

**CONTRACT C1053.06: FLOOD DAMAGE REPAIRS TO STRUCTURES
ON MR309 IN SEWEWEEKSPOORT PASS**

INCEPTION REPORT

11 May 2016

2016/05/11	1	FINAL	M FENTON	D MALAN	D MALAN	
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1. INTRODUCTION

1.1 Background

The Seweweekspoort Pass, located on MR309 approximately between km 40.9 to 58.1, is a gravel road linking the towns of Laingsburg and Ladismith. The road meanders through the narrow gorge of the Seweweekspoort. The gorge is very narrow with the result that the gravel road crosses the Seweweekspoort River numerous times in a short distance of 18km. Structures have been constructed over many years consisting mostly of one or two pipes. The result is that even small rain events cause the road to be overtopped with ensuing damage not only at the river crossing but also along the road since the road acts as a weir when the hydraulic capacity is exceeded. The frequent overtopping of the road requires repair work to be done by the Eden District Municipality (hereafter referred to as “DM”) and the Central Karoo District Municipality since the border is half way through the Seweweekspoort.

1.2 Terms of Reference for this Report

Hatch was appointed by the WCG Roads Network Branch on 27 January per email from Mr. Harry Viljoen to assess, design and monitor the repair work to roads, drainage and protection works. Special care must be exercised with the environment since the site is situated in an area of sensitive natural beauty.

A briefing meeting was held at the WCG offices in Cape Town on 17 February with the details of the project set out in the minutes of the meeting issued via email on 30 March 2015.

1.3 Aim of the appointment

This report describes the findings of the inspections carried out on the structures damaged by flooding in the Seweweekspoort Pass, prioritising repairs, providing preliminary design recommendations based on the visual assessment, as well as a high level cost estimate based on previous projects of a similar nature. The report will be the basis to determine the final scope of the tender as well as the structures to be included in this project for construction.

1.4 Scope of Works

The scope of work was the sites identified in the photographic report and cover letter dated 10 July 2015 “*Vloedskadeverslag: Seweweekspoort*” reference no. 17/3/9 compiled by Mr. Japie Strydom of the Eden District Municipality. This report was handed to Hatch at the briefing meeting by Mr. Harry Viljoen. According to the report, there are 30 structures to be considered for repair work or replacement.

According to the writer of “*Vloedskadeverslag*” the aim of the report was to highlight the necessity for a holistic assessment of the river crossings in the Seweweekspoort since the road has become

an important link between the Central Karoo and the Little Karoo in the Eden District Municipality. This would entail proposals for repair since the repair work in the past was done on an ad hoc basis when infrastructure was damaged with mixed solutions. The solutions vary from one or two pipes to large culverts for the same river with comparable roughness and slope characteristics.

Hatch found three duplicate structures in the report which Mr. Strydom said was possible. He advised that the estimated cost in the report is very high level and he would not rely on it but would rather adapt it when detail design is done. The total estimated cost for the 27 sites was R17.13 million exclusive of contingencies and at July 2015 base cost level.

1.5 Traffic Volumes

Table 1 shows the traffic counts as per the RNIS of projected volumes. The data is taken from the count completed on the 29 April 2015.

Table 1 – Daily Traffic Volumes along MR309

Traffic Designation	Number
Light Vehicles	95
Heavy Vehicles	16
Taxis	1
Buses	0
Total	112

1.6 Field Inspections

Two field inspections were carried out to evaluate and assess the proposed river crossings and extent of the damage.

On 15 and 16 March 2016 Dawie Malan and Matthew Fenton of Hatch carried out an inspection of the pass. This included photographs of each site, GPS coordinates and basic measurement of the sites. Preliminary proposals for design solutions were agreed by the design engineers on site.

A follow up site inspection was conducted on 4 April 2016 with Mr. Gert Verwey and Mr. Kobus Theron of the Eden DM and Central Karoo DM respectively. The proposed solutions for each site were explained by Hatch with additional inputs from the officials of the District Municipalities.

2. LIST OF STRUCTURES

At the inspection in April 2016 the officials of the District Municipalities were requested to prioritize the sites and comment on the proposed solutions. In the process the solutions were adjusted:

- Five sites were omitted as not requiring any attention
- One causeway structure of a tributary river was added
- A stretch of 350m of road was added where the river runs in the road and washes away the gravel leaving only river rock after larger rain events.

Refer to Table 2 for details of the “Vloedskadeverslag” and comments on it.

The final list of sites after all inputs were finalized is shown in Table 3. The prioritisation by the DM representatives is shown, as well as the proposed design solutions.

