

GEORGE MUNICIPALITY



GEORGE ERF 2819 SOLAR PHOTOVOLTAIC PLANT ENGINEERING REPORT

REVISION 1 : MAY 2023

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EXECUTIVE SUMMARY

This document describes the technical activities that will take place to build a solar plant with a capacity of up to 13MWp for George Municipality.

All the activities that are envisaged to take place on the site will be listed as well as a breakdown of how the required space will be used.

DOCUMENT CONTROL

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- Keywords: 13MWp Solar Plant, George
- Client: George Municipality
- Report Prepared by: Lukas van Eck

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08-05-2023	1		



.....
Lukas van Eck

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1. INTRODUCTION

Neil Lyners and Associates (RF) (Pty) Ltd, from hereon referred to as Lyners, were appointed for the detailed planning, preliminary design, procurement documentation compilation, and contract management for the establishment of a ground mounted Photovoltaic (PV) facility. The maximum PV potential on the site is expected to be 13MWp and this will be dependant on the final design and plant effectivity.

This PV plant will be built on an undeveloped ERF and this report will detail the technical requirements for the project to determine to assist the appointed EAP in determining the listed activities required to successfully construct and operate the PV plant to provide energy directly into the existing distribution network that is operated by George Municipality.

2. PRELIMINARY PLANT LOCATION

The preferred site under consideration as proposed by the Municipality is a portion of erf 2819 adjacent to the N2 highway between the airport and Dellville Park in Pacaltsdorp, George. The erf spans over an area of 24ha. A proposed layout of approximately 14.9ha was used to avoid power distribution over waterways. This is ample space for the establishment of a solar plant of up to 13MWp including a substation as required to facilitate the grid connection of the PV plant onto the municipal grid.

Various other sites in George were taken into consideration for the establishment of the PV facility but were found not feasible due to land-use restrictions, sloping and shading complications or remoteness from existing Municipal electrical supply infrastructure. The sites that have been earmarked as feasible alternative sites are Portion 37 of Farm 202 Hansmoeskraal, and a portion of Erf RE/325 in Pacaltsdorp.

The proposed PV facility will trigger a listed activity and thus a Basic Assessment (BAR) Process because more than 1 hectare of land will be cleared.

3. SCOPE OF WORK

The Scope of work that is envisaged for the project can be broken down into the following aspects:

- PV Plant
 - LV Plant
 - MV Plant
 - Ancillary Services
- 66/11kV Step-up Substation
 - 66/11kV Power Transformers
 - 66kV Primary Plant
 - Substation Building
 - 66kV Overhead Lines
- Ancillary services
 - Access Roads
 - Fencing
 - Lighting/Lightning Masts
 - Stormwater drainage

3.1 PV PLANT OF UP TO 13MWp

3.1.1 LV PLANT

The LV plant of the Solar plant will consist of a DC and AC component.

The DC plant will consist of the following components:

3.1.1.1 SOLAR PV MODULES

The solar PV modules that are proposed for this project will be fixed ground mounted solar PV modules. Monofacial or Bifacial modules can be considered with modules with a lower Levelized Cost Of Electricity (LCOE) being preferred.

Fixed modules are used to reduce the presence of high maintenance components and to keep the LCOE lower.

3.1.1.2 DC CABLING

The DC cabling between the solar panels and inverters will be fixed to the mounting structures and wired to the inverters.

MPPT or optimizer modules may be installed underneath the panel mounting structures. The presence of these units are dependent on the detailed design which will be part of the EPC contract of the contractor.

3.1.1.3 STRING INVERTERS

The String inverters will be mounted onto the panel mounting structures and will convert the DC power from the solar PV modules to AC power as is required.

The DC plant will consist of the following components:

3.1.1.4 LV CABLING

All LV cables between the inverters and minisubstations will be buried underground at a depth of roughly 700mm. The LV plant will also be appropriately earthed using bare copper conductors.

3.1.1.5 LV PROTECTION

All of the LV plant will have to be protected against overcurrent and earth faults using appropriate circuit breakers in the MV/LV minisubstations.

3.1.1.6 LV/MV STEP UP TRANSFORMERS

All the LVAC cables will be reticulated between the inverters and the LV/MV step up minisubstations inside the plant. These minisubstations will convert the LV voltage to an MV voltage level of at least 11000V.

These Transformers will be built into minisubs, which will be placed onto concrete plinths. MV and LV cabling will be wired from the ground into the minisubs.

3.1.2 MV PLANT

The MV plant will consist of only AC equipment and will consist of the following:

3.1.2.1 11KV MINISUBSTATIONS

The 11kV minisubstations will consist of the MV to LV transformers mentioned above as well as 11kV Ring Main units. The ring main units will allow several minisubstations to be connected to the 11kV switching station in a ring configuration using underground 11kV cables.

The minisubstations will also house the LV switchgear as mentioned above.

3.1.2.2 11KV CABLES

The 11kV cables between the minisubstations and 11kV Switching station in the substation will be buried in the ground at roughly 1100mm below NGL.

3.1.2.3 11KV HARMONIC FILTER EQUIPMENT

A harmonic filter yard may be constructed between the minisubstations and the 11kV switchgear building if required for power quality purposes

3.1.2.4 11KV INDOOR SWITCHGEAR

The EPC part of the project will terminate at the 11kV indoor switchgear panels of the substation. The panels These 11kV panels will also be used to monitor the quality of supply and meter the energy supplied by the PV plant.

3.2 66/11KV STEP-UP SUBSTATION

3.2.1 SUBSTATION YARD

The substation yard will be fenced off to separate the PV plant from the HV substation equipment. The yard platform will be constructed using layer works to support all equipment foundations. All 66kV equipment will be interconnected with a combination off Centipede or Bull AAAC conductors. Single core XLPE cables will be used to connect each transformer their respective 11kV switchgear panel inside the 11kV switchgear room in the substation building.

The substation yard will also require 21m lightning masts to protect equipment from potential lighting strikes.

3.2.1.1 66/11KV POWER TRANSFORMERS

Two step-up transformers rated at a minimum of 10MVA will be installed to step up the MV voltage from the plant to 66kV to connect onto the existing overhead line that is situated next to the preferred alternative site. The transformers will be mounted on concrete plinths that will be surrounded with bund walls to capture oil in the event of a catastrophic failure.

Concrete pipework will connect the bund walls to an oil dam and oil trap to capture any oil with excess water overflowing to the stormwater system.

3.2.1.2 66KV PRIMARY PLANT

The rest of the primary plant will consist of the following equipment, used to electrically protect, isolate, monitor and control all the equipment in the substation. The equipment that will be installed are; incomer portal gantries, 66kV disconnectors and earth switches, 66kV circuit breakers, 66kV busbars, 66kV voltage transformers, 66kV current transformers and 66kV surge arrestors

All auxiliary LV cabling between the primary plant and transformers will be reticulated in the substation yard using cable trenches with concrete covers.

3.2.1.3 SUBSTATION BUILDING

The substation building will contain the following equipment: 66kV protection relays, 11kV switchgear and protection relays, 110Vdc Battery tripping units, basin and toilet and a storage room.

3.2.2 66KV OVERHEAD LINES

Overhead line works would be required to connect the substation to the existing overhead line between SS Proefplaas and SS Herolds Bay. On Site A(preferred alternative), overhead line works will be kept to a minimum, due to the line servitude being directly next to where the substation is planned to be built.

On Site B, a long extension of this line will need to be built and a new servitude registered.

All 66kV overhead lines planned will be steel monopole lines ranging in height from 20m to 22m.

3.3 ANCILLARY SERVICES

3.3.1 ACCESS ROADS AND INTERNAL ROADS

An access road will need to be constructed from the circle at the end of Discovery road in Pacaltsdorp industrial. The road will be a gravel road and will be used for general access as well as for construction. Low water concrete crossings will be used to cross the waterways that the access road will cross.

