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TRANS-CALEDON TUNNEL AUTHORITY

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

CONTRACT No. TCTA 21-041

ACCESS ROADS - CONCEPT DESIGN

18 MARCH 2022

AMANZI ENTABA JOINT VENTURE

Report No: 1A-R-211-07 (Rev B)

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Title : **ACCESS ROADS - CONCEPT DESIGN**

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ACCESS ROADS - CONCEPT DESIGN

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

ACCESS ROADS - CONCEPT DESIGN

ABBREVIATIONS AND ACRONYMS

AEJV	Amanzi Entaba Joint Venture
BRVAS	Berg River Voëlvlei Augmentation Scheme
CCT	City of Cape Town
dia	diameter
DN	Nominal Diameter
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
h	hours
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
$ℓ/m^2$	litre per square meter
km/h	kilometre per hour
NDU	Natural Drainage Unit
OMC	Optimum Moisture Content
NME	Nano-Modified Emulsions
DCP	Dynamic Cone Penetrometer
O&M	Operation and Maintenance
PDBC	Plant and Design Build Contract
RID	Record of Implementation Decision
TCTA	Trans-Caledon Tunnel Authority
WCWSS	Western Cape Water Supply System
DT&PW	Western Cape Department of Transport & Public Works
DRE	District Roads Engineer

1. INTRODUCTION

1.1. Scope

During the development of the tender documentation the need to further investigate access to the abstraction works on both banks of the Berg River was identified. The following access requirements were identified for further investigation:

- Access for construction vehicles to the pumping station and weir on the left bank of the river.
- Access for construction vehicles to the weir and the earth-fill embankment on the right bank of the river.
- Permanent access to the pumping station for operational and maintenance vehicles on the left bank of the river.

This report addresses the abovementioned aspects with specific focus on the following:

- Assessment of the current condition of the minor roads to be affected by construction vehicles during the construction of the abstraction works (inclusive of the weir, pumping station and earth-fill embankment) and pipeline.
- Assessment of improvements (geometric alignment, drainage and pavement strength) to be implemented by the contractor; prior, during and at the end of the project.
- Develop a concept design for the permanent access road to the pumping station located on private land.
- Formulate options for the temporary access road required to provide access for construction vehicles to the earth embankment area on the right bank of the river as discussed between TCTA and AEJV representatives during a site visit held on the 14th of February 2022.

1.2. Background and Relevant Documentation

The Department of Water and Sanitation identified the need for augmentation of the Western Cape Water Supply System some years ago and proceeded with pre-feasibility and feasibility studies into potential surface water development options, which led to the identification of the BRVAS as the preferred option. As part of the previous studies an Access Road Feasibility Study was conducted by Messrs Sturgeon Consulting and completed in mid-2018. For ease of reference the report is attached as Annexure A to this report. The study assessed the wider road network in and around the project area and the proclaimed provincial road network servicing the area is indicated in Figure 1 below.

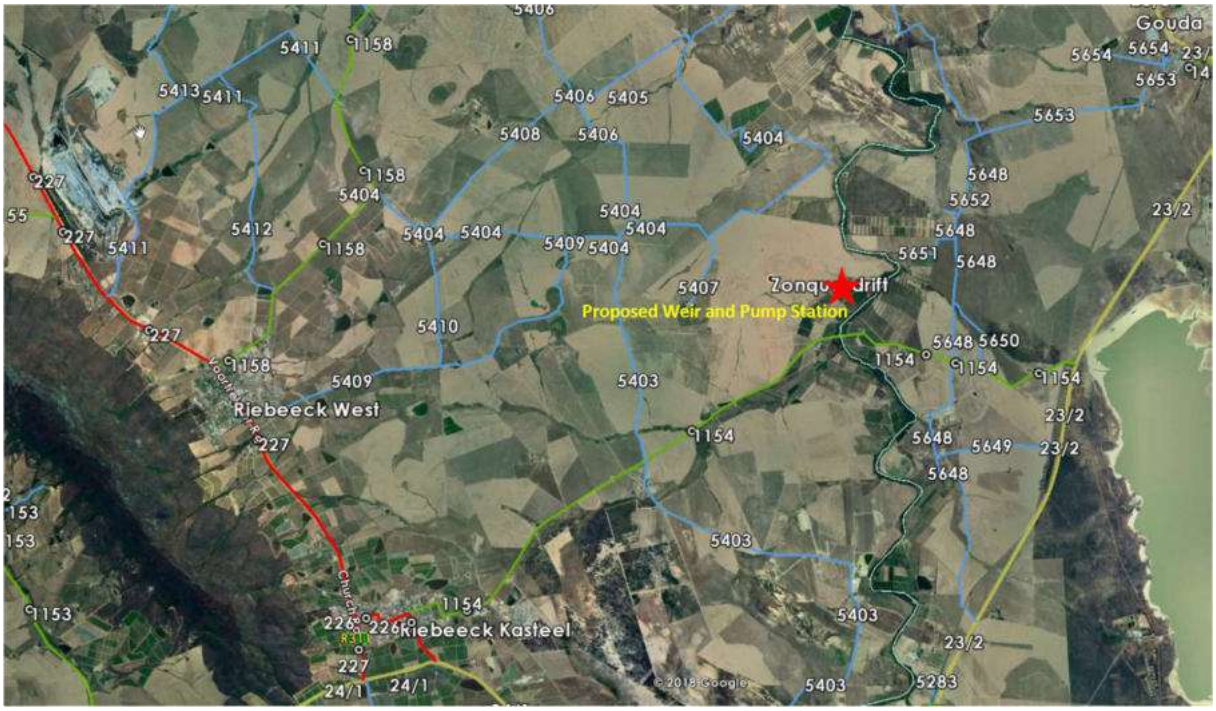

Figure 1: Proclaimed Provincial Road Network (Public Road Right of Way)

The feasibility study addressed among other the following traffic engineering aspects:

- Site observations;
- Engagement with relevant Provincial Roads Departments;
- Traffic counts at the following intersections;
  - TR2302/DR1154 (Voëlvlei Dam - R46) (Pieter Cruythoff Avenue/R46)
  - MR226/DR1154 (Riebeek Kasteel) (Retief Street/Hermon Street)
- Analysis of traffic impact during construction and operational phases;
- Confirmation of upgrade standards from Provincial Roads Design Branch; and
- Conceptual Cost Estimate for possible road upgrades and maintenance thereof.

The consolidated recommendations of the abovementioned feasibility study are listed below:

- That the existing Proclaimed Public Road Network (OP5403 and OP5404; also referred to as 'Minor Roads') be used as the preferred access to the Site during both the Construction Phase (±10 months) and Operational Phase (5 to 6 months in the Winter).
- A 40 km/h speed limit be implemented on the proposed access road with the approval of the Western Cape Department of Transport and Public Works (DT&PW).
- As this is not a change in land use application, access via OP5403 and OP5404 is legal for the construction of the weir and pump station. However, it is unlikely that the Department of Transport and Public Works will contribute towards the upgrade of the road. The District Roads Engineer (DRE) in Ceres may assist with grading the road during the construction period.
- The necessary dust suppression measures be implemented.

During the initial stages of the development of the contract documentation and concept designs for the BRVAS project a few aspects were identified that required amendments to the abovementioned feasibility study.

These aspects are the following:

- The utilisation of OP5403 was discarded for the following reasons;
  - Horizontal geometric alignment that included more sharp bends than OP5404, and
  - Numerous gates installed by farmers to control livestock movement and improve security.
- Inclusion of access via OP5648 to the area for construction of the earth-fill embankment on the right bank of the river.

1.3. Location of Roads

Following initial investigations, the roads to be included in this report for assessment and concept design (in the case of the permanent access road to the pumping station) were finalised and are shown in Figure 2 below.

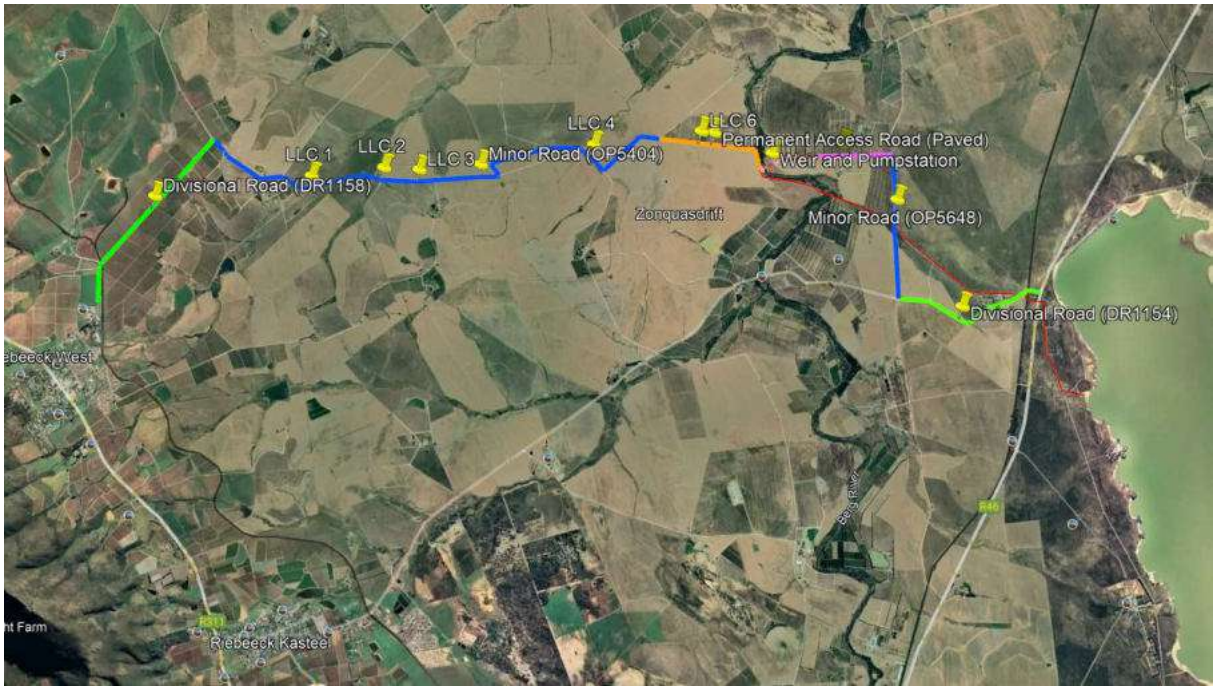

Figure 2: Roads providing access to the Site

2. DESIGN CRITERIA / CONSIDERATIONS

This section highlights the following:

- Design considerations to be considered by the contractor in the taking over, maintaining and handing back of provincial roads (unpaved Divisional Roads and Minor Roads) to the DT&PW.
- Design criteria / considerations in the design of the permanent access road to the proposed pumping station.

2.1. Provincial Roads

a) General

i) Divisional Roads

Divisional Roads are mostly paved and where access is assumed via paved roads no further investigations were carried out in line with discussion with the DT&PW. However, where Divisional Roads are not paved the Dynamic Cone Penetrometer (DPC) testing was carried out.

ii) Minor Roads

Minor Roads are not paved and where access is assumed, Dynamic Cone Penetrometer (DPC) testing was carried out along the centre lines of these roads.

The abovementioned approach was followed to determine the basic condition of the gravel roads and to assess their suitability to accommodate construction vehicle traffic. The results enabled the AEJV to recommend preventative measures, routine maintenance measures and close-out measures to ensure that the roads will be handed back to the DT&PW at the end of construction in a condition similar or better than at the start of construction activities.

b) Road Signage and Traffic Management

i) Road Signage

All road traffic signs are to be designed and installed as per the South African Road Traffic Signs Manual – Revision 2015.

ii) Traffic Management & Safety

The contractor shall compile a holistic site wide Traffic Management Plan that will be submitted to the DT&PW and the Engineer for approval and acceptance. The contractor shall introduce the following:

- Ensure that the speed limit as prescribed in the Design Considerations is adhered to.
- Fit all road going construction vehicles with a satellite tracking system that will record all traffic movement in real time.
- Data recorded will be assessed for transgressions and handed over to the client on a monthly supported by a report highlighting transgressions and remedial steps taken to rectify behaviour of drivers/operators.

2.2. Permanent Access Road

a) Geometric Design

The geometric design standards should follow the TRH17 guidelines. A summary of the recommended Design Criteria for the permanent access road is included in Table 1 below.

