3	33.60		
2.2.5	Placement of 50 mm crushed stone. The layer must be 100 mm thick (0.50 m x 0.10 m)	m^3	8.40		
3	**CABLE TRENCHES**				
3.1	**400 kV Zone**				
3.1.1	Cleaning and leveling of base of the cable trenches including old kerbs removal	m	264.00		
3.1.2	Excavation of the soil within the settlement zone (adjacent to the trenches), minumum 0.60 m x 0.30 m	m^3	47.52		
3.1.3	Compaction of the trenches bed at 95% mod AASHTO	m^2	356.40		
3.1.4	Placement of the geotextile over the base of the cable trenches. At the edje, the geotextile must be exended 0.20 m along the height of the kerbs and 0.30 m over the backfilled soil	m^2	446.16		
3.1.5	Placement of the pre cast concrete kerbs on the base of the trenches	m	264.00		
3.1.6	Placement of a 100 mm thick layer river sand at the bottom of the trench	m^3	3.96		
3.1.7	Backfill of the soil adjacent to the trenches	m^3	26.93		
3.1.8	Compaction of the 170 mm thick backfill layer at 95% mod AASHTO	m^2	158.40		
3.1.9	Replacement of a 130 mm thick layer of crushed stone yard surface	m^3	20.59		
3.1.10	Replacement of the broken pre-cast cover slabs on cable trenches ramp crossings for heavy vehicles (see drawing MOT-REP-S-100)	un	Rate only		
3.1.11	Replacement of the other pre-cast broken cover slabs on cable trenches (see drawing MOT/MAP/035 SHT 17A)	un	Rate only		
4	**BETWEEN MANHOLES (SUB-SOIL DRAIN)**				
4.1	**400 kV Zone**				
4.1.1	Excavation and clearing of the alignments between manholes	m^3	115.20		
4.1.2	Compaction of a 100 mm thick layer of selected granular material	m^2	76.80		
4.1.3	Placement of a non-woven geotextile along the perimeter of the sub-soil drain (French drain)	m^2	942.32		
4.1.4	Replacement of the uPVC 160mm demaged pipes wrapped with geotextile	m	288.00		
4.1.5	Backfill of the the trench with gravel	m^3	115.20		
				SUB-TOTAL	
				CONTINGENCIES (10%)	
				IVA (17%)	
				GRAND TOTAL	

