Stormwater, Wastewater and Erosion Management Plan for McTaggarts PV3

Report Prepared for

McTaggarts PV3 Pty (Ltd)

Report Number 550146/3

Report Prepared by

srk consulting

October 2019

Stormwater, Wastewater and Erosion Management Plan for McTaggarts PV3

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Executive Summary

McTaggarts PV3 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure on a development area located approximately 20km south-west of Upington within the Kai Garib Local Municipality and the ZF Mgcawu District Municipality in the Northern Cape Province. The site borders the Dawid Kruiper Local Municipality.

This report documents the stormwater, wastewater and erosion management plan (referred to as the SWMP) required for the proposed development.

McTaggarts PV3 is proposed to accommodate the following infrastructure, which will enable the solar PV facility to supply a contracted capacity of up to 75MW:

» Fixed-tilt or tracking solar PV panels with a maximum height of 3.5m;

» Centralised inverter stations or string inverters;

» A temporary laydown area;

» Cabling between the panels, to be laid underground where practical;

» A 22kV or 33kV to 132kV on-site substation of up to 1 ha in extent to facilitate the connection between the solar PV facility and the electricity grid;

» An access road to the development area with a maximum width of 6m;

» Internal access roads within the PV panel array area with a maximum width of 5m;

» Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses, a workshop and visitors centre.

The SWMP aims to facilitate protection of surface water resources and covers the project development area as indicated in Figure 1.

The first step in the SWMP development is an analysis of the development area and the proposed facility. The analysis found that the proposed facility is are likely to have an intrinsically low impact on the surface water resources due to:

- The vegetation, soil and topography will remain mostly undisturbed;
- The development footprint and roads are well placed such that they lie mostly outside of the natural watercourses (Figure 1) and most river crossings will have low flows;
- Water use on site, with the potential to generate runoff, such as solar panel washing, is negligible in volume compared to stormflows;
- Sewage and landfill waste will be taken offsite for disposal;
- Rainfall in the area is low and few steep gradients exist.

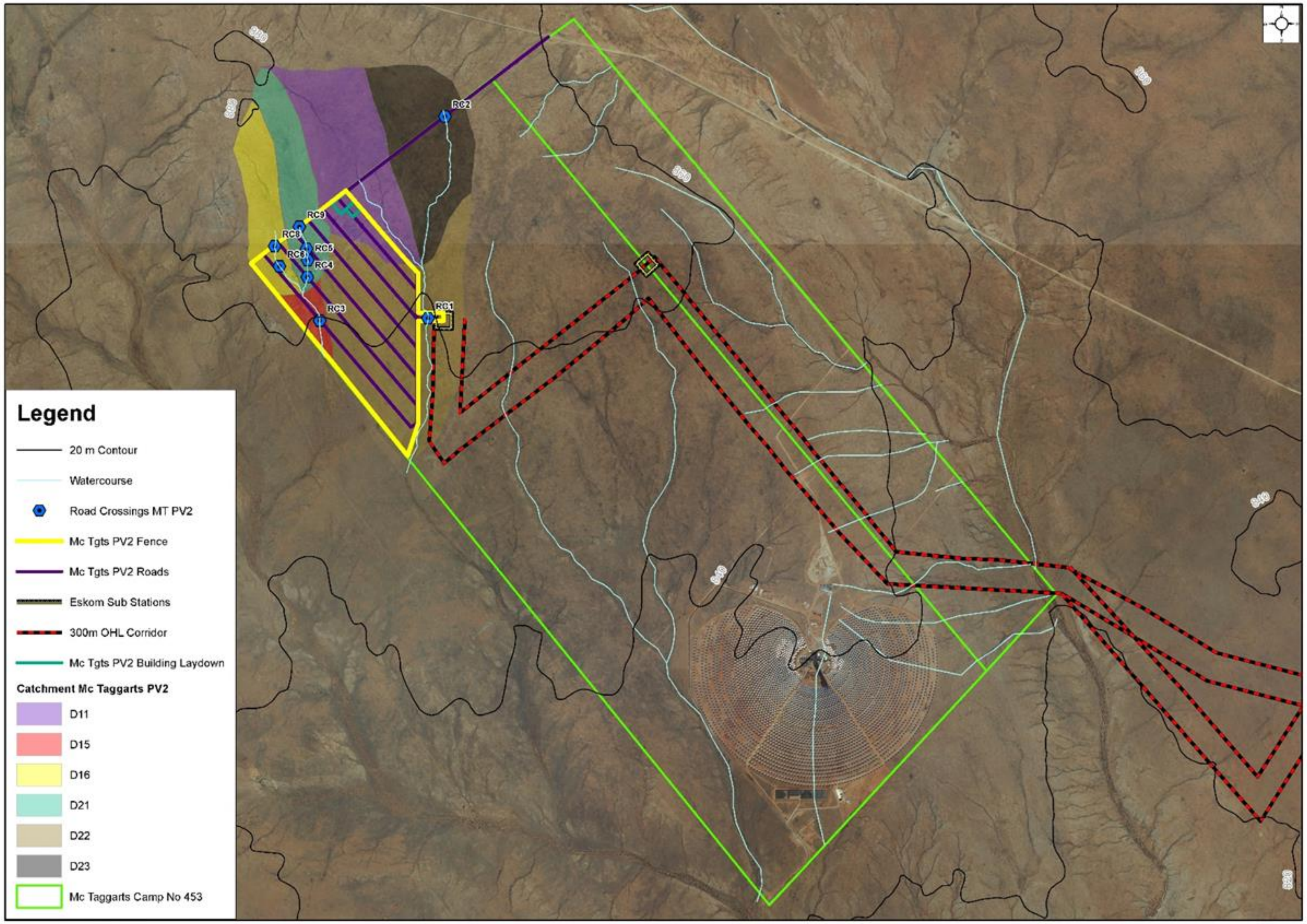
Despite the low impact on surface water resources, some potential impacts are possible including:

- Dirty areas will exist which could contribute to contamination including:
    - Transformers which could leak oil;
    - The workshop which may store oils or lubricants that could contaminate wash down water;

  - The sewage conservancy tank which could leak or overflow.

- Erosion where stormwater drains discharge to the natural environment or around stockpiles – estimated stormflows indicate that erosion could be significant in such localised areas without proper detailed design;
- Road crossings, which could exacerbate erosion without proper design, were identified – four of these crossed relatively large drainage lines;
- Disruption of flow, and possibly erosion, where solar panels are located within watercourses and flood prone areas.