Table 1: Summary of Design Standards for the Access Road

Description		Value
General	Design vehicle: Geometry	WB-12 Truck
General	Design vehicle: Stop sight distance	Passenger car
General	Design Speed: General areas	30 km/h
General	Design Speed: Intersections and 90º bends	< 15 km/h
HOR	Road width	4.0 m
HOR	Lane width	N/A
HOR	Minimum Radius: General areas	60 m
HOR	Minimum Radius: Intersections and 90º bends	25 m
HOR	Stop sight distance	50 m
HOR	Eye height	1 080 mm
HOR	Object Height	600 mm
Cross-fall	General cross fall slope	2%
Cross-fall	Maximum Super elevation	N/A
Cross-fall	Runoff Length Total	N/A
Cross-fall	Runoff Length on straight	N/A
Cross-fall	Runoff Length on curve	N/A
VER	Maximum grade: Flat areas	6%
VER	Min K-value: Crest	12
VER	Min K-value: Sag	12
VER	Minimum Curve Length	60 m

b) Pavement Design

i) Standards and Codes

The following standard specifications and codes of practice are relevant to the design of the internal and access roads:

- Structural Design of Flexible Pavements for Interurban and Rural Roads: TRH4; 1996.
- Traffic Loading for Pavement and Rehabilitation Design: TRH 16; 1991.
- Standard Specification of Road and Bridge Works for State Road Authorities: COLTO; 1998
- All road traffic signs are to be designed and installed as per the South African Road Traffic Signs Manual – Revision 2015.
- South African Pavement Engineering Manual (SAPEM): Chapter 10: Pavement Design; 2013.
- Design of Segmental Block Pavements for South Africa: UTG2 ;1987.
- Human Settlement Planning and Design Volume 2: ISBN 0-7988-5498-7

ii) Design Parameters

The following general parameters were utilized to define the functional requirements of the road pavement and the environmental conditions under which they must perform:

- Base year for analysis: 2022
- Pavement Design Life: 20+ years
- Road Category: UC
- Design Confidence Limit: 80%
- Required subgrade cover: 800mm
- Pavement Type (s): Semi -rigid

iii) Traffic Analysis

The permanent road will only be used when maintenance is required. An UC street category is considered feasible for this project. It is required that a **design class of ES1** is considered for this road.

c) Drainage Design

The design criteria for storm water are summarised in Table 2 below:

Table 2: Design Criteria for Drainage Structures

Description	Value
Flood return period	1:5 years
Minimum time of concentration or storm duration	To be determined
Runoff coefficient: for Rational Method	To be determined
Design method	Rational method
Minimum Pipe Diameter	600 mm ND class 100D external, to SANS 10677
Minimum pipe gradient	0.67% - 1:150
Low-level crossings	As per the details of DRAWING NO. 021.001-A-C6-200

d) Fencing

The road shall be fenced off by means of a seven-strand barbed wire cattle fence and provided with a lockable vehicle gate at the junction with Minor Road OP5404.

2.3. Temporary Access Roads

a) General

A summary of the Design Criteria for the temporary access roads Table 3 below.

Table 3: Design Criteria for Temporary Access Roads

Description		Value
General	Design vehicle: Geometry	WB-15 Truck
General	Design vehicle: Stop sight distance	Passenger car
General	Design Speed: General areas	30 km/h
General	Design Speed: Intersections and 90º bends	< 15 km/h
General	Lane separation to be applied by means of a safety earth-fill berm to separate construction vehicles	Earth-fill berm to be a minimum height of half the design vehicle wheel diameter
HOR	Road width	5.0 m
HOR	Lane width	N/A
HOR	Minimum Radius: General areas	60 m
HOR	Minimum Radius: Intersections and 90º bends	25 m
HOR	Stop sight distance	50 m
HOR	Eye height	1 080 mm
HOR	Object Height	600 mm
Cross-fall	General cross fall slope	3%
Cross-fall	Maximum Super elevation	N/A
Cross-fall	Runoff Length Total	N/A
Cross-fall	Runoff Length on straight	N/A
Cross-fall	Runoff Length on curve	N/A
VER	Maximum grade: Flat areas	6%
VER	Min K-value: Crest	12
VER	Min K-value: Sag	12
VER	Minimum Curve Length	60 m

b) Fencing

The roads shall be fenced off by means of a seven-strand barbed wire cattle fence and provided with a lockable vehicle gates at the junction with Minor Roads OP5404 and OP5648.

3. DESIGN

3.1. Provincial Roads

a) General

The gravel roads were evaluated in terms of the DCPs that were conducted on the centreline of the road. The DCP in general indicated, fair bearing capacity when compared to a traffic curve of 20 to 60 heavy vehicles per day.

The upper 200 mm of the road must be ripped, reworked, shaped and compacted to ensure a camber shaped base with 3% crossfall. The road shall be ripped and reshaped every 6 months to ensure no corrugation. If treated with Nano-Modified Emulsions (NME) or similar approved these processes can be delayed depending on the performance.

b) Dust Suppression

Treatment of gravel roads to protect the gravel layer and reduce dust.

All preparations of the NME materials and construction processes and testing as per normal construction and rehabilitation of roads shall be included in a project specification. The surface of the wearing course should receive additional treated as follows:

- Providing a temporary wearing course

Immediately after completion of the compaction described in subsection (l), Nano-Silane Nano-Polymer prime shall be applied to the finished surface using a water truck (or by hand sprayer) at a pray rate of 1 ℓ/m². The spray rate may be adjusted by the Engineer following a trial section of not less than 100 m.

As alternative, a 50:50 diluted anionic NME may be sprayed onto the layer and compacted using a steel wheeled roller with a mass of not less than 12 tons each, and/or with pneumatic rollers.

The following process is to be followed:

1. Immediately after compaction, slushing of the surface will commence: Spray 1 ℓ/m² of the diluted NME onto the surface followed immediately with further compaction by means of a 13-ton vibratory roller which must follow directly behind the water cart. A 22-ton pneumatic tyre roller (PTR) must then follow directly behind the vibratory roller.
2. Turn around and on the same strip have the water cart first drenching the surface with a further 1 ℓ/m² diluted NME. This time the pneumatic tyre roller follows directly behind the water cart and the vibratory roller follows closely behind the PTR. It is important that the water cart and roller must always work in close tandem; to prevent any pick-up of the material onto the drum of the vibratory roller (although unusual with nano-modified emulsion).
3. Continue points 1 and 2 until the total area to be worked is completed.
4. The area treated then is to be kept closed to traffic for it to properly set (until the top 50 mm of the layer has dried out) with the moisture content of OMC < 50%. The time of required closure is dependent on the prevailing weather and may be as short as 1 hour. Due to the addition of the silane modification a hydrophobic material surface is created, and water is effectively repelled from the layer. Hence, stabilised layers constructed using an anionic NME stabilising agent normally dries much quicker than pavement layers treated using traditional emulsion stabilisation processes which depend only on evaporation as a method of drying. In dry and hot conditions, a pavement layer can sufficiently dry within a period of less than 24 hours to reach 50% of OMC.

The final surface should be smooth, tightly knit, and free of undulations, corrugations, holes, bumps or loose material.

The application of an applicable compatible prime (i.e. a recommended compatible Nano-silane Nano-Polymer based prime) when the base has reached a moisture content of 50% of OMC should prevent most damage under conditions of light trafficking in urban areas. Heavy brushing with soft bristles is recommended prior to the application of the prime to remove any dust or loose materials on the surface, not disturbing the surface itself. The instructions of the supplier should apply - the risk remains with the contractor to achieve an acceptable required base condition after application of the prime. Experience has shown that an applicable Nano-silane Nano-Polymer modified prime will dry within an hour. In cases where the surfacing is applied immediately, the prime may be substituted by an appropriate specified tack-coat. However, this is only applicable to cases where the contractor can ensure that the surfacing material and equipment is available for immediate application.

Additional protection of the surface can be provided by the application of a Nano-Silane Nano-Polymer “clear seal”. The clear seal is applied as per product specifications using a diluted compatible nano-silane modified nano-polymer (applied at 1.6 ℓ to 2 ℓ/m^2) clear surfacing similar to a traditional prime, but with an extended expected duration, especially on fine graded materials.

Details regarding the recommended material specifications for the treatment of wearing courses of gravel roads treated / stabilised with anionic NME are provided in Table 4 below.

Table 4: Recommended Material Specifications for the Treatment of Wearing Courses of Gravel roads treated / stabilised with anionic NME

Test or Indicator	Material[1]	Material classification NME4- WC
Minimum material requirements before stabilisation and/or treatment (Natural materials)		
Material spec.(minimum) Unstabilised material: Soaked CBR (%)(Mod AASHTO)	NG/GS/SSSG (CS)	> 7 (93%)
Sieve analysis % passing the 0.075 mm sieve ($P_{0.075}$)		< 50 %
XRD scans: - Total sample - 0.075 mm fraction	ALL ALL	√ √
The greater of: Identified % Silt and Clay, or % Material passing 2 µm ($P_{0.002}$) (e.g. Clay & Mica & Talc), with Talc <10%) (XRD-scans of the material passing the 0.075 mm sieve is recommended for use to determine the % clay, mica and talc in the material).	NME with emulsion particle size > 2 µm	
	ALL	< 15 %
	NME containing micro-scale as well as nano-scale particles (adjusted according to material grading)	
	ALL	< 35%
	NME with emulsion containing nano-scale and pico-scale particles (grading adjustments) together with technologies addressing workability of materials on site	
	ALL	> 35%
Material specifications after stabilisation and/or treatment		
In-situ density to be required after stabilisation and compaction (mod AASHTO) (%) (minimum)	Base-layer	> 97 %
DCP DN (mm/blow) – Adjusted for Climate (C_f)[2] (stabilised and compacted) (Quality control)	Top of base	< 3.5 / (C_f)
Mod AASHTO density (%) (for laboratory testing)		> 100%
*UCS_{wet} (kPa) (150 mm Φ Sample)	**Design[3]**	**> 750**
	Construction[4]	**> 450**
Retained Compressive Strength (RCS): (UCS_{wet}/UCS_{dry}) (%)		> 75
RCS in relation to minimum $UCS_{wet\ (criteria)}$ ($RCS_{effective}$): (RCS x ($UCS_{wet}/UCS_{wet\ (criteria)}$)) (%)		> 100
*ITS_{wet} (kPa) (150 mm Φ Sample)	**Design[3]**	**> 100**
	Construction[4]	**> 80**
Retained Tensile strength (RTS): ITS_{wet}/ITS_{dry} (%)		> 60
RTS in relation to minimum $ITS_{wet\ (criteria)}$ ($RTS_{effective}$) ((RTS x ($ITS_{wet}/ITS_{wet\ (criteria)}$)) (%)		> 100

[1]CS–Crushed Stone; NG – Natural Gravel; GS – Gravel Soil, and SSSC – Sand, Silty sand, Silt, Clay. UCS_{dry}; ITS_{dry} = testing after rapid curing; UCS_{wet}; ITS_{wet} = testing after rapid curing + 4 hours in water;

[2]Climatic factor (C_f) (Jordaan and Steyn, 2019) for required DCP-DN

Design[3] = Minimum criteria to be met in the laboratory during the design phase

Construction[4] = Minimum criteria to be met during construction as part of quality control

c) Geometric Design

No amendments are proposed to the geometric design of the provincial roads.

d) Drainage Design

Road drainage improvements are recommended at the locations along the OP5404 as indicated on DRAWING NO. 021.001-A-C3-206 (included in Annexure B). These improvements are aimed at providing save crossing of minor water courses during the rainy season. As a minimum these improvements shall include the following:

- Providing low-level crossing structures as indicated on DRAWING NO. 021.001-A-C6-200 (included in Annexure B), suitable to accommodate construction traffic.
- Providing side drains as required, leading up to these crossings.
- All low-level crossing structures must be designed to accommodate a flood with a 1 in 5-year recurrence interval.
- Maximum water depth during the abovementioned flood event must be limited to 150 mm across the base of the low-level crossing structures.

e) Road Traffic Signs

Appropriate road traffic signs must be erected at the following points:

- **Information signs:** At entry points onto the Minor Road system that will be used by construction traffic. To be approved by the DT&PW and the Engineer.
- **Warning signs:** At regular intervals indicating the speed limit as per the Design Criteria.
- **Warning signs:** At railway crossings and low-level water crossings.
- **Warning signs:** At points before sharp bends indicating prompting drivers to reduce speed. The signs must also highlight the reduced speed limit through these sections as per the Design Criteria.

3.2. Permanent Access Road

a) Geometric Design

The geometric design of the permanent access road must conform to the Design Criteria and be guided by the design as included on the following conceptual design drawings (included in Annexure B):

- DRAWING NO. 021.001-A-C3-201
- DRAWING NO. 021.001-A-C3-202
- DRAWING NO. 021.001-A-C3-203
- DRAWING NO. 021.001-A-C3-204
- DRAWING NO. 021.001-A-C3-205

b) Pavement Design

The parameters that were used for the pavement structure are as follows:

- Typical vehicle Heavy deliveries and Farm vehicles
- Road Category UC

It is anticipated that light vehicles (including taxes and short heavy vehicles) will make use of the access road. Provision should be made in the design for this possibility.

Based on the above Table 5 below includes a concept pavement design for the permanent access road.

Table 5: Proposed Pavement Structure based on Human Settlements Guide

Thickness (mm)	Layer	Type of Layer	Description
80	Base	Interlocking paving blocks (type S-A)	Laid in herringbone bond
20	Bedding Sand	Sand (SND)	Commercial clean river sand, grading as per COLTO 7302 (a)
150	Sub-base	Stabilised Natural gravel (C4), Imported Material	Min. UCS of 1.5 MPa at 100% Mod. AASHTO, min ITS of 250 kPa at 100% Mod. AASHTO compacted to 97% MDD
150	Upper Selected /Fill	Natural gravel (G7), Imported Material	Compacted to 95% Mod. AASHTO density, min. CBR of 15% at density specified for the layer, Max PI of 12 or 2(GM)+10. Compacted in 150 mm layer lifts.
Semi-infinite	In-situ	In situ	Rip and recompact 300 mm in place. Apply three roller pass treatment to the roadbed using a vibrating roller or padfoot roller and finished off with a single axle pneumatic roller. If stable, compact the roadbed to at least 93% of MDD.

c) Drainage Design

Drainage must conform to the Design Criteria and be guided by the design as highlighted in DRAWING NO. 021.001-A-C6-200 (included in Annexure B).