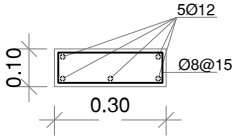
APPENDIX 3 – CONSTRUCTION DRAWINGS



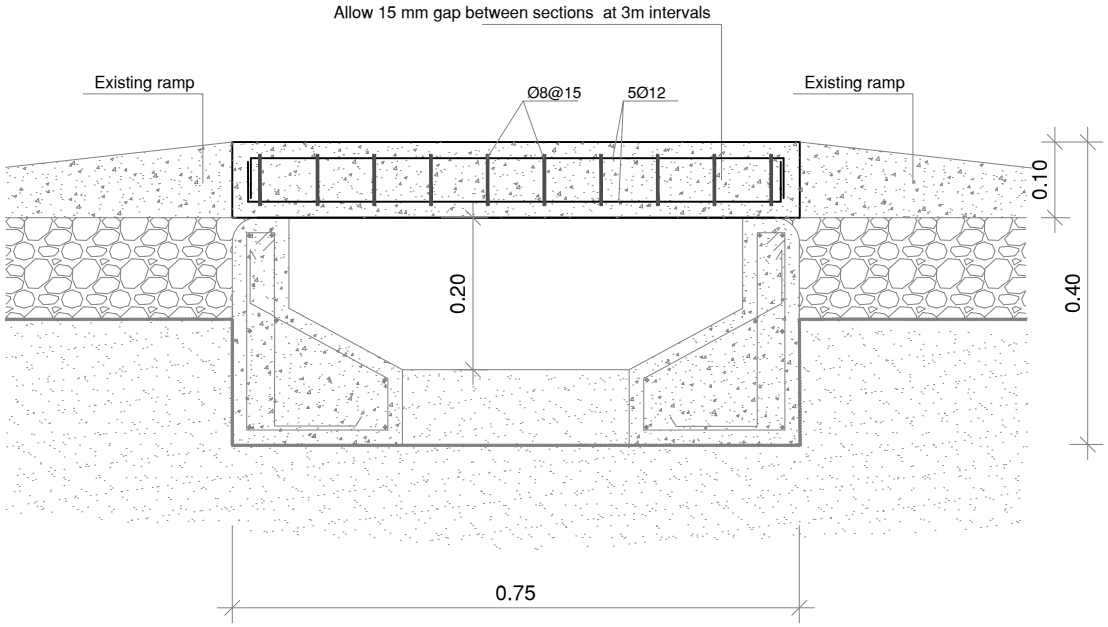
BASE PLANT
SCALE . 1:50



SLAB
SCALE . 1:50



SECTION A-A
SCALE . 1:20



Notes

1 The represented cover refers to the cable trench ramp crossings for heavy vehicles.
2 Slab to be cast in steel moulds with sides chamfered 5mm. Top of slab to heavy vastrap pattern.
3 For other covers, proceed as specified on the As-Built drawing- MOT/MAP/035 sheet 17A, attached to this report.

H.V. YARD CIVIL WORK
STANDARD DETAILS
ESC. 1:10

MATERIALS:
Concrete: B40
Steel: A400
Cover 10 mm

Tanica ENGENHEIROS CONSULTORES , LDA
MAPUTO
MAPUTO
PEMBA
QUELIMANE

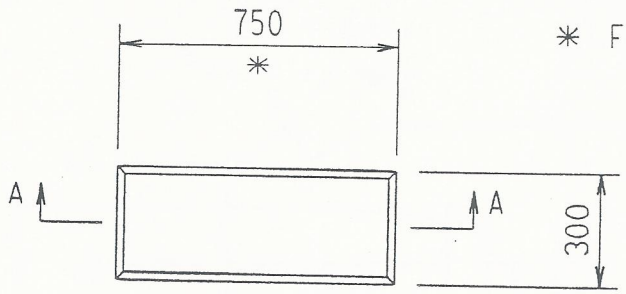
REV	DATE	DESCRIPTION

DATE	AUGUST DE 2022
DESIGNED	HD
DRAWN	AC
CALCULATED	RZ
APPROVED	MC/SA

CLIENT	MOTRACO
PROJECT	SEDIMENT REPAIR AT MAPUTO SUBSTATION

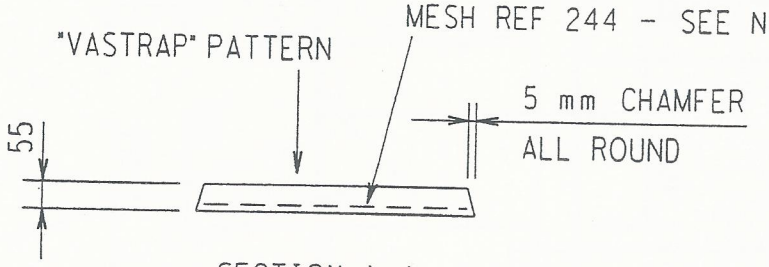
DRAWING N°	MOT-REP-S-100
PROJECT N°	P 914
SUBJECT	PRE-CAST SLAB TRENCH COVER BASE PLANT, DETAILS
SCALE/PAPER	1:50, 1:20, 1:10 / A3

S-100



PLAN

* FOR NON-STANDARDS SEE NOTE 5



SECTION A-A

QUANTITIES:

MASS - 30kg

CONCRETE - 12,3l

MESH REF. 244 - 0,185m^2

NOTES:

