



water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

DAM SAFETY OFFICE 2010/2011 ANNUAL REPORT



**ADMINISTRATION OF THE DAM SAFETY
LEGISLATION IN TERMS OF
CHAPTER 12 OF THE NATIONAL WATER ACT,
1998 (ACT № 36 OF 1998)**

EXECUTIVE SUMMARY

The mission of the Dam Safety Office (DSO) is to promote the safety of new and existing dams with a safety risk so as to reduce the potential harm to the public, damage to property and to resource quality. The work of the DSO is enabled by Chapter 12 of the National Water Act, 1998 (Act No. 36 of 1998). This report covers the activities of the Dam Safety Office for the period 1 April 2010 to 31 March 2011.

A total of 41 dams were registered during the year bringing the total number of dams registered to date in South Africa to 4709. This includes the registration of new dams that were completed during the year, as well as of existing dams that were not registered previously. Some corrections were also made to the database.

Altogether 80 registered dams were classified, bringing the total number of registered existing dams now classified to 4366, which is 92,7% of the 4709 dams registered to date. In addition, about 16 proposed dams have also been classified, bringing the total number of classifications to 96.

Dam safety control over the construction of new dams, including alterations to existing dams, involves the evaluation of design and other reports that forms part of a licence application. A total of 25 dam safety licences were issued i.e. 14 licences to construct, 5 to alter, 4 licences to impound (commission) and 2 to abandon (decommission).

During the year a total of approximately 1156 letters were sent to dam owners to ensure compliance with dam safety legislation.

A total of 148 dam safety inspection instructions were issued to dam owners and a total of 115 dam safety inspection reports were evaluated and accepted.

A total of 52 operation and maintenance manuals with emergency preparedness plans for dams were considered and accepted.

A total of 174 applications to be approved as the Approved Professional Person for a dam safety task were considered.

To date, 3231 deficiencies at category 2 and 3 dams have been registered of which 917 (28%) have been rectified so far. Slow but steady progress was made with the upgrading of dams. Personal finances and apathy on the part of dam owners continue to be the most common stumbling blocks hampering progress with regard to the rectification of deficiencies at dams. Much time and effort were spent with owners and approved professional persons on addressing the entire spectrum of dam safety issues.

The total direct expenditure incurred in administration of the dam safety legislation at Head Office was R 4 795 000 compared to R5 444 000 in the previous reporting year, i.e. a decrease of 12%. The main reason for the decrease is because two critical vacant posts could not be filled (one specialist engineer post and one senior administrative officer post). Because of the small size of the DSO, expenditure is very sensitive to personnel fluctuations. It is believed that the benefits of the dam safety programme far outweigh the total direct expenditure.

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LIST OF ABBREVIATIONS

AAR	alkali-aggregate reaction
APP	Approved Professional Person (this has the same meaning as Approved Professional Engineer)
CMA	Catchment management agency
DSO	Dam Safety Office
DSP	Dam Safety Programme
DWA	Department of Water Affairs
ECSA	Engineering Council of South Africa
EPP	Emergency preparedness plan
H	Maximum dam wall height in metres
m	metre
m ³	cubic metres
NOC	Non-overspill crest
NWA	National Water Act (Act No. 36 of 1998)
O&M	Operation and maintenance
OMM	Operation and maintenance manual
R	Rand (South African)
RMF	Regional maximum flood
SANCOLD	South African National Committee on Large Dams
V	Storage capacity of dam in cubic metres
WARMS	Water Authorisation & Registration Management System
WMA	Water management area
WRFMC	Water Resources Functional Management Committee of DWAF
x 10 ⁶ m ³	million cubic metres
<	This sign means “less than” (e.g. H < 12 m is pronounced as “H is less than 12 metres”)

1. INTRODUCTION

The annual report covers the activities of the Department with regard to administration of the dam safety legislation (Chapter 12 of the National Water Act, 1998 (Act 36 of 1998) read together with the dam safety regulations, R .1560 of 25 July 1986) during the financial year 1 April 2010 to 31 March 2011. The annual report also serves as an auditing tool and progress with the dam safety programme can be assessed by comparing the relevant statistics with those of previous years and with targets that were set in the business plans enclosed in Appendices A and B.

The statistics included in this report reflect the position as for the current nine regions of DWAF.

2. ADMINISTRATION

Administration of the dam safety legislation is carried out jointly by the DSO and selected personnel from the regional offices.

The personnel listed below were employed by the Dam Safety Office at Head Office during the reporting year.

- Two Chief Engineers
- One Control Industrial Technician
- Two Chief Industrial Technicians
- One Deputy Director
- One Assistant Director (vacant for 4 months)
- One Senior Administrative Officer (vacant for 8 months)
- One Administrative Officer (vacant for 4 months)
- Three Senior Administrative Clerks
- Two Senior Admin Clerks doing registry clerk duties (one vacant for 4 months)
- One Senior Admin Clerk doing data capturing
- One Senior Admin Clerk doing Logistic duties

During the year a total of approximately 1156 letters were compiled by Dam Safety Administration officials. The letters are categorised as follows:

TASK	GA	FS	EC	NW	KZN	LI	MP	WC	NC	Total
Classification of dams (new/proposed)	7	2	18	0	9	2	3	16	0	57
Registration of dams/ class and reg (existing)	11	7	37	0	7	3	9	39	0	113
Licence to construct/alter	2	1	1	0	3	2	2	3	1	15
Licence to impound	0	2	0	0	2	0	1	0	0	5
Licence to abandon	0	2	0	0	0	0	0	1	0	3
Dam safety inspection instructions	1	10	21	6	27	4	11	67	1	148
Implementations of recommendations	25	8	7	1	15	3	11	24	0	94
Approval of app's & prof teams (adm)	33	8	21	0	22	11	19	41	0	155
Approval of app's & prof teams (referred to ECSA for recommendation)	5	0	5	0	5	1	2	1	0	19
General letters and reminders/warnings	25	14	36	0	29	17	12	29	1	163
Legal Actions	0	0	0	0	0	0	0	0	0	0
Directives	0	0	0	0	0	0	0	0	0	0
Exemptions	0	0	0	0	0	0	0	0	0	0
Declarations of a dam with a safety risk	0	0	0	0	0	0	0	0	0	0
Dams not a safety risk "by definition"	1	0	1	1	1	0	0	3	0	7
Letters in connection with subsidies	0	0	0	0	0	0	0	0	0	0
Letters re inspection, investigation	19	63	52	2	109	23	58	36	1	363
Letters re licences to construct (design issues)	0	0	0	0	0	0	0	0	0	0
Miscellaneous letters (DSO)	0	0	0	0	0	0	0	0	0	0
No of Title Deeds searches	0	0	4	0	1	2	0	7	0	14
Total for Period	129	117	203	10	230	68	128	267	4	1156

3. DIRECT COST OF DAM SAFETY ADMINISTRATION

The direct expenditure incurred in administration of the legislation at Head Office is shown in Table 1 below.

Table 1: DSO Direct expenditure

Item	Expenditure (R'000)		
	2008/09	2009/10	2010/11
Employee component	3 869	4 383	4 110
Goods & Services	449	668	649
Transfers		122	0
Machinery	26	271	36
Grand Totals	4 344	5 444	4 795

The total direct expenditure was R4 795 000 compared to R5 444 000 in the previous year, i.e. a decrease of 12%. The main reason for the decrease is because two critical vacant posts could not be filled (one specialist engineer post and one senior administrative officer post).

Indirect costs (i.e. expenditure incurred by regional offices who assist the DSO and Head Office overhead cost) are not included in these amounts.

4. REGISTRATION OF DAMS

A new programme was initiated during the year to register dams from the WARMS database onto the Dam Safety Office database making use of Arc Map and Google Earth to verify the positions of the dams. A total of 41 dams were registered during the year bringing the total number of dams registered to date in South Africa to 4709. This is significantly less than the previous year when 229 dams were registered, including from the WARMS database. It has however been found that a number of duplicate registrations took place due to inaccuracies of coordinates of dams in both the WARMS database and dam safety database. It was then decided to first correct coordinates using Arc-Map and Google-Earth. This task was completed for dams in Western Cape. The total figure of 4709 includes registration of new dams that were completed during the year, as well as of existing dams that were not registered previously. Some corrections were also made to the database. The progress with registration of dams is illustrated in figure 1. There are currently 27 mine and industrial residue deposits registered as dams with a safety risk.