Based on the potential impacts, as well as legal requirements and best practice guidelines, specific objectives were developed for stormwater and erosion management. A plan was then developed to address each objective to protect surface water resources. The objectives, as well as the plan, are shown in Table 1: Summary of the SWMP actions.



srk consulting	**MCTAGGARTS PV3** Proposed Layout	Project No. 550146

Figure 7-1: Proposed McTaggarts PV3 Layout

Table 1: Summary of the SWMP actions

General principle	Action
Separate clean- and dirty water to ensure clean water remains uncontaminated	Clean water diversions: Excavate clean water diversion channel to direct clean runoff around dirty areas. Channel to be sized for 1 in 5-year event. Typical design will be an excavated earth channel or berms.
	Clean water diversions or bunds: Construct stormwater drains or bunds to divert clean runoff around the workshop, chemical stores, transformers and wastewater conservancy tank. The bund or diversion should be designed for a 1 in 50-year event.
Collect and, where required, treat dirty water or runoff from any dirty areas.	**Construct silt fences or berms:** to prevent the sediment transport into rivers.
	Dispose of landfill, oils and other contaminants offsite
	Supply chemical toilets
	Workshop collection drain with oil and grease trap: Construct a small concrete drain collecting all water, potentially containing oils and lubricants, from workshop floor and directing it through an oil and grease trap before discharge (or removing to offsite facility). Floor to be sloped such that all water will collect in drains.
	Clean the oil and grease trap: the oil and grease trap are to be inspected and, when necessary, cleaned and waste taken to offsite facility
	Dispose of transformer oil offsite: Dispose of any oil removed from transformers during maintenance to a registered facility
	Transport sewage to municipal works: Collect sewage in a conservancy tank that will regularly be emptied and disposed of at a licensed municipal sewage treatment plant.
	Construct **temporary bunds for any chemicals** such as oils or fuel stored on sited during construction. Bunds must contain at least 100% of the volume of the container. If all containers are stored together the bund must store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the material of bund must be investigated whenever a new substance is added to the bund
	Transformer bunds: All transformers will be bunded with bund capacity of at least 110% of the maximum volume of oil in the transformer. Transformers and bund will be protected from rainfall by small covers or roof or housing in containers.
	Sewage conservancy bund: The sewage conservancy tank will be a closed tank with an automatic alert system.
	Small trays for workshop chemicals: Bund any containers with oils and lubricants by placing them in plastic trays that is at least 100% of the volume of the container If all containers are stored together the bund will store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the bund must be investigated whenever a new substance is added to the bund.
Do not impede surface and subsurface flow along drainage lines	**Diversion channels placed to minimised dirty areas:** Place diversion channels directly beside dirty areas such that dirty areas are minimised in footprint
	Minimise laydown areas and stock piles.
	Ensure that any temporary **stormwater drains** or diversion berms direct water **towards the drainage line to which it would naturally flow**
	Drains to follow natural topography: Ensure outlets drain towards the natural drainage line that would originally have received flow from that area
Control, monitor and manage erosion	**Maintain natural topography:** Do not disturb the natural topography or vegetation between the solar panel installations

	No stockpiles if possible: Do not stockpile (during operation). If spoil from pilings is likely to be significant, a dedicated stockpile location must be identified, and stormwater protection measures designed when detailed layouts are available.
	Engineer low velocity drains: Drains sloped and sized such that velocities do no exceed 1 m/s
	Engineered drifts: Line all major drifts on road crossings with concrete to protect from traffic damage and high flow velocities (For smaller drifts gravel might suffice). Place a section of rip-rap (larger rocks) underlain by gravel and with gravel on either side to facilitate a smooth flow transition. Detailed modelling and design of road crossings such that erosion is controlled to be a feature of the detailed design.
	Dissipaters: At drain outlets widen the channel and use rip-rap (can be sourced from spoil during construction) or reno mattresses to dissipate stormwater flows
	Dissipation at road crossings: Detailed modelling and design of road crossings including rip-rap (can potentially be sourced from spoil during construction) or reno-mattresses.
	Maintain natural topography and vegetation: Do not disturb the natural topography or vegetation where possible
	Engineer low velocity temporary drains: Drains sloped and sized such that velocities do no exceed 1 m/s in a 1 in 5-year event
	Engineered temporary drifts: Build roads and road crossings before other infrastructure.
	Inspect and remediate noticeable erosion: Inspect all focus areas for erosion. If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment and determine the cause. Develop a plan to prevent future erosion.
	Install a rain gauge that can measure greater than 115 mm (100-year, 24-hour event)
	Inspect and remediate acute erosion: Inspect all focus areas for erosion. If erosion is found remediate and redesign the drainage in the area. If erosion is found in a natural drainage line conduct and assessment and determine the cause and develop a plan to prevent future erosion.
	Set up rain data system: Build or buy a basic rain program, preferably electronic, that allows site staff to enter rain data from the rain gauge. Ideally the system should alert the environmental manager and site manager when a rainfall event in excess of 65 mm per day is entered.
	Record rain data: Read and record rain gauge daily;
	Signs at main office to aid problem reporting: Ensure that a sign providing the following is posed in the reception area, the control room, on each transformer and in the workshop: The name, telephone number and email address of the environmental manager. The sign should state: “If you notice any leaks or spills or erosion anywhere on the property please phone or email the environmental manager on …….”
	Training: Provide a short briefing to all construction staff on the dynamics of erosion and leaks that covers at least: How to identify erosion; How to identify a leak, including car leaks; Where to find contact details of the environmental officer/representative in case of leaks or erosion.
	Inspect the site for erosion after rain events. If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment to determine the cause and develop a plan to prevent future erosion.
	Install a rain gauge that can measure greater than 115 mm (100-year, 24-hour event). This rain gauge will also be used during operation.

Monitor and manage stormwater system	**Leak inspection:** regularly check for leaks and for any breaches or evidence of spills or any other problems not in adherence to this SWMP. All cars should also be checked for oil leaks and any leaks found should be stopped immediately, the cause of the leak identified, the problem remediated such that no further leaks occur, and any contaminated soil or water assessed and remediated.
	Leak inspection: regularly check for leaks and for any breaches or evidence of spills or any other problems that would indicate that it is not in adherence to this plan. All cars should also be checked for oil leaks during the inspection. Any leaks found should be stopped immediately, the cause of the leak sought, the problem remediated such that no further leaks occur, and any contaminated soil or water assessed and remediated.
	Data capture, training and signs: see 33, 34, 35, 36, 37 & 38
	Sewage conservancy tank alert system: Install a float switch-controlled alarm that will alert the control room when the conservancy tank has less than 2 weeks of capacity remaining.
	Signs at transformers: Post a sign on transformers stating "If you notice any leaks or spills or erosion anywhere on the property please phone reception on ……and report it"
General	Ensure no infrastructure except roads, solar panels and solar panel supports are built within 300 metres of a water course. In particular, ensure no dirty areas, that may contain pollutants, are within 300 metres of the water course
	Ensure that final infrastructure plans **do not** propose **any potentially polluting infrastructure, such as transformers, workshops or conservancy tanks in the natural drainage** lines (currently none are proposed)
	Review and improve the stormwater plan
	Inspect the site to ensure adherence to the stormwater management plan
	Do not place laydown areas, stockpiles within 300 metres of the watercourse
	Do not place laydown areas, stockpiles or any other materials or equipment within 300 metres of the watercourse
	Develop a specific **environmental specification for any construction** including, but not limited to, the actions in this stormwater management plan and its principles

The report concluded that stormwater impacts can be managed at the development area in a practical way that will protect water bodies and minimise erosion. It is recommended that the stormwater management plan be further developed with detailed designs that have sufficient detail to realise conceptual plans. The plan will be incorporated into an environmental specification for use during construction and be implemented during operation of the facility.

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Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by McTaggarts PV3 (Pty) Ltd. The opinions in this Report are provided in response to a specific request from McTaggarts PV3 Pty (Ltd) to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction

SRK Consulting (South Africa) (Pty) Ltd. (SRK) was approached by McTaggarts PV3 (Pty) Ltd (the Client) to develop a stormwater, wastewater and erosion management plan (referred to as the SWMP) to be implemented at McTaggarts PV3, a proposed solar power generation facility in the Northern Cape of South Africa about 23 km South-West of Upington.

2 Objectives and scope of the report

2.1 Objectives

The objective of this report is to document a SWMP that protects the surface water resources, manages erosion risks and complies with the regulations and guidelines for the construction and operation phases of the McTaggarts PV3 solar PV facility.

