

MOOI MGENI TRANSFER SCHEME PHASE 2 (MMTS-2)

CONTRACT TCTA 04-041
CONSULTING SERVICES FOR MMTS-2

Potential Impact of Overflows
from the Gowrie Break Pressure Tank
on Dam Wall Structures and Other
Existing Infrastructure along the Mpofana
River between Nottingham Road
and Beacons Vlei Dam

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EXECUTIVE SUMMARY

This document reports the findings and recommendations regarding the Potential Impact of Overflows from the Gowrie Break Pressure Tank on Dam Wall Structures and Other Existing Infrastructure along the along an unnamed tributary of the Mpofana River (unnamed river) between Nottingham Road and Beacons Vlei Dam.

Land owners along the reach of the unnamed river between Nottingham Road and the Beacons Vlei Dam are concerned about the impact of overflows from the Break Pressure Tank (BPT) at Gowrie on their dam wall structures and properties along this reach of the unnamed river. Overflows from the Gowrie BPT could occur in the event when the telemetry on the Spring Grove Dam Mpofana Pipeline System fails and the pumps in the Spring Grove Dam Pump Station do not shut down when the valves are closed at Mpofana River Outfall.

This study was conducted for the most extreme scenario, which is for an overflow of 7.70 m³/s from the Gowrie BPT. The following were assessed in terms of dams and existing infrastructure along the reach of the unnamed river, between Nottingham Road and Beacons Vlei Dam:

- *Seven (7) dams, and*
- *Two (2) sites where significant infrastructure occurs, at Laughing Waters and the Zenzani Village about 1km downstream of Greendoch Dam (Farm Dam 6) respectively.*

*The localities of the identified dams and infrastructure are shown on the Locality Map in **ANNEXURE***

***A.** The following tasks were performed for the purposes of this study:*

- *Confirmation of the number of dams and existing infrastructure along the unnamed river between Nottingham Road and Beacons Vlei Dam;*
- *Site visits to the affected farm dams;*
- *Surveys of the affected farm dams;*
- *Assessment of each farm dam's spillway capacity;*
- *Assessment of the peak discharges at Laughing Waters and Zenzani Village;*
- *Reporting*

A detailed flood frequency analysis was performed for Beacons Vlei Dam, which is the last farm dam along the unnamed river that will be impacted upon by overflows from the Gowrie BPT. The

recommended peak discharges at the other farm dams, as well as at the Laughing Waters and Zenzani Village Sites, are based upon the recommended peak discharges at Beacons Vlei Dam.

The classifications of the affected farm dams, in terms of the Dam Safety Legislation, were obtained from the Department of Water Affairs Dam Safety Office for the purposes of the assessment of each of the dams. The assessment of each of the affected farm dams was only a cursory assessment, and any detailed assessment of any of these dams remain the responsibility of the dam owner. A summary of the Department of Water Affairs classifications of the affected farm dams are given in **Table (i)** below.

Table (i): Summary of the Department of Water Affairs' Classifications of the Affected Farm Dams

<i>Dam Description</i>	<i>Dam Type</i>	<i>Estimated Capacity (m³)</i>	<i>Classification in terms of Maximum Wall Height</i>	<i>Category</i>
<i>Farm Dam 1</i>	<i>Earth Fill</i>	<i>16 000</i>	<i>Small</i>	<i>Registration not Required</i>
<i>Farm Dam 2</i>	<i>Earth Fill</i>	<i>120 000</i>	<i>Small</i>	<i>Needs to be Registered</i>
<i>Farm Dam 3</i>	<i>Earth Fill</i>	<i>38 000</i>	<i>Small</i>	<i>Registration not Required</i>
<i>Farm Dam 4</i>	<i>Earth Fill</i>	<i>19 000</i>	<i>Small</i>	<i>Registration not Required</i>
<i>Farm Dam 5</i>	<i>Earth Fill</i>	<i>28 000</i>	<i>Small</i>	<i>Registration not Required</i>
<i>Farm Dam 6 (Greendoch)</i>	<i>Earth Fill</i>	<i>100 000</i>	<i>Small</i>	<i>Category 1</i>
<i>Farm Dam 7 (Beacons Vlei)</i>	<i>Earth Fill</i>	<i>650 000</i>	<i>Small</i>	<i>Category 2</i>

The affected farm dams were assessed in terms of the following:

- Classification in terms of their Dam Safety Classifications, see **Table (i)**;
- Recommended peak discharge for each dam;
- Overflow of 7.70 m³/s from the Gowrie BPT, and
- Spillway capacities.