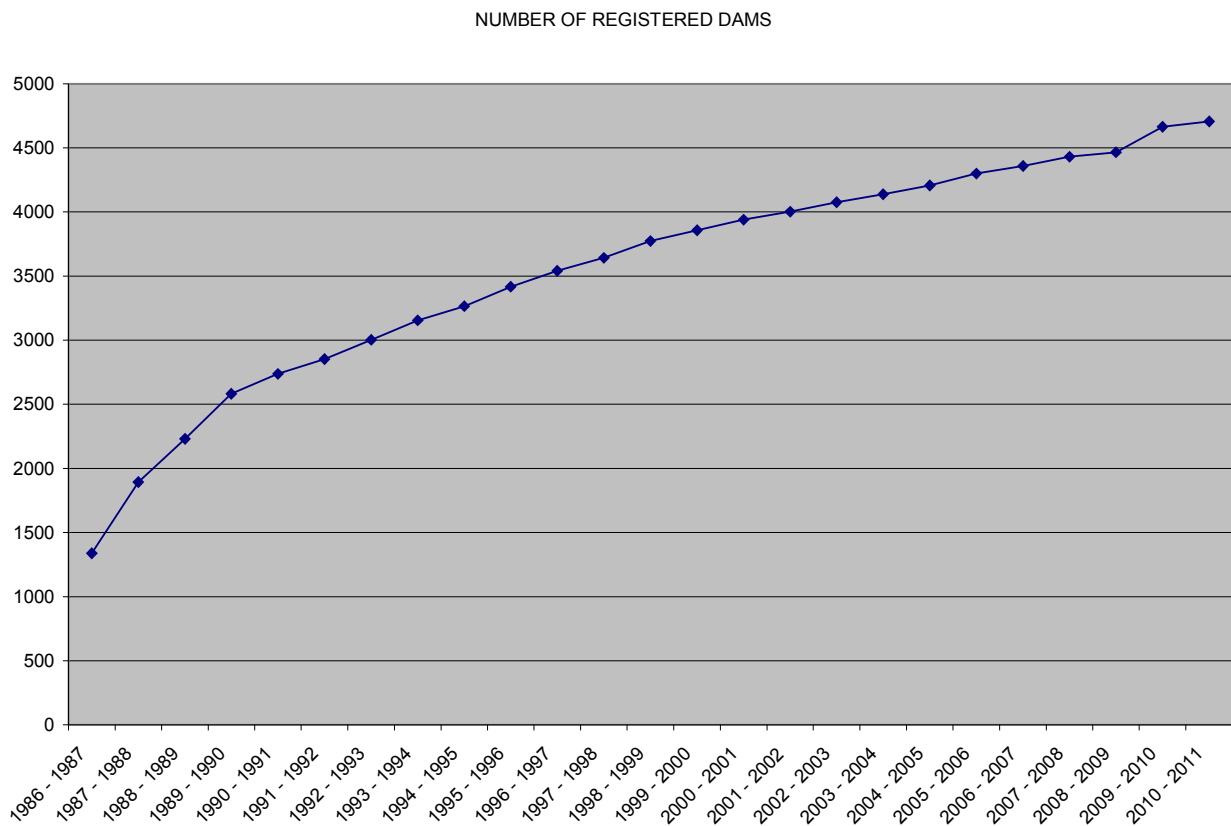


Figure 1: Progress with registration of dams

Distribution of registered dams according to size class and reservoir capacity, and progress with registration of dams on a regional basis is given in Tables 2 to 4.

Table 2: Distribution of dams registered according to size class

Size class	Number	%
Small (5 m – 12 m)	3465	74%
Medium (12 m – 30 m)	1061	22%
Large (30 m and higher)	183	4%
Total	4709	100

Table 3: Distribution of registered dams according to reservoir storage capacity

Capacity (x 10 ⁶ m ³)	Number	%
0,00 – 0,05	148	3.1%
0,05 – 0,10	1168	24.8%
0,10 – 0,25	1698	36.1%
0,25 – 1,00	1063	22.6%
1,00 – 10,00	434	9.2%
10,00 – 100,00	129	2.7%
100 – 1 000	61	1.3%
1 000 – 10 000	8	0.2%
Total	4709	100

Table 4: Registration of dams on a regional office basis

Region	Total No. registered to date	%
Eastern Cape	684	15%
Free State	409	9%
Gauteng	328	7%
Northwest	151	3%
KwaZulu-Natal	929	20%
Limpopo	312	7%
Mpumalanga	491	10%
Northern Cape	80	2%
Western Cape	1325	28%
Total	4709	100%

5. CLASSIFICATION OF DAMS

Altogether 80 registered dams were classified, bringing the total number of registered existing dams now classified to 4366, which is 92,7% of the 4709 dams registered to date. In addition, about 16 proposed dams have also been classified.

Progress with the classification of registered dams in the regions is given in Table 5.

Table 5: Progress with classification of dams on a regional office basis

Region	Total no. registered to date	Total no. classified to date	% Classified to date
Eastern Cape	684	639	93%
Free State	409	360	88%
Gauteng	328	297	91%
Northwest	151	135	89%
KwaZulu-Natal	929	899	97%
Limpopo	312	293	94%
Mpumalanga	491	443	90%
Northern Cape	80	66	83%
Western Cape	1325	1234	93%
Total	4709	4366	92,7%

From Table 5 it can be seen that only KZN has classified more than 95 % of their registered dams. The total percentage classified has risen from 91% in the previous year to 92,7% by the end of this year due to the 80 dams that were classified during the year. The Dam Safety Office currently has 3 technicians who spend about 40% of their time on classifications. It will take about 5 years to classify most of the unclassified registered dams on the list if the current rate of 80 classifications per year can be maintained.

It should be noted that the outstanding classifications generally represent small dams and their hazard potential would mostly be low. There may also be some errors on the DSO database and/or incomplete information.

The distribution of existing dams classified according to hazard potential rating and category are given in tables 6 and 7.

Table 6: Classification of existing dams according to size class and hazard potential

Size class	Hazard potential rating			Total
	Low	Significant	High	
Small	2422 (56%)	788 (18 %)	41 (1%)	3251 (74%)
Medium	295 (7%)	530 (12%)	132 (3%)	957 (22%)
Large	1 (0%)	21 (0.5%)	136 (3%)	158 (4%)
Total	2718 (62%)	1339 (31%)	309 (7%)	4366 (100%)

Table 7: Category classification of existing dams

Category classification	Number of dams	%
Category 1*	2456	56 %
Category 2	1622	37 %
Category 3	288	7%
Total	4366	100 %

* 34 of these dams are actually medium size dams that have been classified as indicated below, in terms of regulation 3.2 of the dam safety regulations.

Size class : Medium
Hazard potential rating : Low
Category classification : 1

6. CONTROL OVER THE CONSTRUCTION & ALTERATIONS OF DAMS

Table 8: Licences issued by DSO

Category	Licence to construct	Licence to Alter	Licence to impound	Licence to Abandon	Total
1	3	2	0	2	7
2	7	3	3	0	13
3	4	0	1	0	5
Total	14	5	4	2	25

Dam safety control over the construction of new dams, including alterations to existing dams, involves the evaluation of design and other reports that forms part of a licence application. A total of 25 dam safety licences were issued, i.e. 14 licences to construct, 5 to alter, 4 to impound and 2 to abandon (decommission).

Provision has been made for inspections by personnel of the regional offices during construction of category I and II dams, but very little success has been achieved in most of the regions because of the lack of human resources.

Response from APPs with regard to the submission of reports after site visits varied from very good to fair.

6.1 Site visits to dams

The DSO made a total of 70 visits to dams during the year. Of these, 22 were to dams under construction whilst the remaining 48 were to existing dams. Where possible, contact was made with APPs to discuss design issues, general problems and quality control. A special effort was made to discuss dam safety and dam engineering issues with owners with respect to operation and maintenance (including contingency plans), as well as the dam safety legislation itself.

6.2 Evasion of the dam safety legislation

The following dam was identified during the year as having been built without a licence to construct:

- Northern Investment Dam near George (H = 14m, V = 0,067 million m³, Cat 2)

This case is being handled by the Directorate Compliance Monitoring & Enforcement for possible prosecution. In the majority of cases the DSO and regions only find out when construction is near completion (or completed), therefore it is not always possible to stop construction.

7. CONTROL OVER THE SAFETY OF EXISTING DAMS

7.1 Progress with the five-yearly inspections

The following table show the status of the dams with respect to the number of inspections performed to date for Category 2 and 3 dams:

Table 9: Progress with 5-yearly inspections of Category 2 and 3 dams

Sector	DWA	Municipal	Industry Mines Business	Other State Dams	Water Boards	Agri cultural	Sector unknown	Total
Total number of Cat 2 & 3 dams	276	252	147	28	42	1038	143	1926
Required number of inspections per year (5 year interval)	55	50	29	6	8	208	29	385
Actual number of inspections received this year	32	16	36	0	6	51	9	150
Current inspection interval based on row above	9 years	16 years	4 years	24+ years	7 years	20 years	16 years	13 years
Outstanding first inspections	18	34	26	1	1	303	102	485
Total number of inspections done since 1987	586	384	232	41	53	940	45	2281
Average inspection interval based on row above	10 years	14 years	14 years	15 years	17 years	24 years	70 years	19 years

The analysis shows that there are a large number of dam owners who are not complying with the target inspection intervals of between 5 and 10 years (average 7,5 years) between inspections. In addition a large number of Category 2 and 3 dams have not been inspected yet. The Table also shows an improved performance for the Industry, Mines & Business Sector and Water Boards for the past year. DWA's (Infrastructure Branch) performance has been the most consistent since 1987, when the dam safety legislation came in force. The Municipal Sector, the Sector Other State Dams and the Agricultural Sector perform unsatisfactorily. The poor performance of the Municipal Sector is of particular concern as their dams are in many cases located close to densely populated areas.

The flow of dam safety inspection reports through the directorate during the reporting year was as follows (statistics of previous year are indicated in brackets):

Table 10: Flow of dam safety evaluations

	Number
Dam Safety Inspection Instructions Issued*	151 (286)
Dam Safety Inspection Reports Received	150 (148)
Dam Safety Inspection Reports Accepted	115 (134)
Reports received but not evaluated or accepted at end of reporting period	98 (88)

* Instructions are currently not issued for dams under control of the DWA Infrastructure Branch because they follow a programme accepted by the DSO and their dams are therefore not included in this figure. Their dams are however included in the number of reports received and accepted.

Presently there are 1926 category II and III dams in the country and these dams should be inspected at an average interval of about 7,5 years. To achieve this, the ideal target should be set at 250 inspections submitted and accepted per year. The ideal target for instructions is set at 220 per year as DWA dams are excluded.

The current capacity of the Dam Safety Office to evaluate and accept these reports are limited and only 115 were accepted and the year ended with a backlog of 98 reports that must still be finalised. More technical capacity is therefore essential.

7.2 Progress with rectification of deficiencies at category II and III dams

The deficiencies listed in Table 11 have been registered on the DSO database with regard to dams for which dam safety inspection reports have been formally accepted since implementation of the dam safety legislation in 1987.

