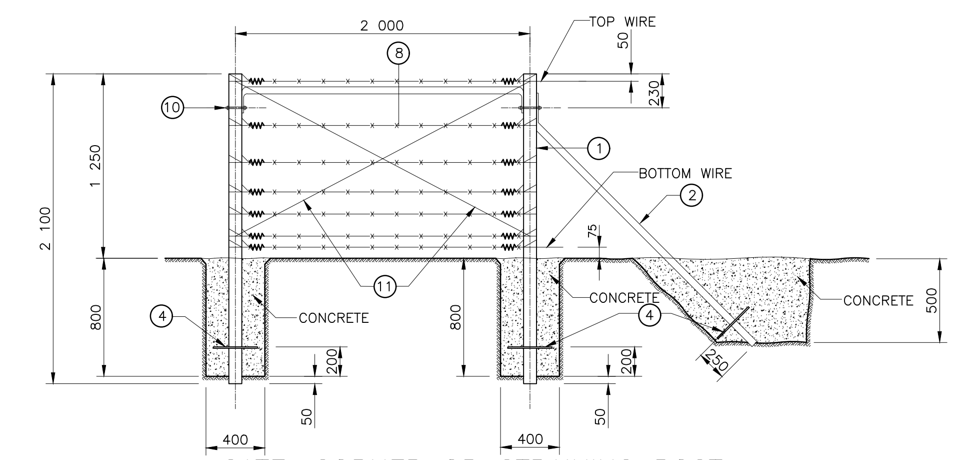
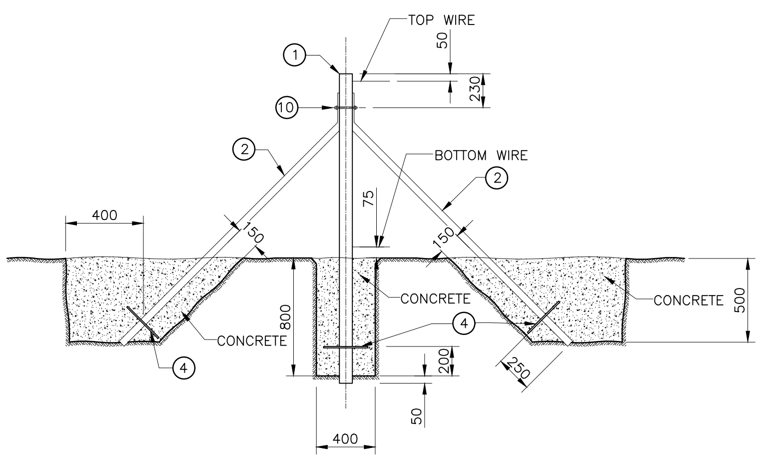


GATE, CORNER OR STRAINING POST

N.T.S.



INTERMEDIATE POST

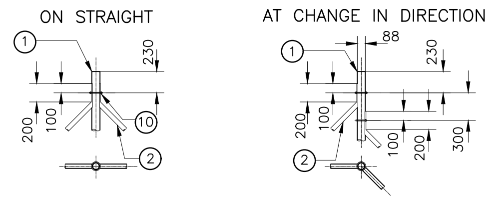
N.T.S.

No. OF STRAINING POSTS, INTERMEDIATE POSTS, STANDARDS & DROPPERS REQUIRED PER 1000m FENCE ERECTED					
DESCRIPTION	SPECIFICATION	LENGTH (m)	CONDITION OF GROUND	MAX. SPACING (m)	No OF ROLLS / 1000 m FENCE
STRAINING POSTS	88mm Dia	2.1	SOFT SOIL ROCK	300 500	3 2
INTERMEDIATE POSTS	88mm Dia	2.1	SOFT SOIL ROCK	100 100	7 8
STANDARDS	2.5kg/m Y–SECTION	1.8	ALL	12	83
DROPPERS	0.56kg/m RIDGED T–SECTION	1.25	ALL	3	250

FENCING WIRE REQUIRED PER 1000 m FENCE ERECTED							
DESCRIPTION	DIAMETER (mm)	UNIT	LENGTH / ROLL (m)	MASS / ROLL (kg)	No. OF STRANDS	LENGTH REQUIRED/ 1000 m FENCE	No. OF ROLLS/ 1000 m FENCE
OVAL– SHAPED BARBED WIRE	2.8mm x 1.9mm	m	845	35	7	7000	8.3

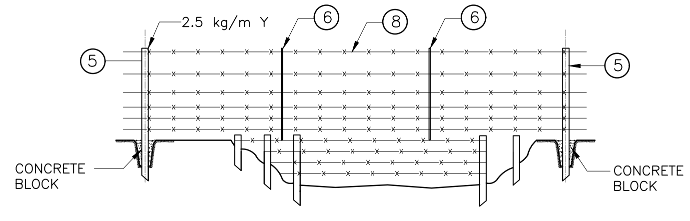
COATING THICKNESS TABLE – MASS OF THE ZINC COATING PER UNIT AREA		
1	2	3
NOMINAL DIAMETER OF ZINC COATED WIRE mm	MINIMUM MASS OF ZINC COATING PER UNIT AREA g/m²	APPROXIMATE EQUIVALENT AVERAGE THICKNESS um
1.20 – 1.50	215	30
1.51 – 1.80	230	32
1.81 – 2.20	245	34
2.21 – 2.50	260	36
2.51 – 3.50	275	38
3.51 – 5.00	290	40

(ABSTRACT FROM SANS 675 – 1997)



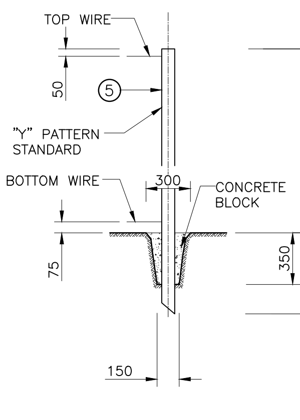
DETAIL OF INTERMEDIATE POSTS

N.T.S.



ACROSS CHANNELS AND TRENCHES

N.T.S.



STANDARDS

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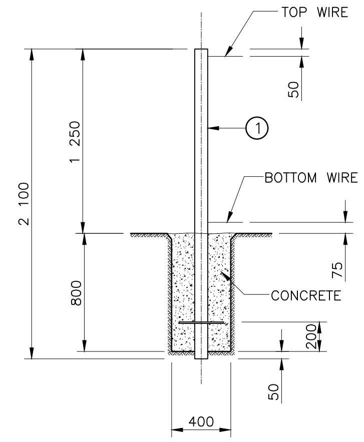

INTERMEDIATE POST

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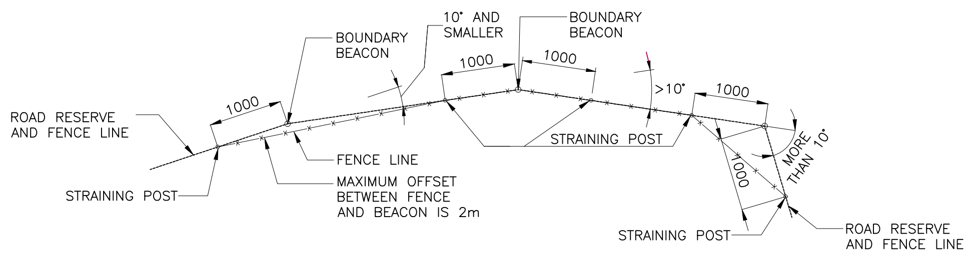
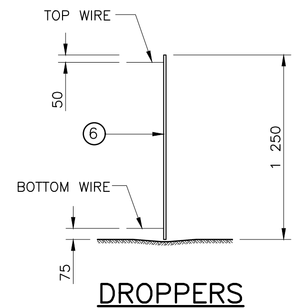


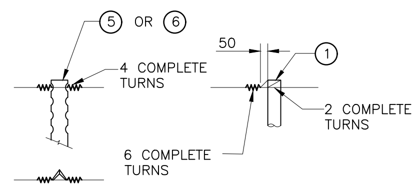
DIAGRAM FOR FENCING AT ROAD RESERVE BEACON

N.T.S.



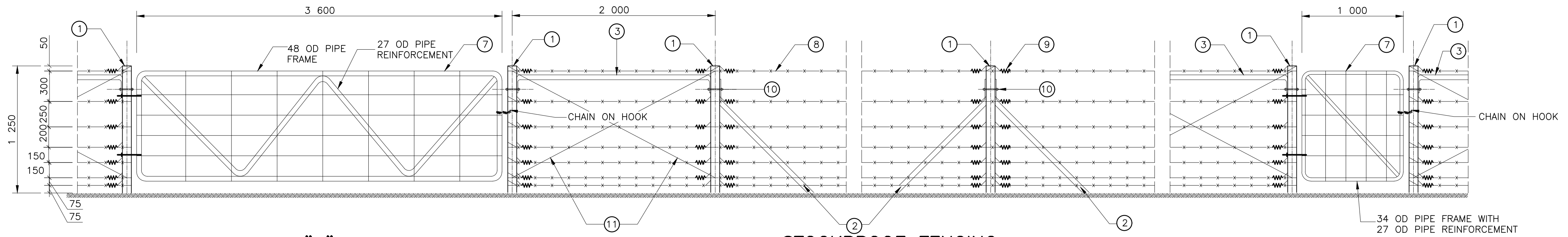
DROPPERS

N.T.S.



FASTENING OF BARBED WIRE ON STANDARDS

N.T.S.



TYPE "B" GATE

N.T.S.

STOCKPROOF FENCING

N.T.S.

TYPE "A" GATE

N.T.S.

TENDER DRAWING

SHEET	DESCRIPTION	OTHER No.	REG. No.
LIST OF DRAWINGS			

FUNCTION	NAME	SIGNATURE
DESIGNED		N/A
DRAWN		N/A
DESIGN CHECKED	P. v HEERDEN	N/A
DRAWING CHECKED		N/A

APPROVAL – CONSULTANT

NAME: REG. No.

SIGNATURE: DATE:

JV DRAWING NUMBER

021.001–A–C6–100

IMPLEMENTING AGENT: TCTA – A new word for water

CONSULTING ENGINEER: Amanzi Entsha JV

REVISION				
MOD No.	DATE	DESCRIPTION	FOR	DWA

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL DESIGN
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 FRANCIS BAARD STREET
PRETORIA
(012) 336–7500

DESIGN:
DRAWN:
CHECKED: DATE:
ENGINEER: DATE: EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE: DIRECTOR (Pr. Eng): DATE:

BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

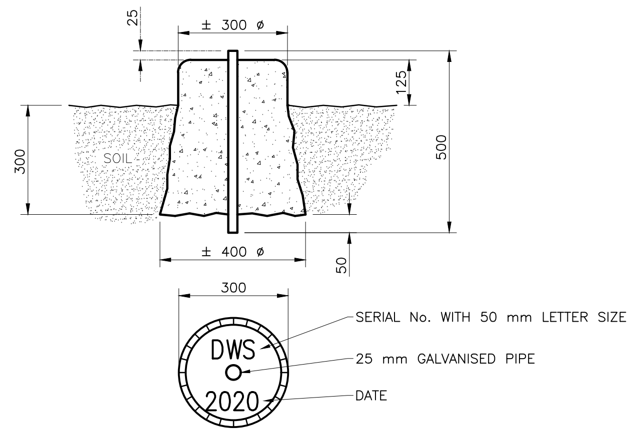
STD DETAILS–TYPICAL

7 STRAND STOCKPROOF FENCE (1.25 m HIGH)

PROVINCE: WESTERN CAPE | DISTRICT: DRAKENSTEIN/SWARTLAND | KEYCODES: | OTHER NUMBER

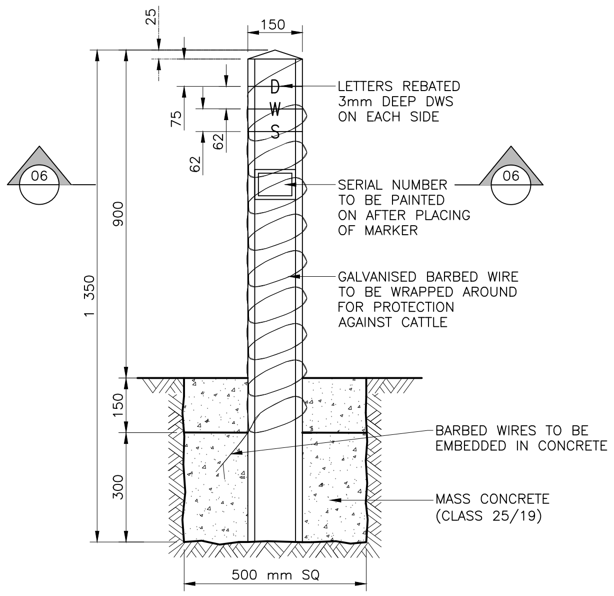
LOCALITY No. XXX | TENDER/ CONTRACT No. XXX | SHEET 1 OF 1 | REG. No. | REV. A

CALC. FILE. XXX



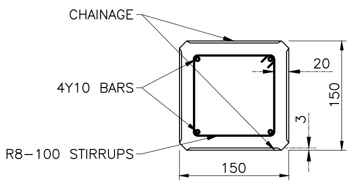
PROJECT REFERENCE MARKS

SCALE 1:10



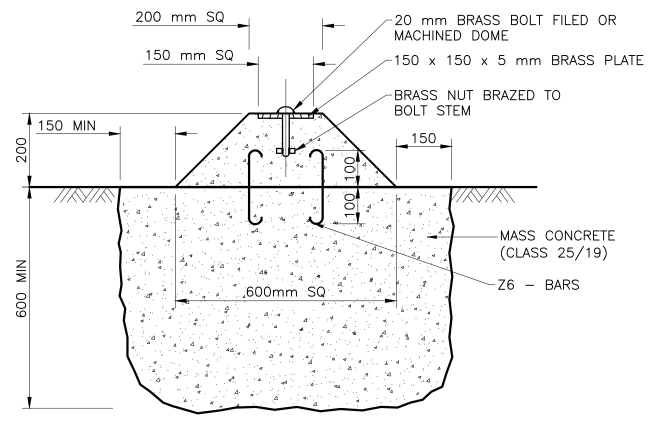
PIPELINE PRECAST CONCRETE MARKER POST

SCALE 1:10



SECTION 06–06

SCALE 1:5



BENCHMARK

SCALE 1:10

TENDER DRAWING

FUNCTION	NAME	SIGNATURE
DESIGNED		N/A
DRAWN		N/A
DESIGN CHECKED	P. v HEERDEN	N/A
DRAWING CHECKED		N/A

APPROVAL – CONSULTANT

NAME: REG. No.

SIGNATURE: DATE:

JV DRAWING NUMBER

021.001–A–C6–101

IMPLEMENTING AGENT: TCTA A new word for water

CONSULTING ENGINEER: Amanzi Entsha JV

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

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SEDIBENG BUILDING
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PRETORIA
(012) 336–7500

DESIGN:

CHECKED: DATE: DRAWN:

ENGINEER: DATE: EXTERNAL APPROVAL: DATE:

CHIEF ENGINEER / APP (Pr. Eng): DATE: DIRECTOR (Pr. Eng): DATE:

BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

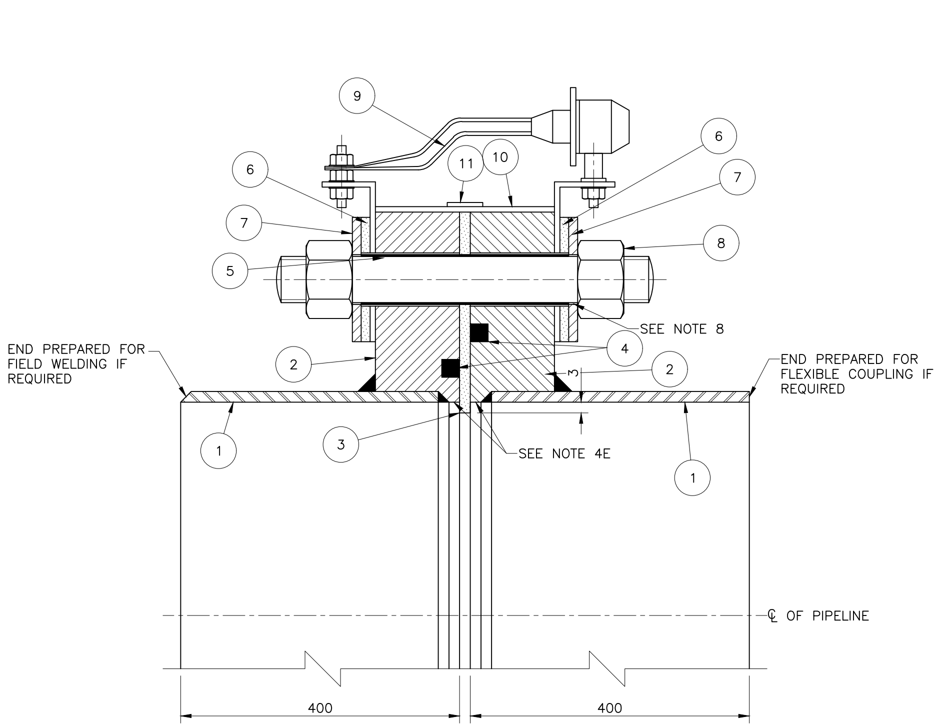
STD DETAILS–TYPICAL

PIPELINE MARKERS

PROVINCE: WESTERN CAPE | DISTRICT: DRAKENSTEIN/SWARTLAND | KEYCODES: | OTHER NUMBER

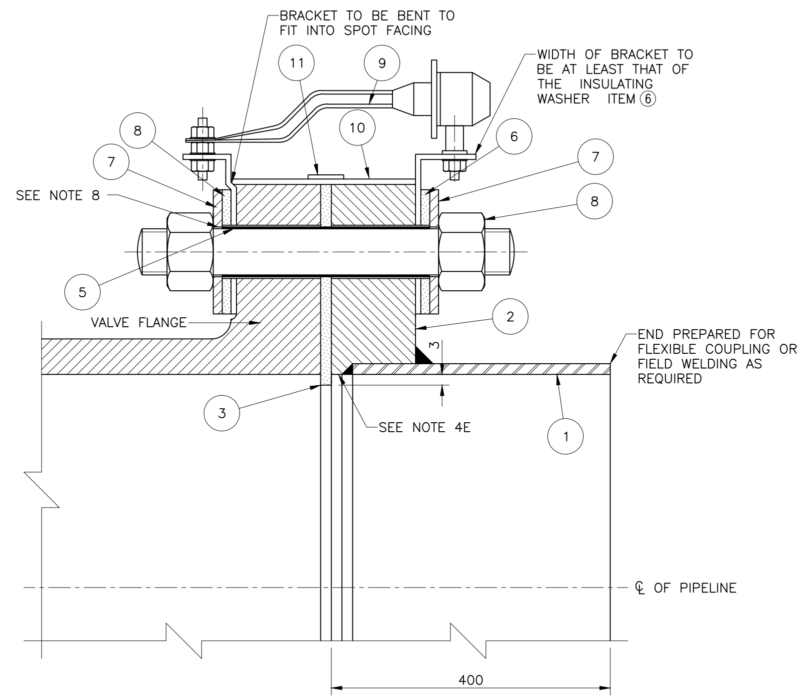
LOCALITY No. XXX | TENDER/ CONTRACT No. XXX | SHEET 1 OF 1 | REG. No. | REV. A

CALC. FILE. XXX



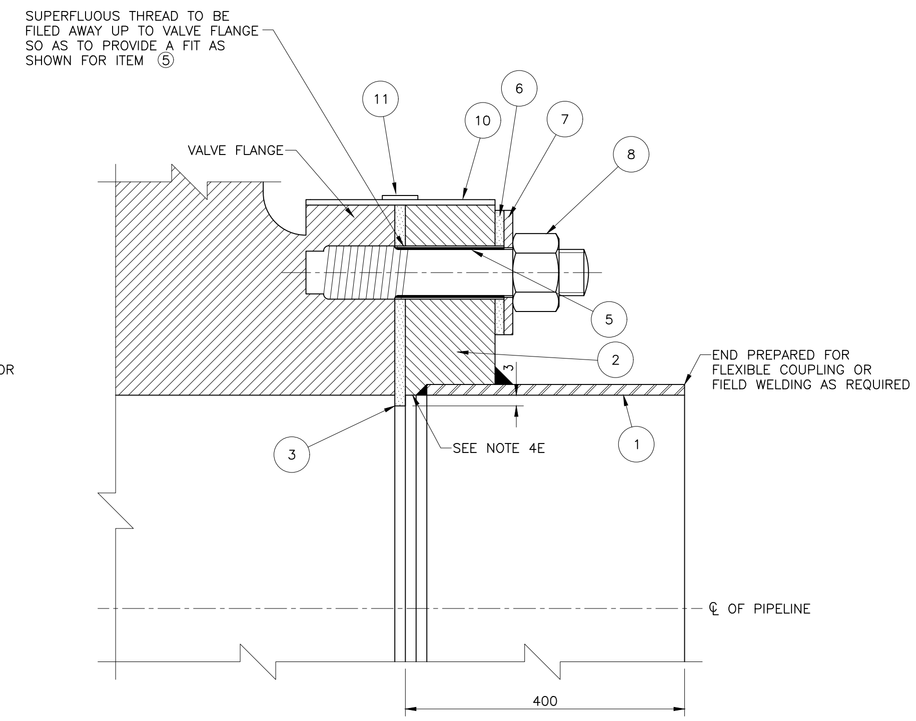
TYPE 1: 'PIPE TO PIPE' INSULATING FLANGE DETAIL

NOT TO SCALE



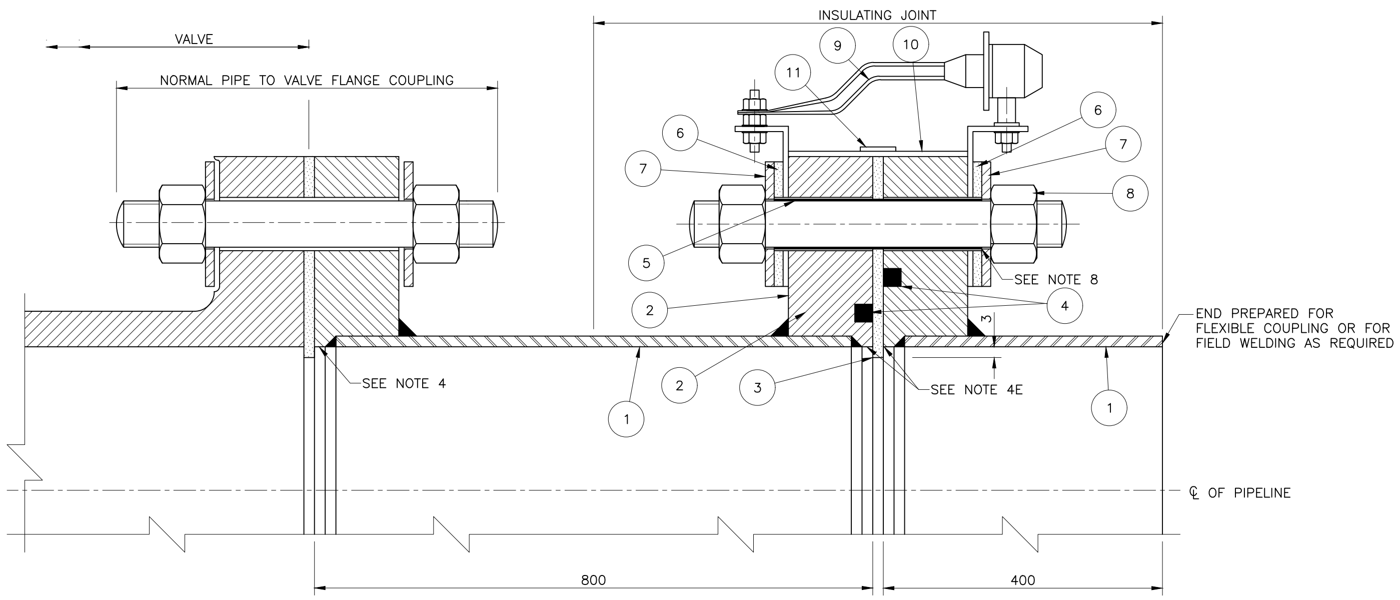
TYPE 2: 'PIPE TO VALVE' INSULATING FLANGE JOINT (STUD BOLT DETAIL)

NOT TO SCALE



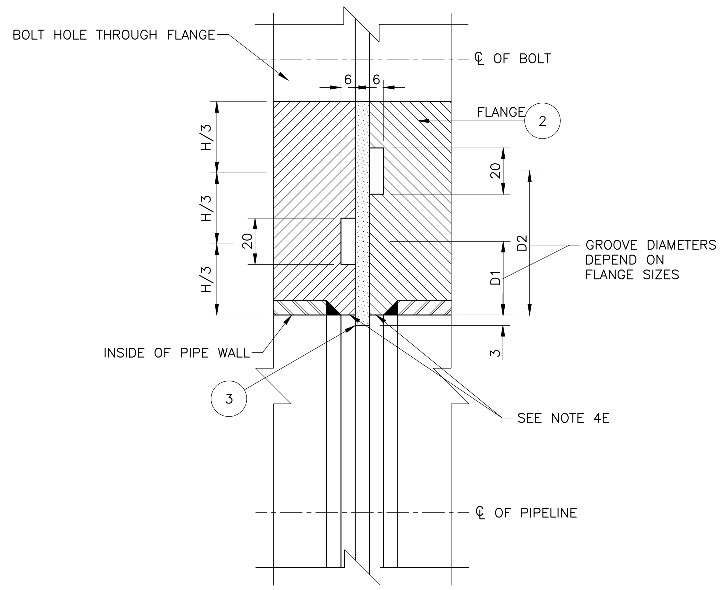
PIPE TO VALVE' INSULATING FLANGE JOINT–STUD DETAIL WHERE STUD BOLTS CAN NOT BE INSTALLED

NOT TO SCALE



TYPE 3: 'PIPE TO VALVE' INSULATING FLANGE JOINT

NOT TO SCALE



DETAIL 'A' OF GROOVES

NOT TO SCALE

TENDER DRAWING

FUNCTION	NAME	SIGNATURE
DESIGNED		N/A
DRAWN		N/A
DESIGN CHECKED	P. v HEERDEN	N/A
DRAWING CHECKED		N/A

APPROVAL – CONSULTANT

NAME: REG. No.

SIGNATURE: DATE:

JV DRAWING NUMBER

021.001–A–E2.6–100

IMPLEMENTING AGENT: TCTA – A new word for water

CONSULTING ENGINEER: Aurecon Entabe JV

REVISION				
MOD No.	DATE	DESCRIPTION	FOR	DWA

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
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SEDIBENG BUILDING
185 FRANCIS BAARD STREET
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(012) 336–7500

CHECKED: DATE: | DESIGN: | DRAWN:

ENGINEER: DATE: | EXTERNAL APPROVAL: DATE:

CHIEF ENGINEER / APP (Pr. Eng): DATE: | DIRECTOR (Pr. Eng): DATE:

BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

STD DETAILS–TYPICAL

CATHODIC PROTECTION:
TYPICAL DETAILS OF INSULATING JOINT

PROVINCE: WESTERN CAPE | DISTRICT: DRAKENSTEIN/SWARTLAND | KEYCODES: | OTHER NUMBER

LOCALITY No. XXX | TENDER/ CONTRACT No. XXX | SHEET 1 OF 2 | REG. No. | REV.

CALC. FILE. XXX

TABLE 1 : THE INSULATING GASKET CONFIGURATION AND GASKET MATERIALS BETWEEN PIPE/VALVE FLANGES TO BE BASED ON THE FOLLOWING PRESSURE RATINGS AND DIAMETERS :

INSULATING GASKET MATERIAL	PRESSURE RATING ie. FIELD TEST PRESSURE	NORMAL PIPE DIAMETER
1. HDPE :		
1.1 A 3,2 mm THICK HIGH DENSITY POLYETHYLENE, TO PEH. HOSTALEN G.M. 5010 SA SPECIFICATION, FULL FACE GASKET, IN ONE PIECE. GROOVE DETAIL 'A' WITH 'O'–RINGS NOT REQUIRED. GASKET I.D. TO BE 6 mm SMALLER THAN THE PIPE I.D.	≤ 2,5 MPa	ALL DIAMETERS
1.2 A 3,2 mm THICK HIGH DENSITY POLYETHYLENE, TO PEH. HOSTALEN GM 5010 SA SPECIFICATION, FULL FACE GASKET, IN ONE PIECE, WITH GROOVE DETAIL 'A' AND 'O'–RINGS. GASKET I.D. TO BE 6 mm SMALLER THAN PIPE I.D.	> 2,5 MPa < 4,6 MPa	ALL DIAMETERS
OR		
2. PHENOLIC WITH NEOPRENE FACING :		
2.1 A 3,2 mm THICK FABRIC REINFORCED PHENOLIC (TESTED TO BS 5102 APPENDICES A–M: TYPE III) FULL FACED GASKET IN ONE PIECE WITH NEOPRENE OR NITRILE FACES 0,8 mm THICK. (GROOVE DETAIL 'A' WITH 'O'–RINGS NOT REQUIRED). GASKET I.D. TO BE 6 mm SMALLER THAN THE PIPE I.D.	≤ 4,6 MPa	≤ 1 200 mm
2.2 A 3,2 mm THICK FABRIC REINFORCED PHENOLIC FULL FACED GASKET (TESTED TO BS 5102 APPENDICES A–M : TYPE III) WITH NOT MORE THAN 3 ONLY FACTORY MADE LAP JOINTS, WITH NEOPRENE OR NITRILE FACES 0,8 mm THICK. (GROOVE DETAIL 'A' WITH 'O'–RINGS NOT REQUIRED). THE GASKET I.D. TO BE 6 mm SMALLER THAN THE PIPE I.D.	≤ 4,6 MPa	> 1 200 mm
OR		
3. PHENOLIC WITH C.A.F.:		
3.1 A 3,2 mm THICK FABRIC REINFORCED PHENOLIC (TESTED TO BS 5102 APPENDICES A–M : TYPE III) FULL FACED GASKET, IN ONE PIECE WITH 0,8 mm THICK "PROLOK SUPER" OR SIMILAR COMPRESSED ASBESTOS FIBRE (TO BS 2815 GRADE A) FULL FACED GASKETS ON EACH SIDE. (GROOVE DETAIL 'A' WITH 'O'–RING NOT REQUIRED). THE GASKET I.D. TO BE 6 mm SMALLER THAN THE PIPE I.D.	> 4,6 MPa	≤ 1 200 mm
3.2 A 3,2 mm THICK FABRIC REINFORCED PHENOLIC (TESTED TO BS 5102 APPENDICES A–M: TYPE III) FULL FACED GASKET WITH NOT MORE THAN 3 ONLY FACTORY MADE LAP JOINTS, WITH 0,8 mm THICK 'PROLOK SUPER' OR SIMILAR COMPRESSED ASBESTOS FIBRE (TO BS 2815 GRADE A) FULL FACED GASKETS ON EACH SIDE. (GROOVE DETAIL 'A' WITH 'O'–RING NOT REQUIRED). THE GASKET I.D. TO BE 6 mm SMALLER THAN THE PIPE I.D.	> 4,6 MPa	> 1 200 mm

FLANGE INSULATING MATERIALS

ITEM	DESCRIPTION
1	PIPE : DIAMETER, WALL THICKNESS, STEEL GRADE, PROTECTION AND END PREPARATIONS TO BE AS SPECIFIED ELSEWHERE.
2	FLANGES : TO BE FULL FACED, FROM STEEL PLATE GRADE 43A TO BS 4360, MACHINED ON FRONT, BACK AND OUTSIDE FACES. SEE NOTE 4.
3	INSULATING GASKET : MATERIAL SPECIFICATION : SEE TABLE 1.
4	'O'–RING : 12 mm DIAMETER NATURAL RUBBER RING TO SABS 974, CLASS D, HARDNESS 60 IRH DEGREES, TOLERANCE 5 ± IRH DEGREES. 'O'–RINGS OMITTED FOR LOW PRESSURE, SEE TABLE 1.
5	INSULATING SLEEVE : 1 mm TO 1,5 mm THICK GLASS–FIBRE REINFORCED POLYESTER SLEEVE FOR EACH BOLT. LENGTH OF SLEEVE TO BE SUCH THAT TOTAL GAP ON SLEEVE LENGTH BETWEEN INSIDE FACES OF STEEL WASHERS IS BETWEEN 2 TO 3 mm.
6	INSULATING WASHER : 6,3 mm THICK FABRIC REINFORCED PHENOLIC RESIN WASHER WITH O.D. THE SAME AS THAT OF THE MACHINED STEEL WASHER, 2 OFF FOR EACH STUDBOLT : ID TO BE A SLIDING FIT OVER OD OF ITEM 5.
7	STEEL WASHERS : MACHINED WITH DIAMETER AND THICKNESS TO SABS 1149, TABLE 3.
8	STUDBOLTS & STUDS : GRADE 8.8 AND NUTS GRADE 8 TO S.A.B.S. 136. STUDBOLT DIAMETERS SHALL BE SELECTED TO THE NEXT SMALLER SIZE FOR INSTALLATION IN STANDARD DRILLED FLANGES. STUD BODIES SHALL BE MACHINED DOWN TO THE NEXT STANDARD SMALLER SIZE AND SUITABLE SMALLER NUT TO BE USED.
9	EXPLOSION–PROOF SPARK GAP : TYPE EXFS COMPLETE WITH HOT–DIP GALVANISED MILD STEEL MOUNTING BRACKETS TO SUIT THE FLANGE BOLT, AS SUPPLIED BY MESSRS 'PONTIS (RSA)' OR SIMILAR APPROVED. THE WIDTH OF THE HOLDING BRACKET OF THE EXPLOSION PROOF SPARK GAP SHALL BE THE SAME AS THE STEEL AND INSULATING WASHERS (ITEM 6 & 7) AND THE BOTTOM END BE ROUNDED OFF TO FIT INTO THE SPOT FACED AREA OF THE VALVE AND OR STEEL FLANGE.
10	WHITE PLASTIC BACKED POLYMER MODIFIED BITUMINOUS TAPE : 1,5 TO 2,0 mm THICK OR SIMILAR APPROVED WITH A MINIMUM 25 mm OVERLAP. IN CASE OF SURFACE IRREGULARITIES i.e. STEPPED FLANGES ETC. AN APPROVED MASTIC MATERIAL SHALL BE USED TO PROVIDE A SMOOTH CONTOUR FOR SUBSEQUENT TAPE APPLICATION.
11	CODING RED COLOUR BAND : OF 30 mm WIDE PLASTIC BACKED ELECTRICAL TAPE TO SABS 122–1975.

NOTES:

1. INSULATING JOINTS ARE TO BE HOUSED IN A WELL DRAINED AND VENTILATED CHAMBER WITH INSPECTION ACCESS.

2. TYPES 1 AND 3 INSULATING JOINTS SHALL BE HYDRAULIC TESTED IN FACTORY TO 1,25 TIMES THE FLANGE CLASSIFICATION. THE TYPE 2 FLANGE SETS SHALL NOT LEAK AT FIELD TEST PRESSURE.

3. THE ASSEMBLED INSULATING JOINT SHALL BE TESTED AS FOLLOWS FOR ELECTRICAL DISCONTINUITY.

A) PLACE A FREE FLOATING COMPASS ON TOP OF THE INSULATING FLANGE. THE NEEDLE WILL ALIGN PARALLEL TO THE PIPELINE.

