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Directorate: Options Analysis

Raising Of Clanwilliam Dam

RECORD OF IMPLEMENTATION DECISIONS

April 2013

Approval

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Abbreviations

AAR	Alkali-aggregate reaction
ASR	Alkali-siliceous reaction
CAPEX	Capital expenditure
CBP&E	Current best practices and efficiency
CDS	Citrusdal syncline
CMA	Catchment management agency
CWT	Clanwilliam trough
°C	Degrees celcius
D:EA&DP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DEA	Department of Environmental Affairs – previously known as
DEVCO	Development company
DWA	Department of Water Affairs previously known as DWAF
DWAF	Department of Water Affairs and Forestry
GWCA	Government water control area
ha	Hectare
HDI	Historically disadvantaged individual
JV	Joint venture
LORWUA	Lower Olifants River Water User Association
LRAD	Land Redistribution for Agricultural Development
mamsl	Metres above mean sea level
MAP	Mean annual precipitation
MAR	Mean annual runoff
MIG	Municipal infrastructure grant
Mm^3/a	million cubic metres per annum
m^3	cubic meter (equal to 1 kilolitre or 1 000 litres)
m^3/a	cubic metres per annum
m^3/s	cubic metres per second
NOC	Non-overspill crest
ODA	Olifants River Development Agency
ODRBS	Olifants/Doring River Basin Study
ORGWS	Olifants River Government Water Scheme
ORS	Olifants river syncline
ORSA	Olifants river system analysis
OX&M	Operation and Maintenance
PAETA	Primary Agriculture Education and Training Authority
PES	Present ecological state
RCC	Roller compacted concrete
RPF	Resource-poor farmers
SEF	Safety evaluation flood
TMG	Table Mountain group
URV	Unit reference value
WAR	Water allocation reform
WMA	Water management area
WODRIS	Western Cape Olifants/Doring River Irrigation Study
WRYM	Water resources yield model
WUA	Water user association
WUL	Water use license

List of Units

mm	millimeter
m	meter
km	kilometer
ha	hectare
km^2	kilometer square
masl	meters above sea level
l	liter
million m^3	million cubic meters
l/cap/day	liter per capita per day
Ml/day	mega liter per day
MW	mega watt
million m^3/a	million cubic meters per annum
m/s	meter per second
m^3/s	cubic meter per second
s	second
min	minute
hr	hour
a	annum
c/m^3	cents per cubic meter (100 cents per Rand)
R/m^3	Rand per cubic meter
GWh	giga watt hour
GWh/a	giga watt hour per annum

1. INTRODUCTION

1.1 Background

The Olifants River Government Water Scheme (ORGWS) supplies raw water from the Clanwilliam Dam to farmers, municipalities, mines and industries in the Olifants River valley between the dam and the estuary.

Clanwilliam Dam is located on the Olifants River in the Western Cape, approximately two kilometres south west of the town of Clanwilliam. Construction of the Clanwilliam Dam was completed in 1935 with a capacity of 69,9 million m^3. The original Clanwilliam Dam was a mass gravity concrete structure with a centrally situated ogee spillway section, 117.5 m long. During the raising, from 1962 to 1966, the overspill crest was increased in length, re-modelled and raised by the addition of 3,05 m of mass concrete to the top of the crest and the installation of 13 crest gates, each 7,77 m wide by 3,05 m high to provide for increasing irrigation water demand. The non-overspill flanks were raised 4,88 m by means of mass concrete. A bridge superstructure was built across the dam to provide access for the operating of the gates. For stability, the dam is tied to its foundation by means of post-tensioned cables positioned along the centreline of the dam, spaced from 1,52 m in the middle section to 3,05 m on the flanks. The height of the dam wall is currently 43 m. The total length of the dam wall is 255 m. The capacity of the dam is 128 million m^3, with a live storage capacity of 122 million m^3.

Most of the surface flows originate in the Cederberg Mountains and are carried to the Atlantic Ocean by the Olifants and Doring Rivers (only the Olifants is a perennial river). The catchment area of the Clanwilliam Dam is 2 033 km^2 in extent. The mean annual runoff (MAR) of the Olifants River, above the Clanwilliam Dam, is 368 million m^3. The historic firm yield of the ORGWS (Clanwilliam Dam and Bulshoek Weir) at current development levels is 124 million m^3/a.

The Jan Dissels River is a tributary flowing into the Olifants River below the Clanwilliam Dam, but upstream of the Bulshoek Weir. The mean annual runoff of the Jan Dissels River is estimated as 43 million m^3 and other tributaries contribute another 34 million m^3.

Spills from the Clanwilliam Dam flow into the Bulshoek Weir. The seepage at the Bulshoek Weir occurs during dry periods and is pumped back into the canal supplying water to the Lower Olifants River Water User Association (LORWUA).

The dam wall suffered chemical attack over the years. In previous dam safety investigations it was found that the stability of the dam and especially the anchors, under high flood conditions during extreme events, does not meet the safety standards. It is thus required to perform extensive remedial works to maintain the integrity of the infrastructure. This provided the opportunity to increase the storage capacity of the dam at the same time through a raising of the full supply level (FSL) of the dam.

The feasibility dam design for the potential raising of the dam was investigated in 2006 by the Sub-directorate: Dam Safety Surveillance. The proposed raising thus aims to increase the storage capacity as well as to improve the stability of the current structure.

Various options regarding the details and height of the raising were investigated. The preferred option for raising the dam is a concrete mass gravity raising by 13 m on the downstream side without crest gates. The inlet and outlet structures also need to be improved to provide for multilevel inlets.

The background to the project is further described in Section 2.

1.2 Scope of the Record of Implementation Decisions

A Memorandum of Agreement between the Chief Directorates Integrated Water Resources Planning (CD: IWRP) and Infrastructure Development (CD: ID) dated March 2005, clarifies "*the division and/or sharing of roles, responsibilities and accountability of the Chief Directorates through the various project phases from planning to the commissioning of a project*".

The Memorandum furthermore states that once the detail planning of the Project has been concluded and the scheme configuration and other related requirements for implementation have been approved by the Minister, the project shall be formally handed over by the CD:IWRP to the CD:ID for implementation. This formal handover of the project is concluded through an official document called the Record of Implementation Decisions (RID), and is signed off by responsible officials from both the CD:IWRP and the CD:ID.

The RID describes the scope of the project, the specific configuration of the scheme to be implemented, the required implementation timelines, the finalisation of required institutional arrangements and the required environmental mitigation measures as described in the Environmental Impact Report (EIR) as well as any further requirements that may be prescribed by the Western Cape Provincial Department of Environmental Affairs and Development Planning (D:EA&DP) in the Record of Decision (ROD).

Any work carried out outside of the scope of the RID is considered unauthorised work unless official approval for such work has been obtained from the CD:IWRP prior to such work being carried out. The powers of the CD:IWRP to authorise the extent of development is vested in the approval by the Minister. Anything beyond what was originally approved by the Minister then becomes unauthorised developments.

This document serves as the RID for the implementation of the raising of the Clanwilliam Dam and therefore concludes the formal handover of the project from CD:IWRP to CD:NWRI. The purpose of the RID is to enable the Department of Water Affairs (DWA) to implement the decisions taken on the basis of the recommendations of the Feasibility Study. In this regard the Feasibility Study report and other reports serve to support this document. The RID should be read in conjunction with the original Feasibility Study

reports and associated reports as well as the Environmental Impact Assessment (EIA), the ROD as issued by D:EA&DP, and the reserve determination study report, amongst others.

The Ministerial approval is included as **Appendix A**. The Feasibility Study reports are listed in **Appendix D**.

The RID does not only deal with the construction of the physical infrastructure but also touches on the water allocation reform (WAR), the institutional arrangements and the other aspects that are required for the successful implementation of the project.

2. OVERVIEW OF THE PROJECT

2.1 Olifants-Doorn Water Management Area

The Olifants-Doorn Water Management Area (WMA) is located on the west coast of South Africa, extending from about 100 km to 450 km north of Cape Town. The south-western portion mainly falls within the Western Cape Province, and the north-eastern section falls within the Northern Cape Province. The catchment is characterised by a Mediterranean climate (winter rainfall). The area is characterised by vast, rural agricultural and conservation land, being sparsely populated with small urban centres. Irrigated agriculture includes citrus, deciduous fruits, grapes, potatoes and summer vegetables. Estimates of the total land under irrigation in the WMA vary, but are more than 50 000 ha. Although the focus of the Feasibility Study for the Raising of Clanwilliam Dam was on the main stem of the Olifants River, the study took into account water management area level considerations.

The three established water user associations (WUAs) in the Olifants River are the Citrusdal WUA, the Clanwilliam WUA and LORWUA. LORWUA irrigators receive their water from the canal system below Bulshoek Weir.

The study area of the feasibility study and the related areas of jurisdiction of the different local authorities are shown in **Figure 2.1**. The ORGWS comprises the Clanwilliam Dam, Bulshoek Weir and a canal system to irrigate land extending along the Olifants River. Clanwilliam Dam and Bulshoek Weir are state-owned.

Irrigation infrastructure in the WMA consists of irrigation directly out of the river, water pumped out of the river and stored in off-channel dams, and diversions of the river into irrigation canals. There are numerous farm dams throughout the upper Olifants and Doring River catchments.