It is proposed that all structures have a clear width of 6m between guide blocks since this is a Main Road.

The proposed dimensions of drainage openings are based on visual assessment of the river stream and are subject to detail hydraulic calculations.

Table 2: Legend of Priority Codes

Colour	Added By/Action Required
N	No Action
L	Low Priority
M	Medium Priority
H	High Priority

Table 3: Initial List of Seweweekspoor Structures based on “Vloedskadeverslag”

Km Dist.	GPS Coordinates	Existing Structure	Priority	Added/Omitted/Original
40.90	33°21'41.30"S 21°24'35.42"E	3x600mm pipes with gabions upstream, ponding occurs at inlet and outlet	M	Original List
44.10	33°22'51.38"S 21°24'31.32"E	2x600mm encased pipes, large skew angle	L	Original List
44.30	33°22'55.45"S 21°24'26.95"E	2x600mm encased pipes, with wing walls, apron slabs, gabions downstream damaged	M	Original List
44.50	33°23'1.12"S 21°24'21.51"E	2x600mm encased pipes, grouted stone head walls, base scoured and water running under structure	M	Original List
44.70	33°23'8.56"S 21°24'22.03"E	2x600mm encased pipes, heavy siltation, low level	H	Original List
45.05	33°23'11.26"S 21°24'31.42"E	2x600mm encased pipes, grouted stone head walls, mostly damaged, slight siltation	H	Original List
45.10	33°23'13.16"S 21°24'34.38"E	2x600mm encased pipes, with stone and concrete head walls upstream	H	Original List
45.50	33°23'24.84"S 21°24'37.91"E	1x600mm pipe only for side stream	H	Original List
45.97	33°23'27.84"S 21°24'22.06"E	2x600mm encased pipes with concrete and stone head walls at inlet and outlet, heavy siltation, structure completely buried	M	Original List
46.35	33°23'23.57"S 21°24'7.61"E	1x600mm pipe with stone head wall	M	Added (Kobus Theron - Central Karoo DM)
46.50	33°23'26.04"S 21°24'5.27"E	2x600mm pipes with concrete and stone head walls at inlet and outlet, stone pitching aprons, siltation, structure completely buried	H	Original List
46.70	33°23'33.62"S 21°24'8.61"E	23m long drift with 2x600mm pipes under 200mm slab, pipes half buried under siltation	N	Omitted (Gert Verwy - Eden DM)
46.90	33°23'38.95"S 21°23'58.14"E	16m long drift with 2x600mm pipes under 200mm slab, 2m stone wing walls	N	Omitted (Gert Verwy - Eden DM)

47.20	33°23'45.64"S	Drift with 2x600mm pipes under 150mm slab, 2m stone walls	N	Omitted (Gert Verwy - Eden DM)
	21°23'51.12"E			
47.85	33°24'0.06"S	Drift with 2x600mm pipes under 200mm slab, 20m stone walls and scouring under pipe	N	Omitted (Gert Verwy - Eden DM)
	21°23'57.89"E			
48.00	33°24'3.53"S	1x900mm pipe, stone head and wing walls, damaged apron slabs both sides, river channel is deep	H	Original List
	21°23'55.81"E			
50.10	33°24'42.25"S	3x600mm pipes with stone head walls up and down stream, stone pitching aprons severely damaged	H	Original List
	21°24'31.50"E			
50.30	33°24'46.14"S	2x900mm pipes with stone head and return wall downstream, severely damaged and siltation issue	H	Original List
	21°24'29.91"E			
50.80	33°24'56.08"S	3x600mm pipes with stone head and return walls up and down stream, severely damaged and siltation prevalent	H	Original List
	21°24'14.54"E			
51.10	33°24'59.11"S	2x900mm pipes with stone head wall up and down stream, severely damaged, large boulders abundant in river bed	H	Original List
	21°24'7.50"E			
51.60	33°25'1.52"S	River blocked by fallen tree and erodes bank and under scours road when flood comes through	H	Original List
	21°23'51.22"E			
52.00	33°25'16.31"S	2x900mm pipes with stone head wall up and down stream, severely damaged, boulders abundant in river bed	H	Original List
	21°23'50.59"E			
53.20	33°25'35.88"S	2x900mm pipes with concrete protection works up and down stream, scouring severe	H	Original List
	21°24'16.53"E			
53.40	33°25'39.94"S	2x600mm pipes with stone head walls at and outlet, mostly buried, nearly completely destroyed	H	Original List
	21°24'20.83"E			
53.50	33°25'43.76"S	2x900mm pipes with concrete protection works up and down stream, scouring severe	H	Original List
	21°24'23.71"E			
53.80	33°25'52.34"S	Road way gets flooded by river and washes material away completely during floods	H	Original List
	21°24'31.94"E			
54.10	33°25'56.48"S	2x900mm pipes with stone head wall up and down stream, mostly damaged, large boulders abundant in river	H	Original List
	21°24'26.57"E			
54.30	33°26'0.20"S	2x900mm pipes with stone head wall up and down stream, mostly damaged, large boulders abundant in river bed, siltation high	H	Original List
	21°24'24.55"E			
54.40	33°26'3.00"S	Road way gets flooded by river and washes material away completely during floods	H	Added (Gert Verwy - Eden DM)
	21°24'24.34"E			
55.30	33°26'28.61"S	57m long causeway with 6x2.4m openings, 500mm thk slab, aprons and wing walls, 100m of gabion walls creating artificial bank	N	Omitted (Gert Verwy - Eden DM)
	21°24'34.70"E			
57.10	33°27'14.40"S	57m long causeway with 6x2.4m openings, 500mm thk slab, aprons and wing walls, 4 openings completely blocked with rocks only 2 openings clear, major rock siltation issue	H	Original List
	21°25'15.08"E			
58.10	33°27'34.98"S	1x1.9m W causeway with 750mm pipe down steam, broken apron slabs and downstream return walls	H	Original List
	21°25'43.17"E			