Table 11: Deficiencies/shortcomings at dams

Description	Number of deficiencies	Number rectified
Hydraulic Problems	720	155
Leakage Problems	223	59
Structural Problems	273	76
Material Problems	37	8
Operation And Maintenance Problems	1953	614
Other Problems	25	5
TOTAL	3231	917

A total of 3231 deficiencies have been registered of which 917 (28%) have been rectified since 1986. Rectification of a deficiency can also mean that a subsequent investigation into the matter proved that a deficiency previously recorded is no longer considered a problem because of better information. A more detailed breakdown of the deficiencies is included in Appendix B.

A total of 52 operation and maintenance manuals (OMM) including emergency preparedness plans (EPP) were formally accepted during the financial year. According to the database, a total of 972 dams now have both an OMM and EPP, 32 have only an EPP and 46 only an OMM.

As in previous years much time and effort were spent on visiting owners, discussing shortcomings requiring rectification and associated problems. It is again reported that limited success has been achieved and where progress has been made, much personal input has

been required. This is only possible for selected (more important) case studies. Financial circumstances and the state of the economy are still the most common “stumbling blocks”. However, in some cases dam owners have put a lot of effort into the upgrading and maintenance of their dams.

The Dam Safety Office tries to follow up in writing (ideally every 6 months) all cases where instructions have been issued and where important recommendations of 5 yearly dam safety inspection reports have not been implemented. This objective has however not been achieved in all cases due to the shortage of technical and administrative staff. Nevertheless, a total of 620 follow-up letters were compiled in this regard.

7.3 Prioritisation of existing dams

The DSO continued with the upkeep of the priority list of dams and the first eleven pages (which include the most important outstanding dam safety work in South Africa) are appended in Appendix C. The total number of dams on the list has increased from 1290 (2009/10) to 1327 (2010/11). The goal is to eventually reflect all category II and III dams (private as well as State dams) on the list. A simplified risk-based assessment is done to determine the ranking of a dam on the list, based on information provided in dam safety inspection reports that were compiled by APPs. The relative risk is expressed in terms of “possible loss of life during the life-span of a dam” (assumed as 100 years on average) and is calculated by using the following parameters:

- The estimated probability of failure of a dam.
- The consequences of such a failure (hazard potential in terms of loss of life during a worst case scenario).
- A reduction factor determined from the standard of operation, maintenance, monitoring programme, emergency preparedness and general condition of a dam.

The priority list serves as a management tool for the DSO to:

- Identify priorities for the DSO.
- Determine appropriate inspection frequencies for dams. The proposed frequency as indicated in the last column of the list in Appendix C is one of the parameters used for the determination of intervals (years) between inspections.
- Monitor progress with the dam safety programme e.g. by comparing the total expected loss of life for the first 50 dams on an annual basis.

It was found that the total possible loss of life for the first 50 dams on the list reduced by 2,5% from 3 494 (2009/10) to 3 440 (2010/11), mainly as a result of dam safety betterment work carried out at dams. Some of the aforementioned reductions are due to better assessments of risks following evaluations of new dam safety inspection reports. The list is not yet adequately “stable” to be used as an accurate short term monitoring tool to measure progress with the dam safety programme. The total possible loss of life for all dams on the list increased by 2,0% from 4 800 (2009/10) to 4 896 (2010/11), mainly due to additional dams added to the list. It is clear that attention should be focused on the first 50 to 200 dams on the list as they have the greatest potential impact on the public.

The priority list provides a tool to assess the current state of dam safety in South Africa. This is reflected in the bottom portion (item 5) of the strategic business plan in Appendix A. Table 12 below provides a snapshot of the status under the first 100 dams on the priority list. As can be seen, slow but steady progress is being made. The rehabilitation programme by the DWA Infrastructure Branch is continuing to make a significant contribution in this regard.

Table 12: Serious deficiencies under the first 100 dams on priority list requiring immediate attention

Item	No. of dams
<ul style="list-style-type: none"> • Serious structural deficiency (estimated probability of failure more than 0,5% per year or more than 39% during dam's life) 	14 (16)
<ul style="list-style-type: none"> • Serious deficient flood handling capacity (probability of failure more than 0,5% per year) 	14 (15)
<ul style="list-style-type: none"> • Total number of dams with probability of failure of more than 0.5% per year 	23 (26)

Note: Numbers in brackets are those for the 2009/10 report year

An asterisk in the action column of the priority list marks urgent actions that should be undertaken in the short term (probability of failure estimated at more than 0,05% and 0,5% per year for category 3 and 2 dams respectively). **For these dams the probability of failure is considered to be unacceptably high.** Some dams appear high on the list on the basis of their massive size and high theoretical hazard potential. Although no betterment work may be required for these dams because they comply with appropriate dam safety standards, it is important that adequate maintenance, monitoring, emergency preparedness and security measures are in place at these dams.

It can be concluded that a lot of work must still be done by several role players to bring the state of dam safety in South Africa to satisfactory levels. The current rate of dam safety betterment work as reflected in Table 12 and 14 is slow but steady. It is important that the top 100 to 200 dams on the priority list are provided with emergency preparedness plans.

Table 13 shows that 80% of the top 100 dams on the priority list belong to DWA and the Municipalities. It should be borne in mind that most of the large dams in the country fall within these two sectors.

Table 13: Number of dams per sector within first 100 dams as ranked on priority list

Sector	Total number of dams registered	Number of dams within first 100 dams as ranked on priority list
DWA Dams	309	58
Municipal Dams	304	22
Other State Dams	46	2
Water Board Dams	48	2
Mines, Industries, Business	255	4
Agricultural Dams	3079	12
Sector Unknown Other	668	0
TOTAL	4709	100

7.4 Legal/criminal proceedings

No new cases were handed to Directorate Legal Services for starting with legal procedures against dam owners during the past financial year.

8. APPROVAL OF PROFESSIONAL PERSONS FOR TASKS

A total of 211 applications for approval were received during the year. Of these 14 applications were submitted to the Engineering Council of South Africa (ECSA) and handled by its Committee on Professional Engineers for Dams. ECSA recommended 9 unconditional approvals and 5 conditional approvals.

The 197 other applications were processed on the strength of similar previous recommended approvals by ECSA and they were not again referred to ECSA for a recommendation.

To date 154 persons have been approved as APPs for dam “tasks” to date. A total of about 76 APPs are classified as still active, i.e. not emigrated or deceased and approved for at least 1 task during the past 5 years.

9. UPGRADING OF EXISTING DAMS

Major work to upgrade existing dams (completed or under construction during the year) are listed in **Table 14**. The amounts shown represent estimates of the total project cost of the work.

Table 14: Upgrading of safety of existing dams

Name of dam	Description	Cost (R)
Klein Maricopoort	Dam Safety Rehabilitation Works – Increase spillway capacity.	R 54 million
Nsami	Dam Safety Rehabilitation Works – Increase spillway capacity, new spillway & bridge and stabilise dam wall.	R 156 million
Molepo	Improve stability and increase spillway capacity.	R 130 million
Elandsdrift	Dam Safety Rehabilitation Works – Increase spillway capacity.	R 210 million
Grassridge	Dam Safety Rehabilitation Works – Increase spillway capacity.	R 100 million
Laing	Dam Safety Rehabilitation Works – Refurbish outlet works.	R 10 million
Belfort	Dam Safety Rehabilitation Works – Increase spillway capacity and strengthen multiple arch structure.	R 25 million
Magwa	Dam Safety Rehabilitation Works – Stabilise and drain downstream slope	R11 million
Albert Falls	Raise NOC level by crest wall	R 10 million
Chuniespoort	Dam Safety Rehabilitation Works – Increase spillway capacity, raising and stabilising dam wall.	R 100 million
Kabokweni	Abandonment/decommissioning.	R 9 million
Taung	Refurbish mechanical equipment and reduce leakage in drainage gallery.	R 8 million
Rust de Winter	Dam Safety Rehabilitation Works – Increase spillway capacity, raising and stabilising dam wall.	R 58 million
Glen Brock	Dam Safety Rehabilitation Works – Upstream and downstream slopes of dam wall, spillway , outlets and roads.	R 33 million
Mashashane	Upgrading of spillway, raising of NOC and installation of toe drain.	R20 million
Mankazana	Upgrading of spillway and levelling of NOC	R20 million
Witbank	Sealing of old outlet pipes through wall by grouting	R2 million

10. INCIDENTS AT DAMS

Table 14: Incidents at Dams

The following significant incident at a dam was reported to the DSO:

NAME OF DAM (TYPE)	LOCALITY AND NUMBER OF DAM	HEIGHT (m)	CAPACITY (m ³)	CAT	INCIDENT OR DAMAGE
Hogsett Dam (earthfill dam)	Dordrecht in the Eastern Cape (12/2/D132/32)	15	125 000	2	Hogsett Dam failed on 24 February 2011 after heavy rains in the area and at least one person lost his life on that day. The flood waters due to heavy rains and failure of the dam caused extensive damage to property in Dordrecht. The dam was originally built in 1932, but was never registered or inspected in terms of dam safety legislation. A licence will be required before the dam may be repaired.

11. REVISION OF THE DAM SAFETY REGULATIONS

In terms of section 163(4) of the NWA the current dam safety regulations (i.e. Government Notice R. 1560 of 25 July 1986) are still in force and have been used effectively in conjunction with the new Act since 1 October 1998. It has however been decided to revise the regulations for the following reasons:

- To better align the regulations with the objectives of the National Water Act of 1998.
- To build on experience gained since 1986.
- To implement the establishment of a register of approved professional persons for tasks at dams with a safety risk as provided for by section 123(1)(a) of the NWA.