Water is released from Clanwilliam Dam (live storage 122 million m^3) into the river to flow to Bulshoek Weir (live storage 5,4 million m^3), some 30 km downstream. Downstream of the weir water is distributed by a canal system, consisting of main and distribution canals totalling 186 km in length. Current canal losses are high, and the canals and associated infrastructure are generally in a poor state.

The Clanwilliam Canal system, operated by the Clanwilliam WUA, starts at Clanwilliam Dam and supplies water to Clanwilliam town and some 750 ha of irrigation.

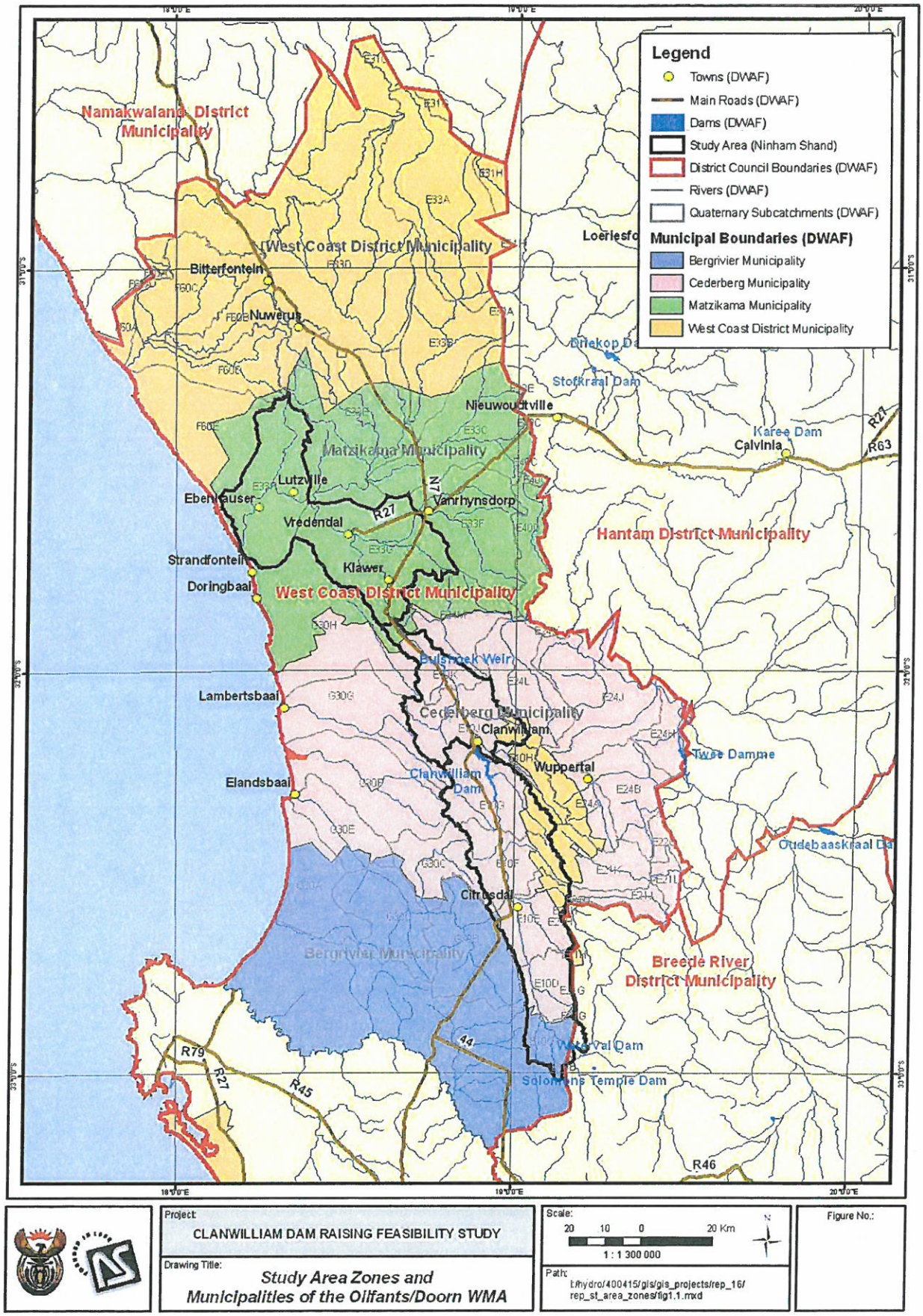

Figure 2.1: Study Area Zones and Municipalities of the Olifants - Doorn WMA

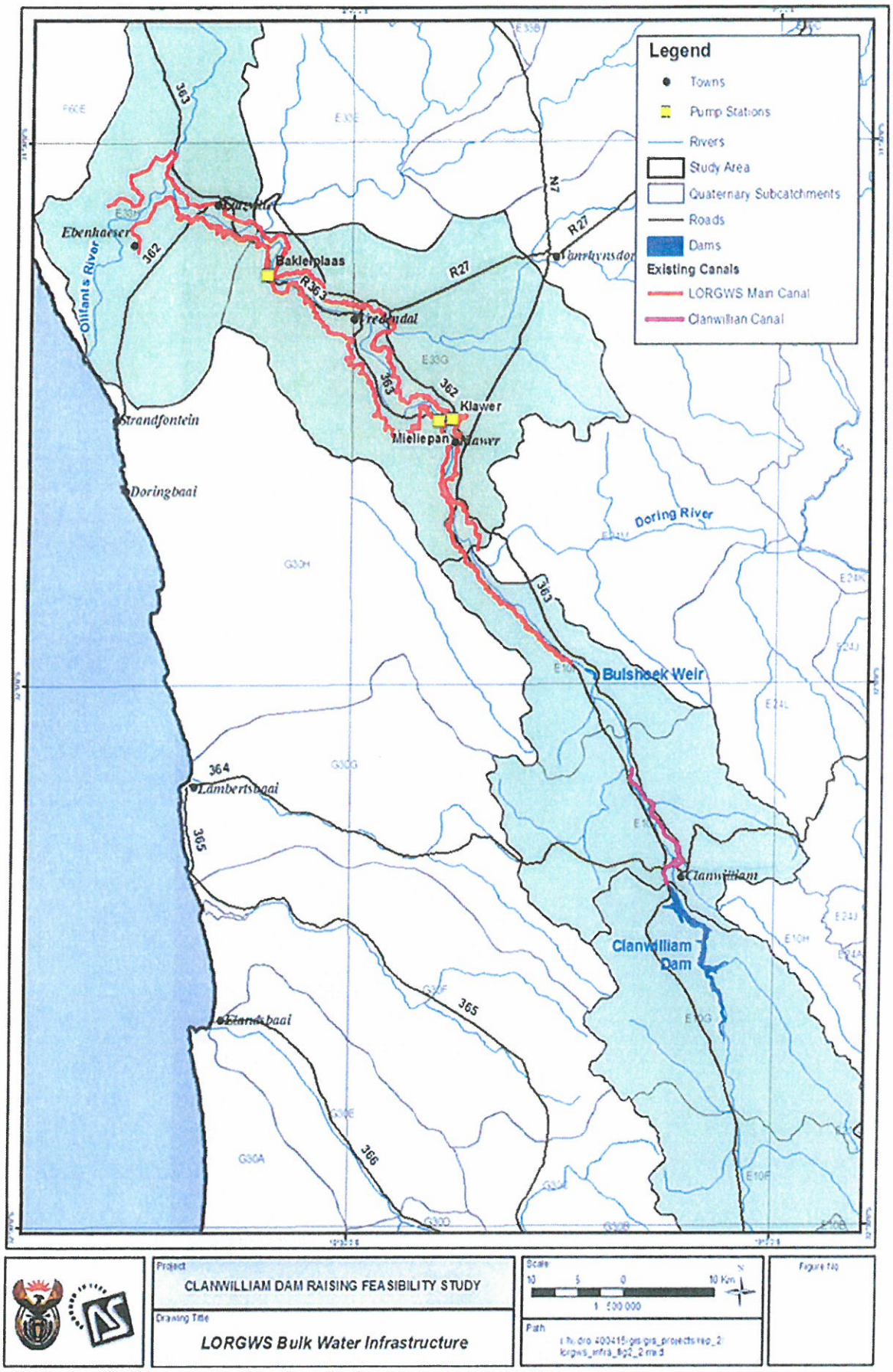

Figure 2.2: ORGWS Bulk Water Infrastructure

2.2 Raising of Clanwilliam Dam

The Clanwilliam Dam, a mass gravity structure, located on the Olifants River in the Western Cape near the town of Clanwilliam, was originally built in 1935, and was raised in the 1960s. There is a requirement for a better assurance of supply for agriculture on the ORGWS and opportunity and interest for further water allocations to be made. The need has further been identified to allocate additional water to resource-poor farmers in this area.

The natural MAR of the Olifants River above the Clanwilliam Dam is 356 million m^3. The storage of Clanwilliam Dam is currently only about 30% of the present day MAR. The dam catchment has a live storage capacity of 122 million m^3, with a historic firm yield of 149 million m^3/a (without any allowance for the EWR). Its full supply is at reduced level (RL) 105,25 m. The dam spills almost every year and the allocation for the coming year is dependent not on how much water flowed into the Clanwilliam Dam, but on how late in the season the last rains come.

The area currently under irrigation from the dam is estimated at about 15 000 ha. Water is also supplied to several towns and to the Namakwa Sands Mine, as well as to some other smaller users.

The average supply from the ORGWS (excluding losses) over the last 25 years was estimated as 174 million m^3/a, although during droughts the supply would have been curtailed. Farmers currently receive water at an unacceptably low assurance of supply.