Internal roads will also be constructed to that heavy equipment can be installed or removed, as well as to do maintenance.

3.3.2 GUARD HOUSE

A Guard house will be constructed at the main entrance to allow a guard on-site for extended periods of time.

3.3.3 SEWERAGE AND WATER SERVICES

There are no sewerage and water services on site. A septic tank will be installed for the guard house and substation building sewerage.

Both these buildings will also use water tanks to capture rainwater to use as a non-potable water source. Should the tanks run dry, the tanks will need to be filled with a water truck, which will be necessary on site from time to time to clean panels as well.

3.3.4 FENCING

A rugged wire mesh fence is proposed for the site. The fence must be designed to prevent scaling, burrowing underneath and cutting of the fence. The fence will also need to be coated to reduce corrosion. Additional security measures will also be required for the fence.

The fence will also need to be properly earthed to keep personnel and public safe, since there will be a 66kV substation in close proximity.

3.3.5 LIGHTING MASTS

Mast will be needed to provided security lighting for the PV plant as well as lighting at the substation to do maintenance or switching at night.

3.3.6 STROMWATER DRAINAGE

Stormwater drainage channels and berms will be installed around the external fence and all internal stormwater will be channeled to these berms.

Berms will be used as far as possible to naturally disperse of stormwater, thus no energy dissipation structures will be required for the stormwater.

These channels will in turn flow excess stormwater to the existing waterways.

4. PV PLANT FOOTPRINT CONSIDERATIONS.

It is estimated that to accommodate PV panels with a total DC power rating of up to 13MWp, approximately 13ha of space is required.

This space requirement can be affected by the solar panels used as well as the spacing between the panels.

A preliminary design was done using Helioscope simulation software. A larger area is considered than the initial 13ha due to the following reasons:

- Avoiding site sensitivities causes large keepout areas.
- The addition of the HV substation adds approximately 1ha of space.
- Taking the shading of the substation, masts and fencing into account reduces the amount of usable space.
- Extra space is allowed to compensate for larger panel spacing, non-optimal panel orientations (could be affected by glare studies etc.) and uncertainty in the choice of panels to be used.

Taking all the above into account, the revised area to be evaluated for site A is approximately 14.9ha.

Annexure A

Preliminary Helioscope Simulation Results

Annexure B

Site A Proposed Layout

Annexure C

Typical Oil Dam Detail

Annexure D

Typical Septic Tank Detail

Annexure E

Typical Water Crossing Detail

Annexure F

Typical Stormwater Channel

Annexure G

Typical Steel Monopole Detail

George 9MWp Prelim R2 George PV, george south africa

Report

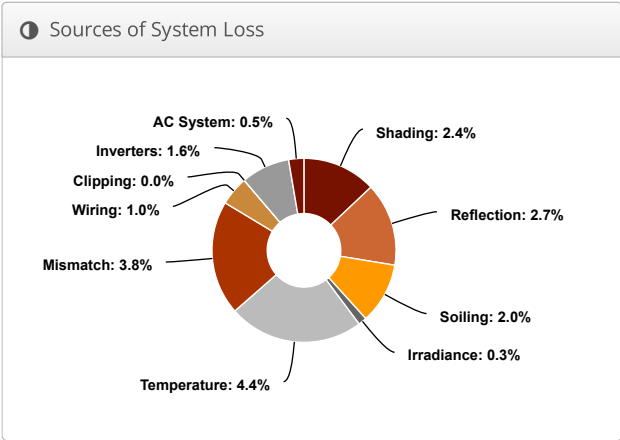
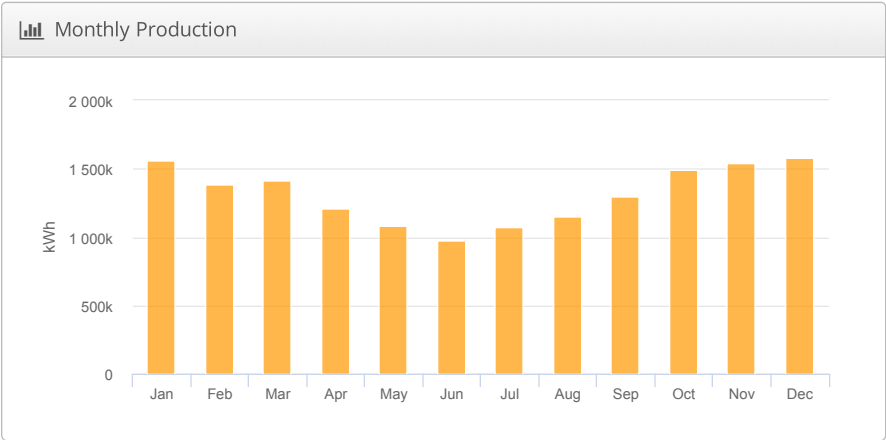
Project Name	George PV
Project Address	george south africa
Prepared By	Bian Vermaak bian@lynners.co.za

Neil
LYNERS
and Associates (RF) (Pty) Ltd

Consulting Engineers & Project Managers

System Metrics	
Design	George 9MWp Prelim R2
Module DC Nameplate	9.04 MW
Inverter AC Nameplate	8.80 MW Load Ratio: 1.03
Annual Production	15,77 GWh
Performance Ratio	82.7%
kWh/kWp	1,743.3
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	654a5617e8-f6fcd7720-2398abb298-4bc6d73c62

Project Location



⚡ Annual Production			
	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,846.8	
	POA Irradiance	2,107.0	14.1%
	Shaded Irradiance	2,056.0	-2.4%
	Irradiance after Reflection	1,999.8	-2.7%
	Irradiance after Soiling	1,959.8	-2.0%
	Total Collector Irradiance	1,959.7	0.0%
Energy (kWh)	Nameplate	17,726,531.3	
	Output at Irradiance Levels	17,677,520.2	-0.3%
	Output at Cell Temperature Derate	16,892,233.4	-4.4%
	Output After Mismatch	16,258,477.6	-3.8%
	Optimal DC Output	16,102,545.2	-1.0%
	Constrained DC Output	16,102,498.3	0.0%
	Inverter Output	15,844,857.9	-1.6%
	Energy to Grid	15,765,633.6	-0.5%
Temperature Metrics			
Avg. Operating Ambient Temp		19.0 °C	
Avg. Operating Cell Temp		29.5 °C	
Simulation Metrics			
Operating Hours			4634
Solved Hours			4634