As a minimum the drainage infrastructure shall include the following:

- Providing low-level crossing structures as indicated on the abovementioned drawings.
- Providing trapezoidal side drains as required, leading up to these crossings.
- All low-level crossing structures and trapezoidal side drains must be designed to accommodate a flood with a 1 in 5-year recurrence interval.
- Maximum water depth during the abovementioned flood event must be limited to 150 mm across the base of the low-level crossing structures.

d) Road Traffic Signs

Warning signs: At points before sharp bends indicating prompting drivers to reduce speed. The signs must also highlight the reduced speed limit through these sections as per the Design Criteria.

3.3. Temporary Access Roads

The designs by the contractor shall conform to the Design Criteria proposed in Section 2.3 of the report and shall be submitted to the Engineer for acceptance.

In his design the contractor shall ensure the following:

- The roadbed preparation and pavement design are in accordance with the requirements of the proposed construction vehicles.

- Drainage is of such a nature to minimise erosion and mitigate any negative impact on adjacent land.
- Dust suppression is carried out in accordance with the Design Criteria.
- Upon completion of the project all temporary access roadworks is to be removed and the areas used for the temporary roads must be rehabilitated to their former condition.

4. 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 access roads. It further provides details regarding Design Criteria / Considerations that are included in the Employer's Requirements and that will have to be met by the contractor in his design of the roads.

ANNEXURE A

Access Road Feasibility Study, Draft Report dated May 2018

No 5 Kleinmelkbos, George Mellet Crescent, Melkbosstrand, 7441
Postnet Suite #347, Private Bag x1, Melkbosstrand, 7437
t: 021 553 4167 f: 086 559 5327

BERG RIVER-VOËLVLEI AUGMENTATION SCHEME (BRVAS)

ACCESS ROAD FEASIBILITY STUDY

Project No.: STUR0219

DRAFT REPORT
May 2018

PREPARED BY:
STURGEON CONSULTING (PTY) LTD
Postnet Suite 347
P/Bag x1
Melkbosstrand
7437

CONTACT PERSON:
Barend du Preez
Tel no: +27 (0)83 701 2299

PREPARED FOR:
NEMAI CONSULTING
PO Box 1673
Sunninghill
2157

CONTACT PERSON:
Ms S Gerber
Tel no: +27 (0)11 781 1730

DOCUMENT CONTROL SHEET

DATE	REPORT STATUS	AUTHORED BY:	APPROVED BY:
14 May 2018	Draft for comment	NAME Sarah Larratt, Pr. Tech Eng	NAME Barend du Preez, Pr. Eng
		SIGNATURE 	SIGNATURE 
		NAME	NAME
		SIGNATURE	SIGNATURE

TITLE:

BERG RIVER-VOËLVLEI AUGMENTATION SCHEME (BRVAS)

ACCESS ROAD FEASIBILITY STUDY

CARRIED OUT BY:
Sturgeon Consulting
Postnet Suite #347
Private Bag x1
Melkbosstrand
7437

Tel: +27 21 553 4167
Fax: +27 86 559 5327
Email: barend@sturgeonsa.co.za

COMMISSIONED BY:
NEMAI CONSULTING
PO Box 1673
Sunninghill
2157

Ms S Gerber

Email: SamanthaG@nemai.co.za

SYNOPSIS:
The primary purpose of this report is to evaluate the feasibility of the proposed access roads for the construction and operation of the weir and pump station on Portion 1 of Farm Sonquas Doordrift 648.

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FIGURES

TABLES

ACRONYMS

BRVAS - Berg River-Voëlvlei Augmentation Scheme
EIA - Environmental Impact Assessment
TIA – Transport Impact Assessment
WTW - Water Treatment Works
WCG – Western Cape Government
NMT – Non-Motorised Transport
vph – Vehicles per Hour
COTO – Committee of Transport Officials
AMP – Access Management Plan
LOS – Level of Service
GLA – Gross Leasable Area
IPTN – Integrated Public Transport Network
AM – Morning
PM – Afternoon
d – Delay in Seconds

1. INTRODUCTION

1.1 APPOINTMENT AND BACKGROUND

Nemai Consulting has appointed Sturgeon Consulting to undertake a feasibility study for the alternative access roads to the proposed weir and pump station for construction and future maintenance of the Berg River-Voëlvlei Augmentation Scheme (BRVAS) as part of the Environmental Impact Assessment (EIA) for the Proposed Surface Water Developments for Augmentation of the Western Cape Water Supply System.

Department of Water and Sanitation identified the need for augmentation of the Western Cape Water Supply System by 2019 and proceeded with pre-feasibility and feasibility studies into potential surface water development options. Initially six options were assessed at a pre-feasibility level of detail. These options were then prioritized to identify the two most viable options. These were:

- Berg River-Voëlvlei Augmentation Scheme (also known as the First Phase Augmentation of Voëlvlei Dam); and
- Breede-Berg Transfer Scheme (also known as the Michell's Pass Diversion Scheme).

Ultimately, the Feasibility Study found that the BRVAS option was the most favourable surface water intervention and as such the Department of Water and Sanitation proposes to implement this scheme which involves the transfer of approximately 23 million m3 per annum from the Berg River to the existing Voëlvlei Dam (i.e. the yield of the dam would be 23 million m3 per annum more than it is currently).

The proposed project is situated in Western Cape in the Drakenstein Local Municipality of the Cape Winelands District as well as the Swartland Local Municipality of the West Coast District.

The proposed developments fall within the Berg River Catchment of the Berg–Olifants Water Management Area. Both Voëlvlei Dam and the Lorelei abstraction site are located in quaternary catchment G10F of the Berg River Catchment.

The project components include the following:

- A low-level weir, abstraction works and 4 m3/s raw water pump station on the Berg River;
- A rising main pipeline from the Berg River to Voëlvlei Dam; and
- A potential new summer release connection at the existing Swartland Water Treatment Works (WTW) to facilitate summer releases into the Berg River for environmental requirements thus eliminating the need to utilize the existing canal from which water losses occur.

All the infrastructure and activities that require environmental authorisation need to be assessed as part of the Environmental Impact Assessment. In this regard, the following associated infrastructure was identified:

- Abstraction works;
- Rising main pipeline and pump station;
- Diversion weir;

- Access roads during construction;
- Access roads during operation; and
- Construction camp (footprint).

1.2 SCOPE OF THIS REPORT

The primary purpose of this report is to evaluate the feasibility of the proposed access roads for the construction and operation of the weir and pump station on Portion 1 of Farm Sonquas Doordrift 648.

The scope of work for this feasibility study includes following traffic engineering aspects:

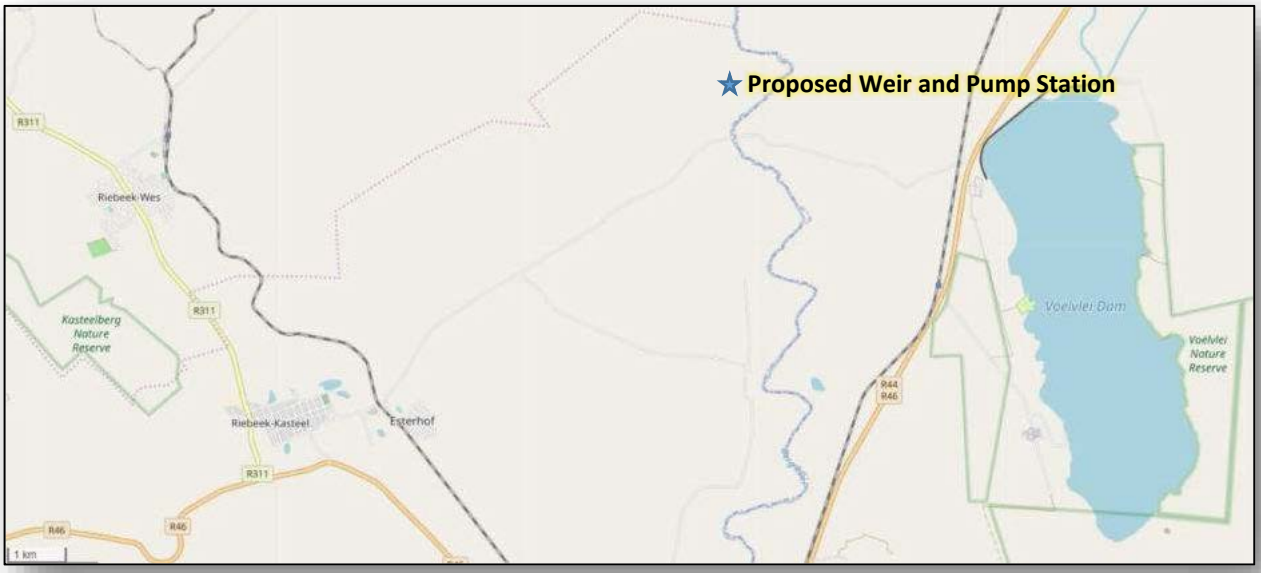
- Site observations
- Engagement with relevant Provincial Roads Departments
- Traffic counts at the following intersections:
    - TR2302/DR1154 (Voelvlei Dam - R46) (Pieter Cruythoff Avenue/R46)
    - MR226/DR1154 (Riebeeck Kasteel) (Retief Street/Hermon Street)
- Analysis of traffic impact during construction and operational phases
- Confirmation of upgrade standards from Provincial Roads Design Branch
- Conceptual Cost Estimate for possible road upgrades and maintenance thereof

2. SITE LOCATION

The proposed weir and pump station (hereafter called the Site) for the BRVAS are located in Berg River in the Zonquasdrift area halfway between Riebeeck West and Gouda as shown in **Figure 2.1** below.

Figure 2.1 – Site Location (Weir and Pump Station)

Source: Google Maps



Source: OpenStreetMap

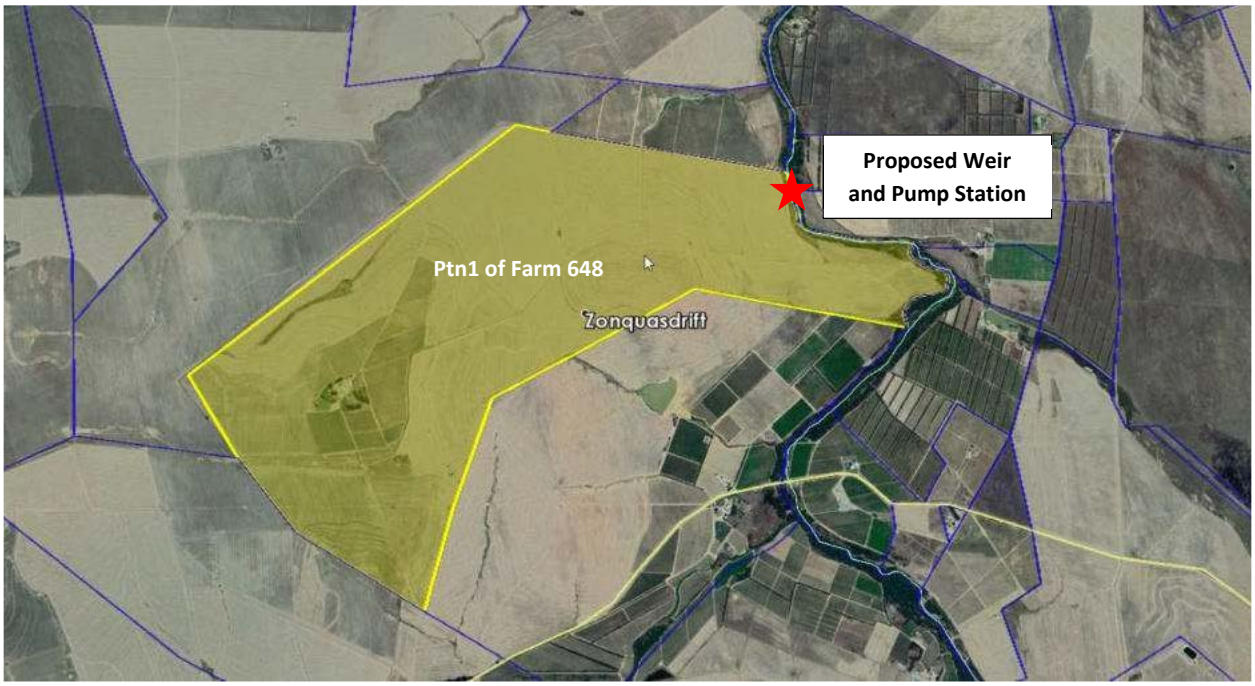
The different components of the proposed BRVAS project are illustrated in **Figure 2.3** and include the following:

- A low-level weir, abstraction works and 4 m^3/s raw water pump station on the Berg River;
- A rising main pipeline from the Berg River to Voëlvlei Dam; and
- A potential new summer release connection at the existing Swartland Water Treatment Works (WTW) to facilitate summer releases into the Berg River for environmental requirements thus eliminating the need to utilize the existing canal from which water losses occur.

The following infrastructure and activities requires environmental authorisation as part of the EIA. This included the following associated infrastructure:

- Abstraction works;
- Rising main pipeline and pump station;
- Diversion weir;
- **Access roads during construction;**
- **Access roads during operation**; and
- Construction camp (footprint).