Table 4 Final List of Seweweekspoort Structures

Km Dist.	GPS Coordinates	Existing Structure	Proposed Structure	Priority
40.90	33°21'41.30"S 21°24'35.42"E	3x600mm pipes with gabions upstream, ponding occurs at inlet and outlet	6m wide causeway	M
44.10	33°22'51.38"S 21°24'31.32"E	2x600mm encased pipes, large skew angle	4m wide causeway	L
44.30	33°22'55.45"S 21°24'26.95"E	2x600mm encased pipes, with wing walls, apron slabs, gabions downstream damaged	6m wide causeway	M
44.50	33°23'1.12"S 21°24'21.51"E	2x600mm encased pipes, grouted stone head walls, base scoured and water running under structure	4m wide causeway	M
44.70	33°23'8.56"S 21°24'22.03"E	2x600mm encased pipes, heavy siltation, low level	6m wide causeway	H
45.05	33°23'11.26"S 21°24'31.42"E	2x600mm encased pipes, grouted stone head walls, mostly damaged, slight siltation	4m wide causeway	H
45.10	33°23'13.16"S 21°24'34.38"E	2x600mm encased pipes, with stone and concrete head walls upstream	4m wide causeway	H
45.50	33°23'24.84"S 21°24'37.91"E	1x600mm pipe only for side stream	3m wide causeway	H
45.97	33°23'27.84"S 21°24'22.06"E	2x600mm encased pipes with concrete and stone head walls at inlet and outlet, heavy siltation, structure completely buried	4m wide causeway	M
46.35	33°23'23.57"S 21°24'7.61"E	1x600mm pipe with stone head wall	2m wide causeway	M
46.50	33°23'26.04"S 21°24'5.27"E	2x600mm pipes with concrete and stone head walls at inlet and outlet, stone pitching aprons, siltation, structure completely buried	6m wide causeway	H
48.00	33°24'3.53"S 21°23'55.81"E	1x900mm pipe, stone head and wing walls, damaged apron slabs both sides, river channel is deep	6m wide causeway	H
50.10	33°24'42.25"S 21°24'31.50"E	3x600mm pipes with stone head walls up and down stream, stone pitching aprons severely damaged	8m wide causeway	H
50.30	33°24'46.14"S 21°24'29.91"E	2x900mm pipes with stone head and return wall downstream, severely damaged and siltation issue	5m wide causeway	H
50.80	33°24'56.08"S 21°24'14.54"E	3x600mm pipes with stone head and return walls up and down stream, severely damaged and siltation prevalent	6m wide causeway	H
51.10	33°24'59.11"S 21°24'7.50"E	2x900mm pipes with stone head wall up and down stream, severely damaged, large boulders abundant in river bed	6m wide causeway	H