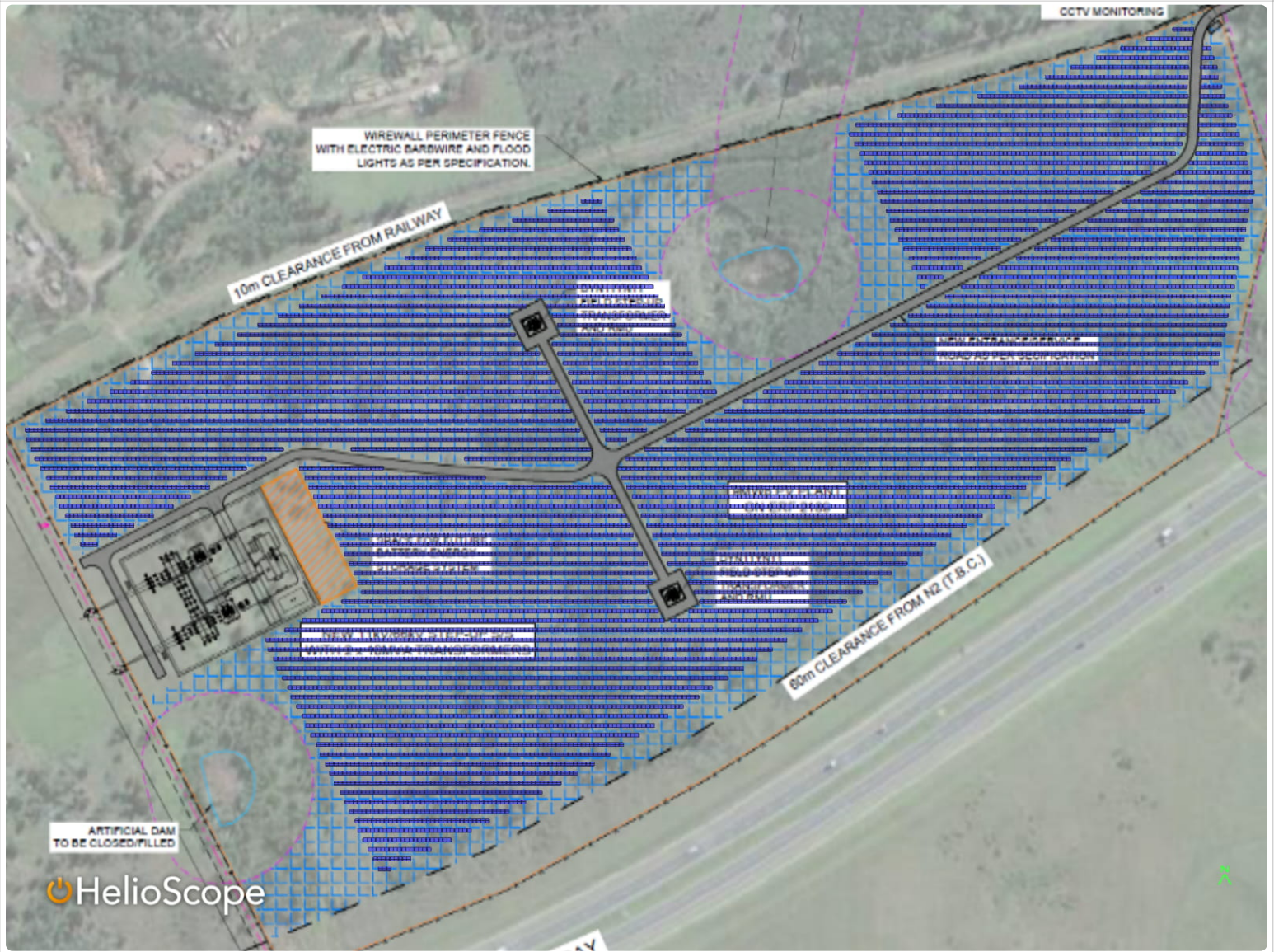
☁ Condition Set												
Description	Condition Set 1											
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)											
Solar Angle Location	Meteo Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Sandia Model											
Temperature Model Parameters	Rack Type			a		b			Temperature Delta			
	Fixed Tilt			-3.56		-0.075			3°C			
	Flush Mount			-2.81		-0.0455			0°C			
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	2	2	2	2	2	2	2	2	2	2	2	2
Irradiation Variance	5%											
Cell Temperature Spread	4° C											
Module Binning Range	-2.5% to 2.5%											
AC System Derate	0.50%											
Module Characterizations	Module					Uploaded By			Characterization			
	CS3W-440PB-AG (1000V) (Canadian Solar)					HelioScope			Spec Sheet Characterization, PAN			
Component Characterizations	Device						Uploaded By		Characterization			
	SUN2000-100KTL-M1 (Apparent Power) (400V) (Huawei)						HelioScope		Spec Sheet			

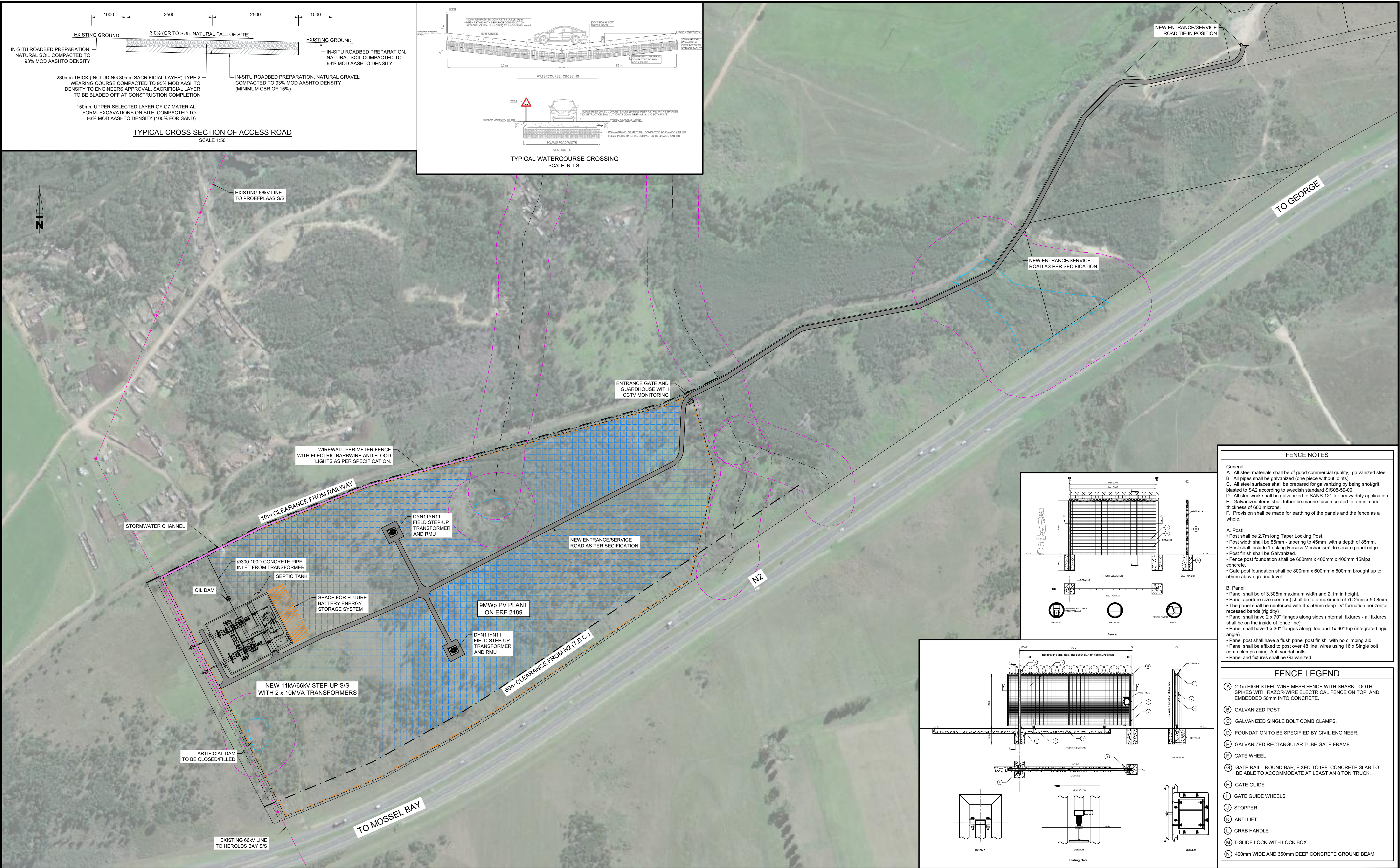
📦 Components		
Component	Name	Count
Inverters	SUN2000-100KTL-M1 (Apparent Power) (400V) (Huawei)	80 (8.80 MW)
Strings	10 AWG (Copper)	1,046 (221,318.0 m)
Module	Canadian Solar, CS3W-440PB-AG (1000V) (440W)	20,554 (9.04 MW)

🔌 Wiring Zones			
Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	6-21	Along Racking

🏠 Field Segments									
Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 2	Fixed Tilt	Landscape (Horizontal)	29°	0°	3.0 m	2x1	10,277	20,554	9.04 MW