The affected Laughing Waters and Zenzani Village Sites were assessed in terms of the following:

- *Recommended peak discharge at each site, and*
- *Overflow of 7.70 m³/s from the Gowrie BPT.*

For the farm dams it was found that:

- *Farm Dam 1 and 7 spillways have adequate capacity and will not be impacted upon negatively by overflows from the Gowrie BPT, and no modifications to these dams will be required by the TCTA.*
- *Farm Dam 2 needs to be registered in terms of the Dam Safety Legislation since its estimated storage capacity exceeds 50 000 m³. This dam seems not to comply with the relevant Dam Safety Regulations from various points of views. It is also a concern that Farm Dam 2 is unable to accommodate even its peak discharge for the 1:2 year recurrence interval.*
- *Farm Dams 3, 4 and 5 do not require registration in terms of the Dam Safety Legislation since each these dams estimated storage capacity is less than 50 000 m³. It is however a concern that Farm Dams 4 and 5 are unable to accommodate their own respective peak discharges for the 1:2 year recurrence interval.*
- *Farm Dam 6 spillway has inadequate capacity and will be impacted upon negatively by overflows from the Gowrie BPT. This dam seems not to comply with the relevant Dam Safety Regulations from various points of views. It is also a concern that Farm Dam 6 is unable to accommodate its peak discharge for the 1:2 year recurrence interval.*

It is recommended that TCTA modifies the spillways of Farm Dams 2, 3, 4, 5 and 6 to ensure that these dams will not overtop when 7.70 m³/s overflows from the Gowrie BPT.

For the Laughing Waters and Zenzani Village Sites it was found that the 7.70 m³/s BPT overflow alone will not affect these two sites since the BPT overflow is much lower than the respective 1:50 year flood peak discharges at these two sites. If the 1:50 year flood and a BPT overflow occur concurrently, resulting in peak discharges greater than the 1:50 year recurrence interval peak discharges, then the BPT overflows could have an impact on buildings and infrastructure at these two sites. The probability for this scenario to occur is however negligible.

For the farm dams it is recommended that TCTA:

- *Constructs spillways for Farm Dams 2, 4, 5 and 6 that will ensure that these dams will not overtop when 7.70 m³/s overflows from the Gowrie BPT.*

- *Improves the spillways for Farm Dam 3 as such to ensure that the dam will not overtop when 7.70 m³/s overflows from the Gowrie BPT in conjunction with the 1:2 year flood.*

The design of the recommended mitigation measures for Farms Dams 2, 3, 4, 5 and 6, in order to accommodate the overflows from the Gowrie BPT, is however beyond the scope of this study.

In terms of the farm dams it should be noted that:

- *This was only a cursory assessment for each farm dam and the detailed assessment of each remains the dam owner's responsibility.*
- *This report is not a Dam Safety Report for any of the farm dams.*
- *The Dam Safety Inspection for each of the farm dams, where applicable, remains the responsibility of each dam owner. Classified dams must be handled by an Approved Professional Person (APP).*

The Laughing Waters and Zenzani Village Sites will not be impacted upon by overflows from the BPT, provided that all buildings and infrastructure are constructed above the 1:50 year flood line.

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INTRODUCTION

Land owners along the reach of the unnamed river between Nottingham Road and the Beacons Vlei Dam are concerned about the impact of overflows from the Break Pressure Tank (BPT) at Gowrie on their dam wall structures and properties along this reach of the unnamed river. Overflows from the Gowrie BPT can for instance occur in the event when the telemetry on the Spring Grove Dam to Mpofana Pipeline System fails and the pumps in the Spring Grove Dam Pump Station don't shut down when the valves are closed at Mpofana River Outfall. If the Mearns Pump Station and Pipeline System are also taken into account, then there are three possible overflow scenarios from the Gowrie BPT, namely:

- A flow rate of $4.50 \text{ m}^3/\text{s}$ which is being pumped from Spring Grove Dam Pump Station, which will result in an overflow of $4.50 \text{ m}^3/\text{s}$ from the BPT;
- A flow rate of $3.20 \text{ m}^3/\text{s}$ which is being pumped from Mearns Pump Station, which will result in an overflow of $3.20 \text{ m}^3/\text{s}$ from the BPT, and
- A flow rate of $4.50 \text{ m}^3/\text{s}$, which is being pumped from Spring Grove Dam Pump Station, as well as a flow rate of $3.20 \text{ m}^3/\text{s}$ which is being pumped from Mearns Pump Station, which will result in an overflow of $7.70 \text{ m}^3/\text{s}$.