51.60	33°25'1.52"S 21°23'51.22"E	River blocked by fallen tree and erodes bank and under scours road when flood comes through	30m concrete or gabion wall	H
52.00	33°25'16.31"S 21°23'50.59"E	2x900mm pipes with stone head wall up and down stream, severely damaged, boulders abundant in river bed	6m wide causeway	H
53.20	33°25'35.88"S 21°24'16.53"E	2x900mm pipes with concrete protection works up and down stream, scouring severe	6m wide causeway	H
53.40	33°25'39.94"S 21°24'20.83"E	2x600mm pipes with stone head walls at and outlet, mostly buried, nearly completely destroyed	6m wide causeway	H
53.50	33°25'43.76"S 21°24'23.71"E	2x900mm pipes with concrete protection works up and down stream, scouring severe	6m wide causeway	H
53.80	33°25'52.34"S 21°24'31.94"E	Road way gets flooded by river and washes material away completely during floods	100m long concrete retaining wall	H
54.10	33°25'56.48"S 21°24'26.57"E	2x900mm pipes with stone head wall up and down stream, mostly damaged, large boulders abundant in river	6m wide causeway	H
54.30	33°26'0.20"S 21°24'24.55"E	2x900mm pipes with stone head wall up and down stream, mostly damaged, large boulders abundant in river bed, siltation high	6m wide causeway	H
54.40	33°26'3.00"S 21°24'24.34"E	Road way gets flooded by river and washes material away completely during floods	350m long concrete retaining wall	H
57.10	33°27'14.40"S 21°25'15.08"E	57m long causeway with 6x2.4m openings, 500mm thk slab, aprons and wing walls, 4 openings completely blocked with rocks only 2 openings clear	Drop inlet and river realignment	H
58.10	33°27'34.98"S 21°25'43.17"E	1x1.9m W causeway with 750mm pipe down steam, broken apron slabs and downstream return walls	6m wide causeway	H

3. DESIGN PHILOSOPHY

This section outlines the proposed design process.

3.1 Report Stage

In March 2016 a field inspection was conducted on all sites listed in the original report. This inspection recorded all relevant information of each site including:

- Km position and GPS location
- Existing structure details and layout
- Up and down stream conditions including stream widths and depths
- Measurements of the existing structures
- Condition of the existing structures based on a visual inspection

From the field inspection information solutions for each site were recommended based on the prevailing river channel widths and depths. The upstream and downstream conditions were considered to determine the openings required for each structure in conjunction with the indicated damage, erosion and siltation witnessed.

During the second field inspection in April 2016 the proposed solutions were refined with the input of the roads officials of the District Municipalities.

The priority for repair of each site was also indicated by the roads officials, although they indicated that all the sites are actually a high priority. They did omit certain structures.

3.2 Design Stage

The design stage will be done in two phases, namely the preliminary design and the detail design.

In preliminary design the General Layout drawings will be completed to a level that it can be presented to the WCG and District Municipalities for discussion and preliminary approval.

The following factors will be assessed during the preliminary design:

3.2.1 Hydraulics

Hydraulic design will be done according to the SANRAL Drainage Manual.

Hydraulic calculations will be done to determine the design floods for the 2 year and 5 year return periods. The design criterion is that the 2 year flood must be accommodated under the structure with no overtopping taking into consideration the risk of debris.

The following general principles are proposed:

- Routing of the water through a drainage opening is preferable to a drift structure where all water passes over the road.
- Make the vertical clear height of drainage openings as big as possible within the constraints of the river bed and the vertical alignment of the road.
- The vertical opening of the drainage structure must have a minimum clear height of 1m for ease of cleaning the structure by hand from siltation and debris.
- The top level of the slab must be lower than the road on both sides to prevent the water creating a new river alignment if the openings are blocked. The vertical alignment of the road has been changed over the years very effectively to achieve this, but this principle may be developed further where it is not implemented yet.
- Drop inlets may be used where required. In such cases the concrete of piers must be protected against abrasion of fast moving rock if present in the river bed.

3.2.2 Scouring

Scour protection will be incorporated to minimize damage for floods in excess of the 2 year flood especially when the flood overtops the structure. The basic principle is to dissipate the energy of the water overtopping the structures as quickly as possible by letting the water drop vertically onto a surface which is scour resistant such as a concrete apron slab or packed rip rap. Special attention will be given to the risk that an overtopping flood would create erosion damage downstream wider than the existing width of the river.

3.2.3 Siltation

In the upper reaches of the river siltation problems do not appear to be a major risk since there is not a great deal of fine sediment movement. Likewise there is not much river boulder movement.

Below the gorge a number of existing structures have problems with blockages due to the movement of river stone siltation. Hatch intends to get specialist input to address this problem with interaction with the Water Laboratory of the University of Stellenbosch.

3.2.4 Supplementary Considerations

Alignment of the opening of the drainage structure to the direction of the river will be done as best as possible.

Clear spans with fewer piers will be favoured to reduce the risk of siltation build up and blockage forming.