The draft Dam Safety Regulations were compiled by the Dam Safety Office after consultation with relevant Directorates in DWA involved with dam safety as well as senior officials in the National Water Resources Infrastructure Branch, and after consultation with members of the ECSA Committee on Professional Engineers for Dams. The Chief State Law Adviser of the Department of Justice reviewed the draft Dam Safety Regulations and their comments were incorporated.

The draft regulations were published in the Government Gazette on 1 September 2009 inviting comment from the public by 30 November 2009. All public comments were considered by an appointed Committee representing various Directorates within DWA, by May 2010. Thereafter, the draft Regulations were amended, translated into a second official language (Sepedi) and submitted for approval by the Minister during June 2010. This was still the status at the end of the report year.

12. PROPOSED REGULATIONS ON FINANCIAL ASSISTANCE

Until 1 October 1998, subsidies were paid out for dam safety related work in accordance with conditions published in Government Notice No. 1854 dated 10 August 1990 (hereafter G.N. 1854), which were published in terms of section 9C (9A) of the previous Water Act, 1956. The National Water Act, 1998, came into effect on 1 October 1998. Since 1 October 1998, new subsidy applications could not be considered, as the previous subsidy conditions were not compatible with the new set of criteria specified in section 61 of the NWA.

The objective of the proposed financial assistance scheme would be to help dam owners who cannot afford it, to comply with requirements of the dam safety legislation to execute tasks such as dam safety evaluations, dam safety investigations and dam safety betterment work in order to upgrade the safety of category II and III dams to appropriate standards. It should be borne in mind that the proposed regulations can only be finalised once the new dam safety regulations (see section 11 above) have been promulgated, due to the many cross references to specific clauses of the dam safety regulations.

13. COURSES/TRAINING/LECTURES AND SYMPOSIUMS

Event attended	Institution	Number of officials	Date
Effective Document & Information Management	NKUFU	2	03/ 2010
Difficult Discussion	Astro Tech	1	10/2010
Monitoring and Evaluation	DMS	2	08/2010
Spread Sheet	UP	1	01/2011
PFMA	Pro Active college/ DMS	2	12/ 2010
Report and Business writing	UP	1	09/2010 10/2010
Lead and Manage team	Pro Active college	1	12/2010
GIS Conference and Workshop	Dikololo	1	10/2010
Project Management	Rose bank College	2	07/2010
Labour Relations and Labour law	Astro Tech	1	09/2010
Conference on Integrated Water Resource Management	DWA and Ethekwini municipality	1	10/ 2010
Conference on sustainable Development of dams in Southern Africa	SANCOLD	4	10/ 2010

14. CONCLUSIONS AND RECOMMENDATIONS

A summary of the current state of dam safety in South Africa is given in the strategic business plan for the dam safety programme (DSP), attached as Appendix A. This strategic business plan also gives an indication of progress made since commencement with the DSP in 1987. In addition, possible steps to attain all the objectives of DSP by different key role players (not only the DSO) are included. The salient points of the current state of dam safety in South are as follows:

- It is expected that most category 2 and 3 dams have been registered, but there may still be a significant number of category 1 dams that have not been registered. Steps to improve on this statistic are proposed in the business plan. The DSO has started to use the WARMS database to identify unregistered dams.
- Most new category 2 and 3 dams with a safety risk are being built in accordance with appropriate safety standards. Proposed steps to further improve quality of design and construction include training of the important role players. SANCOLD through its annual courses and/or conferences is assisting in this regard.
- Of the total of 1926 category 2 and 3 dams, 1422 dams have already undergone the first round of inspections by approved professional persons/engineers. Most of the larger and more important dams have been inspected. Steps to ensure that all category 2 and 3 dams are inspected at regular intervals are proposed in the business plan.
- It will be a requirement in the new dam safety regulations that all category 2 and 3 dam owners must have updated O&M manuals and emergency preparedness plans. At present only about 50% of these dam owners comply with this objective. In the business plan steps to improve the standard of O&M at all dams with a safety risk are proposed.
- **An estimated 65% of the first 400 category II and III dams on the priority list now comply with basic dam safety standards, compared to 57% in the previous year.** This is a significant improvement. Upgrading of the remaining dams to appropriate safety standards remains a long-term task (until 2020 or later) and provisional targets are set on a prioritised basis in the business plan. DWA as a major dam owner has embarked on an aggressive dam safety rehabilitation programme, which will continue to make a significant impact on the safety of the most important dams during the next ten years.
- It can be concluded that reasonable progress has been made since 1987. However, it is also clear that a lot of work by several role players still needs to be done to attain the set targets in order to improve the state of dam safety in South Africa to acceptable standards by 2020.
- The total direct expenditure incurred in administration of the dam safety legislation at Head Office was R 4 795 000 compared to R 5 444 000 in the previous reporting year, i.e. a decrease of 12%. Because of the small size of the DSO, expenditure is very sensitive to personnel fluctuations. It is believed that the benefits of the dam safety programme far outweigh the total direct expenditure.

The following specific recommendations are made to maintain and preferably accelerate progress with the dam safety programme:

- The technical personnel component within the DSO should be strengthened. Significant momentum was lost when one Chief Engineer resigned. The DSO has been unable to fill three vacant Chief Engineer posts over a long period of time.
- A financial assistance scheme should be implemented as soon as possible after promulgation of the “new” dam safety regulations. Previously it was found that financial assistance acted as a moderate incentive for dam owners to implement dam safety betterment work. Dam safety is considered to be in public interest.

APPENDIX A: STRATEGIC BUSINESS PLAN FOR DAM SAFETY PROGRAM

Vision: That all dams with a safety risk shall comply with appropriate safety standards in order to minimize loss of life, damage to property and harm to the environment.

Responsibilities: The success of the dam safety programme depends on action by several role players: Firstly dam **owners** (including Infrastructure Branch within DWA [DWA-IB]), secondly various other components within DWA (Dam Safety Office [DSO], Regional Offices [RO], Legal Services [LS]), Compliance Monitoring & Enforcement (CME), thirdly Disaster Management Structures [DM] and lastly SANCOLD.

Key Performance Area / Objectives	Short Term Targets	Current Status*	Possible Plan of Action to Attain Objectives (+Responsible Role Player)
1. That all dams* are registered and classified.	99% cat II & III and 95% cat I registered by 2015. 99% of reg. dams classified by 2015.	1926 2783 92,7% (of 4709)	<ul style="list-style-type: none"> Register dams from WARMS database plus advertising campaign. (RO) Obtain services of consultants to assist some Regional Offices. (RO) Introduce fines to owners? (LS/CME)
2. That all new dams* are designed/ built / altered in accordance with appropriate standards.	95% by 2015 (measurement of quality of construction subjective, especially at Cat I dams)	~85% (estimate allows for deficient quality at category I dams)	<ul style="list-style-type: none"> Prevent illegal construction by e.g. air and road reconnaissance. (RO) Introduce fines? (LS/CME) Training courses for APPs/contractors/ clerks of works? (APPs, DSO, SANCOLD) Improve control over cat I dams. (RO, DSO)
3. That all Cat II & III dams are inspected and evaluated by APPs* according to schedule and in accordance with current dam engineering standards.	1550 1st inspections by 2015. Then 2 nd and 3 rd inspections to follow at required intervals.	1 st 1422 2 nd 600 3 rd 217 inspection reports received so far.	<ul style="list-style-type: none"> Accelerate instructions. (DSO) Improve system of reminders, warnings, legal action, etc. (DSO, LS/CME) Implement financial assistance scheme. (DSO) Inspection of some DWA dams should be contracted out. (DWA-IB) Training of APPs (SANCOLD, DSO)
4. That all dams* are operated & maintained in accordance with appropriate safety standards and that effective OMMs* and EPPs* are in place.	1100 OMMs & EPPs compiled for Cat II and III by 2015. Standard OMM & EPP issued for all Cat I dams by 2015.	972 OMMs with EPPs compiled for Cat II and III dams so far.	<ul style="list-style-type: none"> Improve system of reminders, warnings, legal action, etc. (DSO, LS/CME) Implement financial assistance scheme. (DSO) Ensure that all Cat II and III dams have OMMs & EPPs. (DSO + owners) Compile a standard OMM & EPP for Cat I dams and issue. (DSO) Motivate dam owners to keep up O&M by two-yearly circulars. (DSO) Implement Disaster Management Act. (DM)
5. That all dams* shall comply with appropriate safety standards (e.g. SANCOLD guidelines). Where necessary, dams must be upgraded to acceptable standards.	<u>According to order of priority list:</u> <ul style="list-style-type: none"> 1st 100 dams 75% by 2015 2nd 100 dams 70% by 2015 3rd 100 dams 70% by 2015 4th 100 dams 70% by 2015 All Cat II & III dams by 2020 	<u>Basic* compliance:</u> <ul style="list-style-type: none"> 64(48**)% 62(59**)% 60(60**)% 73(70**)% (**previous year) 	<ul style="list-style-type: none"> Upgrade dams on prioritized basis. (Owners, DSO) Improve system of reminders, warnings, legal action, etc. (DSO, LS/CME) Implement financial assistance scheme. (DSO) Training courses for APPs/contractors/ clerks of works? (APPs, DSO, SANCOLD) Give special attention to high priority cases and report on progress annually (DSO) Budget R500 M+ per year. (DWA-IB)

*Notes: **APP** means approved professional person. **Basic compliance** means the probability of failure of a dam is estimated to be less than 0,05% (1/2000) and 0,5% (1/200) per year for category 3 and 2 dams respectively. **Dams** in this Table mean dams with a safety risk. **EPP** means emergency preparedness plan. **OMM** means O&M manual. **Current status** is the status as on 31 March 2011.