Figure 2.2 – Close-up Aerial View of Location of proposed Weir and Pump Station



During the EIA process 2 access road routes were identified over Portion 2 of Farm 648 and Portion 1 of Farm 648 as indicated in **Figure 2.3**. Access Road 1 was identified as the preferred route as indicated in **Figure 2.4**. The preferred access road is approximately 6.6km long and runs along the western and northern boundary of the 2 farms. Possible access via public roads were not considered.

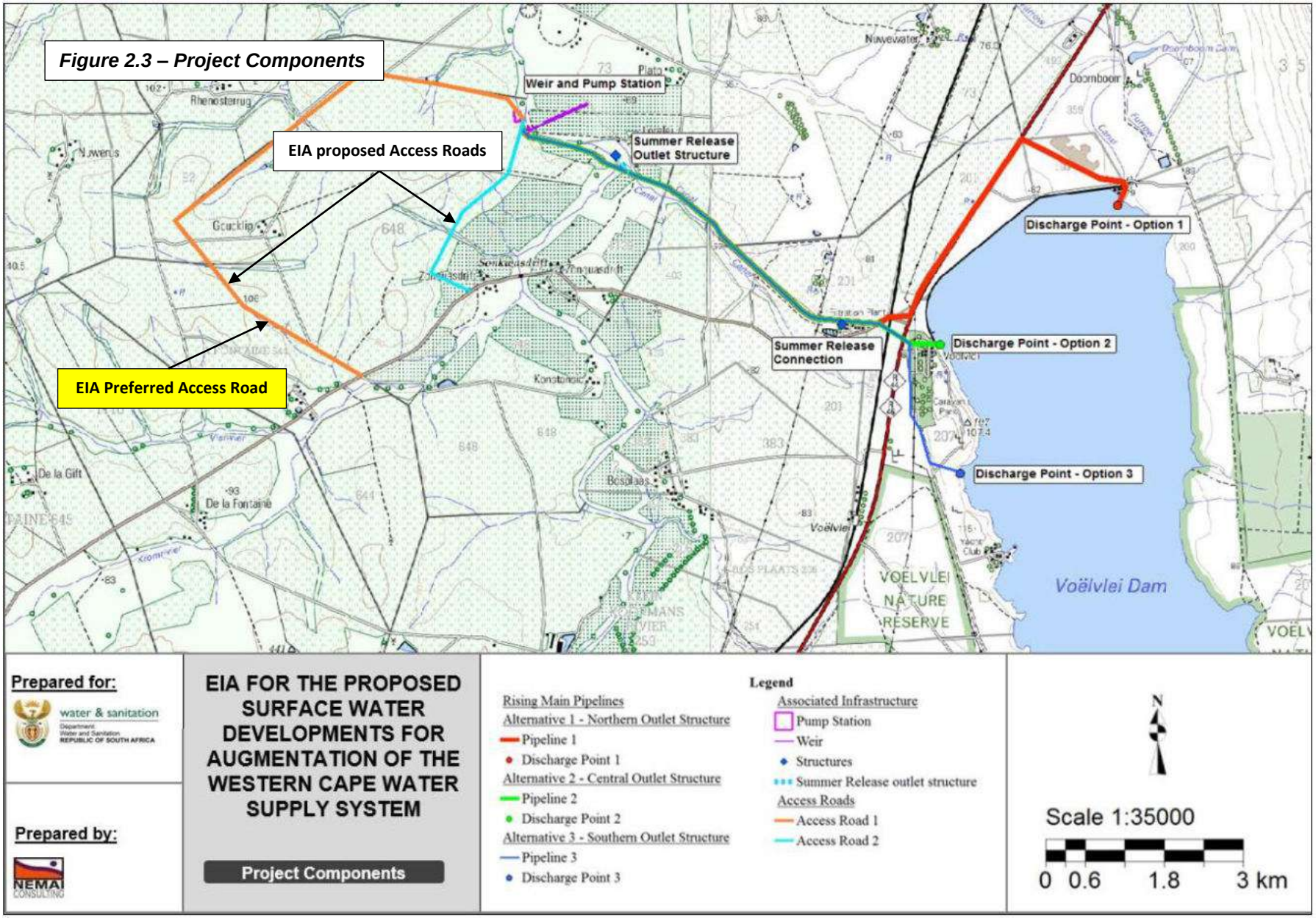
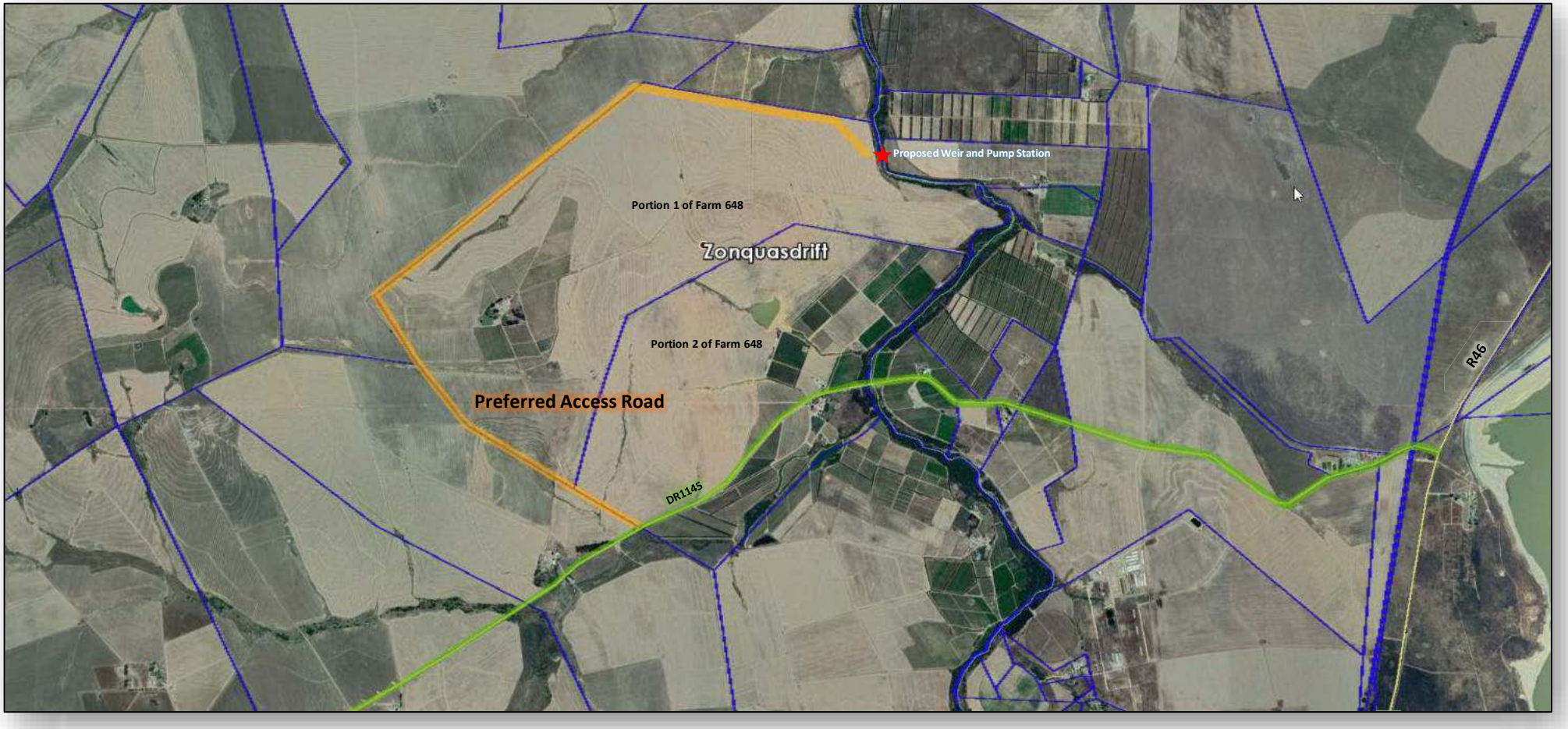


Figure 2.3 – Project Components
Weir and Pump Station
Summer Release Outlet Structure
EIA proposed Access Roads
EIA Preferred Access Road
Summer Release Connection
Discharge Point - Option 1
Discharge Point - Option 2
Discharge Point - Option 3
Voëlvlei Dam
VOELVLEI NATURE RESERVE
Prepared for:
water & sanitation
Prepared by:
NEMAI CONSULTING
EIA FOR THE PROPOSED SURFACE WATER DEVELOPMENTS FOR AUGMENTATION OF THE WESTERN CAPE WATER SUPPLY SYSTEM
Project Components
Legend
Rising Main Pipelines
Alternative 1 - Northern Outlet Structure
Pipeline 1
Discharge Point 1
Alternative 2 - Central Outlet Structure
Pipeline 2
Discharge Point 2
Alternative 3 - Southern Outlet Structure
Pipeline 3
Discharge Point 3
Associated Infrastructure
Pump Station
Weir
Structures
Summer Release outlet structure
Access Roads
Access Road 1
Access Road 2
N
Scale 1:35000
0 0.6 1.8 3 km

Figure 2.5: EIA Preferred Access Road



3. EXISTING ROAD INFRASTRUCTURE AND TRAFFIC DEMAND

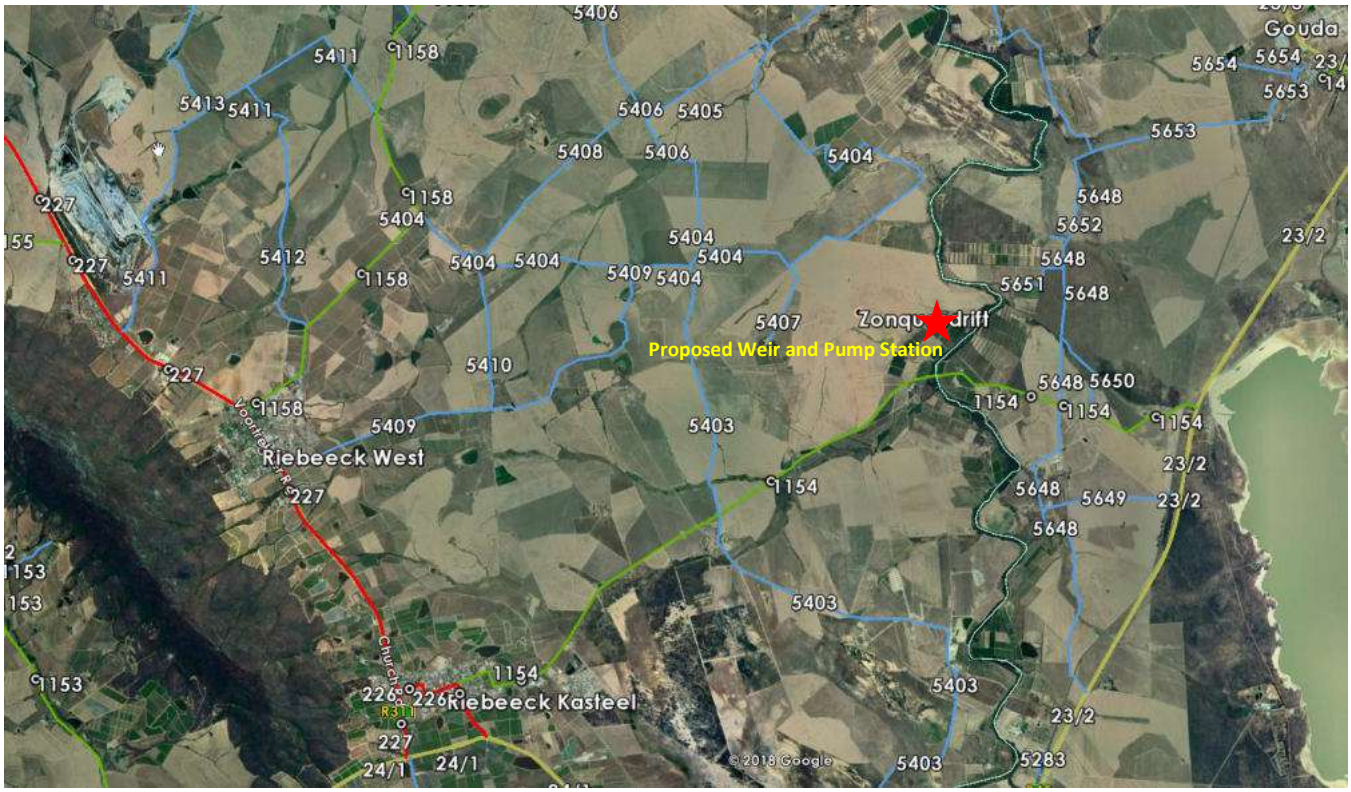
3.1 EXISTING ROAD INFRASTRUCTURE

The surrounding proclaimed public road network consists of the following roads as shown in **Figure 3.1**.

