BEAL

CONSULTING ENGINEERING & PROJECT MANAGEMENT

# REPORT

## ENVIRONMENTAL IMPACT MANAGEMENT SERVICES

# STORM WATER MANAGEMENT PLAN AND WATER BALANCE FOR MANUNGU COLLIERY

**Submitted to:**

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**Report Number:**

B196_SWMP&Water Balance

# 1. CONTENTS



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# 1. INTRODUCTION

Environmental Impact Management Services (EIMS) commissioned BEAL Consulting and Project Management (Pty) Ltd to calculate a water balance for the Manungu Colliery and to size the storm water management infrastructure. This report provides the water balance and infrastructure results for the study as well as recommendations resulting from the work done.

## *1.1. Study objective*

The project objectives are as follows:

- Calculate a desktop water balance for the proposed colliery.
- Size the pollution control dam and spillway.
- Size the clean and dirty storm water channels that are proposed to control storm water on and around the site.

# 2. CLIMATIC DATA

The climate data used in this study is summarised in Table 1.

*Table 1: Climate data*

| Month | Average rainfall (mm) | Average evaporation (mm – S-Pan) |
|---|---|---|
| January | 119.3 | 184 |
| February | 95.5 | 154 |
| March | 86.0 | 152 |
| April | 41.2 | 117 |
| May | 18.4 | 98 |
| June | 6.1 | 80 |
| July | 5.9 | 87 |
| August | 8.3 | 116 |
| September | 22.4 | 150 |
| October | 67.5 | 181 |
| November | 101.1 | 171 |
| December | 106.9 | 188 |
| **Total** | 678* | **1 677** |

* *Note: The mean annual precipitation does not necessarily equal the sum of the monthly average precipitation.*

# 3. SITE LOCATION

Manungu Colliery is located approximately 10 km south of Delmas. The site is located in quaternary catchment B20A, in the Olifants River catchment.

# 4. WATER BALANCE

The water balance presented in this report is a static water balance. It represents average flows between facilities and along hydrological interfaces. Being a static water balance showing average flows, peak flows cannot be accounted for.

The Mpumalanga Highveld has distinct wet and dry seasons. Over 91% of Manungu Colliery's mean annual rainfall falls between September and April inclusively. Over 77% of the area's mean annual evaporation occurs in this period. For this reason, the water balance was divided into a wet season and a dry season water balance. The wet season water balance represents the period 1 September to 30 April. The rest of the year is included in the dry season water balance. The two seasonal water balances are combined into an annual water balance, presented in Appendix A.

## 4.1. Water Balance Components

The water balance on the proposed Manungu Colliery is made up of the contractors camp, product and ROM stockpiles, pollution control dams (PCDs), offices, various overburden stockpiles, and undeveloped areas between this infrastructure.

## 4.2. Water Balance Description

Two water balances are presented – one that represents the current infrastructure layout and one that represents a future infrastructure layout.

The average wet and dry season water balances for the proposed Manungu Colliery are provided in Appendix A. The inflows are presented on the left of the water balance figures. The facilities and inter-facility flows are shown in the centre of the water balance figures. The outflows are shown on the right of these figures.

The direction of water movement is illustrated with black arrows. The values adjacent to the arrows represent average flows in $m^3$/day. Clean water flows are shown in blue, while dirty flows are shown in red.

One of the fundamental principles of a water balance is that inflows must equal outflows unless the difference is accommodated in storage changes. The pollution control dams are relatively small and will not accommodate storage changes over a season so storage changes are assumed to be zero.

## 4.3. Sources of Flow Information

Daily rainfall data was sourced from the CCWR (Computing Centre for Water Research, Natal University) rainfall database (gauge number 0477309 – Delmas). The gauge is located approximately 10 km north of the site. Evaporation data and its monthly distribution were sourced from the Water Resources of South Africa Study data set, zone 4A (Midgley et al., 1990). Runoff factors were informed by average runoff for the quaternary catchments B20A, documented in the Water Resources of South Africa Study report (Middleton et al., 2009). Peak rainfall was statistically calculated from the rainfall data.

Groundwater volumes are based on recorded pit outflows. Potable water and dust suppression volumes are based on recorded data. A groundwater study has been commissioned by the client to confirm the groundwater inflows into the pit. Groundwater modelling results were not available at the time of writing. The water balance assumptions should be revisited once additional reliable data becomes available.

## 4.4. Water Balance Results

The average annual water balances for the proposed Manungu Colliery are provided in Appendix A. A static water balance cannot account for the dynamics of mine development. A snapshot of the colliery's development is used to calculate the water balance. The snapshot comprises the pit development depicted in survey data provided in April 2018, as well as full pit development.

# 5. POLLUTION CONTROL DAM SIZING

## 5.1. Introduction

The pollution control dam accommodates storm water from the dirty areas on the colliery: the ROM stockpile area, the hards dump and surrounding undeveloped catchments.

## 5.2. Methodology

The dam sizing methodology was based on two methods:

1. the required storage resulting from a long term monthly time step water balance, plus the 50-year storm runoff volume. This is to address the requirements set out in Government Notice 704 of the South African National Water Act (GN704).
2. the normal operating volume, plus the 50-year design storm runoff. This is outlined in the GN704 implementation guidelines.

In the GN704 simulations, the 50-year storm was added to the long term monthly time series because individual storms during the month are not modelled and are averaged out during the month. This also aligns it well with the GN704 implementation guidelines.

### 5.2.1. 50-Year and 100-Year Storm Events

The peak rainfall data used is presented in Table 2.

*Table 2: Peak 24-hr rainfall depth for the Manungu Colliery*

| Recurrence interval | 24-hr rainfall depth (mm) |
|---|---|
| 50-yr | 116 |
| 100-yr | 126 |

Peak storm water discharge was calculated using the SCS runoff equations (Schmidt and Schulze, 1987). The curve numbers used in the calculations are presented in Table 3.

*Table 3: Curve numbers used for the SCS storm water calculations*

| Pollution control Dam | Curve Number (CN) |
|---|---|
| Roads and compacted areas | 88 |
| Dumps and stockpiles | 65 |
| Undeveloped catchments | 65 |

### 5.2.2. Monthly Continuous Modelling

Monthly rainfall data from the CCWR's database (gauge number 0477309) was used in the long term water balance modelling. The modelling incorporated the inputs and outputs shown in Table 4.

*Table 4: Inputs and outputs modelled*

| Inputs | Outputs |
|---|---|
| Direct rainfall on the dam | Evaporation losses |
| Storm water generated by the upstream catchment | Recycling to satisfy dust suppression |
| Process water flows to the PCD | |

Storm water generated from the catchment was calculated on a non-linear relationship between monthly rainfall and runoff. This is presented in Appendix B. No antecedent moisture conditions were accounted for. Water reuse from the pollution control dam is based on the water balance presented in Appendix A.

## 5.3. Results

The mine's water balance is a positive water balance so an evaporative PCD is unfeasible. The minimum size of the PCD is the 50-year design storm volume from the PCD's catchment. However, this minimum capacity will provide no operational storage and the PCD will have to be operated empty. This is not how the mine will operate the PCDs and some operational storage will be required.

The required PCD capacities are summarised in Table 5. Note that the PCD capacities assume that the mine water balance is brought back to a neutral or deficit water balance. This can be achieved by a large continuous demand such as a water treatment plant or a washing plant.

The size of the water treatment plant will depend on the groundwater inflows into the pit. The groundwater inflows are not known at the time of writing.

*Table 5: Required PCD capacities*

| PCD | Required capacity ($m^3$) |
|---|---|
| PCD 1 | 46 000 $m^3$* |
| PCD 2 | 18 000 $m^3$ |
| PCD 3 | 5 500 $m^3$ |
| PCD 4 | 4 000 $m^3$ |

** Existing capacity*

**PCD 1**

It is also important to note that the PCD 1 catchment will get smaller as the opencast mining expands. Currently, much of the PCD 1 catchment is made up of land that will be mined. This means that the design storm volume for PCD 1 will decrease over time, as its catchment is converted into an opencast pit.

Given this reality, it is deemed appropriate to provide limited operational storage currently. As the PCD 1 catchment reduces, the 50-year design storm volume decreases and operational storage increases. The capacity of PCD 1 is fixed, so storm volume is effectively converted to operational volume.

PCD 1 currently exists and is slightly too small. The 50-year storm volume is approximately 51 000 $m^3$. To avoid having to increase its capacity, additional capacity is added to PCD 2. Pumping infrastructure must therefore be put in place to transfer water from PCD 1 to PCD 2. The capacity shortfall (5 000 $m^3$) must be able to be transferred in 24 hours, i.e. 210 $m^3$/hr.

**PCD 2**

PCD 2 has a 50-year storm volume of 3 000 $m^3$. The PCD 1 shortfall is 5 000 $m^3$. This must be added to the PCD 2 capacity. The mine also needs some operational storage, so an additional 10 000 $m^3$ (operational storage allowed for) of storage must also be added to PCD 2. The required capacity for PCD 2 is therefore 18 000 $m^3$.

**PCD 3 and PCD 4**

PCD 3 will only be constructed once the underground operations are constructed. The capacity of these dams cannot currently contribute to the operational storage. The required capacity of these two PCDs are limited to their 50-year design storm volumes. It is assumed that all water that accumulates in them can be pumped to the underground workings within 24 hours. The PCDs are therefore operated dry.

### *5.4. Spillway Sizing*

The spillway on the pollution control dam will need to cater for storm water generated from the dirty upstream catchments, plus direct rainfall on the dam. This is shown in Table 6.

*Table 6: Spillway sizing*

| Dam | 100-yr flood peak | Spillway width | 100-yr flow depth |
|---|---|---|---|
| PCD 1 | 12.8 $m^3/s$ | 16 m | 0.63 m |
| PCD 2 | 1.3 $m^3/s$ | 3 m | 0.42 m |
| PCD 3 | 2.1 $m^3/s$ | 5 m | 0.41 m |
| PCD 4 | 2.6 $m^3/s$ | 6 m | 0.42 m |

## 6. STORM WATER CHANNEL SIZING

Clean and dirty storm water channels have been identified by BEAL. These channels, shown in the drawings presented in Appendix B, were sized during this study.

### *6.1. Catchment Delineation*

The catchments were delineated using 0.5 m contour data supplied by Manungu.

### *6.2. Peak Rainfall*

The peak rainfall data, presented in Table 2 was used to calculate the flood peaks.

### *6.3. Flood Peak Calculation*

The positions of the storm water channels are shown in **Appendix B**. The sub-catchments reporting to these channels were delineated. The sub-catchments are small and the rational method is therefore a suitable method of determining the flood peaks. The old Department of Water Affairs' calculation sheet was used to determine the runoff coefficients. The time-to-concentration of the sub-catchments was calculated using the SCS method which is suitable for relatively undeveloped catchments. Adamson's TR102 (Adamson, 1981) was used to convert the 24-hour peak rainfall data to rainfall intensities appropriate to the time-to-concentration of the catchments. The 1085 method was used to calculate catchment slopes. The results of these calculations for all sub-catchments are summarised in Table 7.

### *6.4. Channel and Berm Specifications*

Dirty channels are specified as concrete-lined channels.

Berms should be compacted and vegetated. A geotechnical investigation of the soils should be undertaken to confirm the compaction specifications.

### *6.5. Channel Sizing*

The channels were sized to accommodate the flood peaks presented in Table 7. The Mannings open channel flow equation was used to calculate flow depth in the channel. A

Mannings n of 0.027 was used for unlined channels and 0.015 for concrete lined channels. The channels are sized assuming trapezoidal channels with side slopes of 1:1.5 (V:H).

It is good practice to allow approximately 0.3 m of freeboard in the channel. This is to allow for wave action and flow surges in the channel. A summary of the channel sizes is presented in Table 7.

## *6.6. Channel 1 upgrade*

Channel 1 is an existing concrete-lined channel.

*Table 7: Summary of infrastructure sizes*

| Channel | 50-yr flood peak ($m^3/s$) | Lining | Bottom width (m) | Longitudinal slopes (V:H)* | Max flow depth (m) | Channel depth (m) | Max flow velocity (m/s)* | Flow type at max velocity |
|---|---|---|---|---|---|---|---|---|
| Channel 1 | 8.4 | Concrete | 1.0 | 1:74 | 0.82 | 1.1 | 4.6 | Supercritical |
| Channel 2 | 0.1 | Concrete | 1.0 | 1:200 | 0.36 | 0.6 | 1.8 | Supercritical |
| Channel 3 | 0.3 | Concrete | 1.0 | 1:200 | 0.18 | 0.5 | 1.3 | Supercritical |
| Channel 4 | 1.3 | Concrete | 1.0 | 1:200 | 0.41 | 0.7 | 2.0 | Supercritical |
| Channel 5 | 0.7 | Concrete | 1.0 | 1:125 | 0.26 | 0.5 | 1.9 | Supercritical |
| Channel 6 | 1.0 | Concrete | 1.0 | 1:62 | 0.26 | 0.5 | 2.8 | Supercritical |
| Channel 7 | 0.2 | Concrete | 1.0 | 1:47 | 0.1 | 0.5 | 1.8 | Supercritical |

| Berm | 50-yr flood peak ($m^3/s$) | Lining | Top width (m) | Longitudinal slopes (V:H)* | Max flow depth (m) | Berm Height (m) | Max flow velocity (m/s)* | Flow type at max velocity |
|---|---|---|---|---|---|---|---|---|
| Berm 1 | 1.3 | Unlined | 0.5 | 1:200 | 0.25 | 0.5 | 0.7 | Subcritical |
| Berm 2 | 1.5 | Unlined | 0.5 | 1:80 | 0.18 | 0.5 | 0.9 | Subcritical |

| Culvert | 50-yr flood peak ($m^3/s$) | Type | Span (m) | Height (V:H)* | Diameter (m) | No of |
|---|---|---|---|---|---|---|
| Culvert 1 | negligible | Round | | | 0.3 | 1 |
| Culvert 2 | negligible | Round | | | 0.3 | 1 |
| Culvert 3 | 0.3 | Portal | 1200 | 450 | | 1 |
| Culvert 4 | 1.3 | Portal | 1500 | 600 | | 1 |
| Culvert 5 | 0.7 | Portal | 1200 | 450 | | 1 |

*General note: All channels are trapezoidal with side slopes of 1:1.5 (V:H)*

** Note: Flow velocities are based on the maximum longitudinal gradient. These gradients will need to be confirmed during subsequent design phases.*

## 7. CONCLUSIONS

The water balances were calculated for current and end of life and are presented in Appendix A.

The water balances highlighted the following key results:

- The water balance appears to currently be positive during the wet season. During the dry season, dust suppression demands are likely to exceed available water.
- As the pit development increases, the water balance could become more positive during the wet season with maximum dust suppression demands being less than groundwater and storm water availability. This must be monitored.

The water balance conducted in this study is a high-level desktop water balance, providing high-level water balance outputs.

The storm water management infrastructure was sized to comply with GN704 and is presented in Appendix B.

## 8. REFERENCES


- Middleton, B.J. and Bailey, A.K., Water Resources of South Africa, 2005 study (WR2005), 2009. WRC Report No TT 382/08.
- Midgley, D.C., Pitman, W.V., Middleton, B.J. Surface Water Resources of South Africa, 1990. WRC Report No 298/2.1/94, Volume 2.


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**Water Resources Engineer**

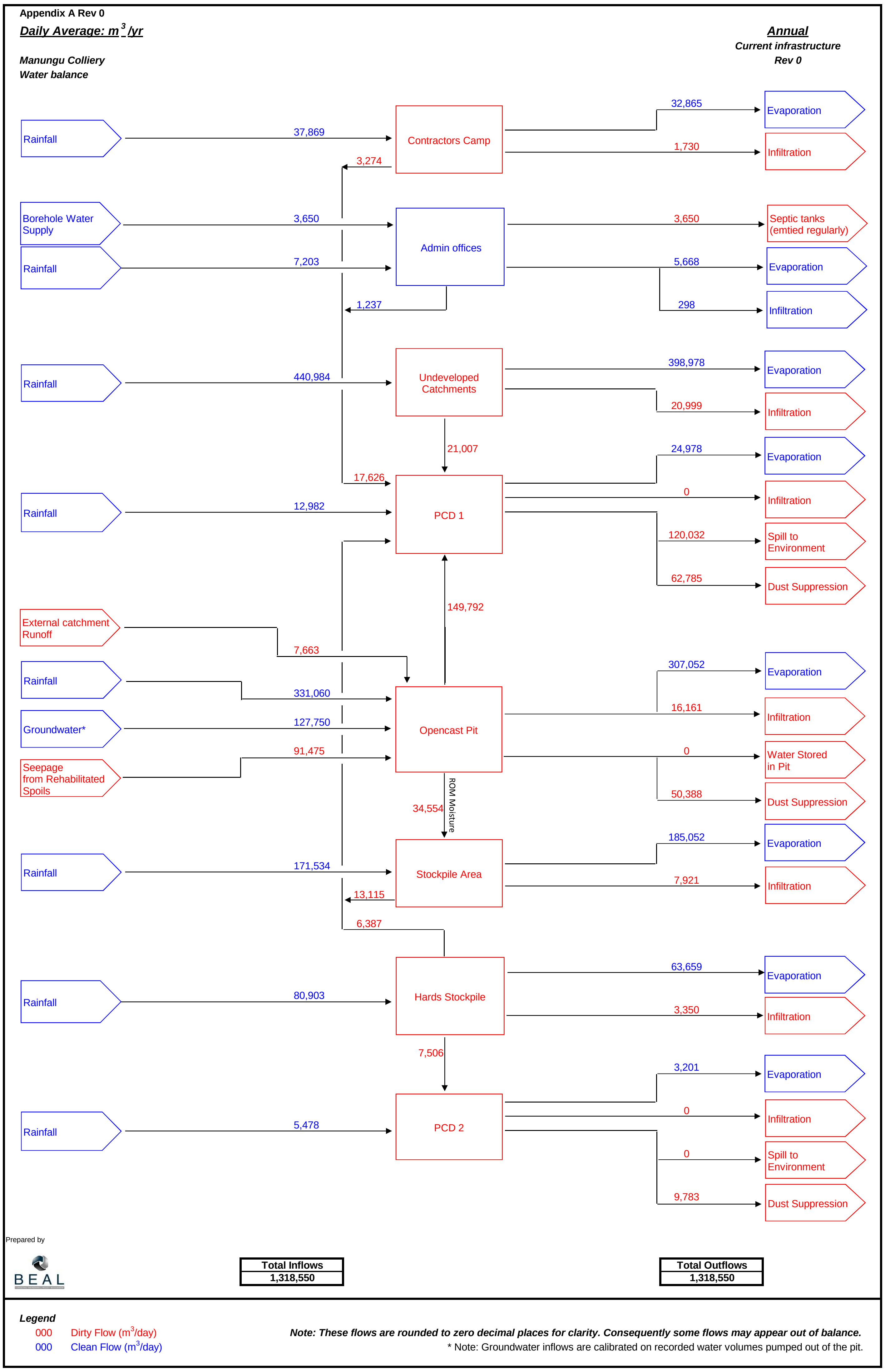
**Johann Le Roux**
**Operational Director**