Detailed Layout





SCALEBAR

0 60 120

Meters 1:2000

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REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR INFORMATION	'22-12-09	NL	BV

DESIGNED BV '22-07

DRAWN NL '22-07

CHECKED TP '22-07

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APPROVED

ENGINEERS: _____

DATE: 2023-04-18

APPROVED

CLIENT: _____

DATE: _____

CLIENT

GEORGE

PROJECT

GEORGE 9MWp PV PLANT

TITLE

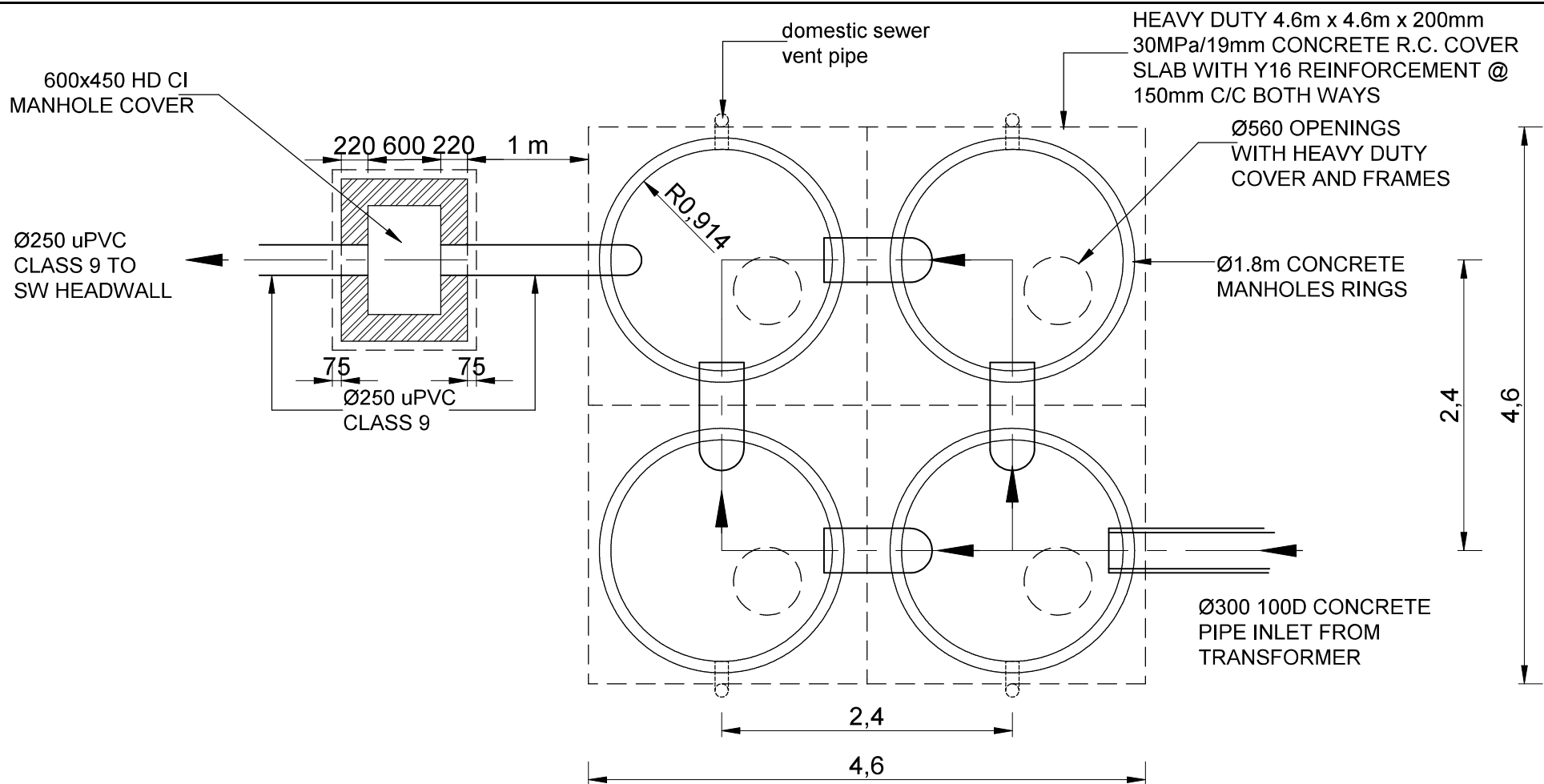
PROPOSED SITE LAYOUT (Erf 2189)