APPENDIX B: DEFICIENCIES AT DAMS WITH A SAFETY RISK

Code	Description	This year		Previous Year	
		Number	Rectified	Number	Rectified
H01	Spillway capacity less than requirements of current criteria	442	86	428	82
H02	Erosion of toe of dam or downstream thereof	46	8	47	8
H03	Damage to spillway lining (e.g. erosion or cavitation)	81	22	80	22
H04	Damage to outlet works (e.g. cavitation)	16	4	16	4
H05	Mechanical equipment or outlet works out of order	42	10	42	10
H06	Spillway or gate vibration	2	1	2	1
H08	Erosion due to wave action (damage to upstream slope protection)	68	15	68	15
H09	Inadequate surface drainage or damage by "rainfall" erosion	22	8	22	8
H11	Hazard to human life upstream of dam during floods ("backwater" effects also)	1	1	1	1
	HYDRAULIC PROBLEMS	720	155	706	151
L01	Excessive loss of water	127	30	125	30
L02	High pore pressures, uplift forces, blocked drains	30	7	29	6
L03	Internal erosion, piping	19	2	19	2
L04	Wet patches observed	46	20	45	20
	LEAKAGE PROBLEMS	223	59	218	58
S01	Stability (gravity and buttress dams)	62	19	62	19
S02	Slope stability (earth and rockfill dams)	76	18	74	17
S03	Structural design criteria exceeded (arch dams)	10	3	10	3
S04	Foundation movement observed	3		3	
S05	Upstream "slip circle movement" observed	2	1	2	1
S06	Downstream "slip circle movement" observed	13	3	13	3
S07	"Flow slide" observed	3	1	3	1
S09	Excessive cracking or differential movement observed in mass concrete	15	4	15	4
S10	Excessive settlement of earth or rockfill dams	78	23	77	22
S11	Formation and development of cracks in earth dams	11	4	11	4
	STRUCTURAL PROBLEMS	273	76	270	74
M01	Weakening of concrete due to alkali-aggregate reaction or swelling/shrinking aggregate	18	4	18	4
M02	Chemical attack, leaching, weathering, bacteriological attack	4	1	2	1
M03	Break up of upstream membrane	1		1	
M06	"Foundation/ abutment material breakdown"(chemical)	1	1	1	1
M07	Corrosion (mechanical equipment)	4	1	4	1
M09	Dispersive soils identified	8	1	8	1
M11	Crumbling/weathering/slaking of rock	1		1	
	MATERIAL PROBLEMS	37		35	8
B01	Flood control: Lack of personnel, untrained personnel	3		3	

B02	Operation and Maintenance Manual (OMM) must be compiled / updated	1152	413	1097	408
B03	Deficiencies in monitoring (instrumentation)	69	24	69	24
B04	Deficiencies in monitoring (routine inspections)	6	3	6	3
B05	Emergency Preparedness Plan (EPP) must be compiled / updated	390	53	329	49
B07	Trees and vegetation that must be removed	204	82	204	81
B08	Burrowing animals that must be exterminated	70	21	70	21
B09	Instruments not read/processed/evaluated	2		2	
B10	Flood control gates out of order	7	4	7	4
B11	Outlet works out of order	24	5	24	5
B12	Maintenance of slope protection	24	9	24	9
B13	Increase non overspill crest width	1		1	
B14	Inadequate freeboard	1		1	
	OPERATION AND MAINTENANCE PROBLEMS	1953	614	1835	604
A01	Sabotage	2		2	
A02	Earthquake Damage	2	1	2	1
A04	Problems in dam basin (unstable slopes, sedimentation)	1		1	
A05	Problems in the river downstream of a dam	1		1	
A06	Further investigations required	19	4	19	4
	OTHER PROBLEMS	25	5	25	5
	TOTAL	3231	917	3091	900

APPENDIX C: PRIORITISATION OF DAMS

PRIORITY LIST OF DAM SAFETY OFFICE (No. of dams on list: 1327)

LEGEND:

PF - Probability of failure during lifespan of dam

LL - Hazard potential in terms of loss of life

EL - Possible loss of life during lifespan of dam based on worst scenario (e.g. failure during night and slow evacuation)

AL - Reduction factor for good O&MM and EPP

N - Lifespan of dam (100 years)

T - Average "recurrence period (years) between failures"

1/T - Annual probability of failure

EPP - Emergency preparedness plan

Sector (owner) - A (Agriculture), M (Municipal), W (DWA), S (Other state departments), O (other e.g. industry)

Guideline for dsi intervals

**Expected DSI interval
loss of life in years**

**< 0.5 10
0.5 - 2 9
2 - 10 8
10 - 20 7
20 - 50 6
> 50 5**

No. Major risk aspect (years)	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval / PROGRESS
1	N120/01	NQWEBA DAM (PREVIOUSLY VAN RYNEVELD'S PASS) *Investigate further *Investigate further and improve EPP to be updated	3	100 100 0 0	0.634 0.634 0.000 0.000	2000 10 0 0	633.968	Y	Programmed for 2011 Programmed for 2011 Programmed for 2011	5
2	C601/01	BLOEMHOEK DAM None Adequate	3	2000 500 0 0	0.049 0.181 0.000 0.000	2140 2140 0 0	284.233	Y	Adequate Adequate	5
3	A210/01	ROODEKOPJES DAM None None Revise existing O&MM and compile EPP *Investigate	3	2000 2000 0 200	0.049 0.049 0.000 0.394	900 500 0 900	271.575	N	Adequate Adequate Programmed for 2007/8 Ongoing	5
4	N230/01	DARLINGTON DAM (LAKE MENTZ) *Investigate and improve None	3	200 2000 0 0	0.394 0.049 0.000 0.000	608 608 0 0	231.893	Y	Programmed for 2010/11 & 2011/12 Adequate	5
5	W440/01	PONGOLAPOORT DAM Investigate further. Operate at reduced FSC (70%). Investigate	3	5000 5000	0.020 0.020 0.000 0.000	6600 6600	181.171	N	Programmed for 2009 Programmed for 2010	5
6	B100/04	WITBANK DAM * Investigate and improve (gated spillway) Pendulums and cracking should be monitored. Concrete corrosion Improve O&MM	3	200 1000 1000	0.394 0.095 0.095	350 350 350	177.681	Y	Programmed for...? Programmed for...? Programmed for...?	5

No. Major risk aspect (years)	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval / PROGRESS
7	C801/10	STERKFONTEIN None except correct operation	3	2000	0.049	5000	0.5	155.857	Y	5
		Spillway		5000	0.020	2500	0.5		Adequate	
		Structure - filters not comprehensive		5000	0.020	5000	0.5		Adequate	
		Material parameters not fully known		0	0.000	0	0		Programmed for 2010	
8	B100/13	MIDDELBURG DAM Investigate options (overtopping spillway)	3	3000	0.033	6000	0.5	127.241	Y	5
		Spillway		10000	0.010	6000	0.5		Ongoing	
		Structure		0	0.000	0	0		Adequate	
				0	0.000	0	0			
9	H800/03	DUIVENHOKS None necessary	3	2000	0.049	200	1	126.794	Y	5
		Spillway capacity		100	0.634	100	1		Adequate	
		Structural stability			0.000				Programmed for 2007/8 & 2008/9 & 2010/1	
					0.000					
10	C300/02	WENTZEL DAM (<u>Improved d/b to be updated</u>) *Detailed investigation and improve	2	133	0.530	312	0.7	125.497	N	5
		Spillway		1000	0.095	312	0.7		Programmed for 2007/8 & 2008/9	
		Structure		0	0.000	0	0		Adequate	
		No O&MM and EPP		0	0.000	0	0		Programmed for 2008/9	
11	R101/01	CATA DAM *Investigate and improve	3	500	0.181	750	0.7	116.217	N	5
		Spillway		2000	0.049	750	0.7		Programmed for 2007/8 & 2008/9	
		Structure		0	0.000	0	0		Adequate	
		No O&MM and EPP		0	0.000	0	0		Programmed for 2008	
12	J330/01	STOMPDRIFT DAM * Increase spillway capacity	3	111	0.595	200	0.8	96.481	Y	5
		Spillway		200	0.394	100	1		Programmed for 2009/10	
		Structure		0	0.000	0	0		Programmed for 2009/10	
				0	0.000	0	0			
13	B310/05	RHENOSTERKOP DAM Investigate further	3	5000	0.020	4000	0.7	82.759	N	5
		Spillway		10000	0.010	4000	0.7		Adequate	
		Structure		0	0.000	0	0		Programmed for 3/97. Outstanding	
		No O&MM and EPP			0.000				Programmed for 3/98. Outstanding	
14	M100/01	GROENDAL DAM None	3	2000	0.049	1000	0.7	66.630	Y	5
		Spillway		2000	0.049	1000	0.7		Adequate	
		Structure			0.000				Adequate	
					0.000					
15	U200/04	INANDA DAM None	3	10000	0.010	1000	0.5	57.676	Y	5
		Spillway		8000	0.012	1000	0.5		Adequate	
		Structure - foundation		1000	0.095	1000	0.5		Adequate	
		Erosion emergency spillway			0.000				Programmed for 2007/8	
16	C120/01	VAAL DAM None	3	2000	0.049	1600	0.6	55.918	Y	5
		Spillway		10000	0.010	1600	0.6		Adequate	
		Structure			0.000				Adequate	
					0.000					