This study was conducted for the most extreme scenario, which is an overflow of $7.70 \text{ m}^3/\text{s}$ from the Gowrie BPT. The following were identified in terms of dams and existing infrastructure along the reach of the unnamed river, between Nottingham Road and Beacons Vlei Dam:

- Seven (7) dams, and
- Two (2) sites where there is significant infrastructure at Laughing Waters and the Zenzani Village about 1km downstream of Greendoch Dam (Farm Dam 6) respectively.

The localities of the identified dams and infrastructure are shown on the Locality Map in **ANNEXURE A**, and the co-ordinates of each dam are given in **Table 1**. The following tasks were performed for the purposes of this study:

- Confirmation of the number of dams and existing infrastructure along the Unnamed river between Nottingham Road and Beacons Vlei Dam;
- Site visits to the affected farm dams;
- Surveys of the affected farm dams;

- Assessment of each farm dam's spillway capacity;
- Assessment of the peak discharges at Laughing Waters and Zenzani Village;
- Reporting

Table 1: Co-ordinates of Farm Dams and Infrastructure

Description (see Annexure A)	Latitude	Longitude
Farm Dam 1	29°21'36.21"S	30°00'09.31"E
Farm Dam 2	29°21'41.50"S	30°00'20.88"E
Farm Dam 3	29°21'55.62"S	30°01'32.41"E
Farm Dam 4	29°21'53.20"S	30°01'35.53"E
Farm Dam 5	29°21'51.11"S	30°01'39.23"E
Farm Dam 6 (Greendoch Dam)	29°22'15.66"S	30°01'50.47"E
Farm Dam 7 (Beacons Vlei Dam)	29°23'05.58"S	30°03'26.58"E
Laughing Waters	29°22'14.99"S	30°00'58.49"E
Zenzani Village	29°22'44.23"S	30°01'49.52"E

1.

2. REPORT STRUCTURE

This report is structured as follows:

- Section 1 – Introduction
- Section 2 – Report Structure
- Section 3 – Limitations and Assumptions
- Section 4 – Flood Hydrology for Farm Dams
- Section 5 - Flood Hydrology for Laughing Waters and Zenzani Village Sites
- Section 6 – Classification of Affected Farm Dams
- Section 7 – Assessment of the Affected Farm Dams
- Section 8 – Assessment of the Laughing Waters and Zenzani Village Sites
- Section 9 – Findings
- Section 10 – Conclusions
- Section 11 – Recommendations
- Section 12 – References
- ANNEXURE A – Locality Map
- ANNEXURE B – Survey Data for the Farm Dams
- ANNEXURE C - Photographs of the Farm Dams
- ANNEXURE D - Correspondence with the DWA's Dam Safety Office

3. LIMITATIONS AND ASSUMPTIONS

The key limitations in terms of this study were the following:

- Available information and methods to estimate peak discharges discussed in more detail under **Section 4** of this report;
- The shapes of the free overflow spillways of the farms dams discussed in more detail under **Section 7** of this report;
- Potential economic impacts and loss of life in case of dam breaks in order to assign dam categories to the farm dams in terms of the relevant Dam Safety Legislation.

The key assumptions for the purposes of this study were the following:

- The free overflow spillways of the farm dams were assumed to be trapezoidal by-wash type spillways in order to apply the Department of Water Affairs' (DWAs') formula for flow over a trapezoidal spillway, and
- Inlet control for a round culvert with a slope of 1:100 was assumed for those cases where the spillways consist of a pipe, which are discussed in more detail under **Section 7** of this report.

4. FLOOD HYDROLOGY FOR FARM DAMS

4.1 APPROACH

A detailed flood frequency analysis was performed for Beacons Vlei Dam, the last farm dam along the unnamed river that will be impacted upon by overflows from the Gowrie BPT. The recommended peak discharges at the other farm dams are derived from the recommended peak discharges at Beacons Vlei Dam. For the available data the following Deterministic Methods were applied for Beacons Vlei Dam:

- The Rational Method (for comparison purposes only);
- The Alternative Rational Method;
- The Standard Design Flood (SDF) Method;
- The TR 137 Method for the calculation of the Regional Maximum Flood (RMF).