The dam safety investigations found that the safety margins during floods in consideration of the risk associated to the cable anchoring of the wall is not in accordance with the required standards. It is thus required that remedial work be done, which will comprise the adding of a downstream apron and adding additional concrete to the downstream face of the dam wall, to improve the stability of the mass gravity wall. This aspect is described in detail in the DWA Internal Report no. 20/2/E100-02/C/1/1. These dam safety remedial measures present an opportunity to raise the FSL, if the marginal cost of raising, over and above the cost of the strengthening, is economically viable.

On the basis of the Olifants/Doring River Basin Study (2003) recommendation, the feasibility of raising the Clanwilliam Dam was investigated in 2007. The aim of the feasibility study was to verify the technical, environmental, social, economic and financial viability of raising the Clanwilliam Dam. The study also aimed to determine the optimal height for such raising, if found to be viable. Four raising options, namely no raising, 5 m, 10 m and 15 m raisings were considered. Other options for increasing supply volumes for irrigation, including clearing invasive alien vegetation, reducing system losses, implementing water demand management measures and exploiting the groundwater potential, were evaluated to ensure that the DWA is aware of the full range of alternatives and implications.

The feasibility study was supplemented by a yield analysis and a comprehensive reserve determination that provided the information and the basis for the Department to reach the decision to raise the Clanwilliam Dam.

The processes involved in the planning are briefly described in Section 3 while the recommended development option is described in Sections 4 and 5 of this document.

3. DETAILED PLANNING PHASE

3.1 Planning Processes

A detailed planning phase regarding the raising of Clanwilliam Dam has essentially been completed; this started off with the Basin study and progressed to the feasibility study with supporting studies. This evaluation determined the feasibility of the raising as well as the optimal increment of the raising. The planning also considered the water resources developments and related interventions needed to meet the requirements for development.

The process started off with the re-assessment of the most promising Basin development options and the consideration of management options. Relevant water resources, engineering, agricultural, environmental and socio-economic supporting investigations were conducted. These further included identifying appropriate agricultural development, institutional arrangements and funding options and the integration of the results into an overall solution and implementation programme.

Some of these investigations are briefly described below.

A comprehensive Environmental Impact Assessment with associated public participation and consultation was undertaken which culminated in the issue by the Western Cape Provincial Department of Environmental Affairs and Development Planning (DEADP) of an appropriate Record of Decision (ROD) for the Raising of Clanwilliam Dam on 12 May 2009. After the appeal process the original ROD was upheld by the DEADP in the appeal decision letter dated 22 February 2010. The expiry date of the ROD: Section J was amended to read as follows: 'This authorisation shall lapse if the activity does not commence within five (5) years of the date of issue of this appeal decision letter'.

3.2 Screening of Alternative Development Options

To gain acceptance for the study of the Raising of Clanwilliam Dam as a specific development option, a review and comparison (so-called screening) of all the potential development schemes (surface and groundwater) in the Olifants-Doorn WMA were undertaken, to determine how the raising of Clanwilliam Dam would influence the viability of other development options, and vice versa.

The three most favourable development options were found to be the development of off-channel farm dams, development of groundwater schemes, the raising of Clanwilliam Dam, or combinations of these three options.

The raising of Clanwilliam Dam was considered to be a favourable option because it does not introduce a new suite of associated environmental and social impacts, and it provides flexibility in terms of supplying potential beneficiaries, opportunities and development options for resource-poor farmers (RPFs), the position of new irrigation development and

crop variety. This scheme also provides the option of either large-scale RPF development or incremental development over time, depending on the flexibility in terms of funding the scheme.

3.3 Soils and Crops

A soils map was compiled for the Olifants River Basin from Keerom, south of Citrusdal, to the coast, and a new soil map legend was compiled. An expert system approach was used to evaluate the potential of the different soil complexes for the production of annual and perennial crops.

Five classes were used to rate the potential of soil types (see **Table 3.1)**.

Table 3.1: Classes used to evaluate the potential of soil types for irrigation

Potential	Recommendation for irrigated crop production	Percentage of maximum potential
Low	Not recommended	≤ 40%
Medium-low	Marginally recommended	> 40 - ≤ 50%
Medium	Conditionally recommended	> 50 - ≤ 60%
Medium-high	Recommended	> 60 - ≤ 80
High	Highly recommended	>80%

The surface area of five potential suitability classes for the production of tuberous and non-tuberous annual crops and perennial (citrus, wine grapes, mangos) crops before and after amelioration of subsoil limitations in the Olifants River Basin was determined as shown in **Table 3.2** and **Table 3.3**

Table 3.2: Surface area for irrigation from Keerom to Bulshoek Weir

Potential class	Annual tuberous crops (ha) [1)]	Annual non-tuberous crops (ha) [2)]	Perennial crops [3)]	
			Before amelioration (ha)	After amelioration (ha)
≤ 40 %	11536	10774	18077	8099
> 40 - ≤ 50 %	7718	7303	9660	11063
> 50 - ≤ 60 %	476	7463	1196	8575
> 60 - ≤ 80 %	9930	4118	726	1922
> 80 %	0	0	0	0
Total area (ha)	29 659			

Table 3.3: Surface area for irrigation from Bulshoek Weir to the coast

Potential class	Annual tuberous crops (ha)	Annual non-tuberous crops (ha)	Perennial crops	
			Before amelioration (ha)	After amelioration (ha)
≤ 40 %	83054	33457	86701	32540
> 40 - ≤ 50 %	812	5194	17418	1552
> 50 - ≤ 60 %	24264	21089	29118	2699
> 60 - ≤ 80 %	34464	82854	9356	105802
> 80 %	0	0	0	0
Total area (ha)	142 594			

The soils in the surveyed area from Bulshoek Weir to the coast differ greatly from those in the southern section. It was concluded that the availability of acceptable soils is not the limiting factor for new irrigation development in the area.

3.4 Water Use

3.4.1 Irrigation

3.4.1.1 Upstream of Bulshoek Weir

The irrigation water requirements upstream of Bulshoek Weir are shown in **Table 3.4**.

Table 3.4: Irrigation Water Requirements upstream of Bulshoek Weir

Quaternary Catchment	Crop Area (ha)	Irrigation Demand (million m^3/a)	Average Annual Demand (mm/a)
E10A	1,256	12.23	974
E10B	917	7.96	869
E10C	249	1.72	693
E10D	1810	13.13	725
E10E	2768	21.39	773
E10F	2056	16.52	803
E10G	2530	23.58	932
Subtotal u/s Clanwilliam Dam	**11,585**	**96.53**	**833**
E10H	146	1.83	1,255
E10J	1,927	18.97	984
E10K	239	2.74	1145
Subtotal u/s Bulshoek Weir	**2,312**	**23.53**	**1,018**
Total for E10	**13,897**	**120.07**	**864**

3.4.1.1 Irrigation downstream of Bulshoek Weir

The off-channel storage dams downstream of the Bulshoek Weir are relatively small in comparison with the Clanwilliam Dam.

Table 3.5 indicates which dams get their water from the canal and which obtain water from rivers such as the Olifants, Doring or tributaries.

Table 3.5: Major storage downstream of the Bulshoek Weir

Registered farm name	Capacity (Ml)	Canal	River		
			Tributary	Olifants	Doring
Zypherfontein	1 000			Y	Y
Vleikraal	242		Y		
Vaalwater	210		Y		
Winkelskloof[1]	765				
Heever	250		Y	Y	
Bruinklip	110			Y	
Maleco		Y		Y	
Melkboom		Y		Y	
Ebenhaeser balancing dam	140	Y			
Koekenaap canal	129	Y			
Olifantsdrif	4 076			Y	
Zoutpansklipheuwel	900			Y	

1) The dam was not yet constructed at the time that the assessment was made

3.4.1.2 Opportunistic irrigation downstream of Bulshoek Weir

Irrigators downstream of the Bulshoek Weir requested a concession from the Minister of Water Affairs to use the water leaking from the weir. In June 1963 the Minister approved 10 morgen (8.6 ha) Water Permit Concessions in terms of Section 62 (2) of the Water Act (1957) allowing existing riparian members of the ORGWS to irrigate an additional 8.6 ha using this water. A letter from the Minister of Water Affairs dated 7 September 1972 spelt out that this was a temporary concession and that the State could continue with developments upstream in the catchment without compensating these irrigators in any way.

As a result of this proviso the LORWUA were able to install a pump downstream of Bulshoek Weir from 2005 that intercepted and pumped the leakage back into the ORGWS Main Canal from where it was distributed to the irrigators. Because the irrigators only received the concession if they had rights to water from the ORGWS this action should not

have impacted on their operations as they would have been entitled to water from the canal.

A subsequent study provisionally estimates the extent of the usage under this concession as follows:

- The total number of persons listed in a DWAF document that could possibly have applied for the 10 morgen (8.6 ha) concession was 439;
- 150 properties responded to a public participation process and completed questionnaires;
- There is to date clear evidence for only 17 concessions;
- A further 18 cases were found which in terms of the assessment were "highly likely" to qualify for a concession;
- An approximately 122 properties have "probably likely" to be able to qualify; and
- An approximately 127 properties have a "low probability" of qualifying.

Table 3.6: gives an indication of the range in irrigation requirements of concessions downstream of Bulshoek Weir.