SCALE on A1 1:2000 SHEET 1 OF 1

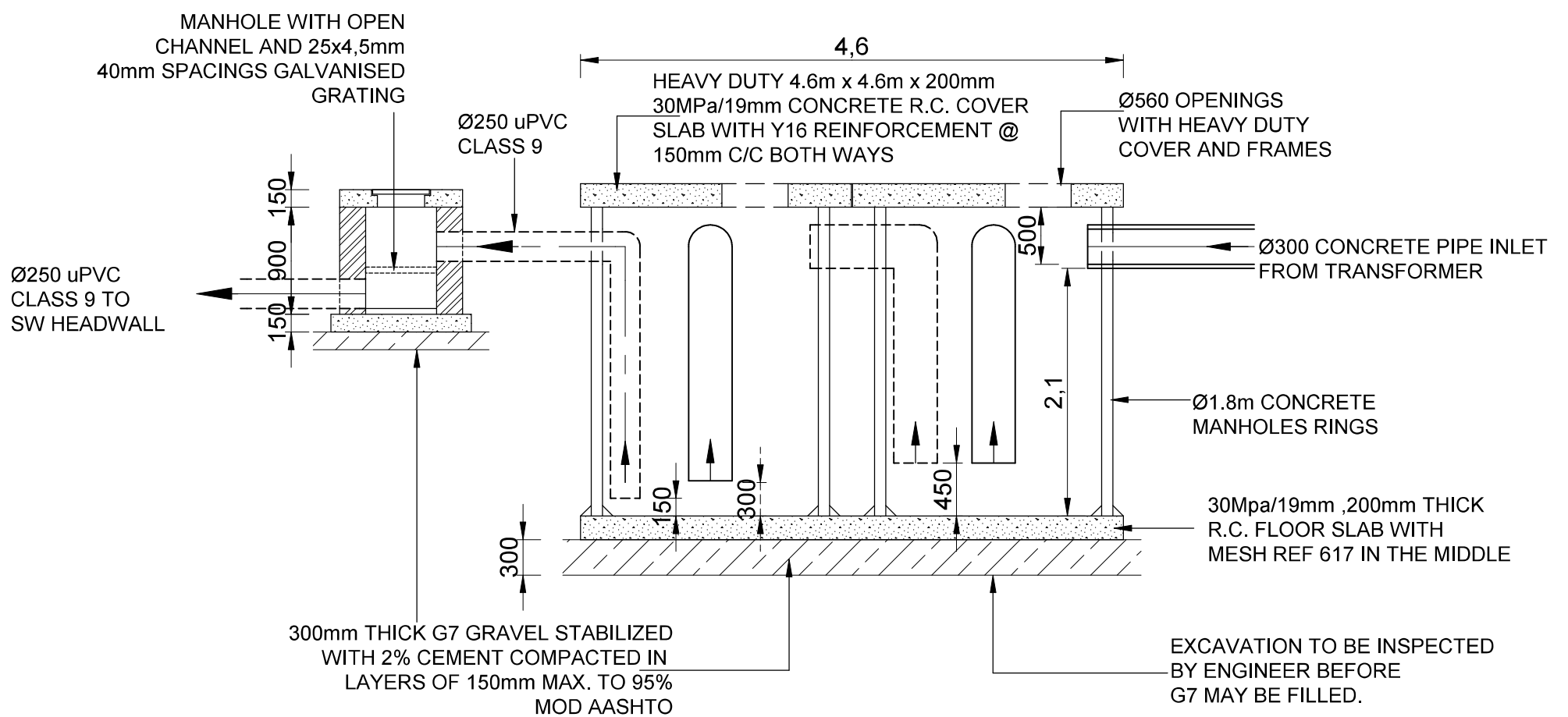
CONTRACT No. PROJECT No. 22063E

DRAWING No. REV 22063-E-301

COORDINATE SYSTEM: WGS84 / L203



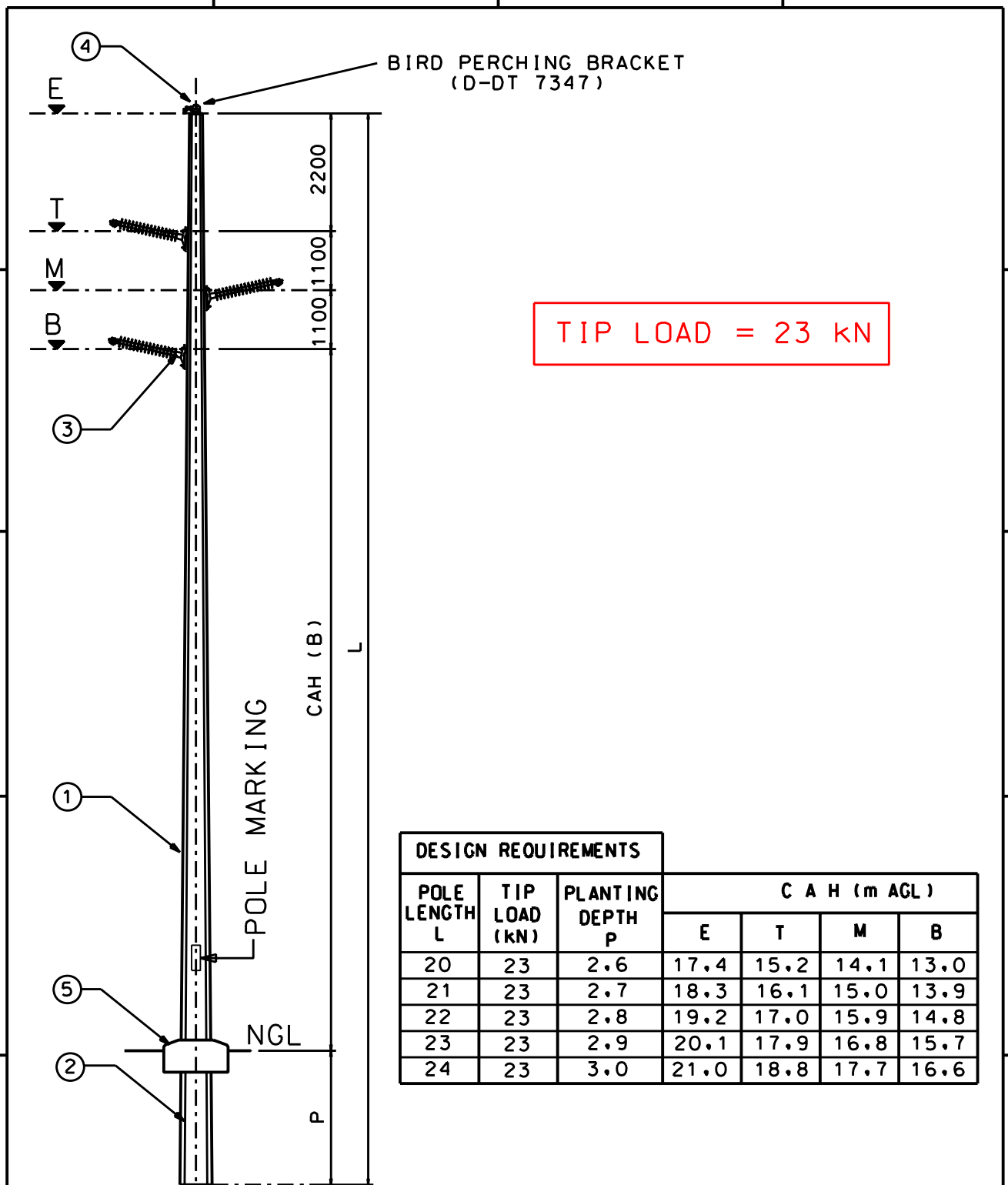
PLAN VIEW
OIL DAM



SECTION
OIL DAM

NOTES:

1. SUMPS TO BE WATER TIGHT.
2. WATER INFILTRATION AND EXFILTRATION TESTS MUST BE DONE TO ENSURE WATER TIGHTNESS.



2	DRG SHT UPDATED. REFERENCES REV'D. GENERAL REVISION	SLR	RAB	AB	JUNE 2004	
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.



AUTH: A BEKKER

DATE: JAN 2004

CHKD: RAB

DATE: JAN 2004

DRAWN: LMP

DATE: NOV 1998

DISTRIBUTION TECHNOLOGY **RETICULATION/SUB-TRANSMISSION LINES** **88/132KV S/C INTERMEDIATE STRUCTURE** **GENERAL ARRANGEMENT**

D-DT 7611

2

1

2

1

2

3

4 A4L

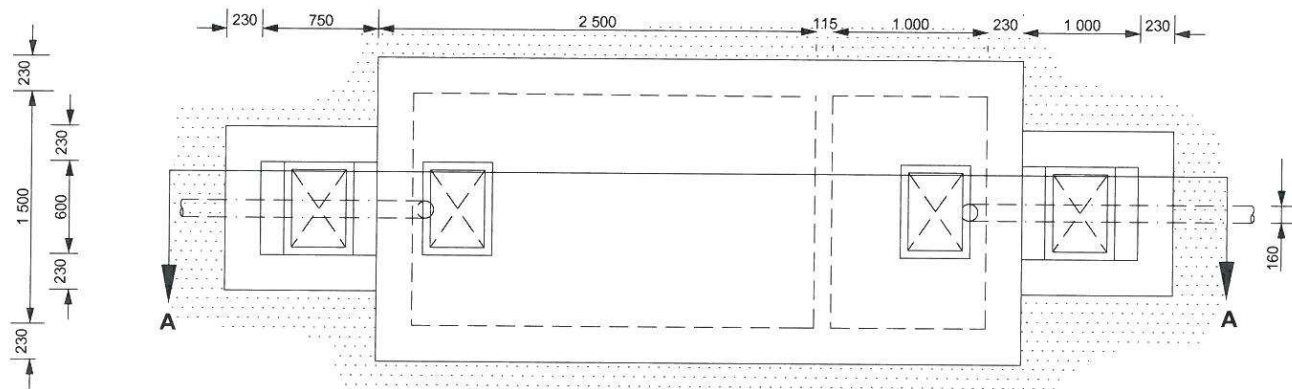
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		STRUCTURE		
		TYPE 259A	D-DT 7611	
		MANUFACTURER: STRUCTATECH		
		TYPE 261A	D-DT 7611	
		MANUFACTURER: CIS		
B	1	POLE LENGTH (BODY)		B
		20m STEEL	D-DT 7100	
		21m STEEL	D-DT 7100	
		22m STEEL	D-DT 7100	
		23m STEEL	D-DT 7100	
		24m STEEL	D-DT 7100	
C	2	FOUNDATION		C
		TYPE 1 (300kPa)	D-DT 7850 SHT 2	
		TYPE 2 (150kPa)	D-DT 7850 SHT 3	
		TYPE 3 (100kPa)	D-DT 7850 SHT 4	
		TYPE 4 (50kPa)	D-DT 7850 SHT 5	
		ROCK & SOFT ROCK	D-DT 7850 SHT 1	
D		ALTERNATE FOUNDATIONS	D-DT 7851	D
	3	INSULATOR ASSEMBLY		
		INTERMEDIATE ASSEMBLY	D-DT 7321	
	4	EARTH WIRE ASSEMBLIES		
		NON INSULATED	D-DT 7326	
		INSULATED	D-DT 7327	
E	5	CONCRETE CAP AND	D-DT 7857	E
		EARTHING DETAILS		