The main roads that could provide access to the project are:

- Main Road 227 (MR227) (R311) which provides regional access from Trunk Road 24 Section 1 (TR24/1) (R46) via Riebeeck Kasteel;
- MR226 through Riebeeck Kasteel providing a link between MR227 and TR24/1;
- Trunk Road 23 Section 2 (TR23/2) (R44) which connects Paarl/Wellington with Gouda and Tulbagh;
- Divisional Road 1154 (DR1154) which provides an east-west link between Riebeeck Kasteel and TR23/2; and
- Several Minor Roads provide access to the different farms in the vicinity of the project:
  - Minor Road 5403 (OP5403) which links DR1154 with OP5404; and
  - OP5404 which links DR1158 with OP5405;

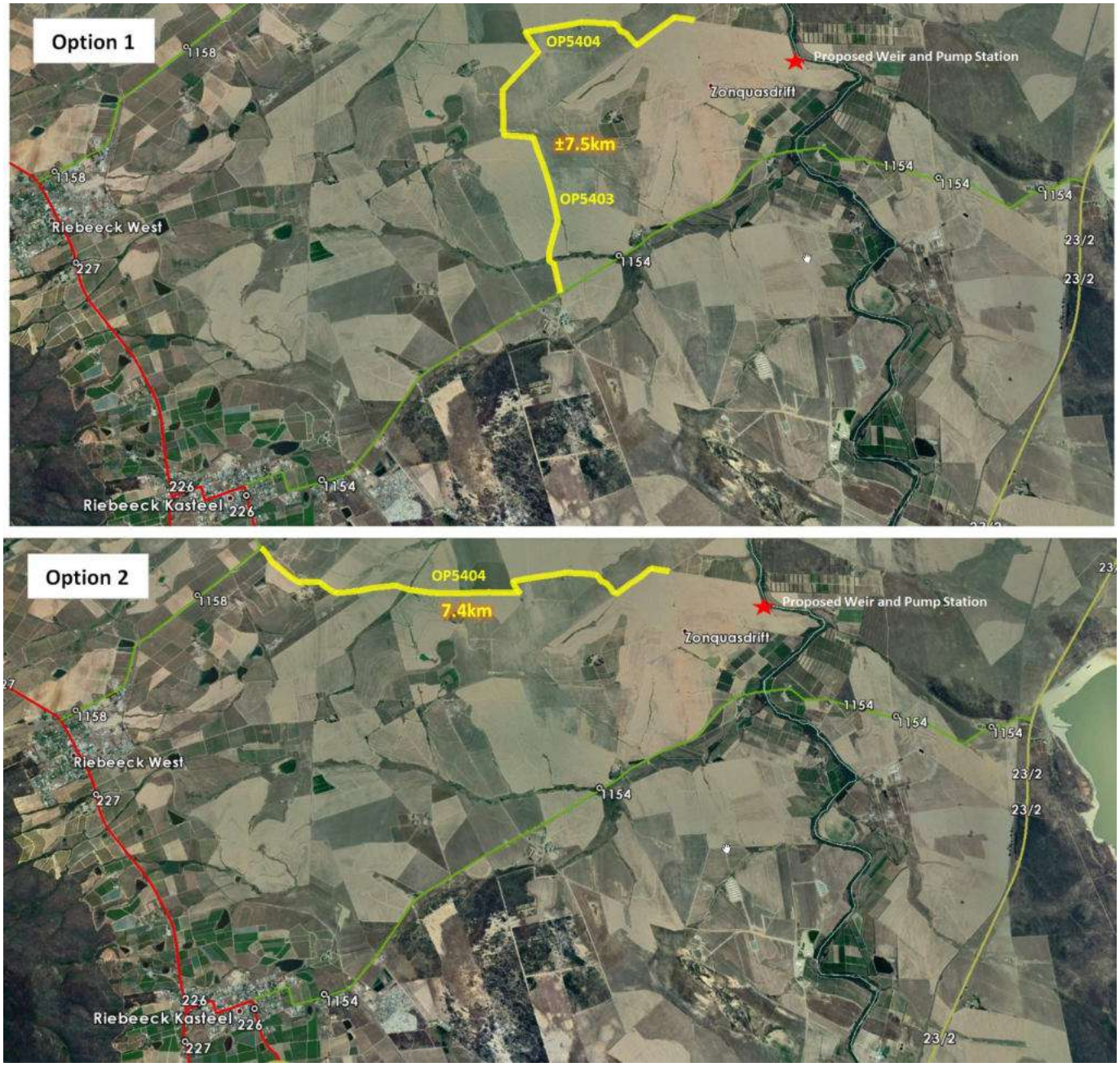
Figure 3.1 – Proclaimed Provincial Road Network (Public Road Right of Way)



3.2 POSSIBLE MINOR ROAD ACCESS ROUTES TO THE SITE

Several Proclaimed Minor Roads (OP) can provide public access to the Site. The first option, also the option on which this feasibility study is focussed, are OP5403 and OP5404 which is approximately 7.5km long. However, and alternative exists via OP5404 from the west (Riebeeck West) which is approximately 7.4km long as illustrated in **Figure 3.2**. Both these roads connect different farms with the major road network and has a public road right of way.

Figure 3.2 – Two Possible Proclaimed Minor Road (OP) Access Options



Option 1 can be accessed via DR1154 from Riebeeck Kasteel in the west and the R44 in the east adjacent to Voëlvlei dam.

Option 2 provides access from Riebeeck west via DR1158.

3.3 TRAFFIC DEMAND

The main access route to the Site is via DR1154 (Pieter Cruythoff Avenue) from either Riebeeck Kasteel or Voëlvlei Dam (R44). Depending on the choice of route to the Site the existing traffic demand along DR1154 were determined via 12-hour classified traffic counts that were conducted on 6 March 2018 at the following intersections as indicated in **Figure 3.3**:

- MR226 (Piet Retief Street/Hermon Street) – the main intersection providing access to DR1154 (4-way stop)
- DR1154 (Pieter Cruythoff Avenue)/TR23/2 (R46) – the T junction on the R46 (Stop control on DR1154)

The Road Network Information System operated by Western Cape Department of Transport and Public Works contains a Traffic Counting System (TCS) which serves the Western Cape Provincial Network and has been around since 1999. The main emphasis of the system is on Trunk, Main and Divisional roads - currently only Minor Roads (OPs) that intersect with more important roads are on the system. The TCS comprises of two "types" of counts namely: - Short Term and Permanent Counts. No Permanent counts are located close to the Site.

There are 3 TCS stations along DR1154 for which counts were recently conducted and indicated **Figure 3.3**:

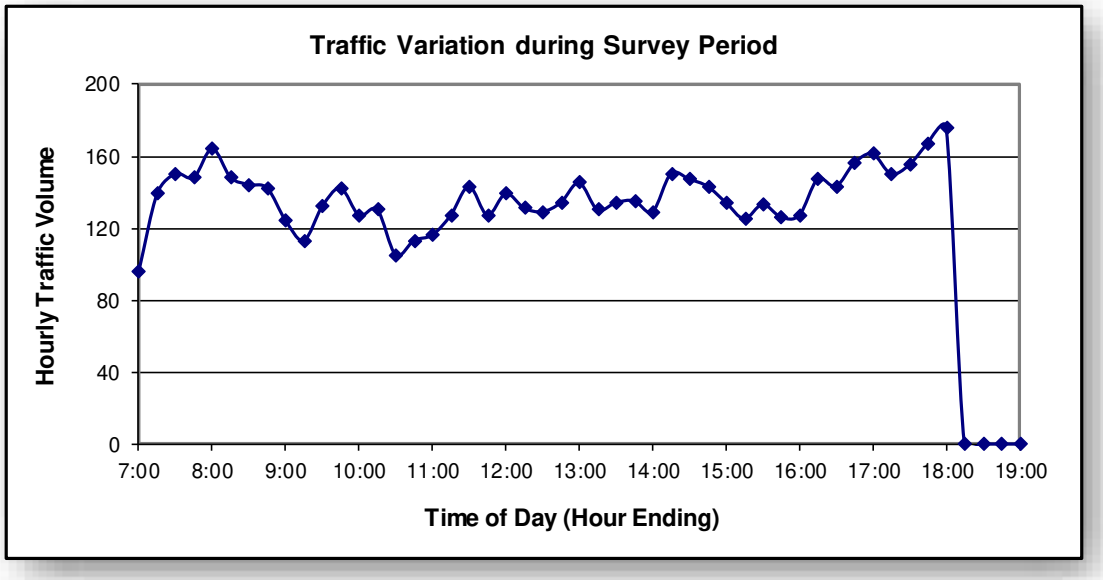
- Station No 0304 (MR226 (Piet Retief Street/Hermon Street)) (2 December 2015);
- Station No 0515 (18 June 2015); and
- Station No 0194 (Pieter Cruythoff Avenue/TR23/2 (R46)) (25 January 2016).

On DR1158 (Station Road) TCS Station No 0696 (DR1158) provides a vehicle count conducted on 17 June 2015.

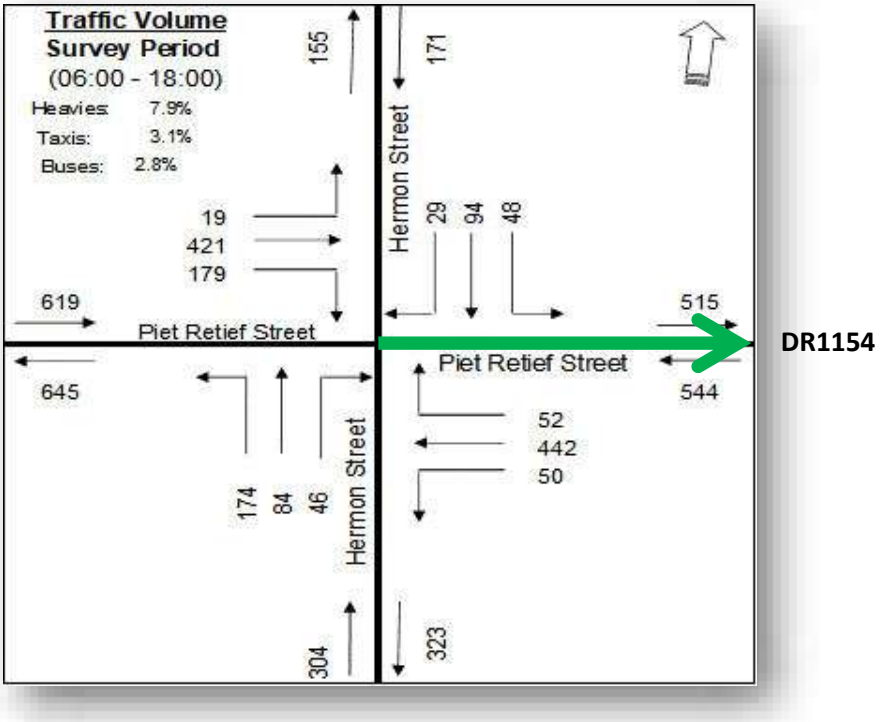
Figure 3.3 – Classified Traffic Count Locations

- **MR226 (Piet Retief Street)/Hermon Street (Station No 0304) Intersection**

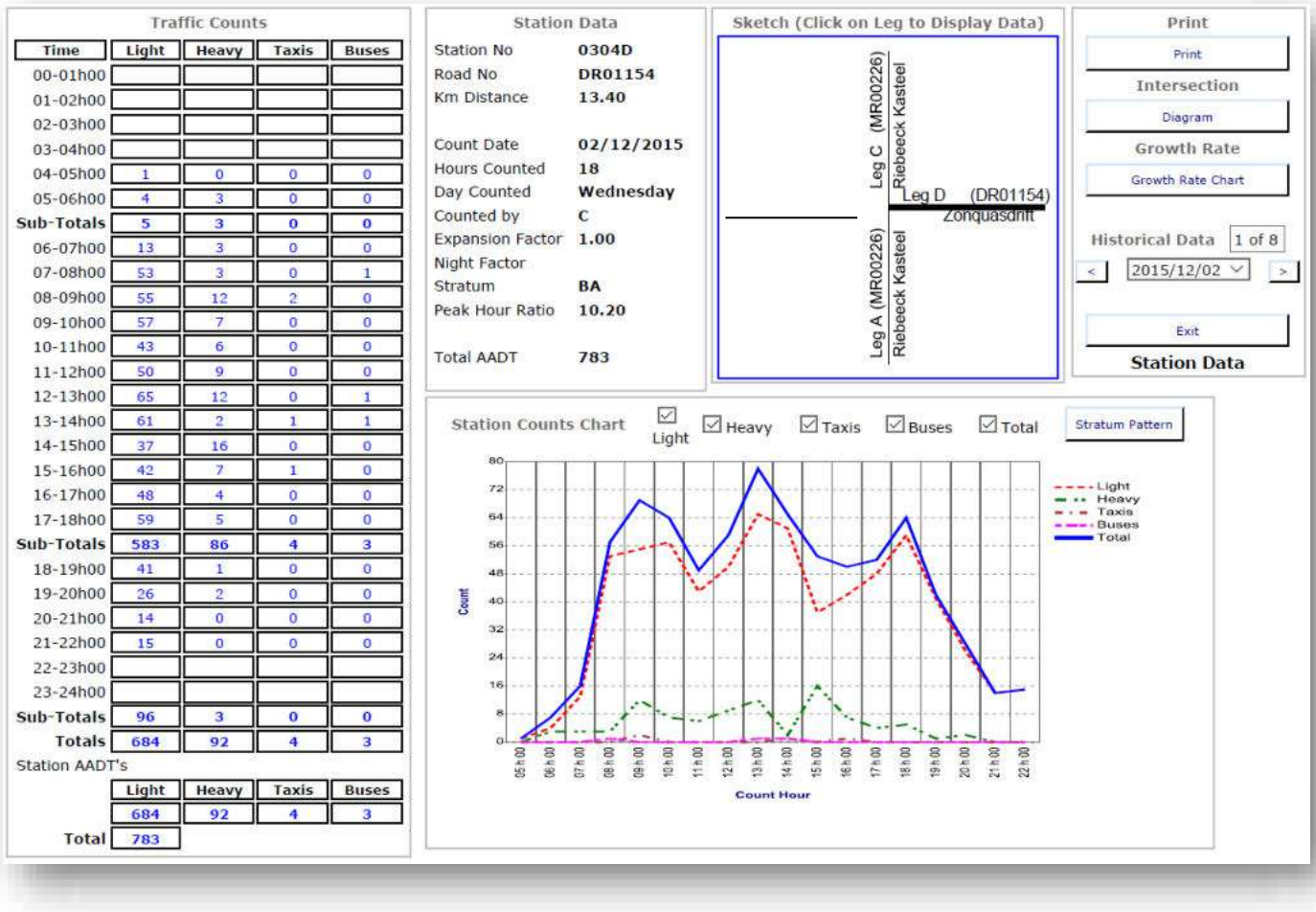
During the traffic count conducted on 6 March 2018, the intersection carried an average of approximately 130 vehicles per hour which is very low (<200) as indicated in the traffic variation graph below.