Table 3.6: Concessions downstream of Bulshoek Weir

Component	Unit	Almost certain	Highly likely	Probably likely	Unlikely	Totals
Number of concessions	No.	17	18	122	127	284
Land area	Ha	146	155	1049	1092	2242
Demand per category	Million m^3	2	2	13	13	30

3.4.1.3 Historical Water Use from Clanwilliam Dam and Bulshoek Weir

Figure 3.1 charts the annual gross water supply, from 1980 to 2006, to the major consumers. About 27% to 30% of the flow to the Lower Olifants River and Clanwilliam Canals is lost through seepage and evaporation.

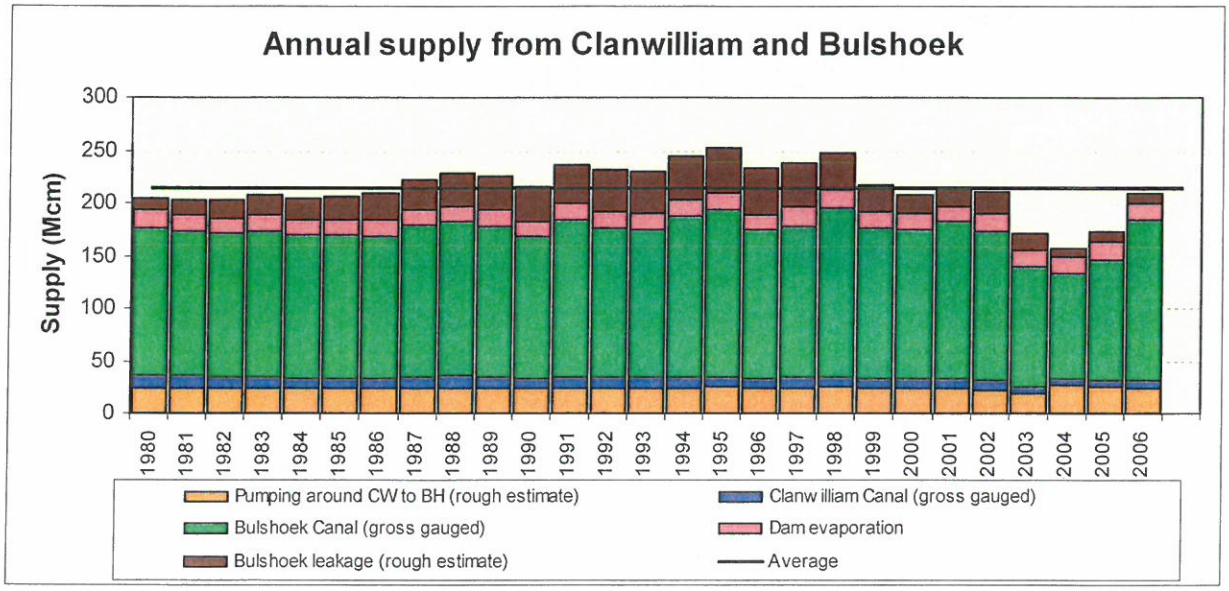

Figure 3.1: Historical annual supply from Clanwilliam Dam and Bulshoek Weir

3.4.2 Urban and industrial use

The municipality of Clanwilliam can receive water from Clanwilliam Dam via the Clanwilliam Canal to augment their supply from the Jan Dissels tributary. They will continue to augment their supply from Clanwilliam Dam after the raising of the dam. The municipality has further evaluated conveyance infrastructure that would be needed to potentially increase their supply from the dam, after it has been raised. Their use is currently constrained by the capacity of their water treatment works (0.95 million m^3/a).

The non-agricultural quota from the ORGWS canal is 8.4 million m^3/a. A number of towns (Vredendal, Lutzville, Vanrhynsdorp, Klawer, Ebenhaeser, Strandfontein and Doringbaai), the Namakwa Sands mine and the domestic requirements of farmers along the canal are also supplied from the Bulshoek Canal.

3.5 Distribution options

This investigation focused on the distribution options of additional yield that is made available through the raising of Clanwilliam Dam. The range of available options to productively and cost-effectively use and distribute the additional water was investigated and costed. Advantages and disadvantages of these distribution options were compared to assess their viability. It can be deduced that the availability of land with suitable soil for irrigated agriculture is not a limiting factor to the expansion of irrigation in the study area. The following water use or distribution options were considered.

3.5.1 Potential options for Region 1: Area upstream of Clanwilliam Dam

Since there is very little scope for irrigation development upstream of Clanwilliam Dam without creating more storage, the water for any new irrigation in this region will likely be

sourced from the river in winter and stored in new off-channel farm dams. These are expected to be expensive options, which would include:

- Expansion of irrigated areas on existing farms; and
- Establishment of new irrigation on new farms.

The effect of the taking of water by users upstream of Clanwilliam Dam on the viability of downstream development would need to be determined.

3.5.2 Potential options for Region 2: Area between Clanwilliam Dam and Bulshoek Weir

Water would be released from Clanwilliam Dam into either the Olifants River, or the existing Clanwilliam Canal. Storage would be provided by Clanwilliam Dam, so it is unlikely (in most cases) that new off-channel farm dams would be required. These options are:

- Increased assurance of supply;
- Expansion of irrigated areas on existing farms;
- Establishment of new irrigation on new farms; and
- Irrigation in the Jan Dissels catchment, either with water released into the Clanwilliam Canal and abstracted by farmers in the lower part of the Jan Dissels catchment, or alternatively abstraction directly from the Olifants River, by a few farmers right at the bottom end of the Jan Dissels tributary. The precise locations and size of farms to make use of such allocations need to be clarified.

3.5.3 Potential options for Region 3: Area downstream of Bulshoek Weir to the estuary

Water can be released either into the ORGWS main canal or down the Olifants River. Water from the river could be pumped into canal sections with spare capacity to avoid bottlenecks in the canal. Abstraction could therefore be from the canal or from the river. Without an increase in the capacity of the canal system, spare capacity in the canal system or increasing salinity in the downstream reaches of the Olifants River will be the limiting factors for the amount of water that can be allocated. Infrastructural improvements to the existing ORGWS canal system are therefore considered to increase the carrying capacity. These options are:

- Increased assurance of supply;
- Expansion of existing farms, or establishment of new farms in the Melkboom/Trawal or Klawer/Vredendal areas (water supplied via and pumped from the existing canal system), with or without the need for additional balancing storage i.e. farm dams;

- Releasing water downriver from Bulshoek Weir and pumping into canal sections to use spare capacity in identified canal sections;
- Increasing the carrying capacity of sections of or the entire canal system, inclusive of:
  - Reducing losses in the canal by refurbishing the canal system;
  - Increasing the capacity of the canal system by raising the canal or getting rid of bottlenecks;
  - Replacement of the canal system, either by a new canal system or pipeline;
  - Provision of new balancing dams along the canal system;
- Pumping directly from the Olifants River in the Melkboom/Trawal or Klawer/Vredendal areas for expansion of irrigated areas on existing farms or the establishment of new irrigation on new farms;
- Pumping directly from the Olifants River to the proposed Zypherfontein Irrigation Scheme (new green fields large-scale scheme); and
- Expansion of supply to the existing Ebenhaeser community (existing large-scale scheme) at the end of the canal.

3.6 Water Demand Management

The aim of the water demand management investigation was to highlight options available for improved water demand management and to make recommendations on how to improve efficiency and save water, in addition to yield becoming available from a raised dam. The objective of the Water Management Plan (WMP), as the deliverable, is to improve agricultural water management by stimulating self-analysis and forward thinking on the part of farmers, WUA officials, CMA officials, consultants and advisors.

A first version WMP for the Olifants/Doorn CMA was therefore developed as part of the feasibility study. One of the major goals of the WMP is to set clear guidelines for communication and water distribution between the WUAs and other stakeholders. It is important for the WUAs to develop their own individual WMPs, using the Olifants/Doring CMA WMP as a guideline. The CMA WMP concentrates on the Olifants and Doring Rivers, and in particular the Clanwilliam Dam and Bulshoek Weir, the Lower Olifants River Canal and Clanwilliam Canal. These form the main elements in the development of the Olifants River and would be influenced by the raising of the Clanwilliam Dam.

Water demand management measures have been identified and discussed as implemented by farmers, irrigation boards or WUAs. Little information is available regarding the irrigation management above the Citrusdal WUA area. Action Plans were developed at desktop level. The Action Plans do not form a complete list of possible activities that the CMA has to perform, and it is expected that the CMA would identify further actions.

3.7 Hydrological Studies

3.7.1 Yield Analysis

Because of the severe nature of the drought of 2003 to 2005, which could have affected the reliability of the yield from the dam, the recently observed streamflow records were used to extend the estimated runoff from the catchment, from 1920 to 2005.

As part of this study the following were updated for the catchment upstream of the Bulshoek Weir:

- Land use and agricultural demands;
- Dam capacities (farm and government water schemes);
- Extent of alien vegetation.

The natural MAR of the Olifants River above the Clanwilliam Dam is 356 million m^3. The average supply from the Lower Olifants River Government Water Scheme over the last 25 years was estimated as 174 million m^3/a, although during droughts the supply would have been curtailed. Farmers currently receive water at a very low assurance of supply.

If Clanwilliam Dam is raised then the dam will absorb more of the winter streamflows before it spills and, as a result, the spillage over the dam will be reduced and delayed. To meet estuarine Reserve flow requirements, releases from Bulshoek Weir could supplement the streamflow at Lutzville to maintain the minimum streamflow at 1.5 m^3/s, providing that the baseflow did not exceed natural streamflow.