2.2 Scope

This report covers the following scope:

- Delineation of the catchments draining to the development area;
- Determination of type of catchment (clean or dirty area) with regards to managing water quality and erosion;
- Calculation of peak stormwater discharges from each catchment and sizing of required infrastructure associated with each catchment; and
- Identification and recommendations regarding considerations that need to be taken into account during construction and operation phases of the proposed project;

The SWMP is a conceptual study at this stage, a detailed survey and SWMP study will need to be undertaken, should the proposed project be awarded preferred bidder status, to design the required infrastructure.

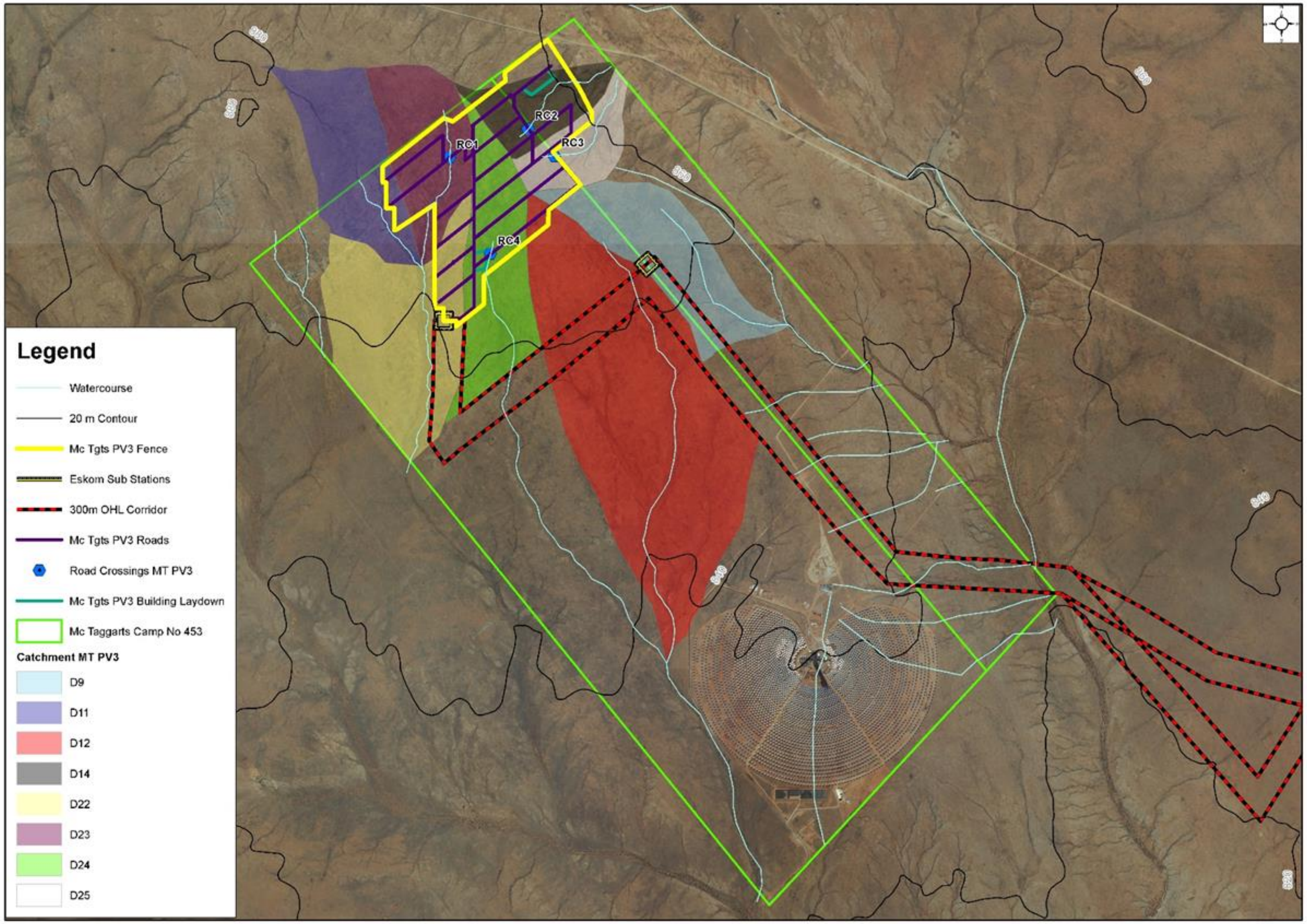
3 Supporting information

This section summarises all the information and assumptions upon which the SWMP is based. This is done to highlight how the plan was developed: by matching regulations and guidelines to the specific needs of the project in the local natural conditions on site, and hence the information is key to understanding the plan. The relevant information can be divided into:

- Project information;
- Guidelines and regulations;
- Natural characteristics on site.

3.1 Project information

The site information was provided by the client, and information for the area in general was obtained from the Background Information Document (Savannah Environmental, September 2019), and Draft Basic Assessment Report compiled by Savannah Environmental October 2019. Further site information was provided by the client in the form of electronic maps, photographs and GIS information. The layout of the development area is shown in Figure 3-1. The development area of the proposed McTaggarts PV3 is anticipated to be approximately 261.3 hectares.



srk consulting	**MCTAGGARTS PV3** Site Layout	Project No. 550146

Figure 3-1: Proposed McTaggarts PV3 Development Area Layout

The proposed infrastructure and the associated potential pollutants are as follows:

- An O&M building inclusive of toilet facilities connected to a conservancy tank for wastewater and a chemical storage area;
- An electrical substation including transformers containing oil;
- On-site inverters located between the panels to step up the power;
- Cabling between the project's components, to be laid underground where practical;
- Fencing around the development area;
- Internal Access Roads:
    - Existing roads will be used as access roads where possible; and,
    - Existing roads will be extended to create access to the McTaggarts PV3 facility as required.
- During construction, a temporary laydown area and a workshop will be added.

Fuel and acids (generally considered high risk contaminants to stormwater) have been ruled out as potential threats as neither will be stored or used on site. General waste will only be stored temporarily and taken off site regularly for disposal to landfill.

3.2 Legislation and guidelines

Stormwater management plans are generally required as part of the Environmental Management Plan (EMPr) and for Water Use License Applications.

The SWMP was developed based on the guidelines in the Best Practice Guidelines (DWAF, 2006) and in compliance with regulation 704 of the National Water Act, 1998 (Act No.36 of 1998). Regulation 704 applies to mining and associated activities but includes principles that should be applied at all sites.

Municipal regulations, which usually determine specific standards for each municipality, but still adhere to the overall principles of the regulations and guidelines above, will be consulted during detailed design.

3.3 Natural conditions

3.3.1 Climate

The development area lies in an arid to semi-arid climatic region with average rainfall below 200 mm per year. The average evaporation rate in the area is 2 281 mm. In summer months temperatures can be in excess of 42°C and in winter months dip to below 4°C.

3.3.2 Design rainfall

The rainfall analysis was based on the "Design Rainfall Estimation in South Africa" (DRE) program developed by JC Smithers and RE Schulze. The program implemented procedures from the Water Research Commission (WRC) project entitled "Rainfall Statistics for Design Flood Estimation in South Africa" (WRC Project K5/1060). We have included a brief insert from the executive summary for background purposes and more technical information can be obtained from JC Smithers from the School of Bio-resources Engineering and Environmental Hydrology, University of Natal.