# APPENDIX A

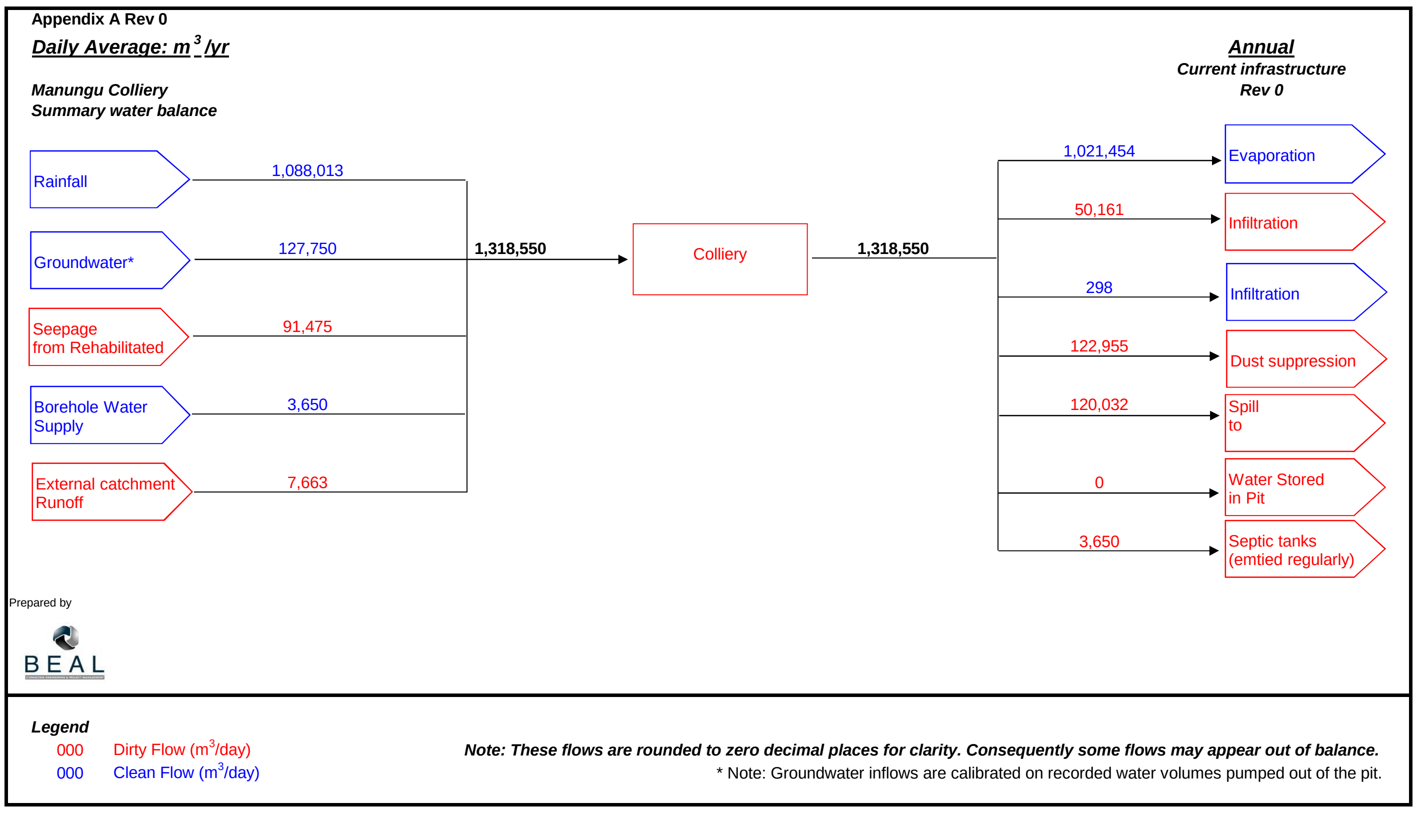
# WATER BALANCE DIAGRAMS

# APPENDIX B

# STORM WATER MANAGEMENT DRAWINGS



Appendix A Rev 0
Daily Average: m3 /yr
Manungu Colliery
Water balance
Annual
Current infrastructure
Rev 0
Rainfall
37,869
Contractors Camp
32,865
Evaporation
1,730
Infiltration
3,274
Borehole Water Supply
3,650
Admin offices
3,650
Septic tanks (emtied regularly)
Rainfall
7,203
5,668
Evaporation
298
Infiltration
1,237
Rainfall
440,984
Undeveloped Catchments
398,978
Evaporation
20,999
Infiltration
21,007
24,978
Evaporation
17,626
PCD 1
0
Infiltration
Rainfall
12,982
120,032
Spill to Environment
62,785
Dust Suppression
149,792
External catchment Runoff
7,663
Rainfall
331,060
Opencast Pit
307,052
Evaporation
16,161
Infiltration
Groundwater*
127,750
91,475
Seepage from Rehabilitated Spoils
0
Water Stored in Pit
50,388
Dust Suppression
ROM Moisture
34,554
185,052
Evaporation
Rainfall
171,534
Stockpile Area
7,921
Infiltration
13,115
6,387
63,659
Evaporation
Rainfall
80,903
Hards Stockpile
3,350
Infiltration
7,506
3,201
Evaporation
0
Infiltration
Rainfall
5,478
PCD 2
0
Spill to Environment
9,783
Dust Suppression
Prepared by
BEAL
Total Inflows
1,318,550
Total Outflows
1,318,550
Legend
000 Dirty Flow (m3/day)
000 Clean Flow (m3/day)
Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance.
* Note: Groundwater inflows are calibrated on recorded water volumes pumped out of the pit.

Appendix A Rev 0
Daily Average: m3 /yr
Manungu Colliery
Summary water balance
Annual
Current infrastructure
Rev 0
Rainfall
1,088,013
Groundwater*
127,750
Seepage from Rehabilitated
91,475
Borehole Water Supply
3,650
External catchment Runoff
7,663
1,318,550
Colliery
1,318,550
1,021,454
Evaporation
50,161
Infiltration
298
Infiltration
122,955
Dust suppression
120,032
Spill to
0
Water Stored in Pit
3,650
Septic tanks (emtied regularly)
Prepared by
BEAL
Legend
000 Dirty Flow (m3/day)
000 Clean Flow (m3/day)
Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance.
* Note: Groundwater inflows are calibrated on recorded water volumes pumped out of the pit.

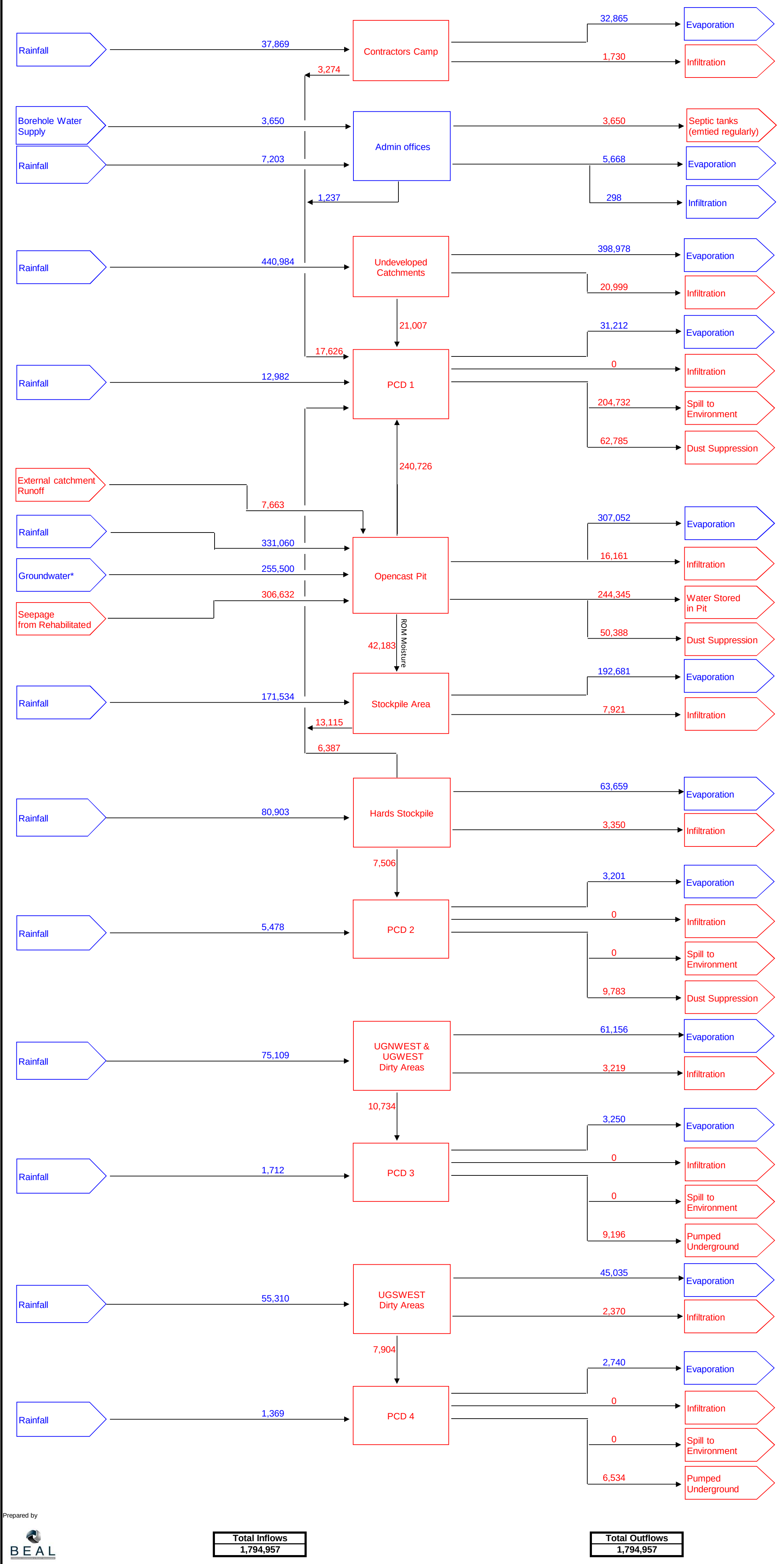
Appendix A Rev 0

***Daily Average: m³/yr***

***Annual***

***Future infrastructure***
***Rev 0***

***Manungu Colliery***
***Water balance***




***Legend***

000 Dirty Flow (m³/day)

000 Clean Flow (m³/day)

***Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance.***

* Note: Groundwater inflows are estimates.

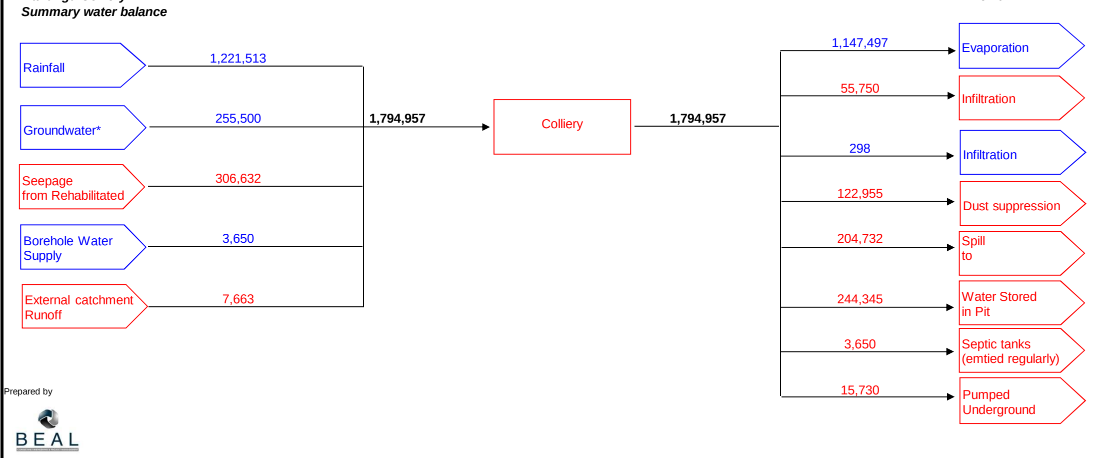
Appendix A Rev 0

***Daily Average: m³/yr***

***Annual***

***Future infrastructure***
***Rev 0***

***Manungu Colliery***
***Summary water balance***




***Legend***

000 Dirty Flow (m³/day)

000 Clean Flow (m³/day)

***Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance.***

* Note: Groundwater inflows are estimates.

# TSHEDZA MINING (PTY) LTD

MBUYELO COAL

## CONCEPTUAL STORM WATER MANAGEMENT DESIGN FOR MANUNGU COLLIERY

## BOOK OF DRAWINGS

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**SEPT 2018**

**Project No :B196**

# TSHEDZA MINING (PTY) LTD
# CONCEPTUAL STORM WATER MANAGEMENT DESIGN FOR MANUNGU COLLIERY

## LOCALITY MAP

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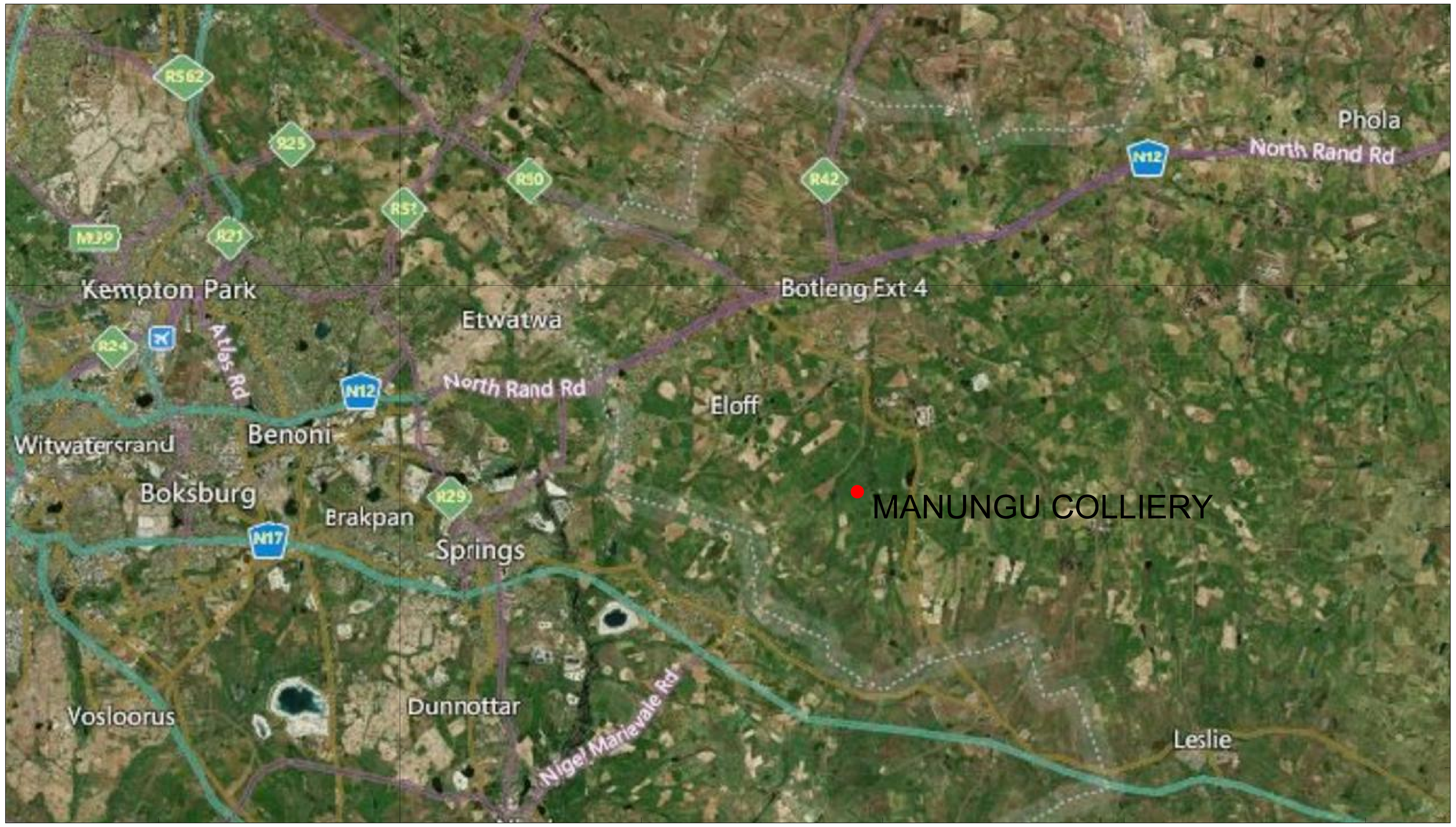


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LIST OF DRAWINGS

| SHEET NUMBER | SHEET TITLE |
|---|---|
| 000 | LOCALITY MAP AND LIST OF DRAWINGS |
| 001 | EXISTING INFRASTRUCTURE LAYOUT DRAWING |
| 002 | PROPOSED NEW INFRASTRUCTURE LAYOUT |
| 003 | STORM WATER MANAGEMENT LAYOUT PLAN |
| 004 | OPENCAST CONTRACTORS CAMP POLLUTION CONTROL DAM LAYOUT AND DETAILS |
| 005 | OPENCAST CONTRACTORS CAMP STORM WATER INFRASTRUCTURE LAYOUT DRAWINGS |
| 006 | NORTH WESTERN UNDERGROUND POLLUTION CONTROL DAM LAYOUT AND DETAILS |
| 007 | NORTH WESTERN UNDERGROUND STORM WATER INFRASTRUCTURE LAYOUT DRAWINGS |
| 008 | PLANT AREA - EXISTING AND PROPOSED NEW STORM WATER INFRASTRUCTURE LAYOUT DRAWING |
| 009 | HARDS STOCKPILE POLLUTION CONTROL DAM AND STORM WATER MANAGEMENT LAYOUT AND DETAILS |

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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: LOCALITY MAP

