Western Cape Government: DTPW Road Programme Management Contract C1157.02: Flood Damage Repairs to Structures in the Garden Route Area

Incident Report

2022/07/28	1	CLIENT REVIEW	P SMIT	D MALAN	D MALAN	
2022/06/13	0	FINAL	P SMIT	D MALAN	D MALAN	
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
Hatch						**Client**

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1. INTRODUCTION

1.1 Background

The Garden Route area experienced significant flooding due to heavy rains in November 2021. Numerous causeways in the George and Plettenberg Bay areas have 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 if openings are too small. Frequent overtopping of these roads lead to repair work needed to be done by the Garden Route District Municipality (hereafter referred to as "DM") on a regular basis. An Armco culvert on the Seven Passes Road near Saasveld has failed causing the road to wash away and another Armco culvert approximately 770m away has failed partially.

1.2 Terms of Reference for this Report

Hatch was appointed by the Western Cape Government (hereafter referred to as "WCG") Transport and Public Works Road Programme Management department on 13 May 2022 to assess, design and monitor the repair work to roads, drainage and protection works with due consideration to the environmental impact.

A briefing meeting was held at the Hatch offices in Cape Town on 17 May 2022 with Wandie Olivier and Sardieq Slamdien. Refer to Annexure A for the Minutes of Meeting that sets out the details of the project.

1.3 Aim of the Appointment

This report describes the findings of the inspections, lists recommended repairs and provides preliminary design recommendations based on the visual assessment, as well as a high-level cost estimate based on previous projects of a similar nature. We have also included preliminary hydraulic information for each site. The report will be the basis to determine the final scope of the project as well as the structures to be included.

1.4 Scope of Works

The scope of work comprised Priority A sites identified in Sardieq Slamdien's email dated 17 May 2022 with accompanying KMZ file locating these sites. Japie Strydom of the DM requested that we inspect three additional Priority B sites which were shown by Ezron du Plessis of the DM. A subsequent email from the WCG, dated 25 May 2022, recommended that the causeway on DR1602 at km 6.20 be elevated from Priority B to Priority A; however, this has not been officially added to the current scope of works.

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1.5 Traffic Volumes

1.5.1 Ø1.5m Armco culvert on road MR00355 at km 3.00

Table 1 – Daily Traffic Volumes along MR355

Traffic Designation	Number
Light Vehicles	1814
Heavy Vehicles	39
Taxis	18
Buses	36
AADT	**1907**

1.5.2 Ø2.0m Armco culvert on road MR00355 at km 3.77

Same Daily Traffic Volumes as provided in Table 1.

1.5.3 Road slip on road MR00355 at km 7.95

Table 2 – Daily Traffic Volumes along MR355

Traffic Designation	Number
Light Vehicles	555
Heavy Vehicles	15
Taxis	1
Buses	8
AADT	**579**

1.5.4 1.6m wide x 1.2m high box culvert causeway on road DR01633 at km 3.35

Table 3 – Daily Traffic Volumes along DR1633

Traffic Designation	Number
Light Vehicles	87
Heavy Vehicles	25
Taxis	0
Buses	2
AADT	**114**

1.5.5 Three Ø600mm concrete pipe culvert causeway on road DR01791 at km 1.59

Table 4 – Daily Traffic Volumes along DR1791

Traffic Designation	Number
Light Vehicles	113
Heavy Vehicles	13
Taxis	2
Buses	1
AADT	**129**

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1.5.6 Inlet and outlet protection works at six Ø450mm precast concrete pipe culvert + two 1.2m wide x 0.6m high box culvert causeway on road DR01639 at km 1.63

Table 5 – Daily Traffic Volumes along DR1639

Traffic Designation	Number
Light Vehicles	59
Heavy Vehicles	10
Taxis	0
Buses	5
AADT	**74**

1.5.7 Missing bridge end-block on road MR00355 at km 8.67

Same Daily Traffic Volumes as provided in Table 2.

1.5.8 Three Ø600mm precast concrete pipe culvert + four 1.2m wide x 0.9m high box culvert causeway on road DR01602 at km 8.48

Table 6 – Daily Traffic Volumes along DR1602

Traffic Designation	Number
Light Vehicles	126
Heavy Vehicles	27
Taxis	0
Buses	3
AADT	**156**

1.5.9 Balustrade walls in Montagu Pass on DR01640 between km 7 and 10

Table 7 – Daily Traffic Volumes along DR1640

Traffic Designation	Number
Light Vehicles	140
Heavy Vehicles	16
Taxis	1
Buses	0
AADT	**157**

1.6 Field Inspections

Field inspections were carried out on 18 and 19 May 2022 by Dawie Malan and Pieter Smit to evaluate and assess the flood damage, accompanied by Ezron du Plessis of the DM.

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2. LIST OF STRUCTURES

2.1 Original Appointment – Priority A Sites

The WCG have provided the following list in letter reference TPW16/6/4/1/1- C1157.02 dated 13 May 2022.

Table 8: List of Elements forming part of Original Appointment – Priority A Sites

Road No.	Km Dist.	GPS Coordinates	Element
MR00355	3.00	33° 58' 05.04'' S 22° 30' 57.65'' E	Ø1.5m Armco culvert
MR00355	3.77	33° 58' 05.32'' S 22° 31' 28.01'' E	Ø2.0m Armco culvert
MR00355	7.95	33° 57' 56.60'' S 22° 33' 26.82'' E	Road slip
DR01633	3.35	33° 56' 15.06'' S 22° 14' 34.11'' E	A single 1.6m wide x 1.2m high box culvert
DR01791	1.59	34° 00' 04.57'' S 23° 19' 27.98'' E	Three Ø600mm precast concrete pipe culverts
DR01639	1.63	33° 55' 56.80'' S 22° 22' 40.04'' E	Six Ø450mm precast concrete pipe culverts at riverbed level with two additional 1.2m wide x 0.6m high box culverts on top of the pipe culverts

2.2 Priority B Sites to be possibly elevated to Priority A and added to current Scope of the Appointment

Table 9: List of Elements forming part of Priority B Sites

Road No.	Km Dist.	GPS Coordinates	Element
DR01602	8.48	33° 57' 35.20'' S 22° 14' 28.80'' E	Three Ø600mm precast concrete pipe culverts and four 1.2m wide x 0.9m high box culverts
MR00355	8.67	33° 57' 53.87'' S 22° 33' 41.26'' E	Missing bridge end-block
DR01640	7.55	33° 53' 42.49'' S 22° 25' 12.60'' E	3.6m long x 600 mm wide x 600mm high stone packed barrier wall
DR01640	7.63	33° 53' 40.99'' S 22° 25' 13.95'' E	12m long x 600 mm wide x 700mm high stone packed barrier wall
DR01640	7.87	33° 53' 36.32'' S 22° 25' 17.47'' E	14.1m long x 600 mm wide x 500-700mm high stone packed barrier wall
DR01640	8.05	33° 53' 33.47'' S 22° 25' 22.56'' E	6.2m long x 600 mm wide x 600mm high stone packed barrier wall
DR01640	9.84	33° 53' 13.38'' S 22° 25' 54.07'' E	3.6m long x 600 mm wide x 900mm high stone packed barrier wall

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3. DESIGN & IMPLEMENTATION CONSIDERATIONS

3.1 Hydraulics

The hydraulic design will be based on the Sanral Drainage Manual 6th edition. The design flood return period will be determined by the Class of road and the size of the flood based on a 20-year return period based on Figure 8.2.