Rainfall, in the form of storm event intensity, was required for site hydrology calculations. The rainfall data was obtained from 6 closest rainfall stations (Smithers and Schulze - Design Rainfall in South

Africa). The rainfall stations for the catchment area were selected based on criteria such as altitude relative to the area of interest, the record history of the weather stations and proximity to the study area.

The catchment has a mean annual precipitation of 152 mm. The rainfall station closest to the development area is Geelkop (0283098W), which is approximately 12 km from the site catchments.

Table 3-1: Design rainfall (mm) data interpolated from the six closest stations

Mean annual rainfall	152	mm	Latitude	-28.587237	degrees		
Altitude	775	mamsl	Longitude	21.040049	degrees		
Storm Duration	**Return Period (Years)**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
5 minutes	5.9	9.3	11.8	14.4	18.1	21.1	24.4
15 minutes	11.1	17.3	22	26.8	33.7	39.3	45.4
1 hour	16.5	25.9	32.9	40.1	50.3	58.8	67.9
1.5 hours	18.6	29.2	37	45.1	56.6	66.1	76.4
2 hours	20.2	31.7	40.2	49	61.6	71.9	83
8 hours	26.2	41.2	52.1	63.3	79.9	93.3	107.7
24 hours	32.2	50.6	64.1	78.2	98.2	114.6	132.4
5 day	36.8	57.8	73.2	89.3	112.2	131	151.3

4 Program Results

4.1 Step 1: Development of specific objectives

The specific objectives were developed based on the laws and guidelines mentioned in Section 3.2 and are as follows:

- Keep clean water clean by constructing diversions or bunds. This prevents any clean runoff from entering any potentially dirty areas. The bunds or diversions should be designed for a 1:50-year flood event;
- Collect and treat discharge water or runoff from any dirty areas. Dirty water should not spill into clean water systems more than once in a fifty-year return period;
- Bund any areas housing hazardous substances or pollutants, including any oils;
- Do not impede surface or subsurface water flows more than hat is required to implement the required clean – dirty water separation:
    - Minimise disturbed areas such that surface and subsurface movement of water along the drainage lines is not reduced;
    - Ensure any engineered clean stormwater drainage directs water to the naturally receiving drainage line.
- Erosion control:
    - Prevent erosion in general, and minimize the potential for erosion in large storm events of 1:50-year flood events or greater;

  - Dissipate stormwater energy at all drainage outlets to velocities that are unlikely to cause erosion in storm events less than 1:50-year flood events (i.e. <1 m/s).
- Monitoring and management:
  - Inspect and monitor performance and integrity of all SWMP infrastructure on an annual basis;
  - Include an erosion monitoring plan that ensures that the onset of erosion is detected and rehabilitated within 6 months, and any acute erosion due to large storm events is detected within two weeks;
  - Include a monitoring system for spills and leaks such that they are detected and remediated as soon as practically possible.
- General:
  - Ensure no infrastructure, except road crossings and solar panel supports (Mounting Structures will straddle the watercourses and therefore won't be located within the watercourse) are built within the water courses.
  - Do not build infrastructure, in particular infrastructure containing potential pollutants, within 300 metres of natural drainage lines;
  - Review and improve the stormwater management plan regularly.

4.2 Step 2: Technical situation analysis and evaluation

4.2.1 Analysis of potential stormwater, wastewater and erosion impacts

An overall analysis of the available data and the development plans reveal the following potential impacts:

- The facility presents a very low risk to adversely impacting surface water resources because:
  - The development will leave the natural vegetation, soil conditions and topography largely undisturbed;
  - The development area and roads have been well placed such that they lie mostly outside of the natural water ways and most river crossings are over very small drainage lines or rivers, characterised with small catchments and low flows;
  - Sewage and landfill waste will be disposed offsite;
  - Rainfall in the area is low and few steep slopes exist to generate high flow velocities.
- Some potential impacts do exist, including:
  - Possible contamination of stormwater by:
    - Oil leaks from the transformers;
    - Oil and lubricant in wash down water from the workshop;
    - Overflow of wastewater from the conservancy tanks.
  - Potential for erosion:
    - Where any stormwater drains discharge into rivers or onto the natural land surface;

        - At river / road crossing.

    - Potential exists to impede and disrupt flow if infrastructure is placed within water courses;
    - Potential exists to damage infrastructure and exacerbate erosion if infrastructure is placed within areas that are inundated in floods.

4.2.2 Delineation of clean and dirty areas

The development area is divided into clean and dirty areas as follows:

- Dirty areas:
    - The workshop where oils and lubricants may be stored and used. The workshop will only be temporary (during the construction phase). A chemical storage area will be constructed for the operational phase of the project;
    - The 40 medium-voltage transformers (at the inverter stations) placed around the development area, as these will contain oil;
    - Transformers at the substation, as they will contain oil;
    - The conservancy tanks, as they will contain sewage.
- Clean areas are deemed to be all areas outside of those stated above as dirty areas.

4.2.3 Delineation of catchments and identification of road crossings

Road crossings were identified for all the roads that will be upgraded or built as part of the project, taking into account that the road / river crossings are conceptual at this stage, and their locations are approximate. It is extremely unlikely that minor modifications in road position will change the assessments and conclusions in this report. Also note that most of the road crossings are over minor natural drainage lines near the source of their flow. Any internal road crossings will be minor and conceptual designs provided in this report can be used as a basis for such crossings.

The crossings are shown in Figure 4-1, and their locations provided in Table 4-1 below. Note that the drainage lines in the figure are, wherever possible, the drainage lines delineated during the ecological assessment (Simon Todd, July 2019).

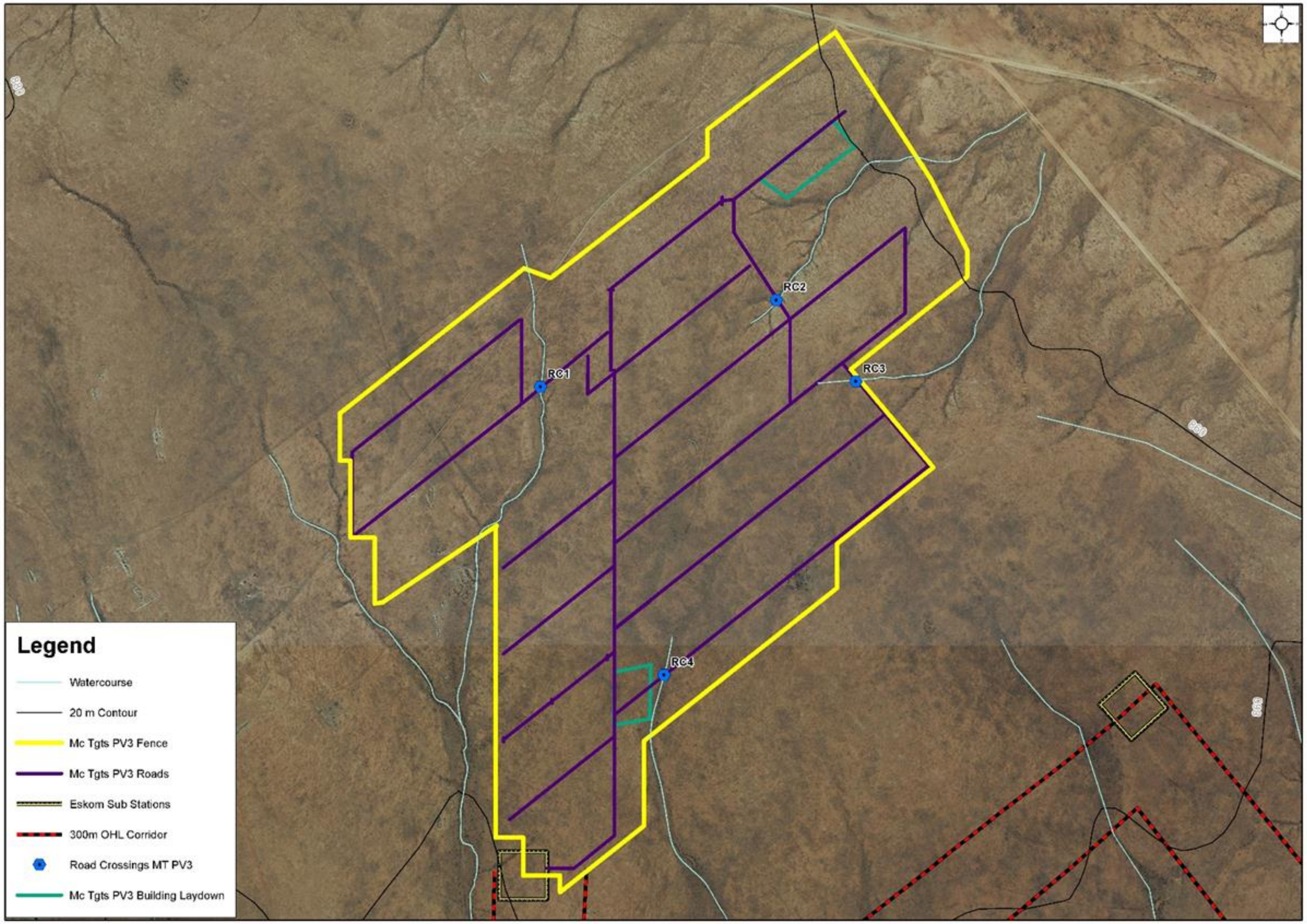
Table 4-1: River crossings with approximate latitude and longitude