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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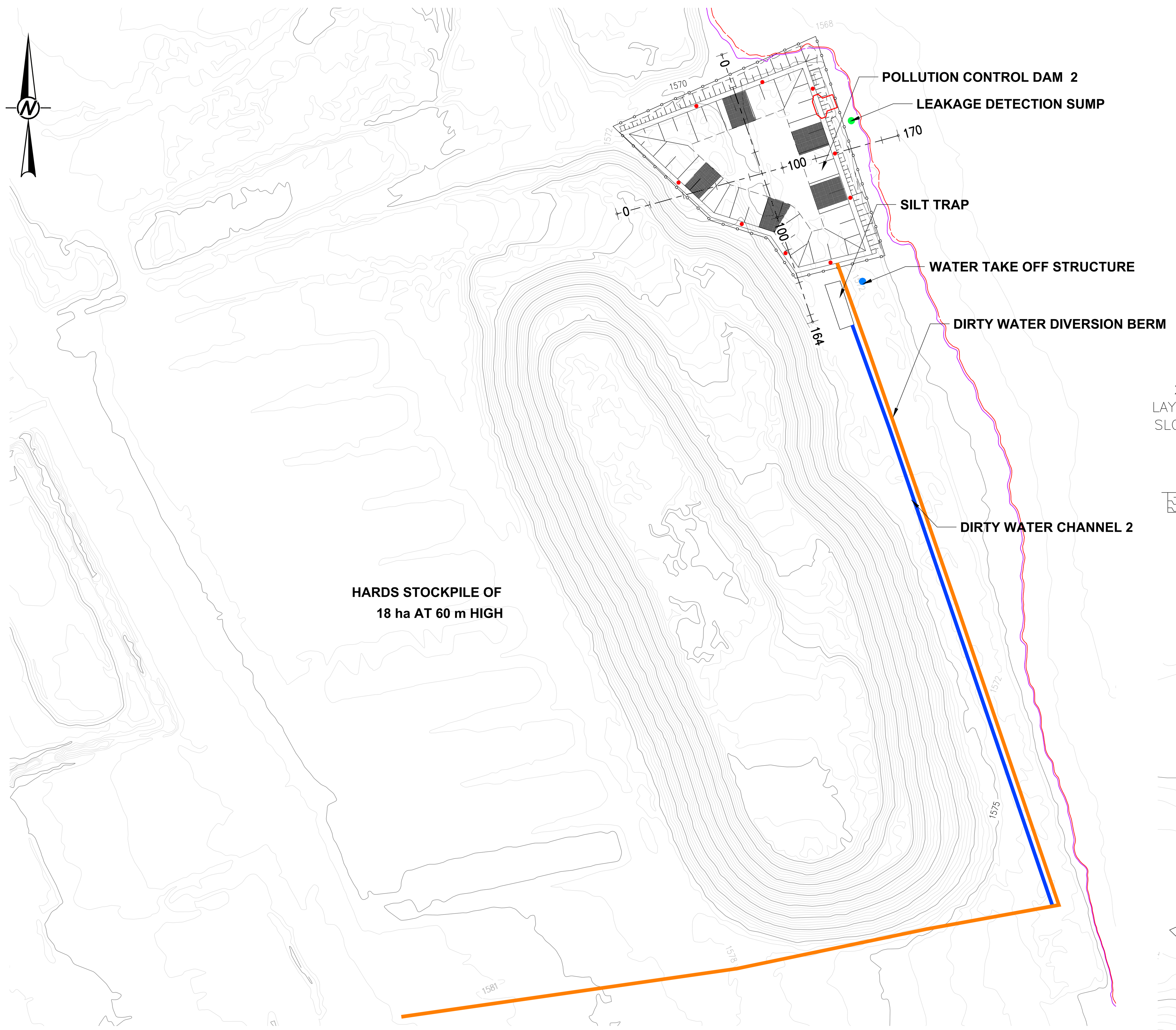
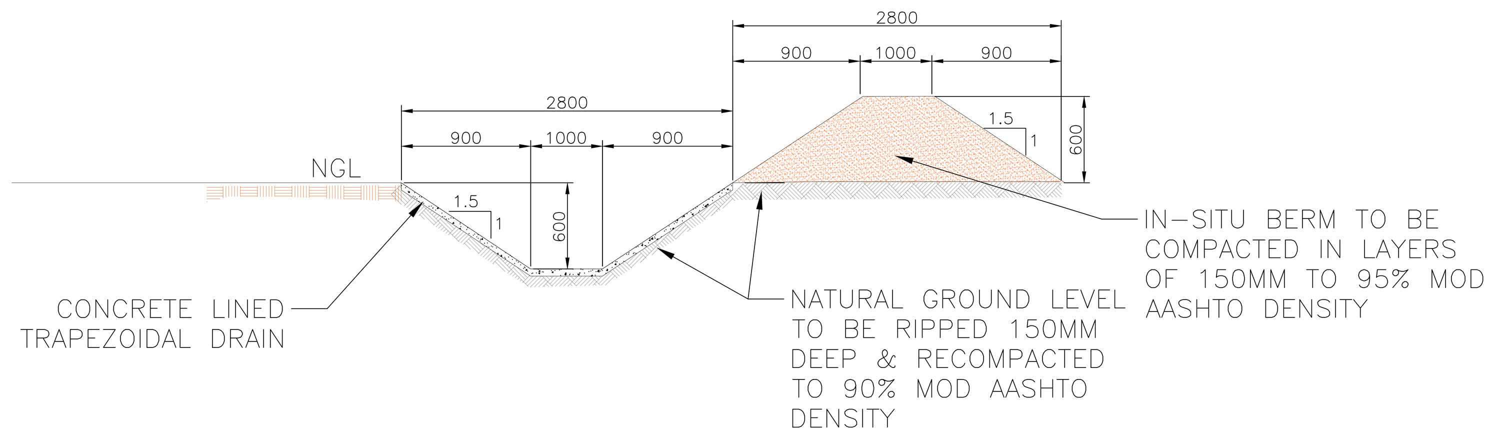
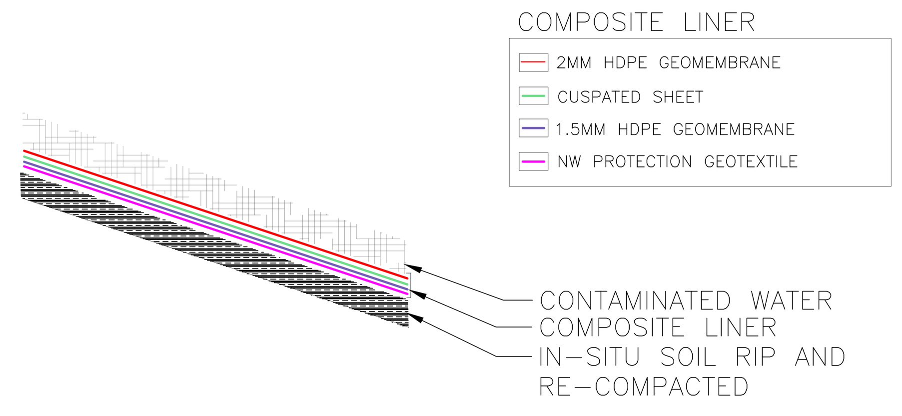


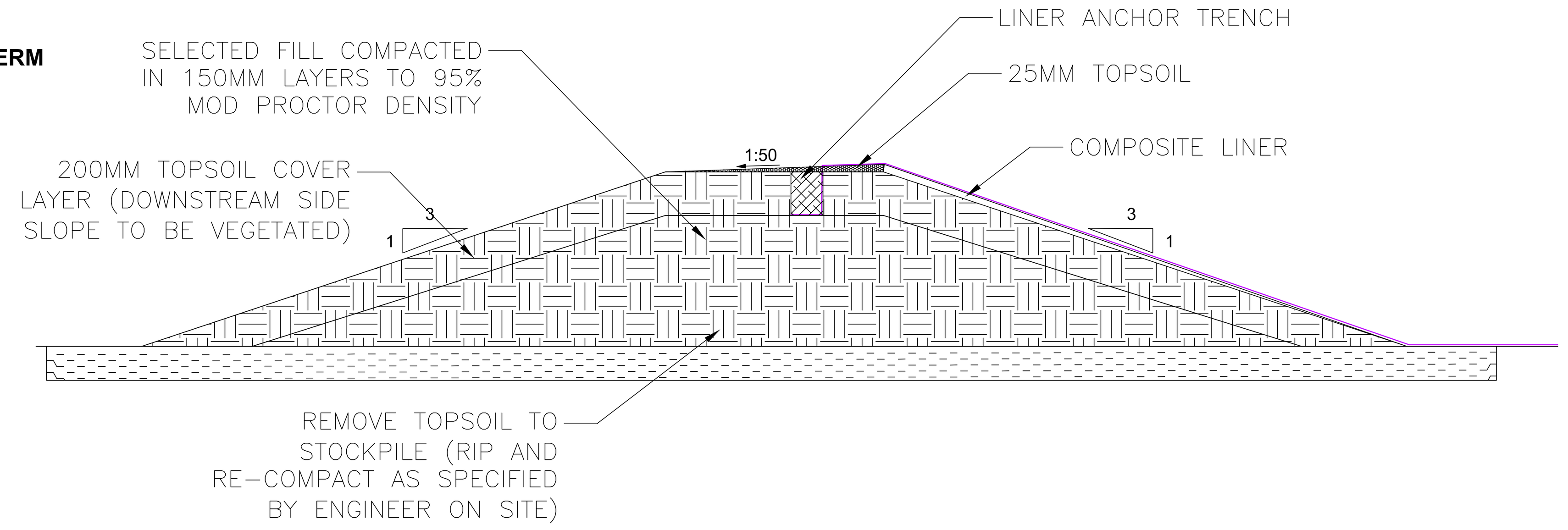

## DIRTY WATER SYSTEM - KEY PLAN



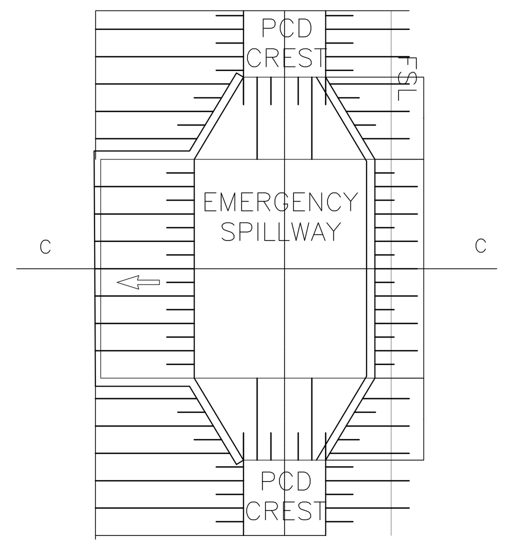

## DIRTY WATER CHANNEL 2




## LINER BARRIER CONFIGURATION



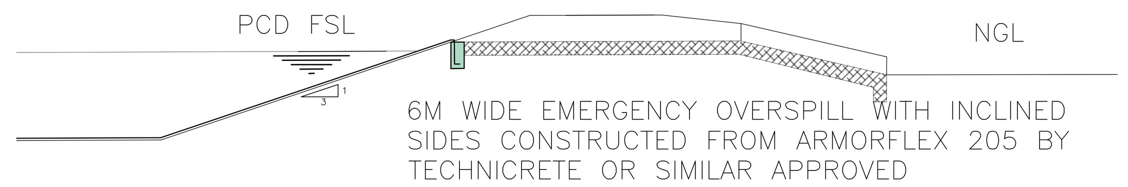

## PCD 2 EMBANKMENT CONFIGURATION



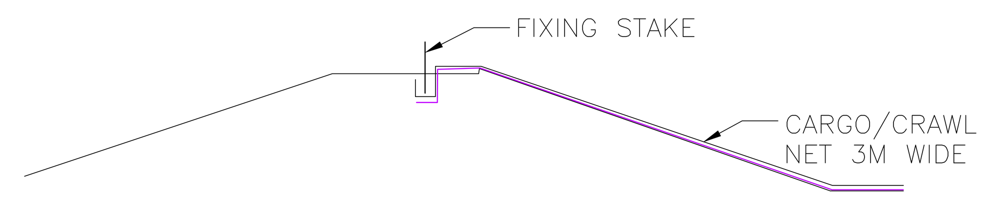

## PCD 2 EMERGENCY SPILLWAY PLAN VIEW

NOTES:

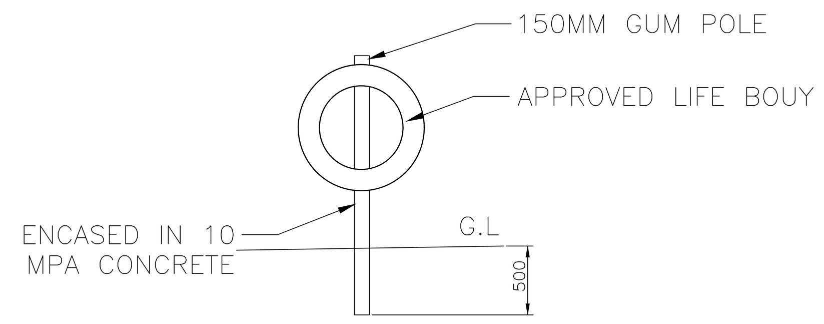
1. ALL WORKS TO BE DONE TO SABS STANDARD.
2. 70KG SAND FILLED UV RESISTANT BALLAST BAGS PLACED ON 5M GRID SPACING ON PCD FLOORS.
3. THE PCD HAS A NORMAL OPERATING STORAGE OF 10 000M³.
4. THE PCD HAS A NORMAL OPERATING STORAGE + 50 YEAR STORM VOLUME OF 18 000M³.
5. THE PCD HAS A 0.8M FREEBOARD AND A CREST WIDTH OF 3M.



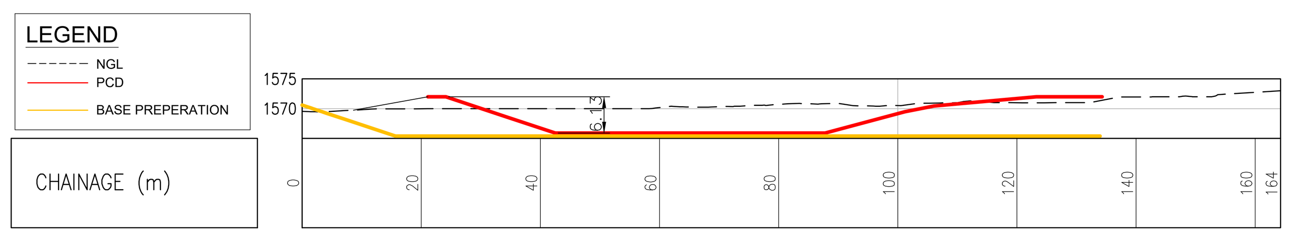

## PCD 2 EMERGENCY SPILLWAY - SECTION



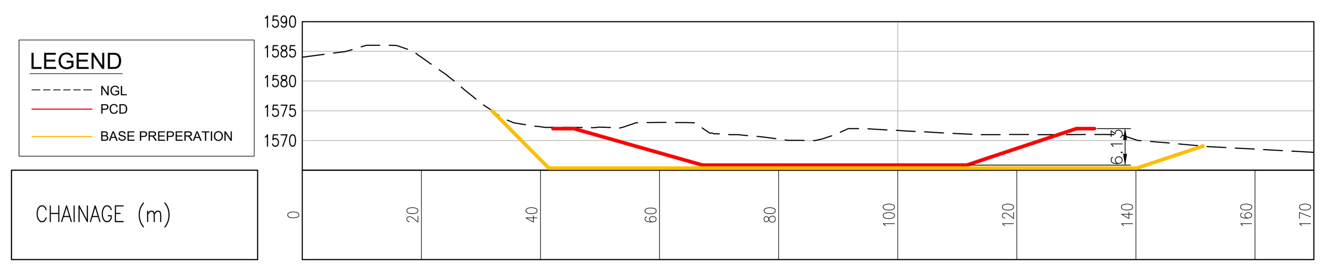

## CRAWL NET DETAIL




## LIFE BOUY DETAIL




## PCD 2 - SECTION 1

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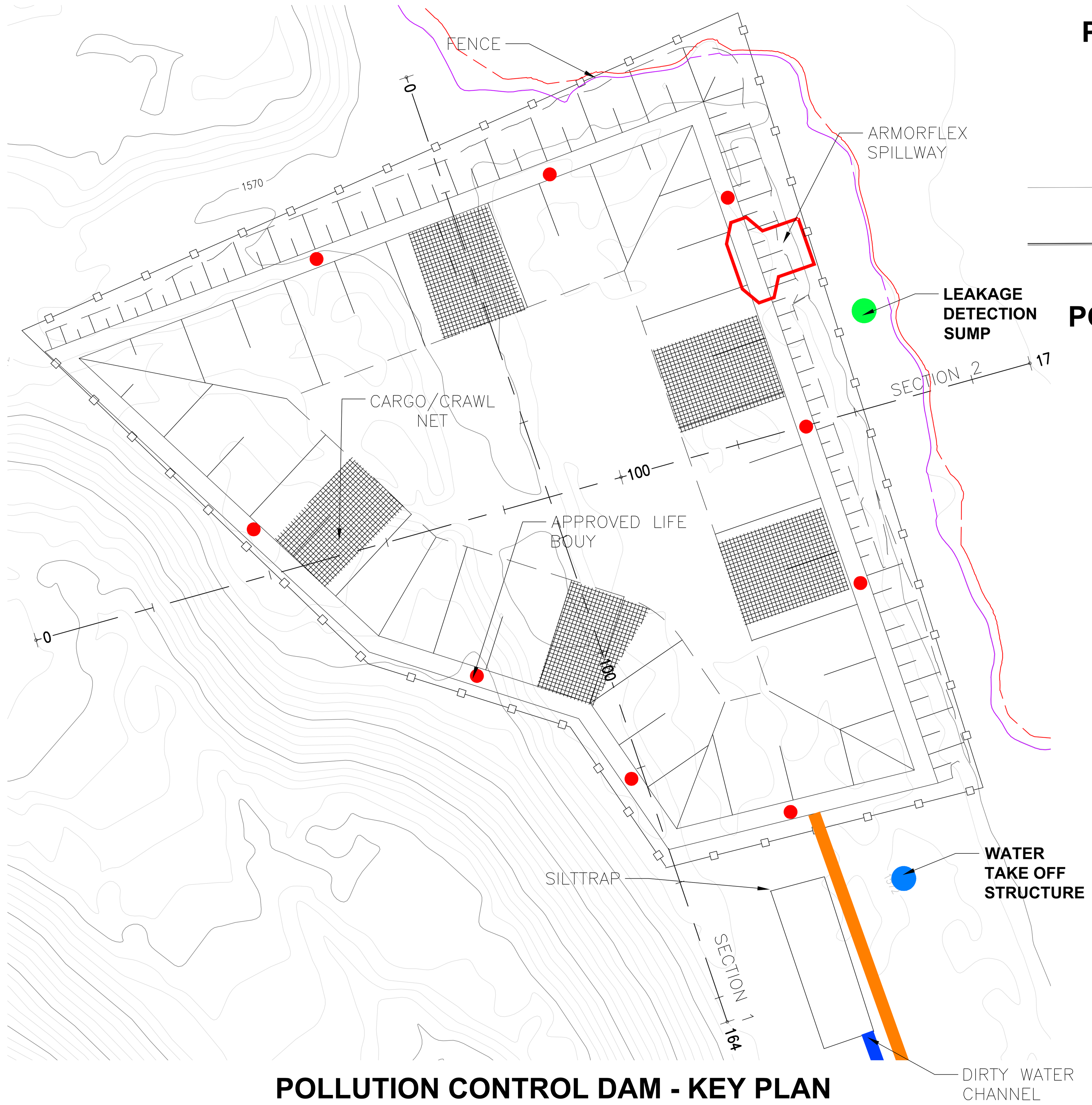


## POLLUTION CONTROL DAM - KEY PLAN

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| REVISION | DESCRIPTION | DRAWN | DRAWN CHECK | DESIGN | DESIGN CHECK | AUTHORISED | DATE |
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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: HARDS STOCKPILE AREA POLLUTION CONTROL DAM AND STORM WATER MANAGEMENT LAYOUT AND DETAILS