Statistical Analysis was also applied for the Flow Gauging Weir at Weltevreden (DWA Station Number U2H007) on the Lions River for the available 60 year flow record. This Gauging Weir has a catchment area of 358 km² and the Beacons Vlei Dam's catchment is 41.15 km². The results of the Statistical Methods for Beacons Vlei Dam are based upon the Statistical Results for the Gauging Weir and were calculated with the following equation for the different Statistical Methods and estimated peak discharges:

$$\frac{Q_1}{Q_2} = \sqrt{\frac{A_1}{A_2}} \text{ where}$$

$Q_1 = \text{Estimated Peak Discharge at Beacons Vlei Dam}$

$Q_2 = \text{Estimated peak Discharge at Gauging Weir}$

$A_1 = 41.15 \text{ km}^2 \text{ (Beacons Vlei Dam's Catchment Area)}$

$A_2 = 358 \text{ km}^2 \text{ (Gauging Weir's Catchment Area)}$

For the available 60 year flow record at the Gauging Weir the following Statistical Methods were applied:

- Log Normal (LN);
- Log Extreme Value (LEV);

- Log Pearson Type 3 (LP3);
- Extreme Value Type 1 (EV1).

Since Beacons Vlei Dam, as well as the upstream affected farm dams, are all located within Midmar Dam's Catchment the results of the Deterministic and Statistical Methods were also compared with the Department of Water Affairs (DWA's) latest recommended peak discharges (2010) for Midmar Dam in order to assess the results of the Deterministic and Statistical Methods. The results and assessment of the results for Beacons Vlei Dam is discussed in more detail in **Sections 4.2** and **4.3** of this report.

4.2 RESULTS

The results of the Deterministic and Statistical Methods for Beacons Vlei Dam is summarised in **Table 2**. The assessment of these results is discussed in **Section 4.3** of this report.

Table 2: Summary of Results of Deterministic and Statistical Methods for Beacons Vlei Dam

Method	Return Period (years)							
	2	5	10	20	50	100	200	RMF
	Estimated Peak Discharges (m ³ /s)							
Rational (for comparison purposes only)	68	96	127	180	248	346	426	-
Alternative Rational	48	88	123	176	231	302	342	-
SDF	14	81	146	220	333	429	532	-
TR 137	-	-	-	-	329	419	518	802
Statistical LN	6	-	20	28	43	56	72	-
Statistical LEV1	5	-	20	36	73	125	213	-
Statistical LP3	5	-	21	32	53	74	104	-
Statistical EV1	7	-	32	42	54	63	73	-
DWA 2010 – Recommended for Midmar Dam for 1xT_c	95	190	270	365	515	645	795	3050

4.3 ASSESSMENT OF RESULTS

If the results of the Deterministic and Statistical Methods for Beacons Vlei Dam, which have a catchment of 41.15 km², are compared with the DWA's recommended peak discharges for Midmar Dam, which has a catchment of 925 km², then the results of the Deterministic Methods appear to be very conservative for Beacons Vlei Dam. The results yielded by the

Statistical Methods however seem to be more realistic for Beacons Vlei Dam. In the light of this the results of the Deterministic Methods were disregarded and the peak discharges at Beacons Vlei Dam were further assessed in terms of DWA's recommended peak discharges for Midmar Dam. The results of this assessment is summarised in **Table 3**.

Table 3: Assessment of Peak Discharges for Beacons Vlei Dam in terms of the Recommended Peak Discharges for Midmar Dam

Method	Return Period (years)							
	2	5	10	20	50	100	200	RMF
	Estimated Peak Discharges (m ³ /s)							
Based on Midmar Dam's Peaks of Square Root of Catchment Areas of Midmar and Beacons Vlei Dams	20	40	57	77	109	136	168	-
Based on Midmar RMF Ratio of Return Periods for Midmar Dam	25	50	71	96	135	170	209	-
TR 137 (RMF)	-	-	-	-	-	-	-	802
DWA 2010 – Recommended for Midmar Dam for 1xT_c	95	190	270	365	515	645	795	3050

The estimated peak discharges for Beacons Vlei Dam in terms of the recommended peak discharges are more realistic than those estimated with the Deterministic Methods. Based on the results of this assessment, in terms of the recommended peak discharges for Midmar Dam, the results yielded by the Statistical Methods for Beacons Vlei Dam appears to underestimate the peak discharges at Beacons Vlei Dam. The results for Beacons Vlei Dam that are based on the RMF Ratio of Midmar Dam's return periods are the more conservative results and are the recommended peak discharges for Beacons Vlei Dam, as summarised in **Table 4**.