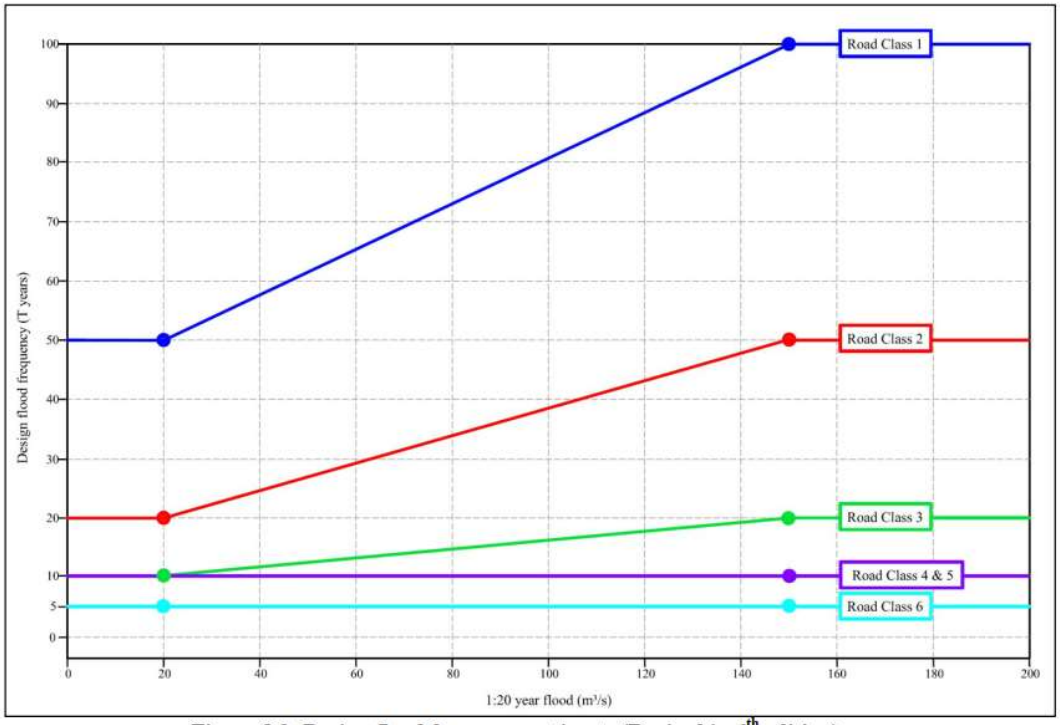

Figure 8.2: Design flood frequency estimate (Revised in 6th edition)

The proposed road classes are as follows:

Table 10: Proposed Road Classes

Road no	Road Class	Design criteria
MR355	R3	QT for a H/D < 1.2 Q2T for a H/D < 2.0
DR1633	R4	QT with water overtopping not exceeding guide block height
DR1791	R4	QT with water overtopping not exceeding guide block height
DR1639	R4	QT with water overtopping not exceeding guide block height

Based on prior knowledge of the design flood of the culvert on MR355 at km 3.77 the 20-year flood was 9m3/s, thus all hydraulic structures will be designed for a 10-year return period for the QT flood.

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Preliminary hydraulic data have been determined for each site and are summarized below.

Table 11: Preliminary Hydraulic Data

Road no	Km marker	Catchment Area (m2)	1:5 year Flood	1:10 year Flood
MR355	3.00	0.4	TBC	TBC
DR1633	3.35	11.5	TBC	TBC
DR1639	1.63	3.2	TBC	TBC
DR1791	1.59	20.7	TBC	TBC
DR1602	8.48	21.4	TBC	TBC

3.2 Inlet and outlet structures

Standard inlet and outlet wing walls and apron slabs will be provided.

3.3 Traffic Accommodation

Table 12: Proposed Traffic Accommodation

Road no	Km marker	Proposed traffic accommodation
MR355	3.00	Road to remain open for two-way traffic
MR355	7.95	Half-width construction
DR1633	3.35	Temporary deviation road on upstream side 4.0m wide
DR1639	1.63	Temporary deviation road on upstream side 4.0m wide
DR1791	1.59	Temporary deviation road on downstream side 4.0m wide
DR1602	8.48	Temporary deviation road on upstream side 4.0m wide
MR355	8.67	Half-width construction
DR1602	7.55 to 9.84	Closing of shoulder at discrete lengths up to 20m long

3.4 Proposed Road Width for Causeways at low level river crossings

WCS60/1/D1 provides the WCG details for “Rural Structure Standards widths” for bridges, agricultural overpasses and Low Level bridges. (See Appendix D). The only standard for a low level crossing is for a single lane and no provision is made for two-way traffic, except that the width can be increased to 6.0m based on agricultural machinery requirements, as some machinery is too

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wide to pass over the 4.0m clear width structure. The 4.0m width is derived from 3.4m lane width with 2 x 0.3m shoulders.

TRH17 Geometric Design of Rural Roads allows for a minimum lane width of 3.1m, thus for two-way traffic a minimum of 6.2m. Extract provided in Appendix E.

It is proposed that we comply with both your "Rural Structure Standard Widths" varying from 4.0m to 6.0m and the TRH17 minimum of 6.2m thus complying with both a structural standard and a geometric standard.

One of the big problems of the low level structures is debris blockages and the wider the structure is, the more difficult it is to clean and the more frequent the blockages are; the result is that it is not frequently maintained. One should thus try to make the structure as narrow as possible, thus the recommendation of 6.2m clear width plus 2 x 0.34m guide blocks on the sides.

3.5 Approach slabs

Concrete approach slabs are often used at either end of vented low level river crossings (causeways). In our experience these slabs are often under-scoured during floods which overtop the structure and then it is difficult, a time-consuming process and expensive to repair or replace the slabs. In our view it is preferably to use earth approaches which can be repaired quickly and cheaply if it washes away. It is proposed to protect the batters with erosion protection measures, eg gabions, if required.

3.6 Environmental

An Environmental Checklist must be completed to determine whether the proposed activities are listed in terms of the NEMA regulations. The Checklist must be submitted to the Competent Environmental Authority and a response must be received from them for the correct way forward in terms of environmental approvals. Sharples Environmental Services was appointed for the checklist and feedback is expected at about 30 August 2022.

3.7 Topographical Survey

African Consulting Surveyors was appointed for a LiDar topographical survey of the five river crossings and provided contour drawings sufficient for Hecras modelling of the proposed structures for the detail design.