Name	Type	Latitude	Longitude
RC1	Crossing	-28.49403	21.04244
RC2	Crossing	-28.49156	21.05003
RC3	Crossing	-28.49387	21.05259
RC4	Crossing	-28.50221	21.04641

The following catchments were delineated:

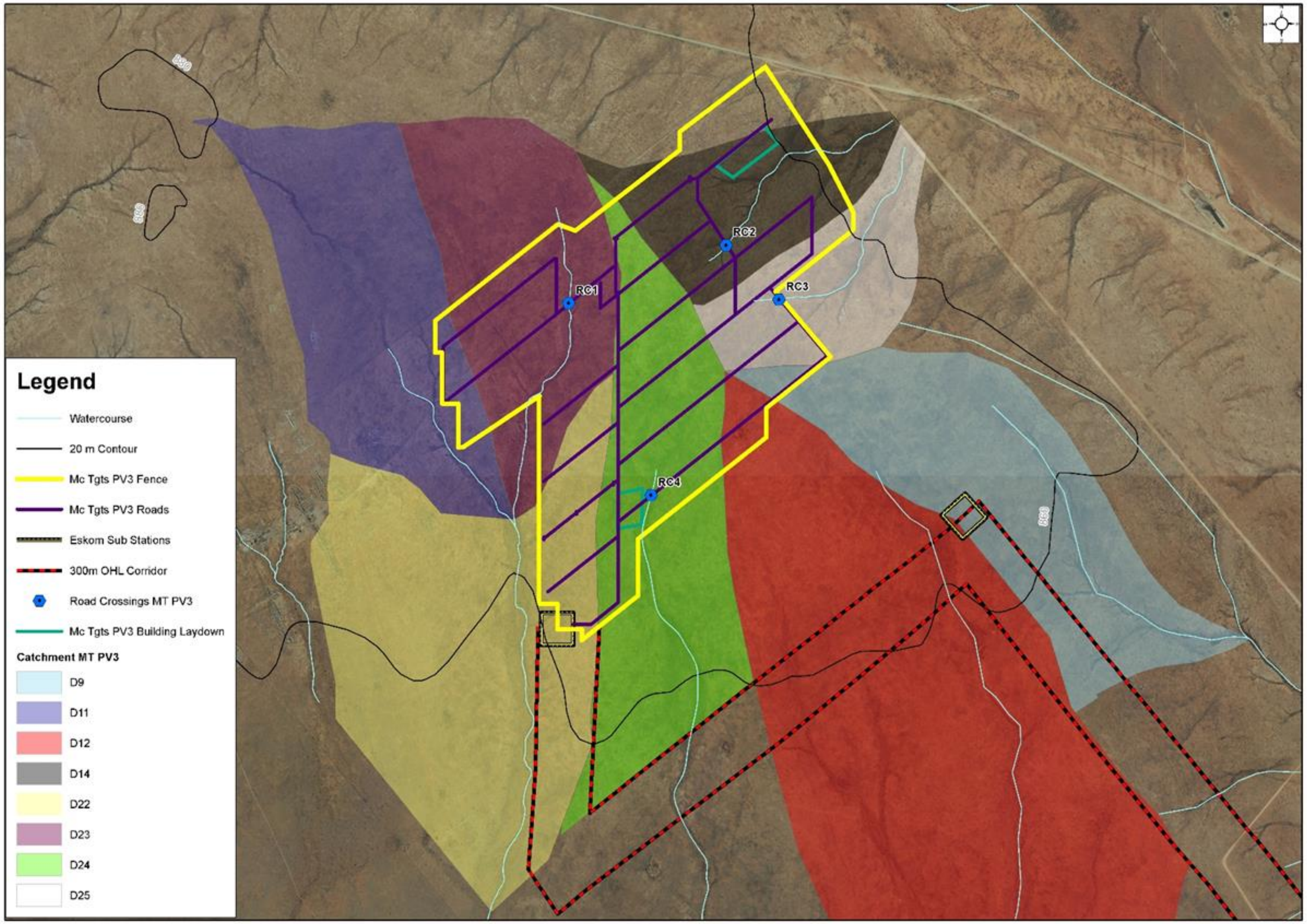
- Catchments of the watercourses where they cross any of the proposed development area;
- The receiving catchments close to where it discharges.

The catchments are as shown in Figure 4-2 below.



srk consulting	**MCTAGGARTS PV3** Road Crossings	Project No. 550146

Figure 4-1: Proposed Road Crossings



srk consulting	**MCTAGGARTS PV3** Stormwater Catchments	Project No. 550146

Figure 4-2: Stormwater Catchments for the Proposed Development

4.2.4 Storm peaks

Storm peaks were calculated for the catchments shown in Table 4-2. Peaks were calculated using only the rational method and other method not considered at this stage as the SWMP is currently only conceptual. The rational method is considered conservative, and detailed contour data (topographical survey data) was not available and thus peaks themselves are currently conceptual.

The peaks, along with the input parameters for each peak, are given in Table 4-2. The peaks are both pre-development and post-development scenarios because the vegetation, topography and soil conditions will largely be the same, except where the main buildings are placed, and this accounts for a negligible proportion of the development area from a surface area viewpoint.

Note that the wash water was not considered in the storm peaks because solar panel washing is unlikely to be done in the rainy season, which will be negligible in comparison to storm volumes.