Table 4: Recommended Peak Discharges for Beacons Vlei Dam

Return Period (years)							
2	5	10	20	50	100	200	RMF
Recommended Peak Discharges for Beacons Vlei Dam (m ³ /s)							
25.0	49.9	71.0	95.9	135.4	169.5	209.0	801.8

4.4 RECOMMENDED PEAK DISCHARGES FOR THE FARM DAMS

The RMF for each one of the farm dams upstream of Beacons Vlei Dam were also calculated with the TR 137 Method and the recommended peak discharges at all the farm dams are

also based upon the RMF Ratio of Midmar and each one of the upstream dams. The recommended peak discharges for each one of the farm dams is summarised in **Table 5**. All the farm dams were assessed in terms of these recommended peak discharges.

Table 5: Recommended Peak Discharges for all the Affected Farm Dams

Description	Catchment Area	Return Period (years)							
		2	5	10	20	50	100	200	RMF
	(km ²)	Recommended Peak Discharges for each Affected Farm Dam (m ³ /s)							
Farm Dam 1	0.73	2.6	5.2	7.4	10.1	14.2	17.8	21.9	84.0
Farm Dam 2	1.42	3.8	7.6	10.8	14.5	20.5	25.7	31.7	121.5
Farm Dams 3, 4 & 5	8.46	10.3	20.6	29.3	39.6	55.8	69.9	86.1	330.5
Farm Dam 6 – Greendoch Dam	14.89	14.1	28.3	40.2	54.3	76.6	96.0	118.3	453.8
Farm Dam 7 - Beacons Vlei Dam	41.15	25.0	49.9	71.0	95.9	135.4	169.5	209.0	801.8
DWA 2010 - Midmar Dam for T_c	925.00	95	190	270	365	515	645	795	3050
RMF Ratios for Midmar Dam	-	0.031	0.062	0.088	0.120	0.169	0.211	0.261	-

4.5 SAFETY EVALUATION FLOODS FOR THE FARM DAMS

The DWA's recommended Safety Evaluation Flood (SEF) for Midmar Dam is Midmar Dam's RMF, but the SEFs for the affected farm dams were calculated according to the relevant SANCOLD Guidelines. The estimated SEFs for the farm dams are summarised in **Table 6**.

Table 6: Estimated SEFs for affected Farm Dams in terms of the SANCOLD Guidelines

Dam Description	Classification in Terms of Maximum Wall Height	Category	Recommended SEF in terms of SANCOLD Guidelines	Estimated SEF (m ³ /s)
Farm Dam 1	Small	N/A	N/A	N/A
Farm Dam 2	Small	Needs to be Registered	TBC	119
Farm Dam 3	Small	N/A	N/A	N/A
Farm Dam 4	Small	N/A	N/A	N/A
Farm Dam 5	Small	N/A	N/A	N/A
Farm Dam 6 (Greendoch)	Small	Category 1	RMF _Δ	386
Farm Dam 7 (Beacons Vlei)	Small	Category 2	RMF	802

5. FLOOD HYDROLOGY FOR LAUGHING WATERS AND ZENZANI VILLAGE SITES

The same approach that was adopted to estimate the peak discharges at the farm dams was followed to estimate the peak discharges at Laughing Waters and Zenzani Village, which is based on the ratios of the return periods and RMF for Midmar Dam. The recommended peak discharges for the Laughing Waters and Zenzani Village Sites are summarised in **Table 7**. These two sites were assessed in terms of these recommended peak discharges.

Table 7: Recommended Peak Discharges at the Laughing Waters and Zenzani Village Sites

Description	Catchment Area	Return Period (years)							
		2	5	10	20	50	100	200	RMF
	(km ²)	Recommended Peak Discharges at each Site (m ³ /s)							
Laughing Waters	16.60	14.95	29.90	42.44	57.87	81.51	101.76	125.88	482.29
Zenzani Village	5.12	7.74	15.47	21.92	29.95	42.18	52.66	65.14	249.57
DWA 2010 - Midmar Dam for T_c	925.00	95	190	270	365	515	645	795	3050
RMF Ratios for Midmar Dam	-	0.031	0.062	0.088	0.120	0.169	0.211	0.261	-

6. CLASSIFICATION OF THE AFFECTED FARM DAMS

A summary of the classification of the affected farm dams are given in **Table 8**. Copies of the correspondence with the Department of Water Affairs' Dam Safety Office in this regard are attached in **ANNEXURE D**.