3.8 Geotechnical investigation

No geotechnical investigation is envisaged.

At MR355 at km 3.0 it is proposed to jack a new culvert over the existing culvert and a limited risk is that boulders or rock may be present, but a geotechnical investigation will not reduce that risk materially. One will also infer that similar bedding conditions will be present at km 3.00 which was present at km 3.77.

The other culvert structures will either be founded on bedrock or have a raft foundation.

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4. DISCUSSION

This section should be read in conjunction with photographs in Appendix B.

4.1 Original Appointment – Priority A sites

4.1.1 Ø1.5m Armco culvert on road MR00355 at km 3.00

The culvert is corroded badly, especially the invert where there are not steel in most sections, thus the culvert has lost its structural integrity. The upstream side of the inlet works is in a good condition, but the last section of the Armco culvert washed away and collapsed due to erosion. There is no outlet structure visible. It appears as if the outlet side of the pipe is considerably higher than the riverbed into which it exits.

Repair options:

1. Repair Armco culvert to the WCG Standard drawing no. WSC/60/9/D1 (See Appendix D)
2. Replace the Armco culvert
    a. By excavating the culvert and laying a new concrete pipe
    b. Jacking a concrete pipe over the existing Armco and subsequently removing the Armco culvert.

New inlet and outlet works consisting of wing walls and an apron slab is required.

Discussion:

Option 1 is the cheapest option, but the Armco has lost its structural integrity and this process will require cutting the remaining steel at the invert level further reducing its load carrying ability temporarily during construction which causes danger to the workers. The diameter of the pipe will be marginally reduced. The biggest concern is that the culvert is badly corroded everywhere and has no corrosion protection remaining, thus the life expectancy of the Armco culvert is limited.

Option 2 (a) will require the road to be closed for a period of minimum 30 days which Japie Strydom of the DM requested should be a last resort as the Saasveld forestry department has already been affected for a period of 6 months due to works being carried out at km 3.77. It would be difficult to build a temporary deviation road due to the deep valley and this will destroy a large area of the indigenous vegetation.

Option 2 (b) will not require the closing of the road nor a temporary deviation road and may be cheaper than Option 2 (a) as earthworks and road building operations will not be required.

4.1.2 Ø2.0m Armco culvert on road MR00355 at km 3.77

This work was done departmentally by the WCG and the road would have been opened by end May 2022. The repair consisted of a 1800mm concrete spigot and socket pipe with concrete upstream and downstream inlet and outlet works consisting of wing walls, apron slabs, cut-off beams and a downstream stilling basin for erosion protection. All this work will be completed departmentally unless the client advises that certain components must be included in this commercial project.

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The road just upstream of the repaired culvert is in a bad condition and may collapse during a high rainfall event, causing the debris to block the opening of the new culvert. Refer to the last photo in the Appendix for this structure. This structure does not belong to the WCG, but its collapse poses a risk to the the integrity of the road fill.

4.1.3 Road slip on road MR00355 at km 7.95

A 15m long section of road has been affected by road slip. There is an existing 2.2m high rock wall on the edge of the road.

We recommend that the affected area is excavated and re-built in layers of 500mm thick reinforced earth. Once the road has been reinstated, either re-use the existing rocks to re-build the wall along the face of the fill material, or alternatively use gabions, to protect the road edge from erosion.

4.1.4 1.6m wide x 1.2m high box culvert causeway on road DR01633 at km 3.35

The existing concrete causeway structure is 30m long and 8m wide and includes one drainage opening of 1600m wide x 1200mm high. The structure has return walls which are underscoured. Due to the undersized drainage opening the structure acts as a weir during larger rainfall events causing wide erosion on the downstream side.

It is recommended to replace this structure with a causeway with adequate drainage openings so that the design flood can pass under the structure with limited overtopping so that it will still be safely trafficable. A visual estimate is that an in situ reinforced concrete structure with two 6m wide x 1.5m high openings will be required. A 6.2m road width between guide blocks is recommended.

New inlet and outlet works, consisting of wing walls and an apron slab, are required. No approach slabs are proposed but the current approach slabs may be retained.

4.1.5 Three Ø600mm precast concrete pipe culvert causeway on road DR01791 at km 1.59

The existing concrete causeway is 20m long x 6.1m wide with three Ø600mm pipes which is submerged permanently thus it does not contribute to hydraulic capacity. This is in essence a drift structure. During the floods of November 2021, a part of the unreinforced concrete deck slab was lifted by the flood action. The structure has water pools on both sides of the road and this appears to be a permanent feature with water lilies growing in the pond on the downstream side.

Local farmers (Henk Stroebel – 072 628 6232 and Peter Schuster – 082 330 3030), whom we met during the inspection, confirmed that flooding occurs about 3 times per year and that the road is inaccessible to traffic for periods up to 5 days during high rainfall events.

The problem can be alleviated if the river can be cleaned of vegetation, but it will not solve the problem and such cleaning operations will need to be done regularly and would have to include areas outside the road reserve.

Repair options:

1. Repair the causeway slab by reinstating the missing top slab to prevent vehicle damage.
2. Replace the structure with a causeway with larger openings and lift the top deck level marginally to increase the hydraulic capacity marginally.

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3. Replace the structure with a causeway which is considerably higher than the current structure with adequately sized openings to cater for the design flood and the overgrown nature of the river. The gravel road and the surfaced road will have to be raised for about 100m on both sides of the causeway. A visual estimate is that an in situ reinforced concrete structure with two cells 6m long x 1.5m high opening will be required. This will raise the road level by about 1.4m. Detail hydraulic analysis will be required to provide more accurate proposals.

Discussion:

Option 1 and 2 would not improve the problem that the structure is inundated for periods following a high rainfall event. Option 1 is cheap and option 2 has a bad benefit-to-cost ratio. Option 3 will resolve the problem permanently.

Options 2 and 3 will require new inlet and outlet works, consisting of wing walls and an apron slab. A 6.2m road width between guide blocks is recommended. No approach slabs are proposed.

4.1.6 Inlet and outlet protection works at six Ø450mm precast concrete pipe culvert + two 1.2m wide x 0.6m high box culvert causeway on road DR01639 at km 1.63

The existing structure is 5.1m long and 4.6m wide and consist of an older structure at the bottom of six Ø450mm concrete pipes and a later structure consisting of two 1200mm wide x 600mm high box culverts which was built on top of the older structure. The pipes are eroded so that the invert is mostly non-existent. It appears that the last flood caused the structure to overtop, and that this water eroded the downstream side wider than the confined riverbed upstream and further downstream as it acted as a weir structure.

Rip rap was placed on the downstream side, and this will alleviate future scouring due to overtopping. The request was to provide erosion protection works.