Various scenarios were analysed, using the WRYM, to determine the historical yields of the system for the existing (unraised) dam and for three different dam raisings. Yields were also determined at various levels of assurance of supply for the current dam and the three dam raising options. The estimated additional yield from a 13 m raising is 69.5 million m^3/a.

From Table 3.7, when compared to the current system, with a drought EWR implemented (historical firm yield (HFY) of 133 million m^3/a), the increase in HFY for a raised dam with a baseflow EWR implemented (HFYs of 165, 192 and 206 million m^3 respectively) is 32, 59 and 73 million m^3/a respectively. These yields were used to determine the yield of the raised dam, as the leak at Bulshoek Weir was considered to be similar to a drought EWR release.

When compared to the current system with no EWR implemented (HFY of 149 million m^3/a), the increases in the HFY are 16, 43 and 57 million m^3/a respectively.

Table 3.7: Yield analysis results

Scenario	Recurrence interval	Absolute yield				Increase in yield with regard to current system yield			
		Dam raising				Dam raising			
		0 m	5 m	10 m	15 m	0 m	5 m	10 m	15 m
No EWR	1 in 5 yrs	185	235	274	305	-	50	89	120
	1 : 10	175	219	248	275	-	44	73	100
	1 : 20	169	197	234	263	-	28	65	94
	HFY	149	184	213	227	-	35	64	78
Drought EWR	HFY	**133**	169	199	214	-	36	66	81
Baseflow EWR	1 in 5 yrs	168	213	254	279	-	45	86	111
	1 : 10	161	196	225	254	-	35	64	93
	1 : 20	156	184	213	242	-	28	57	86
	HFY	128	**165**	**192**	**206**	-	37	64	78
Full EWR	1 in 5 yrs	161	203	238	266	-	42	77	105
	1 : 10	154	183	207	239	-	29	53	85
	1 : 20	142	160	195	218	-	18	53	76
	HFY	124	157	172	187	-	33	48	63

Figure 3.2 shows the additional scheme yields for the various dam raising options. The incremental yield drops after 10 m raising and drops severely after 12.5 m raising.

The potential for additional private diversion from the Olifants River, upstream of Clanwilliam Dam, was assessed by analysing diversions for a range of flows, up to 3 m^3/s. It was concluded that there is potential to pump additional water from the upper Olifants River during winter, for use upstream of the Dam during summer, but the yield of the raised Dam would have to have to be adjusted to take such diversions into account

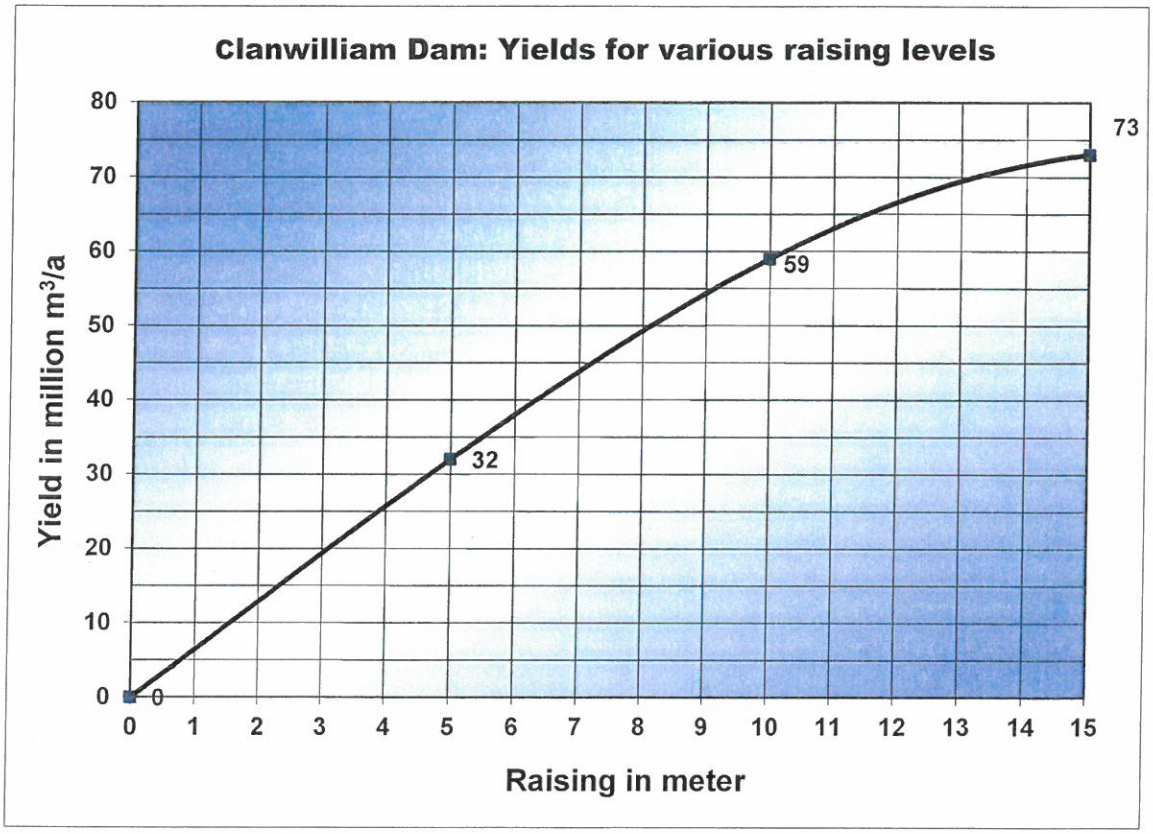

Figure 3.2: Yields for various dam raising levels

3.7.2 Flood Hydrology and Spillway Capacity

The Directorate Hydrological Services of the DWA conducted a flood frequency analysis for Clanwilliam Dam, in 2005. The 1:200 year flood of 1 705 m^3/s was taken as the recommended design flood (RDF). The safety evaluation flood (SEF) is 4 500 m^3/s.

3.8 Comprehensive Reserve Determination

A Comprehensive Reserve determination for the Olifants/Doring River system was completed in 2006. This study focused on the riverine and estuarine ecological water requirements (EWR), including a socio-economic assessment of the catchment-wide flow scenarios. EWRs were determined at six EWR sites, two of which are on the Olifants River, two on the Doring River, and the remaining two on representative tributaries, one being the Rondegat River that flows into Clanwilliam Dam. An EWR site was not selected in the reach of the Olifants River between Clanwilliam Dam and Bulshoek Weir because the riparian and instream vegetation was severely burnt just before the study. A Preliminary Reserve for the Olifants River, downstream of Bulshoek Weir to the confluence with the Doring River (EWR Site 2), has been approved by the Director General of the DWA.

The EWR of the ecologically important Olifants River estuary was also determined. A C-category was recommended to stabilise the current negative trajectory and to maintain the present ecological status (PES) of the estuary. It was concluded that the estuary could be maintained in its present Category C if the Clanwilliam Dam was raised and if the augmentation flows for the summer base flow EWR for the river reach between Bulshoek Weir and the confluence with the Doring River was released from Bulshoek Weir.

3.9 Water Quality

An increase in the height of the dam wall would affect the thermal structure and dynamics of the impoundment. The potential impact of raising the dam wall on thermal stratification and release temperatures was investigated as well as the mitigating effects of installing a multi-level outlet structure.

The water quality requirement is predominantly a temperature constraint due to the spawning requirements of the Clanwilliam Yellow Fish. The temperature of water released from the impoundment should be within the range of 18-24°C during the months of October-January. The water being drawn off from a low level in the impoundment, during the spring and summer months, is normally cold (significantly below 18°C). The current impoundment could not meet either the discharge requirement or the temperature requirement for releases, should releases only be made from the bottom outlets. The change of spillway design from a gated structure to a solid crest for a raised dam is also likely to exacerbate this situation, as spills will be fewer than in the existing situation.

It was concluded that a raising in the height of the dam wall should be accompanied by a multi-level outlet structure, which would release water from various levels, thereby allowing water of different temperatures to mix in an attempt to meet the downstream temperature requirements. This would to some extent offset the impacts on reduced flows in the downstream river.

A reconnaissance level assessment of the present nutrient and eutrophication status of the impoundments of the Clanwilliam Dam and Bulshoek Weir was undertaken. It was concluded that the Clanwilliam Dam impoundment is in a good trophic state and it was estimated that, provided the phosphorus loads remain unchanged, there would probably not be a major shift in trophic status if the dam wall were raised. It was further concluded that the raising of Clanwilliam Dam would probably have little impact on the growth of filamentous algae in the lower reaches of the canal system.

3.10 Resource Poor Farmers

The Olifants River Valley is characterised by significant income and social disparities and fluctuating seasonal unemployment. The potential dam raising offers a unique opportunity to make water available to address some of these issues by supporting water allocation reform. The objective of this investigation was to identify ways in which the additional yield

made available through the dam raising can be used to meet these objectives and to ensure that the available natural resources of the area are used to the greatest benefit of society.

The investigation comprised a review of existing literature on resource-poor farmer (RPF) initiatives around the country as well as in the particular study area. A small workshop of stakeholders was held to consolidate ideas and this was followed by interviews with selected stakeholders. A number of other studies have already been conducted in the area. Results from these studies were analysed and used to make recommendations on appropriate models for using the additional yield to support RPFs and other Historically Disadvantaged Individuals (HDIs) in the area.