Table 8: Classification the Affected Farm Dams by the Department of Water Affairs

Dam Description	Dam Type	Maximum Wall Height (m)	Estimated Capacity (m ³)	Classification in Terms of Maximum Wall Height	Category	Design Flood
Farm Dam 1	Earth Fill	4.05	16 000	Small	N/A	N/A
Farm Dam 2	Earth Fill	6.63	120 000	Small	Needs to be Registered	TBC
Farm Dam 3	Earth Fill	5.42	38 000	Small	N/A	N/A
Farm Dam 4	Earth Fill	2.36	19 000	Small	N/A	N/A
Farm Dam 5	Earth Fill	3.50	28 000	Small	N/A	N/A
Farm Dam 6 (Greendoch)	Earth Fill	6.05	100 000	Small	1	1:50 year
Farm Dam 7 (Beacons Vlei)	Earth Fill	7.49	650 000	Small	2	1:100 year

A detailed analysis and assessment of any of these dams where applicable, remains the responsibility of the dam owner.

7. ASSESSMENT OF THE AFFECTED FARM DAMS

The affected farm dams were assessed in terms of the following:

- Their Dam Safety Classifications, see **Table 8** ;
- Estimated peak discharges for each dam;
- Overflow of 7.70 m³/s from the Gowrie BPT, and
- Spillway capacities.

The relevant statistics for each one of the farm dams dam are summarised in **Table 9**.

Table 9: Relevant Statistics for the Farm Dams

Statistic	Farm Dam Number						
	1	2	3	4	5	6	7
Dam Type	Earth Fill						
Category	N/A	TBC	N/A	N/A	N/A	1	2
Lowest Non Overspill Crest Level (masl)	1 429.69	1 425.15	1 344.09	1 340.01	1 338.60	1 326.41	1 261.86
Full Supply Level (masl)	1 428.08	1 424.52	1 343.74	1 338.99	1 338.28	1 325.61	1 260.04
Available Freeboard above FSL (m)	1.61	0.63	0.35	1.02	0.32	0.80	1.82
Recommended Design Flood (years)	N/A	TBC	N/A	N/A	N/A	1:50	1:100
Recommended Design Discharge (m ³ /s)	N/A	TBC	N/A	N/A	N/A	96.60	169.50
Estimated 1:2 year Peak Discharges	2.60	3.80	10.30	10.30	10.30	14.10	25.00
Estimated Maximum Spillway Capacity before dam overtop (m ³ /s)	54.47	0.48	17.40	1.04	2.06	1.56	292.12
Catchment Area (km ²)	0.73	3.79	10.30	10.30	10.30	14.14	41.15

Farm Dam 1 is the most upstream dam and is a newly constructed earth fill dam. At the time of the site visit this dam was still under construction. This Dam has a free overflow by-wash type of spillway, which have sufficient capacity to accommodate the recommended design flood together with the potential $7.70 \text{ m}^3/\text{s}$ that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will not have an impact on this dam, since the dam is capable to accommodate the BPT overflow plus its recommended design discharge. No modifications are proposed to this dam as far as impact of overflows from the Gowrie BPT is concerned.

Farm Dam 2 only has a 0.88 m diameter pipe that serves as its spillway, which has insufficient capacity to accommodate the recommended design flood or the potential $7.70 \text{ m}^3/\text{s}$ that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will overtop this dam, since the dam is not capable to accommodate the BPT overflow. According to the Department of Water Affairs this dam needs to be registered since its estimated storage capacity exceeds $50\,000 \text{ m}^3$, however, seems that this dam does not comply with the Dam Safety Regulations. It is the dam owner's responsibility to ensure that this dam is modified as such in order for it to comply with the Dam Safety Regulations. It is not TCTA's responsibility to ensure that this dam is modified in order for it to comply with the Dam Safety Regulations.

This dam should be modified by TCTA to accommodate an overflow of $7.70 \text{ m}^3/\text{s}$ from the Gowrie BPT on a "sunny day" without overtopping the dam. It is therefore recommended that TCTA constructs a spillway for this dam that will ensure the dam does not overtop when $7.70 \text{ m}^3/\text{s}$ overflows from the Gowrie BPT. The sizing and design of the proposed the proposed mitigation measures for this dam are, however, beyond the scope of this study.

It should also be noted that even with a spillway constructed by TCTA to accommodate a discharge of $7.70 \text{ m}^3/\text{s}$, this dam will still not comply with the Dam Safety Regulations. It is however the dam owner's responsibility to ensure that the dam complies with the Dam Safety Regulations as well as to construct a spillway that will accommodate the recommended design flood, which depends on the classification of this dam.

Farm Dam 3 has two free overflow by-wash type spillways, overflows from the Gowrie BPT will not overtop this dam since it is capable to accommodate the BPT overflow on a "sunny day". This dam is also able to accommodate the potential $7.70 \text{ m}^3/\text{s}$ overflow from the Gowrie BPT together with the 1:2 year flood before overtopping. This dam, however, does

not have to be registered in terms of the Dam Safety Legislation, since its estimated storage capacity is less than 50 000 m³.