I) BRIDGE THE TWO SIDES OF THE INSULATING JOINT WITH EITHER A 12 VOLT HEAVY DUTY CAR BATTERY OR WELDING GENERATOR. IF THE INSULATING FLANGE IS NOT FUNCTIONING THE COMPASS NEEDLE WILL DEFLECT TO A POSITION ORTHOGONAL TO PIPELINE. IF THE INSULATION JOINT IS FUNCTIONING CORRECTLY, THE NEEDLE WILL DEFLECT 5 TO 7 DEGREES AND THE MAXIMUM CURRENT FLOWING ACROSS THE JOINT SHOULD NOT EXCEED 50 AMPS.

II) SHOULD A FAULTY INSULATING JOINT BE LOCATED THEN THE FAULTY MATERIALS SHALL BE REPLACED AND THE JOINT SYSTEM RE–TESTED.

III) IT IS RECOMMENDED THAT EACH BOLT BE TESTED FOR NON–CONTINUITY BEFORE TIGHTENING THEREOF. THE SAME MUST APPLY WHEN A JOINT IS TESTED AND FOUND TO BE CONTINUOUS. THE FAULTY BOLTS MUST BE NOTED.

B) THE FINAL DEFLECTED POSITION OF THE COMPASS NEEDLE TO BE NOTED, ie. THE STABILIZED POSITION AND NOT THE INITIAL MOVEMENTS.

4. FLANGE MACHINING AND FINISHES (TO BS 4504) AND FITTING (TO BS 2633).

A) INSIDE FACES : A CONTINUOUS SPIRAL GROOVE PRODUCED BY A 3,2 mm RADIUS ROUND NOSE TOOL AT A FEED OF APPROX. 1,2 mm PER REVOLUTION.

B) BACK FACES : MACHINED TO APPROX. 15 um.

C) OUTSIDE FACES : MACHINED TO APPROX. 15 um.

D) THE INSIDE OF BOLT HOLES MUST NOT BE COATED.

E) PIPE FLANGES SHALL BE SUITABLE FOR WELDING AND SHALL CONFORM TO BS 2633, SECTION 7 WITH PREPARATION OF PLATE FLANGES AS SHOWN IN FIG. 41 ('SLIP–ON') FOR PIPES UP TO 100 mm N.B. AND FIG. 39 OR 40 ('BORE AND FILLET') FOR PIPES 125 mm N.B. AND HIGHER.

5. FOR TYPE 1 AND 3 JOINTS, THE MATING FLANGES SHALL BE DRILLED IN PAIRS AND MARKED.

6. WHERE MATING FLANGES ARE TO BE WELDED ON SITE, THE FLANGES SHALL BE BOLTED UP WITH AT LEAST 3 FITTED BOLTS AND ALLIGNED PROPERLY BEFORE WELDING.

7. INSPECTION OF INSULATING JOINTS : AFTER INSTALLATION, THE INSULATING JOINTS MUST BE INSPECTED TO ENSURE THEIR COMPLIANCE WITH THE SPECIFICATIONS AND DRAWINGS AND THEIR EFFICIENCY TESTED FOR SATISFACTORY ELECTRICAL INSULATION (PARAGRAPH 3 ABOVE). THE INSPECTION SHALL BE WITNESSED BY THE ENGINEER, THE DESIGNER OF THE CATHODIC PROTECTION INSTALLATION AND THE CONTRACTOR.

8. INSULATING SLEEVES : THE MAXIMUM GAP WIDTH BETWEEN INSIDE FACES OF STEEL WASHER AND ENDS OF INSULATING SLEEVE TO BE BETWEEN 2 TO 3 mm AT ANY END BEFORE TIGHTENING. A 1 mm GAP MAY BE LEFT BETWEEN THE SLEEVE END AND THE STEEL FLANGE WHERE STUDS ARE REQUIRED AT VALVE CONNECTIONS.

TENDER DRAWING

FUNCTION	NAME	SIGNATURE
DESIGNED		N/A
DRAWN		N/A
DESIGN CHECKED	P. v HEERDEN	N/A
DRAWING CHECKED		N/A

APPROVAL – CONSULTANT

NAME: REG. No.

SIGNATURE: DATE:

JV DRAWING NUMBER

021.001–A–E2.6–101

IMPLEMENTING AGENT: TCTA A new word for water

CONSULTING ENGINEER: Amanzi Entsha JV

REVISION				
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DESIGN:

CHECKED: DATE: DRAWN:

ENGINEER: DATE: EXTERNAL APPROVAL: DATE:

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BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

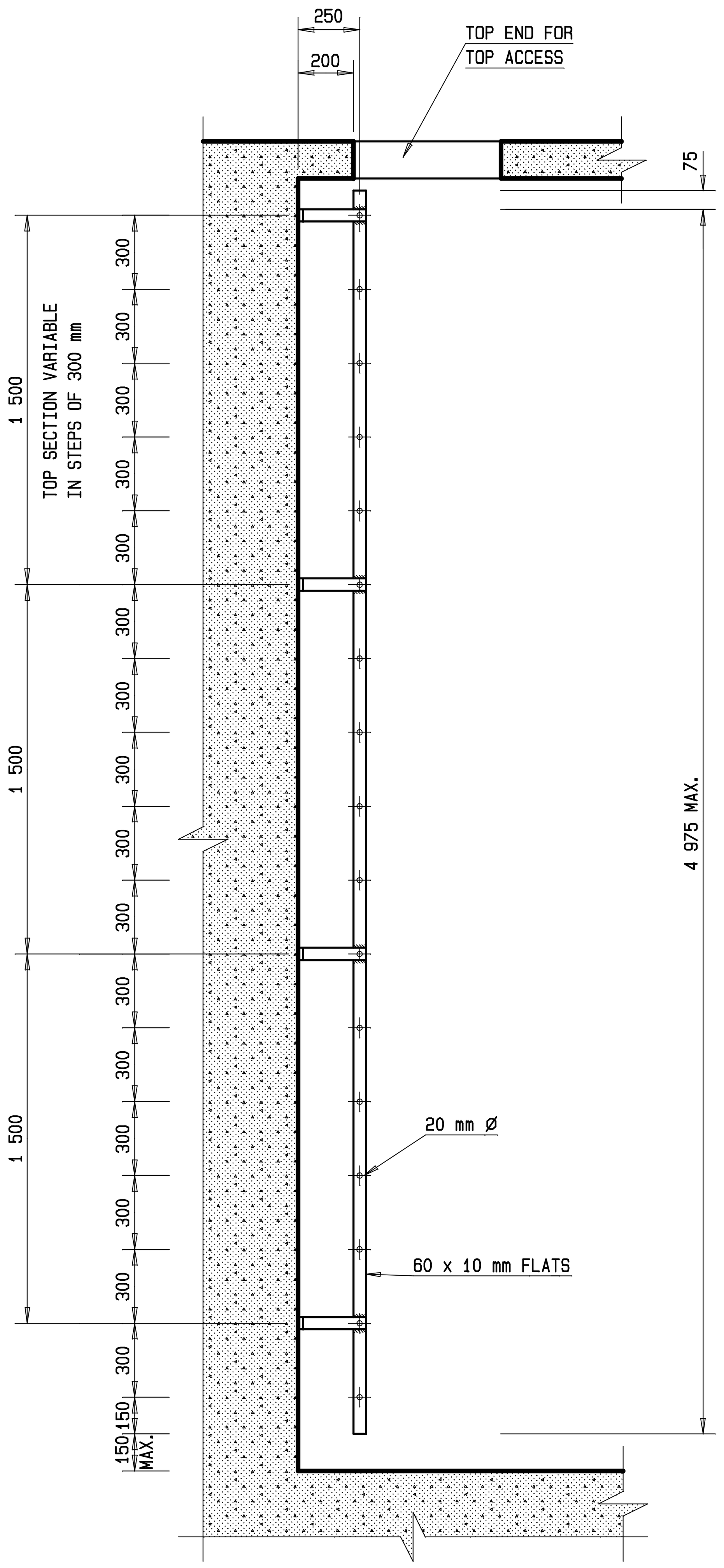
STD DETAILS–TYPICAL

CATHODIC PROTECTION: TYPICAL DETAILS OF INSULATING JOINT

PROVINCE: WESTERN CAPE | DISTRICT: DRAKENSTEIN/SWARTLAND | KEYCODES: | OTHER NUMBER

LOCALITY No. XXX | TENDER/ CONTRACT No. XXX | SHEET 2 OF 2 | REG. No. | REV. A

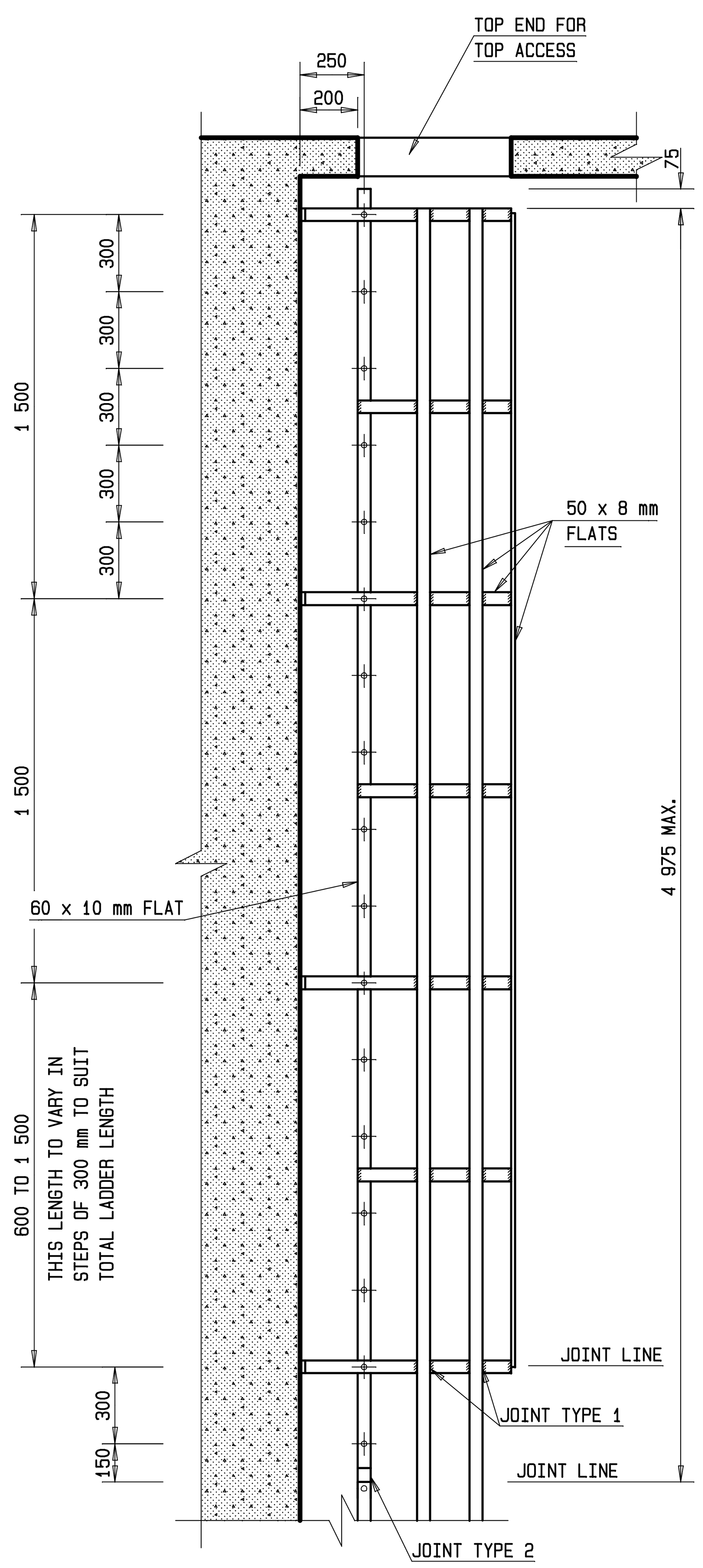
CALC. FILE. XXX



TYPE 'A'

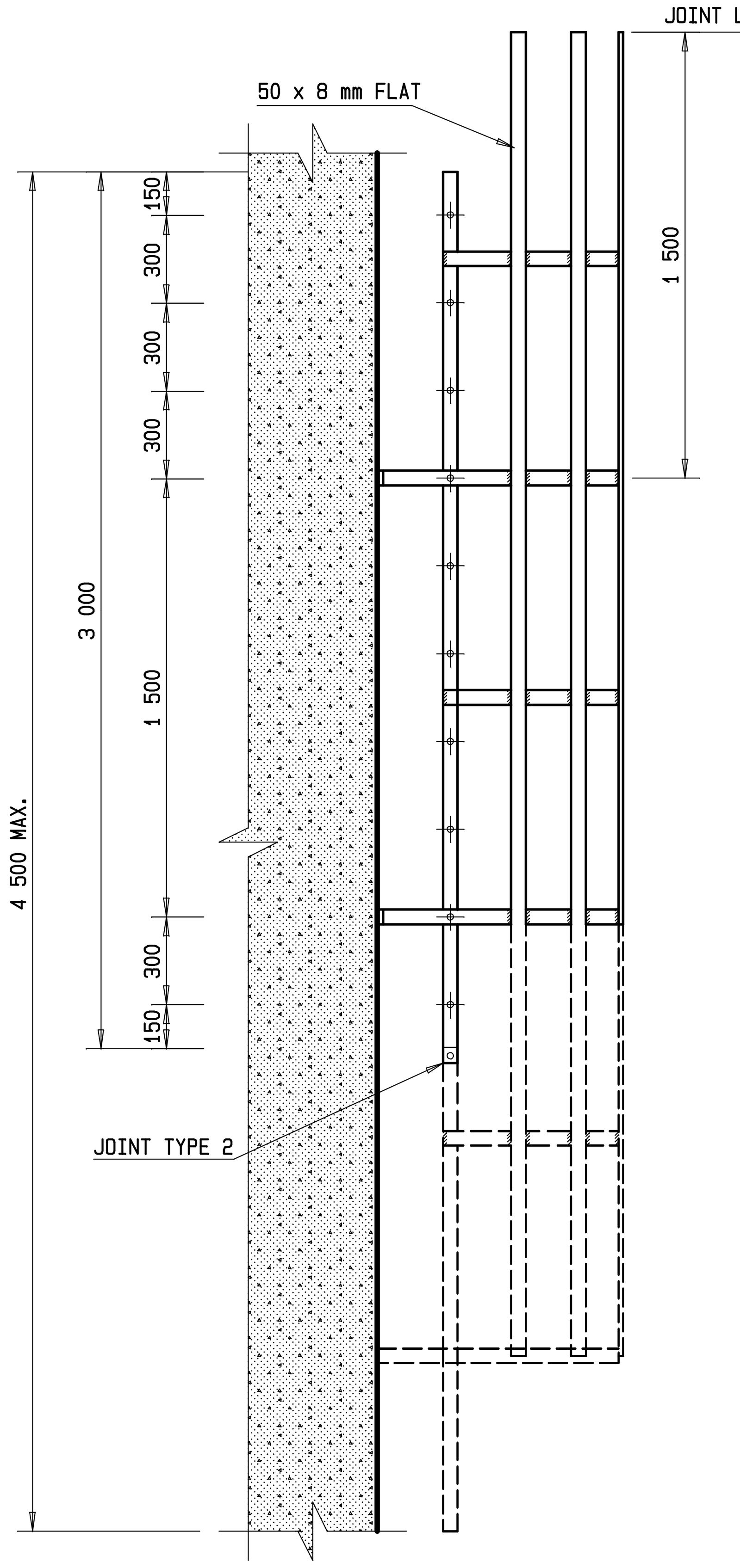
LADDER WITHOUT SAFETY HOOP

SCALE 1:20



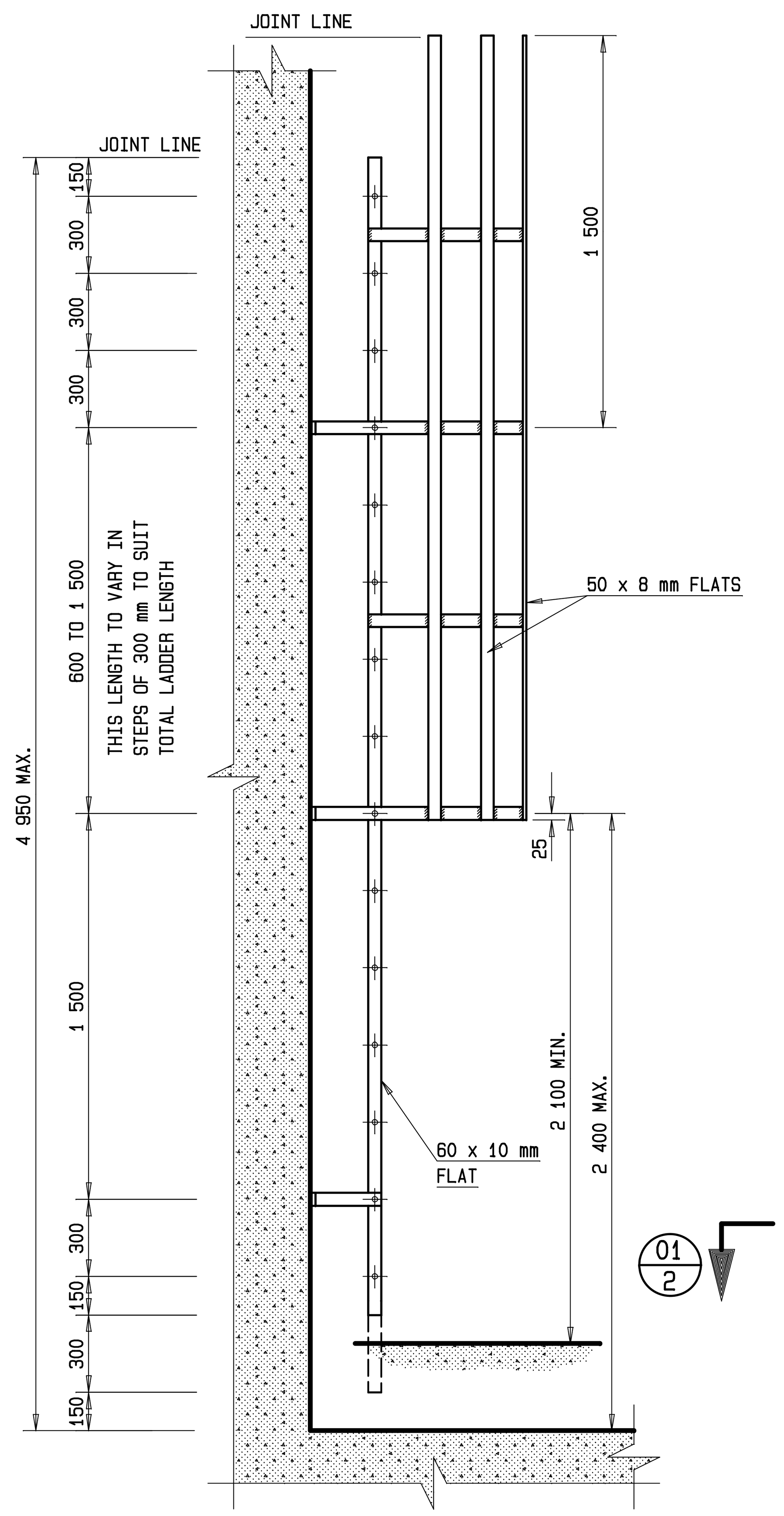
TOP SECTION

SCALE 1:20



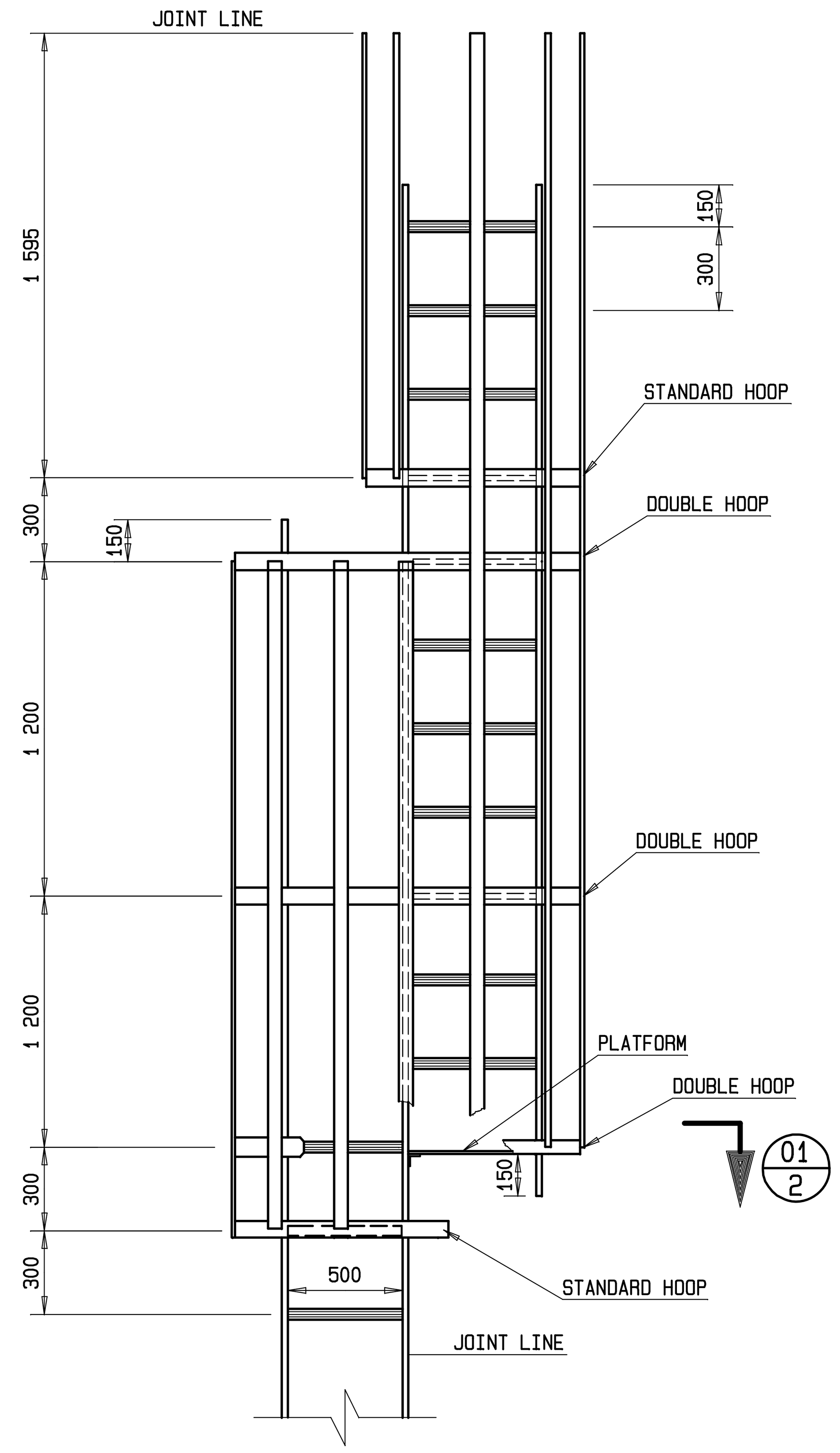
INTERMEDIATE SECTION TYPE 'B'

SCALE 1:20



BASE SECTION

SCALE 1:20



INTERMEDIATE SECTION

WITH RESTING PLATFORM

SCALE 1:20

SECTION

07 SECTION NUMBER

3 SHEET NUMBER

NOTE:

DETAILS FOR DOUBLE HOOP THE SAME AS FOR STANDARD HOOP BUT WITH STRAIGHT CENTRE SECTIONS OF 485 mm ADDED. ONE EXRA SAFETY STRAP TO BE FITTED IN CENTRE.

TYPE 'B'

LADDER WITH SAFETY HOOP

SCALE 1:20

THIS DRAWING SUPERSEDES
DRG. REG. NO'S. 69 031/78 AND 69 032/78.

SHEET	DESCRIPTION	OTHER No.	REG. No.
3/3	TYPE DRAWING : DETAIL OF GALVANISED MILD STEEL LADDER		125 771/97
2/3	TYPE DRAWING : DETAIL OF GALVANISED MILD STEEL LADDER		125 770/97

LIST OF DRAWINGS

SCALE 1:20 — 0, 0,5, 1, 1,5, 2, 4 m

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA
1.	01/00	DRAWING REDRAWN	R.H.	

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL ENGINEERING
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 SCHOEMAN STREET
PRETORIA
(012) 336-7500

P. YAKO
DIRECTOR GENERAL

DESIGN: J.C. SWANEPOEL

CHECKED: J.C. SWANEPOEL DATE:

DRAWN: J.C. SWANEPOEL/CADDIE

ENGINEER: DATE:

EXTERNAL APPROVAL: DATE:

CHIEF ENGINEER / APP (Pr. Eng): DATE:

DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING

DETAIL OF GALVANIZED MILD STEEL LADDER

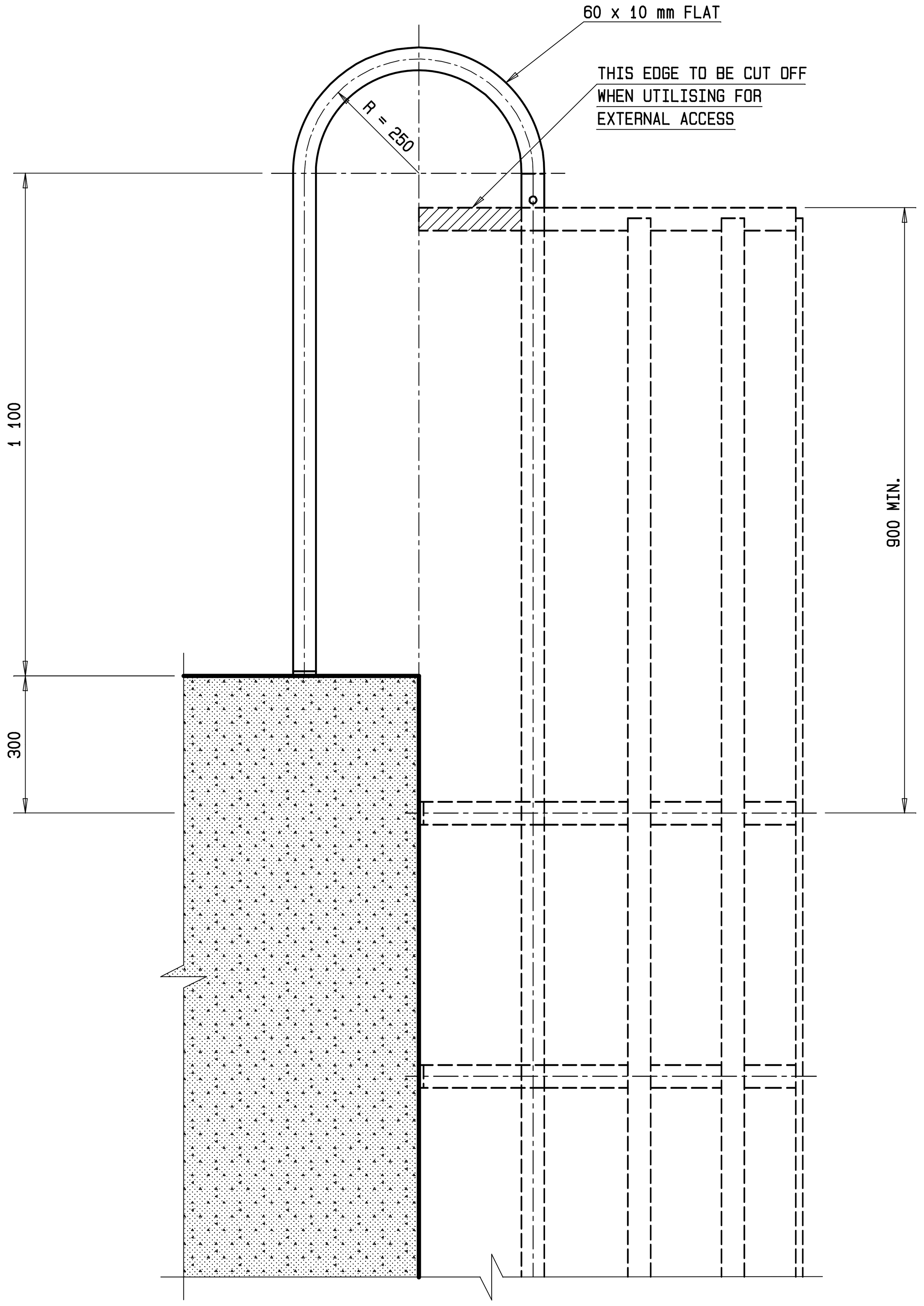
PROVINCE: DISTRICT:

KEYCODES: TYP : SFY : LDR : DET : LYD OTHER NUMBER

LOCALITY No.: – TENDER/ CONTRACT No.

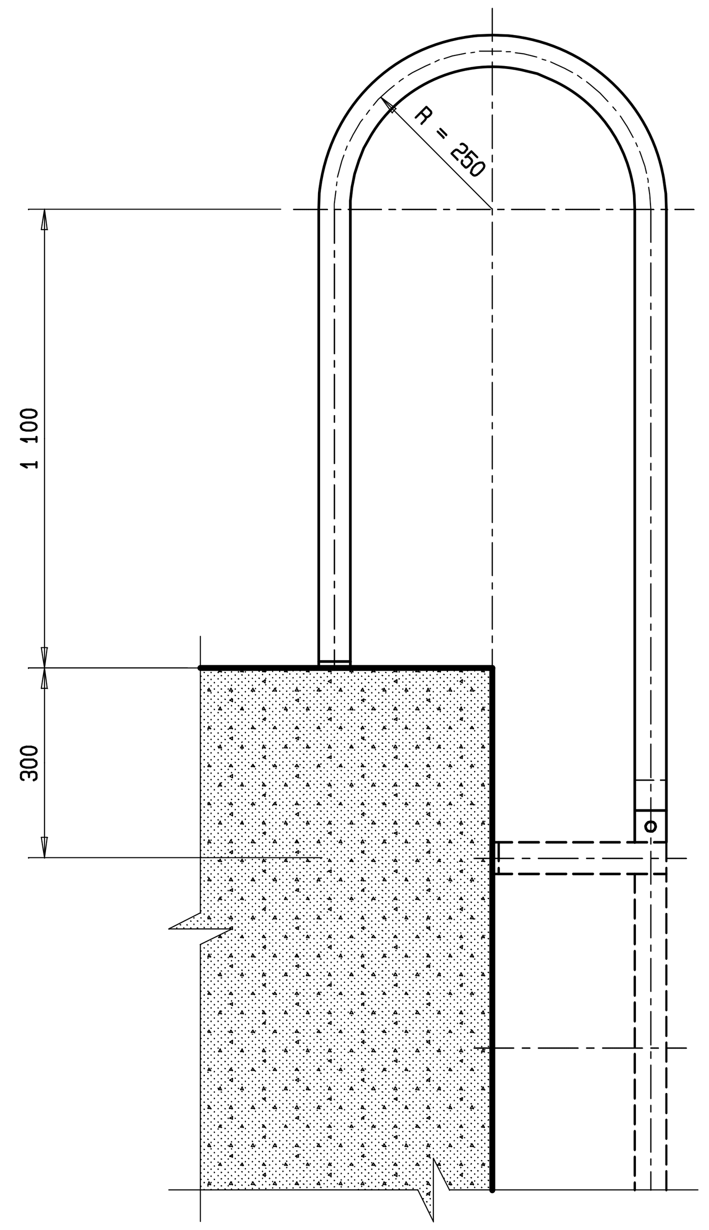
CALCULATION FILE: –

SHEET 1 OF 3 REG. No. 125 769/97 REV. 00



TOP HANDRAIL SECTION FOR EXTERNAL ACCESS

NTS



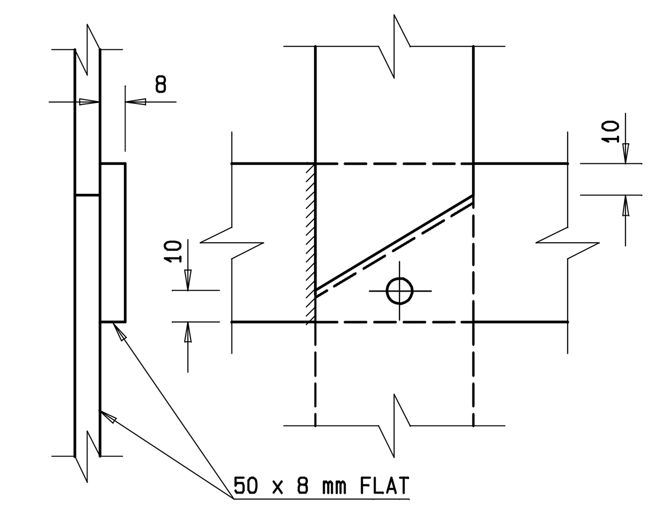
TOP HANDRAIL SECTION FOR EXTERNAL ACCESS

NTS

ITEM NO.	LENGTH OF LADDER	NO. OFF	LADDER TYPE	d1	d2	COMMENTS

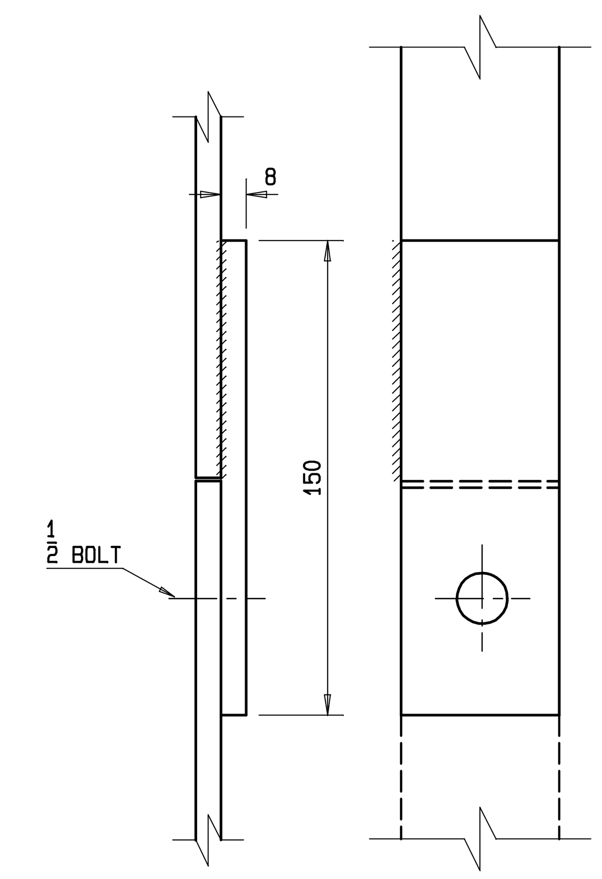
NOTE:

DETAILS FOR DOUBLE HOOP THE SAME AS FOR STANDARD HOOP BUT WITH STRAIGHT CENTRE SECTIONS OF 485 mm ADDED. ONE EXRA SAFETY STRAP TO BE FITTED IN CENTRE.