Table 4-2: Peak flows for receiving catchments, major crossings and stormwater catchments

Receiving catchments								
Catchment name	Catchment Area (km^2)	Tc (Hours)	Flood Peaks (m^3/s)					
			1:2	1:5	1:10	1:20	1:50	1:100
D9	1.4	0.9	1.03	1.50	2.02	2.64	3.61	4.68
D11	1.4	0.7	1.11	1.61	2.16	2.83	3.88	5.02
D12	4.8	1.4	2.41	3.50	4.71	6.15	8.42	10.90
D14	0.7	0.5	0.75	1.08	1.46	1.91	2.61	3.39
D22	4.6	1.3	2.52	3.67	4.91	6.42	8.81	11.40
D23	1.2	0.7	0.99	1.44	1.93	2.52	3.55	4.48
D24	1.4	0.9	1.00	1.45	1.95	2.54	3.57	4.52
D25	0.6	0.4	0.69	1.00	1.35	1.76	2.41	3.13

The above peaks may be reduced using other calculation methods such as SCS during detailed design. The implications of the storm peaks calculated, and their impact on the SWMP, are discussed in Section 4.3.

4.3 Conceptual design and review

This section should be read in conjunction with the stormwater, wastewater and erosion management plan in Section 5. This section provides detail on why management approaches were selected, any alternatives that should be considered, and further steps required to confirm or improve the conceptual plan.

4.3.1 Waste and wastewater management

Waste will be disposed of at a registered landfill site and domestic wastewater at a licensed wastewater treatment plant (i.e. waste will be treated off site), hence, the SWMP only focuses on temporary storage on site.

Domestic waste should be stored out of the rain and wind, collected (and disposed of) regularly as is currently proposed for the development.

Conceptual design of the wastewater (sewage) conservancy tank was not within the scope of this report, however, the current conceptual plan was evaluated in terms of the risks that this may pose to stormwater. Management of the tank is the main risk because the system could fail if the tank is not emptied regularly resulting in overflows. Consequently, a float switch controlled alert system is recommended.

Oil and lubricants in the workshop, and oil from the transformers must be bunded (See Section 4.3.5 for bunding requirements) as per legal requirements and hence, this was recommended without any alternatives.

4.3.2 Channels, diversions and dissipaters

It is recommended that channels be placed on the upgradient side of any roads to control erosion as well as around any of the dirty areas to divert clean water. Note that in most cases diversions will not be required around dirty areas because bunds will “keep clean water clean”.

Solar panel areas are not considered dirty, and upstream catchment areas are small and thus stormwater does not generally need to be diverted around these solar panel areas.

Using the conceptual infrastructure layout plans and regional contours, high-level conceptual designs were developed (i.e. typical drain and dissipater types). These were based on the following preliminary conclusions:

- Peak flows for the stormwater catchments are low;
- Most of the area is under 2% grade, and it is potentially possible to design earth or gravel drains rather than concrete drains because low erosion potential exists at these low flow gradients; and
- Even though engineering designs might achieve low velocity flows in the drains, dissipaters are recommended at any outlets to control the transition of water from concentrated channel flow to overland dispersed flow or in-river flow – in addition, it is possible that outlets (e.g. adjacent to road/river crossings) could be locally steep.

Typical generic conceptual designs, based on the above discussions, were compiled as shown in Figure 5-1.

4.3.3 Road crossings

Using the conceptual infrastructure layout plans and regional contours, high-level conceptual designs were developed. These were based on the following preliminary conclusions:

- Most crossings are small and on areas with low gradients, and thus the roads are well-placed to generally avoid erosion at crossings; and
- Drifts would be the best crossing design from a practical, economic and environmental point of view for the road crossings;

Typical conceptual designs, based on the above discussions, were compiled for information purposes and are shown in Figure 5-1.

4.3.4 Erosion and sediment transport

The main erosion risks are drain outlets (Section 4.3.1), road crossings (Section 4.3.3) and stockpiles. Permanent stockpiles should be avoided. However, material excavated during construction of the panels might be significant (cumulative volume). In that case, a suitable area should be selected for the stockpile such that it is unlikely to erode and result in sediment transport. Sediment traps and diversion drains should also be designed for the stockpile. Where possible, the stockpiled material should be used in the construction of diversions and bunds.

During construction, stockpiles will be necessary. A suitable area should be selected for such stockpiles. Temporary silt fences and diversion drains should also be designed for the stockpiles.

4.3.5 Bunding

Requirements for bunding of potential contaminants are specified in detail in the National Norms and Standards for the Storage of Waste (Notice 926 of 29 November 2013, Department of Environmental Affairs, National Environmental Management: Waste Act 2008, Act No.29 of 2008). The specification, which will apply to the development area, reads as follows: "bunds having a capacity which can contain at least 110% of the maximum contents of the waste storage facility. Where more than one container or tank is stored, the bund must be capable of storing at least 110% of the largest tank or 25% of the total storage capacity, whichever is greater (in the case of drums the tray or bund size must be at least 25% of total storage capacity)."

4.3.6 Monitoring and management

Monitoring and management are key to the success of a SWMP. The following are therefore included as a key aspect of SWMP:

- Frequent inspections until the success of the design and any unexpected problems are resolved/confirmed;
- Review of the plan after a few years to improve, where possible, its practicality, cost-effectiveness or efficacy;
- Alerts that do not rely on a fulltime environmental manager on site (which may not be feasible) including:
    - Automatic alert systems for the wastewater conservancy tank (e.g. a float driven switch alert system);
    - Brief, annual refresher training that should not take more than half an hour of time for each staff member;
    - Well placed signs that reminds staff members of reporting of incident / issues as soon as possible and reduce the likelihood that forgetfulness or confusion will prevent reporting.

5 Stormwater, wastewater and erosion management plan (SWMP)

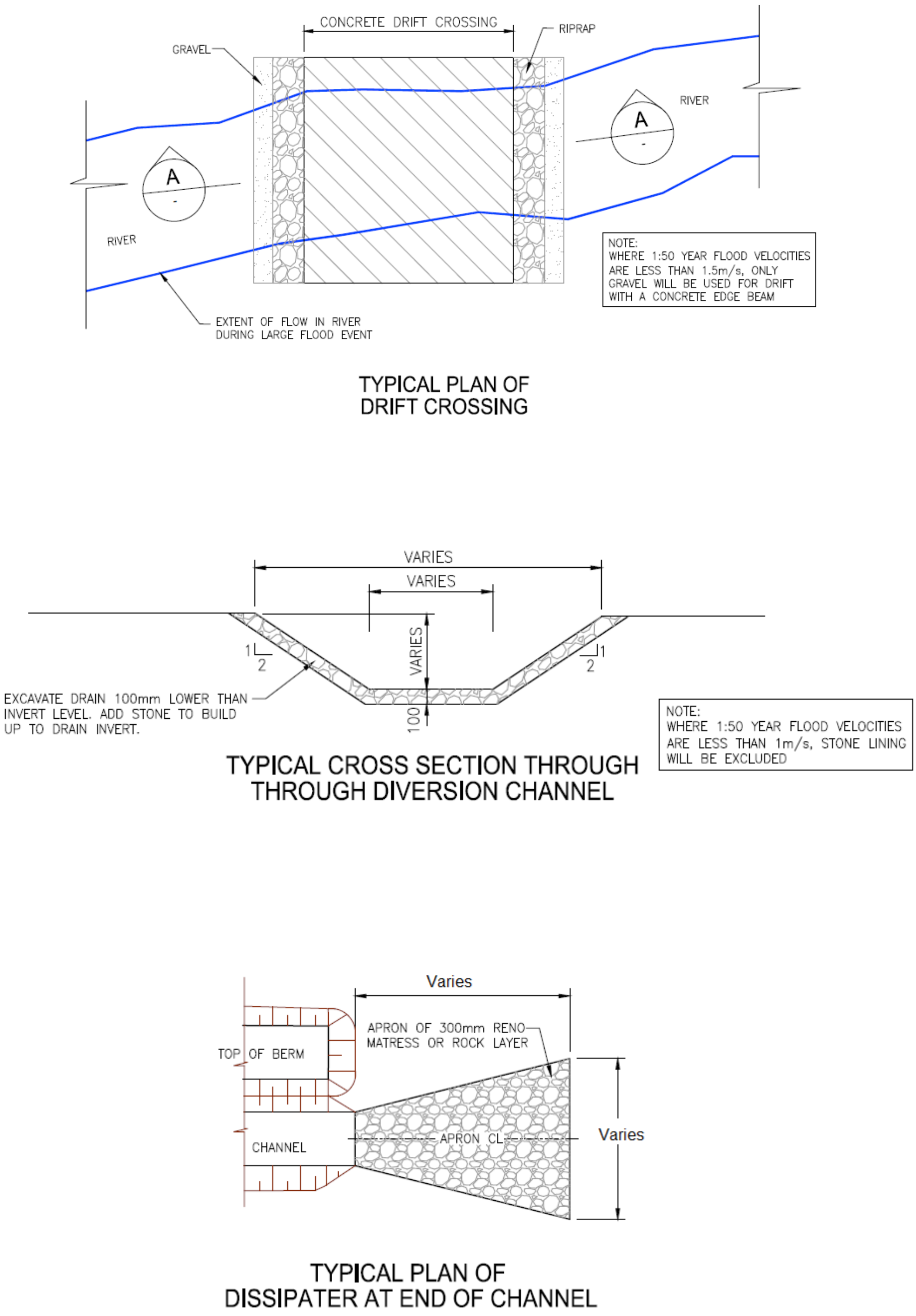
The SWMP, including waste water management, is summarised in Table 5-1 and Figure 5-1 with supporting information and discussions of alternatives, where relevant, is provided in Section 3 and Section 4.