Repair options:

1. Upstream and downstream erosion works can be provided consisting of wing walls, apron slabs and cut-off beams.
2. The structure can be replaced with a causeway with adequately sized openings for the design flood. A visual estimate is that an in situ reinforced concrete structure with an single cell of 5m wide x 1.4m high will be required.
3. Do nothing.

Discussion:

The rip rap which was recently placed on the downstream side will reduce scour and this can be improved by placing more rip rap. The basic problem, i.e., the drainage openings are too small for the catchment area and small debris would easily block these small drainage openings, will remain. These problems will not persist if a structure with adequate large draining openings is provided. Should option no. 1 be implemented, and the causeway must ever be replaced due to collapsing pipes, the new works will make it very difficult to carry out these repair works and the road width will remain at 4.6m unless the inlet and outlet structures are demolished.

Option 2 will require new inlet and outlet works, consisting of wing walls and an apron slab. A 6.2m road width between guide blocks is recommended.

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The flood fence on the downstream side is missing and needs to be replaced.

4.2 Priority B sites to be Elevated to Priority A sites at discretion of the Client

Japie Strydom of the District Municipality requested that the following sites be investigated during our site inspection and that design proposals be provided in case the sites classification can be elevated to Priority A site.

4.2.1 Three Ø600mm precast concrete pipe culvert + four 1.2m wide x 0.9m high box culvert causeway on road DR01602 at km 8.48

The existing causeway is 22m long and 4.2m wide and includes three Ø600mm pipes and four 1200mm wide x 900mm high box barrels. The upstream and downstream sides are scoured to 500mm and 1000mm respectively below the invert levels of the drainage openings. During the November 2021 flood the George side approach road was washed away for a length of 15m. From initial investigation it appears as if the bedrock is about 1000mm below the invert level of the drainage openings.

The DM reported that the large grain and milk trucks regularly falls off the causeway as the structure is too narrow just past the sharp bend on the George side. The DM improved the bend, but the problem persists according to Japie Strydom of the DM. The structure is unsafe when it overtops as it does not have guide blocks.

Repair options:

1. The structure can be locally widened on the side of the sharp bend and guide blocks can be added
2. The structure can be replaced with a causeway with adequately sized drainage openings for the design flood. A visual estimate is that an in situ reinforced concrete causeway with three cells of approximate 6m wide by 1.5m high will be required. and it can be widened to 6.2m between guide blocks, unless the detail design of the safe turning circle and sweep of trailers determine that an even wider structure is required locally.

Option 2 will require new inlet and outlet works, consisting of wing walls and an apron slab.

4.2.2 Missing bridge end-block on road MR00355 at km 8.67

This bridge is named the Silver River bridge.

One of the end blocks and part of the balustrade, which are both constructed in unreinforced concrete, was knocked down by vehicle impact. The bridge straddles a very deep gorge and therefore road users' safety is endangered.

The only repair option available is to replace the end-block with the same geometric dimensions but to use reinforced concrete to make it more robust.

This structure is not part of the current scope of work, but as the structure is also on MR355 the writer wishes to remind the reader of the damage.

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4.2.3 *Balustrade walls in Montagu Pass on DR01640 between km 7 and 10*

There are five sections where the dry-stack wall is missing with the following section lengths: 4m, 12m, 14m, 6m and 4m. The wall is 600mm wide and 700mm high with a thin layer of mortar on the top surface. The pass is dangerous to road users where the balustrade wall is missing.

These defects do not form part of our current appointment; however, the Garden Route DM have requested that we visit these sites at the same time of our initial site visit.

A combined length of 40m of dry-stack wall needs to be reinstated using existing rocks in the vicinity. We recommend that mass concrete is used to bind these rocks together whilst ensuring that the mass concrete is not visible on the external faces of the wall.

We further recommend that the road is re-gravelled in the near future as signs are visible that the foundation to this wall is starting to be undermined in localised areas.

5. RECOMMENDATIONS

5.1 Original Appointment – Priority A sites

5.1.1 *Ø1.5m Armco culvert on road MR00355 at km 3.00*

Replace the Armco culvert by jacking a concrete pipe over the existing Armco and subsequently remove the Armco culvert.

New inlet and outlet works, consisting of wing walls and an apron slab, are required.

5.1.2 *Ø2.0m Armco culvert on road MR00355 at km 3.77*

This work was done departmentally by the WCG. Client to confirm with DM whether any works are outstanding that has to be included in this Contract.

The culvert structure immediately upstream of the culvert must be investigated and a decision taken what actions are required or if no action is required.

5.1.3 *Road slip on road MR00355 at km 7.95*

Repair slip with reinforced earth complete with a screen wall, consisting of stone, to protect the reinforcement fabric.

5.1.4 *1.6m wide x 1.2m high box culvert causeway on road DR01633 at km 3.35*

Construct a new causeway with adequate drainage openings (visual estimate of 2 cells 6m wide x 1.5m high). A 6.2m road width between guide blocks is recommended.

New inlet and outlet works, consisting of wing walls and an apron slab, are required.

5.1.5 *Three Ø600mm precast concrete pipe culvert causeway on road DR01791 at km 1.59*

Construct a new causeway with adequately sized openings (visual estimate of 2 cells 6m wide x 1.5m high) . A 6.2m road width between guide blocks is recommended.

New inlet and outlet works, consisting of wing walls and an apron slab, are required.

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The gravel road and the surfaced road will have to be raised for about 100m on both sides of the causeway, which will possibly require some modification of the tow accesses on the eastern side.

5.1.6 Inlet and outlet protection works at six Ø450mm precast concrete pipe culvert + two 1.2m wide x 0.6m high box culvert causeway on road DR01639 at km 1.63

Construct a new causeway with adequately sized openings (visual estimate of 1 cell 5m wide x 1.4m high). A 6.2m road width between guide blocks is recommended.

New inlet and outlet works, consisting of wing walls and an apron slab, are required.

The flood fence on the downstream side is missing and needs to be replaced.

5.2 Priority B sites to be Elevated to Priority A sites at discretion of the Client

5.2.1 Three Ø600mm precast concrete pipe culvert + four 1.2m wide x 0.9m high box culvert causeway on road DR01602 at km 8.48

Construct a new causeway with adequately sized openings (visual estimate of 3 cells 6m wide x 1.5m high). A 6.2m road width between guide blocks is recommended unless the detail design of the safe turning circle and sweep of trailers determine that a wider structure locally at the side of the sharp bend is required.

New inlet and outlet works, consisting of wing walls and an apron slab, are required; but this may be omitted if base rock is at riverbed level.

5.2.2 Missing bridge end-block on road MR00355 at km 8.67

Replace missing end-block (of the same geometric dimensions) with a reinforced concrete structure.

5.2.3 Balustrade walls in Montagu Pass on DR01640 between km 7 and 10

A combined length of 40m of dry-stack wall needs to be reinstated using existing rocks in the vicinity.

5.3 Detail Design

A detailed design to be carried out during the next phase to confirm hydraulic data and structural sizes.