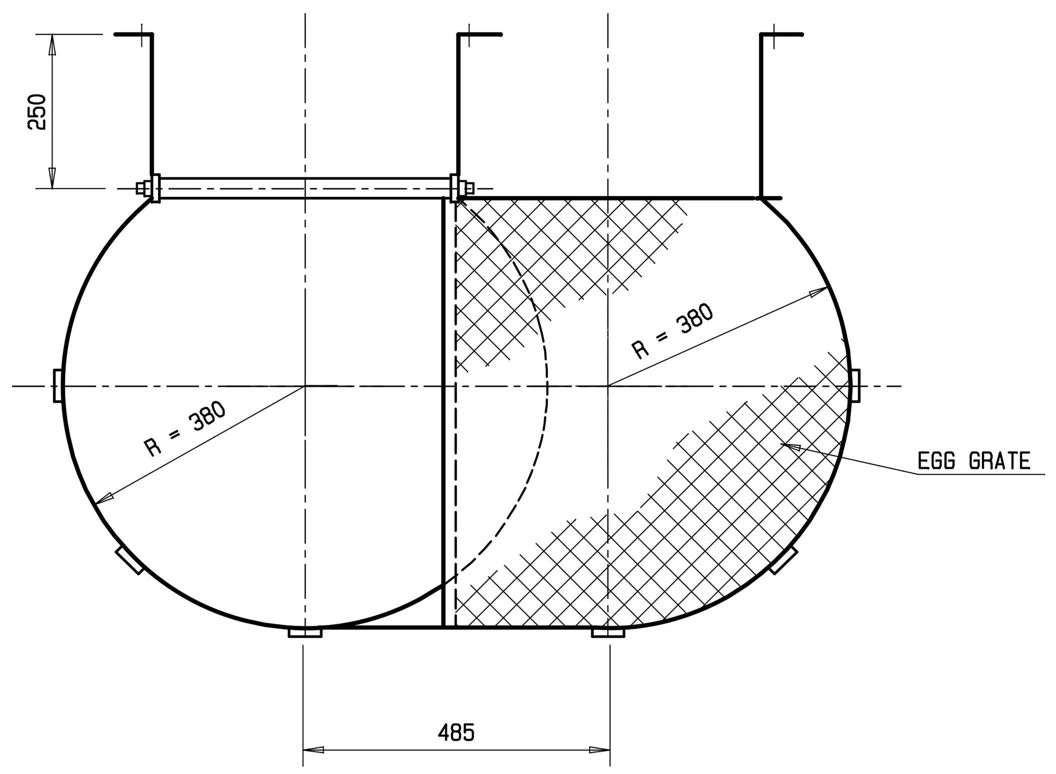
JOINT TYPE 1

SCALE 1:2



JOINT TYPE 2

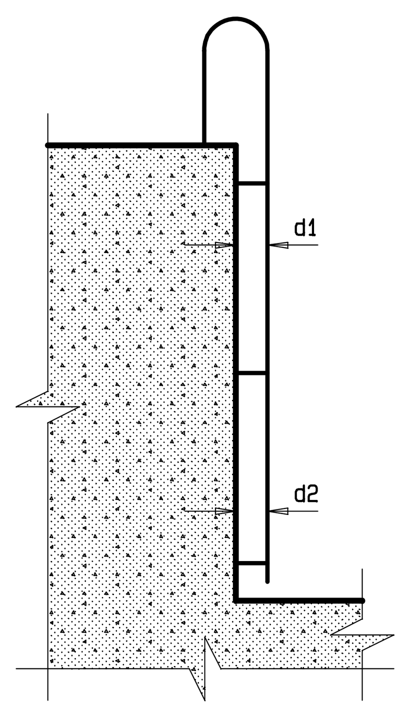
SCALE 1:2



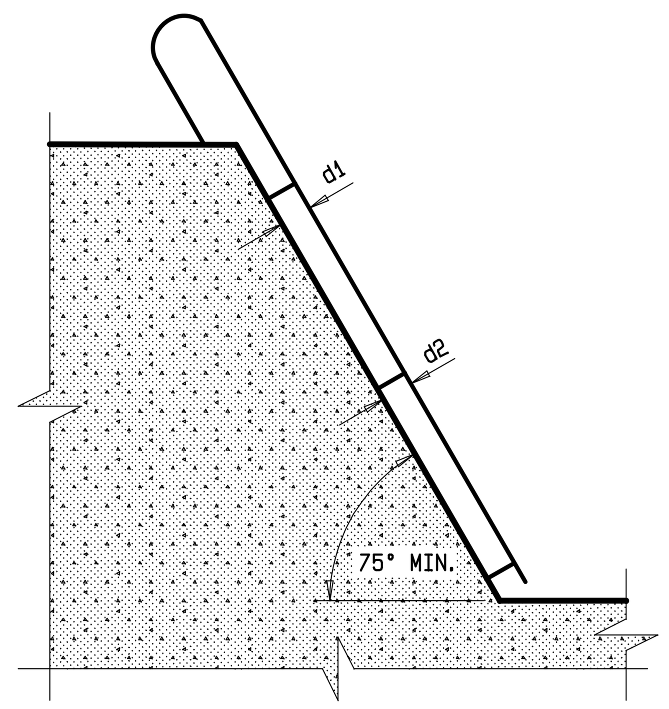
SECTION 01-01

SHOWING THE PLATFORM AND PLAN OF DOUBLE HOOP

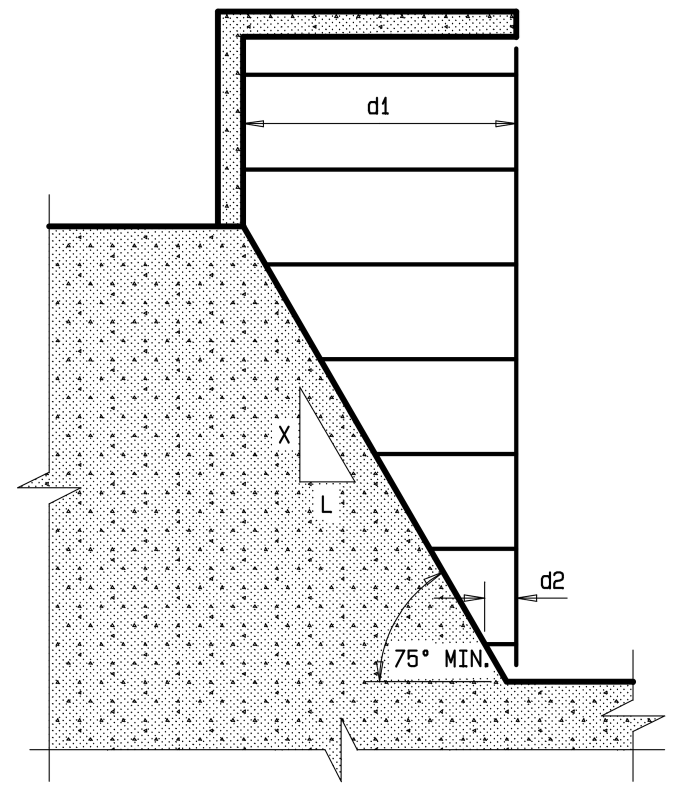
SCALE 1:10



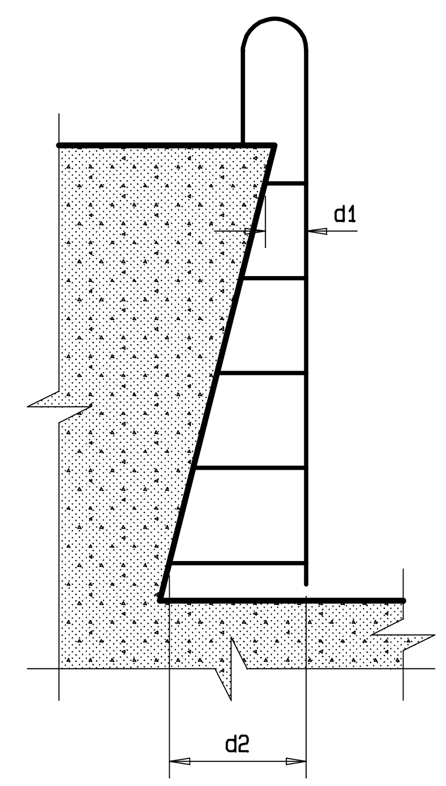
TYPE 1: VERTICAL



TYPE 2: OUTER



TYPE 3: OUTER



TYPE 4: INNER

WALL CONDITION

NTS

THIS DRAWING SUPERSEDES
DRG. REG. NO'S. 69 031/78 AND 69 032/78.

SCALE 1:2 — 0, 0,05, 0,1, 0,15, 0,2, 0,4 m

SCALE 1:10 — 0, 0,1, 0,2, 0,3, 0,4, 0,5, 1, 2 m

SHEET	DESCRIPTION	OTHER No.	REG. No.
3/3	TYPE DRAWING : DETAIL OF GALVANISED MILD STEEL LADDER		125 771/97
1/3	TYPE DRAWING : DETAIL OF GALVANISED MILD STEEL LADDER		125 769/97

LIST OF DRAWINGS

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA
1.	01/00	DRAWING REDRAWN	R.H.	

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL ENGINEERING
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 SCHOEMAN STREET
PRETORIA
(012) 336-7500

P. YAKO
DIRECTOR GENERAL

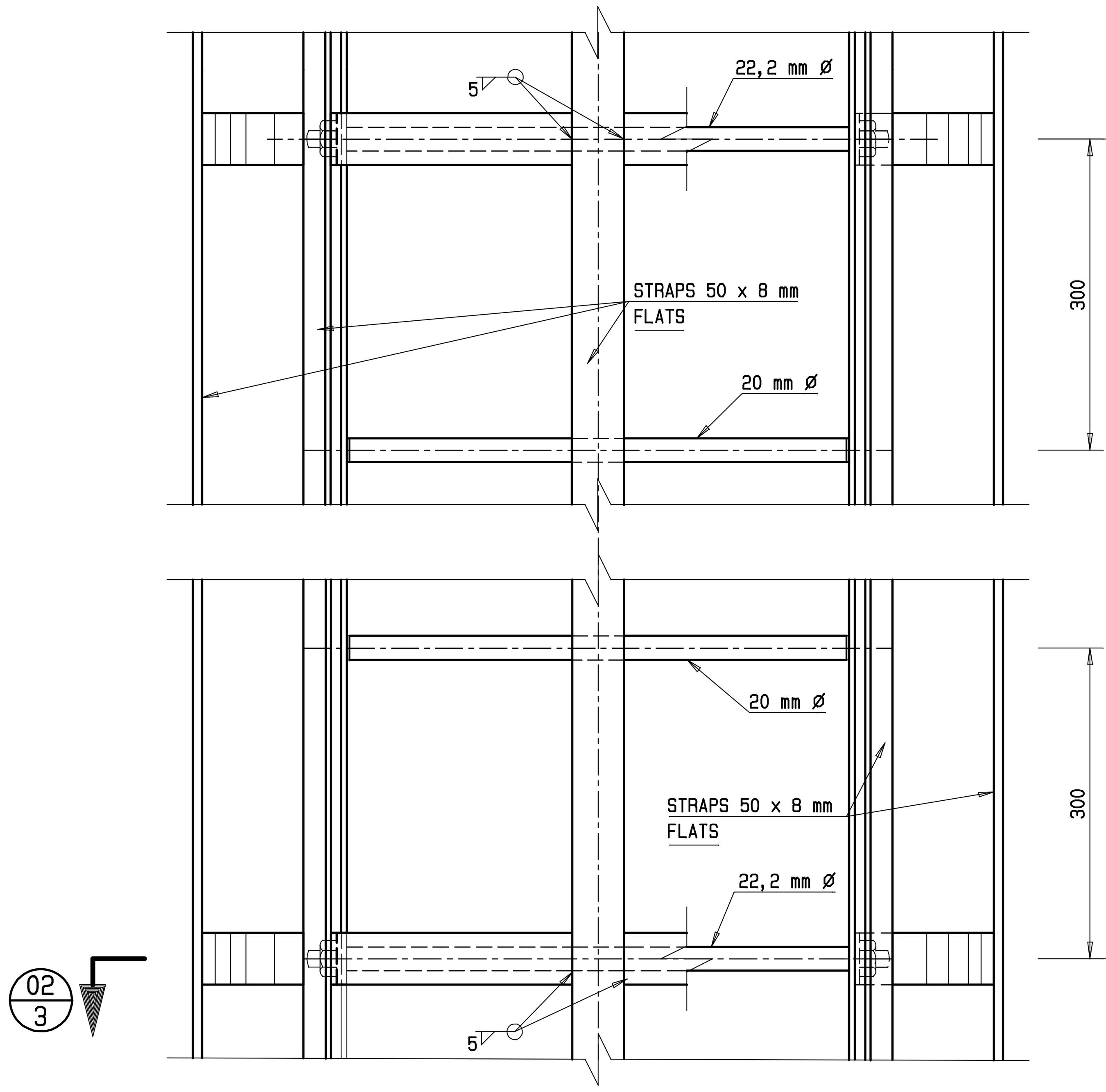
DESIGN: J.C. SWANEPOEL
CHECKED: J.C. SWANEPOEL DATE:
DRAWN: J.C. SWANEPOEL/CADDIE
ENGINEER: DATE:
EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE:
DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING

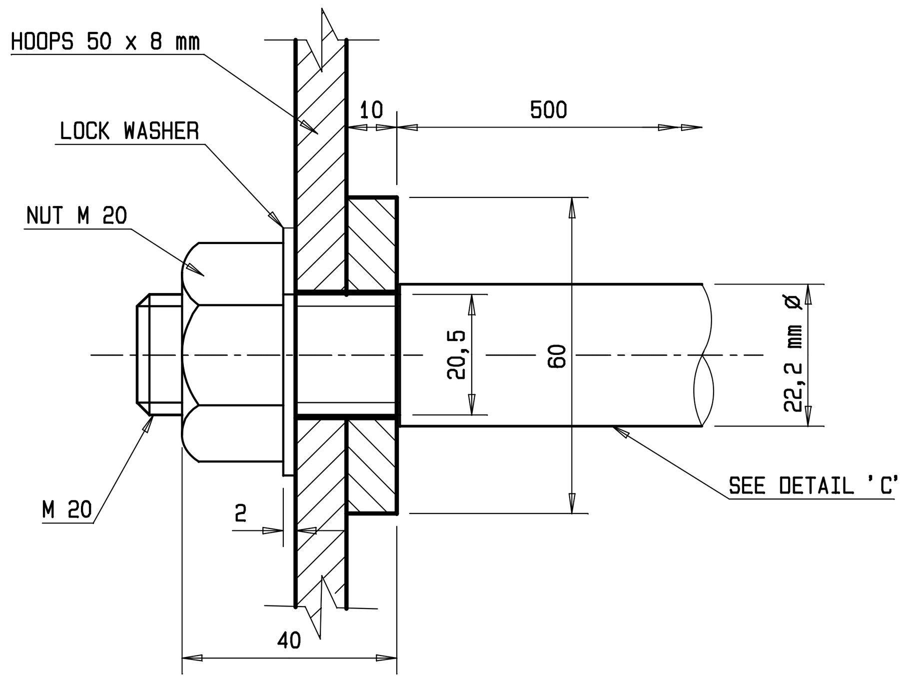
DETAIL OF GALVINIZED MILD STEEL LADDER

PROVINCE:
DISTRICT:
KEYCODES: TYP ⁞ SFY ⁞ LDR ⁞ DET ⁞ LYD
OTHER NUMBER
LOCALITY No.: –
TENDER/ CONTRACT No.
CALCULATION FILE: –
SHEET 2 OF 3
REG. No. 125 770/97
REV. 00



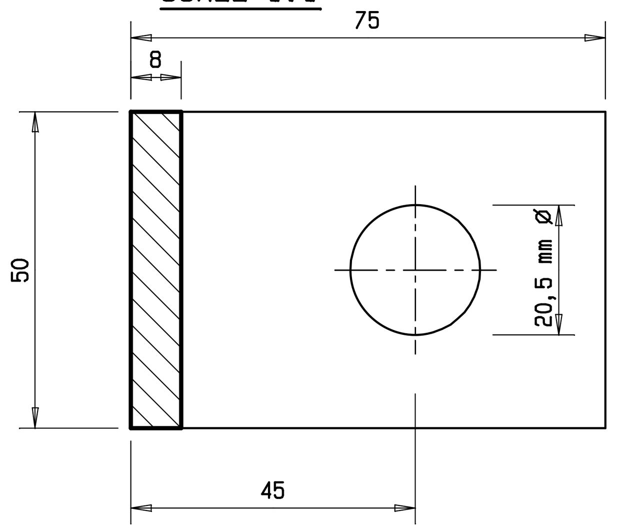
FRONT VIEW

SCALE 1:5



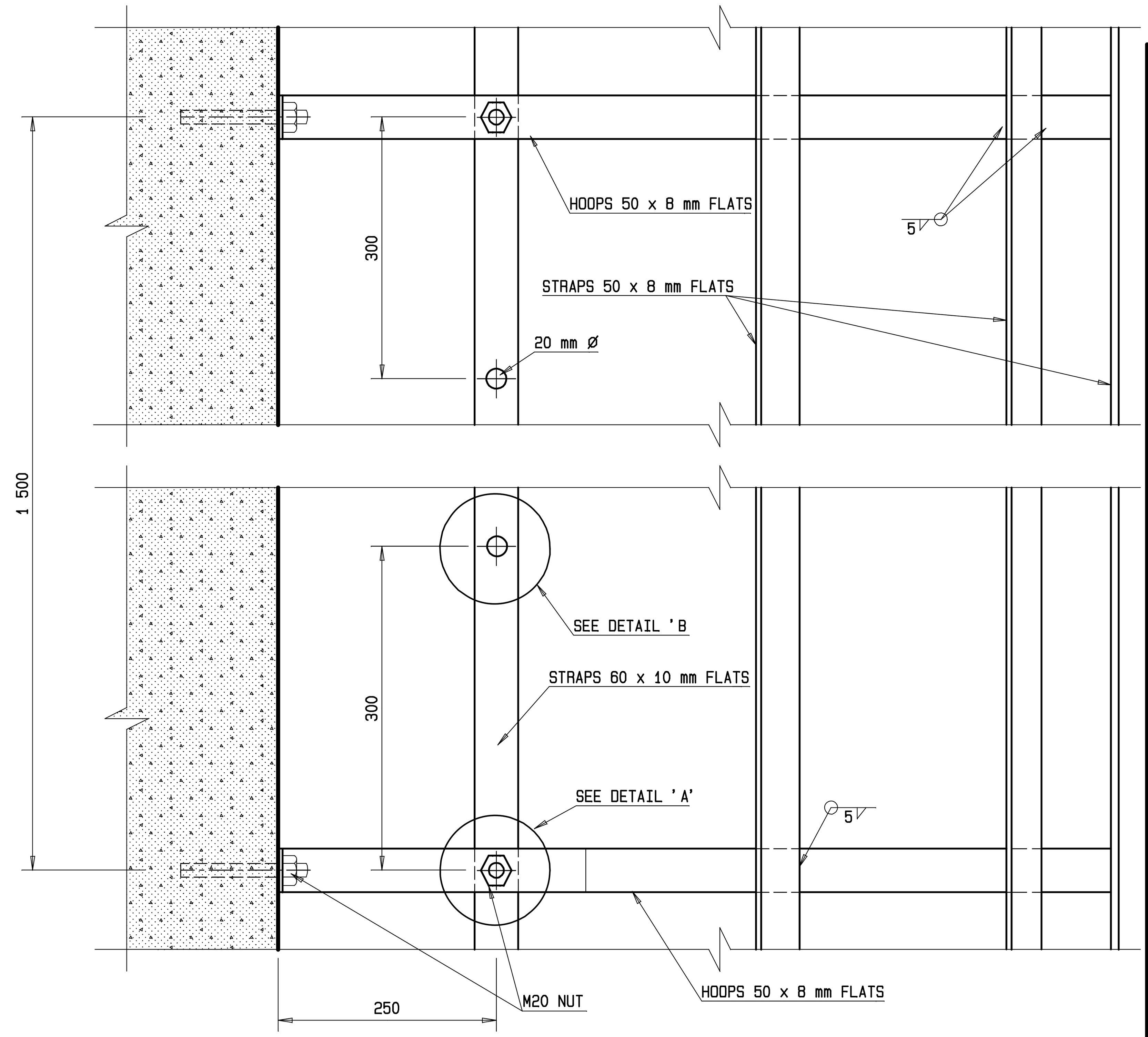
DETAIL 'A'

SCALE 1:1



SECTION 03-03

SCALE 1:1



SIDE VIEW

SCALE 1:5

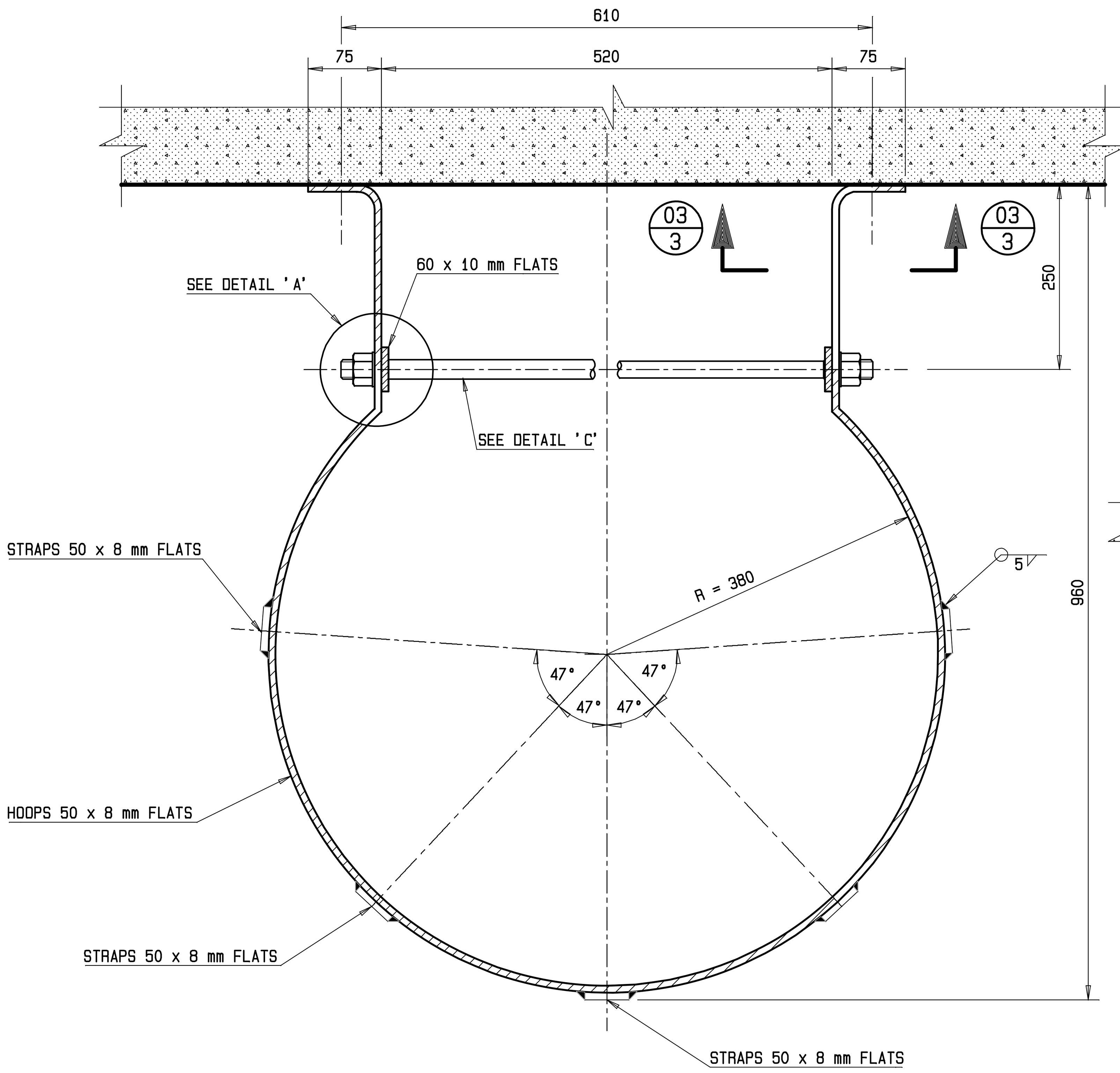
NOTES:

1. FOR LADDER SCHEDULE SEE DRAWING REG. NO. 125 770/95.
2. LADDERS LONGER THAN 5 m SHALL BE FITTED WITH HOOPS.
3. FOR LADDERS WITH LENGTHS BETWEEN 5,6 m AND 8,7 m SHORTEN TOP AND BASE SECTION BY 1,5 m.
4. FOR ALL LADDERS LONGER THAN 6 m AN INTERMEDIATE PLATFORM IS REQUIRED AT MAXIMUM SPACING 6 m.
5. ALL LADDER DETAILS SHALL CONFORM TO SABS 0162. THE MANUFACTURER WILL BE REQUIRED TO DESIGN THE WALL SUPPORTS.
6. BRACKETS FOR TYPE 'A' LADDER TO BE DESIGNED SO THAT IT WILL BE RIGID AFTER TIGHTENING OF TIE BAR.
7. THIS DRAWING SHALL BE READ IN CONJUNTION WITH DRG. REG. NO'S. 125 769/97 AND 125 770/97.
8. ALL ITEMS TO BE HOT DIP GALVANISED TO 90 MICRON EQUIVALENT THICKNESS IN ACCORDANCE WITH SABS SPEC. NO. 1461.
9. ALL WELDING AND GALVANISING TO BE DONE IN WORKSHOP. ASSEMBLY OF ITEMS ON SITE ONLY. SCREWING IN OF NUTS ON RUNGS TO BE CHECKED IN THE WORKSHOP AFTER GALVANISING. WELDS SHALL BE CONTINUOUS - SEAL.
10. MILD STEEL SHALL BE GRADE 300 W.
11. ALL ANCHORS IN CONCRETE SHALL BE STAINLESS STEEL TO ASTM A240 GRADE 316.

    SPECIAL CARE SHALL BE TAKEN TO ENSURE THAT ANCHORS BE INSTALL TO THE CORRECT LEVEL AND DEPTH. AHCORS SHALL NOT BE CUT AFTER INSTALLATION WITHOUT PRIOR INSPECTION AND APPROVAL BY THE ENGINEER.

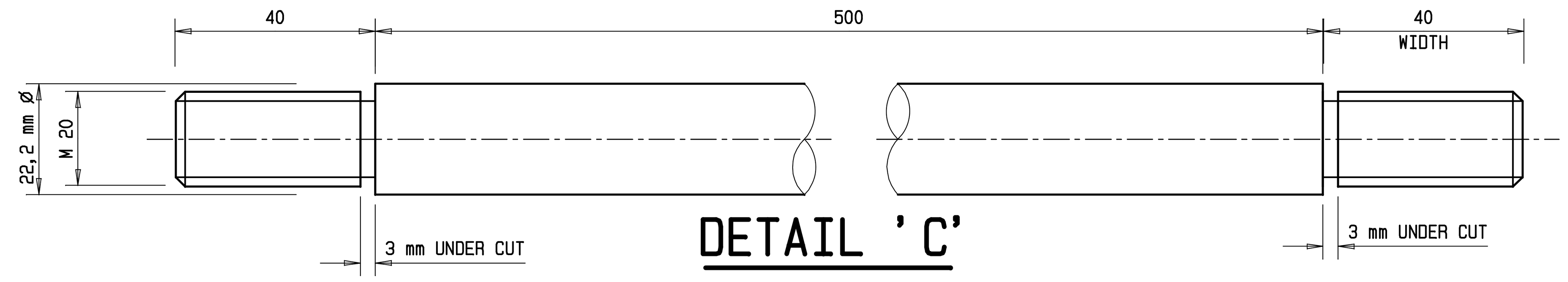
    TO AVOID A GALVANIC REACTION (STAINLESS STEEL/GALVANISING) UNDER WET CONDITIONS, THE NUT AND WASHER SHALL BE FBE COATED. WHERE NECESSARY CAPS SHALL BE SPECIFIED BY THE CORROSION ENGINEER.
12. FASTENERS, WASHERS AND ANCHORS IN CONCRETE TO BE AS THE TABLE BELOW:

ELEMENT	MATERIAL	PROTECTION	MINIMUN DFT (um)
FASTENERS WASHERS	MILD STEEL	HOT-DIP GALVANISED - PLUS THREADS COATED WITH MOLYBDENUM DISULPHIDE LUBRICANT OR WAX	45
	STAINLESS STEEL 304	THREADS COATED WITH MOLYBDENUM DISULPHIDE LUBRICANT OR NICKEL ANTI-SEIZE COMPOUND	UNIFORM COVER
ANCHORS IN CONCRETE SEE NOTE 11	SS 316	THREADS COATED WITH MOLYBDENUM DISULPHIDE LUBRICANT OR NICKEL ANTI-SEIZE COMPOUND	UNIFORM COVER



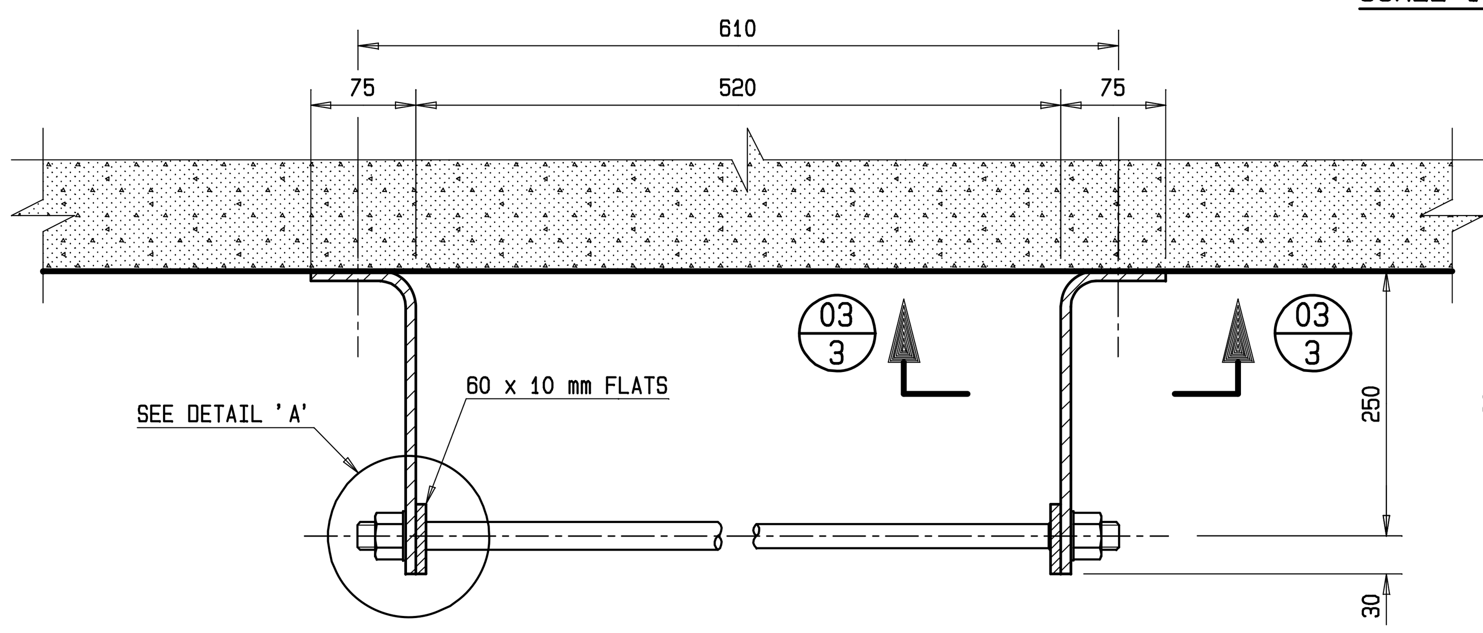
SECTION 02-02

SCALE 1:5



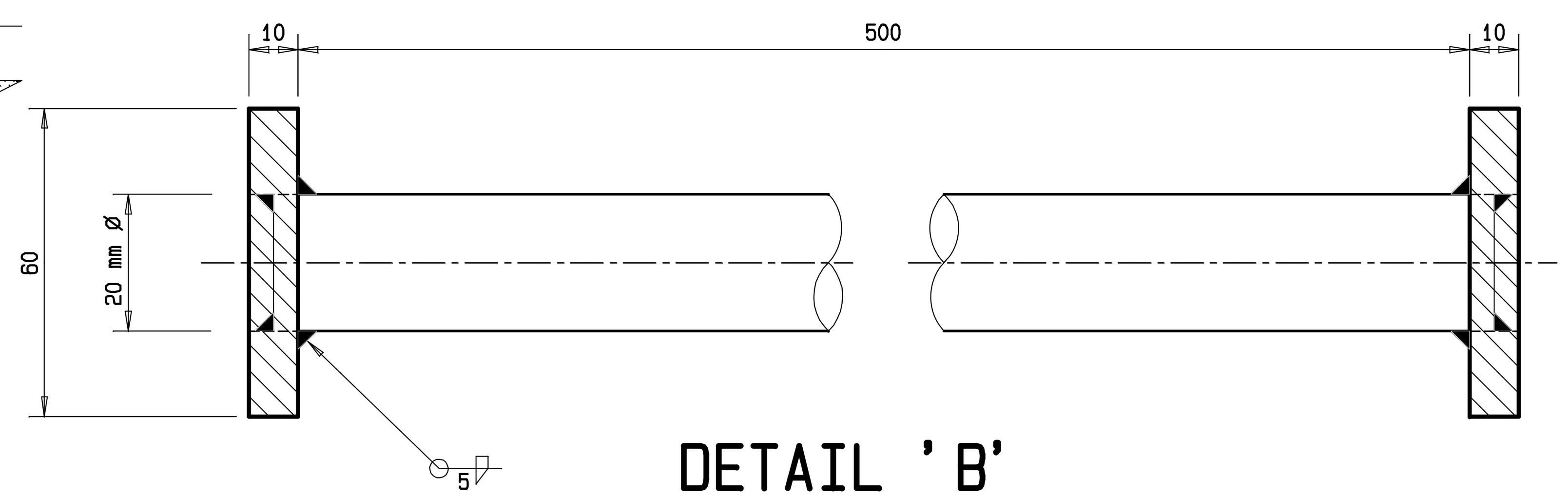
DETAIL 'C'

SCALE 1:1



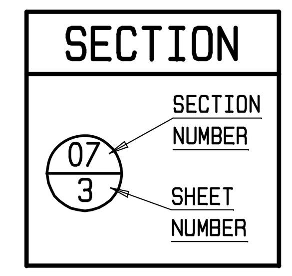
LADDER WITHOUT SAFETY HOOP

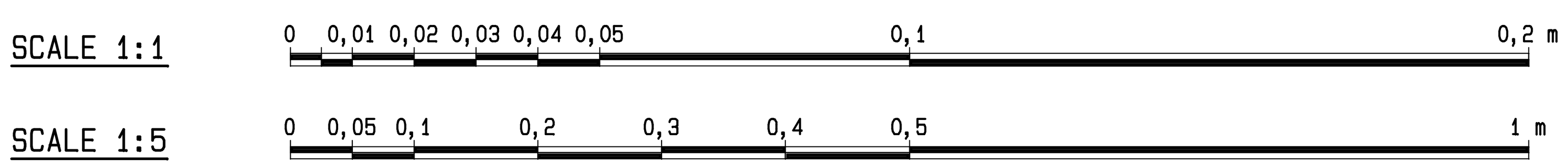
SCALE 1:5



DETAIL 'B'

SCALE 1:1





THIS DRAWING SUPERSEDES
DRG. REG. NO'S. 69 031/78 AND 69 032/87

LIST OF DRAWINGS

SHEET	DESCRIPTION	OTHER No.	REG. No.
1/3	TYPE DRAWING: DETAIL OF GALVANISED MILD STEEL LADDER		125 769/97
2/3	TYPE DRAWING: DETAIL OF GALVANISED MILD STEEL LADDER		125 770/97

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA
1.	01/00	DRAWING REDRAWN	C.S.	