Table 5-1: Construction and Operations / Maintenance SWMP of McTaggarts PV3

General principle	Specific objective	Ref No.	Focus area	Action	When	By whom
Separate clean- and dirty water to ensure clean water remains uncontaminated	Temporary containments and diversion (designed for a 1 in 5-year event)	1	Stockpiles Laydown areas Workshops Any other area likely to generate sediment during a storm event or contain contaminants that can be disbursed	Clean water diversions: Excavate clean water diversion channel to direct clean runoff around dirty areas. Channel to be sized for 1 in 5-year event. Typical design will be an excavated earth channel or berms.	During contractors site establishment	Construction contractor's **onsite environmental officer/representative**
	Permanent containments and diversions (designed for a 1 in 50-year event)	2	The workshop The waste water conservancy tank Transformers	Clean water diversions or bunds: Construct stormwater drains or bunds to divert clean runoff around the workshop, chemical stores, transformers and wastewater conservancy tank. The bund or diversion should be designed for a 1 in 50-year event.	Constructed prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
Collect and, where required, treat dirty water or runoff from any dirty areas.	Dirty water should not have the potential to spill into clean water systems more than once every fifty years (where influenced by stormwater)	3	Stockpiles	**Construct silt fences or berms:** to prevent the sediment transport into rivers.	Before stockpiles are deposited	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		4	Waste	**Dispose of landfill, oils and other contaminants offsite**	Throughout construction	
		5	Sewage	**Supply chemical toilets**	During site establishment	
		6	Workshop	**Workshop collection drain with oil and grease trap:** Construct a small concrete drain collecting all water, potentially containing oils and lubricants, from workshop floor and directing it through an oil and grease trap before discharge (or removing to offsite facility). Floor to be sloped such that all water will collect in drains.	Constructed prior to operation	
		7	Workshop	**Clean the oil and grease trap:** the oil and grease trap are to be inspected and, when necessary, cleaned and waste taken to offsite facility	Inspect every 3 months for first 2 years and then revise	**Workshop manager** and assurance by **environmental manager**
		8	Transformers	**Dispose of transformer oil offsite:** Dispose of any oil removed from transformers during maintenance to a registered facility	Constructed prior to operation	
		9	The sewage conservancy tank	**Transport sewage to municipal works:** Collect sewage in a conservancy tank that will regularly be emptied and disposed of at a licensed municipal sewage treatment plant.	As required when the tank is full	
	Bund any hazardous substance or pollutant storage areas (including any oils) as per regulations	10	General	Construct **temporary bunds for any chemicals** such as oils or fuel stored on sited during construction. Bunds must contain at least 100% of the volume of the container. If all containers are stored together the bund must store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the material of bund must be investigated whenever a new substance is added to the bund	Throughout construction	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		11	Transformers	**Transformer bunds:** All transformers will be bunded with bund capacity of at least 110% of the maximum volume of oil in the transformer. Transformers and bund will be protected from rainfall by small covers or roof or housing in containers.	Constructed prior to operation	
		12	The sewage conservancy tank	**Sewage conservancy bund:** The sewage conservancy tank will be a closed tank with an automatic alert system.		
		13	Workshop	**Small trays for workshop chemicals:** Bund any containers with oils and lubricants by placing them in plastic trays that is at least 100% of the volume of the container If all containers are stored together the bund will store at least 110% of the largest container or 25% of the total storage capacity, whichever is greater. Suitability of the bund must be investigated whenever a new substance is added to the bund.	During operation: as and when containers are purchased	**Workshop manager** and assurance by **environmental manager**
Do not impede surface and subsurface flow along drainage lines	Minimise dirty areas such that surface and subsurface movement of water along the drainage lines is not impeded	14	The workshop, transformers, waste water conservancy tank	**Diversion channels placed to minimised dirty areas:** Place diversion channels directly beside dirty areas such that dirty areas are minimised in footprint	Constructed prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		15	Laydown areas Stockpiles	**Minimise laydown areas and stock piles**.	Throughout construction	
	Ensure any engineered clean stormwater drainage directs water to the naturally receiving drainage line	16	All drains	Ensure that any temporary **stormwater drains** or diversion berms direct water **towards the drainage line to which it would naturally flow**		
		17	Along roads, the workshop, transformers, waste water conservancy tank	**Drains to follow natural topography:** Ensure outlets drain towards the natural drainage line that would originally have received flow from that area	Constructed prior to operation	