5.4 Topographical Survey

Appoint African Consulting Surveys for a LiDAR topographical survey of the five sites where hydraulic structures are proposed. Pierre Spence of WCG surveying department approved the quotation and technical requirements for a cost of R83 000 ex VAT.

5.5 Environmental Checklist

Appoint Sharples Environmental Services to prepare the Environmental Checklist at a cost of R28 000 excl. VAT which was agreed to by Sardieq Slamdien by email dated 11 July 2022.

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6. COST ESTIMATE

Contracts of a similar nature were used to estimate the costs for this project. The components of the estimated cost include the structural costs, road costs and General Items.

Table 13: Cost estimate

No	Road No.	Km Dist.	Proposed Structure	Estimated Cost	
6.1 Original Appointment – Priority A sites					
6.1.1	MR00355	3.00	New jacked concrete pipe	R	2,640,000.00
6.1.2	MR00355	3.77	New concrete pipe (completed departmentally)	R	-
6.1.3	MR00355	7.95 to 7.96	15m long road slip repair	R	400,000.00
6.1.4	DR01633	3.35	New causeway	R	1,180,000.00
6.1.5	DR01791	1.59	New causeway	R	3,770,000.00
6.1.6	DR01639	1.63	New causeway	R	900,000.00
6.2 Priority B sites to be Elevated to Priority A sites at discretion of the Client					
6.2.1	DR01602	8.48	New causeway	R	950,000.00
6.3.1	MR00355	8.67	New bridge end-block	R	40,000.00
6.3.2	DR01640	7.55 to 9.84	New 40m long dry-stack balustrade wall	R	120,000.00
			Total Structures	R	10,000,000.00
			P&G (50%)	R	5,000,000.00
			Sub Total 1	**R**	**15,000,000.00**
			Day works	R	50,000.00
			Total	**R**	**15,050,000.00**
			VAT	R	2,257,500.00
			Estimate Contract Sum	**R**	**17,307,500.00**

Note: The General Item cost for this type of project is high due to the small quantities of scheduled work, the different location and the fact that large construction teams cannot be used. We used actual costs from previous projects, and the General Item cost varied from 50% to 60% on these.

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APPENDIX A: MINUTES OF BRIEFING MEETING

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From: Malan, Dawie
Sent: Tuesday, May 17, 2022 10:16 AM
To: Sardieq.Slamdien@westerncape.gov.za
Cc: Wandie Olivier; Manchip, Chris; Smit, Pieter
Subject: C1157.02 Garden Route Flood Damage

Hi Sardieq

Thank you very much for the briefing sessioin this morning at our office.

Attendance:
Dawie Malan
Sardieq Slamdien
Wandie Olivier

Scope of work:
6 sites
One site already completed construction by GRDM
Area: George & Plettenberg Bay

- Functional road class
  - MR 355 – class 3 (proposed)
  - Other roads (Class 4)
  - Hatch will finalize proposal
- KMZ file (Google Earth) of site positions for hydraulic calculations before site visit

C-contract
Hatch to appoint surveyor, ECO, OHS

Programme

- 2 weeks for incident report. Intend to visit site between 23 & 27 May. Probably 2 or 3 days
-

Incident Report

- Stage 1 (status quo, repair proposal, Estimated cost, Detail design – programme)
- Submit 2 weeks after site visit
- Information required

Sardieq & Wandie: Thank you very much for the appointment; it is greatly appreciated.

Regards

Dawie Malan, Pr Eng
Senior Engineer/Structures & Bridges

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2nd Floor, False Bay Building, Tygerberg Park, 163 Uys Krige Drive, Plattekloof, Cape Town, 7500, South Africa
www.hatch.co.za

Processing of personal information / POPIA compliance
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APPENDIX B: PHOTOGRAPHS OF LISTED STRUCTURES

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B1: Original Appointment – Priority A sites

B1.1: Ø1.5m Armco culvert on road MR00355 at km 3.00

Road MR00355 at km 3.00

Upstream – looking away from culvert

Upstream – looking towards culvert

Head fall and culvert inlet

Severe corrosion to invert of Armco culvert

Downstream section of the Armco culvert washed away and collapsed due to erosion

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Downstream section of the Armco culvert washed away and collapsed due to erosion

Downstream section of the Armco culvert washed away and collapsed due to erosion

Downstream – looking towards culvert

B1.2: Ø2.0m Armco culvert on road MR00355 at km 3.77

Road MR00355 at km 3.77; upstream on RHS. Backfilling in progress.

Road MR00355 at km 3.77; upstream on LHS. Backfilling in progress.

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Downstream – looking away from culvert

Downstream – looking towards culvert

Downstream – looking towards culvert. Headwall construction in progress.

Inside newly installed pipe culvert

Upstream – looking towards culvert

Upstream – looking away from culvert

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Existing Armco culvert on private road upstream of MR00355 at risk of collapse. May cause damage to MR00355 if this happens.

B1.3: Road slip on road MR00355 at km 7.95

Road slip on RHS at MR00355 at km 7.95

Road slip on RHS at MR00355 at km 7.95

Close-up view of road slip

Close-up view of road slip

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2.2m high rock wall on the edge of the road

Close-up view of rock wall

B1.4: 1.6m wide x 1.2m high box culvert causeway on road DR01633 at km 3.35

Road DR01633 at km 3.35; upstream on LHS.

Road DR01633 at km 3.35; upstream on RHS.

Road DR01633 at km 3.35; upstream on RHS.

Upstream – looking away from culvert

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 Upstream – looking towards culvert	 Upstream – looking towards culvert
 Corrosion visible to inside of causeway structure	 Downstream – looking away from culvert
 Downstream – looking away from culvert	 Downstream – looking towards culvert

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<table>
<tr><td> 
Downstream – looking towards culvert</td><td> 
Downstream – looking towards culvert</td></tr>
<tr><td> 
Downstream – looking towards culvert</td><td></td></tr>
<tr><td colspan="2">B1.5: Three Ø600mm precast concrete pipe culvert causeway on road DR01791 at km 1.59</td></tr>
<tr><td> 
Road DR1791 at km 1.59; upstream on RHS.</td><td> 
Road DR1791 at km 1.59; upstream on RHS.</td></tr>
</table>

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Road DR1791 at km 1.59; upstream on LHS. Debris from previous flood trapped against fence.

Debris from previous flood trapped against fence on downstream side of road.

Water ponding downstream of drift

Water ponding downstream of drift

Water ponding upstream of drift. Damage to deck caused during previous flood.

Water ponding upstream of drift. Damage to deck caused during previous flood.

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Damage to deck and pipe culvert caused during previous flood.

B1.6: Inlet and outlet protection works at six Ø450mm precast concrete pipe culvert + two 1.2m wide x 0.6m high box culvert causeway on road DR01639 at km 1.63

Road DR1639 at km 1.63; upstream on LHS.

Road DR1639 at km 1.63; upstream on RHS.