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL ENGINEERING
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 SCHOEMAN STREET
PRETORIA
(012) 336-7500

P. YAKO
DIRECTOR GENERAL

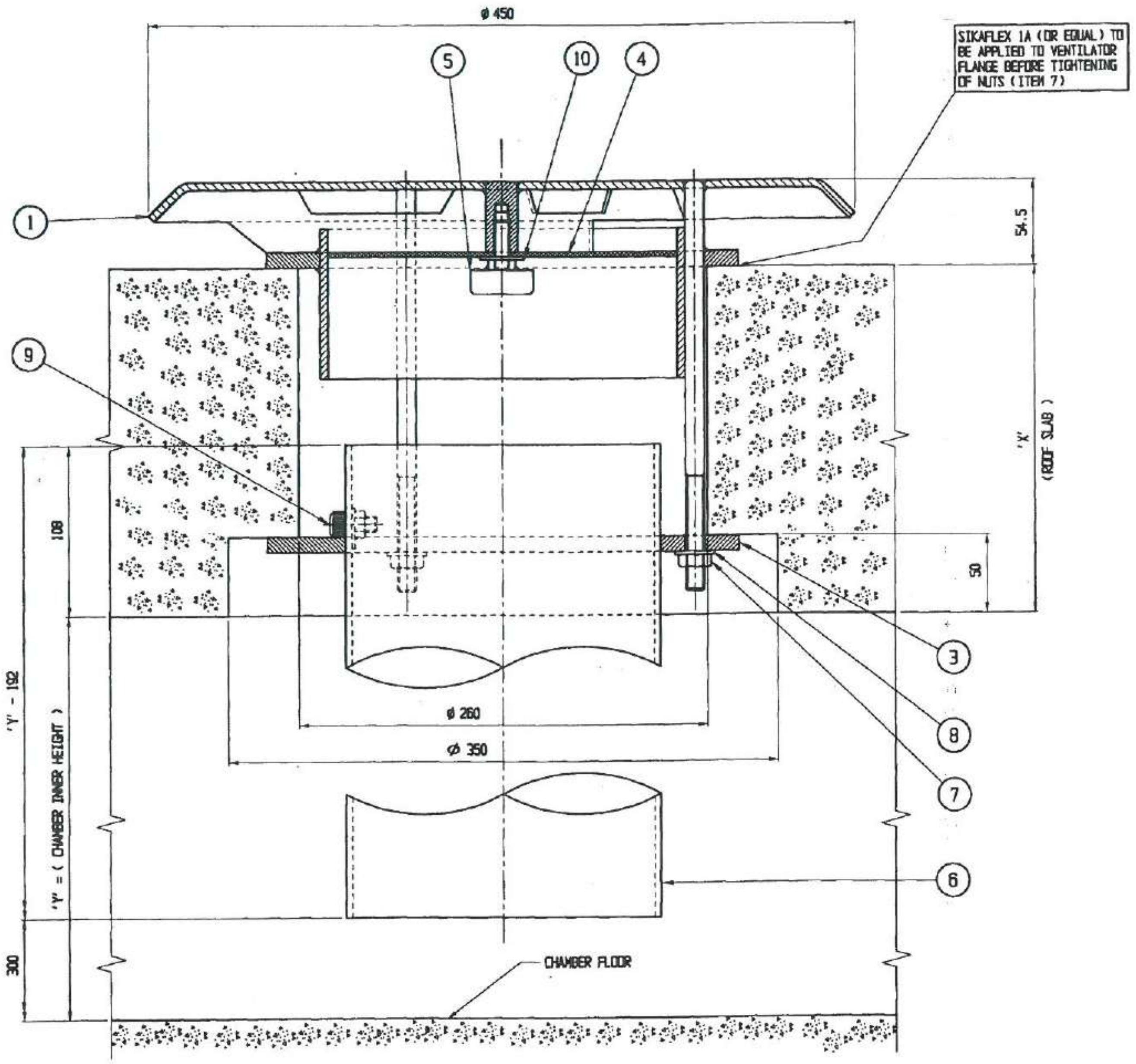
DESIGN: J.C. SWANEPOEL
CHECKED: J.C. SWANEPOEL DATE:
DRAWN: J.C. SWANEPOEL/CADDIE
ENGINEER: DATE:
EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE:
DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING

DETAIL OF GALVINIZED MILD STEEL LADDER

PROVINCE:
DISTRICT:
KEYCODES: TYP SFY LDR DET -
OTHER NUMBER
LOCALITY No.: -
TENDER/CONTRACT No.
SHEET 3 OF 3
REG. No. 125 771/97
REV. 00
CALCULATION FILE: -

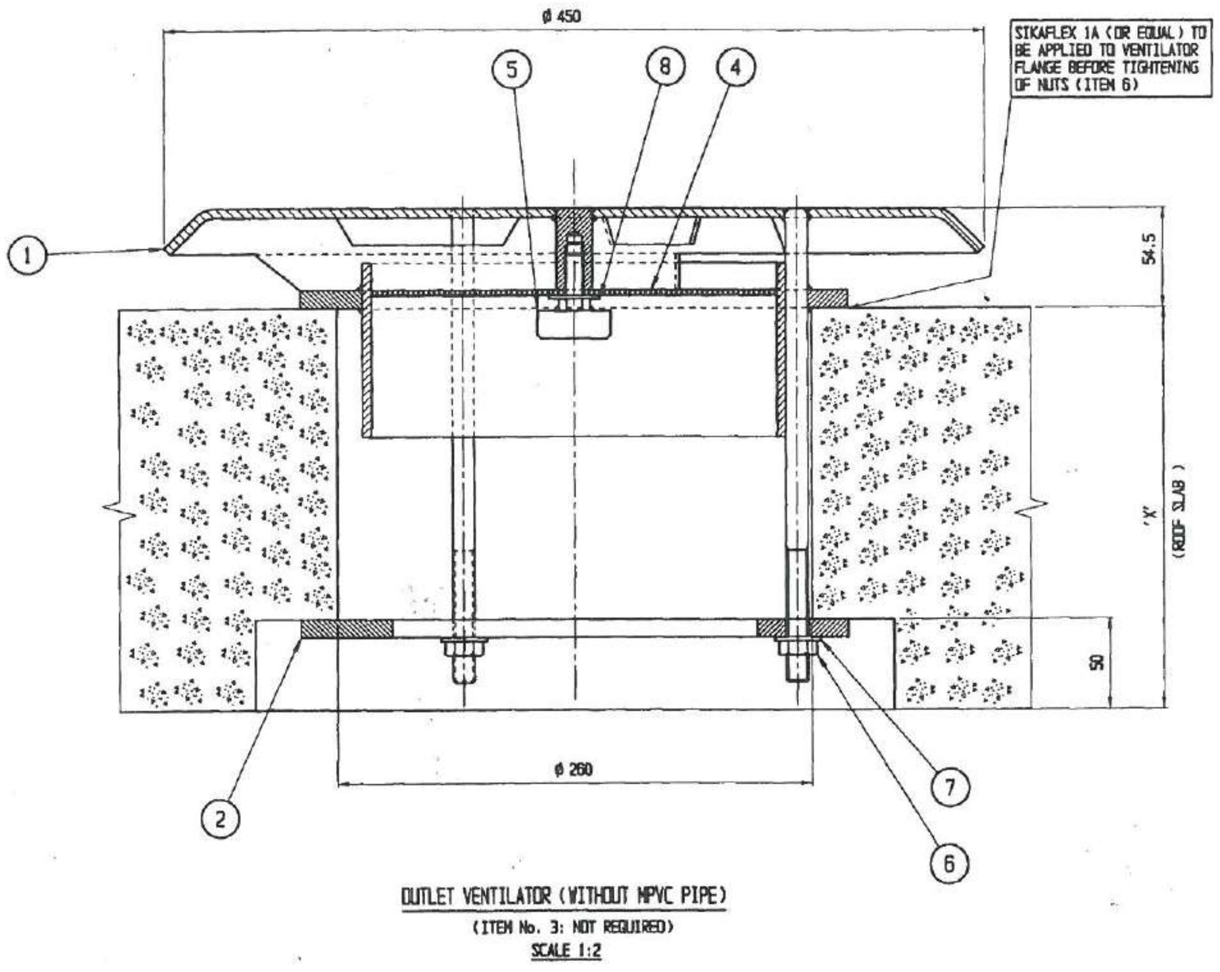


INLET VENTILATOR (WITH MPVC PIPE)

(ITEM No. 2: NOT REQUIRED)

SCALE 1:2

* NOTE:
QUANTITIES SHOWN IN PARTS LIST ARE FOR ONE INLET VENTILATOR ONLY



OUTLET VENTILATOR (WITHOUT MPVC PIPE)

(ITEM No. 3: NOT REQUIRED)

SCALE 1:2

* NOTE:
QUANTITIES SHOWN IN PARTS LIST ARE FOR ONE OUTLET VENTILATOR ONLY

PARTS LIST FOR INLET VENTILATOR

ITEM	DESCRIPTION	QTY	MATERIAL	DETAIL DRG.	ASSEMBLY DRG.	REMARKS
10	LARGE DIAMETER WASHER TO SUIT M10 SCREW	1	ST/STL. 304	STANDARD	131012/98 ME	
9	CAP SCREW: M12 x 25 LONG WITH NUT AND WASHER	3	ST/STL. 304	STANDARD	131012/98 ME	
8	WASHER TO SUIT M12 SCREW	3	ST/STL. 304	STANDARD	131012/98 ME	
7	HEX. NUT: M12	3	ST/STL. 316	STANDARD	131012/98 ME	
6	VENT PIPE	1	M.P.V.C.	131013/98 ME	131012/98 ME	CLASS 6
5	SCREW	1	ST/STL. 316	131013/98 ME	131012/98 ME	
4	SCREEN	1	ST/STL. 304L	131013/98 ME	131012/98 ME	
3	INLET VENTILATOR FLANGE	1	3CR12	131013/98 ME	131012/98 ME	PICKLED AND REPASSIVATED
2	NOT REQUIRED					
1	VENTILATOR	1	3CR12 AND ST/STL. 304L	131013/98 ME	131012/98 ME	PICKLED AND REPASSIVATED

PARTS LIST FOR OUTLET VENTILATOR

ITEM	DESCRIPTION	QTY	MATERIAL	DETAIL DRG.	ASSEMBLY DRG.	REMARKS
8	LARGE DIAMETER WASHER TO SUIT M10 SCREW	1	ST/STL. 304	STANDARD	131012/98 ME	
7	WASHER TO SUIT M12 SCREW	3	ST/STL. 304	STANDARD	131012/98 ME	
6	HEX. NUT: M12	3	ST/STL. 316	STANDARD	131012/98 ME	
5	SCREW	1	ST/STL. 316	131013/98 ME	131012/98 ME	
4	SCREEN	1	ST/STL. 304L	131013/98 ME	131012/98 ME	
3	NOT REQUIRED					
2	OUTLET VENTILATOR FLANGE	1	3CR12	131013/98 ME	131012/98 ME	PICKLED AND REPASSIVATED
1	VENTILATOR	1	3CR12 AND ST/STL. 304L	131013/98 ME	131012/98 ME	PICKLED AND REPASSIVATED

0 5 10 SCALE (mm) 100

PROJECTION (U.O.S.)

REVISION

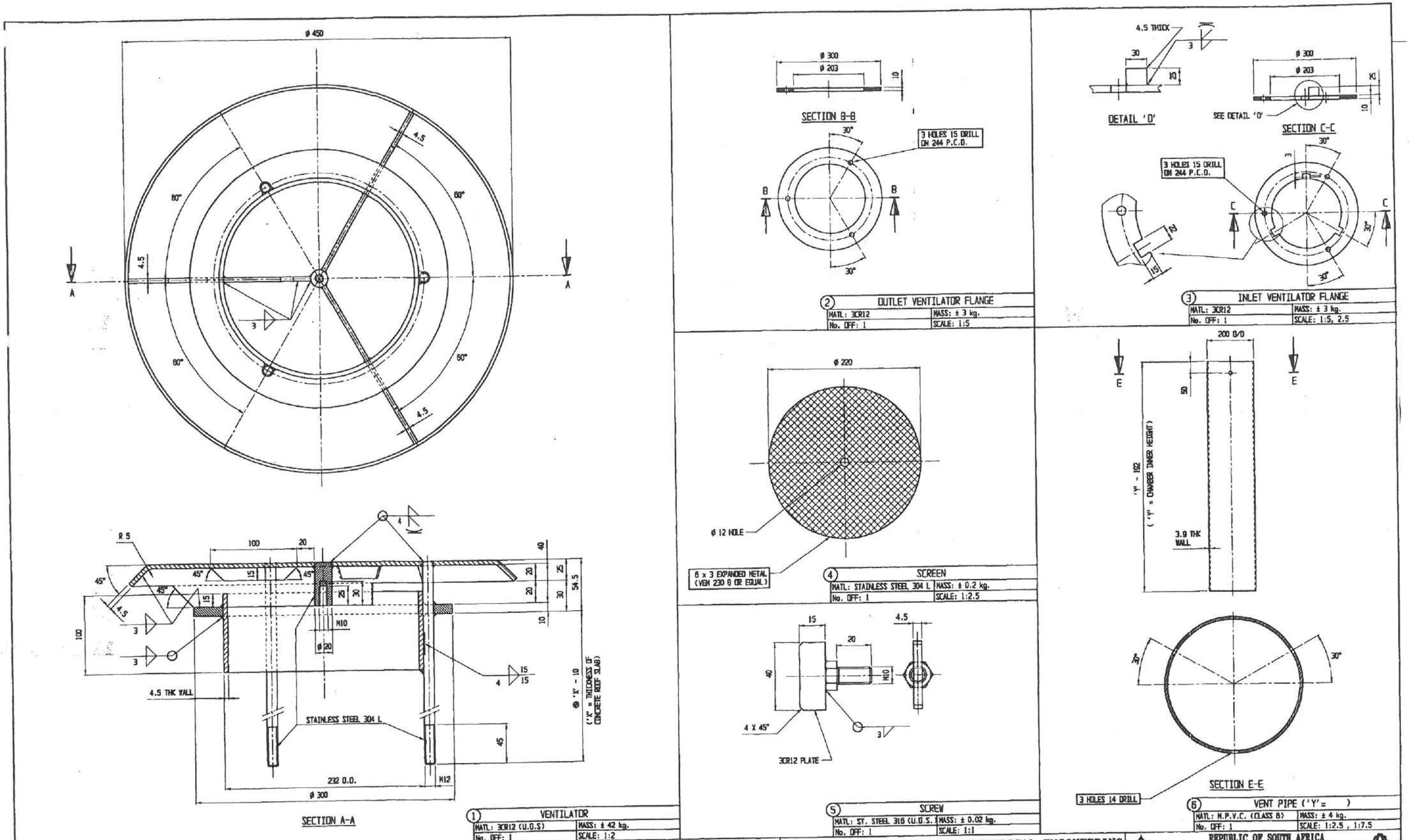
MOD No	DATE	DESCRIPTION	SIGN.

DIRECTORATE: MECHANICAL & ELECTRICAL ENGINEERING

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTOR GENERAL: M. MULLER

TECHNICAL DESIGN SERVICES 10/5/2004 DATE	DESIGNED: P.VAN DALEN	KEY CODES:	TYPE
	DRAWN: M.P. OIKOBE 16-10-1998	TYP	TYPE DRAWING: 3CR12 INLET AND OUTLET VENTILATORS - GENERAL ASSEMBLY -
ENGINEER DATE	CHECKED: 10/5/04 DATE	VET	
act. CHIEF ENGINEER (Pr.Eng) 10/5/04 DATE	CALCULATIONS FILE: ME/ DM ZZZ-03	ASD	
	LOCALITY No. DM ZZZ-03		PROVINCE: / DISTRICT:
act. DIRECTOR (Pr.Eng) 10/5/04 DATE	TENDER No./ CONTRACT No.		OTHER No. / SHEET 1 OF 2 / REG.No.: 131012/98 ME

DO NOT SCALE DRAWING | ALL DIMENSIONS IN MILLIMETRES | REMOVE ALL SHARP EDGES



GENERAL DIMENSIONAL TOLERANCES (U.O.S.)
DIMENSIONS:±2 mm (MIN.)
THICKNESS OF MATERIAL- AS MANUFACTURED

WELDING
IDENTICAL WELDS SYMBOLISED ONCE ONLY
CODED WELDERS TO BE UTILISED FOR WELDING OPERATIONS.

MATERIAL
MATERIAL TO BE: 3CR12 No 1 FINISH (U.O.S.)
STAINLESS STEEL TO BE GRADE: 304 L

SURFACE PROTECTION:
AFTER FABRICATION ALL 3CR12 AND STAINLESS STEEL ITEMS TO BE PICKLED AND REPASSIVATED.

0 5 10 SCALE (mm) 100

PROJECTION (U.O.S.)

DO NOT SCALE DRAWING | ALL DIMENSIONS IN MILLIMETRES | REMOVE ALL SHARP EDGES

REVISION

MOD No	DATE	DESCRIPTION	SIGN.
1	18-05-2004	@LENGTH OF M12 STUDS AT ITEM 1 ALTERED TO: 'X' - 5 (WAS 'X' + 45)	

DIRECTORATE: MECHANICAL & ELECTRICAL ENGINEERING

TECHNICAL DESIGN SERVICES — 19/5/2004 DATE
ENGINEER — DATE
CHIEF ENGINEER (Pr.Eng) — 19 May '04 DATE
DIRECTOR (Pr.Eng) — 20/5/04 DATE

DESIGNED: P.VAN DALEN
DRAWN: M.P. DIKOBE 16-10-1998
CHECKED: 19/5/2004 DATE
CALCULATIONS FILE: ME/ DM ZZZ-03
LOCALITY No. DM ZZZ-03
TENDER No./ CONTRACT No.

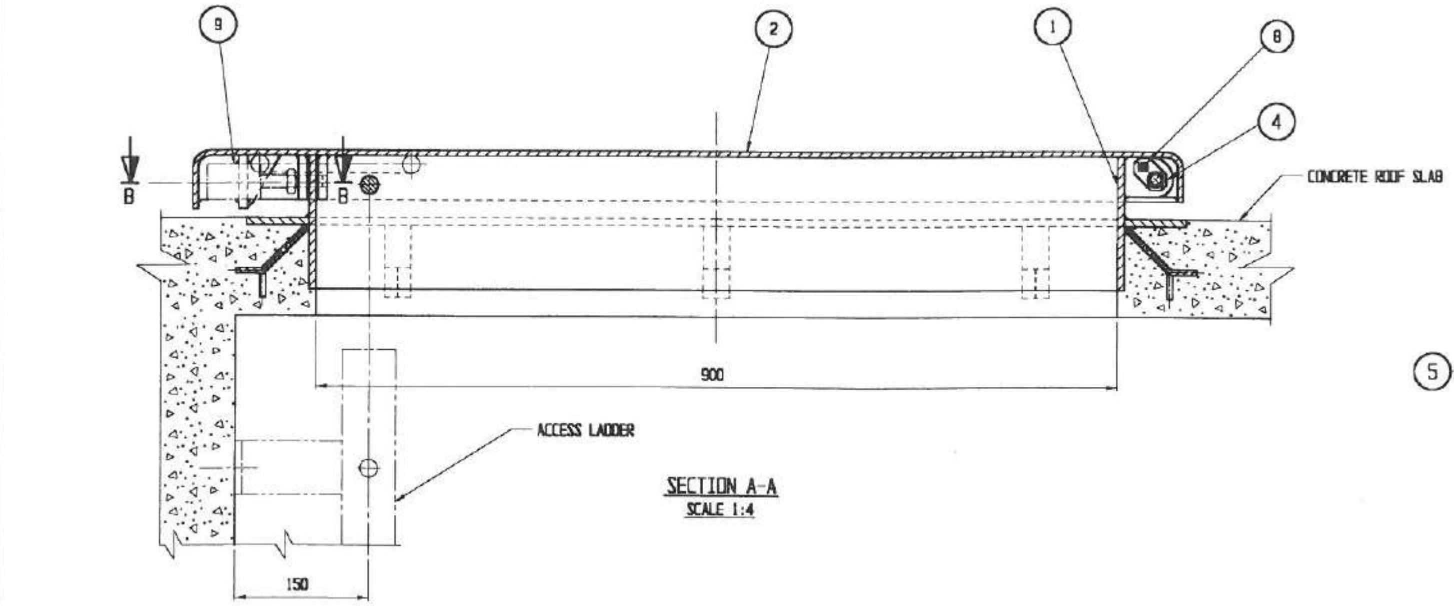
KEY CODES:
TYP
VET
DET

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTOR GENERAL: [illegible]

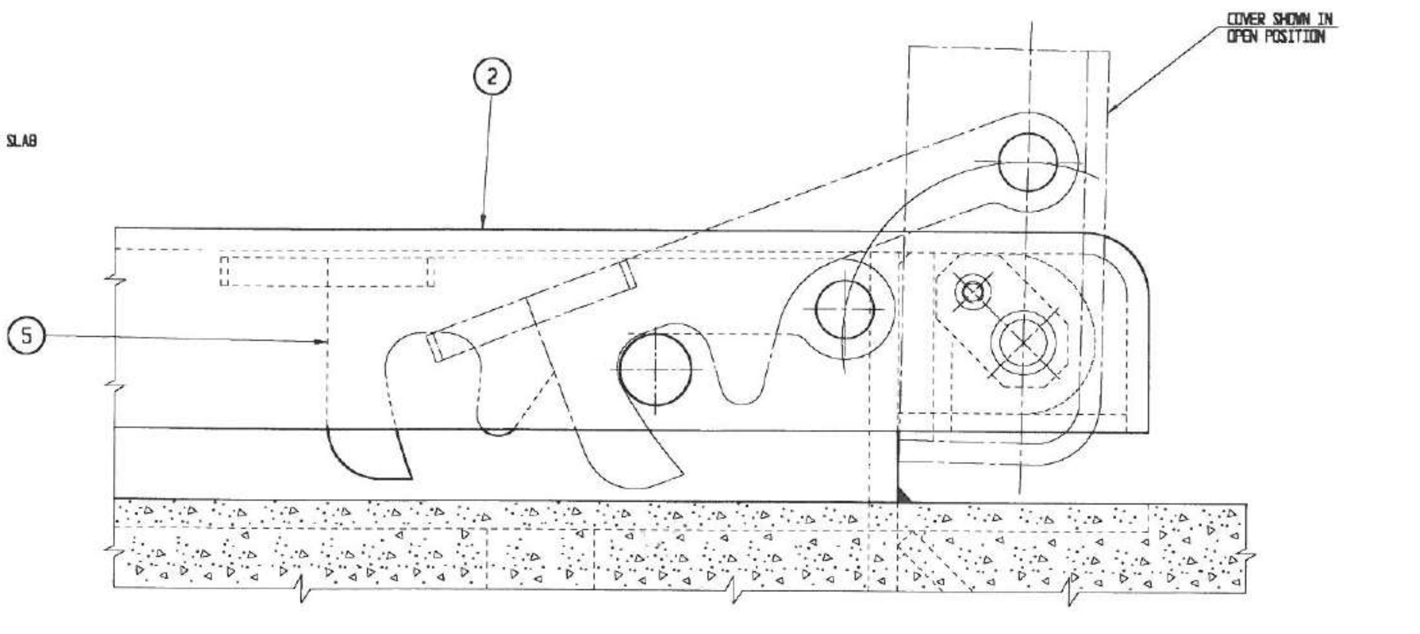
TYPE

TYPE DRAWING:
3CR12 INLET AND OUTLET VENTILATORS
- DETAILS -

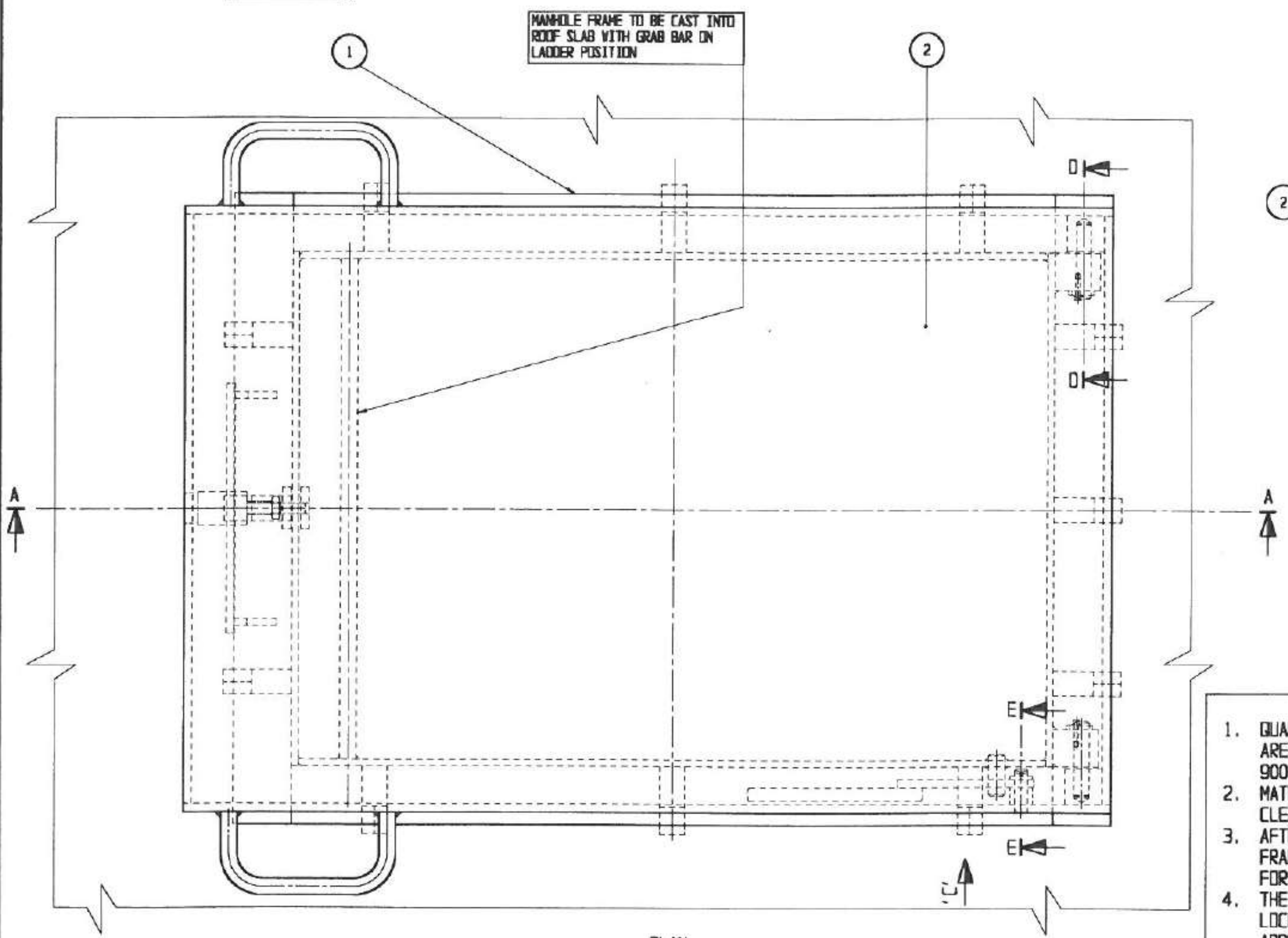
PROVINCE:
DISTRICT:
OTHER No.
SHEET 2 OF 2
REG.No.: 131013/98 ME



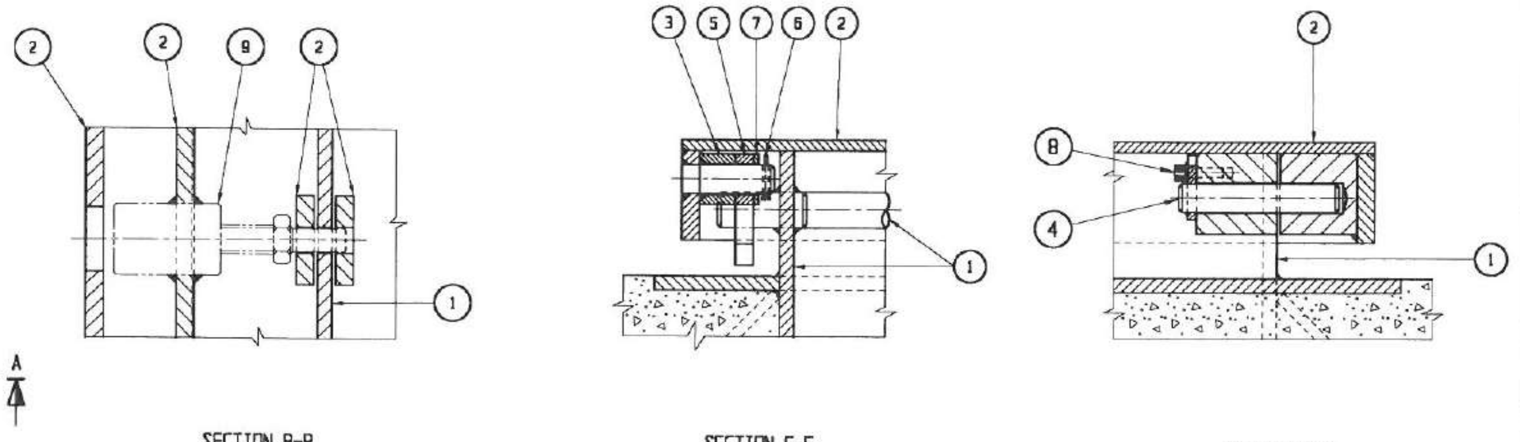
SECTION A-A
SCALE 1:4



VIEW ON ARROW 'C'
SCALE 1:1



PLAN
SCALE 1:4



SECTION B-B
SCALE 1:2

SECTION E-E
SCALE 1:2

SECTION D-D
SCALE 1:2

NOTE:

1. QUANTITIES REFLECTED IN PARTS LIST ARE FOR ONE COMPLETE MANHOLE: 900 x 600 mm OPENING.
2. MATCHING FRAME AND COVER TO BE CLEARLY IDENTIFIED THROUGH NUMBERING.
3. AFTER FACTORY ASSEMBLY MATCHING FRAME AND COVER TO REMAIN ASSEMBLED FOR DELIVERY TO SITE.
4. THE USE AND ORDER OF THE PATENTED LOCKING DEVICE (ITEM 9) IS SUBJECT TO APPROVAL BY THE DIRECTOR: M/E ENGINEERING

ITEM	DESCRIPTION	QTY	MATERIAL	DETAIL DRG.	ASSEMBLY DRG.	REMARKS
9	PATENTED LOCKING DEVICE	1	STAINLESS STEEL	STANDARD	137079/01 ME	304 L (PATENTED BY D. N. ENTERPRISES)
8	CAP SCREW:M6 x 20 LONG WITH WASHER	2	STAINLESS STEEL	STANDARD	137079/01 ME	304 L
7	WASHER: 27 O/D x 17 I/D x 3 THICK	1	STAINLESS STEEL	STANDARD	137079/01 ME	304 L
6	SPLIT PIN TO SUIT Ø 4 HOLE	1	STAINLESS STEEL	STANDARD	137079/01 ME	304 L
5	LOCKING DEVICE	1	STAINLESS STEEL	137081/01 ME	137079/01 ME	304 L
4	PIN	2	STAINLESS STEEL	137081/01 ME	137079/01 ME	304 L
3	SPACER	1	STAINLESS STEEL	137081/01 ME	137079/01 ME	304 L
2	MANHOLE COVER	1	3CR12 & ST.STEEL	137080/01 ME	137079/01 ME	
1	MANHOLE FRAME	1	3CR12 & ST.STEEL	137080/01 ME	137079/01 ME	

PARTS LIST

CORROSION PROTECTION FOR UNDERSIDE (INSIDE) OF MANHOLE COVER (ITEM 2) AND MANHOLE FRAME (ITEM1)

SURFACE PREPARATION:
REMOVE OIL AND CONTAMINANTS WITH A WATER SOLUBLE DEGREASER OR SOLVENT.
WASH SURFACES WITH CLEAN WATER TO A "WATER BREAK FREE" SURFACE.
ROUGH SURFACE WITH NON-METALLIC PAPER OR PADS.
REMOVE ALL DUST AND DEBRIS BY VACUUM.

APPLICATION:
APPLY ONE COAT OF MULTIPURPOSE ALUMINIUM MODIFIED EPOXY COATING (CARBOMASTIC 15)
TO DFT 125-175 MICRONS IN ACCORDANCE WITH THE PRODUCT DATA SHEET.

SURFACE PROTECTION: AFTER FABRICATION ALL 3CR12 AND STAINLESS STEEL ITEMS TO BE PICLED AND PASSIVATED, EXCEPT FOR SURFACES TO BE COATED

DO NOT SCALE DRAWING | ALL DIMENSIONS IN MILLIMETRES

0 5 10 SCALE (mm) 100

PROJECTION (U.O.S.)

MOD No	DATE	REVISION DESCRIPTION	SIGN.

DIRECTORATE: MECHANICAL & ELECTRICAL ENGINEERING

TECHNICAL DESIGN SERVICES [signature] 13/6/01 DATE
ENGINEER DATE
CHIEF ENGINEER (Pr.Eng) K. [signature] 13/6/01 DATE
act. DIRECTOR (Pr.Eng) [signature] 13/6/01 DATE

DESIGNED: G. BREED
DRAWN: G. BREED 11-06-2001
CHECKED: [signature] 12/06/01 DATE
CALCULATIONS FILE: ME/ DM ZZZ-03
LOCALITY No. DM ZZZ-03
TENDER No./
CONTRACT No.