Control, monitor and manage erosion	Prevent erosion in general	18	All areas	**Maintain natural topography:** Do not disturb the natural topography or vegetation between the solar panel installations	Constructed prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		19		**No stockpiles if possible:** Do not stockpile (during operation). If spoil from pilings is likely to be significant, a dedicated stockpile location must be identified, and stormwater protection measures designed when detailed layouts are available.	During operation	Assurance by **environmental manager**
	Minimize erosion in large storm event of 1 in 50 years or greater	20	All drains	**Engineer low velocity drains:** Drains sloped and sized such that velocities do no exceed 1 m/s	Constructed prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		21	Road crossings	**Engineered drifts:** Line all major drifts on road crossings with concrete to protect from traffic damage and high flow velocities (For smaller drifts gravel might suffice). Place a section of rip-rap (larger rocks) underlain by gravel and with gravel on either side to facilitate a smooth flow transition. Detailed modelling and design of road crossings such that erosion is controlled to be a feature of the detailed design.		
	Dissipate stormwater at all drainage outlets to velocities unlikely to cause erosion in natural soils for a 1 in 50-year storm event	22	All drains	**Dissipaters:** At drain outlets widen the channel and use rip-rap (can be sourced from spoil during construction) or reno mattresses to dissipate stormwater flows		
		23	Road crossings	**Dissipation at road crossings:** Detailed modelling and design of road crossings including rip-rap (can potentially be sourced from spoil during construction) or reno-mattresses.		
	Prevent erosion in general	24	All	**Maintain natural topography and vegetation:** Do not disturb the natural topography or vegetation where possible	Throughout construction	Construction contractors **onsite environmental officer/representative**
	Minimize erosion in large storm event of 1 in 5 years or greater	25	All drains	**Engineer low velocity temporary drains:** Drains sloped and sized such that velocities do no exceed 1 m/s in a 1 in 5-year event		
		26	Road crossings	**Engineered temporary drifts:** Build roads and road crossings before other infrastructure.	Early in construction	
	Ensure that any chronic erosion is detected and rehabilitated within 6 months	27	PV cell blocks Drains Outlet of all Drains All-Natural drainage lines that cross the access road	**Inspect and remediate noticeable erosion:** Inspect all focus areas for erosion. If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment and determine the cause. Develop a plan to prevent future erosion.	Every 3 months for the first 2 years and annually thereafter	**Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager
	Ensure that any acute erosion due to large storm events is detected within two weeks.	28	Main office	**Install a rain gauge** that can measure greater than 115 mm (100-year, 24-hour event)	Install prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		29	All-natural drainage lines that run through the site	**Inspect and remediate acute erosion:** Inspect all focus areas for erosion. If erosion is found remediate and redesign the drainage in the area. If erosion is found in a natural drainage line conduct and assessment and determine the cause and develop a plan to prevent future erosion.	After a rain event of greater than 65 mm in one day (a 10-year rain event) or when staff notice flood damage.	**Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager
		30	All	**Set up rain data system:** Build or buy a basic rain program, preferably electronic, that allows site staff to enter rain data from the rain gauge. Ideally the system should alert the environmental manager and site manager when a rainfall event in excess of 65 mm per day is entered.	Design and development prior to operation	
		31	Main office	**Record rain data:** Read and record rain gauge daily;	Daily	Onsite staff member tasked by the **Environmental manager**
		32		**Signs at main office to aid problem reporting:** Ensure that a sign providing the following is posed in the reception area, the control room, on each transformer and in the workshop: The name, telephone number and email address of the environmental manager. The sign should state: "If you notice any leaks or spills or erosion anywhere on the property please phone or email the environmental manager on ……."	Update annually in case of staff change	**Environmental manager**

	Training	33	All	**Training:** Provide a short briefing to all construction staff on the dynamics of erosion and leaks that covers at least: How to identify erosion; How to identify a leak, including car leaks; Where to find contact details of the environmental officer/representative in case of leaks or erosion.	Annually	**Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager
	Ensure that any erosion is detected and rehabilitated	34		**Inspect the site for erosion after rain events.** If erosion is found, remediate and redesign the drainage in the area. If erosion is found in a natural drainage line, conduct an assessment to determine the cause and develop a plan to prevent future erosion.	After rain events	**Contractors environmental officer/representative**
		35		**Install a rain gauge** that can measure greater than 115 mm (100-year, 24-hour event). This rain gauge will also be used during operation.	During site establishment	
Monitor and manage stormwater system	Include a monitoring system for spills and leaks such that they are detected as soon as possible.	36	All	**Leak inspection:** regularly check for leaks and for any breaches or evidence of spills or any other problems not in adherence to this SWMP. All cars should also be checked for oil leaks and any leaks found should be stopped immediately, the cause of the leak identified, the problem remediated such that no further leaks occur and any contaminated soil or water assessed and remediated.	Once every two weeks	**Contractors environmental officer/representative**
	Include a monitoring system for spills and leaks such that they are detected as soon as possible.	37		**Leak inspection:** regularly check for leaks and for any breaches or evidence of spills or any other problems that would indicate that it is not in adherence to this plan. All cars should also be checked for oil leaks during the inspection. Any leaks found should be stopped immediately, the cause of the leak sought, the problem remediated such that no further leaks occur and any contaminated soil or water assessed and remediated.	Every 3 months for the first 2 years and annually thereafter	**Environmental manager** or hydrologist/engineer/environmental scientist appointed by the environmental manager
		38		**Data capture, training and signs:** see 33, 34, 35, 36, 37 & 38	Continuous	**Environmental manager** and staff in general
		39	The sewage conservancy tank	**Sewage conservancy tank alert system:** Install a float switch-controlled alarm that will alert the control room when the conservancy tank has less than 2 weeks of capacity remaining.	Construct prior to operation	Included in detailed designs of **design engineer** and carried out by contractor appointed for construction
		40	Transformers	**Signs at transformers:** Post a sign on transformers stating "If you notice any leaks or spills or erosion anywhere on the property please phone reception on ……and report it"		
General	Do not build infrastructure within near to watercourses	41	All	Ensure no infrastructure except roads, solar panels and solar panel supports are built within 300 metres of a water course. In particular, ensure no dirty areas, that may contain pollutants, are within 300 metres of the water course	Detailed design	Design engineer or engineer appointed by the design engineer
	Do not build infrastructure containing potential pollutants in any of the natural drainage lines.	42		Ensure that final infrastructure plans **do not** propose **any potentially polluting infrastructure, such as transformers, workshops or conservancy tanks in the natural drainage** lines (currently none are proposed)		
	Review and improve stormwater management plan regularly.	43		**Review and improve** the stormwater plan	Once every 5 years	**Environmental manager** or engineer appointed by the environmental manager
	Review and inspect	44		**Inspect the site to ensure adherence to the stormwater management plan**	Once every two months depending on the construction schedule	**Clients environmental representative or Engineer**
	Do not place stockpiles or other potentially polluting construction items within 300 metres of the watercourse	45		**Do not place laydown areas, stockpiles** within 300 metres of the watercourse	Detailed design and throughout construction	**Design engineer** or engineer appointed by the design engineer
	Do not allow pollutants within 300 metres of a water course	46		**Do not place laydown areas, stockpiles** or any other materials or equipment within 300 metres of the watercourse	Throughout construction	**Design engineer** or engineer appointed by the design engineer
	General	47		Develop a specific **environmental specification for any construction** including, but not limited to, the actions in this stormwater management plan and its principles	Detailed design	**Clients environmental representative or specialist**



srk consulting	**MCTAGGARTS PV3 SWMP** Typical conceptual designs of stormwater infrastructure (to be confirmed in detailed design)	Project No. 550146

Figure 5-1: Typical conceptual designs of stormwater infrastructure

6 Conclusions and Recommendations

In conclusion:

- The proposed facility will have an intrinsically low impact on surface water resources;
- The potential stormwater impacts that do exist can be managed in a practical and cost-effective way;
- The plan is conceptual because no detailed contour data is available and only conceptual infrastructure layouts were made available at the time of the study.

It is recommended that the SWMP be developed further during detailed design by:

- Conducting a detailed topographic survey;
- Delineating floodlines for major rivers and assessing any safety requirements due to flooding;
- Developing a stormwater layout and conceptual designs based on the above information and infrastructure layout plan;
- Sizing the culverts or drifts associated with the proposed road crossings such that it can handle at least the 1:20 year flood event;
- Developing conceptual designs into detailed designs with sufficient detail to support construction; and,
- The plan should be incorporated into an environmental specification for use during construction and incorporated into the operational environmental management of the site.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

7 References

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