Minimize the use of concrete approach slabs since they are as expensive as creating drainage openings and often get under scoured in the case of large floods, in which case they need to be

replaced. It is recommended to create larger drainage openings and to do quick maintenance of approaches when scouring occurs by importing new gravel which is a relatively quick and easy operation. The drainage structure must be designed not to be damaged so that concrete work is not required.

Structural design details of the WCG latest Standard Drawings will be followed.

At the end of the preliminary design, cost estimates will be used to agree with the WCG Head Office in consultation with the District Municipalities the priority of structures, should a construction budget problem prevail.

The output of the detail design phase would be concrete drawings, rebar layout drawings and bending schedules.

3.2.5 Traffic Accommodation

The pass cannot be closed for traffic as it is used by farmers and is also a tourist destination.

Traffic accommodation will have to be via 4m wide temporary deviation roads capable of accommodating interlinks which use the pass on a daily basis.

The flora which is damage by the deviation roads will have to be revegetated.

3.2.6 Environmental

The environmental approval process often leads to delays to the implementation of a project. It is important that the environmental process starts immediately after the approval of this report and that definite milestones are set and monitored by Hatch.

The Seweweekspoort is part of the Cape Nature Reserves and is a sensitive and unique area as well as a tourist destination. It is also situated in a World Heritage site.

The target date for Environmental approvals to be complete is December 2016.

3.3 Tender Stage

The tender will be an open tender and the functionality criteria will set a minimum standard of expertise to tenderers.

6. SUMMARY

- The original number of structures provided by WCG was 30. Two structures were added and six omitted by Gert Verwey and Kobus Theron of the Eden and Central Karoo District Municipalities respectively.
- The final list contains 27 structures.
- The projected estimate of the 27 structures is R 30 129 949.20. The budget on the RPM is presently R 20 million.
- In order to address the budget constraints two options are suggested:
 - i. The number of sites to be included can be amended based on the District Municipalities' priority rating of low, medium or high.
 - ii. The sites can be separated into two construction phases.
- In terms of the design philosophy rectangular causeways with larger clear spans (few piers) are preferred to pipe causeways as the risk of blockage is much reduced.
- Concrete approach slabs are to be omitted as far as possible due to under scour risks and expensive repairs.
- The sizing of openings will be to allow floods with a 2 year return period to pass through drainage openings under the deck slab.
- Typical sizes for the structures will be 4m to 6m wide perpendicular to the flow of the river and structures will be aligned with the direction of the river.
- The District Municipalities of Eden and Central Karoo will be invited to provide comment on the designs and the final details will be agreed with the WCG's Chief Engineer Structures.
- The pass may not be closed for traffic during construction.
- Temporary deviation roads should be used which must be revegetated.
- The environmental approval process must start immediately to ensure completion by December 2016 with milestones clearly indicated and monitored.
- The costing for the proposed work in this report is a high level estimate based on rates from previous similar projects. The projected costs will be continuously refined as the design phase proceeds and discussed with the client.

7. RECOMMENDATIONS

- The list of structures detailed in Table 3 is to supersede the list of structures described in the “*Vloedskadeverslag: Seweweekspoort*” compiled by Mr. Japie Strydom.
- Design solutions must be discussed and agreed with Chief Engineer Structures (Mr. Harry Viljoen), with comments from the officials of the Eden (Mr. Gert Verwey) and Central Karoo (Mr. Kobus Theron) District Municipalities respectively.
- The scope of works must be agreed on with the WCG for the design phase.
- The design width of the structures are to be 6m clear width between guideblocks and not materially wider than the gravel road which is narrower in many parts of the pass, as recommended by Mr Harry Viljoen and Mr Wally Silbernagl.

APPENDIX A: PHOTOGRAPHS OF LISTED STRUCTURES



MR309_40.9KM



MR309_44.1KM



MR309_44.3KM



MR309_44.5KM



MR309_44.7KM



MR309_45.05KM





MR309_45.1KM



MR309_45.5KM



MR309_45.97KM



MR309_46.35KM



MR309_46.5KM



MR309_48KM





MR309_50.1KM



MR309_50.3KM



MR309_50.8KM



MR309_51.1KM



MR309_51.6KM



MR309_52KM





MR309_53.2KM



MR309_53.4KM



MR309_53.5KM



MR309_53.8KM



MR309_54.1KM



MR309_54.3KM





MR309_54.4KM



MR309_57.1KM



MR309_57.1KM



APPENDIX B: PROPOSED STRUCTURES



6m Causeway (Loop River Structure – C960.1)



Retaining Wall (Opzoek – C960.1)