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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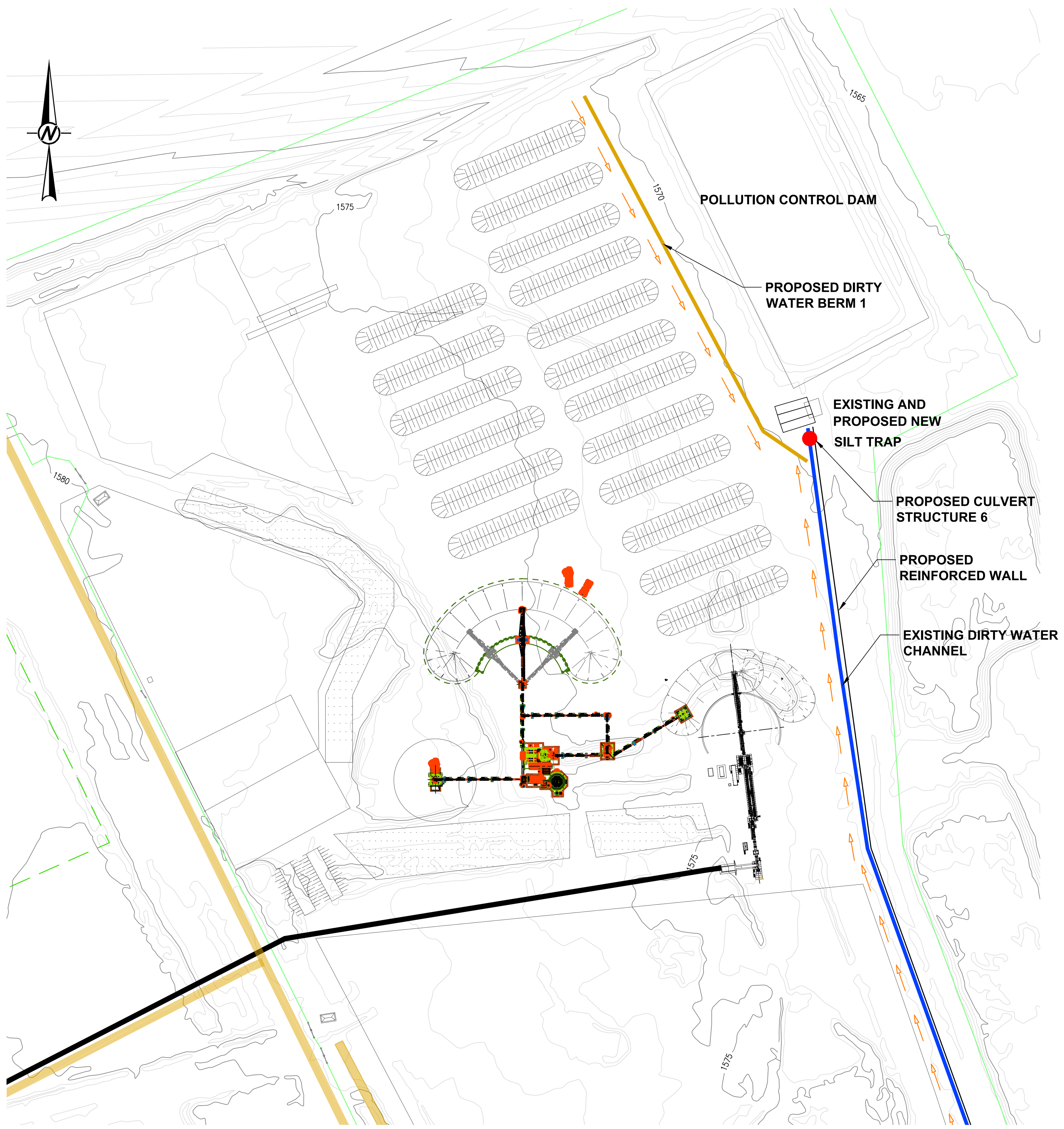
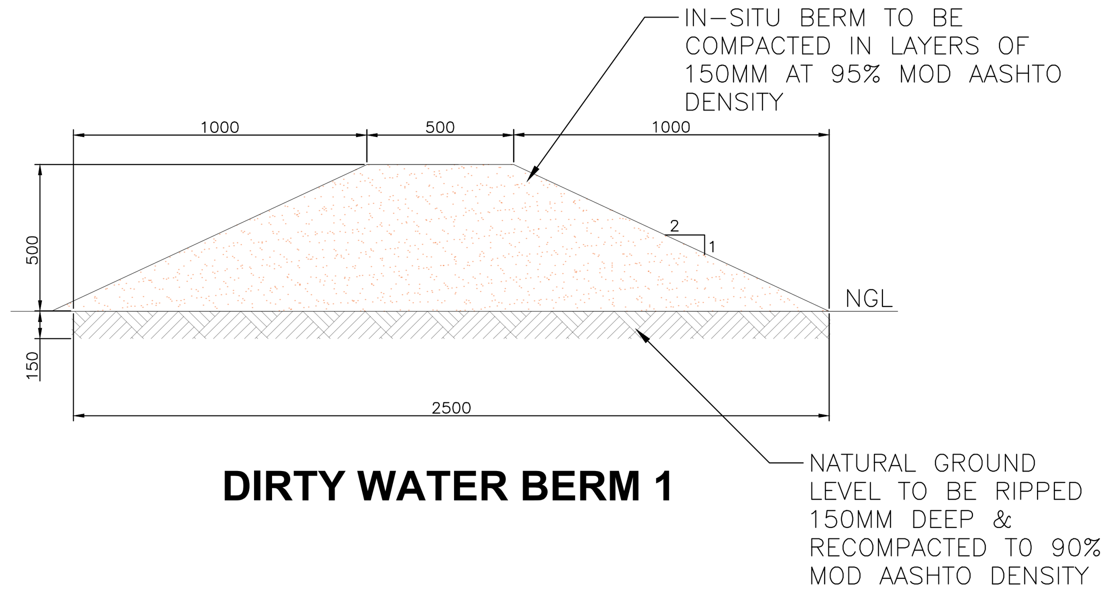
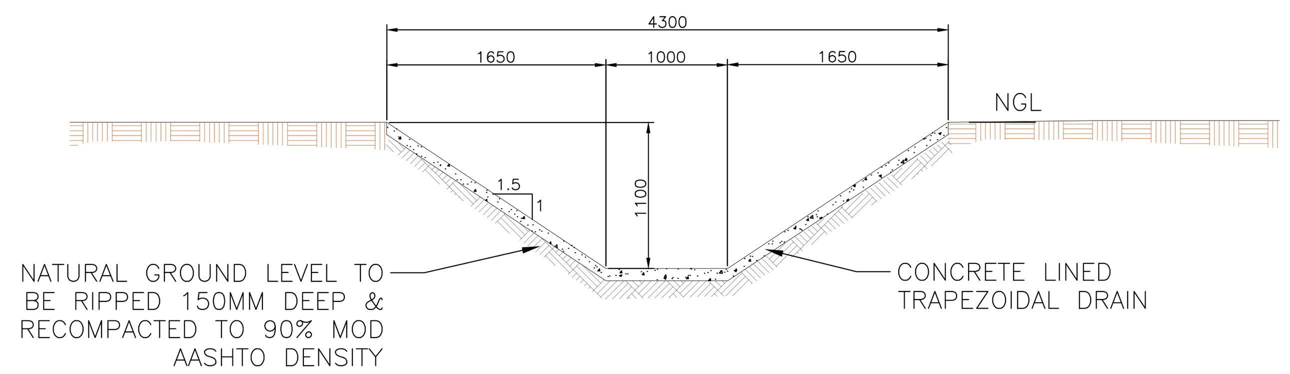
| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 009 | 00 |



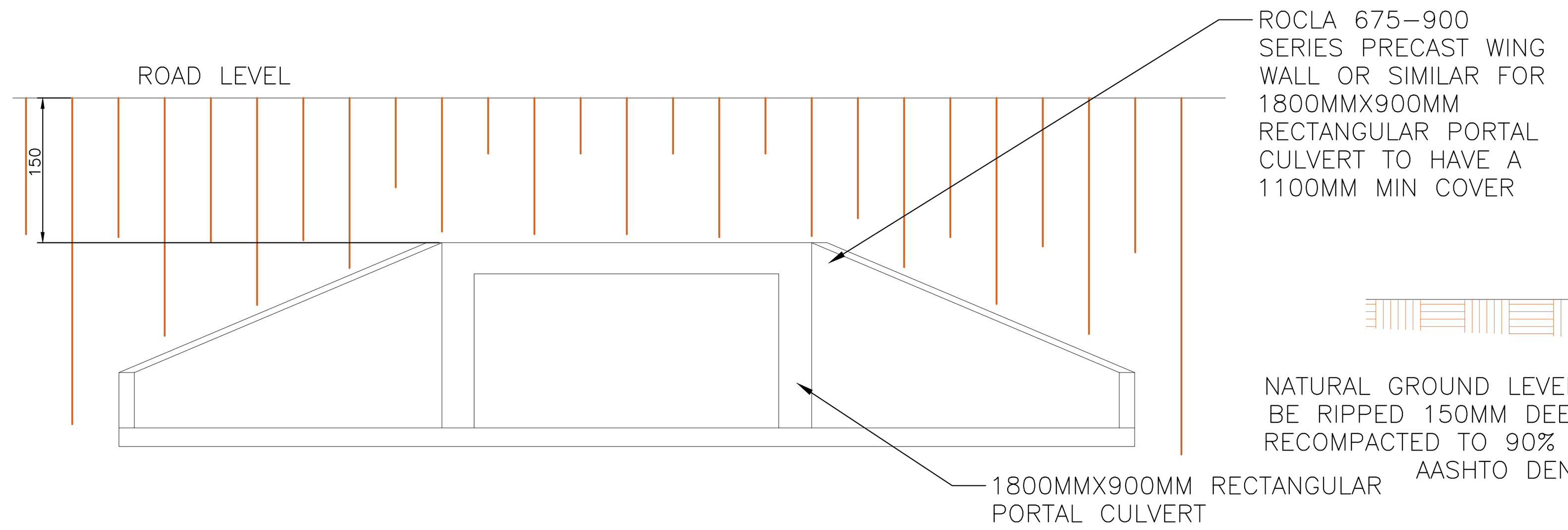

## DIRTY WATER SYSTEM - KEY PLAN



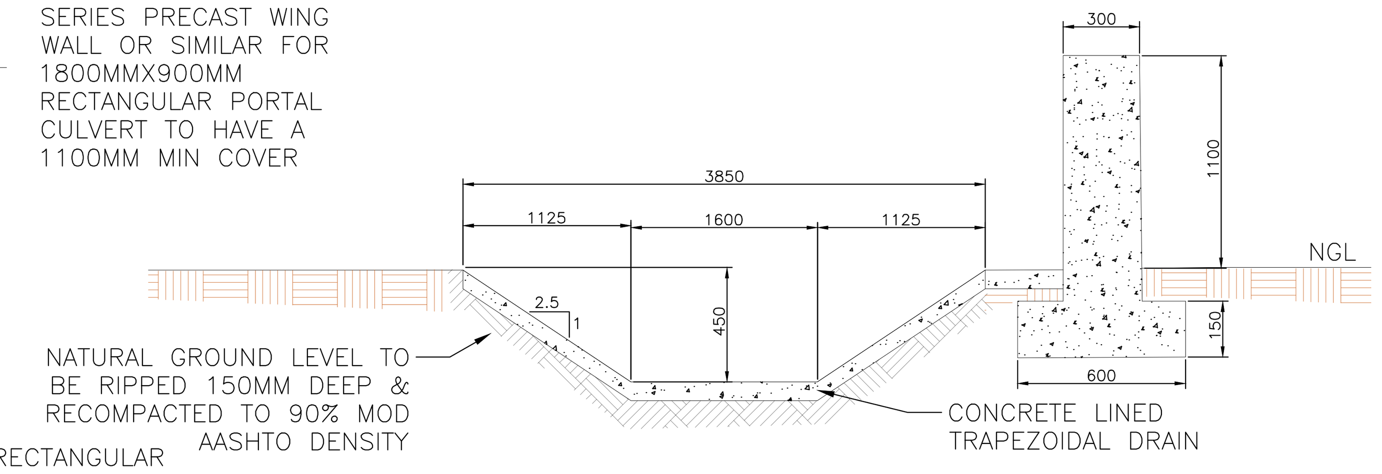

## DIRTY WATER BERM 1



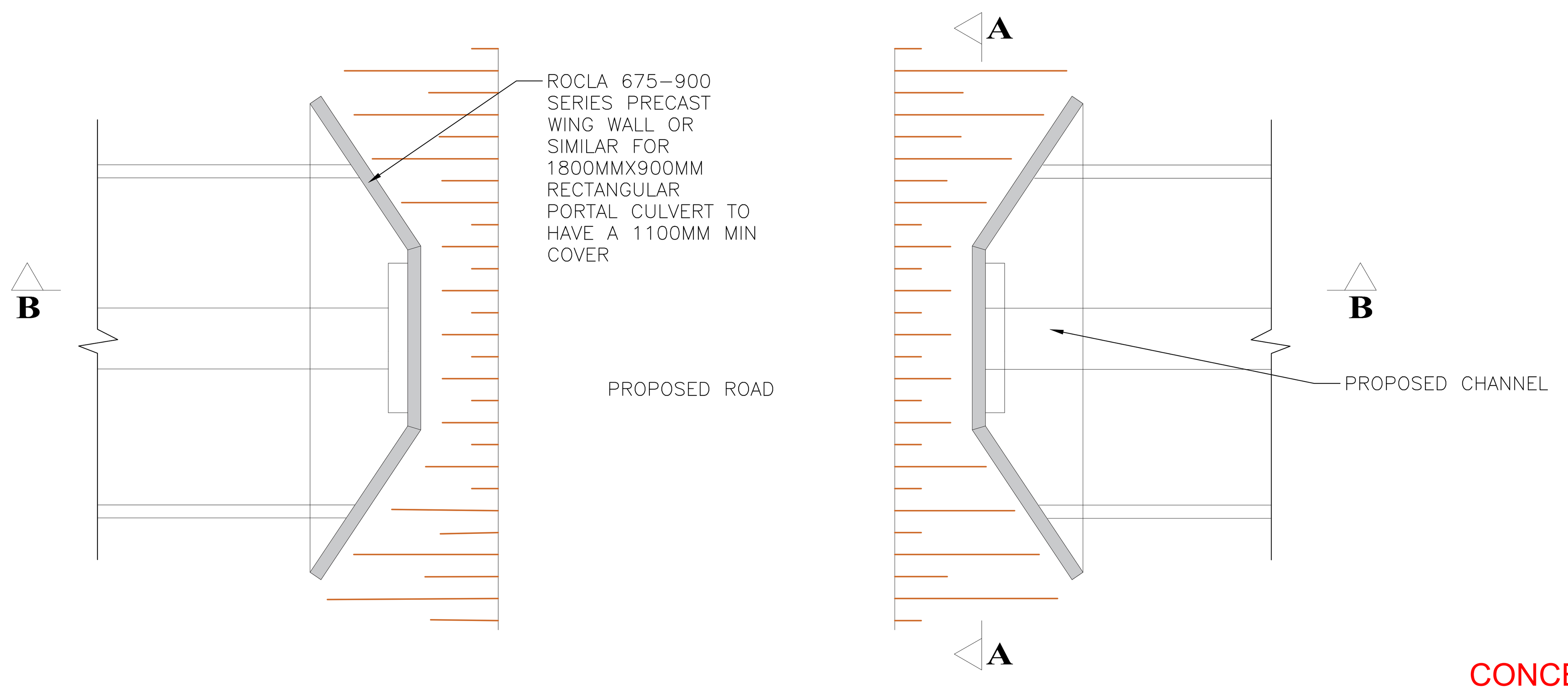

## OPTION 1: PROPOSED UPGRADE FOR EXISTING DIRTY WATER CHANNEL 1




## DIRTY WATER CULVERT STRUCTURE 6-SECTION A-A




## OPTION 2: REINFORCED CONCRETE WALL NEXT TO EXISTING DIRTY WATER CHANNEL 1




## DIRTY WATER CULVERT STRUCTURE 6-PLAN VIEW

CONCEPTUAL DESIGN
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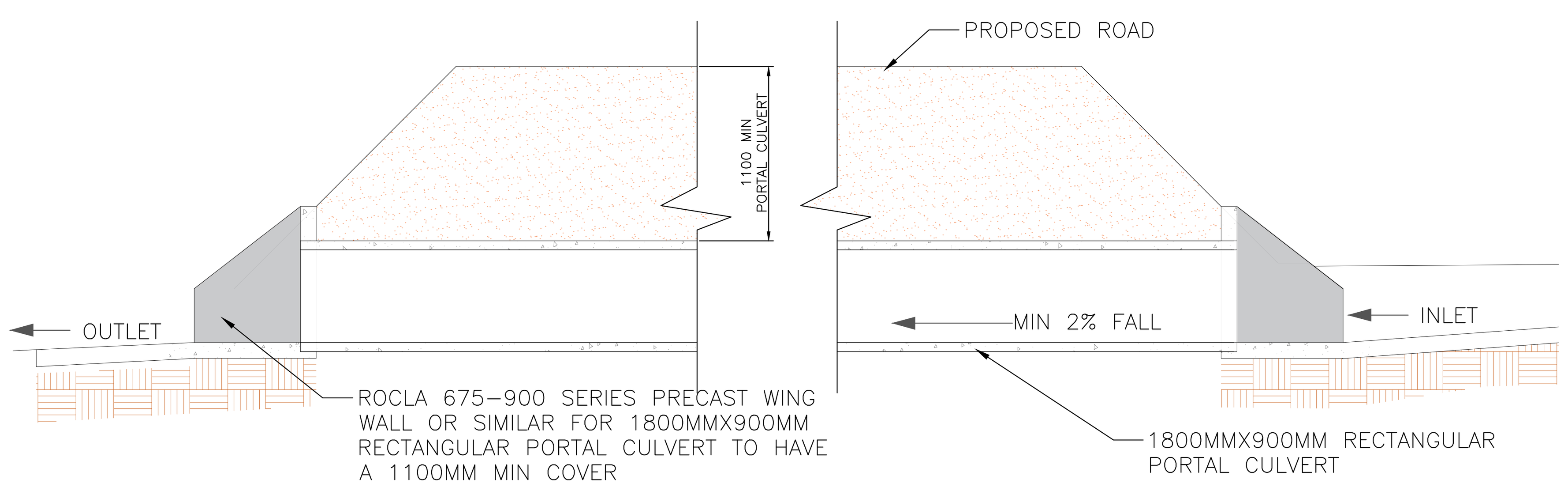


## DIRTY WATER CULVERT STRUCTURE 6-SECTION B-B

| REVISION | DESCRIPTION | DRAWN | DRAWN CHECK | DESIGN | DESIGN CHECK | AUTHORISED | DATE |
|---|---|---|---|---|---|---|---|
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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: PLANT AREA - EXISTING AND PROPOSED NEW STORM WATER INFRASTRUCTURE LAYOUT DRAWING

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 008 | 00 |


| REVISION | DESCRIPTION | DRAWN | DRAWN CHECK | DESIGN | DESIGN CHECK | AUTHORISED | DATE |
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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: EXISTING INFRASTRUCTURE LAYOUT DRAWING