This dam should, however, be modified as such by TCTA to accommodate an overflow of 7.70 m³/s from the Gowrie BPT together with the 1:2 year flood without overtopping the dam. It is recommended that TCTA improves the spillways as such to ensure that the dam does not overtop when 7.70 m³/s overflows from the Gowrie BPT in conjunction with the 1:2 year flood. The sizing and design of the proposed mitigation measures for this dam is however beyond the scope of this study.

Farm Dam 4 has a 0.88 m diameter pipe that serves as the spillway, which has insufficient capacity to accommodate the potential 7.70 m³/s that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will overtop this dam, since this dam is not capable of accommodatin the BPT overflow. This dam does not have to be registered in terms of the Dam Safety Legislation, since its estimated storage capacity is less than 50 000 m³. This dam should be modified by TCTA to accommodate an overflow of 7.70 m³/s from the Gowrie BPT on a “sunny day” without overtopping the dam. It is recommended that TCTA constructs a spillway for this dam that will ensure the dam does not overtop when 7.70 m³/s overflows from the Gowrie BPT. The sizing and design of the proposed mitigation measures for this dam is however beyond the scope of this study.

Farm Dam 5 has a free overflow by-wash type spillway, which has insufficient capacity to accommodate the potential 7.70 m³/s that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will overtop this dam, since this dam’s spillway is not capable to accommodate the BPT overflow on a “sunny day”. This dam, does not have to be registered in terms of the Dam Safety Legislation, since its estimated storage capacity is less than 50 000 m³.

This dam should be modified as such by TCTA to accommodate an overflow of 7.70 m³/s from the Gowrie BPT on a “sunny day” without overtopping the dam. It is recommended that TCTA constructs a spillway for this dam that will ensure the dam does not overtop when 7.70 m³/s overflows from the Gowrie BPT occurs. The sizing and design of the proposed mitigation measures for this dam is however beyond the scope of this study.

Farm Dam 6 (Greendoch Dam) has a 0.88 m diameter pipe that serves as a spillway, as well as a free overflow spillway. These spillways have insufficient capacity to accommodate the recommended design flood or the potential 7.70 m³/s that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will overtop this dam, since the dam is not capable of

accommodating the BPT overflow. This dam is classified as a Category 1 dam by the Department of Water Affairs, and it seems that this dam does not comply with the Dam Safety Regulations. It is, however, the dam owner's responsibility to ensure that this dam is modified in order for it to comply with the Dam Safety Regulations. It is however not TCTA's responsibility to ensure that this dam is modified in order for it to comply with the Dam Safety Regulations.

This dam should be modified as such by TCTA to accommodate an overflow of 7.70 m³/s from the Gowrie BPT on a "sunny day" without overtopping the dam. It is recommended that TCTA constructs a spillway for this dam to ensure the dam does not overtop when 7.70 m³/s overflows from the Gowrie BPT. The sizing and design of the proposed mitigation measures for this dam is however beyond the scope of this study.

It should also be noted that even with the improvements to the dam's spillways by the TCTA to accommodate a discharge of 7.70 m³/s this dam will still not comply with the Dam Safety Regulations. It is the dam owner's responsibility to ensure that the dam complies with the Dam Safety Regulations as well as to construct a spillway that will accommodate the recommended design flood.

Farm Dam 7 (Beacons Vlei Dam) has a free overflow by-wash type spillway, which has sufficient capacity to accommodate the recommended design flood together with the potential 7.70 m³/s that could overflow from the Gowrie BPT. Overflows from the Gowrie BPT will not have an impact on this dam, since the dam is capable to accommodate the BPT overflow plus its recommended design discharge. No modifications are proposed to this dam as far as impact of overflows from the Gowrie BPT is concerned. This dam is classified as a Category 2 dam by the Department of Water Affairs, and it seems that it complies with the Dam Safety Regulations.

For all these farm dams (1 to 7) that are discussed in this report it should be noted that:

- These assessments were y cursory assessments for each one of the farm dams.
- This report is not a Dam Safety Report for any of these dams.
- Any Dam Safety Inspections, Reports and Classifications of these dams, where applicable, remains the responsibility of each dam owner, and must be performed by an Approved Professional Person (APP).

8. ASSESSMENT OF THE LAUGHING WATERS AND ZENZANI VILLAGE SITES

The laughing waters and Zenzani Village Sites were assessed in terms of the following:

- Recommended peak discharges at each site, and
- Overflow of 7.70 m³/s from the Gowrie BPT.