Rip rap has recently been placed on the downstream side to reduce scour

Rip rap has recently been placed on the downstream side to reduce scour

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 Downstream – looking towards culvert. Flood fence missing.	 Downstream – looking towards culvert. Flood fence missing.
 Upstream – looking away from culvert	 Upstream – looking towards culvert
 Severe corrosion to invert of pipe culvert	

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B2: Priority B sites to be elevated to Priority A sites at discretion of Client

B2.1: Three Ø600mm precast concrete pipe culvert + four 1.2m wide x 0.9m high box culvert causeway on road DR01602 at km 8.48

Road DR1602 at km 8.48; upstream on RHS.

Road DR1602 at km 8.48; upstream on LHS.

Upstream – looking away from culvert

Upstream – looking towards culvert

Downstream – looking away from culvert

During the November 2021 flood the George side approach road was washed away for a length of 15m. This portion of road has been repaired and widened

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Downstream – looking away from culvert

Downstream – looking towards culvert

Downstream – looking towards culvert

B2.2: Missing bridge end-block on road MR00355 at km 8.67

One of the end-blocks and part of the balustrade to the Salt River bridge on road MR00355 at km 8.67 was knocked down by vehicle impact. This is on the RHS when approaching the bridge from Saasveld side.

One of the end-blocks and part of the balustrade to the Salt River bridge on road MR00355 at km 8.67 was knocked down by vehicle impact. This is on the RHS when approaching the bridge from Saasveld side.

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 Remains of the damaged end-block and balustrade	 Image of existing end-block on opposite side of the bridge
B2.3: Balustrade walls in Montagu Pass on DR01640 between km 7 and 10	
 Image of existing dry-stack balustrade wall in Montagu Pass on road DR1640	 Damage to dry-stack balustrade wall on DR1640 at km 7.55
 Damage to dry-stack balustrade wall on DR1640 at km 7.63	 Damage to dry-stack balustrade wall on DR1640 at km 7.87

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 Damage to dry-stack balustrade wall on DR1640 at km 7.87	 Damage to dry-stack balustrade wall on DR1640 at km 9.84

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APPENDIX C: PROPOSED STRUCTURES

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Typical Causeway

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APPENDIX D: WCG DTPW STANDARD DRAWINGS

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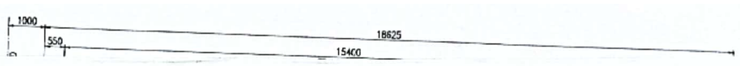
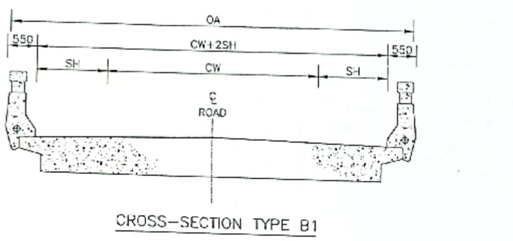
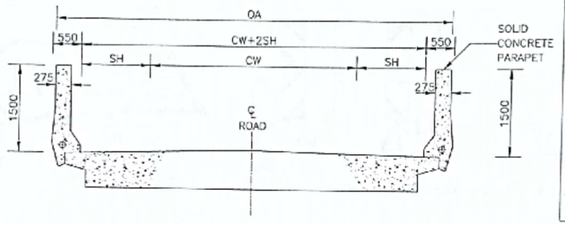




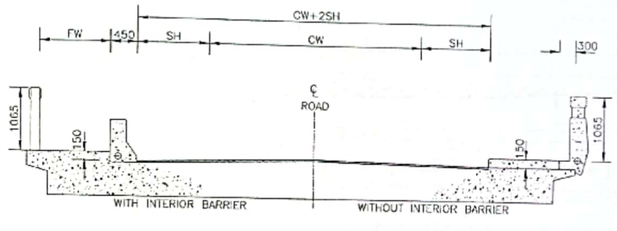
CROSS–SECTION TYPE B1



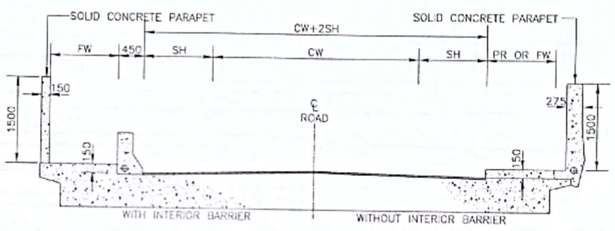
CROSS–SECTION TYPE R1

NOTES :

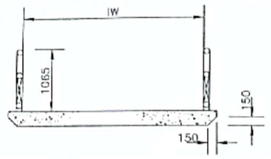
1. PROVINCIAL TRUNK ROAD BRIDGES NOT TO BE OF STATUS LOWER THAN CLASS II.
2. SHOULDERS ARE DELINEATED BY YELLOW PAINTED LINES AT CARRIAGEWAY EDGES.
3. PARAPET HEIGHTS ON ROAD/RAIL BRIDGES IN ACCORDANCE WITH SATS 1983 BRIDGE CODE.
4. CROSS SECTIONS TO TOP OF ASPHALT.
5. FOR STRUCTURE NUMBERS REFER TO DWG. No. WCS/60/8/D1.



CROSS–SECTION TYPE B2
TYPE B: ROAD/ROAD AND ROAD/RIVER BRIDGES



CROSS–SECTION TYPE R2
TYPE R: ROAD/RAIL BRIDGES

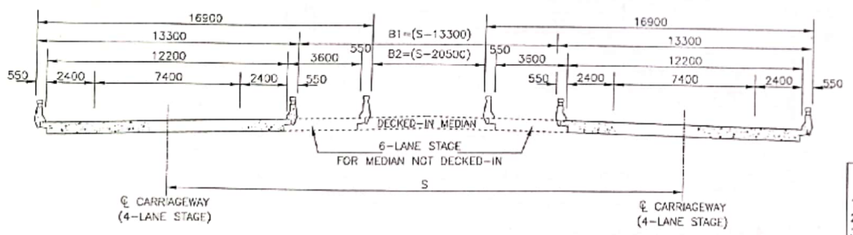


CYCLISTS / HIGH PEDESTRIAN TRAFFIC IW = 3,00
HIGH PEDESTRIAN TRAFFIC IW = 2,50
LOW PEDESTRIAN TRAFFIC IW = 2,00

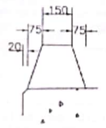
DECK CROSS–SECTION OF PEDESTRIAN UNDERPASS

STANDARD RURAL SINGLE CARRIAGEWAY BRIDGE WIDTHS

ROAD CLASS	TRAFFIC COUNT EVU'S PER DAY	CARRIAGE WAY WIDTH CW	TYPE B1 AND R1 BALUSTRADES OVERALL (MIN) OA	SHOULDER SH	BETWEEN KERBS CW+2SH	TYPE B2 AND R2 INTORDUCED FOOTWALK SHOULDER SH	BETWEEN KERBS CW+2SH	FOOTWALK (MIN) FW	EXTERIOR PEDESTRIAN REFUGE/FOOTWALK SHOULDER SH	BETWEEN KERBS CW+2SH	PEDESTRIAN REFUGE PR	FOOTWALK (MIN) FW
PROV.CLASS I	1000–2000	7,40	12,30	2,00	11,40	1,20	9,80	1,20	2,40	12,2	0,80	1,20
PROV.CLASS II	400–1000	6,80	10,70	1,50	9,80	0,90	8,60	1,20	1,80	10,40	0,80	1,20
PROV.CLASS III	< 400	6,50	9,50	0,90	8,60	0,80	8,00	1,20	1,20	9,20	0,80	1,20
PROV.CLASS IV SINGLE LANE (TYPE B1 & B2 ONLY)										4,00	0,80	