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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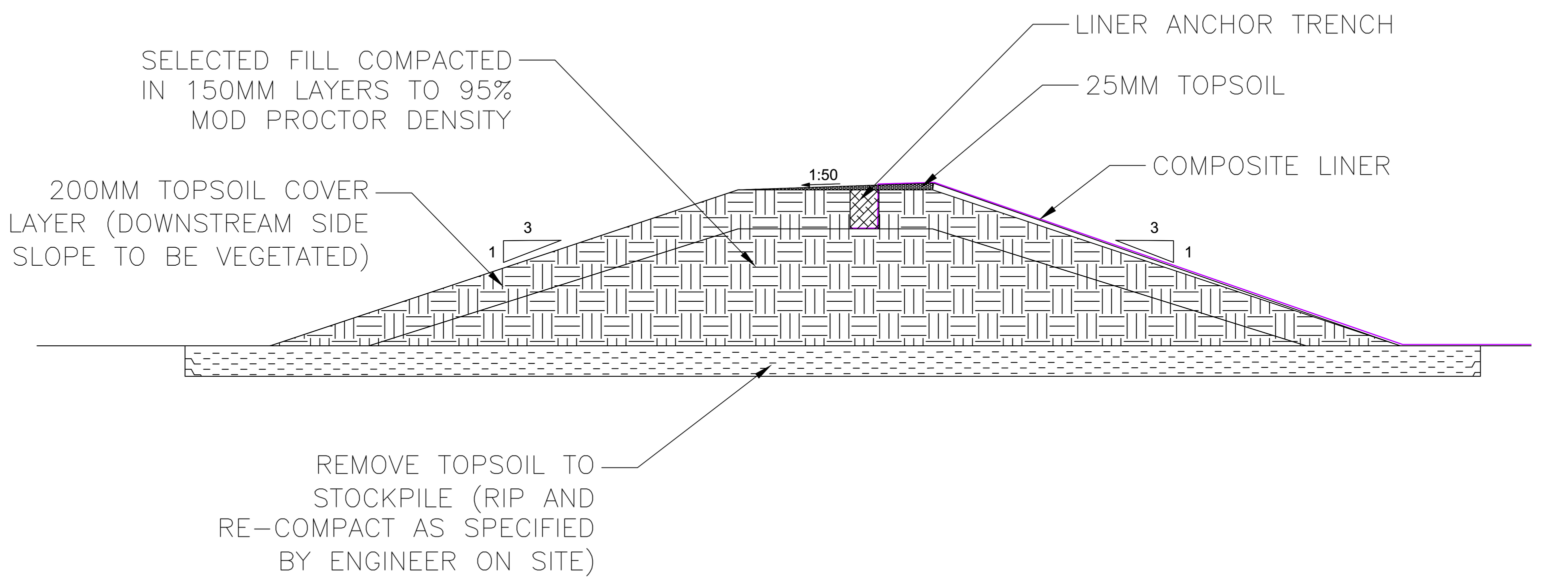
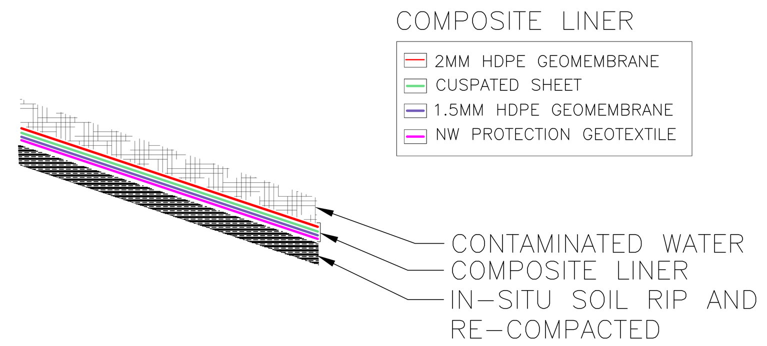
| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 001 | 00 |


**POLLUTION CONTROL DAM - KEY PLAN**



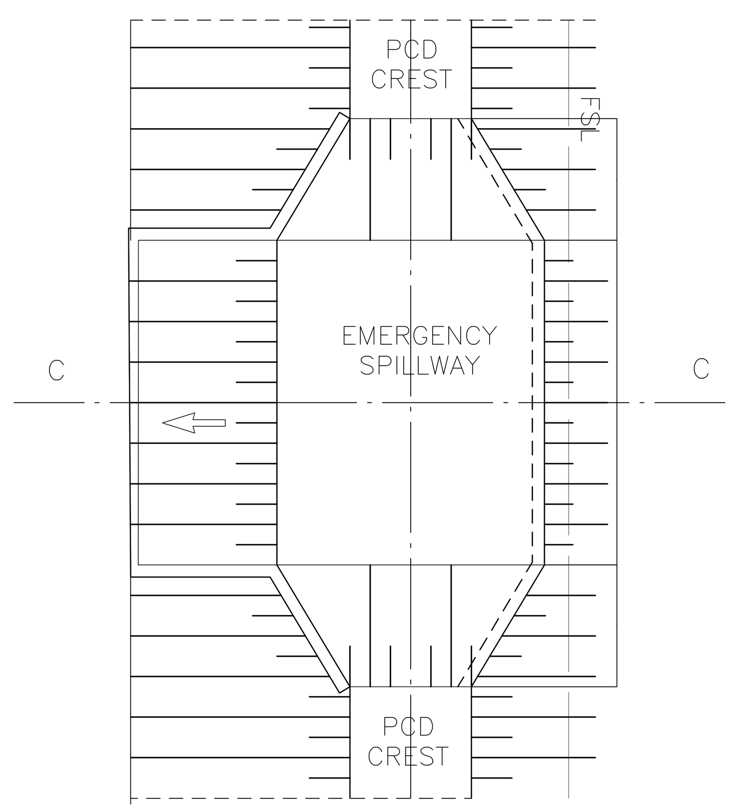

**PCD 4 EMBANKMENT CONFIGURATION**



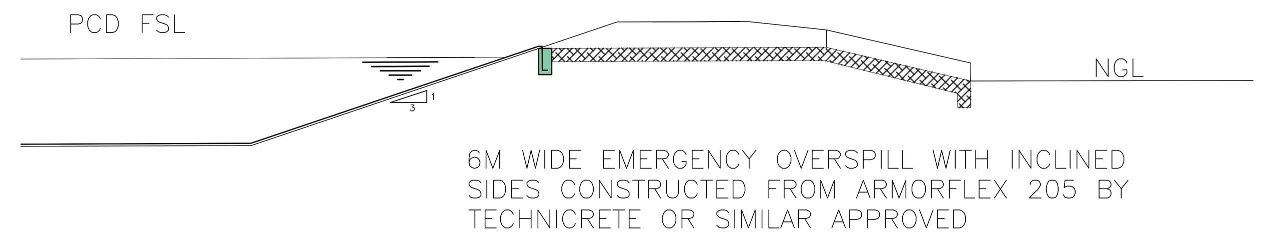

**LINER BARRIER CONFIGURATION**

NOTES:

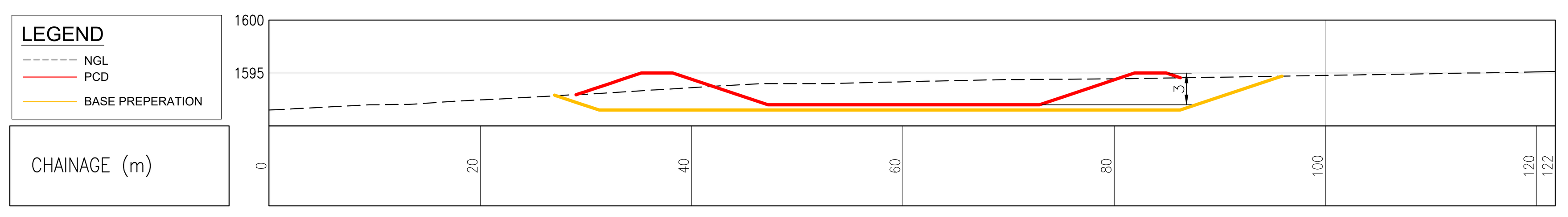
1. ALL WORKS TO BE DONE TO SABS STANDARD.
2. 70KG SAND FILLED UV RESISTANT BALLAST BAGS PLACED ON 5M GRID SPACING ON PCD FLOORS.
3. THE PCD HAS A NO OPERATIONAL STORAGE AND IS ASSUMED TO BE OPERATED EMPTY.
4. THE PCD HAS A 4000M$^3$ CAPACITY THAT WILL ACCOMODATE THE 50 YEAR STORM VOLUME.
5. THE PCD HAS A 0.8M FREEBOARD AND A CREST WIDTH OF 3M.



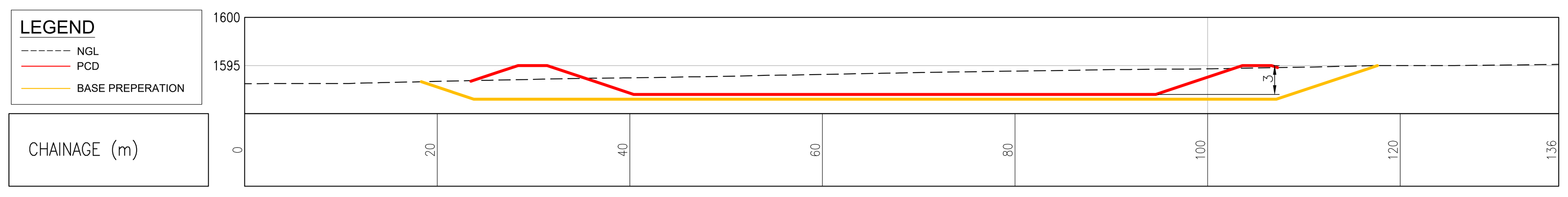

**PCD 4 EMERGENCY SPILLWAY - PLAN VIEW**



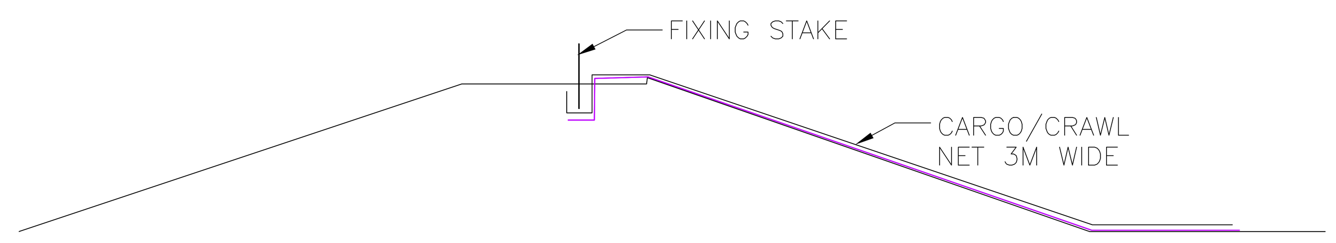

**PCD 4 EMERGENCY SPILLWAY - SECTION**



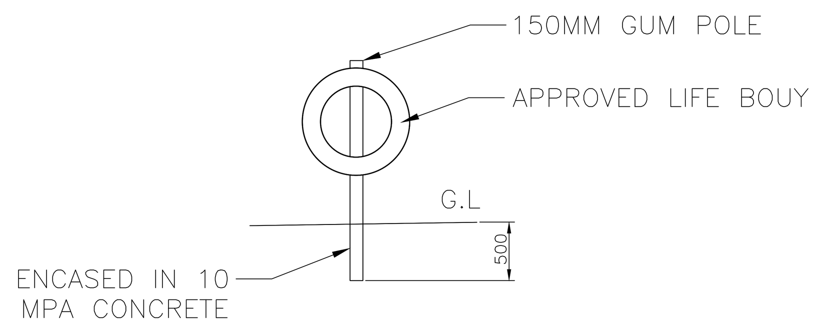

**PCD 4 - SECTION 1**




**PCD 4 - SECTION 2**




**CRAWL NET DETAIL**




**LIFE BOUY DETAIL**

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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: OPENCAST CONTRACTORS CAMP POLLUTION CONTROL DAM LAYOUT AND DETAILS

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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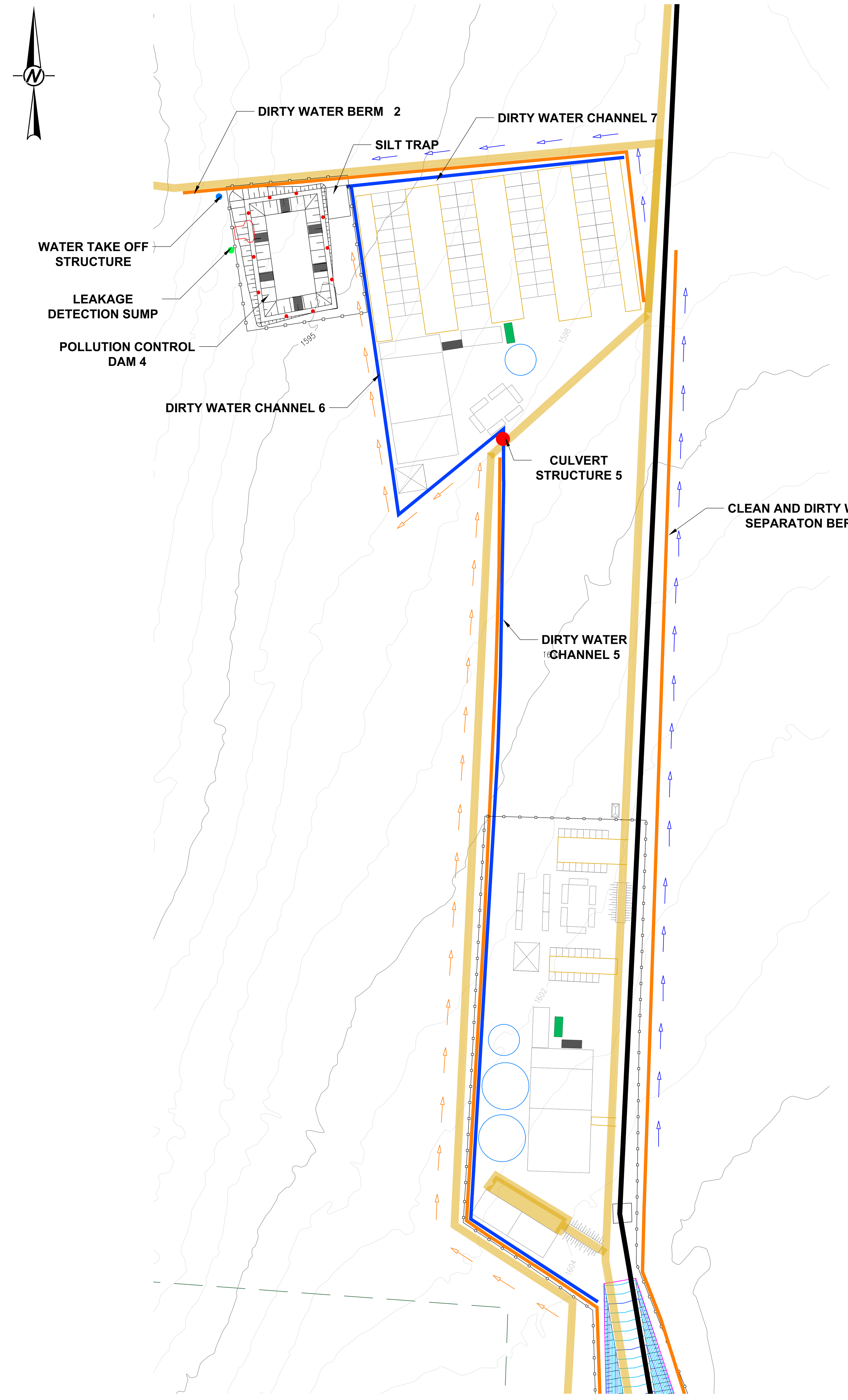
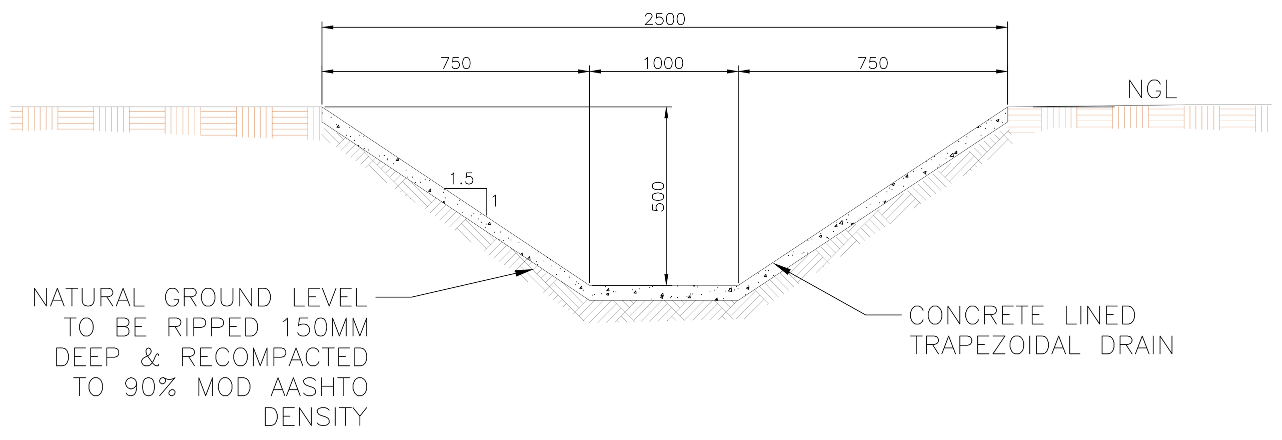
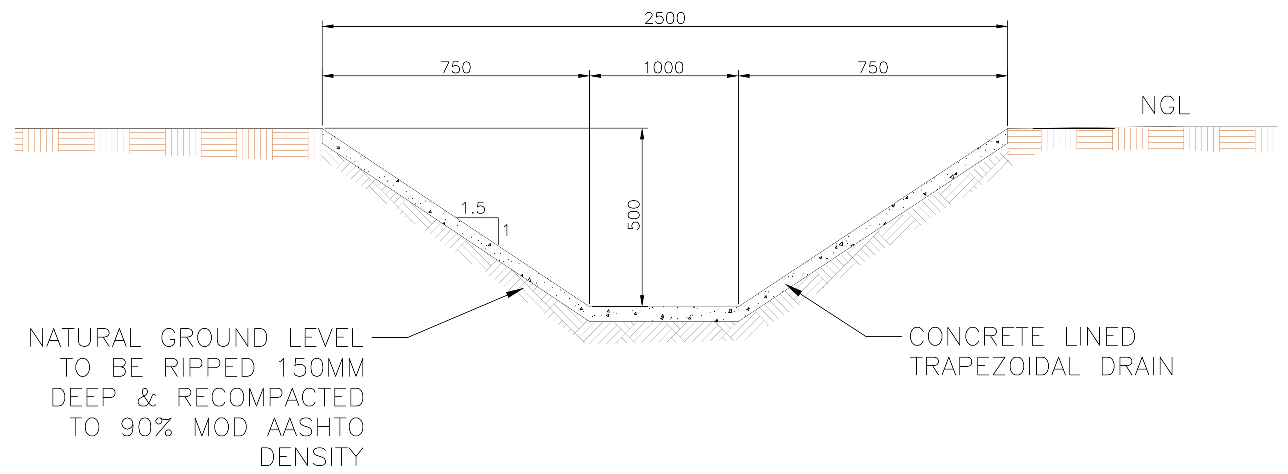
| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 004 | 00 |