All buildings and infrastructure at these two sites are supposed to be constructed above the 1:50 year flood line. The recommended peak discharge for the 1:50 year flood at Laughing Waters and Zenzani Village are 81.51 m³/s and 42.18 m³/s respectively, which is much higher than the anticipated maximum BPT overflow of 7.70 m³/s. Buildings and infrastructure at these two sites should therefore only be affected when an overflow from the BPT at Gowrie occurs concurrently, but the probability that this scenario will occur is negligible. The determining of any flood lines at the these two sites to assess whether any buildings or infrastructure are located within the 1:50 year flood lines is the responsibility of the owner in the case of Laughing Water, and in the case of Zenzani Village it is the responsibility of the Local Municipality who's area of jurisdiction includes Zenzani Village.

9. FINDINGS

For the farm dams it was found that:

- Farm Dam 1 and 7's spillways have adequate capacities and will not be impacted upon negatively by overflows from the Gowrie BPT, and no modifications to these dams will be required by TCTA.
- Farm Dam 2 needs to be registered and does not seem to comply with the relevant Dam Safety Regulations in various aspects. It is a concern that Farm Dam 2 is unable to accommodate its own peak discharge for the 1:2 year recurrence interval.
- Farm Dams 3, 4 and 5 do not require registration in terms of the Dam Safety Legislation, but it is a concern that Farm Dams 4 and 5 are also unable to accommodate their respective peak discharges for the 1:2 year recurrence interval.
- Farm Dam 6's spillway has inadequate capacity and will be impacted upon negatively by overflows from the Gowrie BPT, and does not seem to comply with various Dam Safety Regulations. It is a concern that Farm Dam 6 is unable to accommodate its peak discharge for the 1:2 year recurrence interval.

It is recommended that TCTA modifies the spillways of Farm Dams 2, 3, 4, 5 and 6 to ensure that these dams will not overtop when $7.70 \text{ m}^3/\text{s}$ overflows from the Gowrie BPT.

For the Laughing Waters and Zenzani Village Sites it was found that the maximum anticipated overflow of $7.70 \text{ m}^3/\text{s}$ from the BPT are less than the 1:50 year peak discharges at these two sites of $81.51 \text{ m}^3/\text{s}$ and $42.18 \text{ m}^3/\text{s}$ respectively for Zenzani Village and Laughing Waters. The BPT overflows could however have an impact at these two sites should the 1:50 year flood and the overflow from the BPT occur concurrently, but the probability that this scenario will occur is negligible.

10. CONCLUSIONS

For the farm dams it is concluded that:

- Farm Dams 1 and 7 will not be impacted upon negatively by overflows of up to 7.70 m³/s from the Gowrie BPT, and no modifications to these two farm dams will be required from the TCTA.
- The spillways of Farm Dams 2, 3, 4, 5 and 6 have insufficient capacity to accommodate overflows of up to 7.70 m³/s from the Gowrie BPT and modifications to these five farm dams will be required from TCTA, as per the recommendations in this report.
- Farm Dam 2 needs to be registered, since its estimated storage capacity exceeds 50 000 m³. This dam seems not to comply with the Dam Safety Regulations.

This report is by no means a dam safety report for anyone of the farm dams that were assessed for the purposes of this study.

For the Laughing Waters and Zenzani Village Sites it is concluded that buildings and infrastructure could be impacted upon if the 1:50 year flood, and BPT overflow occurs concurrently, but the probability that this scenario will occur is negligible.

11. RECOMMENDATIONS

For the farm dams it is recommended that:

- Constructs spillways for Farm Dams 2, 4, 5 and 6 that will ensure that these dams will not overtop when $7.70 \text{ m}^3/\text{s}$ overflows from the Gowrie BPT.
- Improvements to the spillways for Farm Dam 3 to ensure that the dam will not overtop when $7.70 \text{ m}^3/\text{s}$ overflows from the Gowrie BPT in conjunction with the 1:2 year flood.

No mitigation measures are required at the Laughing Waters and Zenzani Village Sites by the TCTA as far as the BPT overflows is concerned, provided the infrastructure is located above the 1:50 year flood line.

12. REFERENCES

- Department of Water Affairs, Directorate Hydrological Services, 2010, Midmar Dam Flood Frequency Analysis: Estimation of Flood Peaks for Required Probabilities, Report Number U200-R001-2010.11
- South African National Committee on Large Dams (SANCOLD), 1991, Safety Evaluation of Dams, Report No. 4, Guidelines on Safety in Relation to Floods
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