The suite of options that should be considered when water allocation is considered includes:

- Ensuring the protection of the Reserve, to provide socio-economic benefits such as tourism ventures, or through direct dependence.
- Allocation of additional water to the municipalities. Most of this water would be used to directly support equity needs.
- Allocation of water to ensure availability for municipal commonage schemes.
- Establishment of a development company (DEVCO) to co-ordinate the development of a sustainable broad based black economic empowerment agricultural project.
- Support for joint ventures (JVs) between existing commercial farmers and RPFs.
- Encouraging black commercial farmers and investors.
- Encouraging existing commercial farmers to provide sufficient land and water to existing farm workers.
- Using allocation of additional water as an incentive to make land available for land reform.
- Retaining water "in trust" for future allocation to HDI farmers, or for other development opportunities that may arise in the future.

The main conclusion from this evaluation was that there is potential to use water to support the development of HDIs in the area, but that the solution is not necessarily a single large-scale RPF scheme. Instead a suite of development options was proposed. The proposed development options will require significant engagement by the DWA and close co-operation with other spheres of government to ensure the success of any initiative.

3.11 Economic Assessment

A socio-economic impact assessment of the various dam raising options was conducted. There are a number of complexities, as some individuals and activities will benefit from the dam raising, while others will be either temporarily disrupted or permanently affected in a

negative way. A socio-economic impact assessment was needed to analyse and weigh these effects against one another.

Both the Cederberg and Matzikama Municipalities are characterised by vast, rural agricultural and conservation land, with small urban centres. The chief economic activity is agriculture, and poverty is particularly high in the rural areas.

Recognised input-output modelling techniques were utilised to determine the direct and indirect economic impacts of the various alternatives in terms of employment, economic growth and economic opportunities created and lost by each alternative. As not all of the impacts could be quantified, qualitative discussions supplemented the results of this modelling process. The results were framed within a national and regional policy context, as well as various international trends regarding sustainable development. It was determined that positive impacts far exceed the negative ones.

Social benefits of the Clanwilliam Dam raising are important for the poverty alleviation strategies of the study area. Jobs, new sources of income and opportunities for economic advancement are all created. With adequate support in terms of access to transport, training and funding, the project could result in significant improvements in the overall standard of living of the populations of the Cederberg and Matzikama Local Municipalities.

3.12 Financial Viability of Irrigation Farming

This investigation dealt with the evaluation of the financial viability of existing irrigation farming as well as the envisaged expansion of irrigation farming in relevant regions of the Olifants River system that may utilise additional irrigation water, following the raising of the Clanwilliam Dam. The envisaged expansion of irrigation farming addresses the option of the expansion of existing irrigation farms as well as the development of new irrigation farms.

Typical farming situations were modelled for each of the identified regions of the study area, with information *inter-alia* being provided by leading farmers and industry experts. The financial analyses were done at constant 2005/06 price levels. The financial viability of irrigation farming was evaluated with the aid of a computer model and by applying the decision-making criteria of profitability, affordability and the relative "efficiency" of the utilisation of irrigation water.

Farming practices in the relevant regions of the study area are relatively capital intensive and risky. It is clear from the financial analysis that, given the assumptions made, existing irrigation farming is quite profitable in the relevant regions of the study area. It seems that it might be more viable to expand existing farms than to develop new irrigation farms. In some areas though, the development of new irrigation farms would be profitable. The expansion of citrus farming upstream of the Clanwilliam Dam (i.e. irrigation development on individual farms in Citrusdal) is not envisaged to be profitable, mainly due to the expected relatively high cost of irrigation infrastructure.

Sensitivity analysis showed that, given the small variation in the unit cost of irrigation water that is associated with alternative dam raising possibilities, the water cost per se would only have a minor impact on the profitability level of individual farms.

Top-grade managerial and labour skills are preconditions for financial success and any shortcomings in this regard will have a negative impact on the financial results from farming.

3.13 Dam Raising Financial Evaluation

The financial evaluation focused on the cost of the dam, as well as the cost of water and its affordability. It further evaluated the various options available for the financing of the dam raising scheme, as well as the financing options available to resource-poor farmers.

Capital costs have been determined, with a base year of 2006, to make the dam safe for extreme events (0 m for dam safety), as well as for the raising of the dam by 5 m, 10 m and 15 m. Unit reference values (URVs) were determined for three scenarios, based on a range of assumptions, for the various dam raising options, and for discount rates of 4%, 6% and 8%, respectively.

The capital costs for the dam wall and for infrastructure costs related to the dam raising (excluding distribution costs) are shown in **Figure 3.3**.

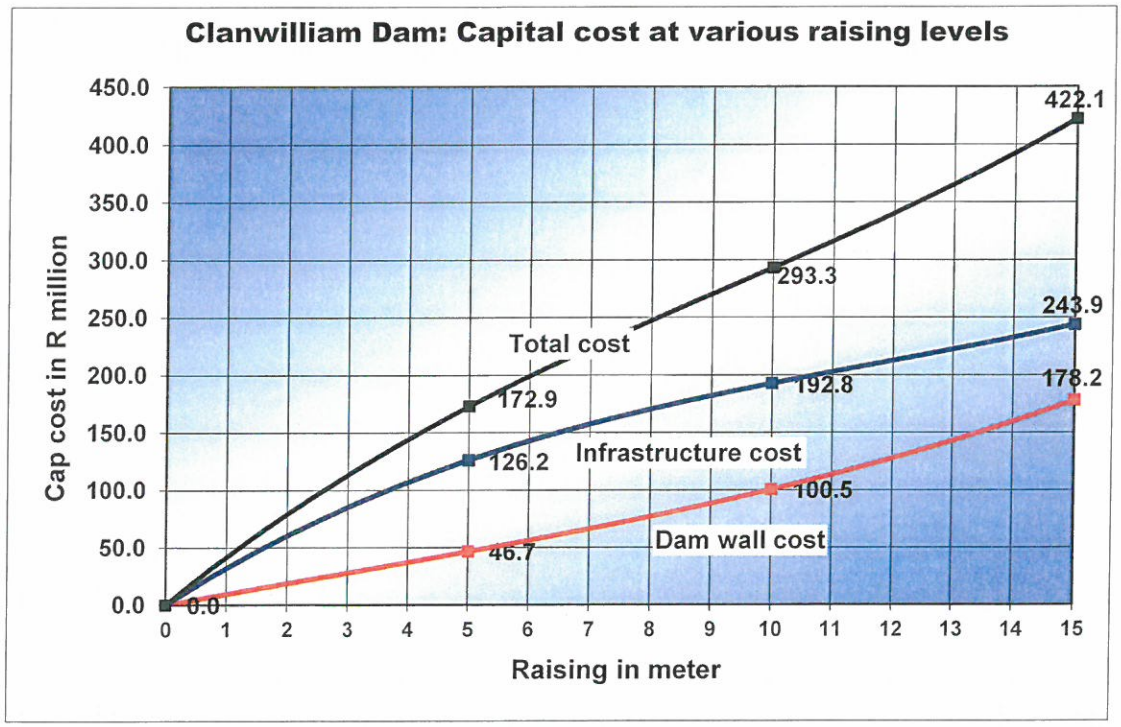

Figure 3.3: Capital Costs of Dam Wall Raising

Incremental URVs are shown in **Figure 3.4**.

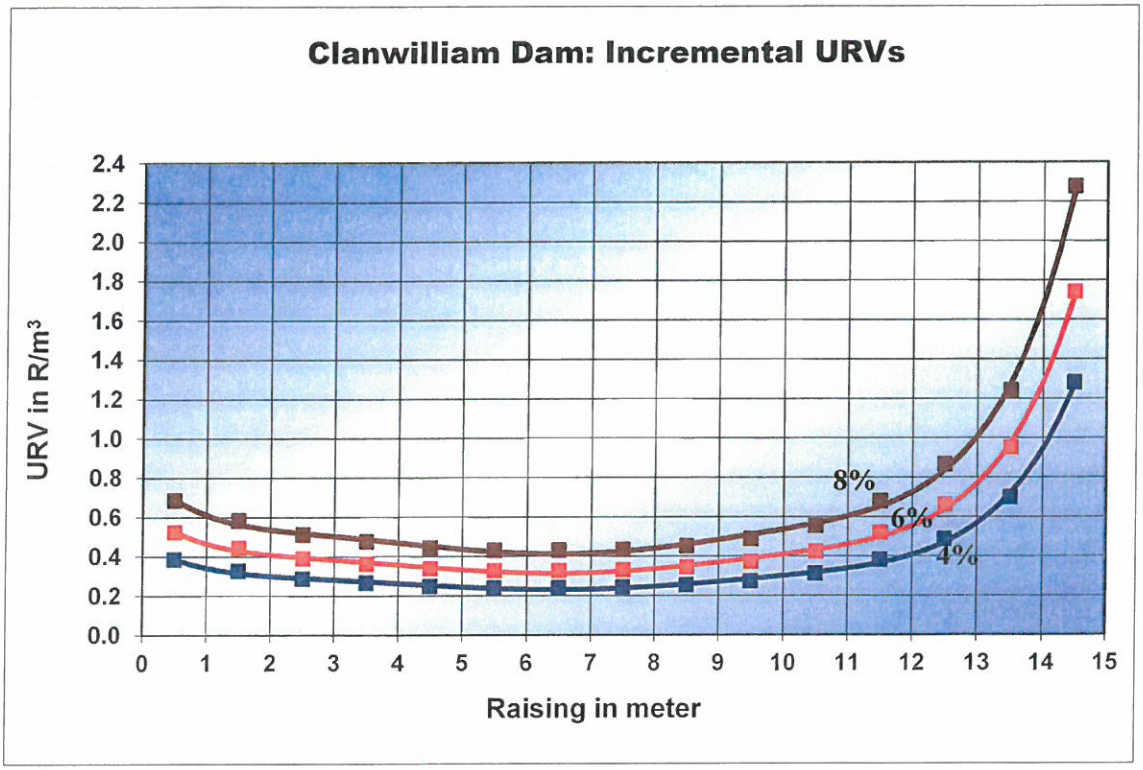

Figure 3.4: Incremental URVs

3.14 Conclusions from the Feasibility Study

Selection of the recommended height of raising is a function of:

- The real demand for uptake of the increased yield;
- The average URV of the scheme, for a specific level of raising and the incremental URVs, for the raising intervals evaluated, notably for more than a 10m raising;
- Environmental or social considerations limiting the height of raising;
- Who would be required to pay for the implementation of the Reserve; and
- Affordability, i.e. the cost of additional water from the scheme relative to what is affordable by irrigation farmers, and notably resource-poor farmers, in terms of profit margins, cash flow and viability.