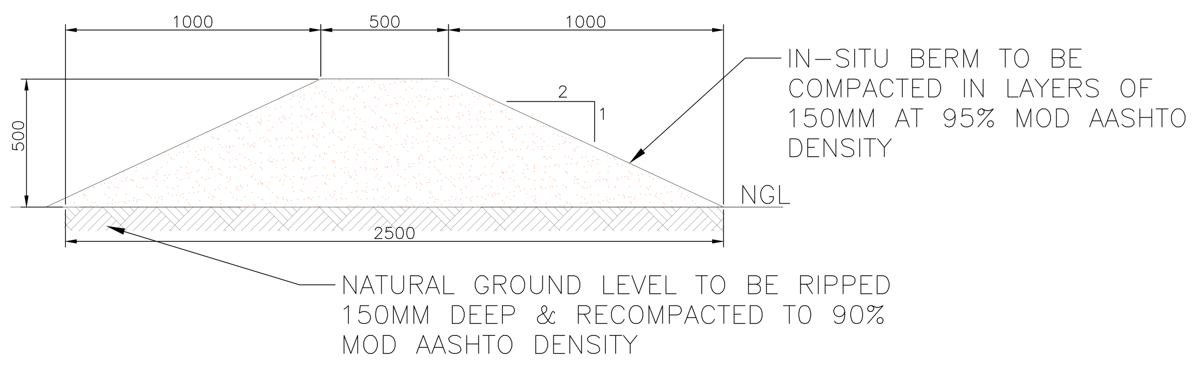

DIRTY WATER SYSTEM - KEY PLAN



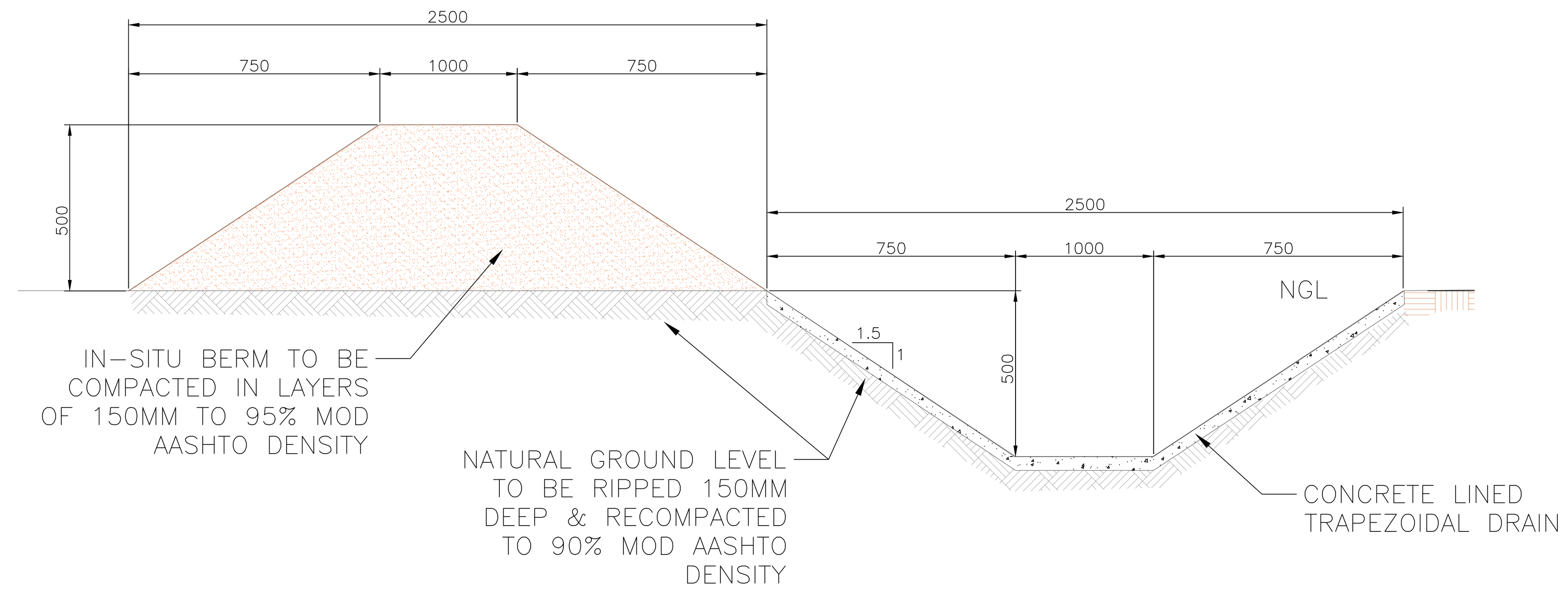

DIRTY WATER CHANNEL 7



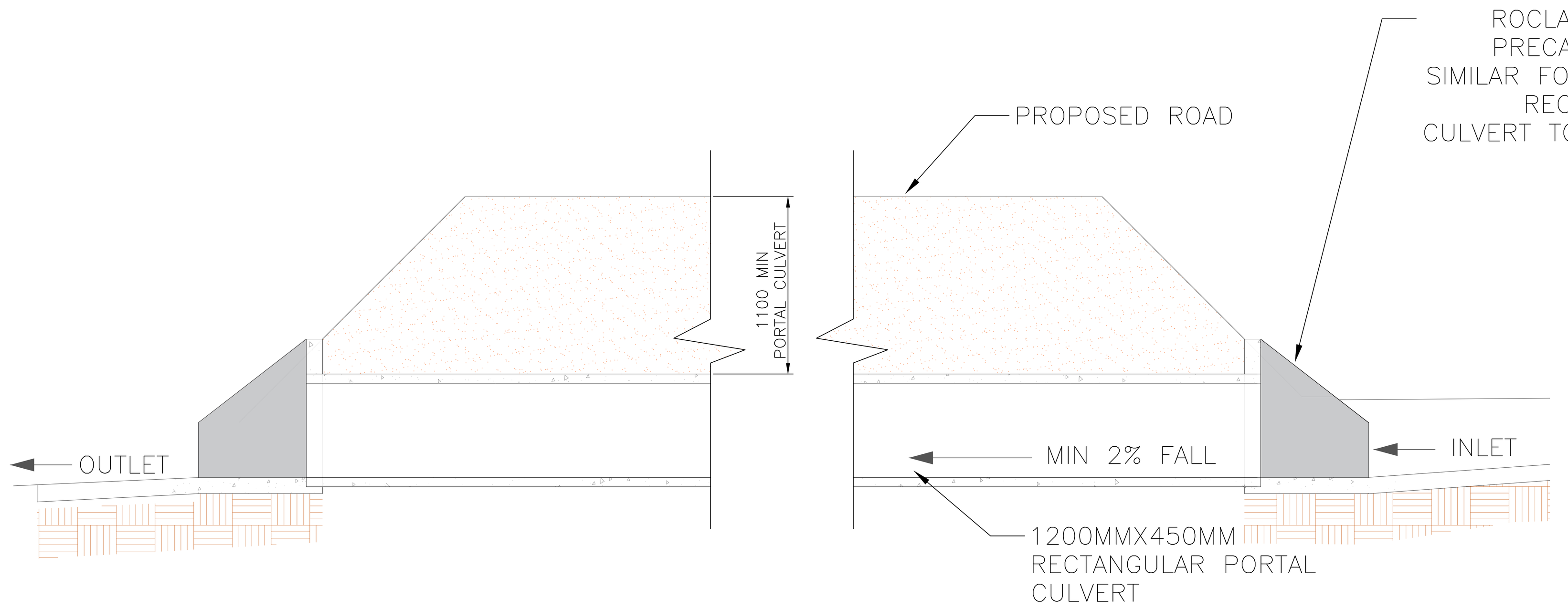

DIRTY WATER CHANNEL 6



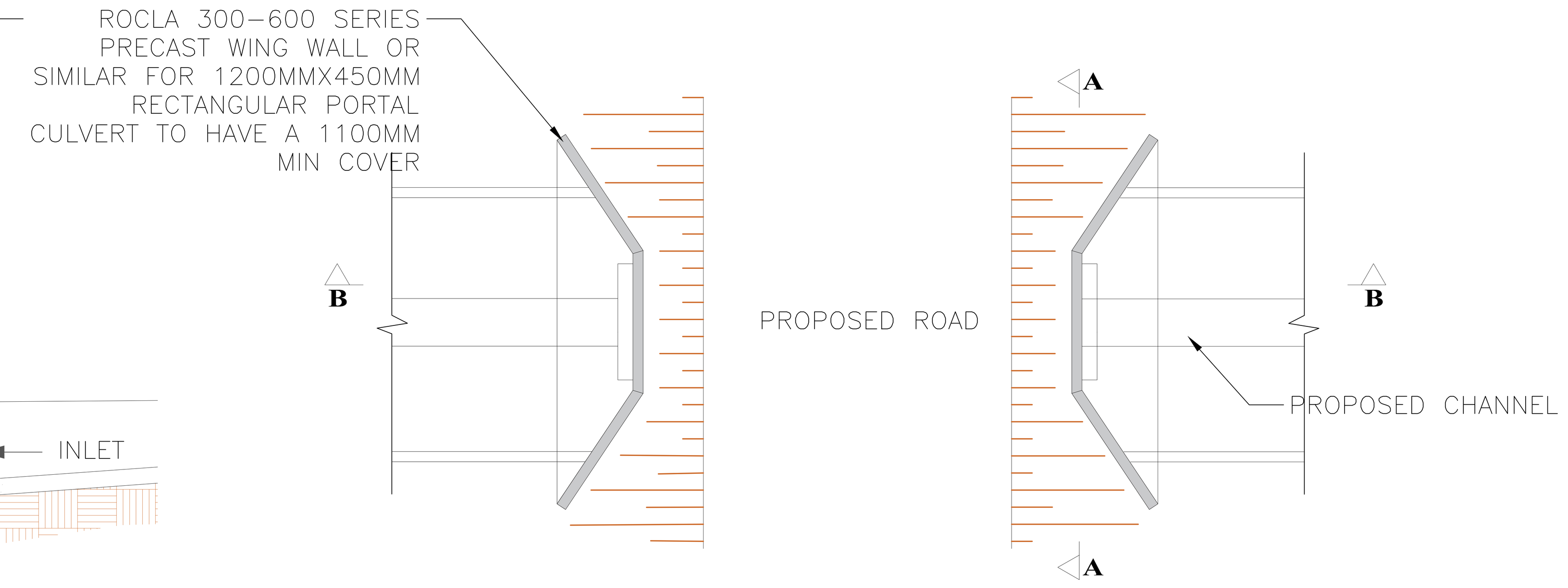

CLEAN AND DIRTY WATER SEPARATION BERM 2



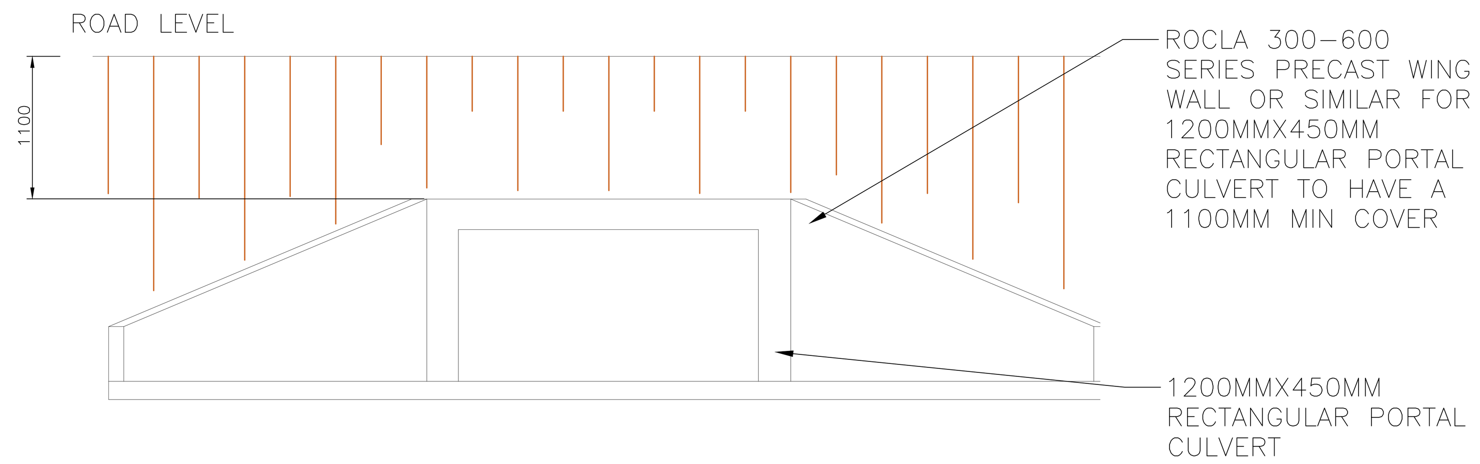

DIRTY WATER CHANNEL 5




DIRTY WATER CULVERT STRUCTURE 5-SECTION B-B




DIRTY WATER CULVERT STRUCTURE 5-PLAN VIEW




DIRTY WATER CULVERT STRUCTURE 5-SECTION A-A

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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: OPENCAST CONTRACTORS CAMP STORM WATER INFRASTRUCTURE LAYOUT DRAWING

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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: PROPOSED NEW INFRASTRUCTURE LAYOUT

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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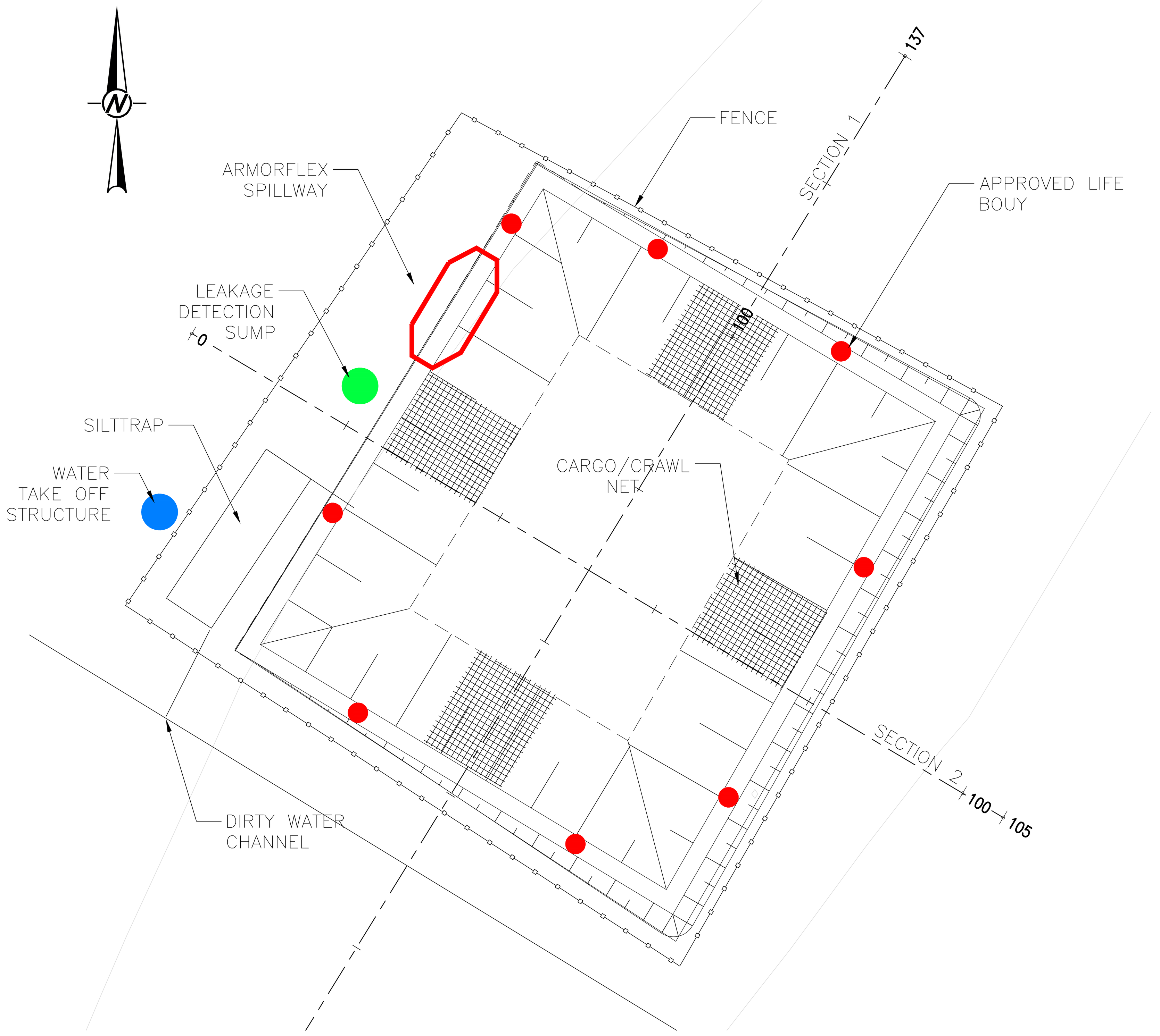
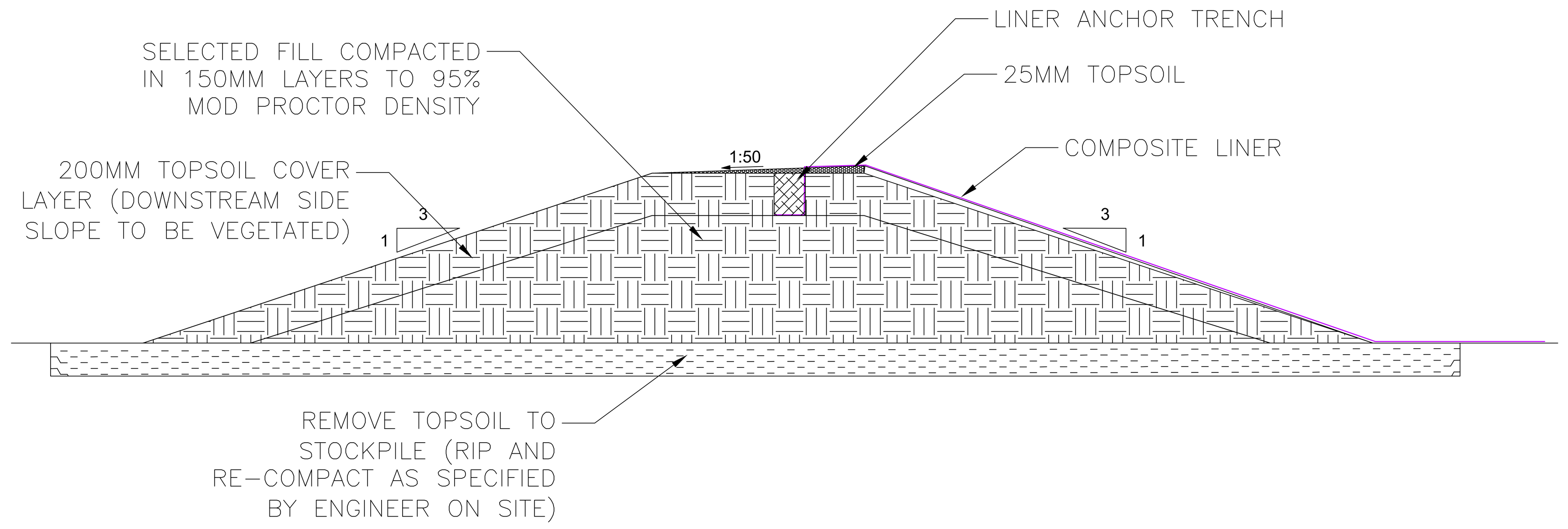
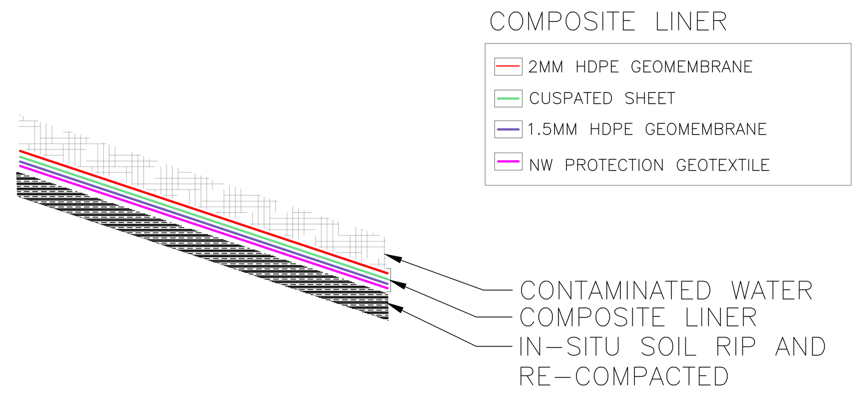