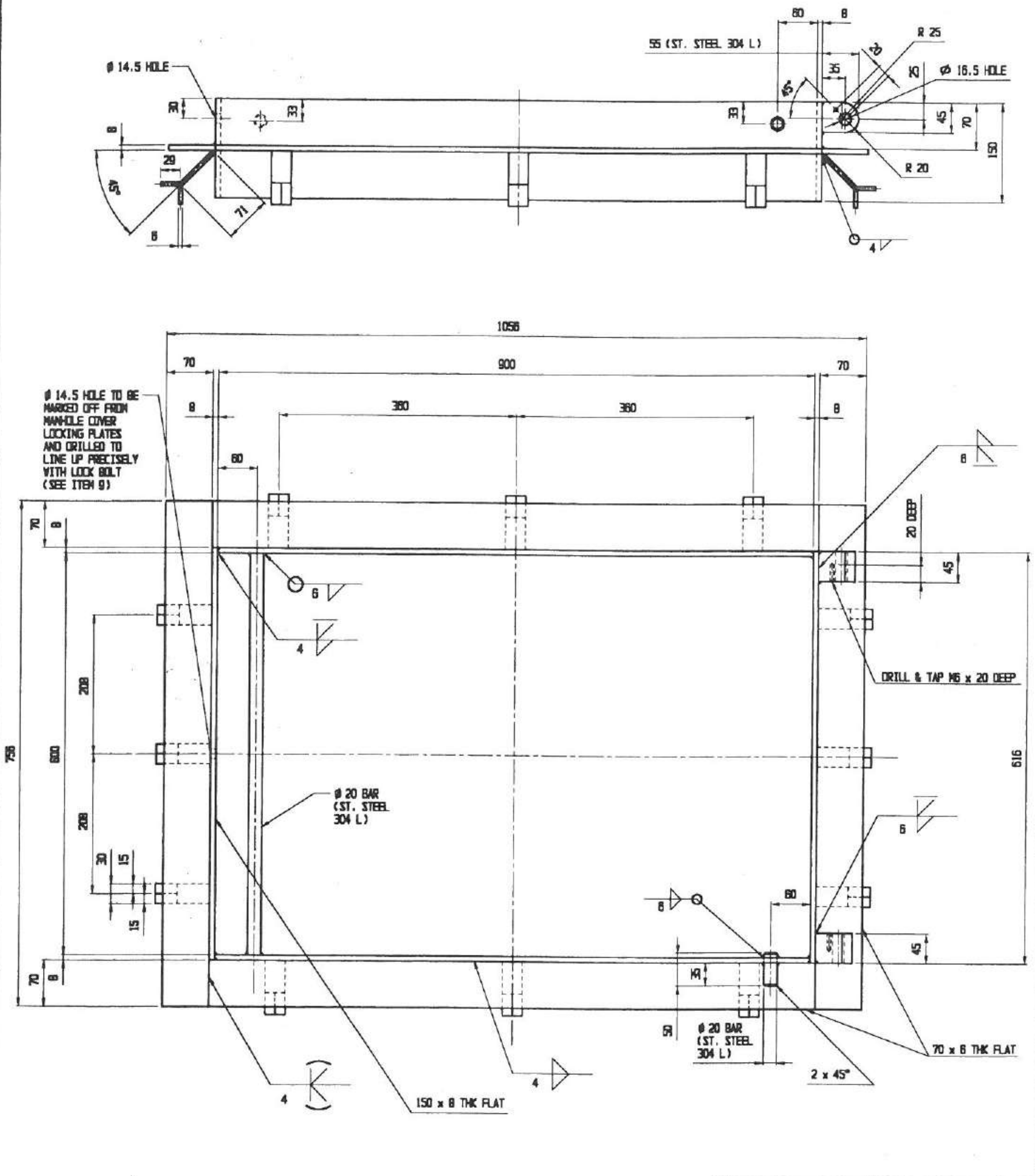
KEY CODES:
TYP
MAN
COV
ASO

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTOR GENERAL: M. MULLER

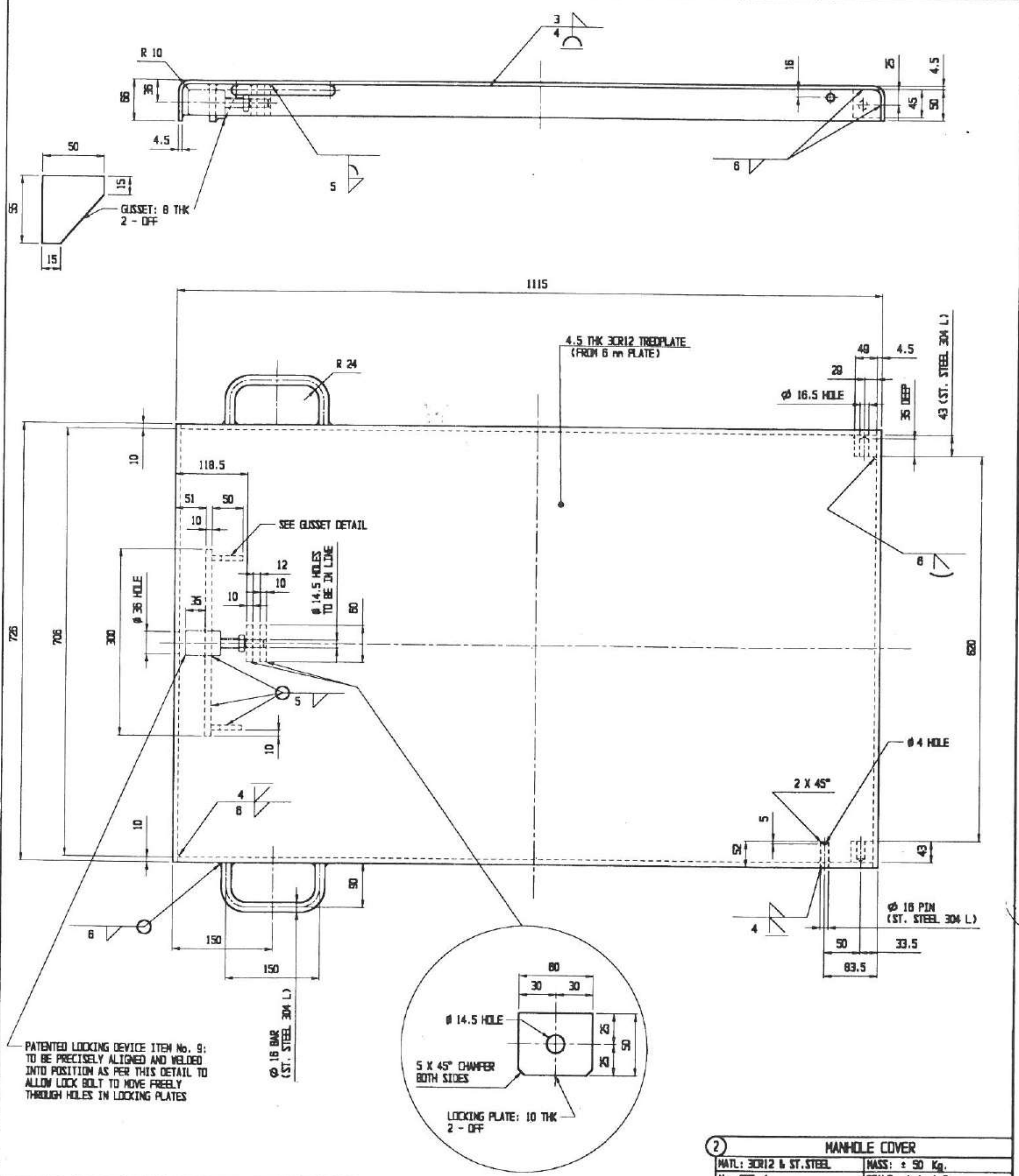
TYPE

TYPE DRAWING:
STANDARD 900 x 600 mm 3CR12 MANHOLE
-ASSEMBLY AND PARTS LIST-

PROVINCE:
DISTRICT:
OTHER No.
SHEET 1 OF 3
REG.No.: 137079/01 ME



① MANHOLE FRAME	
MATL: 3CR12 & ST. STEEL	MASS: ± 85 Kg.
No. OFF: 1	SCALE: 1:4



② MANHOLE COVER	
MATL: 3CR12 & ST.STEEL	MASS: ± 50 Kg.
No. OFF: 1	SCALE: 1:4, 1:2

GENERAL DIMENSIONAL TOLERANCES (U.O.S.)
DIMENSIONS UP TO 500 : ± 1 mm
DIMENSIONS ABOVE 500 TO 1000 : ± 2 mm
DIMENSIONS ABOVE 1000 : ± 3mm
THICKNESS OF MATERIAL- AS MANUFACTURED

WELDING
IDENTICAL WELDS SYMBOLISED ONCE ONLY.
CODED WELDERS TO BE UTILISED FOR WELDING OPERATIONS.

MATERIAL
MATERIAL TO BE 3CR12 No 1 FINISH (U.O.S.)
STAINLESS STEEL TO BE GRADE 304 L

DO NOT SCALE DRAWING

SURFACE PROTECTION: SEE DRG. REG. No.137079/01 ME

ALL DIMENSIONS IN MILLIMETRES

0 5 10 SCALE (mm) 100

PROJECTION (U.O.S.)

REMOVE ALL SHARP EDGES

REVISION			
MOD No	DATE	DESCRIPTION	SIGN.

DIRECTORATE: MECHANICAL & ELECTRICAL ENGINEERING

TECHNICAL DESIGN SERVICES 13/6/01 DATE	DESIGNED: G. BREED
	DRAWN: G. BREED 11-06-2001
ENGINEER DATE	CHECKED: 12/6/01 DATE
K. [signature] 13/6/01 CHIEF ENGINEER (Pr.Eng) DATE	CALCULATIONS FILE: ME/ DM ZZZ-03
	LOCALITY No. DM ZZZ-03
a.d. 13/6/01. DIRECTOR (Pr.Eng) DATE	TENDER No./ CONTRACT No.

KEY CODES: TYP, MAN, COV, DET

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY

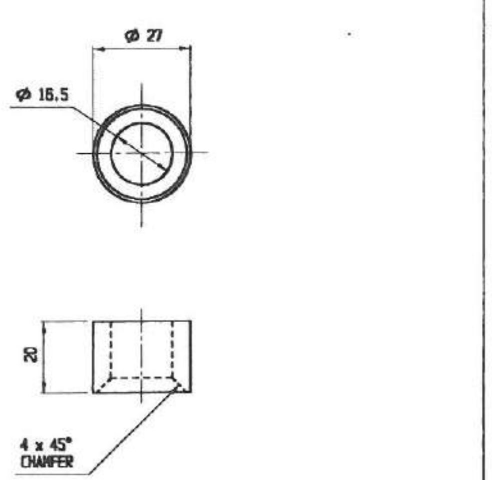
TYPE

TYPE DRAWING:

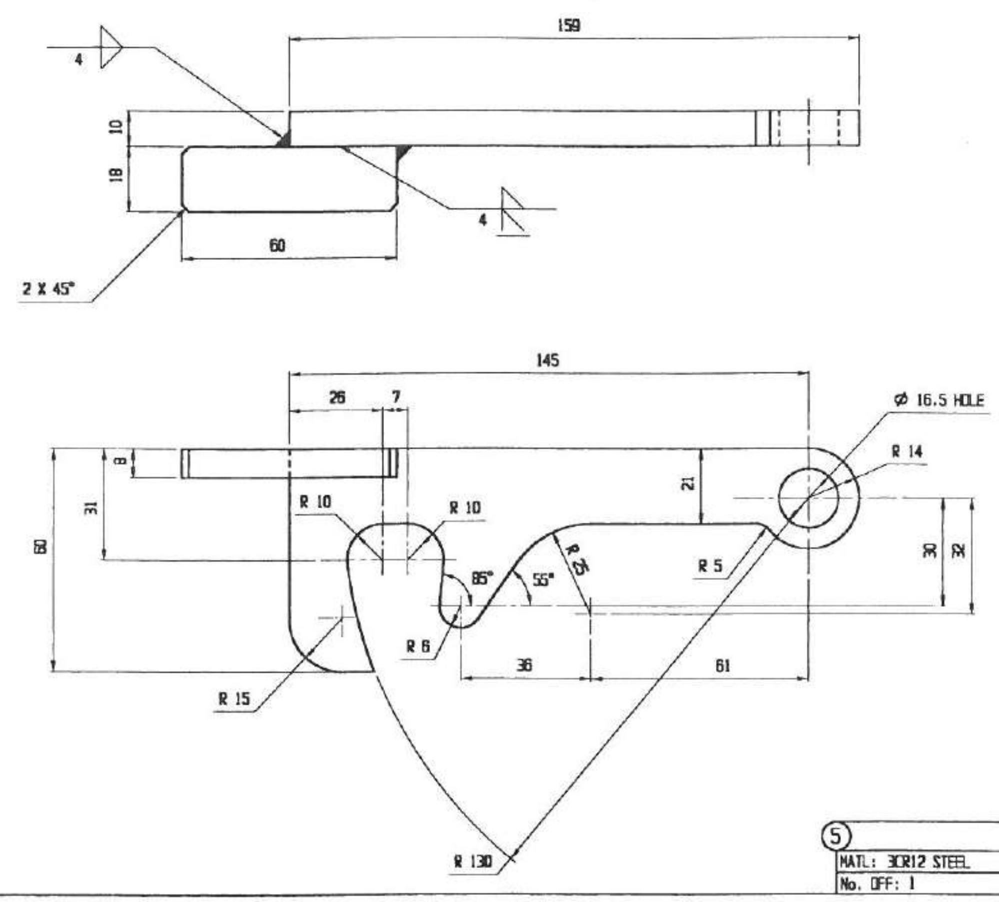
STANDARD 800 x 600 mm 3CR12 STEEL MANHOLE
-DETAILS OF FRAME AND COVER-

PROVINCE:		DISTRICT:
OTHER No.	SHEET 2 OF 3	REG.No.: 137080/01 ME

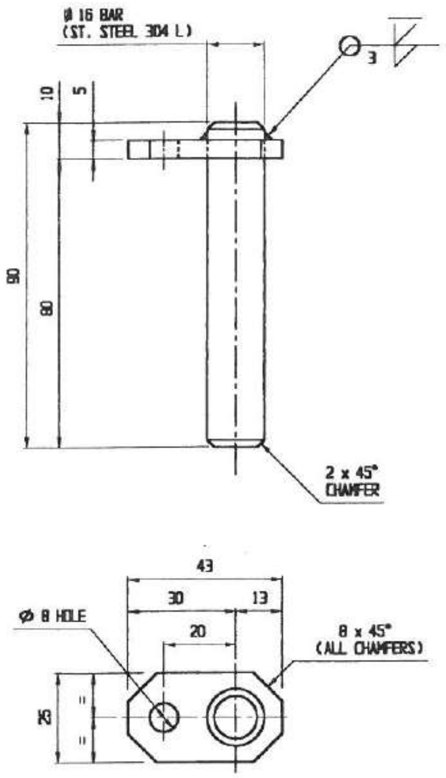
VERMIKROFILM MICROFILMED



③ SPACER	
MATL: ST.STEEL 304 L	MASS: ± 0.05 Kg.
No. OFF: 1	SCALE: 1:1



⑤ LOCKING DEVICE	
MATL: 3CR12 STEEL	MASS: ± 0,4 Kg.
No. OFF: 1	SCALE: 1:1



④ PIN	
MATL: STAINLESS STEEL 304 L	MASS: ± 0.2 Kg.(EA)
No. OFF: 2	SCALE: 1:1

GENERAL DIMENSIONAL TOLERANCES (U.O.S.)
DIMENSIONS UP TO 500 : ± 1 mm
DIMENSIONS ABOVE 500 TO 1000 : ± 2 mm
DIMENSIONS ABOVE 1000 : ± 3mm
THICKNESS OF MATERIAL- AS MANUFACTURED

WELDING
IDENTICAL WELDS SYMBOLISED ONCE ONLY
CODED WELDERS TO BE UTILISED FOR WELDING OPERATIONS.

MATERIAL
MATERIAL TO BE 3CR12 No 1 FINISH (U.O.S.)
STAINLESS STEEL TO BE GRADE 304 L

DO NOT SCALE DRAWING

SURFACE PROTECTION: SEE DRG REG No 137079/01 ME

ALL DIMENSIONS IN MILLIMETRES

0 5 10 SCALE (mm) 100

PROJECTION (U.O.S.)

REMOVE ALL SHARP EDGES

REVISION			
MOD No	DATE	DESCRIPTION	SIGN.

DIRECTORATE: MECHANICAL & ELECTRICAL ENGINEERING

TECHNICAL DESIGN SERVICES [signature] 13/6/01 DATE	DESIGNED: G. BREED
	DRAWN: G. BREED 11-06-2001
ENGINEER DATE	CHECKED: [signature] 12/06/01 DATE
K. [signature] 13/6/01 CHIEF ENGINEER (Pr.Eng) DATE	CALCULATIONS FILE: ME/ DM ZZZ-03
	LOCALITY No. DM ZZZ-03
ad. [signature] 13/6/01 DIRECTOR (Pr.Eng) DATE	TENDER No./ CONTRACT No.

KEY CODES: TYP / MAN / CON / DET

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DIRECTOR GENERAL: M. MULLER

TYPE

TYPE DRAWING:
STANDARD 900 x 600 mm 3CR12 STEEL MANHOLE
-DETAILS OF PARTS-

PROVINCE:		DISTRICT:
OTHER No.	SHEET 3 OF 3	REG.No.: 137081/01 ME

PART INSIDE ELEVATION OF FENCE

SCALE 1:20

PLAN OF FENCE

SCALE 1:20

CONCRETE GRADES:

1. GATE-THRESHOLD: 30/38.
2. POST-FOOTINGS: 15/19.
3. STAY: 15/19.
4. KERBING: 15/19.

SCALE 1:20 (0 — 0,5 — 1 — 1,5 — 2 — 4 m)

SHEET	DESCRIPTION	OTHER No.	REG. No.
4/4	3 m FENCE: MATERIALS LIST		167 769/13
3/4	3 m FENCE: DETAILS		167 768/13
2/4	3 m FENCE: HINGED GATE		167 767/13

LIST OF DRAWINGS

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL ENGINEERING
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 SCHOEMAN STREET
PRETORIA
(012) 336-7500

M. SIRENYA
DIRECTOR GENERAL

DESIGN: J.C. SWANEPOEL
DRAWN: J.C. SWANEPOEL
CHECKED: DATE:
ENGINEER: DATE:
EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE:
DIRECTOR (Pr. Eng): DATE:

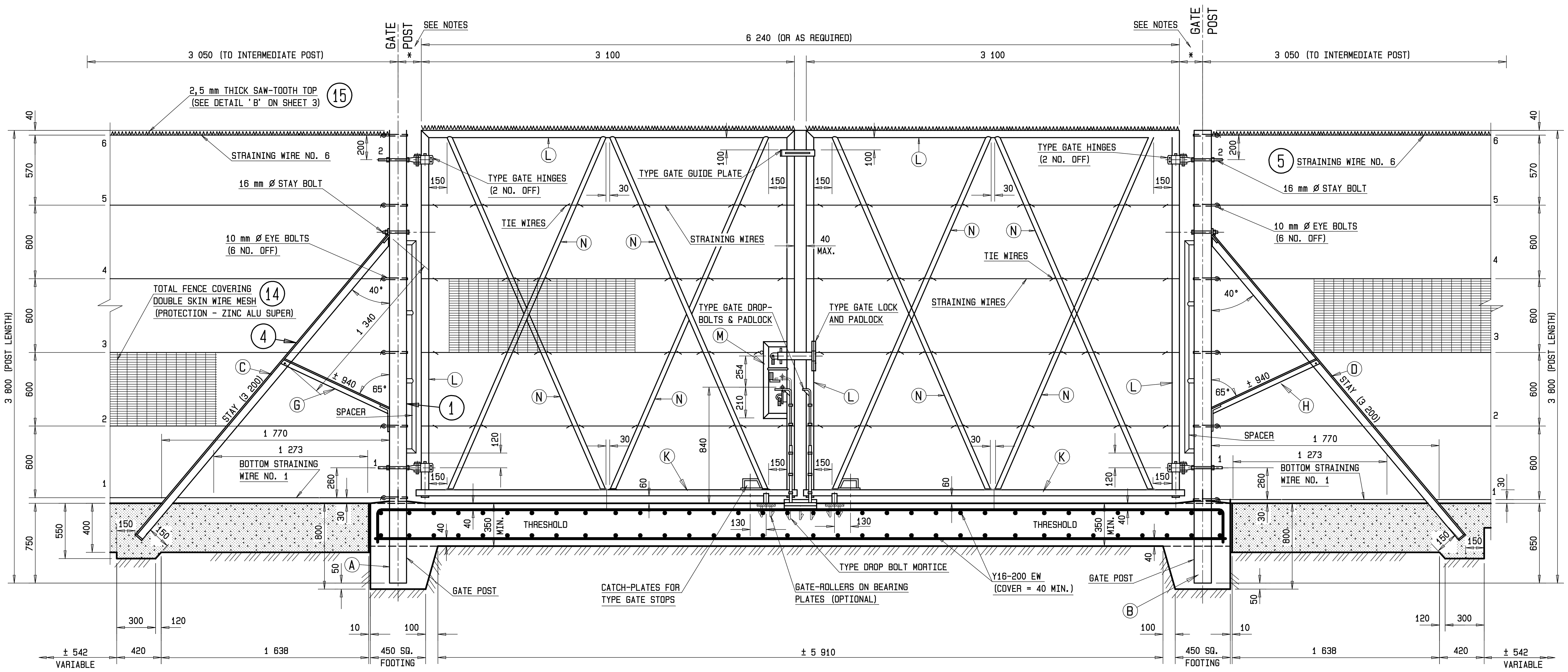
TYPE

TYPE DRAWING:

3 m HIGH FENCE FOR
IMPORTANT WORKS

PROVINCE: | DISTRICT: | KEYCODES: TYP : FDG : SER : - : - | OTHER NUMBER
LOCALITY No.: ZZZZ-03 | TENDER/CONTRACT No.: -
CALCULATION FILE: ZZZZ-03

SHEET 1 OF 4 | REG. No. 167 766/13 | REV. 00

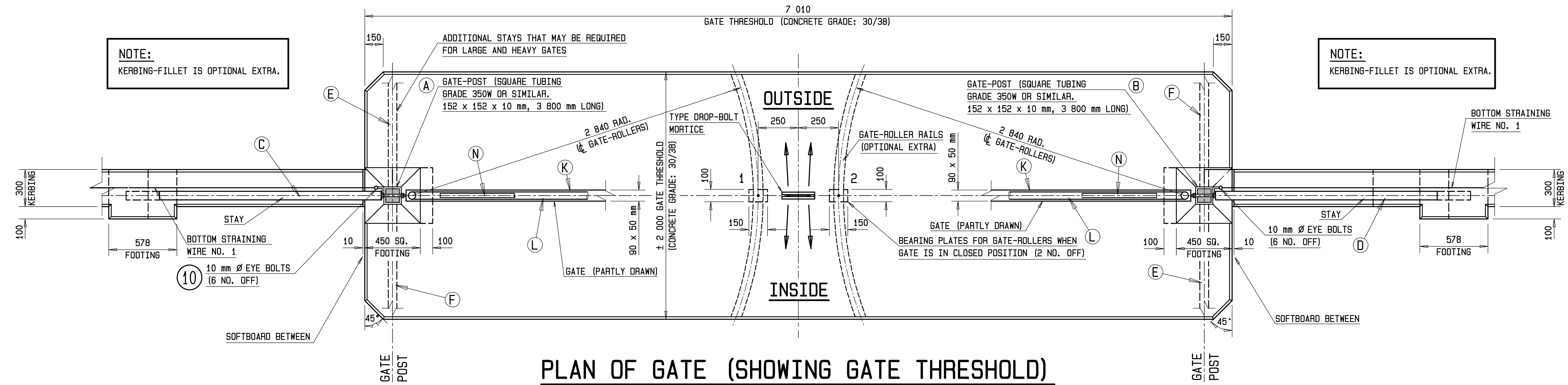


INSIDE ELEVATION OF GATE

SCALE 1:20

NOTE:
THE HEIGHT OF THE GATE SHALL MATCH THE HEIGHT OF THE ADJOINING FENCE (AS SHOWN ON DRAWING).

NOTE:
KERBING-FILLET IS OPTIONAL EXTRA.



NOTE:
KERBING-FILLET IS OPTIONAL EXTRA.

PLAN OF GATE (SHOWING GATE THRESHOLD)

SCALE 1:20

NOTES:

1. THE DIMENSION MARKED THUS * WILL VARY DEPENDING ON TYPE OF GATE-HINGE USED.
2. THE GATE & FENCE-FITTINGS AS SHOWN ON THIS PLAN ARE TYPICAL DESIGNS ONLY.
3. SEE NOTES AND MATERIAL LIST ON SHEET 8.

GATE-POST AND GATE-FRAME PIPE SCHEDULE

PART & REF. NO.	NOMINAL O. DIA. mm	NOM. WALL THICKNESS mm	MATERIAL
GATE-POSTS (A) AND (B) L.H. R.H.	152 x 152	10	SQUARE STEEL TUBING (GRADE 350W OR SIMILAR)
POST-STAYS (C) AND (D) L.H. R.H. (E) AND (F) L.H. R.H.	70 x 70	10	MILD STEEL ANGLE
STAY BRACINGS (G) AND (H) L.H. R.H.	50 x 50	8	MILD STEEL ANGLE
(K) MAIN FRAME	90 x 50	5	SQUARE STEEL TUBING (GRADE 350W OR SIMILAR)
(L) MAIN FRAME	0,DIA. 60 mm	5 mm	STRUCTURAL AND GENERAL ENGINEERING MILD STEEL TUBING
(M) MAIN FRAME	0,DIA. 42 mm	4 mm	
(N) FRAME BRACINGS	0,DIA. 34 mm	3,2 mm	

CONCRETE GRADES:

1. GATE-THRESHOLD: 30/38.
2. POST-FOOTINGS: 15/19.
3. STAY: 15/19.
4. KERBING: 15/19.

SECTION

07 SECTION NUMBER
3 SHEET NUMBER

SHEET	DESCRIPTION	OTHER No.	REG. No.
4/4	3 m FENCE: MATERIALS LIST		167 769/13
3/4	3 m FENCE: DETAILS		167 768/13
1/4	3 m FENCE FOR IMPORTANT WORKS		167 766/13

LIST OF DRAWINGS

REVISION				
MOD No.	DATE	DESCRIPTION	FOR	DWA

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REPUBLIC OF SOUTH AFRICA

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PRETORIA 0001

SEDIBENG BUILDING
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PRETORIA
(012) 336-7500

M. SIRENYA
DIRECTOR GENERAL

DESIGN: J.C. SWANEPOEL
DRAWN: J.C. SWANEPOEL
CHECKED: DATE:
ENGINEER: DATE:
EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE:
DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING:

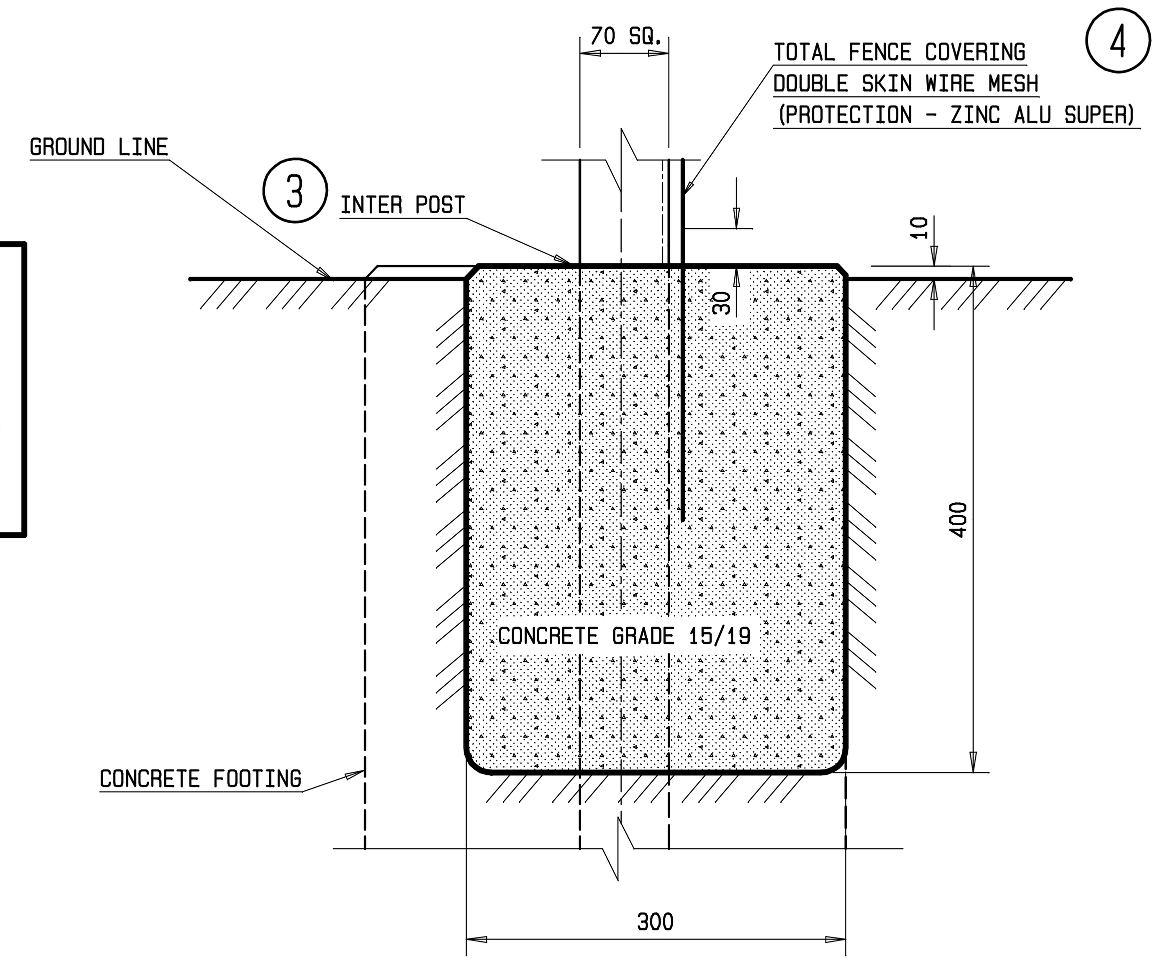
3 m HIGH FENCE FOR IMPORTANT WORKS
HINGED GATE

PROVINCE:
DISTRICT:
KEYCODES: TYP FDG SER - -
OTHER NUMBER
LOCALITY No.: ZZZZ-03
TENDER/CONTRACT No. -
CALCULATION FILE: ZZZZ-03
SHEET 2 OF 4
REG. No. 167 767/13
REV. 00

SCALE 1:20 0 0,5 1 1,5 2 4 m

NOTE:

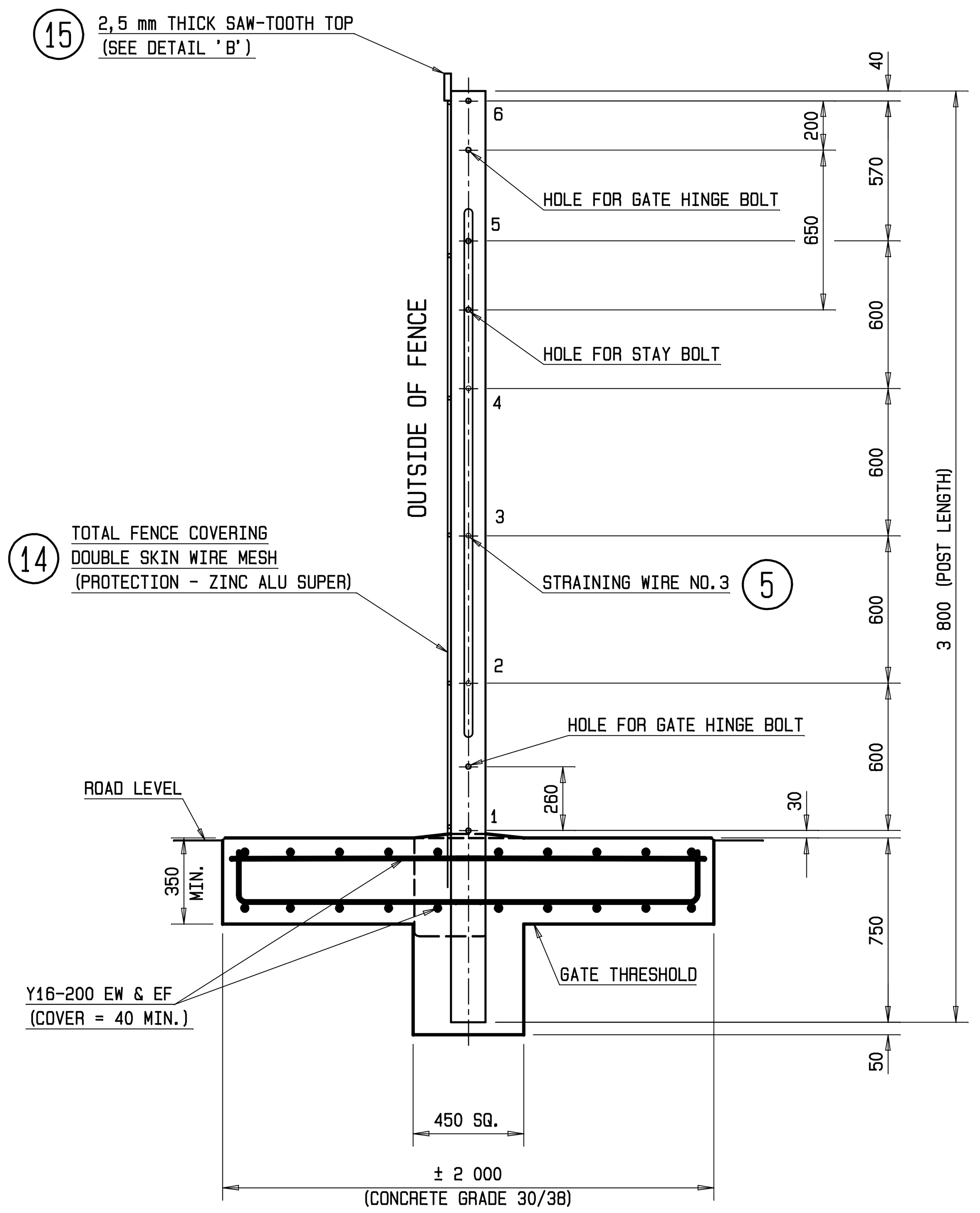
KERBING CONCRETE, 15/19 MPA AT 28 DAYS CAST IN SITU BETWEEN POST-FOOTINGS & FINISHED 10 mm ABOVE GROUND LEVEL AS SHOWN.