1 - CONCRETE GRADE 25/13

2 - CONCRETE COVER = 20mm

3 - REINFORCEMENT TO BE PLACED WITH MAIN STRANDS RUNNING IN LONGEST DIRECTION

4 - SLABS TO BE CAST IN STEEL MOULDS WITH SIDES CHAMFERED 5mm. TOP OF SLAB TO HAVE "VASTRAP" PATTERN

5 - FOR NON-STANDARD PANELS FROM 800 TO 1050 USE MESH REF 244 x 2 BOTTOM

AS BUILT

PRE-CAST SLAB TRENCH COVER

THE C.A.D. REFERENCE NUMBER IS: MUTS0.54 00390K17A.R02

ESKOM

MOTRACO

DRAWN GETEKEN	DIEZ	12.6. 1985	CHKD NAGES	R.J.C.	12.6. 1985	AUTH MAS			REV	0	DATE DATUM	

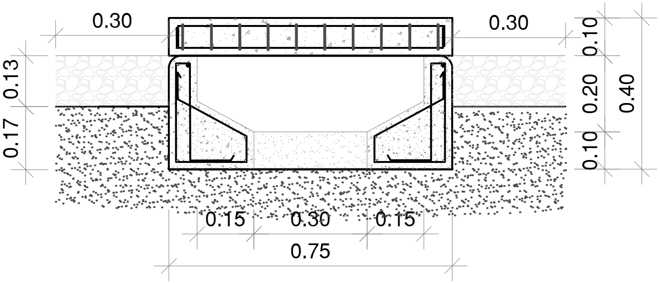
H.V. YARD CIVIL WORK STANDARD DETAILS

MOT/MAP/035

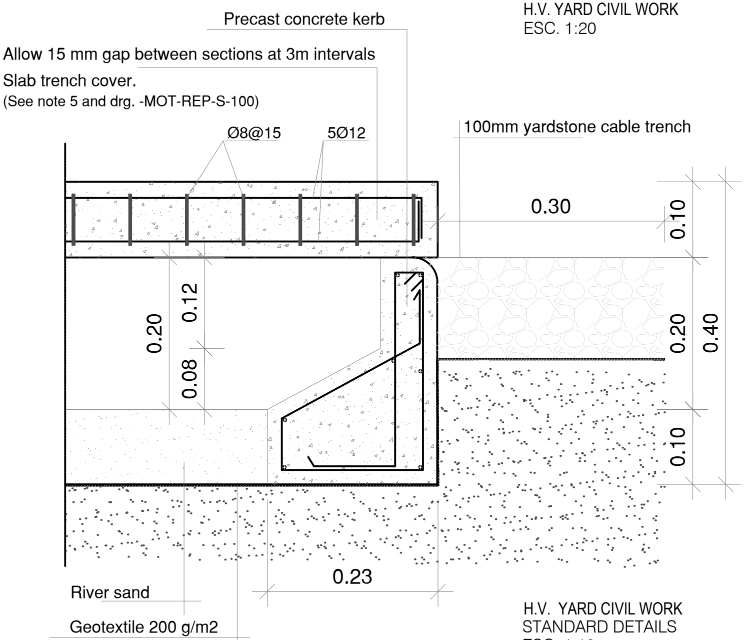
SHEET 17A

DRG.TEK REGISTR		

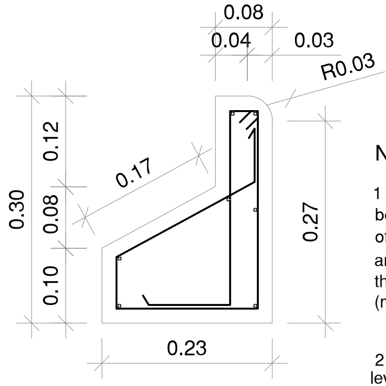
390K17A.DGN A4L

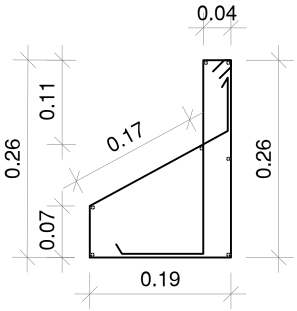


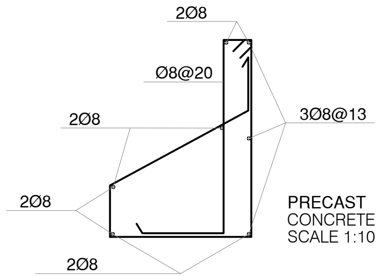
H.V. YARD CIVIL WORK
ESC. 1:20



H.V. YARD CIVIL WORK
STANDARD DETAILS
ESC. 1:10







PRECAST
CONCRETE KERB
SCALE 1:10

Notes

1 - Removal of the old kerbs must be preceeded by cleaning of the soil within the cable trenches and excavation of the soil within the adjacent settlement zone (minimum 0.60x0.30m2).

2 - The cable trenches bed must be levelled and compacted at 95% Mod AASHTO.

3 - After compaction of the trenches bed, one geotextile layer must be placed over the trenches bed.

4 - At the edge of the cable trenches, the geotextile must be extended 0.17m along the height of the kerbs and 0.30m over the backfilled soil.

5 - The represented cover (0.10m thick) only applies to the zones for trucks traffic (ramp crossings heavy vehicles).

MATERIALS:
Concrete: B40
Steel: A400
Cover 20 mm

tecnica ENGENHEIROS CONSULTORES, LDA.