No.	Major risk aspect (years)	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval / PROGRESS	
17	Spillway Structure	C520/02	KRUGERSDRIFT None None	3	2000 2000	0.049 0.049	930 930	0.6 0.6	53.113	Y	Adequate Adequate	5
18	Spillway Capacity Structural Stability Piping	G401/AM	SPIOENKOP(Improved, d/b to be updated) None necessary * Repair cracking Permanent monitoring	3	10000 50 50 0	0.010 0.867 0.867 0.000	40 20 60 0	0.8 0.9 1 0	52.043	Y	Adequate Programmed for...?	5
19	Spillway Structure	U200/01	ALBERTFALLS DAM (Improved, d/b to be updated) Improve the spillway capacity Monitor seepage	3	1500 5000	0.065 0.020	1200 1200	0.5 0.5	49.824	Y	Programmed for 2007/8 Adequate	6
20	Spillway Structure No O&MM and EPP	A300/03	KLEIN MARICOPOORT DAM (being improved) *Improve spillway None, except monitoring Compile	3	500 1000 0 0	0.181 0.095 0.000 0.000	206 126 0 0	1 1 0 0	39.821	N	Programmed for 2007/8 & 2008/9 Adequate Programmed for 2007/8	6
21	Spillway Structure	R300/01	NAHOON DAM None None	3	2000 1000 0 0	0.049 0.095 0.000 0.000	400 400 0 0	0.7 0.7 0 0	39.017	Y	Adequate Adequate	6
22	Spillway Structure	C520/04	MOUTLOATSI SETLOGELO None None	3	5000 10000	0.020 0.010	1870 1870	0.7 0.7	38.690	Y	Adequate Adequate	6
23	Spillway Structure Relocate water supply pressure pipeline on dam	X103/50	MBAMBISO DAM- Confirm / analyse spillway discharge capacity. Maintenance must be done. *Investigate and relocate.	3	5000 5000 50 0	0.020 0.020 0.867 0.000	40 40 40 0	1 1 1 0	34.917	Y	Adequate Adequate Programmed for ...?	6
24	Spillway Capacity Structural Stability O & MM	R101/03	MNYAMENI DAM * Improve	3	200 0 0 0	0.394 0.000 0.000 0.000	0 80 0 0	1 0 0 0	31.538	Y	Adequate Adequate	6
25	Spillway capacity Structural capacity	C230/04	BOSKOP DAM Low due to poor maintenance + sinkholes.	3	2000 2000	0.049 0.049	519 519	0.6 0.6	29.641	Y	Adequate Adequate	6
26	Spillway Structure	B800/01	TZANEEN DAM None Improved monitoring required	3	10000 5000	0.010 0.020	2000 2000	0.5 0.5	29.557	Y	Adequate Adequate	6

No.	Major risk aspect (years)	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS /	DSI interval PROGRESS
27	Spillway Structure - piping potential	X100/22	DRIEKOPPIES DAM None None except monitoring	3	10000 5000 0 0	0.010 0.020 0.000 0.000	2000 2000 0 0	0.5 0.5 0 0	29.557	Y Adequate Adequate	6
28	Spillway Structure No EPP	B200/01	BRONKHORSTSPRUIT DAM Investigate safety of foundations during overtopping Investigate foundation and do structural analysis Compile	3	3000 4000 0	0.033 0.025 0.000 0.000	600 600 0 0	0.8 0.8 0 0	27.203	N Programmed for 2008 Programmed for 2008 Outstanding	6
29	Spillway Structure	A210/02	HARTBEESSPOORT DAM Routed flood that can be handled by channel before overtopping. None	3	1000 10000 0	0.095 0.010 0.000 0.000	323 323 0 0	0.7 0.7 0 0	23.562	N Programmed for ...? Adequate	6
30	Spillway Capacity Structural Stability O & MM	D200/18	SMITHFIELD DAM *Investigate	3	200 0 0 0	0.394 0.000 0.000 0.000	0 60 0 0	0.9 0 0 0	21.288	N Programmed for ...? Programmed for ...? Programmed for ...?	6
31	Spillway Structure Potential clogging of shaft spillway.	B800/02	EBENEZER DAM *Investigate further. *Install safe seepage monitoring system. *Install structure to prevent clogging.	3	200 1000 50	0.394 0.095 0.867 0.000	43 43 43 0	0.5 0.5 0.5 0	20.637	N Programmed for ...? Programmed for ...? Programmed for ...?	6
32	Spillway Structure	A601/42	VAALKOP NO.II-DAM *Improve *Improve	2	100 20	0.634 0.994 0.000 0.000	20 20	1 1	19.957	N Programmed for ...? Programmed for ...?	7
33	Spillway Structure	A900/03	ALBASINI DAM *Must be improved. Post-stressed cables must be monitored/ investigated.	3	500 5000 0	0.181 0.020 0.000 0.000	100 100 0 0	1 1 0 0	19.764	N Programmed for 2012 Programmed for ...?	7
34	Spillway capacity Structural stability	S300/10	BONGOLO DAM	3	2000 100000 0 0	0.049 0.001 0.000 0.000	600 600 0 0	0.6 0.6 0 0	17.904	Y Adequate Adequate	7
35	Spillway capacity . Structure stability. Lack of maintenance.	C212/44	MIDDLE LAKE *Investigate	2	150 1000 100 0	0.488 0.095 0.634 0.000	20 20 20 0	1 1 1 0	17.196	Y Programmed for ...?	7
36	Spillway Structure	A220/02	OLIFANTSNEK DAM None None	3	2000 2000 0 0	0.049 0.049 0.000 0.000	292 292 0 0	0.6 0.6 0 0	16.676	Y Adequate Adequate	7

No.	Major risk aspect (years)	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS /	DSI interval PROGRESS
37	Spillway Structure No O&MM and EPP	S302/35	SHILOH DAM-CISKEI None None Compile	3	2000 2000 0	0.049 0.049 0.000	250 250 0	0.7 0.7 0	16.657	N Adequate Adequate Programmed for 2007/8	7
38	Spillway Structure	J250/02	CALITZDORP DAM None necessary Investigate stability	3	2000 500 0 0	0.049 0.181 0.000 0.000	100 50 0 0	0.8 0.8 0 0	15.833	Y Adequate Programmed for ...?	7
39	Spillway Structure	H300/02	PIETERSFONTEIN DAM None necessary None necessary	3	1000 10000	0.095 0.010 0.000 0.000	280 210	0.7 0.7	15.802	Y Adequate Adequate	7
40	Spillway Structure	S300/16	THRIFT DAM (MOUNT HOPE)-CISKEI Investigate and improve None	2	500 10000 0	0.181 0.010 0.000 0.000	100 100	0.8 0.8	15.166	Y Outstanding Adequate	7
41	Spillway Structure	J250/01	GAMKAPOORT DAM None None	3	10000 3333 0 0	0.010 0.030 0.000 0.000	543 300	0.8 0.8	15.116	Y Adequate Adequate	7
42	Spillway Structure	X201/68	NGODWANA DAM Adequate, but erosion should be monitored Adequate, but monitoring essential	3	10000 5000 0 0	0.010 0.020 0.000 0.000	1000 1000	0.5 0.5	14.778	N Adequate Adequate	7
43	Spillway Structure	G100/13	WEMMERSHOEK DAM None None	3	18182 10000	0.005 0.010 0.000 0.000	1000 2000	0.7 0.7	14.593	N Adequate Adequate	7
44	Spillway Structure	J340/02	KAMMANASSIE DAM None * Unblock/ clean pressure relief holes	3	1000 200	0.095 0.394 0.000 0.000	50 30	0.7 0.7	14.586	Y Adequate	7
45	Spillway Structure	U401/08	LAKE MERTHLEV Investigate & wall stability * Investigate integrity of post stressed bables	2	1000 100 0 0	0.095 0.634 0.000 0.000	21 21	1 1	14.045	N Programmed for ??? Programmed for ???	7
46	Spillway Capacity Structural Stability	H300/01	POORTJIESKLOOF DAM None None	3	1000 2000	0.095 0.049 0.000 0.000	400 40	0.6 0.6	13.541	Y Adequate	7

No.	Sector	Major risk aspect	DAM NO.	NAME OF DAM	Category	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval
(years)			Action to be taken (*urgent)		T (Years)						/	PROGRESS
47			H200/07	ROODE ELSBERG DAM	3					N		7
	Spillway			None	10000	0.010	50	0.6	12.891		Adequate	
	Structure			Structural analysis & risk analysis	2000	0.049	50	0.6			Programmed for 2010	
		Internal erosion. Leaching sand from foundation		*Monitor	200	0.394	50	0.6			Ongoing	
						0.000						
48			L300/01	BEERVLEI DAM	3					N		7
	Spillway			None	200	0.394	41	0.7	12.163		Adequate	
	Structure			None	2000	0.049	41	0.7			Adequate	
						0.000						
						0.000						
49			V700/01	WAGENDRIFT DAM	3					Y		7
	Spillway Capacity			Check freeboard and spillway length	2000	0.049	250	0.5	11.898		Programmed for 2008	
	Structural Stability			Install monitoring instruments	2000	0.049	250	0.5			Programmed for 2008	
						0.000						
						0.000						
50			G101/AH	PARYS DAM	2					Y		7
	Spillway Capacity			None	500	0.181	30	0.8	11.303		Adequate	
	Structural Stability			None	10000	0.010	20	0.8			Adequate	
	O & MM				0	0.000	0	0				
	Erosion of spillway lining (reno mattresses)			* Repair	100	0.634	20	0.8			Programmed for 2006/7	
51			S302/33	GLENBROCK DAM (Being improved)	3					Y		7
	Spillway Capacity			* Improve	100	0.634	21	0.8	11.236		Programmed for 2008	
	Structural Stability			None	1000	0.095	21	0.8			Programmed for 2008	
						0.000						
						0.000						
52			A901/42	DAMANI DAM	3					N		7
	Spillway			Adequate	1000	0.095	60	1	10.881		Adequate	
	Structure			Adequate	1000	0.095	60	1			Adequate	
	No O&MM and EPP			Compile	0	0.000	0	0			Outstanding	
						0.000						
53			B501/11	FLAG BOSHIELO DAM - WAS ARABIE DAM	3					Y		7
	Spillway			None	10000	0.010	500	0.7	10.345		Adequate	
	Structure			Monitor	5000	0.020	500	0.7			Adequate	
						0.000						
						0.000						
54			U700/11	BEAULIEU DAM	3					N		7
	Spillway capacity			*Reinstate NOCL	500	0.181	62	0.5	10.228		Programmed for...?	
	Structural stability			Monitoring essential	500	0.181	62	0.5			Adequate	
					0	0.000	0	0				
					0	0.000	0	0				
55			A800/01	NZHELELE DAM(NJELELE)	3					N		7
	Spillway			Investigate spillway capacity	2000	0.049	250	0.7	10.193		Programmed for 2007/8	
	Structure			None	10000	0.010	250	0.7			Adequate	
	No O&MM and EPP			Compile	0	0.000	0	0			Outstanding	
						0.000						
56			G204/65	DRIFTSANDS STORMWATER RETENTION DAM	2					Y		7
	Spillway			None	1000	0.095	5	1	10.092		Adequate	
	Structure			None	10000	0.010	106	1			Adequate	
					0	0.000	0	0				
					0	0.000	0	0				