SECTION 01-01 INNER FENCE

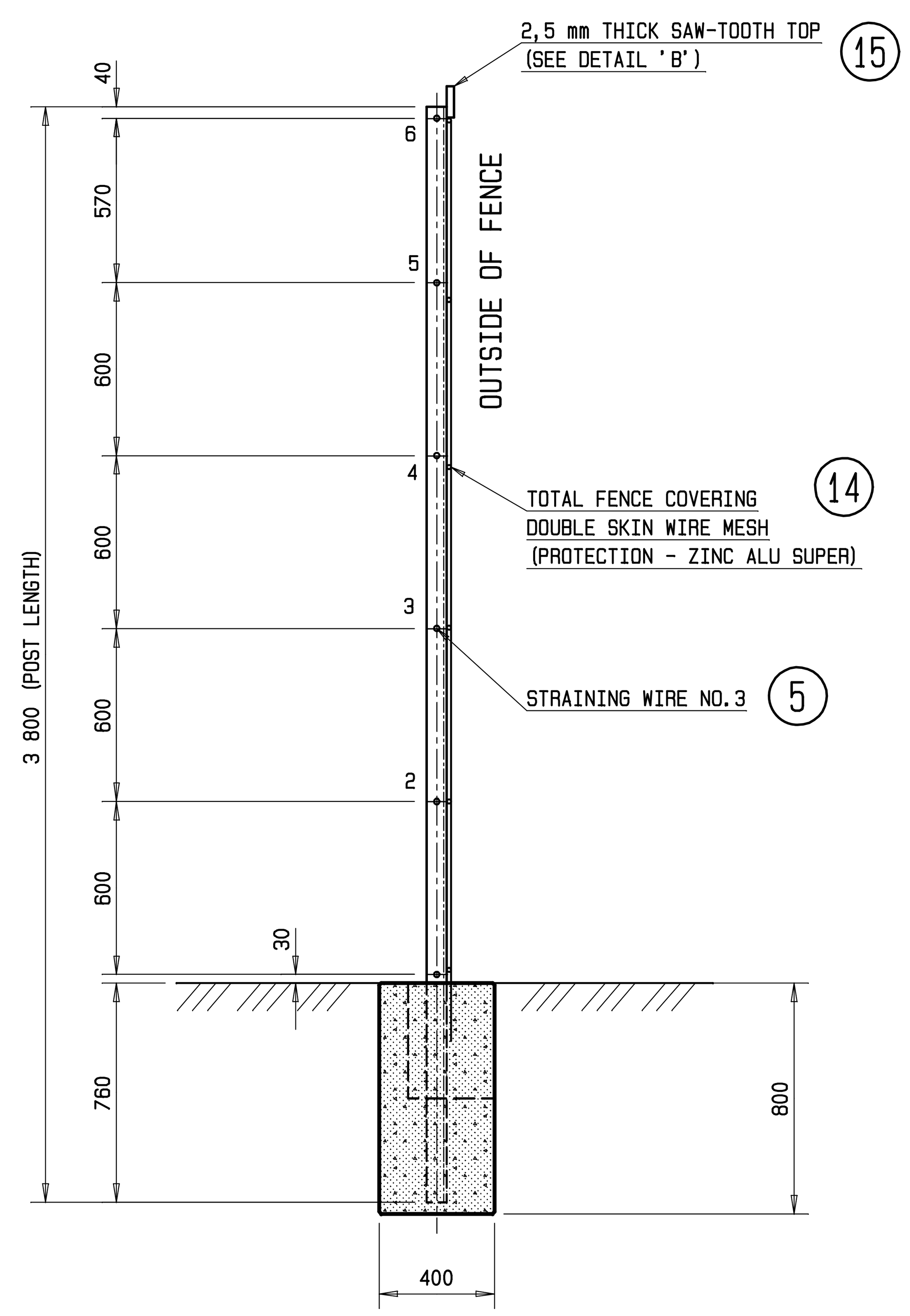
KERBING DETAILS

SCALE 1:5



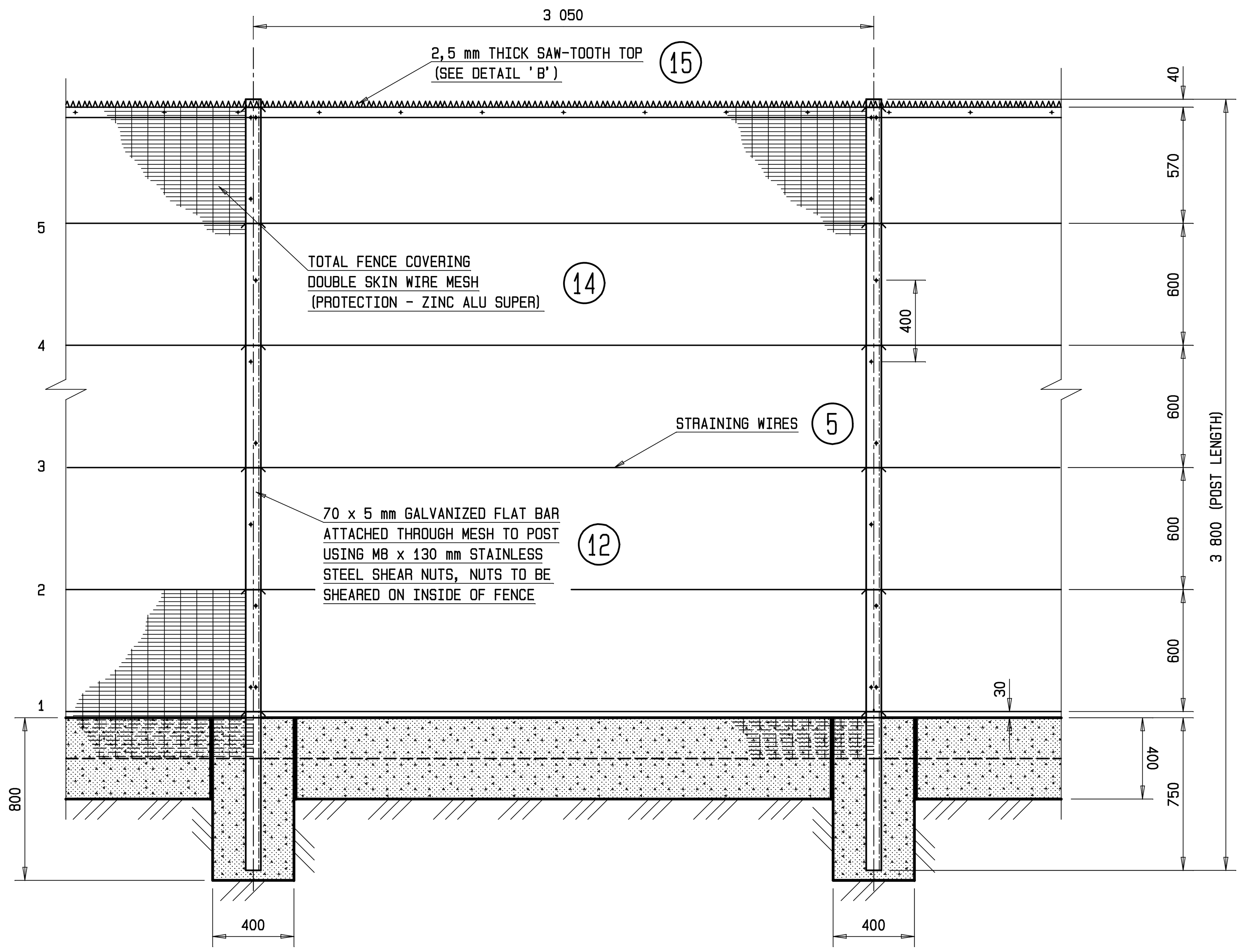
SECTION 02-02 GATE POST (INNER FENCE)

SCALE 1:20



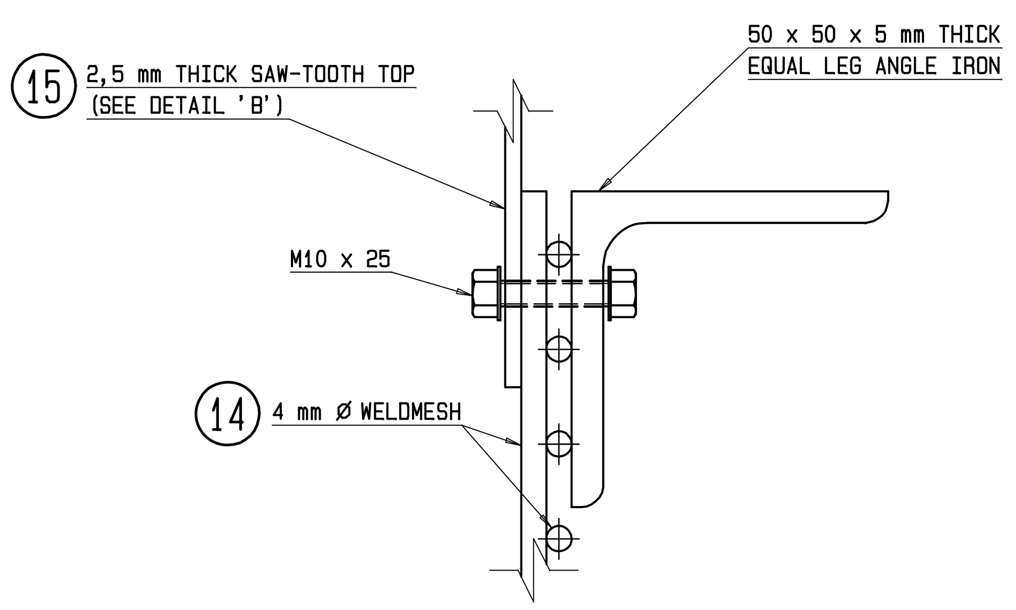
SECTION 03-03 INTER POST (INNER FENCE)

SCALE 1:20



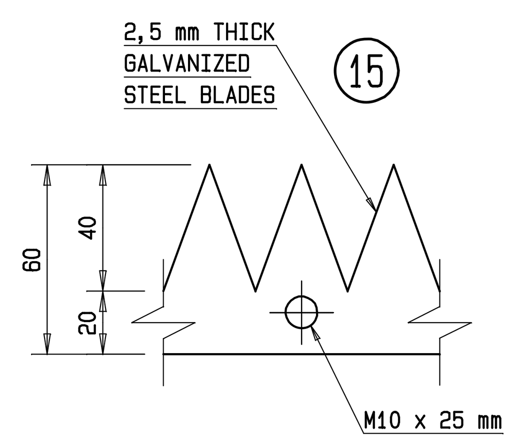
TYPICAL WELDED MESH PANEL FENCE INNER FENCE
HORIZONTAL INSTALLATION

SCALE 1:20



TOP RAIL DETAIL

SCALE 1:1



DETAIL 'B'

(SAW-TOOTH TOP)

SCALE 1:2

CONCRETE GRADES:

1. GATE-TRESHOLD: 30/38.
2. POST-FOOTINGS: 15/19.
3. STAY-FOOTINGS: 15/19.
4. KERBING: 15/19.

SCALE 1:1 — 0, 0,01, 0,02, 0,03, 0,04, 0,05, 0,1, 0,2 m

SCALE 1:2 — 0, 0,05, 0,1, 0,15, 0,2, 0,4 m

SCALE 1:5 — 0, 0,05, 0,1, 0,2, 0,3, 0,4, 0,5, 1 m

SCALE 1:20 — 0, 0,5, 1, 1,5, 2, 4 m

SHEET	DESCRIPTION	OTHER No.	REG. No.
4/4	3 m FENCE: MATERIALS LIST		167 769/13
2/4	3 m FENCE: HINGED GATE		167 767/13
1/4	3 m FENCE FOR IMPORTANT WORKS		167 766/13

LIST OF DRAWINGS

REVISION				
MOD No.	DATE	DESCRIPTION	FOR	DWA

DEPARTMENT OF WATER AFFAIRS
REPUBLIC OF SOUTH AFRICA

HEAD OFFICE
CIVIL ENGINEERING
PRIVATE BAG X313
PRETORIA 0001

SEDIBENG BUILDING
185 SCHOEMAN STREET
PRETORIA
(012) 336-7500

M. SIRENYA
DIRECTOR GENERAL

CHECKED: DATE:	DESIGN: J.C. SWANEPOEL
	DRAWN: J.C. SWANEPOEL
ENGINEER: DATE:	EXTERNAL APPROVAL: DATE:
CHIEF ENGINEER / APP (Pr. Eng): DATE:	DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING:
3 m HIGH FENCE FOR IMPORTANT WORKS
DETAILS

PROVINCE:	DISTRICT:	KEYCODES: TYP FDG SER - -	OTHER NUMBER
LOCALITY No.: ZZZZ-03	TENDER/ CONTRACT No. -	SHEET 3 OF 4	REG. No. 167 768/13
CALCULATION FILE: ZZZZ-03			REV. 00

NOTES:

1. THE POSTS AND STAYS SHALL BE DESIGNED AND MANUFACTURED BY THE TENDERER.

2. 3 m HIGH MESH TO BE SECURIFOR 358 DOUBLESKIN OR EQUAL. MESH TO BE EFFECTIVELY CORROSION PROTECTED USING A ZINC-ALU COATING.

2. STRAINING WIRES, BARBED WIRES, TIE WIRES AND ALL THE OTHER MILD STEEL PARTS MUST BE EFFECTIVELY PROTECTED FROM CORROSION BY A ZINC-COATING (CLASS A OR B), BY HOT-DIP GALVANIZING.
FOR INLAND AREAS A CLASS 'B' COATING MUST BE SPECIFIED BUT FOR COASTAL AREAS (OR INDUSTRIAL AREAS WHERE THE LEVEL OF POLLUTION IS HIGH) A CLASS 'A' COATING IS RECOMMENDED, OR OTHERWISE A CLASS 'B' COATING PROTECTED BY AN APPROVED PLASTIC COATING.
WHERE THE ZINC-COATING HAS BEEN DAMAGED IN HANDLING SUCH DAMAGE MUST BE MADE GOOD BY MEANS OF COLD GALVANIZING.

MATERIAL LIST

ITEM NO.	DESCRIPTION
	POST AND STAYS FOR 3 m HIGH FENCE
1	GATE POST: SQUARE STEEL TUBING (GRADE 350W OR SIMILAR). 152 x 152 x 10 mm x 3 800 mm LONG, COMPLETE WITH THE NECESSARY FITTINGS. HOT-DIP GALVANIZED (CLASS A). THE POST SHALL BE CAPPED AS SHOWN AND GROUT-FILLED IN IT'S ERECTED POSITION. THIS WILL PREVENT WATER ACCUMULATING IN THE SECTION.
2	INTER-STRAINING-POST, CORNER-POST AND END-POST: MILD STEEL ANGLE. 120 x 120 x 15 mm x 3 800 mm LONG, COMPLETE WITH THE NECESSARY FITTINGS. HOT-DIP GALVANIZED (CLASS A).
3	INTER-POST: MILD STEEL ANGLE 70 x 70 x 10 mm x 3 800 mm LONG, HOT-DIP GALVANIZED (CLASS A).
4	POST-STAYS: MILD STEEL ANGLE 70 x 70 x 10 mm x 3 800 mm LONG, COMPLETE WITH THE NECESSARY FITTINGS. HOT-DIP GALVANIZED (CLASS A).
5	STRAINING WIRE: HIGH TENSILE WIRE, GAUGE NO. 8 MIN. HOT-DIP GALVANIZED (CLASS A). THE WIRE TO BE FREE FROM IMPERFECTIONS AND MUST COMPLY WITH SANS 675. BOTTOM STRAINING-WIRE OF FENCE TO BE THREADED THROUGH THE EYES OF THE STAPLES IN THE KERB CONCRETE.
6	TIE-WIRE: (STRAINING-WIRE TO INTER-POST) 3,0 mm DIA. HOT-DIP GALVANIZED (CLASS A).
7	TIE-WIRE: (WELDED MESH TO STRAINING WIRE) 1,60 mm DIA. HOT-DIP GALVANIZED (CLASS A). (TIE-WIRES TO COMPLY WITH SANS 675).
8	STAPLES: 8 mm DIA. 150 mm LONG. HOT-DIP GALVANIZED. PRESSED INTO THE WET KERB-CONCRETE.
9	BOLTS AND NUTS: STAINLESS STEEL OR MILD STEEL GALVANIZED TO SANS 135/6 SPECIFICATIONS.
10	EYE BOLTS: 10 mm DIA. (MILD STEEL) THAT MAY BE WELDED TO POSTS BEFORE POST GALVANIZING. NB: NO DRILLING, CUTTING OR WELDING SHALL BE CARRIED OUT ON MILD STEEL PARTS AFTER GALVANIZING. ALL MILD STEEL PARTS MUST BE CORRECTLY CUT, DRILLED AND WELDED BEFORE GALVANIZING.
11	THE CONCRETE-FILLET OF THE KERBING IS OPTIONAL IF SPECIFIED.
12	3 m LONG LOCKING BAR, 70 x 5 mm FLAT BAR.
13	50 x 50 x 5 mm EQUAL LEG ANGLE IRON TOP RAIL.
14	MESH FOR FENCE DOUBLE SKIN WIRE MESH - 3,05 m x 3 m HIGH PANEL (PROTECTION - ZINC ALU SUPER) (SANS 10244-2:2004)
15	2,5 mm THICK HOT-DIPPED GALVANISED SAW-TOOTH SPIKE TOPPING.

SHEET	DESCRIPTION	OTHER No.	REG. No.
3/4	3 m FENCE: DETAILS		167 768/13
2/4	3 m FENCE: HINGED GATE		167 767/13
1/4	3 m FENCE FOR IMPORTANT WORKS		167 766/13

LIST OF DRAWINGS

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CHIEF ENGINEER / APP (Pr. Eng): DATE:
DIRECTOR (Pr. Eng): DATE:

TYPE

TYPE DRAWING:

MATERIAL LIST:
3 m HIGH FENCE FOR
IMPORTANT WORK

PROVINCE:
DISTRICT:
KEYCODES: TYP FDG SER - -
OTHER NUMBER
LOCALITY No.: ZZZZ-03
TENDER/ CONTRACT No. -
CALCULATION FILE: ZZZZ-03
SHEET 4 OF 4
REG. No. 167 769/13
REV. 00

Technical Survey Report

Project: TS10117 BERG RIVER VOËLVLEI AUGMENTATION SCHEME, TOPOGRAPHICAL SURVEY

Western Cape
South Africa
Report Number: TS10117.1
21 June 2021

Prepared for:
Bigen Africa Services (Pty) Ltd

PROJECT DESCRIPTION

Tritan Survey (Tritan) was requested to perform a detailed topographical survey, including the immediate weir catchment area, the tail water impact area downstream of the weir and the pipeline route, as well as proclaimed minor roads OP5403, OP5404 and Road DR1145 which will be used to access the weir construction site.

Location and Description of the Survey Site

The site is located Northwest of the Voelvlei Dam, Western Cape

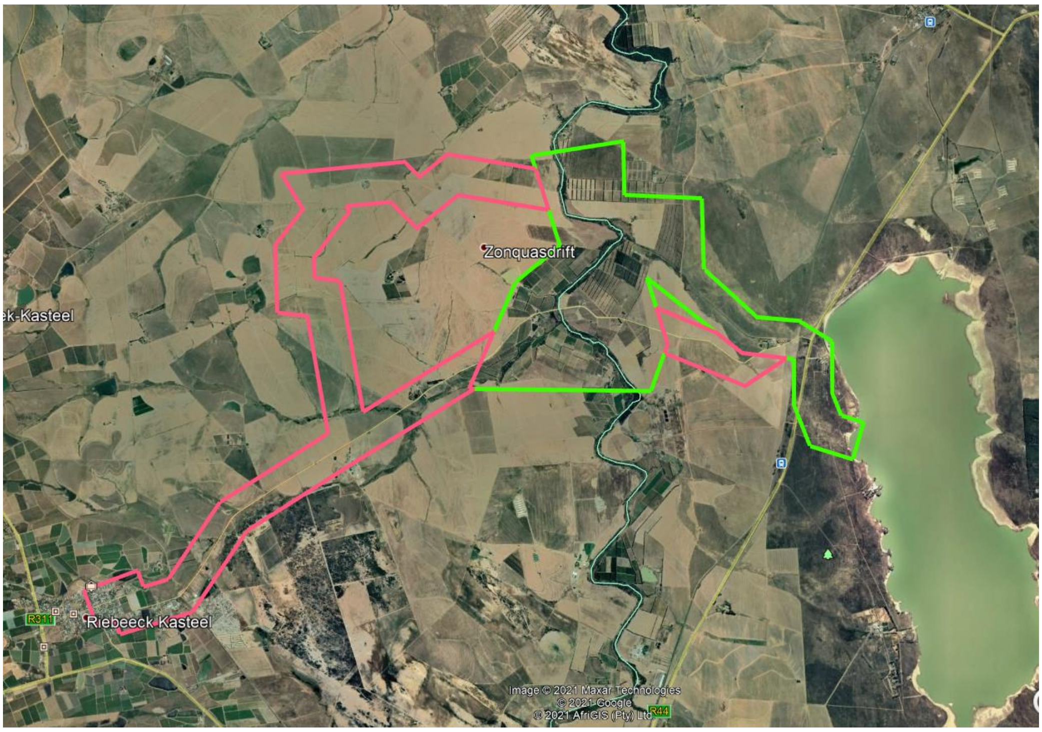


Figure 1: Survey Site Location. ***© Google Earth***

Date and Duration of the Survey

Date	Activity
2021/05/05	Bathymetric Survey
2021/05/05 - 07	Topographical survey, Structure's scanning, Control survey, Ground control for LiDAR and Benchmark construction
2021/05/10	LiDAR Survey
2021/05/17-18	Photogrammetric and LiDAR survey
Various	Calculations, data processing, drafting and reporting.

Surveyors Involved

The survey was conducted by the following Tritan Survey personnel:

Mr James Parkes	-	Professional Land Surveyor
Mr James Christie-Smith	-	Survey Technician
Mr Chris de Wet	-	Surveyor
Mr Paul Higgins	-	Surveyor
Mr Jackson Dyonta	-	Survey Assistant

SURVEY COORDINATE SYSTEM AND CONTROL

Instruments and equipment used:

- Trimble S8 Robotic Totalstation
- Trimble DiNi Level
- Trimble R4 GNSS Receivers

Survey Coordinate System and Control Points

DATUM	: Hartebeesthoek94
ELLIPSOID	: World Geodetic System 1984 (WGS 84)
PROJECTION	: GAUSS CONFORM Lo19
GEOID MODEL	: SA GEOID 2010
CENTRAL MERIDIAN	: 19°00' 00" E
VERTICAL DATUM	: Land Level Datum (LLD), Approximately MSL

The survey is based on the four surrounding Trignet CORS Stations (LGBN, WORC, STBS, MALM) and two Trig Beacons (3319-107 and 3318-383) located on the site. A mean horizontal shift based on all six control points was adopted and all show excellent horizontal agreement. The vertical datums is based on the SA2010 Geoid since there were no precise levelling benchmarks found within a reasonable distance of site. The SA2010 Geoid has typical accuracy 70mm or better and is an order of magnitude better than trig beacon heighting accuracy. Height residuals are shown in grey and are for information only.

	Published Control			Residuals		
	Y	X	Z	dY	dX	dZ
LGBN	78735.71	3650012.23	33.28	0.03	-0.03	0.03
WORC	-41285.09	3724361.64	255.55	-0.05	0.03	0.05
STBS	15117.13	3746438.97	235.51	-0.02	0.02	0.19
MALM	25020.96	3704223.10	129.10	-0.01	-0.01	0.05
3319-107	-2634.16	3692172.44	108.60	0.06	0.01	-0.22
3318-383	7282.85	3690592.53	141.70	-0.01	-0.01	-0.15

BENCHMARK SURVEY

A total of 70 Benchmarks were constructed and surveyed at approximately 500m intervals along both the access routes and pipeline route. Six benchmarks were placed at the weir location. Benchmarks are 16mm round iron pegs in concrete beacons. Two GNSS base stations were logged each day, while a third GNSS rover measured each point for a 3min occupation. Post-processed GNSS baselines were calculated thereafter. The beacons along the pipeline route from the weir to Voelvlei dam were all double run spirit levelled.

BATHYMETRIC SURVEY

A Single-beam echosounder survey (SBES) was conducted to capture the underwater topography of 5.7km of the Berg River. Instruments and equipment used:

- CEEPULSE 200kHz Single-beam echo sounder.
- Trimble R4 GNSS RTK Rover.
- 3m inflatable boat with 15hp outboard motor.
- Valeport Swift SVP (Sound Velocity Profiler)

The SBES system was mobbed on the boat and offsets between the GNSS receiver and SBES transducer were measured and entered into the system. The speed of sound in water was measured (1476m/s) with the SVP and entered into the system to correct depth measurements.

The survey was done over two days, first the portion upstream of the Sonkwasdrift bridge followed by the downstream portion the next day. The water level in the river was low (reading 0.1m on Gauge plate at bridge) for the duration of the survey. Portions of the river were too shallow to navigate and were walked. There was one rapid and one tree blockage both requiring portaging.

STRUCTURE SURVEY

The client requested five structures to be surveyed, four structures on the Berg River and tributaries, and one on the Voelvlei Dam outlet canal weir.

Structure		y	x	Comment
1	Sonkwasdrift Road Bridge	1959.6	3690679.4	
2	Sonkwasdrift Pipe Bridge	1948.6	3690714.3	
3	Drainage furrow pipe culvert	978.6	3689285.4	
4	Tributary	1942.6	3690913.3	No structure
5	Voelvlei Water Treatment Works	-1381.4	3691153.3	Pipe weir outlet to canal

The two bridge structures on the Berg River were laser scanned and 3D modelled. A total of 27 scans were captured and the individual scans were registered using both cloud and planes-based registration methods in Z&F Laser Control. This is a procedure whereby the individual scans are combined into a common reference frame. The combined point cloud was then geo-refenced into the survey control system using 10 scan targets.

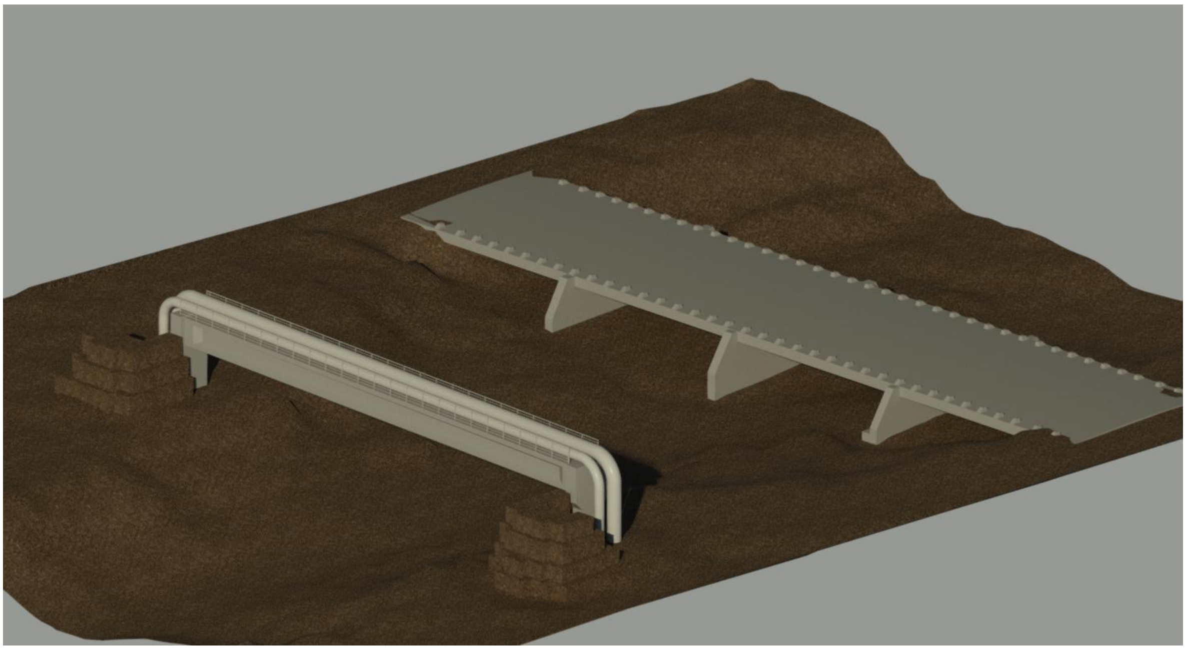


Figure 2: 3D Model of Bridge Structures 1 & 2.

AERIAL SURVEYS

Aerial LiDAR Survey

The LiDAR survey was conducted to accurately map the site. Lidar's ability to penetrate vegetation is critical along the riverbanks to accurately survey the river channel and adjacent floodplain. During the flight on 10th May, the pilot noted a strange engine noise an hour into the flight. The survey was aborted, and the plane returned safely to base with 60% of the survey being completed.

Following maintenance checks the aircraft was remobilised to site on the 18th of May to complete the survey.

Instruments and equipment used:

- Piper Cub Aircraft
- Riegl VUX-1 Lidar with Applanix AP15 INS.
- Trimble R4 GNSS Receiver

Figure 3: LiDAR system

Data Processing

The GNSS base station from each day was logged and downloaded. Flight trajectories were post processed using the logged base data in POSPac and then merged with Lidar data. The entire dataset was then adjusted using RiPRECISION bundle adjustment. During our QC checks, a misalignment between the two lidar missions was encountered, however this was corrected by surveying additional control points and constraining them in the adjustment. The Lidar point cloud was then colourised from the orthophoto and ground classified.

Lidar Ground Truthing

Nine ground truthing test sites were surveyed throughout the site. A small portion of flat open terrain was surveyed with GPS and compared to the Lidar point cloud. See the table below with average differences between GPS checks and Lidar:

Area	Diff (m)	Area	Diff (m)
Area_01	-0.045	Area_06	-0.049
Area_02	-0.021	Area_07	0.053
Area_03	0.125	Area_08	-0.081
Area_04	-0.067	Area_09	0.030
Area_05	-0.048	**Average**	**-0.011**

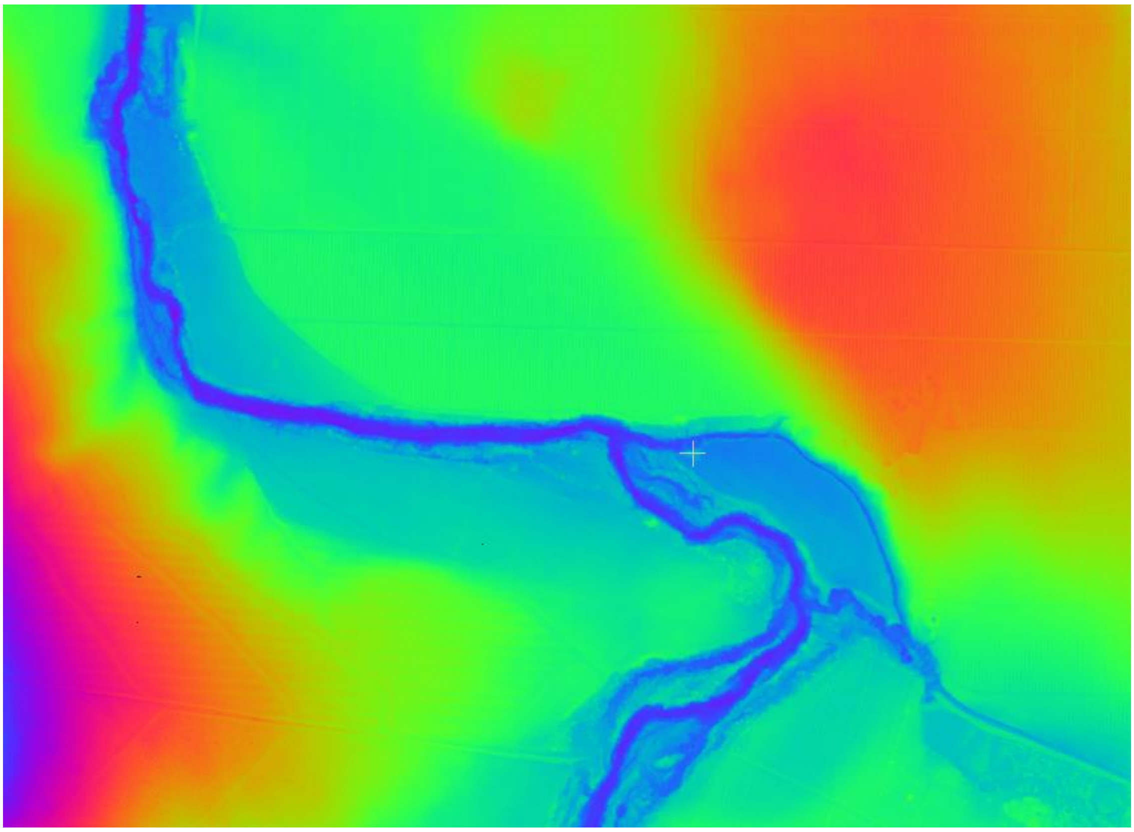


Figure 4: LiDAR height thematic image, showing the weir location and river channel.

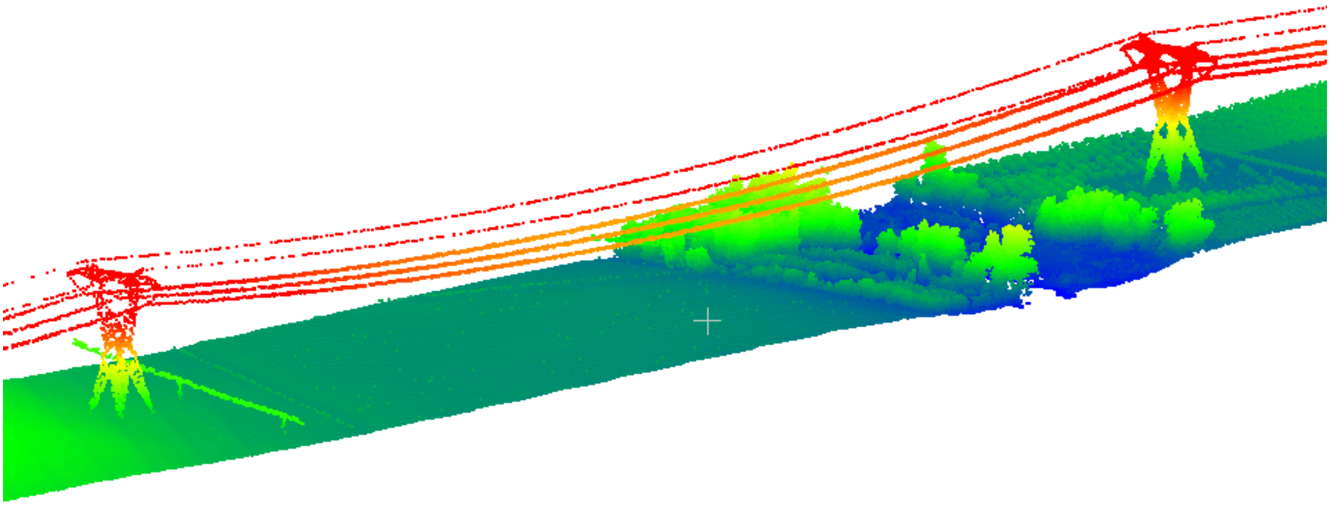


Figure 5: LiDAR point cloud showing large powerline crossing the Berg River.

Aerial Photogrammetric Survey

Following the initial problem of the LiDAR mission on day one we mobilised a second aircraft to site to capture high-resolution imagery of the entire site. This was done to ensure the imagery for the orthophoto was captured in a single flight with constant lighting condition, as well as provide a backup to the Lidar mapping. Only a small portion of the photogrammetry DTM was required for the last 4km of the access road to Riebeek-Kasteel.

Instruments and equipment used:

- Van's RV8 Aircraft
- Phase One iXM-RS150F Camera (150 Megapixels) with RS-90mm lens
- Trimble R4 GNSS Receiver

Figure 6: RV8 aircraft equipped with camera belly pod for the Phase One iXM-RS (150Mpix) camera

The aerial survey was flown at a height of approximately 4000ft Above Ground Level (AGL) resulting in a Ground Sample Distance (GSD) of 5.5cm. A total of 2036 images were acquired at approximately 85% forward-lap and 60% side-lap.

Data Processing

The aerial imagery was processed using Pix4D photogrammetric software package. A total of 12 well distributed Ground Control Points (GCP's) were pre-marked and surveyed before the flight. The GCP's were marked in the imagery and held fixed during processing. Processing results were within expected accuracies of 5cm in horizontal and 10-15cm in vertical. A dense 3D colour point cloud and orthophoto were generated.

RECORDS SUBMITTED

All records have been submitted electronically, containing the following:

Item	Folder	Sub- Folder	Description	Digital Format
0			Technical Survey Report	pdf
01	1	1	2D Line Map	dgn, dwg, kmz
02	1	2	0.5m Contours	dgn, dwg
03	1	3	3D Bridge Model	dgn, dwg
04	1	3	3D Cross Sections	dgn, dwg
05	1	4	Cadastral	dgn, dwg, kmz
06	2	1	SG Diagrams	tif
07	2	2	Title Deeds	pdf
08	2	0	Farm List	pdf, xls
09	3	1	LiDAR Point Cloud	las
10	3	2	Photogrammetric Point Cloud	las
11	3	3	Bathymetric SBES Points	csv
12	3	4	Merged Model 1m Grid DTM	las
13	4	0	Orthophoto	ecw
14	5	1	Control Co-ordinate List	xls
15			Topo Survey of Water Treatment Works - additional	

CONCLUSION AND RECOMMENDATIONS

The survey project has been successfully completed with the topography accurately captured within the survey extents.

James Parkes

Professional Land Surveyor

Date: June 2021

On behalf of Tritan Survey.