The total traffic on each leg of the intersection between 7:00 and 18:00 was:



The highest volumes occurred on Piet Retief Street (>1 000vpd 2-way). The intersection carries approximately 8% heavy vehicles. Piet Retief Street (DR1154) to the east carries approximately 1 060 vehicles (2-way) with almost 11% heavy vehicles.



Traffic Counts

Time	Light	Heavy	Taxis	Buses
00-01h00				
01-02h00				
02-03h00				
03-04h00				
04-05h00	1	0	0	0
05-06h00	4	3	0	0
Sub-Totals	**5**	**3**	**0**	**0**
06-07h00	13	3	0	0
07-08h00	53	3	0	1
08-09h00	55	12	2	0
09-10h00	57	7	0	0
10-11h00	43	6	0	0
11-12h00	50	9	0	0
12-13h00	65	12	0	1
13-14h00	61	2	1	1
14-15h00	37	16	0	0
15-16h00	42	7	1	0
16-17h00	48	4	0	0
17-18h00	59	5	0	0
Sub-Totals	**583**	**86**	**4**	**3**
18-19h00	41	1	0	0
19-20h00	26	2	0	0
20-21h00	14	0	0	0
21-22h00	15	0	0	0
22-23h00				
23-24h00				
Sub-Totals	**96**	**3**	**0**	**0**
Totals	**684**	**92**	**4**	**3**

Station AADT's

	Light	Heavy	Taxis	Buses
	684	92	4	3
Total	783			

Station Data

Station No	0304D
Road No	DR01154
Km Distance	13.40
Count Date	02/12/2015
Hours Counted	18
Day Counted	Wednesday
Counted by	C
Expansion Factor	1.00
Night Factor	
Stratum	BA
Peak Hour Ratio	10.20
Total AADT	783

Sketch (Click on Leg to Display Data)

Print

Print

Intersection

Diagram

Growth Rate

Growth Rate Chart

Historical Data 1 of 8

< 2015/12/02 >

Exit

Station Data

Station Counts Chart

Light Heavy Taxis Buses Total

Stratum Pattern

In December 2015 DR1154 had an Annual Average Daily Traffic (AADT) of almost 800 vpd (2-way) with approximately 12% heavy vehicles. However, the number of heavy vehicles were very low at less than 20 vph.

- **DR1154 (Pieter Cruythoff Avenue)/Station Road (Station No 0515) Intersection**

A TCS traffic count conducted on 18 June 2015 indicated a 2-way AADT of close to 500 vpd with approximate 14% heavies on DR1154 to the east. The extent of heavy vehicles per hour were very low (<10 vph).

Traffic Counts

Time	Light	Heavy	Taxis	Buses
00-01h00				
01-02h00				
02-03h00				
03-04h00				
04-05h00	0	0	0	0
05-06h00	5	2	0	0
Sub-Totals	**5**	**2**	**0**	**0**
06-07h00	20	0	1	0
07-08h00	29	0	0	4
08-09h00	30	8	0	3
09-10h00	24	4	0	0
10-11h00	13	1	0	0
11-12h00	34	3	0	0
12-13h00	37	1	0	0
13-14h00	42	5	0	4
14-15h00	32	2	0	0
15-16h00	28	6	1	0
16-17h00	21	4	0	0
17-18h00	21	5	0	1
Sub-Totals	**331**	**39**	**2**	**12**
18-19h00	21	4	0	0
19-20h00	4	1	0	0
20-21h00	2	0	0	0
21-22h00	8	0	0	0
22-23h00				
23-24h00				
Sub-Totals	**35**	**5**	**0**	**0**
Totals	**371**	**46**	**2**	**12**

Station AADT's

Light	Heavy	Taxis	Buses
419	52	2	14

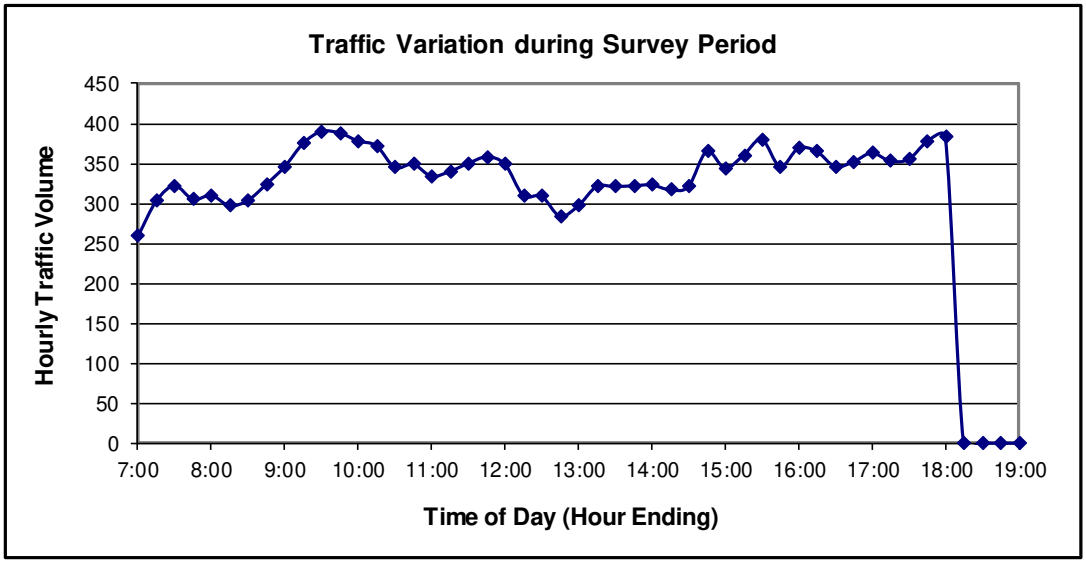
Total 487

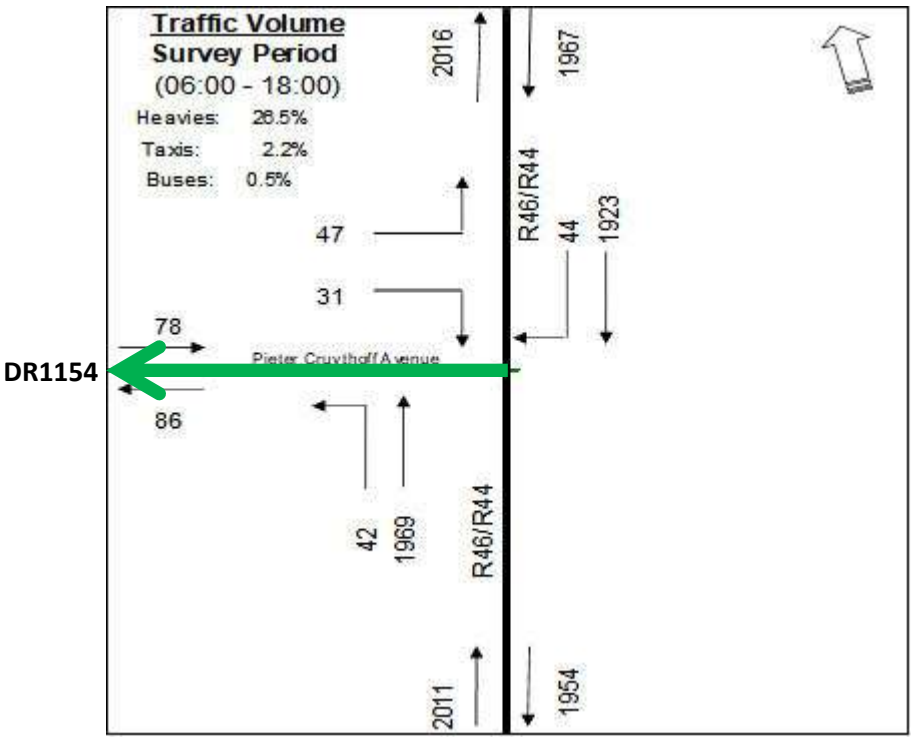
Station Data

Station No	0515A
Road No	DR01154
Km Distance	11.87
Count Date	18/06/2015
Hours Counted	18
Day Counted	Thursday
Counted by	C
Expansion Factor	1.13
Night Factor	
Stratum	GA
Peak Hour Ratio	0.00
Total AADT	487

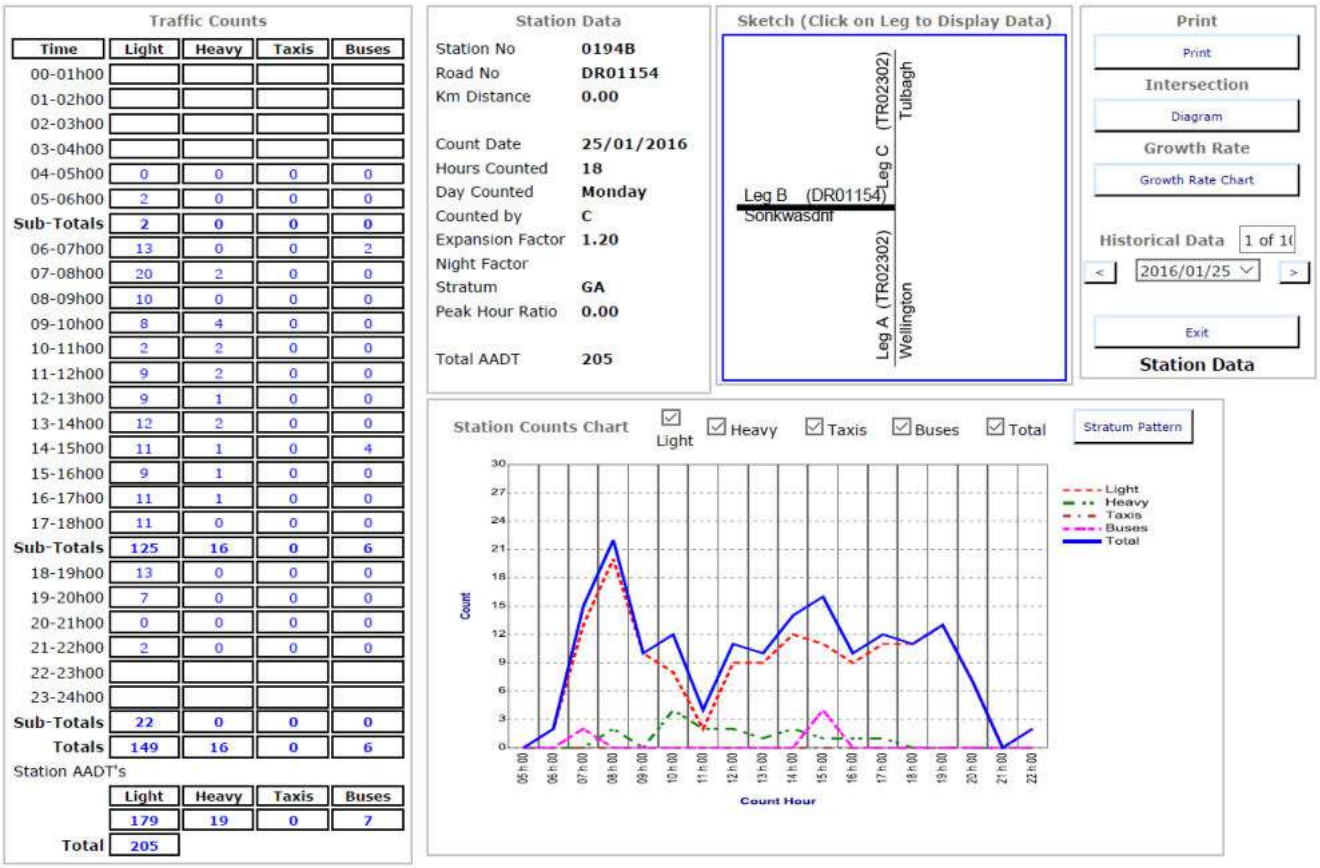
- **DR1154 (Pieter Cruythoff Avenue)/TR23/2 (R46) (Station No 0194) Intersection**

The intersection carried an average of approximately 350 vehicles per hour which is low (<500) as indicated in the traffic variation graph below.