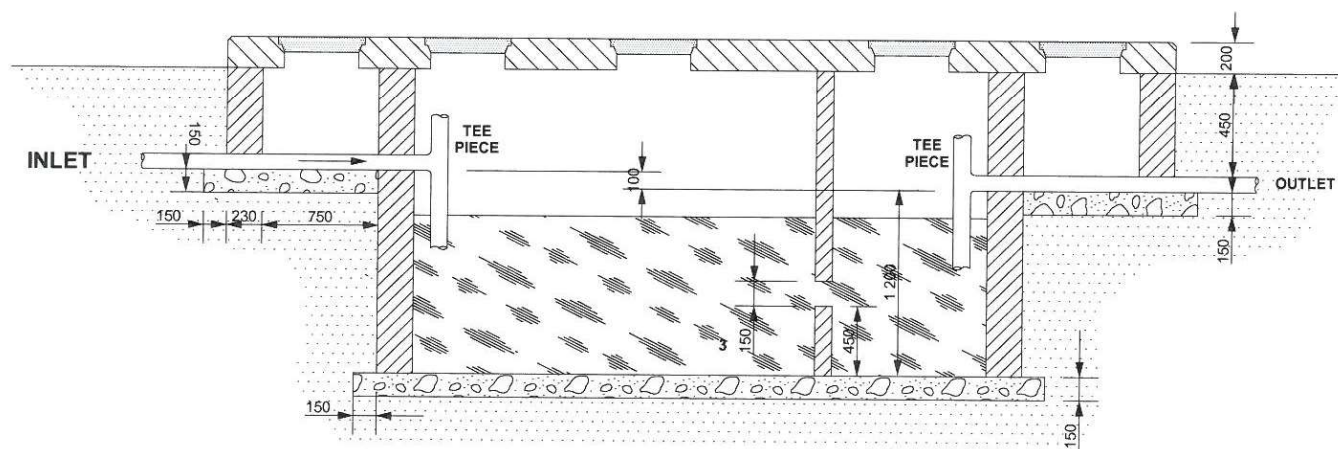
2	DRG SHT UPDATED. REFERENCES REVISED. GENERAL REVISION	SLR	RAB	AB	JUNE 2004	
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.

F		DISTRIBUTION TECHNOLOGY RETICULATION/SUB-TRANSMISSION LINES 88/132KV S/C INTERMEDIATE STRUCTURE REFERENCE TABLE				F
	AUTH: A BEKKER					
	DATE: JAN 2004					
	CHKD: RAB					
	DATE: JAN 2004	SET	SHEET	REVISION		
	DRAWN: SLR	D-DT 7611	2	2	2	
DATE: JAN 2004						

1	2	3	4 A4L
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PLAN VIEW



SECTION A - A

NOTES

1. SEPTIC TANK MUST BE PLASTERED 2 LAYERS OF 1 BAG CEMENT, 6 KG LIME AND 150 l OF SAND TO MIN 18 mm
2. NEW CONNECTING MANHOLE MUST BE CONSTRUCTED BEHIND THE SEPTIC TANK, WITH REDUCTION DIA FROM 110 TO 50 mm DEPENDING ON THE CONNECTION POINT
3. MIN REINFORCEMENT REQUIRED IN SLAB & FOUNDATION MUST BE REF. 245 EXPANDED MESH
4. LIGHT DUTY MANHOLE FRAMES AND COVERS TO BE USED
5. AVOID BUILDING SEPTIC TANK IN ROAD AREAS, BUT LOCATION MUST BE ACCESSIBLE BY MUNICIPAL SERVICES
6. MIN DIFFERENCE IN HEIGHT BETWEEN INLET AND OUTLET MUST BE 100 mm
7. SEPTIC TANK IS NOT ALLOWED IN AREAS WHERE EXISTING MUNICIPAL SEWER SERVICE IS AVAILABLE
8. CAPACITY DEPENDS ON THE REQUIREMENTS



DEPARTMENT: CIVIL ENGINEERING SERVICES

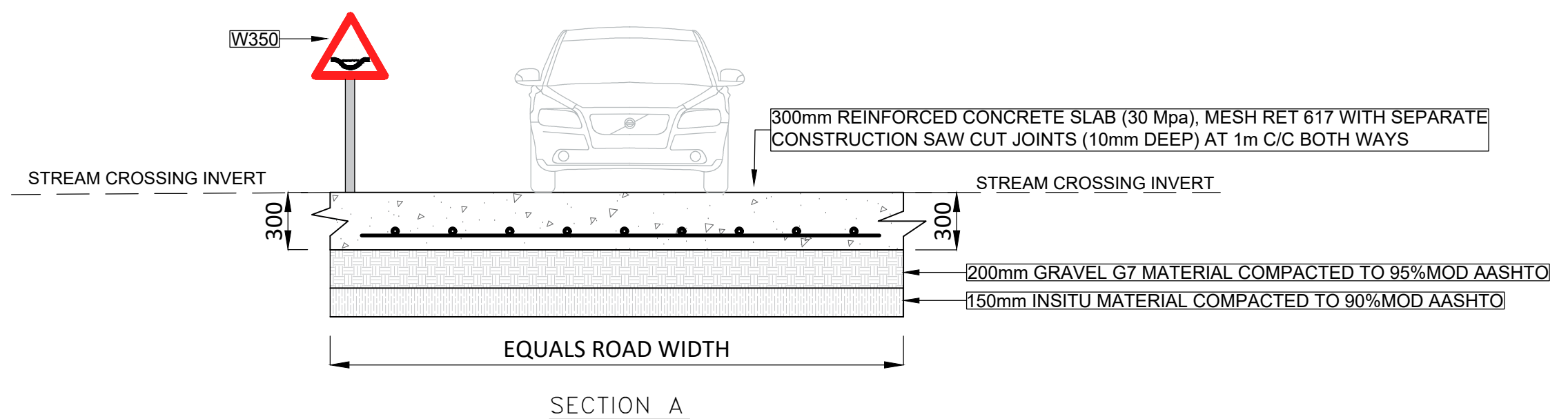
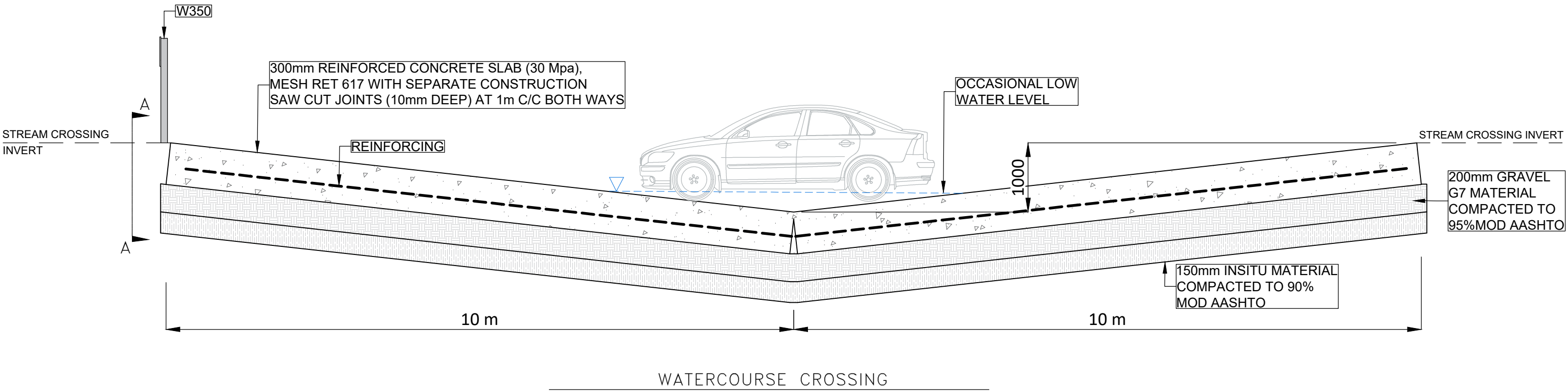
STANDARDS