TRANS-CALEDON TUNNEL AUTHORITY

CONSULTING SERVICES FOR THE BERG RIVER VOELVLEI AUGMENTATION SCHEME (BRVAS)

CONTRACT No. TCTA 21-041

DIVERSION WEIR CONCEPT DESIGN

8 DECEMBER 2021

AMANZI ENTABA JOINT VENTURE

Report No: 1A-R-211-08 (Rev B)

CONSULTING SERVICES FOR THE BERG RIVER VOELVLEI AUGMENTATION SCHEME (BRVAS)

CONTRACT NO. TCTA 21-041

DOCUMENT CONTROL SHEET

Report No : **1A-R-211-08 (Rev B)**

Title : **DIVERSION WEIR CONCEPT DESIGN**

Rev No	**Date of Issue**	**Originator**		**Checked**		**Approved**		**Description**
		Initials	Signature	Initials	Signature	Initials	Signature	
A	13 Dec 2021	FdL		PG		CM		Issued for comments

CONSULTING SERVICES FOR THE BERG RIVER VOELVLEI AUGMENTATION SCHEME (BRVAS)

CONTRACT NO. TCTA 21-041

DIVERSION WEIR CONCEPT DESIGN

TABLE OF CONTENTS

List of Annexures

Annexure A: Conceptual Design Drawings

Tables

Figures

CONSULTING SERVICES FOR THE BERG RIVER-VOELVLEI AUGMENTATION SCHEME (BRVAS)

DIVERSION WEIR CONCEPT DESIGN

ABBREVIATION AND ACRONYMS

AEJV	Amanzi Entaba Joint Venture
AI	Aggressiveness Index
BRVAS	Berg River Voëlvlei Augmentation Scheme
CCPP	Calcium Carbonate Precipitation Potential
CCT	City of Cape Town
dia	diameter
DN	Nominal Diameter
D/t	Diameter (D) divided by pipe wall thickness (t)
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EWRs	Environmental Water Requirements
GRP	Glass-fibre reinforced polyester
h	hours
HDPE	High-Density Polyethylene
JV	Joint Venture
km	kilometre
m	meter
m asl	meter above sea level
m^3/s	cubic meters per second
m/s	metre per second
M&E	Mechanical and Electrical
NDU	Natural Drainage Unit
NERSA	National Energy Regulator of South Africa
O&M	Operation and Maintenance
PV	Present Value
PDBC	Plant and Design Build Contract
RID	Record of Implementation Decision
TCTA	Trans-Caledon Tunnel Authority

WCWSS	Western Cape Water Supply System

1. INTRODUCTION

1.1. Scope

The Berg River Voëlvlei Augmentation Scheme (BRVAS) Inception Report (Report No. 1A - R - 2112 - 01 (Rev B) dated 22 April 2021 has reference. During the review of the available Feasibility Study and related documentation, a number of shortcomings and gaps in the feasibility designs were identified and recorded in the Inception Report. A proposal to develop the feasibility designs to a higher level of detail, to address shortcomings and gaps related to the Diversion Weir, was submitted to TCTA on 26 April 2021 (AEJV letter ref. 3177-00-00/1 (AEJV-TCTA-L033). TCTA accepted the proposal on 29 April 2021 (TCTA letter ref. AEJV 023-290421).

The objective of this report is to give guidance to the contractor/designer regarding important aspects to be considered in the design of the weir. The report will address the following aspects:

a) Draw attention to relevant results that emerged from the Physical Model Study;

b) Bring to attention the critical findings from the Physical Model Study of the Temporary River Diversion Works;

c) Highlight various factors, as listed below, that influence the design of the Weir.

- Topography
- Geotechnical and Geological conditions
- Flood hydrology
- River hydraulics
- Hydrodynamic movement of sediment
- Flow measurement requirements
- Constructability
- River diversion during construction; and
- Safety of Dams in terms of Regulation R.139 of Section 123(1) of the National Water Act, 1998 (Act 36 of 1998).

The abovementioned inputs into the design of the Weir and Earth-fill Embankment are discussed in more detail in the reports listed in Section 1.2

1.2. Background and Relevant Documentation

Geotechnical Investigation – A detailed geotechnical and geophysical investigations for the weir and abstraction works was carried out from July to October 2021. The investigation by Applied Scientific Services and Technologies (ASST) is set out in *Report to Mukona on Geophysical Investigations for the BRVAS Project* and forms part of the Geotechnical Investigation by Mukona Consulting Engineers (Pty) Ltd.

Flood hydrology – The preliminary study of ASP (May 2012) titled *Hydraulic Design of the proposed Berg River Abstraction Works at Voëlvlei Dam*, derived flood peaks for the BRVAS site but the probabilistic flood hydrology analysis had to be updated with more recent data and allowance for climate change. This is described in Appendix C of the report titled *Berg River Voëlvlei Augmentation Scheme (BRVAS) River Abstraction Works and Weir - Hydraulic Model Study* (August 2021). The hydrological results for flood events with average recurrence intervals of 2 to 100-years (or annual exceedance probabilities ranging from 1% to 50%), as well as for the Regional Maximum Flood (RMF) informs the river hydraulic analyses.

River hydraulic analyses – The floodlines for the 50-year and 100-year floods with future climate change impact as well as proposed expropriation lines upstream of the proposed abstraction works and weir, is described in Appendix F of the report titled *Berg River Voëlvlei Augmentation Scheme (BRVAS) River Abstraction Works and Weir - Hydraulic Model Study* (August 2021).

The flood levels are required:

i. as input into the sediment transport model study;
ii. to determine the non-overspill crest level of the earth-fill embankment on the right flank of the weir;
iii. to determine the top floor level of the pumping station;
iv. to perform buoyancy stability calculations for the pumphouse;
v. to position the access road to the abstraction works;
vi. to determine the crest height of the river diversion works; and
vii. to determine inundation and high flood lines and land acquisition and compensation areas upstream of the weir.

Hydrodynamic Modelling – The preliminary study of ASP (May 2012) titled *Hydraulic Design of the proposed Berg River Abstraction Works at Voëlvlei Dam*, discusses and presents the results of a two dimensional fully hydrodynamic model used to simulate the flow patterns and sediment dynamics in the Berg River to aid in the design of the abstraction works. The numeric modelling was updated with 2021 underwater and topographical survey. The results informed the design of the physical model used to finalize the design of the abstraction works.

Physical Model Study – The design and results of this study is presented in the report titled *Berg River Voëlvlei Augmentation Scheme (BRVAS) River Abstraction Works and Weir - Hydraulic Model Study* (August 2021). These results informed the conceptual design of the Abstraction works, Weir, Fishway-cum-canoe chute, Earth-fill embankment and temporary river diversion works.

2. HYDRAULIC DESIGN CONSIDERATIONS

2.1. Location of the BRVAS Weir

During the feasibility study for future schemes in the Western Cape, the Consultants (Aurecon), located the BRVAS Abstraction Works at approximately Latitude 33° 19’ 42.4” Longitude 18° 58’ 49.5” as shown in ***Figure 1*** below.

Several options of the layout were analysed in the hydrodynamic model study to optimize the position, orientation and design of the proposed BRVAS weir and abstraction works.

The final position of the left flank crest of the Crump weir was fixed at Latitude 33° 19’ 40.69” Longitude 18° 58’ 49.13” some 50m downstream of the original position.

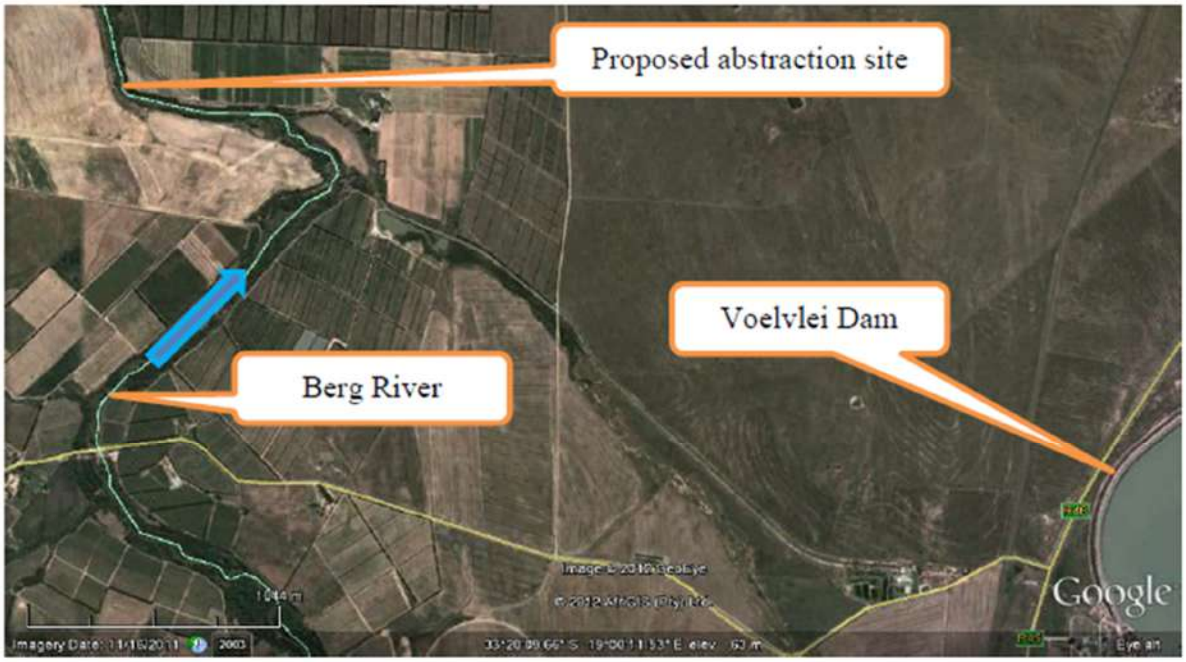


Figure 1: View of Selected Position of the BRVAS Weir with Abstraction Works

2.2. Topography

The location of the weir is downstream of a sharp 60-degree right-hand turn in the river, which is cause by a steep rise in the landscape on the left flank with visible rocky outcrops. The almost horizontal floodplain stretches out on the right flank until it reaches steeper topography some 620m away from the river, as can be seen on ***Figure 2*** below. The contour level that equals the top of the embankment, lies another 140m further to the east.

2.3. Alternative Positions for the Earth-fill Embankment

During the feasibility study the centre line of the earth-fill embankment was in line with the concrete weir and crossed over the cadastral boundary of the farm Halfgewaagd 73 Portion 10 into Portion 20 (see ***Figure 2*** below).

When the proposed position of the weir was moved 50m downstream, the embankment was curved in order not to cross over the boundary between the two properties.

In informal discussions with the two landowners during the geotechnical investigation, it was mentioned that the roots of the trees planted along the cadastral boundary depleted the soil from nutrients and renders it unfruitful. It was then decided to move the centre line onto the cadastral boundary to save as much as possible of the orchards on the two farms. (See ***Figure 2*** below.)

The earth-fill volumes were calculated for all three layouts of the embankment, and it was found that the S-curved embankment layout requires approximately 4% more earth-fill material, but it is preferred because of its lesser impact on existing orchards.

Figure 2: View of the Initial and Final Positions of the BRVAS Weir and Abstraction Works with Alternative Positions for the Earth-fill Embankment

2.4. Geotechnical and Geological Conditions

Below is a summary of some pertinent observations from the investigation by Applied Scientific Services and Technologies (ASST) as set out in *Report to Mukona on Geophysical Investigations for the BRVAS Project*. (See ***Figure 3*** for the position of the Seismic Refraction survey lines.)

i. There is a potential fault at about Ch 1500W along the embankment alignment (on the resistivity plots) – but nothing to worry about.

ii. The material at shallow depth under the earth-fill embankment consists of silty sandy clay – which is expected to be relatively impermeable.

iii. Bedrock (very soft to soft) is shallow on the left flank at the weir – survey line 4.1.

iv. Bedrock (very soft to soft) on the right flank of the weir is relatively deep – at about 10m depth (located at about the 1500m/s velocity line) – survey line 4.2.

v. Depth to bedrock (very soft to soft) below the wing wall on the right flank is relatively deep – at about 10m depth (located at about the 1500m/s velocity line) – survey lines 6, 7 and 8.

vi. Depth to bedrock (very soft to soft) below the wing wall on the left flank is relatively shallow – at about 6m depth (located at about the 1500m/s velocity line) – survey lines 10 and 11.

Figure 3: Seismic Refraction Traverses

2.5. Dam Safety Considerations

The classification of the BRVAS Diversion Weir, in terms of Regulation R.139 of Section 123(1) of the National Water Act, 1998 (Act 36 of 1998), shall be obtained by the designer. The weir will probably be classified by DWS as a Category II dam of medium size with a significant hazard potential. For a Category II dam the SANCOLD *Guidelines on Safety in Relation to Floods* (1991), recommends that the flood with an average recurrence period of 100 years shall be used as the Recommended Design Flood (RDF) and the Regional Maximum Flood (RMF) as the Safety Evaluation Flood (SEF). Allowance shall be made for climate change over the lifetime of the weir.

2.6. Hydrological Study

A flood hydrology study was conducted to establish the peak flows which were adjusted to include 15% allowance for climate change. The recommended values for average recurrence intervals ranging from 2 to 100 years as well as for the RMF, are shown in ***Table 1***.

Table 1: Recommended Flood Peaks at the BRVAS Weir Site

Recurrence Interval (year)	Peak Flow including Climate Change (m^3/s)
2cc	210
5cc	424
10cc	613
20cc	830
50cc	1 169
100cc (RDD)	1 468
RMFcc (SED)	4 494

The Recommended Design Discharge (RDD) is the Q100cc which was used to establish the recommended elevations of the BRVAS structures including freeboard. The RMF based on TR137 was used as the Safety Evaluation Discharge (SED) for design of the earth-fill embankment on the right bank floodplain. The current scenario Regional Maximum Flood (RMF) peak is 3 908 m^3/s. Note that the RMFcc of 4 494 m^3/s was tested in the laboratory to determine the embankment crest level.

The hydrographs for the Recommended Design Discharge (100-year recurrence interval adjusted for climate change) and the 50-year recurrence interval adjusted for climate change, are shown in ***Figure 4***, and were used as input data to the model study.

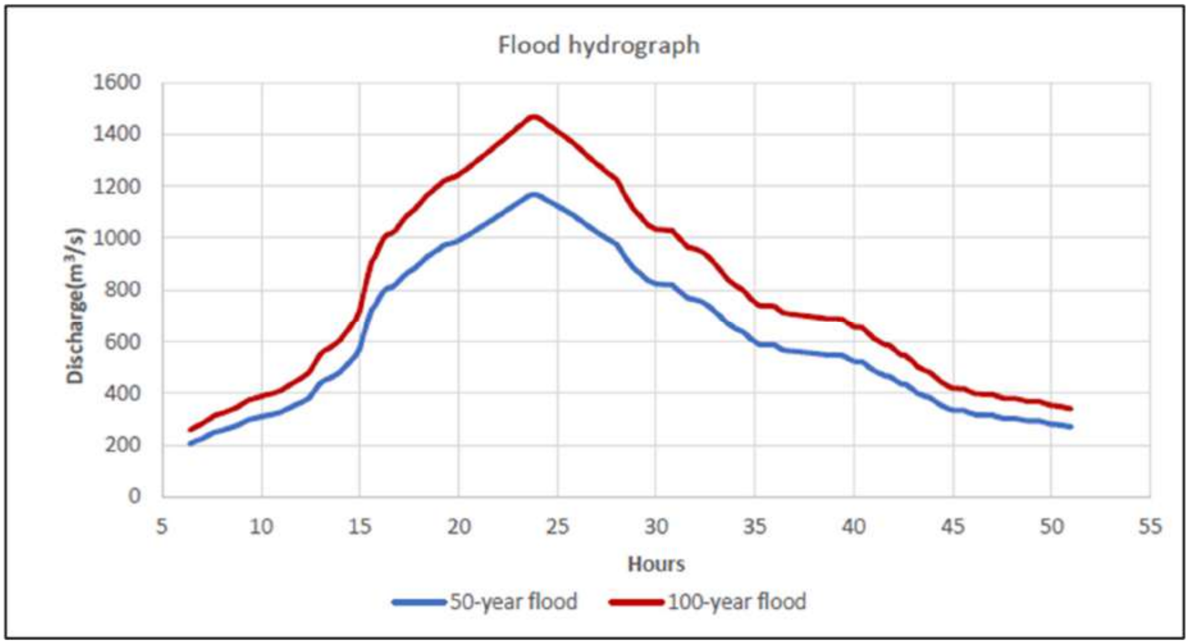


Figure 4: Flood Hydrographs for the Q50cc and Q100cc Floods

2.7. River Hydraulic Analyses

A river hydraulic study was conducted to establish the flood peak levels for storm events with average recurrence intervals ranging from 2cc to 100cc years as well as for the Regional Maximum Flood (RMF), all adjusted for climate change. The water levels obtained at positions upstream and downstream of the weir in the physical model, without and with the weir, are shown in ***Table 2*** and ***Table 3*** below.

These positions were:

Upstream without weir:	X – coordinate (m):	-1838.67	Y – coordinate (m):	-3689132.78
Upstream with weir:	X – coordinate (m):	-1822.43	Y – coordinate (m):	-3689125.92
Downstream without weir:	X – coordinate (m):	-1879.41	Y – coordinate (m):	-3688996.60
Downstream with weir:	Measured at the works structure at left bank side			

It must be noted that these values represent the measured water levels in the flow channel of the physical model. Water levels in stagnant or slow flowing areas, as on the floodplain on the right bank against the embankment, will be higher.

Table 2:Flood Levels Upstream of BRVAS Weir

Recurrence Interval (year)	Flood Level without Weir (masl)	Flood Level with Weir (masl)
2cc	52.27	53.10
5cc	53.57	54.06
10cc	54.40	55.68
20cc	55.23	55.54
50cc	56.21	56.58
100cc (RDD)	56.72	57.22
RMFcc (SED)	59.21	59.86

Table 3:Flood Levels Downstream of BRVAS Weir

Recurrence Interval (year)	Flood Level without Weir (masl)	Flood Level with Weir (masl)
2cc	51.71	51.94
5cc	53.23	53.13
10cc	54.13	54.09
20cc	54.94	54.88
50cc	55.91	55.94
100cc (RDD)	56.37	56.33
RMFcc (SED)	58.56	58.97

2.8. Layout of the Abstraction Works

The abstraction works (see attached drawing in Annexure A) shall consist of:

i. A 60m wide mass concrete Crump weir, stretching from the abstraction works on the left flank to the guiding wall on the right bank, and a 100m wide mass concrete broad crested weir from the guiding wall to the erosion protection wall at the beginning of the 625m long earth-fill embankment. The Crump weir shall consist of three measuring notches, increasing in crest level from 51.30 masl at the 3m wide fishway-canoe chute, to 51,60 masl at the 17m wide notch on the left-hand side from the chute to the abstraction works, to 15,90 masl at the 40m wide notch on the righthand side of the Fishway-canoe chute that terminates at the guiding wall on the right flank. Further to the right, from the guiding wall to the retaining wall protecting the edge of the earth-fill embankment, stretches the 100m wide broad crested weir at the Q50cc flood level of 57,00 masl, followed by the earth-fill embankment with its crest at the RMFcc level of 61,2 masl.

ii. The sediment traps placed in the existing river channel,

iii. The Pumping Station and appurtenant works,

iv. An earth-fill platform around the pumping station inside the enclosure provided by the reinforced concrete / gravity guiding wall on the left flank.

2.9. Hydrodynamic Modelling

The 2012 numerical simulations by means of the Mike21C hydrodynamic and morphological models of the DHI Group, was used to design the subsequent 2021 Physical Model setup.

For the final abstraction works and weir design, a new model was set up based on the 2021 LiDAR and bathymetric survey data. The long-term sedimentation upstream and downstream of the weir was simulated by using a 15-year historical observed river flow record.

Five design scenarios were simulated to arrive at Option B2, which is the best design that complies with the approved EIA based on the feasibility study layout with an added left flank wall and a central guide wall.

The following results were obtained:

a) Flow velocities and water depths for the 50-year and 100-year flood peaks and the RMF for constant flow simulation with no moving bed.

b) Simulated sediment transport bed levels at the peak and end of the 50-year and 100-year floods with movable bed, (current scenario with weir) and maximum flow velocities and water depths.

c) Simulated bed level change after 15 years with movable bed.

d) Same as b) for future scenario after 15 years of operation. ***Figure 5*** below depicts the resultant long section of simulated maximum water levels and bed levels. (Refer to Figure 5.3-60 on p.55 in the Physical Model Study Report.)

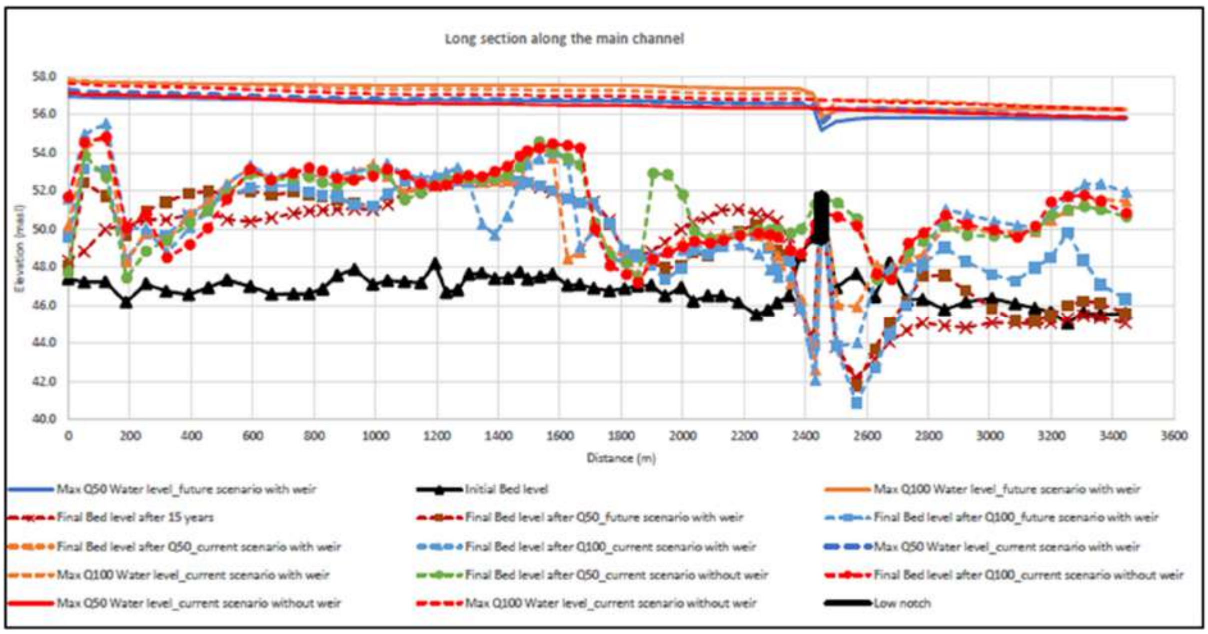


Figure 5: Long section of simulated maximum water levels and bed levels

2.10. Physical Model Study

Moveable bed tests were carried out for option B2. The purpose of the movable bed tests was:

i. to evaluate the scour patterns during different floods to establish whether the abstraction works will be able to scour the intakes,

ii. to ensure that the main channel does not move away from the left bank, and

iii. to determine the downstream effects on bed movement with the abstraction works and weir in place.

The movable bed tests were carried out in sequence from 10 m^3/s up to 1468 m^3/s (Q100cc). Figures 9-26 to 9-34 in the Physical Model Test Report show the observations from the tests. The following were the key findings from the tests:

a) Scour at the downstream toe of the weir down to bedrock happens at low flows (Q = 10 m^3/s – lowest tested) and a sand bar forms just downstream of the scour hole as shown in Figure-9-26. The fishway-canoe chute scours downstream which is beneficial for both fish and canoeists to navigate the chute safely.

b) At 50 m^3/s local scour around the dividing walls of the Crump weir was observed (Figure 9-27). The scour will ensure that the fishway-canoe chute approach remains accessible.

c) Significant local scour and general sediment movement was visible for the Q2cc (210 m^3/s), the scour is mainly focussed on the left-hand side of the weir and toward the fishway-canoe chute. Scour at a low recurrence interval flood is beneficial for the potential scouring of the intake near the boulder trap.

d) For the movable bed tests, self-scour of the boulder trap was not as effective as shown in the tests with the fixed bed. Figure 9-29 shows self-scour for the Q5cc (424 m^3/s), but the scour shown just upstream of the boulder trap increases the flow depth in the vicinity which in turn reduces the velocity and secondary currents. The boulder trap should still self-scour at this flood peak, but it can also be flushed effectively at this flow.

e) A deflection caused by the abstraction works is visible on the Crump weir in Figure 9-30, this deflection may cause fluctuations in the flow measured over the low notch. Furthermore, deposition on the inside bend, near the guide wall, may affect the flow measurements.

f) The scour patterns of the sediment upstream of the weir was parallel to the intake of the abstraction works, this indicates that the flow exhibits secondary currents on the outside of the bend which promotes scour on the left bank.

g) Scour around the upstream curve of the right bank guide wall have been observed as shown in Figure 9-32. The guide wall will need to be sufficiently protected against scour in this area or constructed on bedrock, similar to the weir and abstraction works.

Figures 9-35 to 9-37 show the surveyed bed elevations after the Q10cc, Q50cc and Q100cc tests were completed. Figure 9-35 is for a section 12 m upstream of the weir, Figure 9-36 is for a section 30 m upstream of the weir and Figure 9-37 is for a section 35.6 m downstream of the weir. Locations where the bed had scoured onto the fixed bed are marked with red. The bed upstream of the weir is scoured from left to right between the dividing walls as the flood peak increases, this is a favourable result which will ensure that the outside of the bend near the intake will be scoured first. The shift in the main channel downstream of the weir is evident in Figure 9-37.

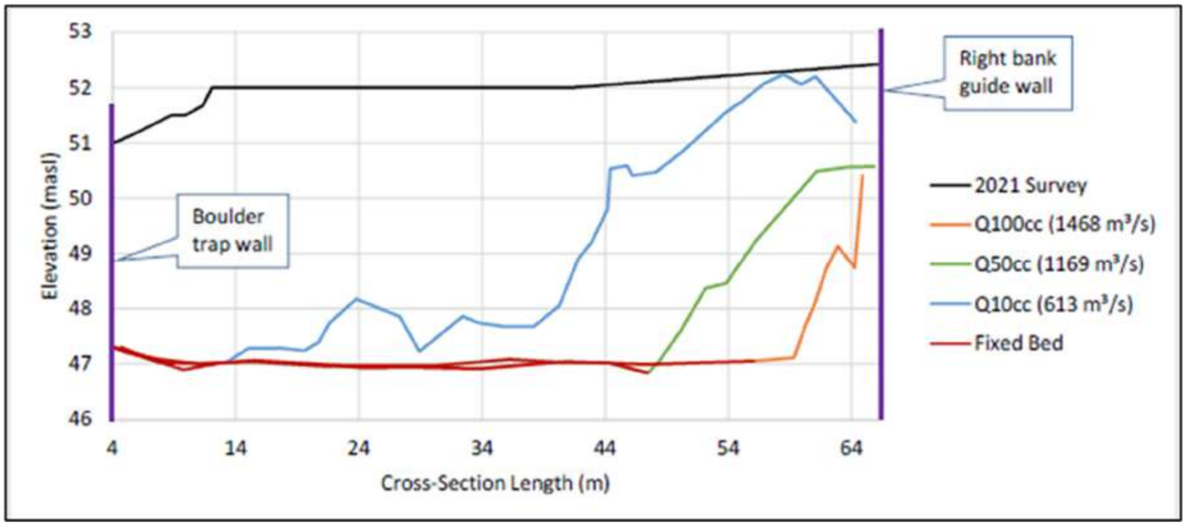


Figure 9-35: Cross-section 12 m upstream of the weir showing the observed bed scour during the Q10cc, Q50cc and Q100cc flood events

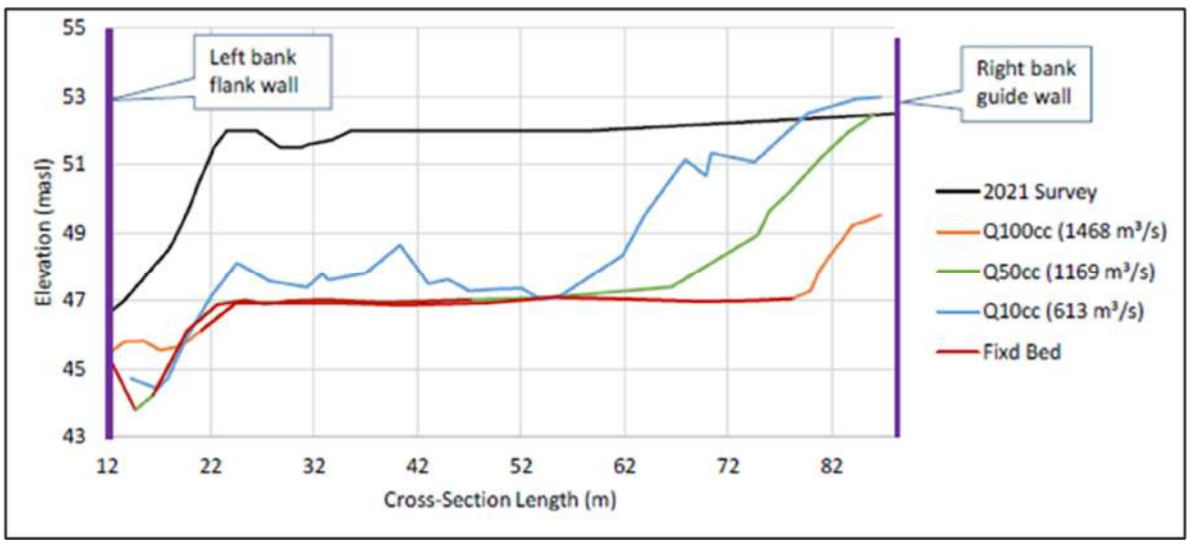


Figure 9-36: Cross-section 30 m upstream of the weir showing the observed bed scour during the Q10cc, Q50cc and Q100cc flood events

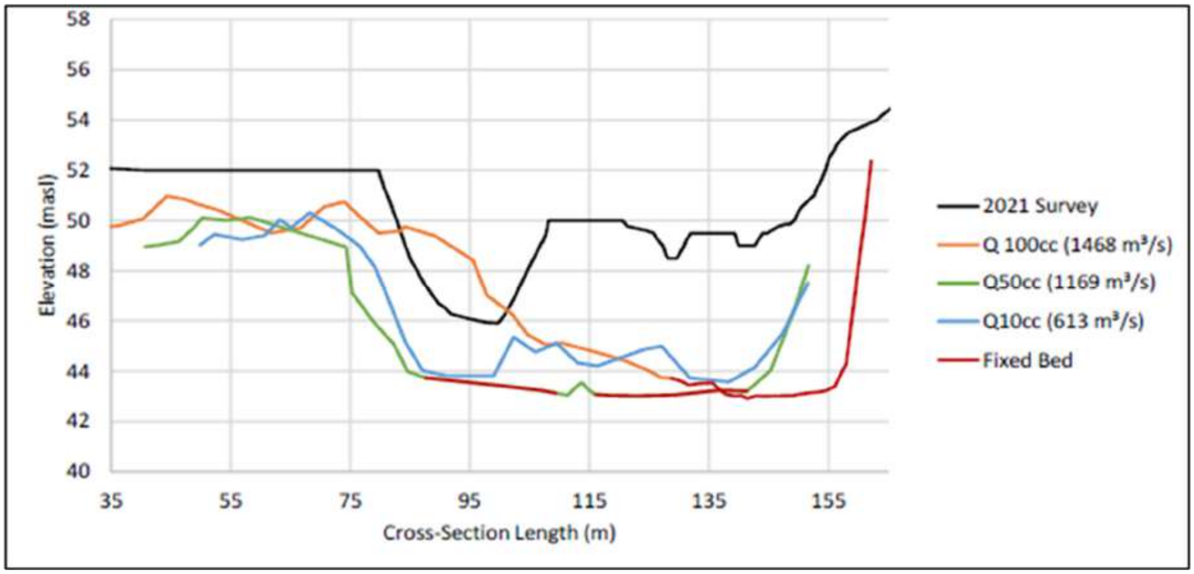


Figure 9-37: Cross-section 35.6m downstream of the weir showing the observed bed scour during the Q10cc, Q50cc and Q100cc flood events

The stage-discharge rating curves for the weir, measured during the physical model movable bed tests for the final proposed BRVAS weir (option B2) is shown in Figure 9-38 (p.88) for up to Q100cc of 1458 m3/s is a crucial element in the operation of the Abstraction Works.

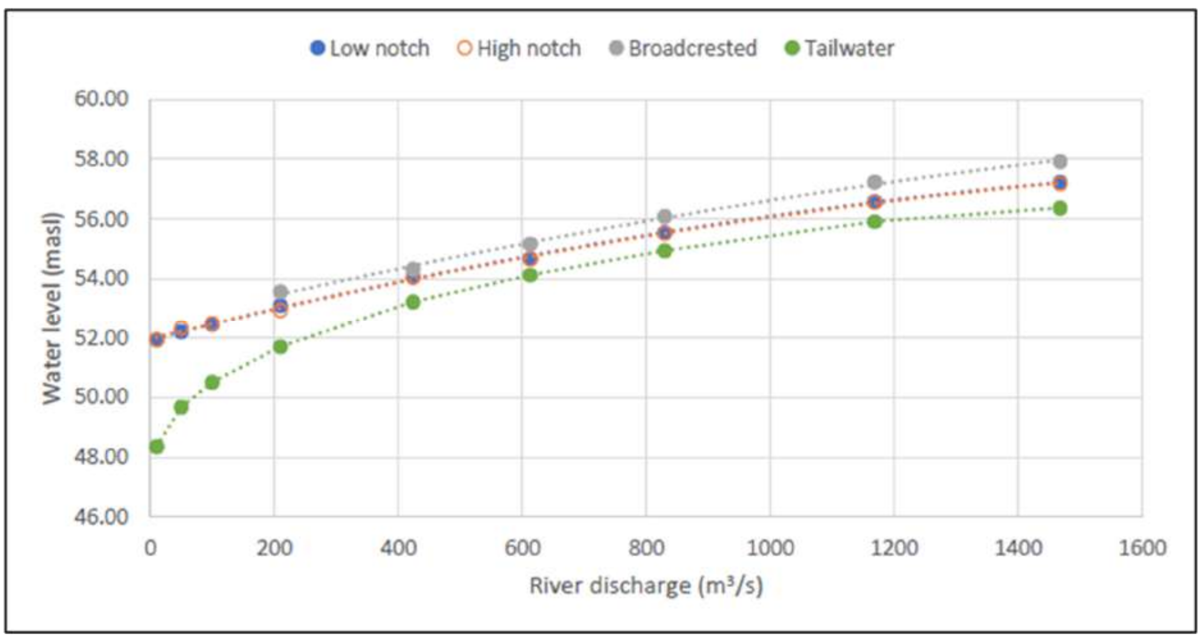


Figure 9-38: Stage-discharge rating curves for the proposed weir

Important elevations that were measured during the physical model tests are summarized below:

a) The dividing walls for the Crump weir are built for the weir's design flood of 120 m3/s to a level of 52.8 masl (between a 1-year and 2-year flood)

b) The broad crested weir and guide wall elevation of 57 masl coincides with the Q50cc flood

c) The level of the top of the intake structures and flank wall is 58.48 masl i.e. the Q100cc flood level plus an additional 0.5 m for freeboard against wave action

d) The berm on the right bank was designed to prevent spilling up to the RMFcc of 61.2 masl.