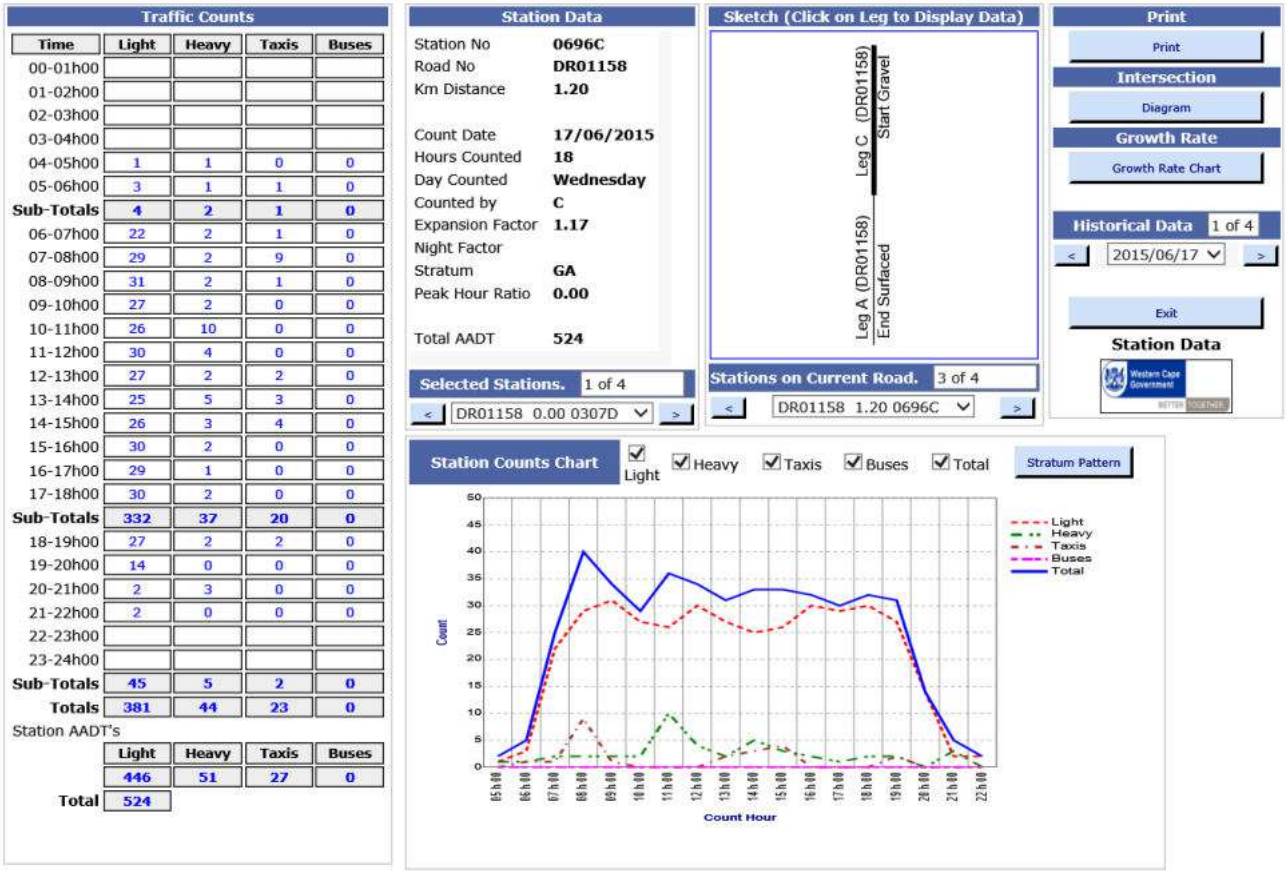


On this eastern side of the intersection, DR1154 only carries approximately 170 vehicles per day which is low (<200 vpd). The intersection carries approximately 27% heavy vehicles with DR1154 only caring around 4% heavies. The R46 therefore carries the bulk of the heavy vehicles.



- **DR1158 (Station Street)**

In 2015 DR1158 carried approximately 10% heavy vehicles or 50 per day. Unfortunately, no traffic count information is available for the DR1158/OP5404 intersection. However, it is estimated that the volumes of traffic are very low (<50vpd) with an even lower heavy vehicle component.



Traffic Counts

Time	Light	Heavy	Taxis	Buses
00-01h00				
01-02h00				
02-03h00				
03-04h00				
04-05h00	1	1	0	0
05-06h00	3	1	1	0
Sub-Totals	**4**	**2**	**1**	**0**
06-07h00	22	2	1	0
07-08h00	29	2	9	0
08-09h00	31	2	1	0
09-10h00	27	2	0	0
10-11h00	26	10	0	0
11-12h00	30	4	0	0
12-13h00	27	2	2	0
13-14h00	25	5	3	0
14-15h00	26	3	4	0
15-16h00	30	2	0	0
16-17h00	29	1	0	0
17-18h00	30	2	0	0
Sub-Totals	**332**	**37**	**20**	**0**
18-19h00	27	2	2	0
19-20h00	14	0	0	0
20-21h00	2	3	0	0
21-22h00	2	0	0	0
22-23h00				
23-24h00				
Sub-Totals	**45**	**5**	**2**	**0**
Totals	**381**	**44**	**23**	**0**

Station AADT's

	Light	Heavy	Taxis	Buses
	446	51	27	0
Total	524			

Station Data

Station No	**0696C**
Road No	**DR01158**
Km Distance	**1.20**
Count Date	**17/06/2015**
Hours Counted	**18**
Day Counted	**Wednesday**
Counted by	**C**
Expansion Factor	**1.17**
Night Factor	
Stratum	**GA**
Peak Hour Ratio	**0.00**
Total AADT	**524**

Selected Stations. 1 of 4 — DR01158 0.00 0307D

Sketch (Click on Leg to Display Data)

Leg C (DR01158) Start Gravel

Leg A (DR01158) End Surfaced

Stations on Current Road. 3 of 4 — DR01158 1.20 0696C

Print

Print

Intersection

Diagram

Growth Rate

Growth Rate Chart

Historical Data 1 of 4 — 2015/06/17

Exit

Station Data

Station Counts Chart — Light, Heavy, Taxis, Buses, Total — Stratum Pattern

- **OP5403 and OP5404**

Both these roads currently carry very low traffic volumes (<10vpd) and is only use by the local farmers. Once the flood damage repairs have been completed the road will be open to the public.

3.4 CONDITION OF ROADS

During the site visits a drive through observation of the condition of the different roads were conducted. The results of these are listed below:

- **DR1154 (20m Proclaimed Road Reserve)**

DR1154 starts at the TR23/2 (R46) and ends at MR226 (Piet Retief Street), totalling a distance of 13.4km. **Table 3.1** provides a summary of the different sections of the road as well as the observed condition.

Table 3.1 – Summary of Road and Road Condition

Start KM	End KM	Distance (m)	Surface Type	Road Width (m)	Condition
0.00	0.79	790	Surfaced	6.0	Very Poor
0.79	3.85	3 060	Gravel	6.0	Very Poor
3.85	3.91	60	Surfaced	5.0	Very Good
3.91	4.57	660	Gravel	6.0	Poor
4.57	4.79	220	Surfaced	5.0	Very Good
4.79	11.86	7 070	Gravel	6.8	Very Good
11.86	13.40	1 540	Surfaced	6.0	Poor

TR23/2 (R46) – Start of DR1154

Intersection in very poor condition

Level Railway Line Crossing

1st Surfaced Section in very poor condition

Start of 1st Gravel Section

Gravel Road in very poor condition

Gravel Section in very poor condition

Section before crossing the Berg River

Gravel Road in very good condition

Start of street network and level railway crossing

Piet Retief Street in very poor condition

- **OP5403 (20m Proclaimed Road Reserve)**

Start KM	End KM	Distance (m)	Surface Type	Road Width (m)	Condition
11.67	15.58	3 910	Gravel	3.0	**Flood damage and maintenance required**

Road Closed at km11.67 due to flood damage

Section between DR1154 and the river – northbound

Road in good condition

Flood Damage

Farm Gate Locked due to flood damage

3.5 TRIP GENERATION DURING CONSTRUCTION AND OPERATION PHASES

Construction Phase:

It is estimated that the construction of the weir and pump station will take approximately 10 months.

Although there will be light motor vehicles, the main consideration should be for the heavy vehicles ranging from short (<12m) to long (>17m). This will require the access road to be designed to accommodate the turning circles of these vehicles. Furthermore, the main pumps and other electrical equipment for the pump station will probably be delivered (more or less 10 trips to the site) on long heavy vehicles with low ground clearance i.e. lowboy trailer. The access road must be able to accommodate these trucks.

During construction approximately 4 000m^3 of commercial concrete will be required per day which would equate to around 5 truck deliveries. Should concrete be batched on-site, the figures will obviously be much less.

There will be other trucks and light motor vehicles, but this should not result in significant numbers e.g. rebar, bricks, valves, gravels, staff and labour, etc.

It is assumed that spoil material will be discarded on site and not at a commercial landfill. However, there could be a few heavy loads per month that would need to travel away from the Site, but these will have an insignificant impact on the access road/s.

For the construction of the 6.3km pipeline, 332 pipes (19m each) will be delivered to the site along the pipeline servitude. It is estimated that 2 pipes will be delivered per heavy vehicle due to the size of the pipes. At a production rate of 50m per day, approximately 4 trucks will deliver pipes per day over a period of 5 months. These deliveries will occur on the opposite side of the river connecting the new pump station and weir with Voëlvlei Dam. A few of these pipes may be delivered at the construction site for the pump station and weir.

Maintenance of the access road/s will be required, and the frequency and extent will depend on the trip generation. Regular monitoring of the road surface will trigger ad hoc maintenance that may be required.

Operational Phase:

During the operational phase, which would predominantly be during the 5 to 6 winter months, operating and maintenance staff will access the Site via light motor vehicles with the odd heavy vehicle.

The impact of vehicles during the operational phase on the access road/s will be insignificant.

3.6 COMPARISON OF ACCESS ROUTES

This study focuses on determining the feasibility of utilising the existing Proclaimed Road Network to access the Site.

Currently only the first approximately 575m over Portion 2 of Farm 648 of the preferred access road is an existing farm gravel road. The remainder of the proposed access road does not exist and would need to be constructed **(Refer to Figure 2.4)**.

An alternative to Access Road 1 is using the existing Proclaimed Minor Road network as indicated in **Figure 3.4.** The route consists of a section of OP5403 (±4.4km) plus a section of OP5404 (±3km) and a Farm Access Road (±1.6km) totalling ±9km.

See below the different distances between Riebeeck Kasteel and Access Road 1 and OP5403 as well as between the R44 and Access Road 1 and OP5403 via DR1154.

For Access Road 1 the following distances apply:

- Riebeeck Kasteel to Site: 8.2km + 6.7km = 14.9km
- R44 to Site: 6.2km + 6.7km = 12.9

For OP5403 the following distances apply:

- Riebeeck Kasteel to Site: 6.2km + 9.0km = 15.2km
- R44 to Site: 8.2km + 9.0km = 17.2

Access via OP5403 is 300m longer from Riebeeck Kasteel while it is 4.3km longer from the R44. However, it should be noted that the opening and closing of farm gates along OP5403 and OP5404 could impact on travel time.

Taking into account the difference in distance and the condition of DR1154 east of Access Road 1 and OP5403 it is recommended that plant and materials destined for the Site be delivered from Riebeeck Kasteel. Access to Riebeeck Kasteel from the N7 via Mooreesburg and Malmesbury is also closer than Paarl via the R44.

The PPC Cement quarry is also locate north-west of Riebeeck Kasteel. Concrete can easily be transported to the Site from the cement plant.

Figure 3.4 – Alternative Access Road via Proclaimed Road Network

Please note that die Provincial RNIS in places show a different alignment to the actual alignment for OP5403 and OP5404 as indicated above

Distance between Riebeeck Kasteel to Access Road 1

Distance between R44 and Access Road 1

Distance between R44 and OP5403

Distance between Riebeeck West and OP5403

4. COST ESTIMATES

To construct, repair and maintain the alternative access roads depends on the existing alignment and condition of the road. The estimated costs for each of the access road options are listed below:

EIA Preferred Access Road:

The proposed access road over Portion 1 and 2 of Farm 648 will be a private road that would not attract other public traffic in the area. Currently only the 1st 560m of the access road over Portion 2 of Farm 648 exists. The remaining 6.15km road will have to be constructed. The road will not have to comply with all the public road design standards as it will only be used for the construction and operation of the weir and pump station. It is estimated that a 6m wide gravel road will cost approximately R2 million per km. The total cost for the construction of the access road is therefore **R12.3 million**. Narrowing the road could have a significant impact on the construction cost.

Maintenance of the road will be approximately R80 000.00 per month consisting of Re-Cutting & Cleaning of Side-Drains and Pipes and Grading & Shaping as well as Dust Suppression.

OP5403 plus section of OP5404

The proclaimed section is ±7.46km long and will require some upgrading. The road is only wide enough to accommodate 1 vehicle per direction. It is recommended that passing embayments be constructed strategically (line of sight) to allow for vehicles to wait and pass each other. It is estimated that it will cost R500 000 per km to upgrade OP5403 and OP5404 (A detail inspection of the road will be required). The upgrading will therefore cost approximately R3.7 million.