MAPUTO
AV. 25 DE SETEMBRO Nº 2526
TEL +258 21 322185
FAX +258 21 322186
EMAIL tec@tec.co.mz
WWW.tec.co.mz

NAMPULA
AV. 25 DE SETEMBRO Nº 31 R/C
TEL +258 26 216684
FAX +258 26 216958
EMAIL tecnpl@tdm.co.mz

PEMBA
Rua DO CHAI Nº 1518 CARIACÓ
TEL +258 272 - 21977
FAX +258 272 - 20973
EMAIL tecpmb@tdm.co.mz

QUELIMANE
Rua HEROIS DA LIBERTAÇÃO NACIONAL Nº 309 1ºANDAR
TEL +258 24 215784
FAX +258 24 215784
EMAIL tecklm@tdm.co.mz

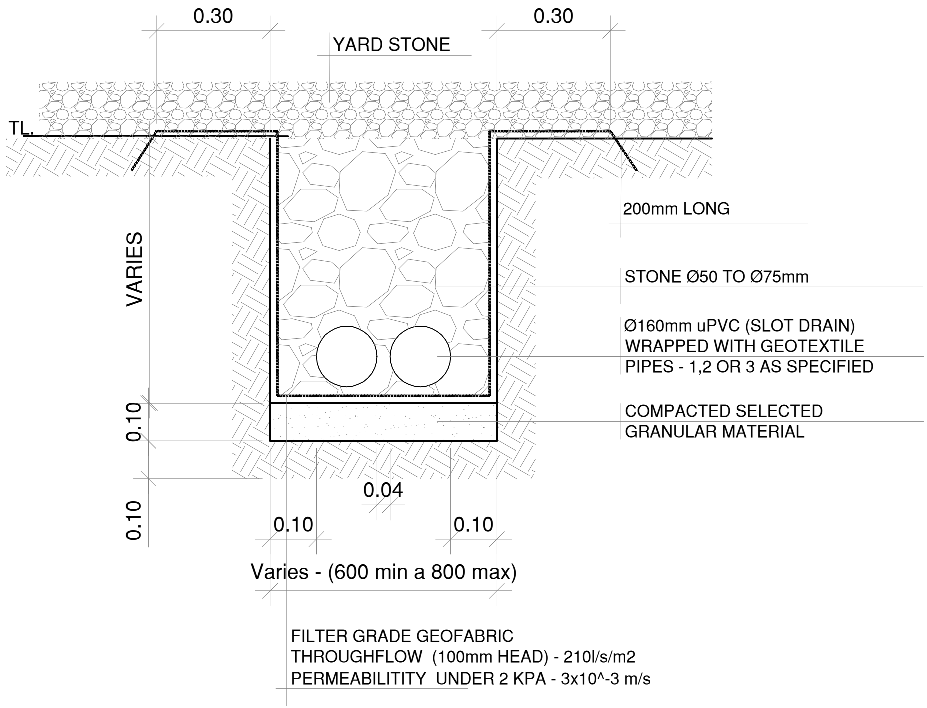
REV	DATE	DESCRIPTION

DATE AUGUST DE 2022
DESIGNED HD
DRAWN AC
CALCULATED RZ
APPROVED MC/SA

CLIENT MOTRACO
PROJECT SEDIMENT REPAIR AT MAPUTO SUBSTATION

DRAWING N° MOT-REP-S-101
PROJECT N° P 914
SUBJECT CABLE TRENCHES
SCALE/PAPER 1:20, 1:10 / A3

S-101



SUB-SOIL DRAIN
ESC. 1:20

tecnica ENGENHEIROS CONSULTORES, LDA.

MAPUTO
AV. 25 DE SETEMBRO Nº 2526
TEL +258 21 322185
FAX +258 21 322186
EMAIL tec@tec.co.mz
WWW.tec.co.mz

NAMPULA
AV. 25 DE SETEMBRO Nº 31 R/C
TEL +258 26 216684
FAX +258 26 216958
EMAIL tecnpl@tdm.co.mz

PEMBA
Rua DO CHAI Nº 1518 CARIACÓ
TEL +258 272 - 21977
FAX +258 272 - 20973
EMAIL tecpmb@tdm.co.mz

QUELIMANE
Rua HEROIS DA LIBERTAÇÃO NACIONAL Nº 309 1ºANDAR
TEL +258 24 215784
FAX +258 24 215784
EMAIL tecklm@tdm.co.mz

REV	DATE	DESCRIPTION

DATE	AUGUST DE 2022
DESIGNED	MOTRACO
DRAWN	AC
CALCULATED	....
APPROVED	SA

CLIENT	MOTRACO
PROJECT	SEDIMENT REPAIR AT MAPUTO SUBSTATION

DRAWING N°	MOT-REP-S-102
PROJECT N°	P 914
SUBJECT	SUB-SOIL DRAIN - DETAIL
SCALE/PAPER	1:20 / A3

S-102