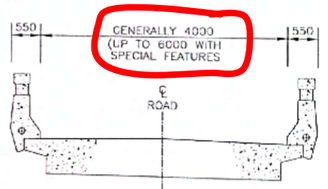
STANDARD RURAL DUAL DIVIDED CARRIAGEWAY BRIDGE WIDTHS



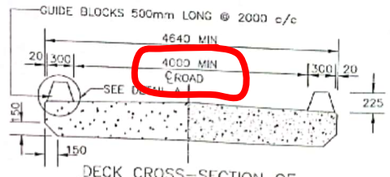
DETAIL A

BRIDGE MEDIAN DECKED–IN WHEN:

1. B1 OR B2 < 22m; BRIDGE LENGTH < 6m or
2. B1 OR B2 < 12m; BRIDGE LENGTH < 15m or
3. B1 OR B2 < 6m; BRIDGE LENGTH < 30m or
4. B1 OR B2 < 3m;



DECK CROSS–SECTION OF AGRICULTURAL UNDERPASS



DECK CROSS–SECTION OF SINGLE LANE LOW LEVEL BRIDGE

No	DATE	ADDITIONS AND AMENDMENTS	APPROVED	DATE

Issue Date: 2019

STANDARD PLANS

WESTERN CAPE GOVERNMENT
DEPARTMENT OF TRANSPORT AND PUBLIC WORKS

L.G.FOURIE
CHIEF DIRECTOR
ROAD NETWORK MANAGEMENT

BRIDGES

RURAL STRUCTURE STANDARD WIDTHS

SCALE : N.T.S.

A2 ORIGINAL

INDEX NO. WCS/60/1/D1

PLAN NO. SHEET 1 OF 2

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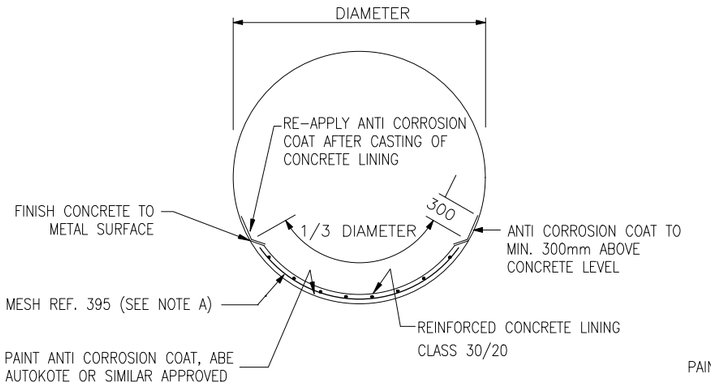
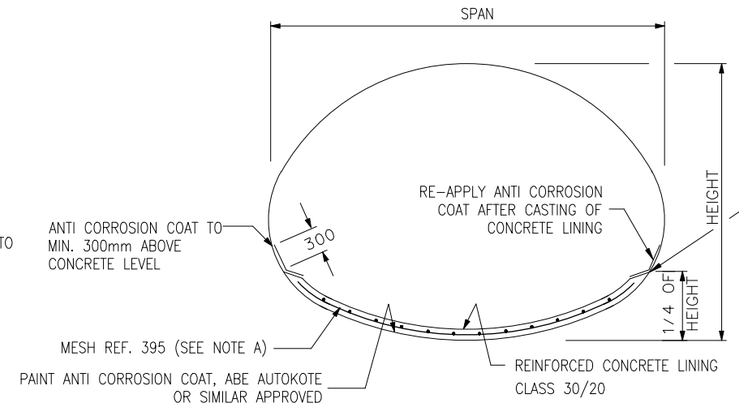