The last 1.5km of the access road will have to be constructed over Portion 1 of Farm 648. This section could cost around R1.5 million depending on the width of the road. The total cost for the alternative access road is therefore **R5.2 million**.

The client can also approach the District Roads Engineer in Ceres to assist in grading the road frequently. Without their assistance it is estimated that the Re-Cutting & Cleaning of Side-Drains and Pipes and Grading & Shaping as well as Dust Suppression will be approximately R50 000.00 per month.

5. RECOMMENDATIONS

It is recommended that the existing Proclaimed Public Road Network (OP5403 and OP5404) be used as the preferred access to the Site during both the Construction Phase (±10 months) and Operational Phase (5 to 6 months in the Winter).

Other recommendations:

- A 40km/h speed limit be implemented on the proposed access road with the approval of the DRE in Ceres;
- As this is not a change in land use application, access via OP5403 and OP5404 is legal for the construction of the weir and pump station. However, it is unlikely that the Department of Transport and Public Works will contribute towards the upgrade of the road. The DRE in Ceres may assist with scarping the road during the construction period; and
- The necessary dust suppression measures be implemented.

6. REFERENCES

1. City of Cape Town, *Guidelines for the Public Transport Component of Transport Impact Assessments, Draft*, December 2001.

2. Committee of Transport Officials, *South African Road Classification and Access Management Manual, TMH 26*, August 2012

3. Committee of Transport Officials, *South African Trip Data Manual, TMH 17*, September 2013.

4. Committee of Transport Officials, *South African Traffic Impact and Site Traffic Assessment Manual*, *TMH 16 Volume 1*, August 2012.

5. Committee of Transport Officials, *South African Traffic Impact and Site Traffic Assessment Manual Standards and Requirements Manual, TMH 16 Volume 2*, August 2012.

6. Department of Transport, Geometric Design of Rural Roads, TRH 17, Pretoria, 1988.

7. Department of Transport, *Guidelines for Traffic Impact Studies, Report No. PR 93/645*, Pretoria, 1995.

8. Department of Transport, *Pedestrian Facility Guidelines, RR 92/126*, 1993.

9. Department of Transport, *Pedestrian and Bicycle Facility Guidelines, Draft 1.0*, August 2003.

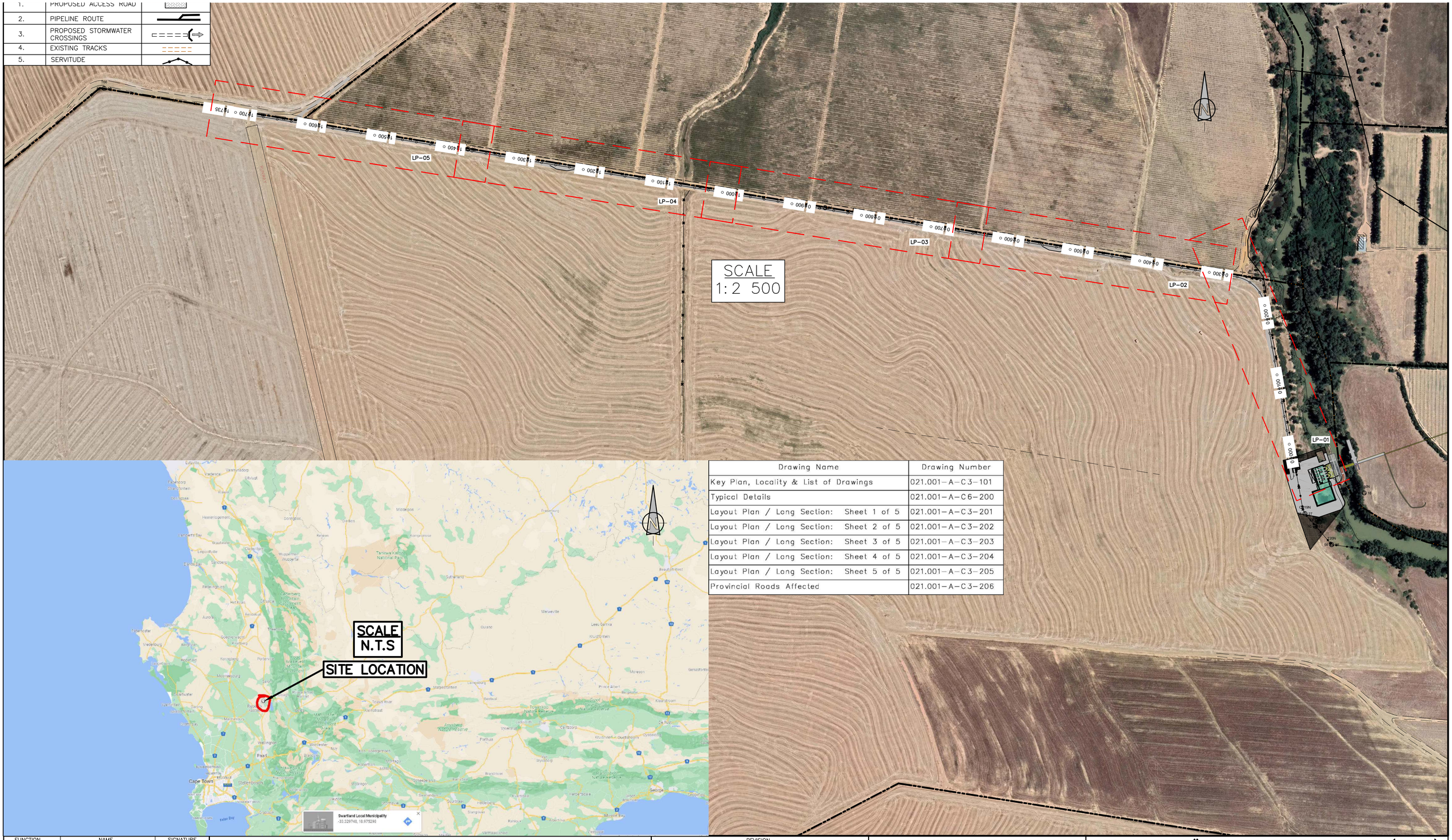
10. Department of Transport, *South African Trip Generation Rates, Report No. RR 92/228*, Pretoria, 1995.

11. PGWC Department of Economic Affairs, Agriculture & Tourism: Transport Branch, *Road Access Guidelines, Second Edition and Second Print*, September 2002.

ANNEXURE B

Conceptual Design Drawings

1.	PROPOSED ACCESS ROAD	
2.	PIPELINE ROUTE	
3.	PROPOSED STORMWATER CROSSINGS	
4.	EXISTING TRACKS	
5.	SERVITUDE	



Drawing Name	Drawing Number
Key Plan, Locality & List of Drawings	021.001-A-C3-101
Typical Details	021.001-A-C6-200
Layout Plan / Long Section: Sheet 1 of 5	021.001-A-C3-201
Layout Plan / Long Section: Sheet 2 of 5	021.001-A-C3-202
Layout Plan / Long Section: Sheet 3 of 5	021.001-A-C3-203
Layout Plan / Long Section: Sheet 4 of 5	021.001-A-C3-204
Layout Plan / Long Section: Sheet 5 of 5	021.001-A-C3-205
Provincial Roads Affected	021.001-A-C3-206

FUNCTION	NAME	SIGNATURE
DESIGNED	S MALOPE	
DRAWN	Z SHOYOSA	
DESIGN CHECKED	F LE ROUX	
DRAWING CHECKED	P GROBLER	

APPROVAL – CONSULTANT

NAME: P GROBLER REG. No. 950304

SIGNATURE: DATE:

JV DRAWING NUMBER

021.001-A-C3-101

IMPLEMENTING AGENT: TCTA A new word for water

CONSULTING ENGINEER: Amanzi Entaba JV

REVISION

MOD No.	DATE	DESCRIPTION	FOR	DWA

FOR TENDER

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: DATE:

CHECKED: DRAWN:

ENGINEER: DATE: EXTERNAL APPROVAL: DATE:

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

BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

GENERAL

KEY PLAN,LOCALITY AND LIST OF DRAWINGS

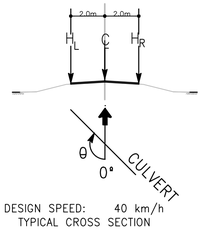
PROVINCE: WESTERN CAPE	DISTRICT: DRAKENSTEIN/SWARTLAND	KEYCODES:		OTHER NUMBER
LOCALITY No. XXX	TENDER/ CONTRACT No. XXX	SHEET 01 OF 01	REG. No.	REV. A
CALC. FILE. XXX				

REF. NO	ITEM	SYMBOL
1.	PROPOSED ACCESS ROAD	
2.	PIPELINE ROUTE	
3.	PROPOSED STORMWATER CROSSINGS	
4.	EXISTING TRACKS	
5.	SERVITUDE	

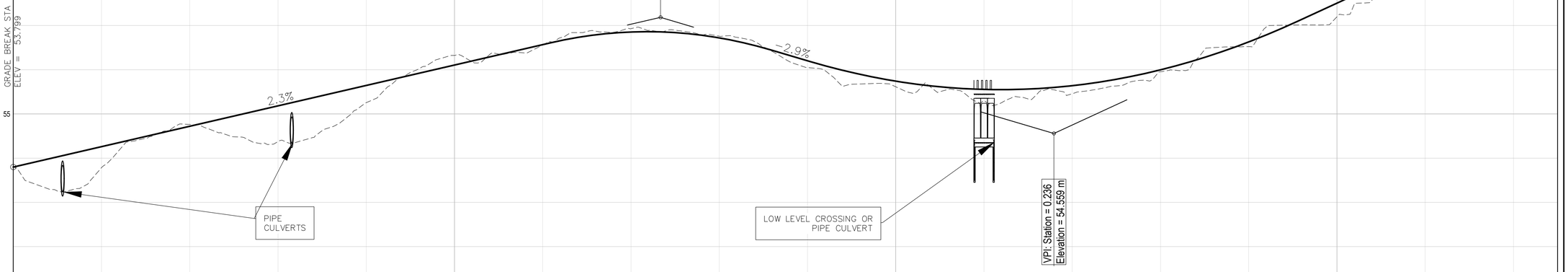
1. TERRAIN AROUND LOW SPOTS ALONG THE ALIGNMENT TO BE SHAPED TO ALLOW DRAINAGE TO CLOSEST T CULVERT.
2. SIDE DRAIN TO DRAIN TO NEAREST CULVERT.
3. ROAD LEVELS ARE ON TOP OF GRAVEL.
4. FOR TYPICAL CROSS SECTION AND PAVEMENT DESIGN REFER TO DRAWING 021-A-C6-200.

CURVE DATA			
Radius	Length	Tc	Delta
50.000m	61.675m	35.451m	70°40'29"
CO-ORDINATE WGS 84 Lo 29			
Point	Y-COORD	X-COORD	
BCC	1943.391	3688892.054	
ECC	1984.526	3688851.393	
CCC	1992.632	3688900.732	
PI	1949.544	3688857.141	

Notes:
1. Drainage structures are indicative only
2. Drainage design in accordance with the Employer's requirement

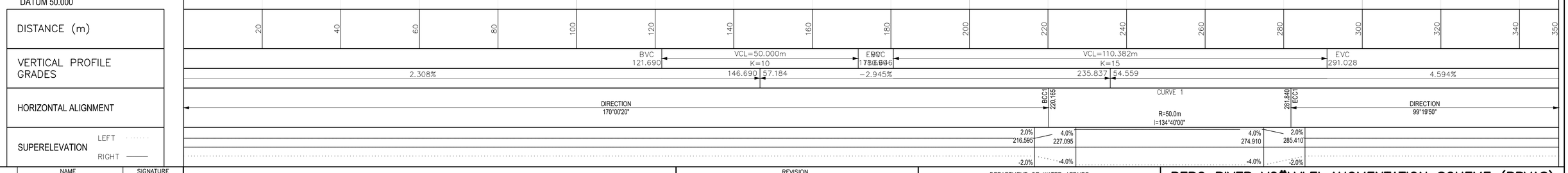


DESIGN SPEED: 40 km/h
TYPICAL CROSS SECTION



SCALES:
Horizontal 1:500
Vertical 1:50

DATUM 50.000



FUNCTION	NAME	SIGNATURE
DESIGNED	S MALOPE	
DRAWN	Z SHOYOSA	
DESIGN CHECKED	F LE ROUX	
DRAWING CHECKED	P GROBLER	

APPROVAL – CONSULTANT
NAME: P GROBLER REG. No. 950304
SIGNATURE: DATE:

JV DRAWING NUMBER
021.001-A-C3-201

IMPLEMENTING AGENT: TCTA A new word for water
CONSULTING ENGINEER: Amanzi Entaba JV

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BERG RIVER VOËLVLEI AUGMENTATION SCHEME (BRVAS)

GENERAL

LAYOUT PLAN/LONG SECTION
SHEET 1 OF 5

PROVINCE: WESTERN CAPE | DISTRICT: DRAKENSTEIN/SWARTLAND | KEYCODES: | OTHER NUMBER
LOCALITY No. XXX | TENDER/ CONTRACT No. XXX | SHEET 01 OF 05 | REG. No. | REV. A
CALC. FILE. XXX