## POLLUTION CONTROL DAM - KEY PLAN



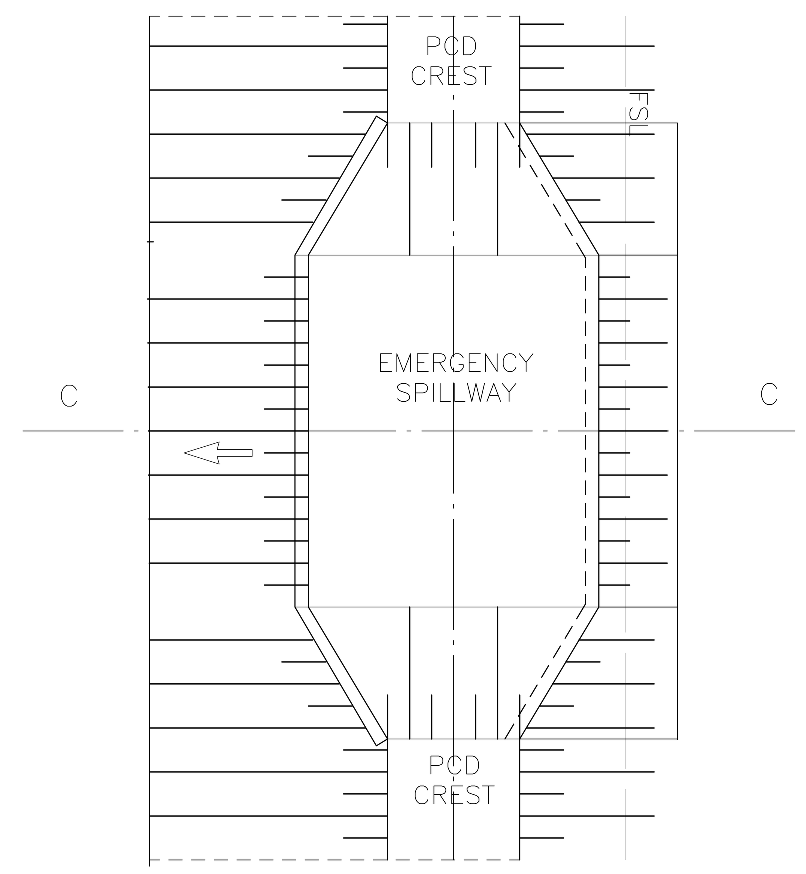

## PCD 3 EMBANKMENT CONFIGURATION



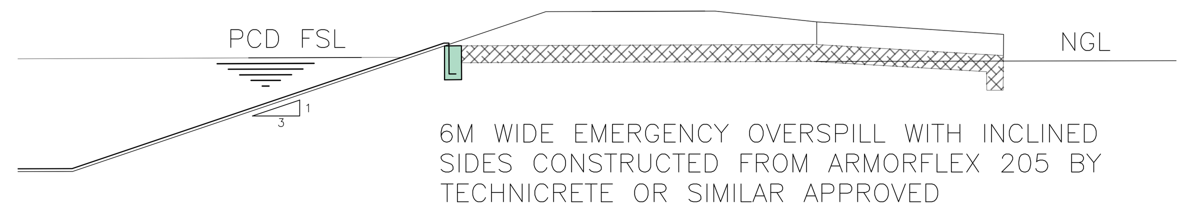

## LINER BARRIER CONFIGURATION

NOTES:

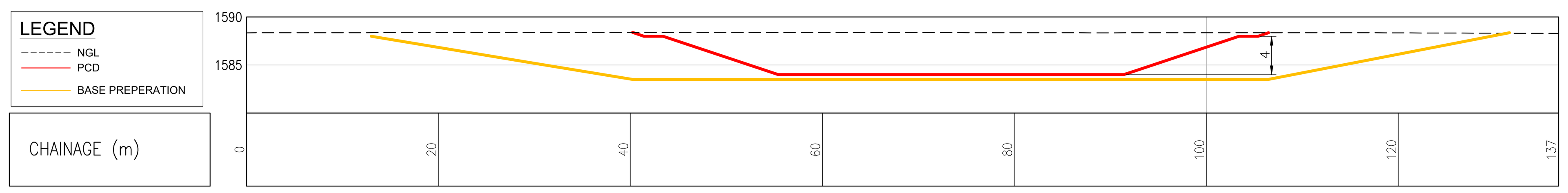
1. ALL WORKS TO BE DONE TO SABS STANDARD.
2. 70KG SAND FILLED UV RESISTANT BALLAST BAGS PLACED ON 5M GRID SPACING ON PCD FLOORS.
3. THE PCD HAS A NO OPERATIONAL STORAGE AND IS ASSUMED TO BE OPERATED EMPTY.
4. THE PCD HAS A 5500M³ CAPACITY THAT WILL ACCOMODATE THE 50 YEAR STORM VOLUME.
5. THE PCD HAS A 0.8M FREEBOARD AND A CREST WIDTH OF 2M.



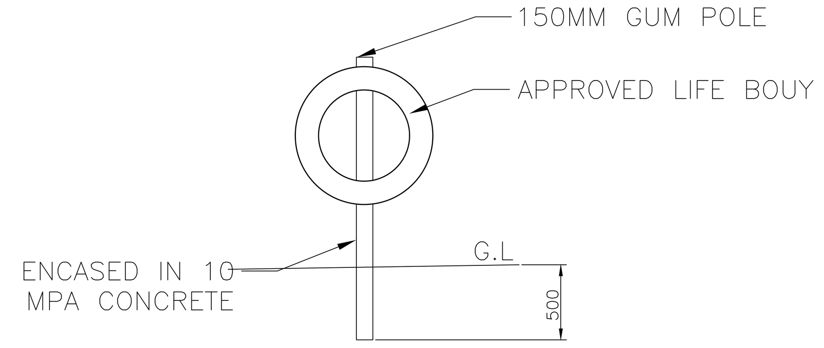

## PCD 3 EMERGENCY SPILLWAY - PLAN VIEW



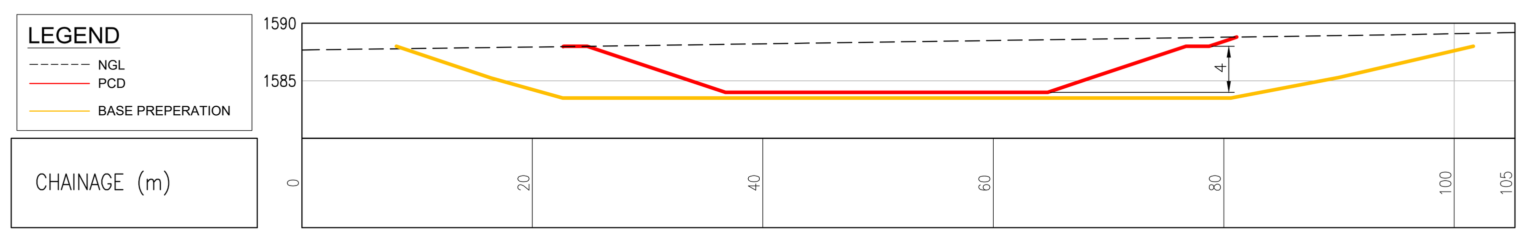

## PCD 3 EMERGENCY SPILLWAY - SECTION



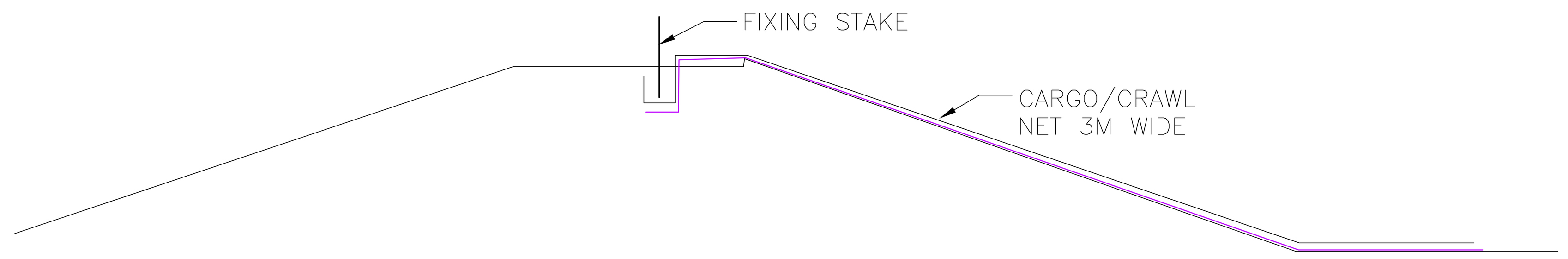

## PCD 4 - SECTION 1




## LIFE BOUY DETAIL




## PCD 3 - SECTION 2




## CRAWL NET DETAIL

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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN
DRAWING TITLE: NORTH WESTERN POLLUTION CONTROL DAM LAYOUT AND DETAILS

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
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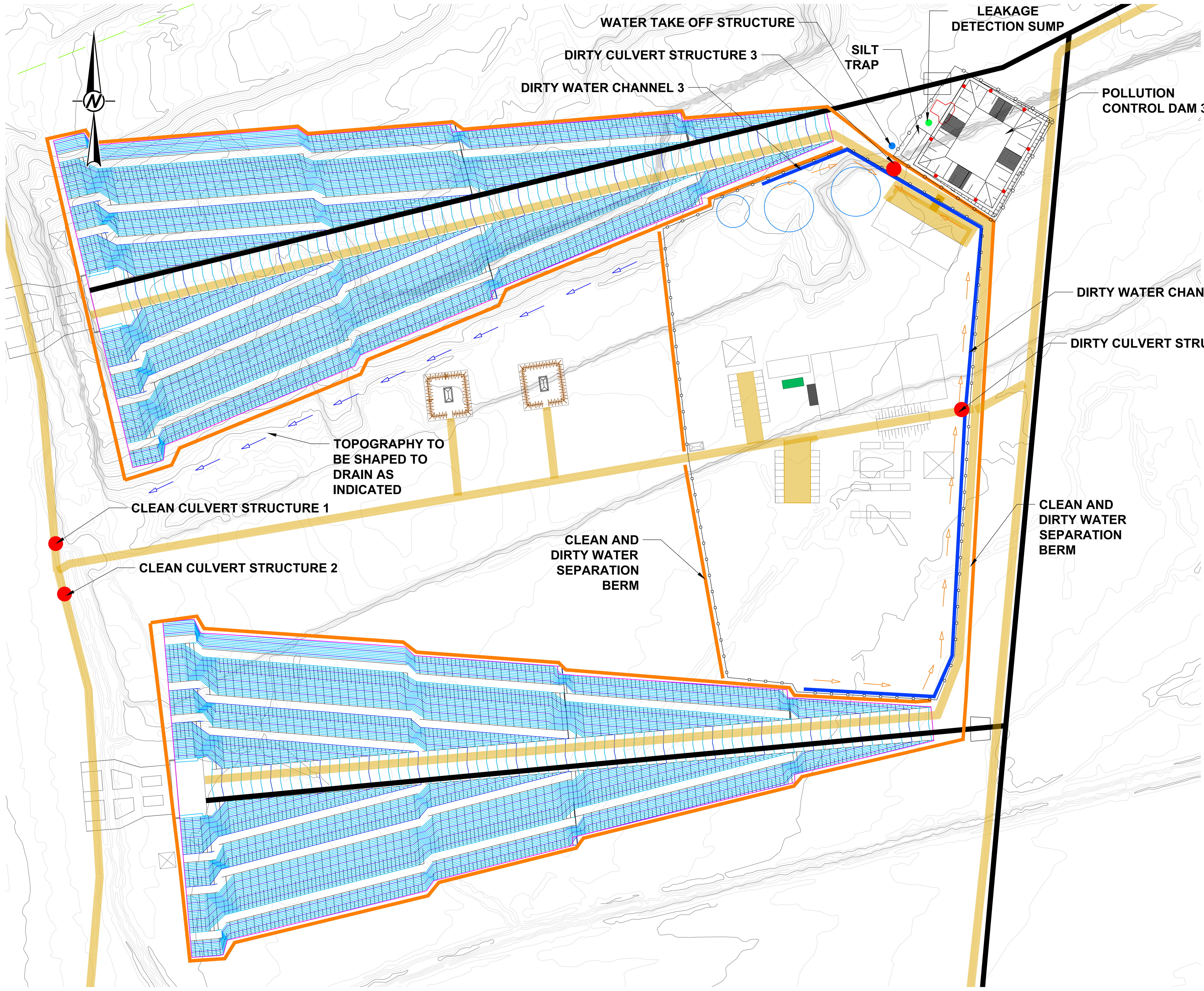
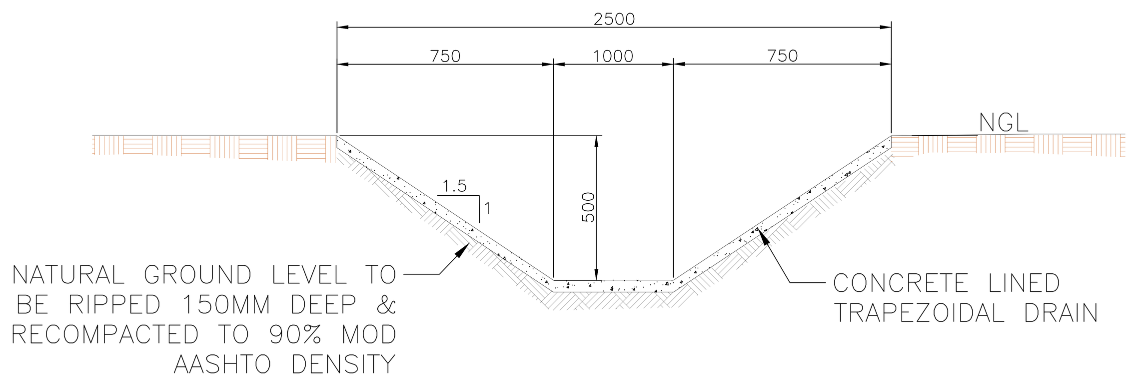
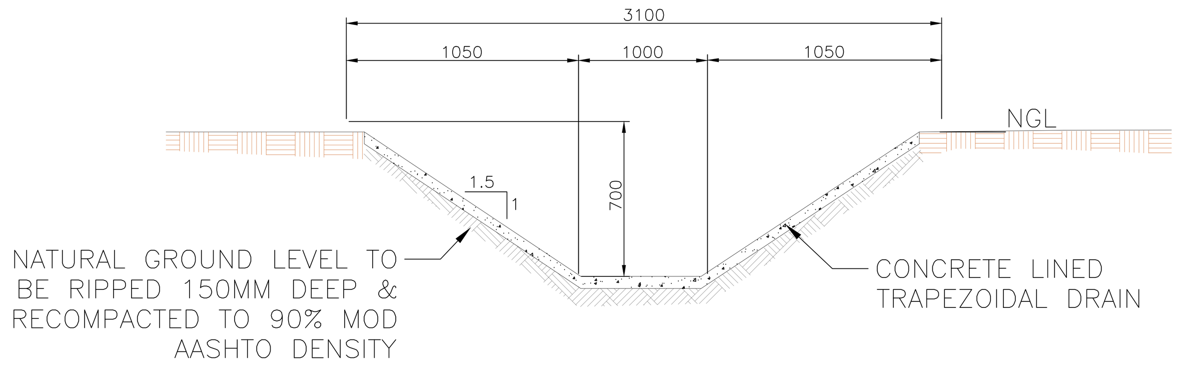