2.11. Fishway-cum-Canoe Chute Design

A combination canoe chute-fishway was designed as part of the model study based on discussions with DWS and fishway expert Dr Anton Bok. The combined fishway-canoe chute depicted in Figure 10-9 in the Physical Model Study Report and (see also below) is described as follows:

a) The Fishway-canoe chute is 3 m wide with upstream dividing walls to guide the fish, canoes and for flow measurement

b) It is placed between the 17m long low notch of the Crump weir and the 40 m long high notch, with the crest level 0.3 m lower than the low notch at 51.3 masl. At a river discharge of 5 m3/s the tailwater level is about 48 masl, which results in a 3.3 m drop from the crest of the weir to the downstream water level, or a 3.8 m head difference from the upstream to downstream water levels. The fishway-canoe chute is 35.75 m in length to provide safe flow patterns for canoeists through the unstable jump at the downstream end of the chute.

c) Curved baffles with 1m radius and 0,3m openings for fish are placed on the left- and right-bank sides of the canoe chute, at an angle to the flow direction. The baffles create small resting zones behind them for fish migrating upstream.

d) The floor levels immediately downstream of the baffles are lowered on the sides of the chute to increase the flow depth and the improve resting conditions for fish.

e) Downstream of the crest the total width of the canoe chute is 4 m, including the baffles on the sides.

f) Chevron shaped, 200mm high floor “weirs” are included in the canoe chute to increase the flow depth near the baffles while still safe for the canoeists.

g) The combined fishway-canoe chute has a 1:5 (V:H) general longitudinal slope with steps 1m in length and 0,2m high.

h) Fish resting pools are added at every 2 m drop i.e. every 10 m along the chute.

i) The crest of the canoe chute has a Crump shape like the rest of the weir for DWS flow measurement. The fishway-canoe chute starts 0.5 m downstream of the crest and at an elevation 0.1 m lower not to affect flow measurement.

The proposed fishway-canoe chute design is enclosed in Annexure A. Figures 10-1 to 10-3 in the Physical Model Study Report, show the fishway-canoe chute model at 1:15 scale setup in the flume as well as with flow.

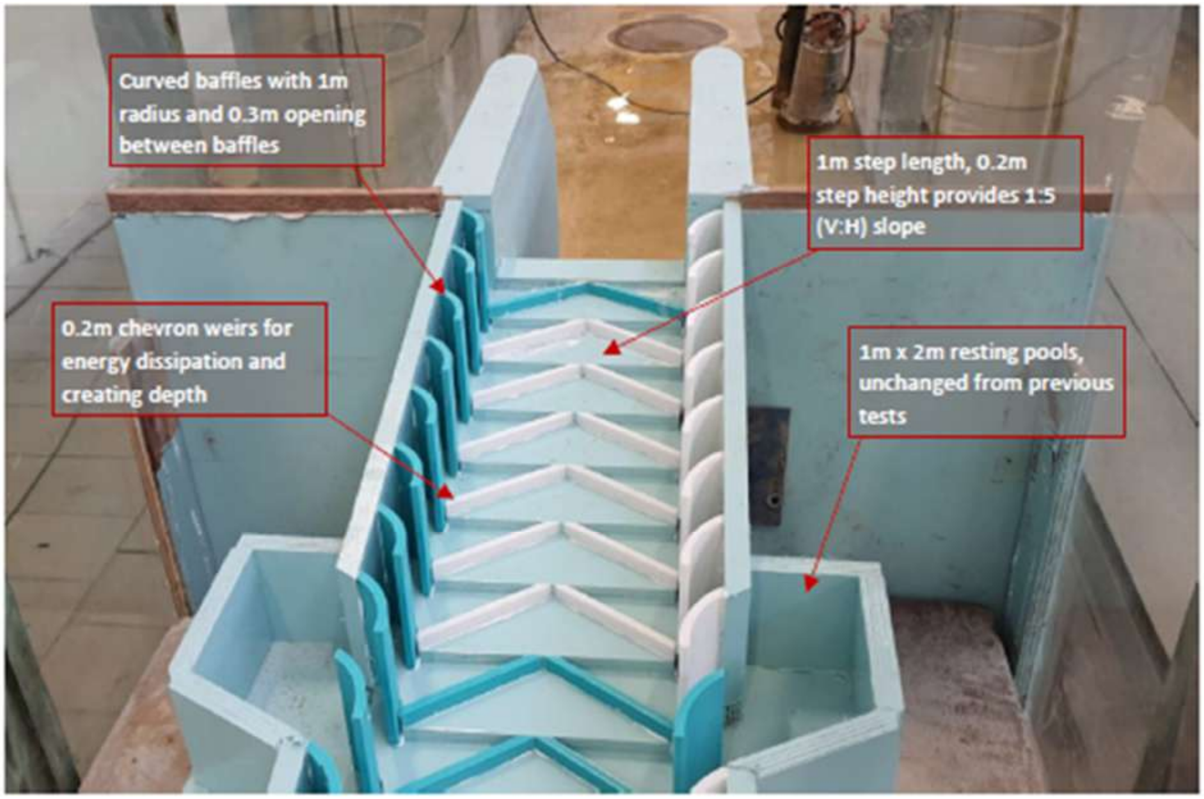


Figure 10-9: Modified fishway-canoe chute model viewed from downstream

3. WEIR DESIGN

3.1. Crump Weir Configuration

One of the objectives of the physical model and numerical modelling was the hydraulic design and optimization of the Crump weir (design head, notch lengths and dividing walls). The weir's hydraulic design was also discussed with DWS to establish accurate flow measurement requirements.

The geotechnical information obtained during the course of the hydraulic model study, indicated that the bedrock at the proposed site is at an elevation of between next to the river, (see ***Figure 6*** below). Initially it was thought that additional energy dissipation or erosion protection (roller bucket; riprap) would not be required, but the Seismic Refraction survey along Line 4.1 to 4.2 (see Appendix D4 and D5 in the Geophysical Investigations Report), indicates that the bedrock is very soft to soft. Therefore, additional energy dissipation or erosion protection (e.g. concrete scour protection slab), at the proposed Crump weir is required.

For the proper control of the pumping station, it is necessary to be able to accurately measure the environmental compensation flow of 1,2 m^3/s.

The weir will consist of three measuring notches, increasing in crest level from 51.30 masl at the 3m wide fishway-canoe chute, to 51,60 masl at the 17m wide notch next to the abstraction works, to 15,90 masl at the 40m wide notch on the righthand side of the Fishway-canoe chute that terminates at the guiding wall on the right flank. Further to the right, from the guiding wall to the retaining wall protecting the edge of the earth-fill embankment, stretches the 100 m wide broad crested weir at the Q50cc flood level of 57,00 masl, followed by the earth-fill embankment with its crest at the RMFcc level of 61,2 masl.

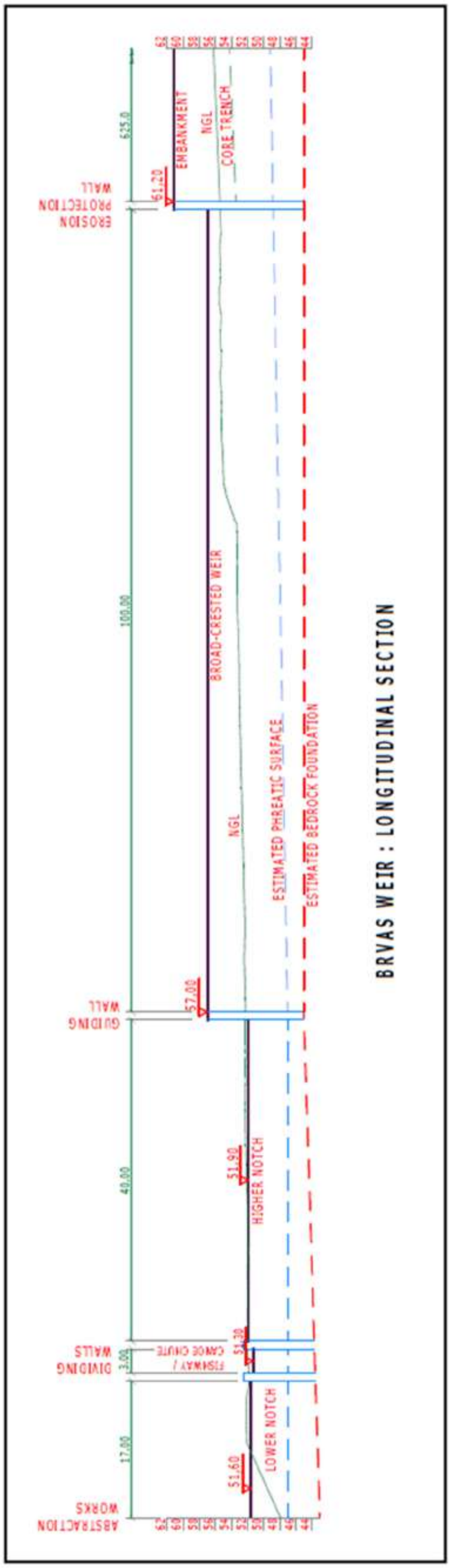


Figure 6: Longitudinal Section of Diversion Weir

The Crump weir will have a 1:2 upstream and 1:5 downstream profile from 1,3 m upstream of the crest to 2,6m downstream of it, followed by a vertical drop onto a scour protection slab that covers the soft bedrock. The height of the mass concrete weir from bedrock to crest will be approximately 9m.

The weir shall have a discharge measuring capacity of 123 m^3/s for all notches combined (Ha = 1,5m).

3.2. Broad Crested Weir

The 100m wide broad crested gravity wall section of the weir, with its top level of 57,00m, will only start overtopping at the Q50cc flood of approximately 1170m^3/s. The bedrock is at an elevation of approximately 45 masl, (see adjacent ***Figure 6***), resulting in a weir height of 12m. Energy dissipation or erosion protection (roller bucket; riprap) may not be required, as the water level on the downstream side of the wall during the Q50cc flood will be close to the top of the weir.

The phreatic surface is estimated at between 47 to 48 masl, which may make excavation down to bedrock very difficult and foundation improvement techniques such as stone vibratory columns, soil-mixing or jet grouting may be considered.

3.3. Left Bank Guiding Wall

The concrete flow guiding wall on the upstream side of the Pumping Station, with its top level of 58,48m, will have a freeboard of 0,5m during the Q100cc flood of approximately 1468m^3/s. The bedrock is at an elevation of approximately 46 masl, resulting in a wall height of 12,5m. A buttress or mass concrete gravity wall with the vertical face on the upstream side and the sloped face covered by the earth-fill platform around the pumping station, may be considered.

3.4. Right Bank Guiding Wall

The concrete flow guiding wall on the right bank, with its top level of 57,0m, stand approximately 4,7m proud of the surrounding floodplain level of 52,3 masl. The bedrock is at an elevation of approximately 45,0 masl, resulting in a wall height of 12,0m. A buttress or mass concrete gravity wall with the vertical face on the stream side and the sloped face towards the land side, may be considered.

The phreatic surface is estimated at between 47 to 48 masl, which may make excavation down to bedrock very difficult and foundation improvement techniques such as stone vibratory columns, soil-mixing or jet grouting may be considered.

3.5. Right Bank Erosion Protection Wall

Careful attention should be given to the design of the erosion protection wall at the right-hand end of the broad-crested weir. The top level of the embankment at 61,2m, is 16,2 m above the bedrock level of 45,0 masl.

3.6. Embankment

As mentioned in Section 2.3, the earth-fill volumes were calculated for all three alternative layouts of the embankment, and it was found that the S-curved embankment layout as shown in ***Figure 7*** below, requires approximately 4% more earth-fill material, but it is preferred because of its lesser impact on existing orchards.

The earth-fill volumes were calculated based on a typical cross-section with a 5m wide crest and 1:2 (vert:hor) side slopes on both the upstream and downstream sides and 3m deep core trench. The three layouts are compared in ***Table 4*** below:

Figure 7: Alternative Positions for the Earth-fill Embankment

Table 4:Comparison of Alternative Embankment Layouts

Layout	Earth-fill Volume (m^3)	Footprint Area (m^2)	Length (m)	Remarks
Straight	47 245	14 690	598	Layout not applicable as weir was moved 50m downstream
Arch	52 435	15 720	608	2ha of orchards lost on Portion 10

S-curved	54 685	15 690	624	Loss of orchards minimized

3.7. Design Considerations

Due attentions shall be given to the following design consideration and best practice methods shall be applied to design the various components of the weir to appropriate safety factors.

3.7.1. Concrete Gravity Wall Stability Analyses

As a result of the varying sediment levels upstream and downstream of the weir over its lifetime, due consideration shall be given to the Load Conditions recommended in Section 2.7.4.

3.7.2. Earth-fill Embankment Stability Analyses

The embankment will only come into operation during floods with a recurrence interval of more than 50 years and then only for a short duration. Depending on the soil properties of the foundation and wall, a full phreatic surface throughout the embankment may not develop and steady seepage and sudden drawdown conditions may not need to be evaluated. If the soil excavated from the temporary river diversion canal is used for the embankment, soil-cement-Bentonite at optimum moisture content, compacted in layers of 200mm thick and 1m wide, may be used as an outer erosion protection layer on both upstream and downstream sides of the embankment.

3.7.3. Earthquake Risk Analyses

The following is an abstract from a 2011 Council of Geoscience publication titled: Seismic Hazard in South Africa by M. Brandt:

> *"Fernandez and Du Plessis (1992) described seismic hazard (SHA) using a direct method of estimating the apparent probability of exceeding a certain horizontal peak ground acceleration. They used earthquake records from the South African National Seismological Database (SANSD) to map the seismicity. The SANSD is a compilation of seismological data from the South African National Seismograph Network (SANSN), operated by the Council for Geoscience, and historical data recently updated by Brandt et al. (2005). Instrumental data recorded by the SANSN has been published in regular seismological bulletins since 1977.*
>
> *"Figure 3 and Figure 4 (taken from Fernandez and Du Plessis, 1992) are maps showing respectively seismic intensity (Modified Mercalli Scale, MMS) and peak horizontal ground acceleration (PGA) levels that have a 10 percent probability of being exceeded, at least once a year, in a period of 50 years. The maps represent data from 1620 to 1989. Both maps depict natural as well as mining-related seismicity. In respect of the latter, the maps are relevant only if mining activities continue."*

The peak horizontal acceleration according to ***Figure 8*** is > 200 cm/s^2 (or 0.2g) with a 10% probability of being exceeded at least once in a period of 50 years. From ***Figure 9*** it can be read that this translates to an event with an average return period of 500 years.

A pseudo-static earthquake analyses may be done following the procedure set out in Design of Small Dams (DSD) (3rd Edition), Par. 8.14 taking horizontal and vertical accelerations into account. In the analyses both horizontal and vertical earthquake loads shall be applied in the direction that produces the least stable structure. For the full reservoir condition, this will be a foundation movement in the upstream direction and a foundation movement downward.

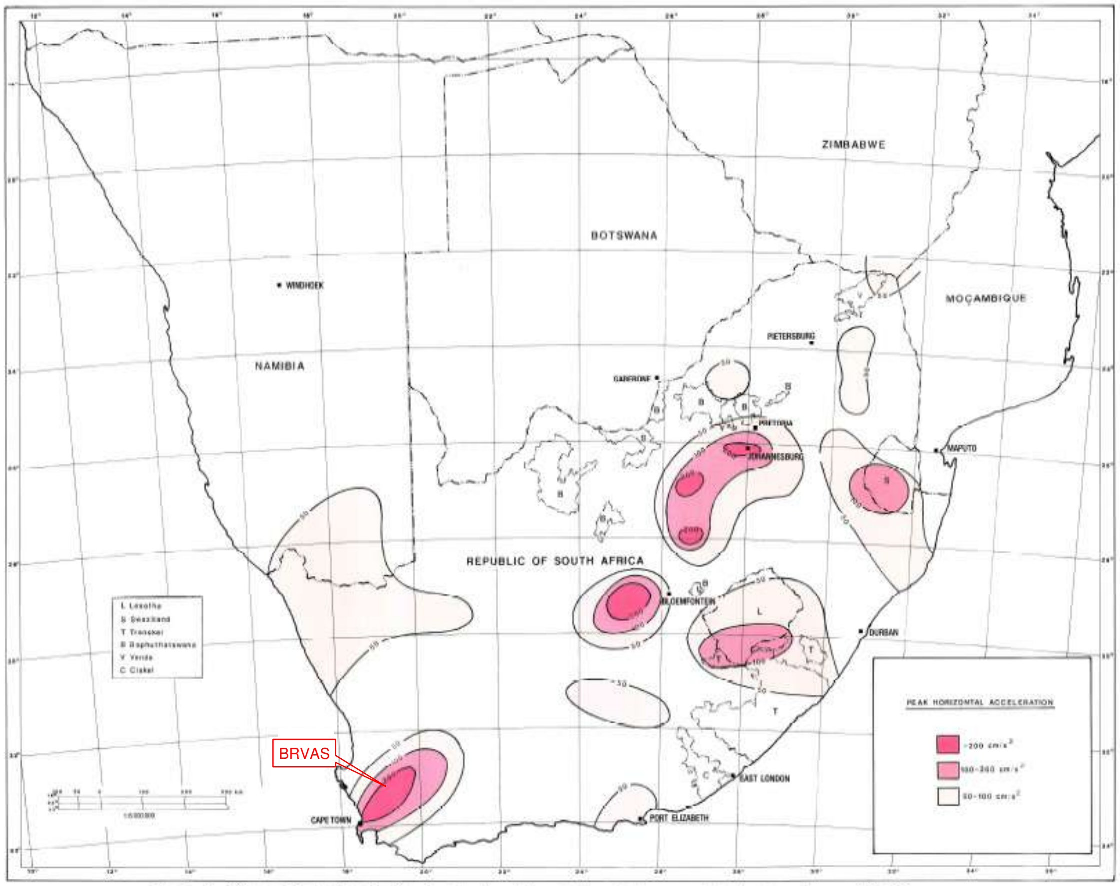


Figure 4: Peak horizontal acceleration (cm/s^2) with a 10% probability of being exceeded at least once in a period of 50 years

Figure 8: Horizontal Acceleration Chart

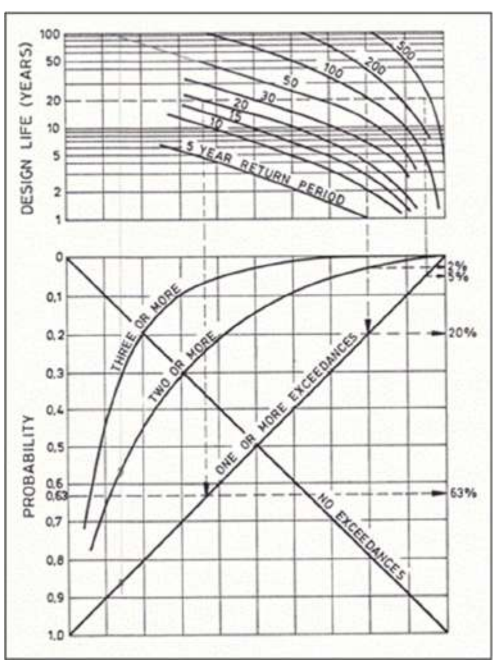


Figure 9: Probability of exceedance within a given design period

The design shall be based on appropriate peak ground accelerations (PGA) such as:

Horizontal direction:

- Operating Basis Earthquake OBE_{200} = (0.1g)
- Design Basis Earthquake DBE_{500} = (0.2g)

Vertical direction: 75% of horizontal acceleration (even though DSD suggests 50%)

The increase in water pressure P_e, at any elevation due to horizontal earthquake acceleration, is given by the following equation:

Pe = Cλωh where

C = a dimensionless coefficient giving the distribution and magnitude of pressure

λ = earthquake intensity = earthquake acceleration / g

ω = unit weight of water

h = total depth of reservoir at study section

y = vertical distance from reservoir surface to elevation in question

- The total horizontal force $V_e = 0{,}726\ P_e.y$
- The total overturning moment $M_e = 0.299\ P_e.y2$

The decrease in the effective weight of the water and concrete due to vertical earthquake acceleration is not described in DSD but can be handled by applying vertical uplift forces equal to the mass of the water or concrete x vertical earthquake acceleration.

- Effective weight = Mass x g – Mass x a_{vert}

It can also be applied by calculating the effective weight of the concrete and water by multiplying its mass by gravity acceleration minus vertical earthquake acceleration:

- Effective weight = Mass x (g – a_{vert})

3.7.4. Load Conditions

Table 5 below summarizes the load cases that are relevant to the weir and shall be analysed in accordance with the recommendations of the US Army Corps of Engineers (EM 1110-2-2200 30 Jun 95). Full uplift is applicable to most load cases while partial uplift is only applicable in the case of extreme drought when the downstream water level is drained to below plane Y-Y.

Abbreviations:

G = gravity; TW = tailwater; FSL = full supply level; RDF = recommended design flood; RMF = Regional Maximum Flood; SEF = Safety Evaluation Flood; PU = partial uplift; FU = full uplift; S = silt; OBE_{200} = operational basis earthquake; DBE_{500}= design basis earthquake. Subscript refers to return period. D/S and U/S = downstream and upstream side or direction.

Table 5: Load Conditions

Load category	USACE Load Conditions	Description of load case
Service (Usual)	2	FSL + TW + S + G + FU
Abnormal (Unusual)	2a	FSL + S + G
	3	RDF + TW + S +G + FU
	5	FSL + TW + S + G+ FU + OBE_{200}(D/S)
Extreme	6	FSL + TW + S + G + FU + DBE_{500} (D/S)
	7	SEF + TW + S + G + FU

4. TEMPORARY RIVER DIVERSION WORKS

A desktop study has been carried out to investigate four possible options of the temporary works (coffer damming) for the construction of the abstraction works, pump station, fishway-canoe chute and weir. The physical model study report presents these four options and the considerations for construction of the river diversion for the proposed BRVAS abstraction works and weir. The 10-year annual recurrence interval (ARI) flood (533 m^3/s), without the effects of climate change, was assumed as the design flood for the temporary works and was used in the 1:40 physical model (used to evaluate and optimise the ultimate intake structures) to evaluate the preferred temporary works option.

The following design conditions were assumed for the layout options of the temporary works options:

- The maximum water level upstream of the weir site caused by the temporary works are assumed to not exceed 55 masl for a Q10 flood event (the future MOL = low notch of the Crump weir is at 51.6 masl and the river main channel bed level at the weir site is at 47 masl)
- The maximum water level downstream of the weir site is expected not to exceed 54 masl for a Q10 flood event
- Cofferdams (earth embankments) and excavations have bank slopes of 1:2.5 (V:H)
- Cofferdams (earth embankments) have a crest width of 3 m.
- The river diversion channel must return to the main Berg River channel at the same elevation as the bed of the present main channel to prevent retrogressive erosion
- Temporary concrete walls were not considered as the bedrock at the site of the weir is relatively deep, between 41 masl and 44 masl.
- The selected temporary works were tested in the hydraulics laboratory for the current Q2, Q5 and Q10 floods (without future climate change impacts) to guide the contractor to decide on the acceptable risk during construction.

The layouts of the four options are shown and the advantages and disadvantages are discussed in the physical model study report. Option C, shown ***in Figure 10,*** was considered to be the most practical and was subsequently modelled, first with a fixed bed and afterwards with a movable bed.

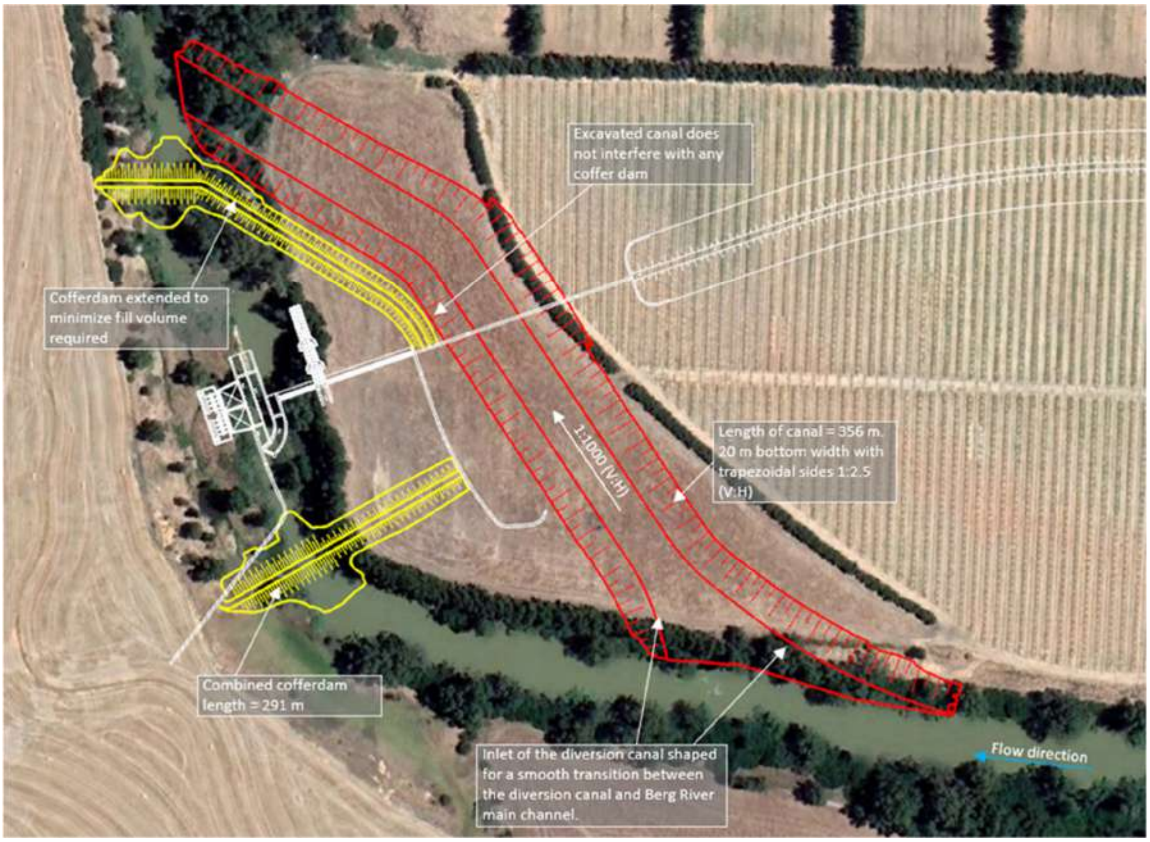


Figure 10: Modified final option C layout with a shaped inlet, straight upstream section and one downstream bend

The findings and recommendations of this study on the selected temporary works were made to guide the contractor to decide on the acceptable risk during construction. The following findings and recommendations are made:

- A 20 m wide (bottom width) trapezoidal (1:2.5 (V:H)) diversion canal that is excavated through the right bank floodplain is suitable to convey the 10-year ARI-flood (533 m^3/s) safely around the construction area of the abstraction works on the left bank.
- The diversion canal inlet is at 47.3 masl with a bed slope of 1:1000 (V:H), the canal must return to the main river channel bed invert level to prevent retrogressive erosion.
- Upstream, a cofferdam is required with a crest level of 54.7 masl.
- Downstream, a cofferdam is required to have a crest elevation of 54.6 masl.
- The final layout of the upstream cofferdam will depend on the construction of the left bank flank wall.
- A 10 m radius rounded inlet is recommended for the inlet of the diversion canal to reduce turbulence and erosion due to the sharp inlet angle relative to the main channel.
- The bends in the diversion canal should be gradual, the recommended radius used in ***Figure 10*** is 50m
- The maximum observed flow velocity in the canal upstream of the weir location was 2.5 m/s and 2.3 m/s downstream of the weir location against the left bank and cofferdam

- Possible erosion protection measures must be investigated by the contractor. The recorded water levels and flow velocities from this study could be used to design suitable erosion protection measures for the coffer dams and diversion canal banks.

5. CONCLUSION

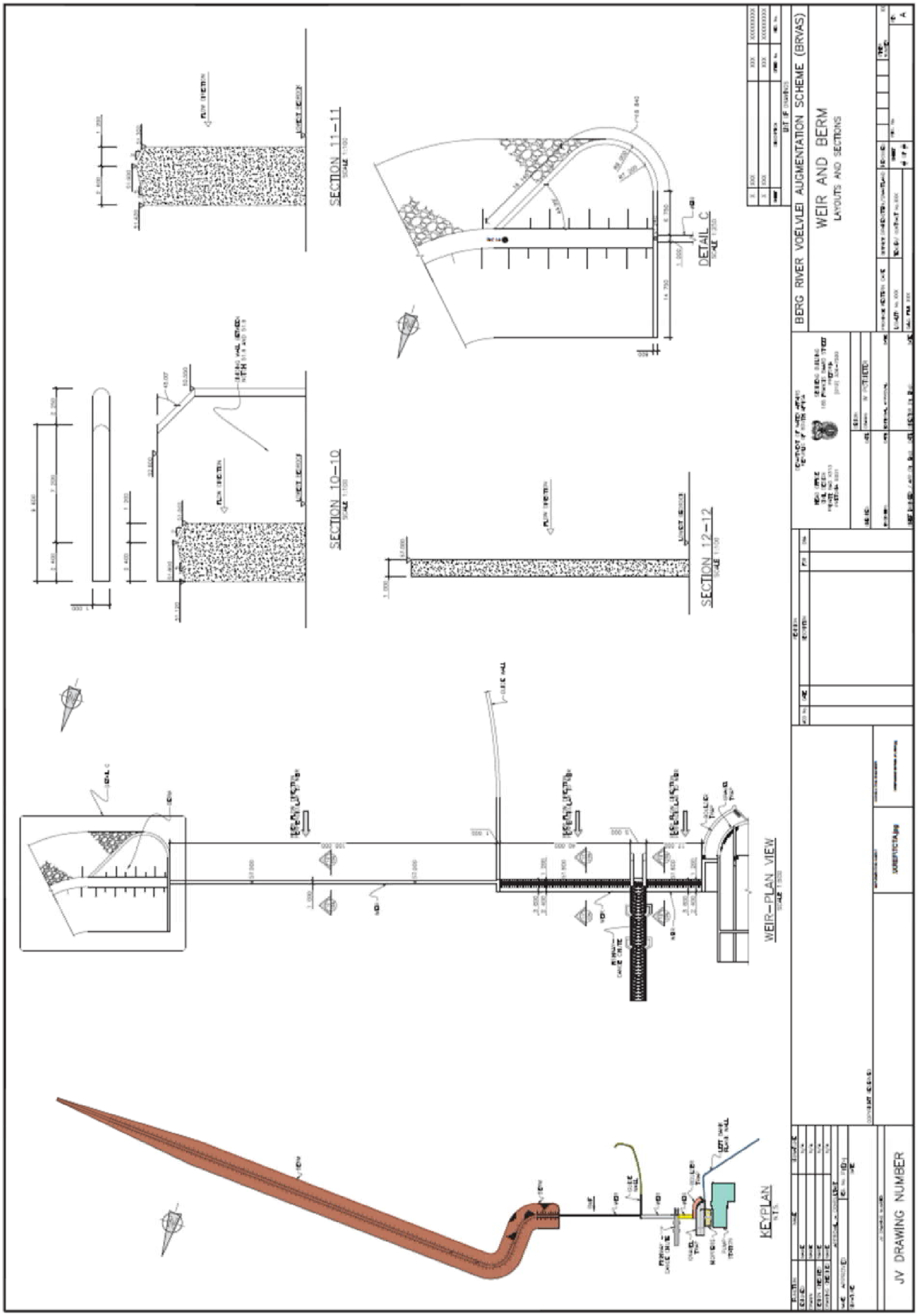
The objective of this report is to give guidance to the contractor/designer regarding important aspects to be considered in the design of the weir. The report is intended to draw attention to relevant results that emerged from the Physical Model Study and to bring to attention the critical findings from the Physical Model Study of the Temporary River Diversion Works. It highlighted various factors that will influence the design of the Weir such as the topography, geotechnical and geological conditions, flood hydrology, river hydraulics, hydro-dynamic movement of sediment, flow measurement requirements, constructability, river diversion during construction and Dam safety in terms of Regulation R.139 of the National Water Act.

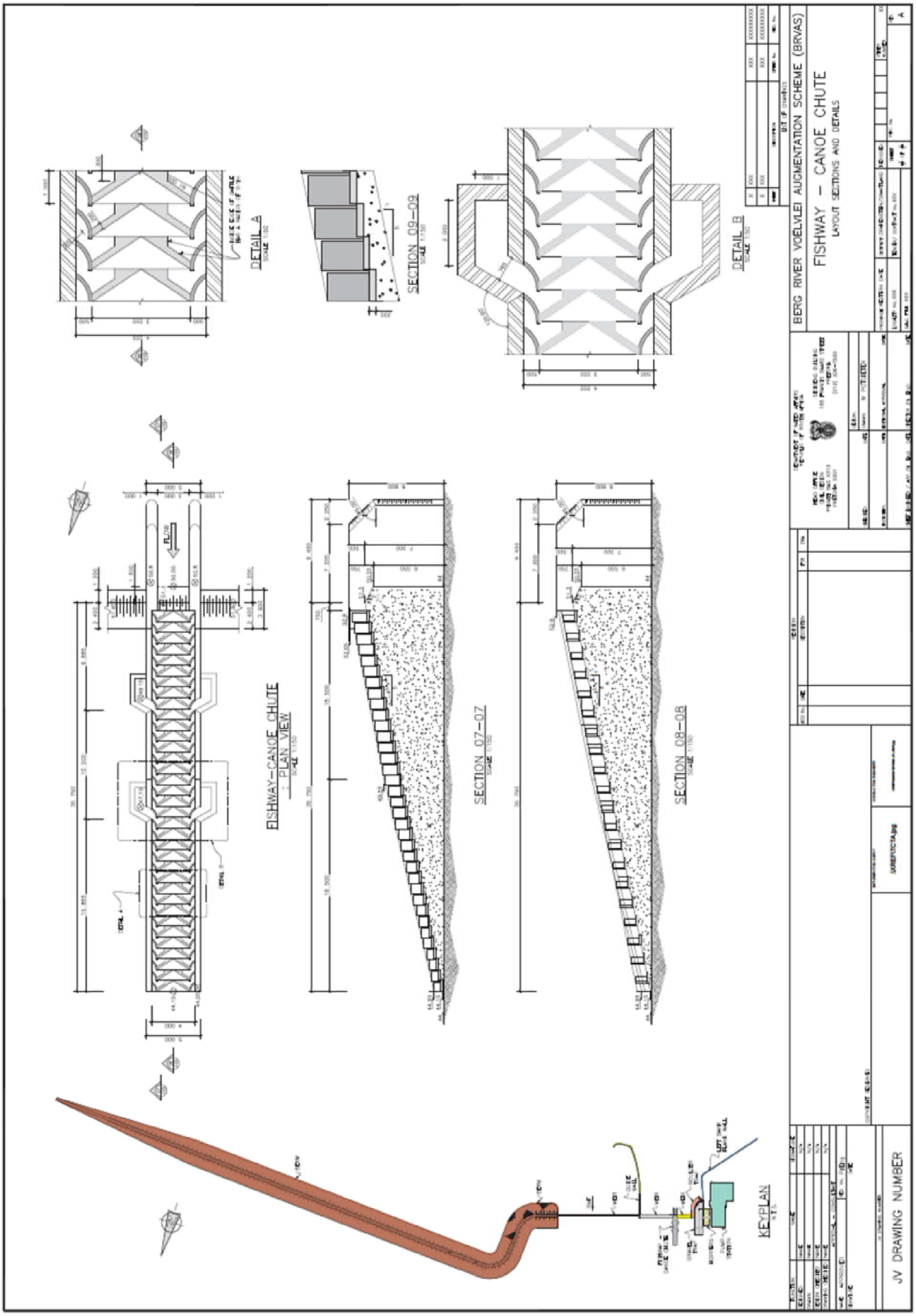
ANNEXURE A

Conceptual Design Drawings

Weir and Berm – Layouts and Sections Rev A

Fishway – Canoe Chute – Layout Sections and Details


SECTION 11-11
SECTION 10-10
SECTION 12-12
DETAIL C
WEIR-PLAN VIEW
KEYPLAN
BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)
WEIR AND BERM
LAYOUTS AND SECTIONS
JV DRAWING NUMBER


BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)
FISHWAY – CANOE CHUTE
LAYOUT SECTIONS AND DETAILS
DETAIL A
SECTION 09–09
DETAIL B
FISHWAY–CANOE CHUTE – PLAN VIEW
SECTION 07–07
SECTION 08–08
KEYPLAN
JV DRAWING NUMBER