Based on the Feasibility Study findings, conclusions are drawn in terms of the items listed below. The future actions that need to be taken following the Feasibility Study are indicated below, against each conclusion:

- Dam design and related issues;
- Water quality;
- Associated water resources;
- Costs and URVs;
- Other technical and economic considerations;

- Use of water;
- Environmental issues and mitigation measures;
- Social upliftment and equity;
- Operating rules;
- Operationalisation of the Reserve; and
- Scheme financing and implementation.

3.14.1 Dam design and related issues

Following a design philosophy, as adopted by the DWA, for the remedial works and/or proposed raising of Clanwilliam Dam, of structural reliability, minimal operational requirements / predictable operation and minimal maintenance requirements, the following is concluded:

Findings	Remarks
i) The remedial work to be undertaken to ensure the safety of the dam under extreme circumstances provides the opportunity to simultaneously raise the dam wall, at a relatively low cost.	Raising of 13m was approved in conjunction with dam safety work to be undertaken.
ii) Raising of the dam, up to 15 m, the maximum potential level of raising, is technically feasible although a 13 m raising is recommended. The preferred method of dam raising is the construction of an integral mass concrete structure against the downstream face of the existing mass gravity dam.	To be optimised in the design phase. The method of construction and the type of spillway to be confirmed.
iii) The lowest construction costs will be achieved by constructing an ogee spillway.	The recommended 13 m raising was approved. Spillway design to be optimised in the design phase.
iv) A multi-level outlet structure must be built to ensure that the water quality and temperature requirements of the downstream aquatic system can be satisfied.	The ROD requires a multi-level outlet structure. Operating rules to be established.
v) The required outlet capacity of the raised Clanwilliam Dam could be determined by the recommended EWR peak flow in the Olifants River reach between Clanwilliam Dam and Bulshoek Weir and the maximum required future releases for irrigation.	River outlet capacity to be optimised in the design phase, considering the EWR requirements and releases required for irrigation. The Reserve has been signed off and releases are only required to maintain the status quo. No additional releases will be required
vi) The size of the outlet works for the Clanwilliam WUA into the Clanwilliam Canal would remain unchanged.	Layout to be finalised in the design phase. Outlet to canal remains the same.

Findings	Remarks
vii) Further evaluation of the hydropower generation possibilities and the linking of the future multi-level outlet to the intake of the hydro-power plant are needed.	To be considered during the design phase.
viii) Results from the geotechnical investigations indicate that adequate course aggregate is available for the proposed raising. The source/availability of sand still needs to be confirmed.	Geotechnical work required for the design phase to also include sourcing of construction material. The source/availability of sand needs to be confirmed.

3.14.2 Water quality

Water quality recommendations regarding thermal stratification and the need for a multi-level outlet structure are as follows:

Findings	Remarks
i) Clanwilliam Dam is in a good trophic state and it was estimated that, provided the phosphorus loads remain unchanged, there would probably not be a major shift in trophic status if the dam wall is raised.	A multi-level intake for the outlet structure is required in terms of the ROD.
ii) For the proposed dam raising level, the following approach should be adopted during the dam design phase to determine the level of confidence that can be attached to the results presented in this report: • Re-run the dam trajectories with realistic ecological requirements imposed, to determine the most probable dam levels at the beginning of November for each proposed new dam height; • Re-run the hydrodynamic and water quality model using the most probable starting level at the beginning of November to determine the probability of meeting the temperature requirement; • Decide, in consultation with an ecologist whether the resulting probability for meeting the downstream temperature requirement is acceptable.	The approved Preliminary Reserve must be complied with.

3.14.3 Associated water resources

	Findings	Remarks
i)	The potential for agricultural water demand management measures have been identified and evaluated, but was hampered by the lack of reliable information. A first-level Water Management Plan was developed for the study area, and Action Plans were developed at desktop level. Further development of the Water Management Plan is proposed, to improve agricultural water management by stimulating self-analysis and forward thinking.	This action to be continued by CMA. The CMA must enforce the development of this Plan and then help the WUAs each year to evaluate and review it in order to achieve water conservation and demand management. Drip irrigation would be the most efficient.
ii)	Two large-scale confined artesian basins are located within the study area, comprising two significant fractured Table Mountain Group rock aquifers. The water quality is good and is suitable for domestic use and irrigation. Two schemes, the Clanwilliam Trough and the Citrusdal Syncline Basin Schemes, have been identified to develop and manage these artesian basins, in an incremental manner in the longer-term. Significant yield could be realised, with URVs estimates ranging from R 0.49/m^3 to R 1.04/m^3. Groundwater schemes could be developed for direct groundwater use from the Clanwilliam Trough and the Citrusdal Syncline Basin Schemes, or for conjunctive use with surface water.	Any further investigations required to expand irrigation or augment domestic water supply in the area will be undertaken by Chief Directorate: Integrated Water Resource Planning (IWRP) jointly with the Regional Office.

3.14.4 Costs and URVs

	Findings	Remarks
i)	The cost of the dam wall and appurtenant infrastructure is R 165.9 million (2006 costs) for remedial work only (zero raising).	Costing to be updated after detail design.
ii)	The scheme would have a yield of 69.5 million m^3/a, at a capital cost of R365 million (2006 costs) and a unit reference value (URV) of R0.45/m^3, at a 6% discount rate. Incremental costs of the last one to two meters of raising above 13 m are significantly higher than the average URVs. The lowest average URV is at the 9 m raising. For this scheme, the URV is so attractive, relative to the cost of other bulk water schemes, that an increased height of raising up to 13m has been recommended.	A 13 m raising was approved by the Minister. Cost to be updated.

Findings	Remarks
iii) Cost estimates for mitigating the impacts on the roads and other infrastructure for the three dam raising options are R 126.2 million, R 192.8 million, and R 243.9 million, for the 5 m, 10 m, and 15 m raising levels respectively. Total costs for the three dam raising options are R 172.9 million, R 293.3 million, and R 422.1 million, for the 5 m, 10 m, and 15 m raising levels respectively.	Impact on roads and other infrastructure, and associated costs to be finalised during design.

3.14.5 Other technical and economic considerations

Findings	Remarks
i) Technically feasible re-alignments can be achieved for those sections of the N7 national road affected by the raising of the dam wall. It is not considered feasible to re-align Divisional Road 2183 all the way along the eastern bank of the dam up to the intersection with the road to Algeria (DR 1487) to the south so as to maintain through access. Road DR 2182 and a section of the Algeria road (MR 539/DR 1487) would serve as the alternate through-road. The impact of the raising on portions of other affected roads can be mitigated.	Details of road realignment to be optimised in the design phase.
ii) Land between the purchase line for the current dam and the purchase lines for the three raising options that would be affected contain tourist facilities, residential development, agricultural developments and municipal infrastructure.	This aspect need to be considered in more detail and a purchase line should be determined. This should be negotiated with land owners, and finalised for expropriation.
iii) A macro-economic evaluation found that the permanent benefits of raising Clanwilliam Dam far exceed the temporary and permanent losses.	Approval granted for 13 m raising.