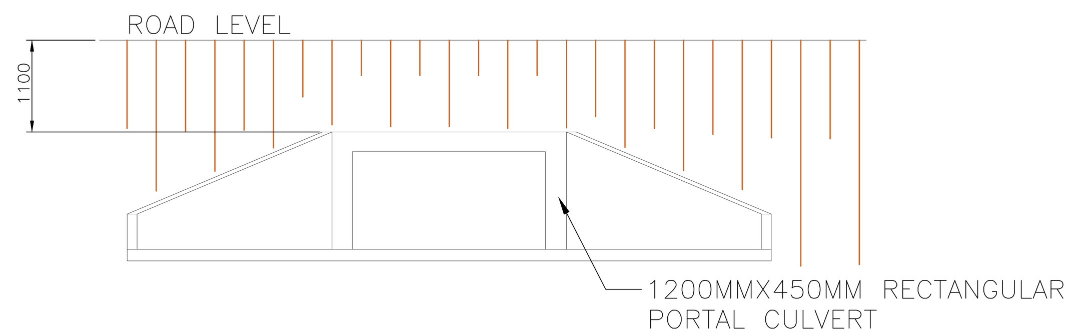

## DIRTY WATER SYSTEM - KEY PLAN



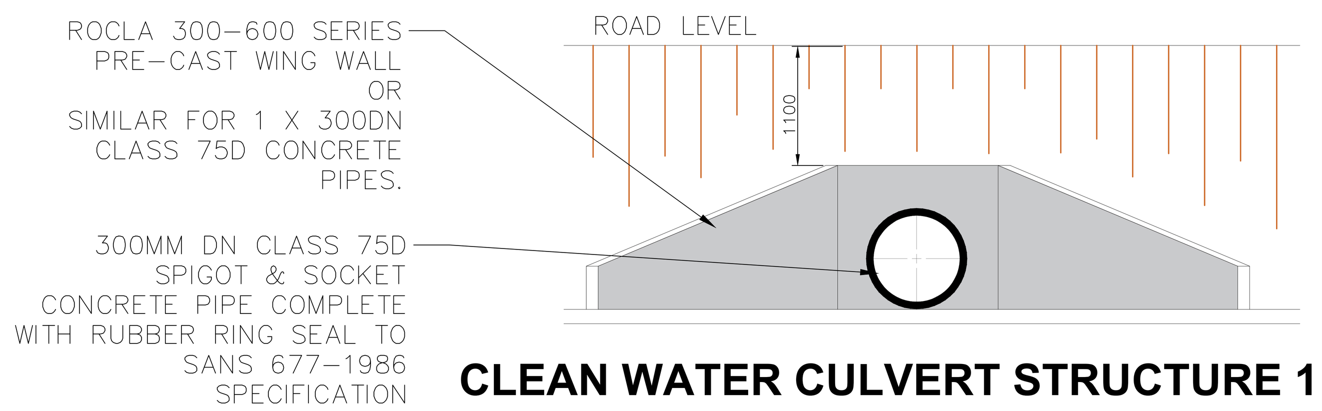

## DIRTY WATER CHANNEL 3



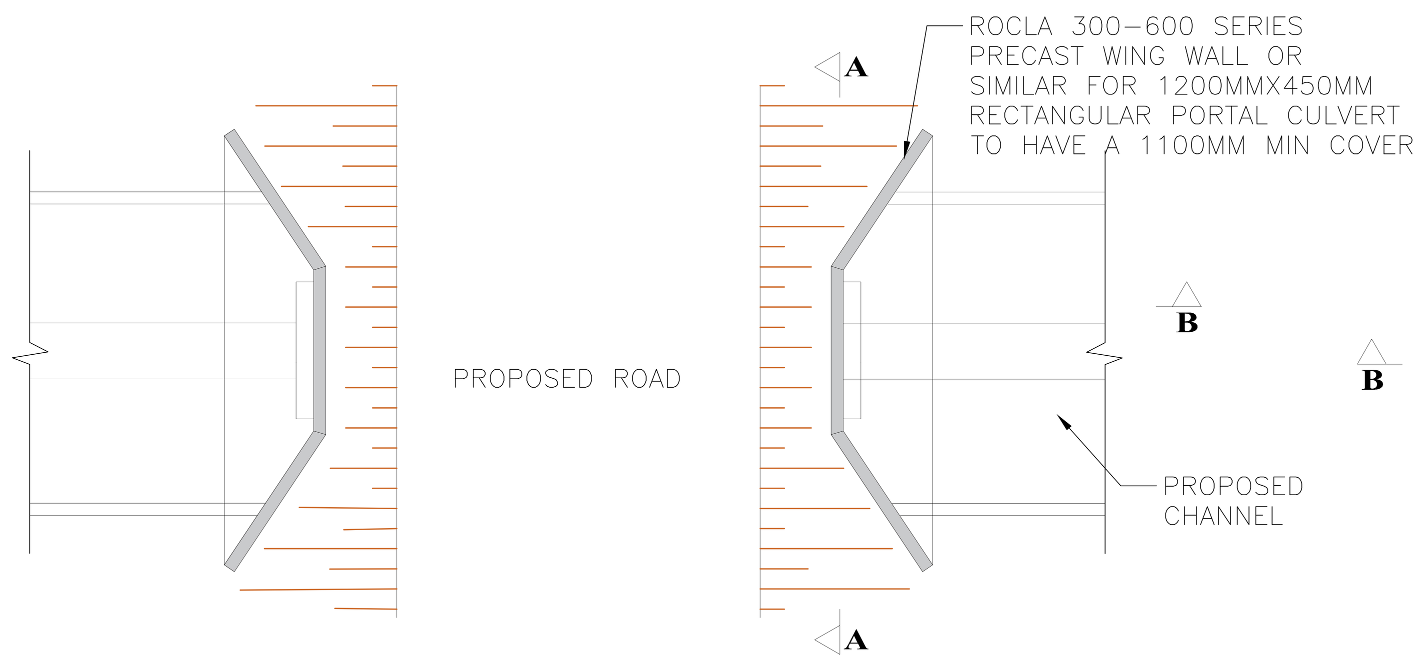

## DIRTY WATER CHANNEL 4



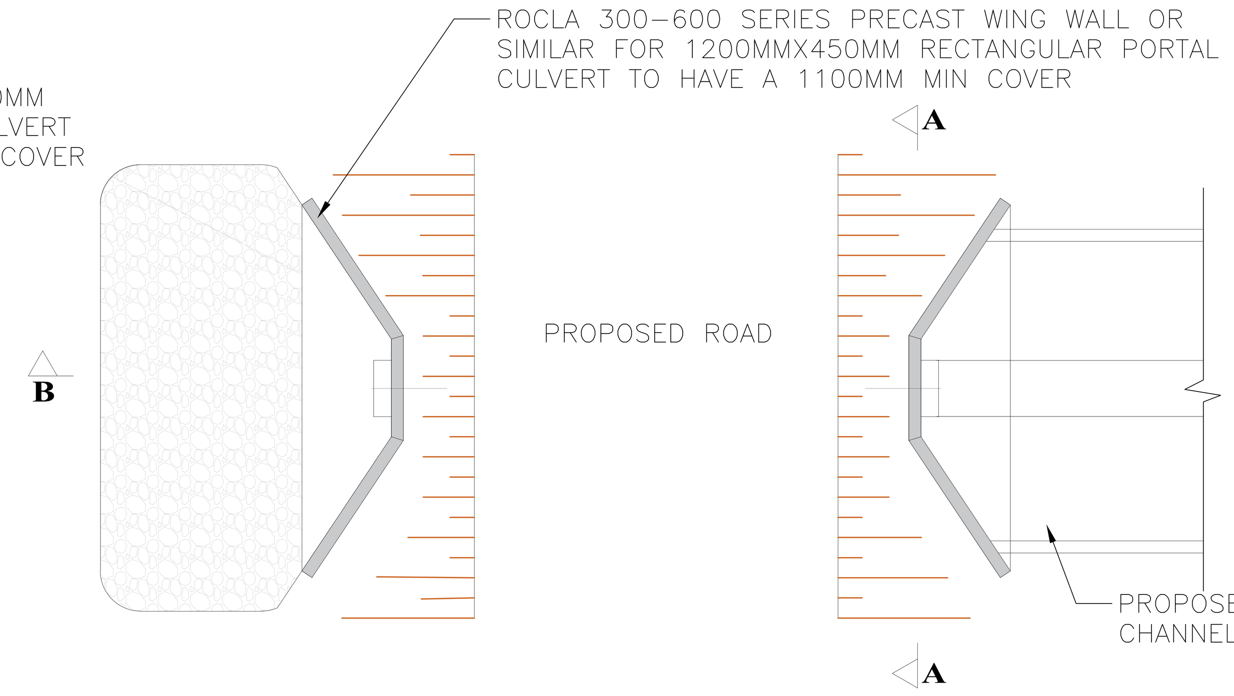

## DIRTY WATER CULVERT STRUCTURE 3-SECTION A-A



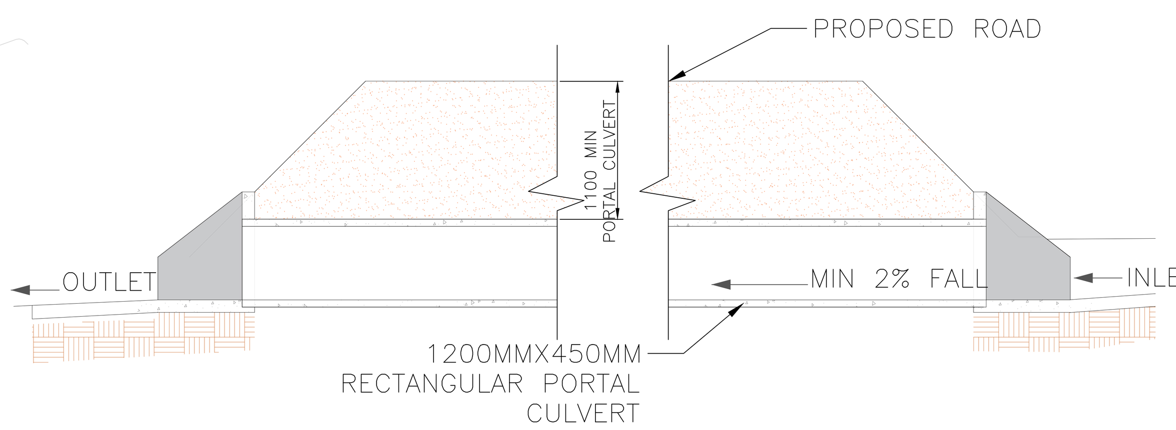

## CLEAN WATER CULVERT STRUCTURE 1 & 2-SECTION A-A



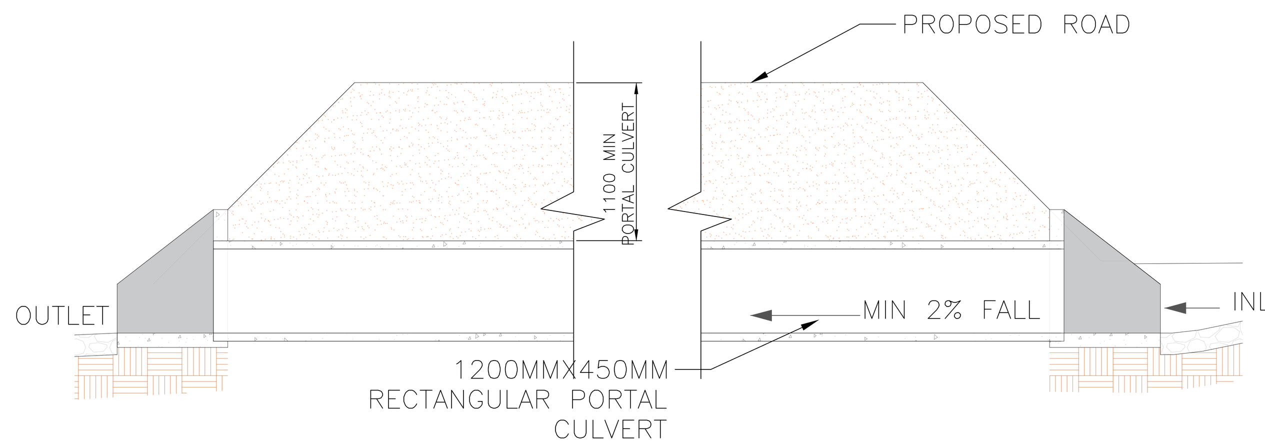

## DIRTY WATER CULVERT STRUCTURE 3-PLAN VIEW



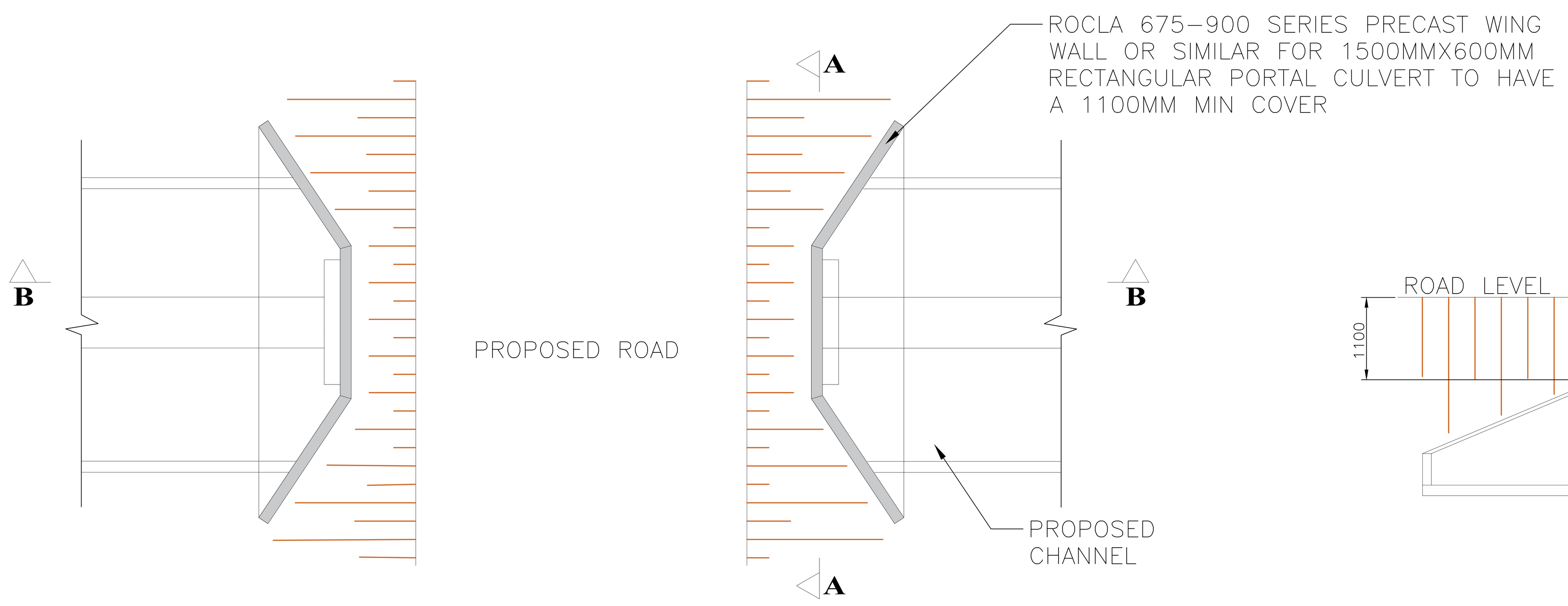

## CLEAN WATER CULVERT STRUCTURE 1 & 2-PLAN VIEW



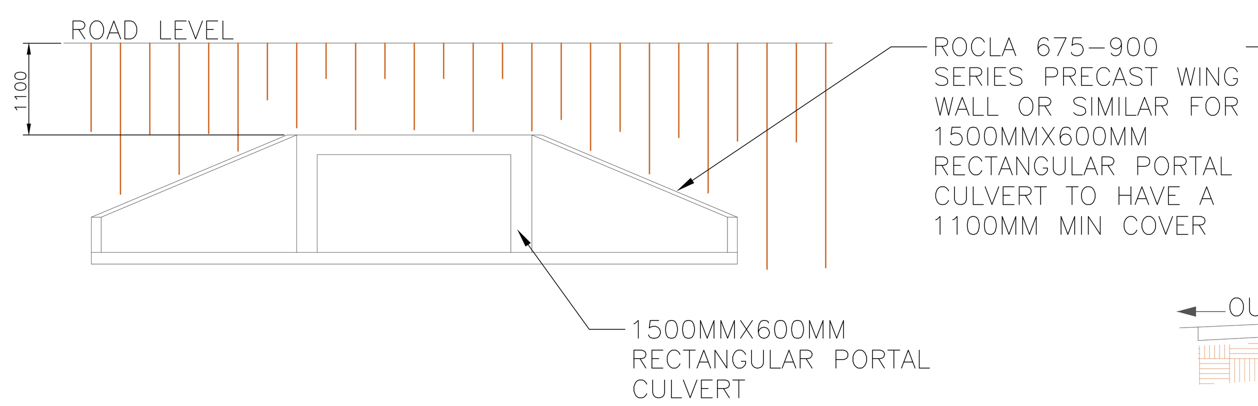

## DIRTY WATER CULVERT STRUCTURE 3-SECTION B-B



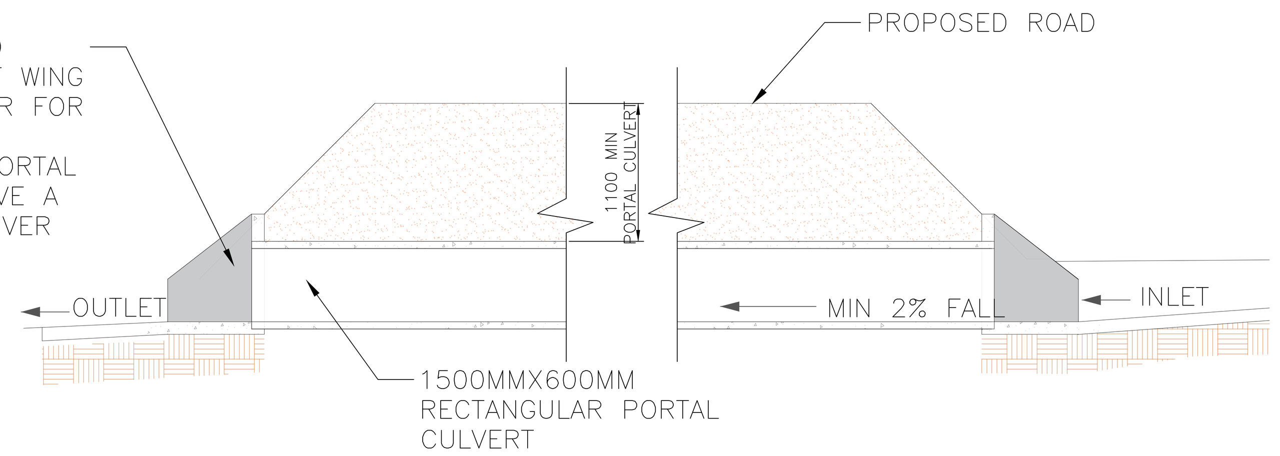

## CLEAN WATER CULVERT STRUCTURE 1 & 2-SECTION B-B



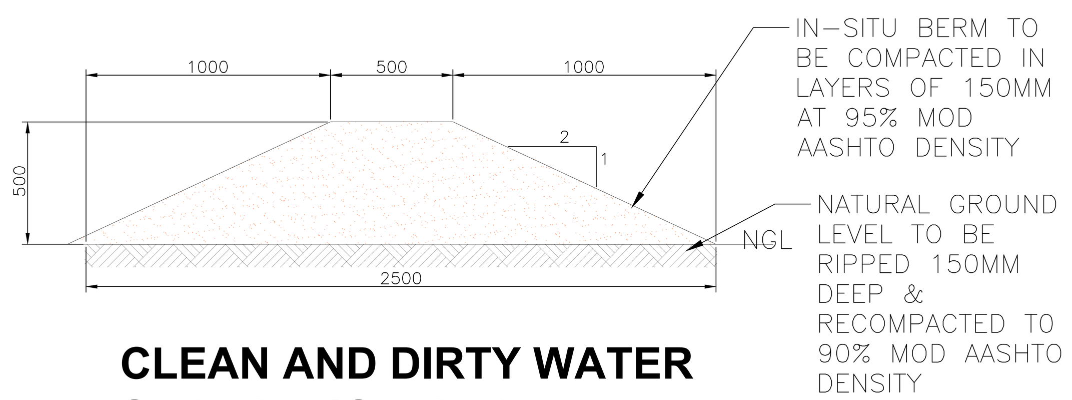

## DIRTY WATER CULVERT STRUCTURE 4-PLAN VIEW




## DIRTY WATER CULVERT STRUCTURE 4-SECTION A-A




## DIRTY WATER CULVERT STRUCTURE 4-SECTION B-B




## CLEAN AND DIRTY WATER SEPARATION BERM

CONCEPTUAL DESIGN
ISSUED FOR INFORMATION ONLY

| REVISION | DESCRIPTION | DRAWN | DRAWN CHECK | DESIGN | DESIGN CHECK | AUTHORISED | DATE |
|---|---|---|---|---|---|---|---|
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CLIENT: TSHEDZA MINING (PTY) LTD

PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: NORTH WESTERN UNDERGROUND STORM WATER INFRASTRUCTURE LAYOUT DRAWING

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
|---|---|---|---|---|---|---|---|---|
| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 007 | 00 |


| REVISION | DESCRIPTION | DRAWN | DRAWN CHECK | DESIGN | DESIGN CHECK | AUTHORISED | DATE |
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PROJECT: CONCEPTUAL STORM WATER MANAGEMENT DESIGN

DRAWING TITLE: STORM WATER MANAGEMENT LAYOUT PLAN

| LEAD PROJECT DRAFTER | PROJECT MANAGER | SCALE | SHEET SIZE | PROJECT No | DOC No | DOC TYPE | DRAWING No | REVISION |
|---|---|---|---|---|---|---|---|---|
| MVDW | RDB | N.T.S | A1 | B196 | 001 | CONC | 003 | 00 |