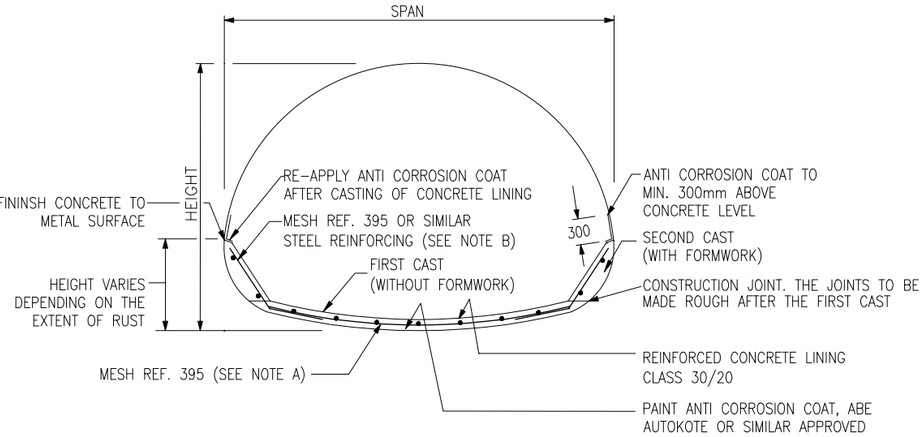
TYPICAL REINFORCED CONCRETE LINING FOR CIRCULAR ARMCO PIPE

FIGURE 1



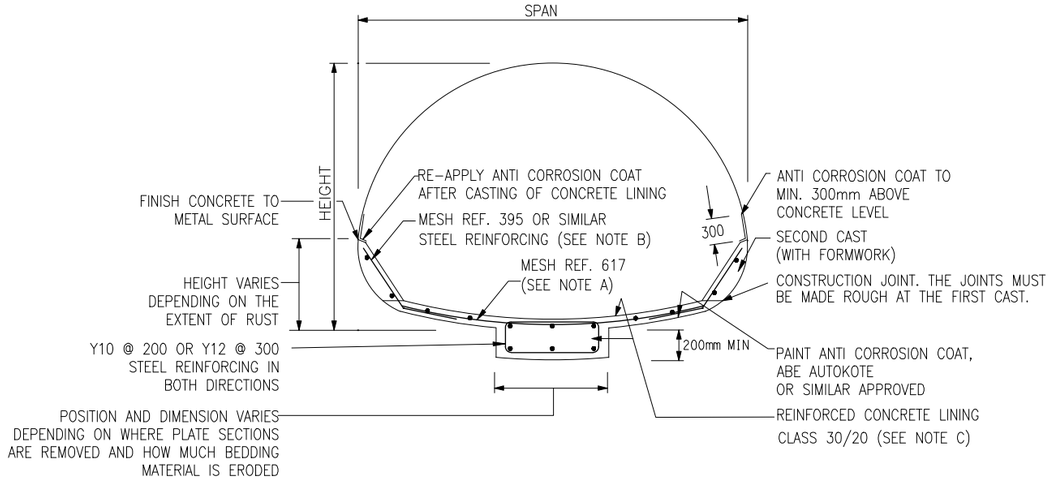
TYPICAL REINFORCED CONCRETE LINING FOR OVAL ARMCO PIPE

FIGURE 2



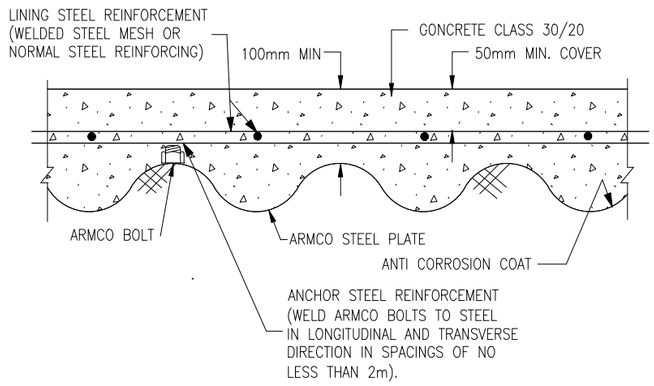
TYPICAL REINFORCED CONCRETE INVERT LINING FOR FOR ARMCO PIPES WHERE RUST OCCURS HIGHER UP ON THE ARMCO WALLS OR WHERE THE ARMCO WALLS BECOME TOO STEEP FOR CASTING IN ONE STAGE.

FIGURE 3



TYPICAL REINFORCED CONCRETE INVERT LINING FOR CASES WITH EXTREME CORROSION WHERE SECTIONS OF THE INVERT STEEL PLATE IS REMOVED AND BEDDING MATERIAL IS ERODED.

FIGURE 4



LONGITUDINAL SECTION THROUGH CONCRETE INVERT LINING

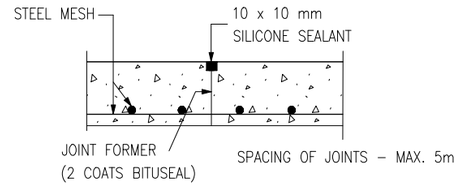
FIGURE 5

NOTES :

A. THE STEEL MESH TO BE BENT ON SITE TO SUIT THE ARMCO DIMENSIONS. IN CASES WHERE THE STEEL MESH CANNOT BE BENT TO THE ARMCO DIMENSIONS, THEN NORMAL STEEL REINFORCEMENT BARS TO BE USED EQUIVALENT TO THAT OF THE PRESCRIBED STEEL MESH.

B. THE REINFORCEMENT STEEL TO BE ANCHORED TO THE ARMCO BY MEANS OF WELDING ANCHOR STEEL TO THE EXISTING ARMCO BOLTS (SEE FIGURE 5). IN THE TRANSVERSE DIRECTION THE REINFORCEMENT MUST BE ANCHORED INTO THE FLOOR SECTION (FIRST CAST) BY 500mm MINIMUM.

C. THE FLOOR SLAB TO BE CAST IN SECTIONS WHERE BEDDING MATERIAL IS REPLACED WITH CONCRETE (FIGURE 4).



BUTT JOINT

FIGURE 6

No.	DATE	ADDITIONS AND AMENDMENTS	APPROVED	DATE

Issue Date: 2019

STANDARD PLANS

WESTERN CAPE GOVERNMENT
DEPARTMENT OF TRANSPORT AND PUBLIC WORKS

L.G.FOURIE
CHIEF DIRECTOR
ROAD NETWORK MANAGEMENT

ARMCO CULVERT REPAIR METHODS

CORRUGATED METAL CULVERT INVERT LINING

SCALE : N.T.S.

A2 ORIGINAL

INDEX NO. WSC/60/9/D1

PLAN NO. SHEET 1 OF 1

APPENDIX E: EXTRACT FROM TRH17: 1988 – GEOMETRIC DESIGN OF RURAL ROADS

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TECHNICAL RECOMMENDATIONS
FOR HIGHWAYS

TRH17

GEOMETRIC DESIGN OF RURAL ROADS

1988

ISBN 0 7988 3312 2

TRH17, Pretoria, South Africa, 1988

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5. CROSS-SECTIONAL ELEMENTS

5.1 Introduction

The cross-section of a road provides accommodation for moving and parked vehicles, drainage, public utilities and, to a lesser extent in the rural areas, pedestrians. For the safety and convenience of drivers, wide lanes and shoulders and gently sloping border areas are desirable, since they forgive minor errors of judgment and promote ease of operation.

Cross-sectional dimensions are discussed in the following sections. Alternatives to the dimensions suggested may be appropriate for particular conditions. Variations should be selected to suit these conditions, and careful consideration should be given to the function of the cross-sectional element before any departure from the recommended values.

5.2 Lanes

Undivided roads may have either one lane in each direction (two-lane two-way roads) or more than one lane in each direction (multi-lane roads). Dual carriageway roads have two or more lanes in each direction and are described in terms of the total number of lanes, e.g. as four-lane divided or six-lane divided roads.

Customarily, there is symmetry of through lanes, and assymmetry on a particular section of road should arise only from the addition of an auxiliary lane that is clearly allocated to one direction of travel. Three-lane two-way roads have been built that were intended to function as two-lane two-way roads with a continuous central passing lane. These roads were found to have twice the capacity of two-lane two-way roads, but they have been abandoned, in spite of the saving in construction costs resulting from the narrower cross-section, because the practical effect of the three-lane cross-section is to concentrate the faster vehicles of the two opposing traffic streams in a common lane. This is similar to the situation found in the overtaking manoeuvre on a two-lane road, but in the latter case it is clear which of two opposing vehicles has the right of way. When three-lane roads are only marked as having three lanes with no passing restrictions, there is no clarity regarding right of way, and it is this lack of clarity that causes three-lane roads to be unsafe.

The selection of lane width is based on traffic volume and vehicle type and speed. Higher volumes and speeds require wider lanes, and the greatest lane width recommended is 3,7m. The narrowest width recommended is 3,1m, giving a clear space of 0,3 m on either side of a vehicle that is 2,5 m wide. This lane width will normally be employed only where speeds or traffic volumes are expected to be low. Intermediate conditions of volume and speed can be adequately catered for by a lane width of 3,4 m.

Where traffic volumes are such that a multi-lane cross-section or a divided cross-section is required, 3,7 m is a logical lane width to adopt. Lesser lane widths may however be warranted by abnormal circumstances.

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