TYPICAL SEPTIC TANK (FARM AREAS)

DATE: AUG 2011

SCALE: NTS

PLAN NO: CES/ S / 4A



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email: george@lyniers.co.za

PROJECT

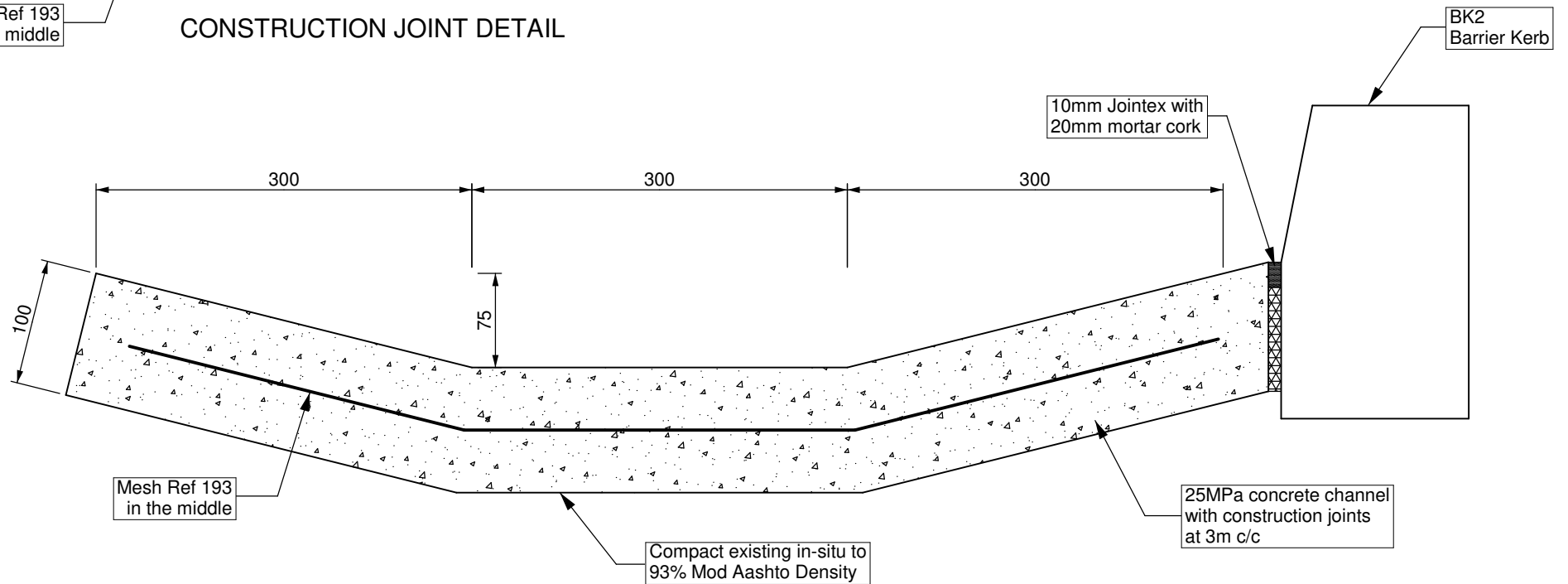
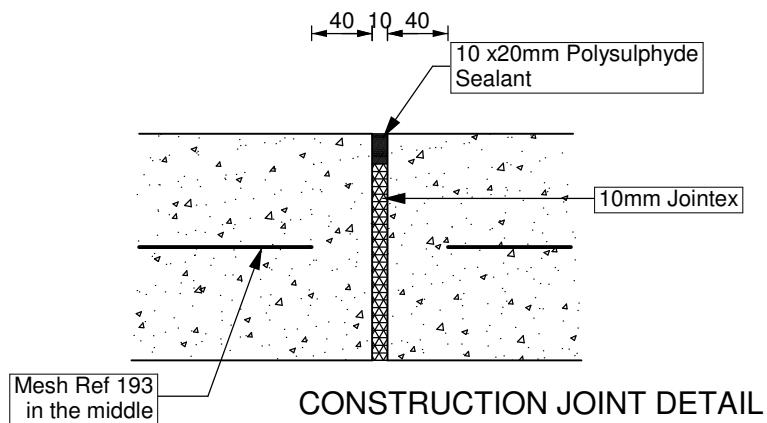
TYPICAL WATERCOURSE CROSSING

SCALE

N.T.S

DRAWING No.

STE/R-100



SCALEBAR

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TITLE

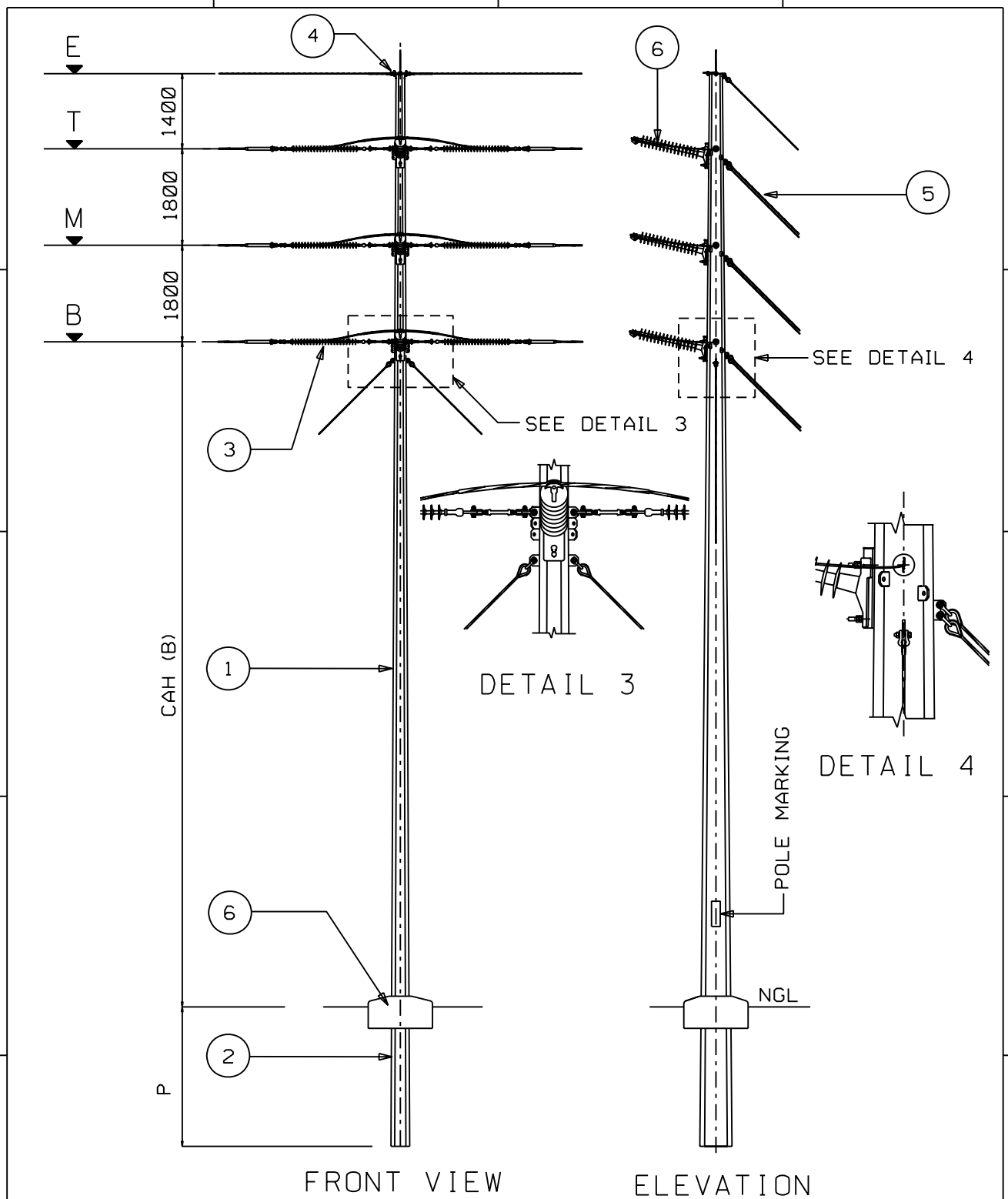
900 WIDE CONCRETE TRAPEZOIDAL CHANNEL

SCALE

1:5

DRAWING No.