No. Sector	Major risk aspect	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval / PROGRESS	
57	Spillway Structure No O&MM and EPP	B401/33	LEEUKLIP DAM *Enlarge / abandon *Improve / abandon Compile	2	50 50 0 0	0.867 0.867 0.000 0.000	10 10 0 0	1 1 0 0	9.824	N	Programmed for 2004 Outstanding Programmed for 2004 Outstanding Programmed for 2004 Outstanding	8
58	Spillway Structure Outletpipe O&M Manual	B502/23	CHUNIESPOORT DAM (being improved) Investigate and improve No drain - investigate dispersiveness *Investigate founding conditions Compile	2	200 200 50 0	0.394 0.394 0.867 0.000	9 9 9 0	1 1 1 0	9.775	N	Programmed for 2007 - 2008 Programmed for 2007 - 2008 Programmed for 2007 - 2008 Outstanding	8
59	Spillway Structure	C240/05	JOHAN NESER DAM (KLERKSDORP DAM) Investigate betterments None	2	200 10000	0.394 0.010 0.000 0.000	30 30	0.8 0.8	9.606	Y	Programmed for 2007/8 Adequate	8
60	Spillway Capacity Structural Stability O & MM	D120/02	KLOOF DAM *Investigate	3	100 0 0 0	0.634 0.000 0.000 0.000	0 15 0 0	1 0 0 0	9.510			8
61	Spillway Structure	A600/06	DONKERPOORT DAM *Investigate further - then improve None	3	500 10000 0 0	0.181 0.010 0.000 0.000	100 100 0 0	0.5 0.5 0 0	9.479	Y	Programmed for ??? Adequate	8
62	Spillway Capacity Structural Stability O & MM	Q940/01	KATRIVIER DAM Can take RMF + no apron protection * Improve stability	3	2000 1000 0 0	0.049 0.095 0.000 0.000	82 82 0 0	0.8 0.8 0 0	9.141	Y	Adequate Programmed for 2012/3 & 2013/4	8
63	Spillway Structure	B402/35	DER BROCHEN DAM * Cavities beneath Spillway Crest to be grouted Significant settlement should be monitored.	3	200 1000	0.394 0.095 0.000 0.000	20 20	1 1	9.038	Y	Programmed for...??? Adequate for now	8
64	Spillway - radial gates Structure O&MM and EPP not to standard	A220/07	BOSPOORT DAM (Improved, d/b to be updated) *Inadequate. Enlarge spillway capacity None Compile O&MM and update EPP	3	200 1000 0 0	0.394 0.095 0.000 0.000	20 20 0 0	1 1 0 0	9.038	Y	Programmed for 2008/9 & 2010/1 Programmed for 2008/9 & 2010/1 Programmed for 2007/8	8
65	Spillway Capacity Structural Stability Piping	H402/66	MCGREGOR-NUWE DAM NO.1 None None *Monitoring	2	10000 500 50 0	0.010 0.181 0.867 0.000	10 8 10 0	1 1 1 0	8.924	Y	Adequate Adequate Ongoing	8
66	Spillway Structure	J340/08	EZELJACHT DAM None *Investigation to determine "safe operating level"	3	100000 100 0 0	0.001 0.634 0.000 0.000	20 5 0 0	0.6 0.7 0 0	8.876	Y	Adequate Programmed for 2006/7 & 2007/8	8

No.	Sector	Major risk aspect	DAM NO.	NAME OF DAM	Category	T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval	PROGRESS
67			B320/01	LOSOP DAM	3						N		8	
	Spillway			None	10000	0.010	500	0.6		8.867		Adequate		
	Structure			*Monitoring essential / Improve drainage	5000	0.020	500	0.6				Adequate		
	No O&MM and EPP			Compile	0	0.000	0	0				Outstanding		
68			G200/12	KLEINPLAAS DAM	3						N		8	
	Spillway			None	1177	0.081	120	0.8		8.758		Adequate		
	Structure			None	1818	0.054	60	0.8				Adequate		
					0	0.000	0	0						
					0	0.000	0	0						
69			Q800/13	BESTERSHOEK DAM	2								8	
	Spillway Capacity				2000	0.049	10	1		8.738				
	Structural Stability			*Investigate	50	0.867	10	1						
						0.000								
						0.000								
70			A213/52	HIPPO DAM	2						N		8	
	Spillway capacity			*Investigate and improve	50	0.867	0	1		8.674				
	Structural Stability				0	0.000	10	0						
					0	0.000	0	0						
					0	0.000	0	0						
71			C900/07	BLOEMHOF DAM	3						N		8	
	Spillway			None necessary	10000	0.010	50	0.8		8.268		Adequate		
	Structure			None necessary	10000	0.010	50	0.8				Adequate		
	Flood control			Improve skills and knowledge during emergency (flood) situations.	1000	0.095	100	0.8						
						0.000								
72			S401/05	KOCH DAM (Improved, d/b to be updated)	2						Y		8	
	Spillway			*Recently improved	20	0.994	9	0.9		8.057		Still need to be verified		
	Structure			None	1000	0.095	9	0.9				Adequate		
					0	0.000	0	0						
					0	0.000	0	0						
73			C230/07	LAKESIDE DAM (Improved, d/b to be updated)	2						Y		8	
	Spillway			* Upgrade	100	0.634	18	0.7		8.034		Programmed for 2012		
	Structure			None	10000	0.010	18	0.7				Adequate		
	O&MM and EPP				0	0.000	0	0						
					0	0.000	0	0						
74			D540/01	VANWYKSVLEI	2						Y		8	
	Spillway Capacity			None	2000	0.049	10	0.8		7.994		Adequate		
	Structural Stability			None	1000	0.095	5	0.9				Adequate		
	Piping due to animal burrows.			* Maintenance and monitoring	100	0.634	14	0.9				Ongoing		
					0	0.000	0	0						
75			B800/25	LORNA DAWN DAM	2						Y		8	
	Spillway			None but monitor erosion	2000	0.049	9	1		7.939		Adequate		
	Structure			None	2000	0.049	9	1				Adequate		
	Strong leak at RF			* Investigate and repair	50	0.867	9	1				Programmed for 2006/7		
						0.000								
76			B501/17	UPPER GOMPIES DAM	2						N		8	
	Spillway			*Investigate / improve	50	0.867	9	1		7.865		Programmed for 2007		
	Structure			None	2000	0.049	9	1				Adequate		
	No O&MM and EPP			Compile	0	0.000	0	0				Outstanding		
						0.000								

No. Sector	Major risk aspect	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval PROGRESS
77	Spillway Structure	W120/01	GOEDERTROUW DAM Erosion must be monitored/repaired Monitoring	3	5000 5000 0	0.020 0.020 0.000	400 400 0	0.5 0.5	7.843	Y Adequate Adequate	8
78	Spillway Structure	B800/29	MIDDELLETABA DAM Investigate Further Investigate stability of embankment and piping potential	3	500 1000	0.181 0.095 0.000 0.000	30 30	1 1	7.781	N Programmed for ??? Programmed for ???	8
79	Spillway Capacity Structural Stability O & MM	C221/70	FLEURHOF DAM * Investigate and improve	2	100000 100 0 0	0.001 0.634 0.000 0.000	12 12 0 0	1 1 0 0	7.612		8
80	Spillway Structure	G400/21	MOSSELRIVIER DAM *Increase spillway capacity None	3	500 3000 0 0	0.181 0.033 0.000 0.000	20 50 0 0	0.8 0.8	7.566	Y Investigation to start 6/2000 Adequate	8
81	Spillway Capacity Structural Stability O & MM	A215/61	EASTERN PLATINUM MINE RETURN WATER DAM None None Compile	2	200 10000 0 0	0.394 0.010 0.000 0.000	6 31 0 0	0.6 0.6	7.333	N Adequate Adequate Programmed for 2006	8
82	Spillway Structure	L820/01	KOUGA DAM (PAUL SAUER) None * Investigate and improve	3	10000 1000	0.010 0.095 0.000 0.000	100 100	0.7 0.7	7.295	Y Adequate Ongoing monitoring	8
83	Spillway Structure Pipeline buried in dam wall	B501/14	MAHLANGU DAM None Monitor *Relocate / monitor	2	2000 1000 50	0.049 0.095 0.867 0.000	8 8 8 1	1 1	7.119	N Adequate Adequate Programmed for 2006 - 2008	8
84	Spillway Structure No O&MM and EPP	C700/05	WELTEVREDE DAM *Investigate *Leakage along RHS pipe Compile	2	50 50 0 0	0.867 0.867 0.000 0.000	9 9 0 0	0.8 0.8	7.073	N Programmed for ...? Programmed for ...? Programmed for ...?	8
85	Spillway Structure	D350/02	GARIEP DAM (HENDRIK VERWOERD) Monitoring Monitoring	3	100000 100000	0.001 0.001 0.000 0.000	5000 5000	0.7 0.7	6.993	Y Adequate Adequate	8
86	Spillway Structure No O&MM and EPP	D310/01	VAN DER KLOOF DAM Monitoring Monitoring Compile	3	80000 80000 0	0.001 0.001 0.000 0.000	4000 4000 0	0.7 0.7	6.991	N Adequate Adequate Programmed for 2007	8