STE/SW - 88A



3	SHEET 3 ITEM 2 FOUNDATION DRG. NO.S CORRECTED	P.A.T.	S.MASHABA	B.BRANFIELD	19.03.2010	
2	DRG SHT UPDATED. REFERENCES REVISED. GENERAL REVISION	SLR	RAB	AB	MARCH 2004	
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.



AUTH: A BEKKER

DATE: JAN 2004

CHKD: RAB

DATE: JAN 2004

DRAWN: LMP

DATE: NOV 1998

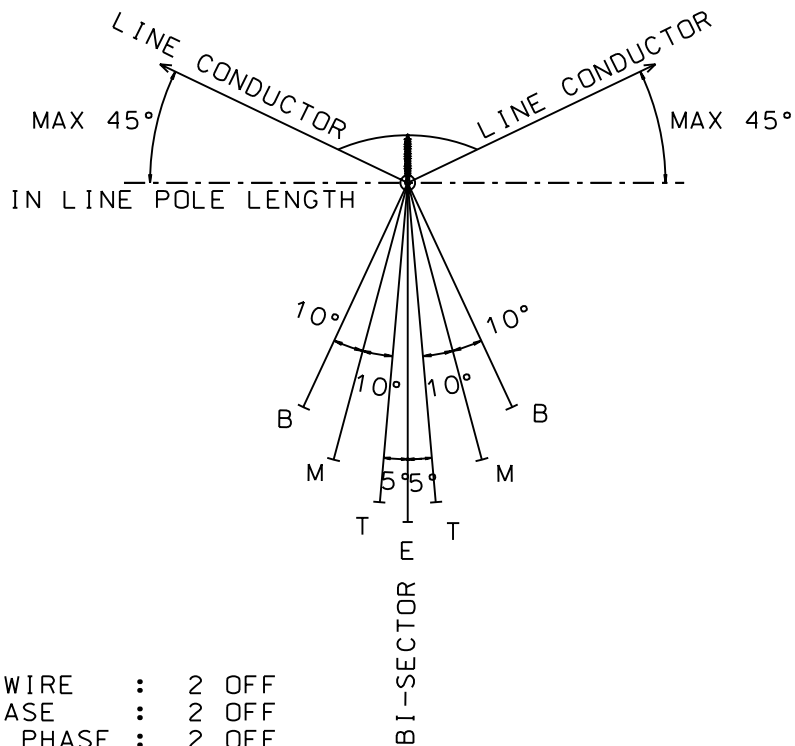
DISTRIBUTION TECHNOLOGY RETICULATION/SUB-TRANSMISSION LINES STAYED ANGLE STRAIN STRUCTURE GENERAL ARRANGEMENT (0-90°)

D-DT 7615

3

1

3



8 STAYS
 E) EARTH WIRE : 2 OFF
 T) TOP PHASE : 2 OFF
 M) MIDDLE PHASE : 2 OFF
 B) BOTTOM PHASE : 2 OFF

TOP VIEW

STAY ARRANGEMENT FOR STAYED STRUCTURES

DESIGN REQUIREMENTS			SCHEDULE FOR CONDUCTOR ATTACHMENT HEIGHTS			
POLE LENGTH L	TIP LOAD (kN)	PLANTING DEPTH P	C A H (m AGL)			
			E	T	M	B
18	23	2.0	16.0	14.6	12.8	11.0
19	23	2.0	17.0	15.6	13.8	12.0
20	23	2.0	18.0	16.6	14.8	13.0
21	23	2.0	19.0	17.6	15.8	14.0
22	23	2.0	20.0	18.6	16.8	15.0
23	23	2.0	21.0	19.6	17.8	16.0
24	23	2.0	22.0	20.6	18.8	17.0

3	SHEET 3 ITEM 2 FOUNDATION DRG. NO.S CORRECTED	P.A.T.	S.MASHABA	B.BRANFIELD	19.03.2010	
2	DRG SHT UPDATED. REFERENCES REVISED. GENERAL REVISION	SLR	RAB	AB	MARCH 2004	
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.



AUTH: A BEKKER

DATE: JAN 2004

CHKD: RAB

DATE: JAN 2004

DRAWN: LMP

DATE: NOV 1998


DISTRIBUTION TECHNOLOGY
 RETICULATION/SUB-TRANSMISSION LINES
 STAYED ANGLE STRAIN STRUCTURE
 DESIGN CRITERIA & STAYS (0-90°)

D-DT 7615

3

2

3

	1	2	3	4
A	ITEM NO.	DESCRIPTION	D-DT NO.	
		STRUCTURE		
		TYPE 259D	D-DT 7615	
B		MANUFACTURER: STRUCTATECH		
		TYPE 261D	D-DT 7615	
		MANUFACTURER: CIS		
	1	POLE LENGTH (BODY)		
		18m STEEL	D-DT 7104	
		19m STEEL	D-DT 7104	
		20m STEEL	D-DT 7104	
		21m STEEL	D-DT 7104	
		22m STEEL	D-DT 7104	
		23m STEEL	D-DT 7104	
C		24m STEEL	D-DT 7104	
	2	FOUNDATION		
		TYPE 1 (300kPa)	D-DT 7851 SHT 2	
		TYPE 2 (150kPa)	D-DT 7851 SHT 3	
		TYPE 3 (100kPa)	D-DT 7851 SHT 4	
		TYPE 4 (50kPa)	D-DT 7851 SHT 5	
D		ROCK & SOFT ROCK	D-DT 7851 SHT 1	
	3	INSULATOR ASSEMBLY		
		STRAIN ASSEMBLY	D-DT 7311	
	4	EARTH WIRE ASSEMBLIES		
		STRAIN NON INSULATED	D-DT 7323	
E		STRAIN INSULATED	D-DT 7324	
	5	STAY ASSEMBLY/LOCATION	D-DT 7325/7346	
	6	JUMPER ASSEMBLY	D-DT 7321	
	7	CONCRETE CAP AND EARTHING	D-DT 7857	
F	3	SHEET 3 ITEM 2 FOUNDATION DRG. NO.S CORRECTED		P.A.T. S.MASHABA B.BRANFIELD 19.03.2010
	2	DRG SHT UPDATED. REFERENCES REVISED. GENERAL REVISION		SLR RAB AB MARCH 2004
	REV	REVISION DESCRIPTION		BY CHKD AUTH DATE PROJECT NO.
			DISTRIBUTION TECHNOLOGY RETICULATION/SUB-TRANSMISSION LINES STAYED ANGLE STRAIN STRUCTURE REFERENCE TABLE (0-90°)	
	AUTH: A BEKKER			
	DATE: JAN 2004			
	CHKD: RAB			
	DATE: JAN 2004			
	DRAWN: LMP			
	DATE: NOV 1998			
		D-DT 7615		SET 3 SHEET 3 REVISION 3
1	2	3	4 A4L	