No. Sector	Major risk aspect	DAM NO.	NAME OF DAM Action to be taken (*urgent)	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS	DSI interval PROGRESS
87	Spillway Structure No O&MM and EPP	A804/04	NWANEDZI Investigate erosion potetial during overtopping *Do structural and foundation analysis Compile	3	2000 1000 0	0.049 0.095 0.000	50 50 0	1 1 0	6.967	N	8 Programmed for 2007/8 Programmed for 2007/8 Outstanding
88	Spillway Structure	G200/06	BLUEGUM DAM None necessary None necessary	3	5000 2000 0	0.020 0.049 0.000	200 100 0	0.6 0.6 0	6.943	Y	8 Adequate Adequate
89	Spillway Structure No O&MM and EPP	C212/46	KLEINFONTEIN DAM Check assessment None Compile	2	50 2000 0	0.867 0.049 0.000	2 8 0	1 0.6 0	6.939	N	8 Adequate Adequate Programmed for ???
90	Spillway Capacity Structural Stability	A210/03	BUFFELSPOORT DAM None * Investigate (AAR + GEODETIC SURVEYS)	3	2000 200	0.049 0.394 0.000	20 20	0.8 0.8	6.780	N	8 Adequate
91	Spillway Structure	H200/06	LAKENVALLEI DAM None None	3	100000 33333	0.001 0.003 0.000	2600 2600	0.65 0.65	6.747	Y	8 Adequate Adequate
92	Spillway Structure	A231/35	PREMIER MINE NO.7 SLIMES DAM Overall estimate None	3	1000 0 0	0.095 0.000 0.000	0 70 0	1 0 0	6.665	N	8 Adequate
93	Spillway Structure	Q440/01	LAKE ARTHUR DAM None None	3	200 200	0.394 0.394 0.000	15 15	0.7 0.7	6.647	Y	8 Adequate Adequate
94	Spillway Capacity Structural Stability	H402/74	DASSIESHOEK DAM None None	3	100000 500 0	0.001 0.181 0.000	40 30 0	0.8 0.9 0	6.549	Y	8 Adequate Adequate
95	Spillway Structure Retaining wall/embankment transition.	E400/01	KAREE DAM None necessary None necessary Monitor leakage(L03)	3	20000 2000 200 0	0.005 0.049 0.394 0.000	12 12 20 0	0.7 0.7 0.8 0	6.439	Y	8 Adequate Adequate Programmed for...?
96 8	Spillway capacity Structural stability	U202/45	DURBAN HEIGHTS RESERVOIR NO.3 (Improved_d/b to be updated) None. Investigate stability.		5000 100 0 0	0.020 0.634 0.000 0.000	20 20 0 0	0.5 0.5 0 0	6.412	3	N Adequate. Programmed for...?

No. Sector (years)	Major risk aspect	DAM NO. Action to be taken (*urgent)	NAME OF DAM	Category T (Years)	PF	LL	AL	EL (Total)	EPP (Y/N)	STATUS /	DSI interval PROGRESS	
97	Spillway Structure Piping	G402/57	BOTRIVIER RAILWAYS DAM	2	200 500 100	0.394 0.181 0.634	9 4 9	1 1 1	6.367	Y	Programmed for 2006/7 Adequate Programmed for 2006/7	8
98	Spillway Structure No O&MM and EPP	B310/01	RUST DE WINTER DAM (Improved, d/b to be updated)	3	500 5000 0	0.181 0.020 0.000	40 40 0	0.8 0.8 0	6.325	N	Programmed for 2006 - 2008 Adequate Outstanding	8
99	Spillway Structure	S702/07	XILINXA DAM	3	1000 500	0.095 0.181	30 30	0.8 0.8	6.225	Y	Adequate Programmed for ???	8
100	Spillway Structure (Wet patch) No O&MM and EPP	S600/04	GUBU DAM	3	6000 300 0 0	0.017 0.284 0.000 0.000	30 30 0 0	0.7 0.7 0 0	6.210	N	Adequate Adequate Programmed for ???	8
101	Spillway Capacity Structural Stability	S302/36	OXKRAAL DAM-CISKEI	3	5000 10000	0.020 0.010	300 300	0.7 0.7	6.207	Y	Adequate Adequate	8
102	Spillway Structure	T201/03	MTATA DAM	3	5000 1000 0 0	0.020 0.095 0.000 0.000	54 54 0 0	1 1 0 0	6.109	Y	Adequate Adequate	8
103	Spillway Capacity Structural Stability O & MM	C221/55	FOREST HILL NO 2 RESERVOIR	2	50 0 0 0	0.867 0.000 0.000 0.000	0 10 0 0	0.7 0 0 0	6.072	Y	Adequate Adequate Adequate	8
104	Spillway Structure - high phreatic surface Outlet works out of order Inlet tower and access bridge is a safety hazard	X302/26	KASTEEL DAM	2	1000 50 50 20	0.095 0.867 0.867 0.994	4 7 7 1	1 1 1 1	6.072	N	Adequate Programmed for 2007 Programmed for 2007 Programmed for 2007	8
105	Spillway Structure	K100/02	HARTBEESKUIL DAM	3	2000 500 0 0	0.049 0.181 0.000 0.000	42 28 0 0	0.7 0.7 0 0	6.048	Y	Adequate Adequate	8
106	Spillway Capacity Structural Stability O & MM	V100/01	SPIOENKOP DAM	3	10000 10000 0	0.010 0.010 0.000	600 600 0	0.5 0.5 0	5.941	Y	Adequate Adequate Outstanding	8

APPENDIX D: PHOTOGRAPHS OF INTERESTING CASE STUDIES



Helderstroom Donkerhoek Dam

Department of
Correctional
Services

Betterment Works to
Spillway Return
Channel Training
Wall

May 2010



Jan F La Grange Dam

Ladismith, Western
Cape.

Wet condition on
downstream face
reported to Dam
Safety Office during
the year.

The municipality has
been instructed to
operate the dam
level below a
specified level until
the problem has
been resolved.



Hogsett Dam

Dordrech, Eastern Cape.

Dam failed on 24 February 2011, most likely due to overtopping.

This relatively small dam was never registered or inspected.

H = 15 m
V = 125 000 m³.



Hogsett Dam

The spade indicates the water level at this house in Dordrecht, possibly due to the failure of Hogsett Dam.



Gariep Dam

Department of
Water Affairs

Spilling on 9
January 2011.



Ngqeleni Dam

Department of
Water Affairs

Construction started
in 2006 but the
upstream rip rap has
not been completed
yet.



Ngqeleni Dam

Construction started in 2006 but the upstream rip rap has not been completed yet.



Bedford Dam under construction near Harrismith in the Free State.

ESKOM (Ingula Hydro Power Station).

The upper reservoir of the pump storage scheme consists mainly of a concrete faced rockfill dam (CFRD) wall.

Construction is nearing completion, Sep 2010.



Bedford Dam
Closer view of construction of upstream reinforced concrete membrane, on top of concrete kerbs at the outer edge of placed rockfill.



Bramhoek Dam (gravity arch) under construction near Ladysmith in KZN.
ESKOM (Ingula Hydro Power Pump Storage Scheme).
This RCC (roller compacted concrete) dam wall is also nearing completion, Sep 2010.
This dam forms the bottom reservoir of the pump storage scheme.



Molepo Dam near Zion City in Limpopo.

Department of Water Affairs.

Major rehabilitation work, which included raising and stabilising the earthfill wall, provision of new spillways and provision of new outlet works, was completed during the year.



Molepo Dam

The new multi arch "rubble" masonry spillway structure is performing quite well during first spilling after completion.



Goxhill Dam near Himeville in KZN.

Pholela Irrigation Board

Overview of new dam under construction in the Pholela River near Himeville during September 2010.



Goxhill Dam

Foundation preparation in core trench before starting with earthfill placing.



Goxhill Dam

River outlet pipe used as river diversion, September 2010.



Goxhill Dam

Discharge through river outlet pipe was just able to prevent water level to reach spillway level, following rain storm in Dec 2010.



Goxhill Dam near Himeville in KZN.

Spillways were still incomplete at start of rain season, Dec 2010. Dam filled up rapidly after rain storm.



Goxhill Dam

Low flow spillway was still under construction during Dec 2010.



Goxhill Dam

Main flood spillway was still incomplete, Dec 2010. Picture shows preparation for construction of one of the reinforced concrete ground beams to limit erosion in this bywash type of spillway.



Goxhill Dam

This picture shows the effective functioning of the same concrete ground beam limiting erosion during a small flood in January 2011. Grass protection was not yet in place. (Photograph courtesy of MBB, Pietermaritzburg).



**Mhlabatsane Dam
near Highflats,
KZN.**

Umgeni Water

New dam under construction, Dec 2010. Left flank foundation for earthfill wall in background.

Concrete spillway with gravity retaining walls to be constructed in foreground. Grout holes being drilled in foreground.



Mhlabatsane

Right flank foundation for earthfill wall in background.

Concrete spillway with gravity retaining walls to be constructed in foreground. Grout holes being drilled for grout curtain.