3.14.6 Use of the water

Findings	Remarks
i) Indications are that there is adequate requirement for water and significant support for the dam raising from WUAs.	Chief Directorate: IWRP is currently investigating optimum layout of conveyance infrastructure needed to reach resource poor farmers, and the results of the study will be communicated to Chief Directorate: Infrastructure Development or

Findings	Remarks
	development agency.
ii) The availability of land with suitable soil for irrigated agriculture is not a limiting factor to the expansion of irrigation in the study area.	Chief Directorate: IWRP is currently investigating suitable land for new irrigation development on the scheme, and the results of the study will be communicated to Chief Directorate: Infrastructure Development or development agency.
iii) All irrigation initiatives for uptake of water from the dam raising should be proven to be feasible and beneficial.	Chief Directorate: IWRP is currently investigating optimum layout of the expansion of irrigation development, and the results of the study will be communicated to Chief Directorate: Infrastructure Development.
iv) The scheme would provide the possibility to make significant water allocations to resource-poor farmers. The DWA should ensure that as much as practically possible of the water made available from the raising of the Clanwilliam Dam goes towards transformation and poverty alleviation in the area.	This is the prime objective of the development and further investigations mentioned.
v) Farming practices in the relevant regions of the study area are relatively capital intensive. Evaluations done for various regions of the study area with similar characteristics has evaluated the viability of "typical farms" in these regions, for the existing situation, expansion of existing farms, and for new farms. It seems that it might be more viable to expand existing farms than to develop new irrigation farms. The Melkboom/Trawal region holds the most potential, but the Klawer/Vredendal and Clanwilliam regions could also be profitably farmed. Irrigators upstream of Clanwilliam Dam would likely find it too costly to take up water from the scheme.	Chief Directorate: IWRP is currently undertaking cost-benefit analyses for various regions and farming models in support of resource poor development, and the results of the study will be communicated to Chief Directorate: Infrastructure Development or development agency.
vi) Any potential identified opportunities for future irrigation would need to be evaluated in terms of the conditions and costs relating to that specific opportunity. Final cost estimates of specific development options must be obtained, based on the cost of the dam, and the available yield for allocation to new irrigation development.	Investigation into future irrigation development will be the function of Chief Directorate: IWRP or the development agency. Water allocation to future irrigation users will be dealt with by the Directorate: Water Allocation.
vii) The financing model would determine the cost of	Chief Directorate: IWRP is currently

Findings	Remarks
additional water from the scheme, in terms of the Revised Pricing Strategy. New infrastructure development may have a social as well as a commercial component, in which case State funding and related charges will apply on the social component, while loan funding and related charges will apply on the commercial component. The State could alternatively also finance the entire scheme and negotiate a rate equivalent to off-budget funding with commercial users.	investigating potential funding models and resultant implications on water pricing. The findings of the study will be communicated to Chief Directorate: Infrastructure Development or development agency.
viii) Consideration should be given to establishing an Olifants/Doring River Development Agency, or other relevant implementation vehicle, which could vary in scale of influence, to: – Develop a common vision for the catchment/scheme; – Identify possible development opportunities and partnerships; – Develop an allocation schedule and business plan for ensuring the support of resource-poor farmers and other broad-based black economic empowerment opportunities; – Co-ordinate and support the proposed developments.	Institutional aspects relating to an appropriate implementing vehicle for the project are being investigated in the study being undertaken by Chief Directorate: IWRP.
ix) A business plan should be developed for the uptake of additional yield from a raised Clanwilliam Dam which should address: – Funding and cost-related issues; – Salient features of the raised dam scheme and a summary of the most relevant other supporting information from this study; – How to meet the objectives of water allocation reform; – Recommend models for the allocation of water; – How to convey the message on opportunities to potential future users; – Mechanisms of support for potential resource-poor farmers; – A guideline for potential applicants; – Clarification of the roles and responsibilities that various government organisations and other organisations would have;	These are all included in the current investigations by the CD:IWRP. Also involved are Department of Agriculture, Forestry and Fisheries and Department of Rural Development and Land Reform.

	Findings	Remarks
x)	Monitor the progress of the proposed developments and make changes when necessary or in reaction to new opportunities.	Continued monitoring will be required and is to be included in the business plan of the relevant institution, e.g. implementing agency.
xi)	A study should be undertaken into the potential for one (or more) large new schemes for the uptake of additional yield, such as the identified Zypherfontein Scheme. While such a scheme presents the opportunity to settle a larger number of resource-poor farmers on land simultaneously, there may be many pitfalls and sensitivities that need to be carefully unpacked and evaluated. The opportunity for national government to fund (or assist in funding) such a development should be considered, as it could become a flagship development project in support of ASGISA and other government initiatives.	Chief Directorate: IWRP is currently investigating availability of suitable land for new irrigation development in the area. The outcome of the study will be communicated to Chief Directorate: Infrastructure Development or development agency.
xii)	Evaluate applications from non-agricultural users on merit, and make some allowance for the future uptake of non-agricultural use. The uptake of non-agricultural use that can benefit the poor would need special attention.	To involve the Cederberg Local Municipality, Department of Agriculture, Forestry and Fishery and Department of Rural Development and Land Reform or CMA.

3.14.7 Environmental issues and mitigation measures

	Findings	Remarks
i)	The scheme would have relatively low environmental impacts compared to other surface water development options of the same scale;	ROD for up to 15 m raising was issued.
ii)	The Environmental Impact Assessment concluded that the difference between the 5 m, 10 m and 15 m impacts are not sufficient to motivate one raising option strongly over another for environmental reasons. There are no impacts that, with mitigation, are so significant that they would rule out a raising up to the 15 m option.	ROD for up to 15 m raising was issued.
iii)	The scheme would provide the opportunity to meet the ecological Reserve of the Olifants River and Estuary. The Preliminary Reserve was approved on condition that no major impoundments or abstraction weirs would be allowed on the mainstem of the Doring (or Groot)	ROD conditions relating to the preliminary Reserve of the Olifants River and Estuary and the Doring River to be complied with.

Findings	Remarks
rivers to ensure that the contribution of water for the maintenance of the estuary is provided from the Doring River tributary.	
iv) A multi-level outlet structure must be built for all options that would increase the height of the dam wall, to ensure that the water quality and temperature requirements of the downstream environment can be satisfied.	Multi-level intake approved in ROD to be optimised in the design phase.
v) Operating rules for the Clanwilliam Dam and Bulshoek Weir must be compiled to ensure the achievement of the requirements of the Reserve.	Operating rules should comply with the signed off Reserve and should be addressed in the EMP.
vi) Undertake releases from the system to meet the recommended EWRs, to ensure that the Olifants River and estuary receive the required volume and quality of water, at the right times.	Operating rule evaluation needs to be performed considering all needs and reserve requirements.
vii) Environmental specifications for the construction phase need to be developed in concert with the detailed design of the dam and associated infrastructure. These must include a detailed riverine monitoring programme and vegetation rehabilitation plan.	Develop during detailed design phase.
viii) A biodiversity conservation offset should be adopted which includes the following provisions: a) No new physical structures or development nodes must be allowed in a buffer area that falls within 1.5 m vertical of the FSL or 15 m for purchase line. b) A conservation zone (in addition to the 50 m buffer) should be established around the dam, which is equivalent to the area lost to inundation. This should include natural uncultivated area and critical habitats. This zone should be established through the most appropriate mechanism, which may include expropriation, contractual conservation areas and/or limited activity zones.	Applicable DWA policies regarding expropriation and land management in dam basins needs to be applied for the implementation.
ix) The appropriate heritage permits, for the re-interment of graves and for the removal, preservation and/or recording of heritage artefacts must be obtained.	Part of the environmental management plan and application before and during construction.
x) No lay-bys or picnic areas must be situated within the locality of the Andriesgrond Cave, to minimise the risk of vandalism of the rock art or deposits.	Part of environmental management plan and the resource management plan.

Findings	Remarks
xi) Any road construction activities at the present Kransvlei River marsh crossing must avoid changing the Kransvlei River channel itself and its immediate banks.	To be optimised in the design phase.

3.14.8 Social upliftment and equity

Findings	Remarks
i) There is significant potential to use water to support the development of historically disadvantaged individuals in the area, but the solution is not necessarily a single large-scale RPF-scheme. Instead a suite of development options is proposed.	The study currently being undertaken by Chief Directorate: IWRP is intended to address this issue.
ii) Social benefits of the Clanwilliam Dam raising are important for the poverty alleviation strategies of the study area and for water allocation reform. Jobs, new sources of income and opportunities for economic advancement could be created. With adequate support in terms of access to transport, training and funding, the project could result in significant improvements in the overall standard of living of the local population.	The study currently being undertaken by Chief Directorate: IWRP will address this issue.
iii) The lack of financial support has been highlighted as one of the main hindrances to emerging farmers. Funding is required for capital expenses as well as to fund equity acquisition in a joint venture. A wide range of potential sources of funding for resource-poor farmers have therefore been identified and discussed.	Chief Directorate: IWRP is currently investigating funding models appropriate to the development of resource poor farmers

3.14.9 Operating rules

Findings	Remarks
i) New operating rules need to be established for the raised dam. The operating rules need to take the current operation serving the existing users in the different river reaches, the inflow from tributaries downstream, the water quality issues such as the seasonal higher salinity etc., into consideration. New areas of possible irrigation development will *inter-alia* also need to be considered.	Since the latest information on the ecological water requirements only became available after the modelling task was completed, it is recommended that a refined release pattern be determined, based on the operating rules of the dam as well as the ecological requirement and

	irrigation requirements downstream of the dam.
ii) Revised operating rules for the ORGWS should be established, including: a) Releases for irrigators, the Reserve and the hydro-power scheme; b) A refined release pattern from the multi-level outlet works; c) Changing of the operation from using almost all of the available water each summer to allowing for a carry-over from year-to-year for drought years.	Operating rules will be determined by the Regional Office in consultation with Directorate: Water Resource Planning Systems.

3.14.10 Operationalisation of the Reserve

Findings	Remarks
i) Manage the increased pumping of winter water upstream of Clanwilliam Dam, for storage and use during summer, through revised licence conditions, to significantly limit the pumping from the river during the summer months, and as a result improve the ecological condition of the upper Olifants River.	Operating rules will be determined by the Regional Office in consultation with Directorate: Water Resource Planning Systems.
ii) Consider cancelling concessions granted to riparian irrigators downstream of Bulshoek Weir, as there is a risk that the summer baseflow releases for the estuary may be intercepted and not reach the estuary.	To be done in consultation with Directorate: Water Allocation.
iii) Halt all illegal activity in the river channel, such as bulldozing, which increases the volume of water that needs to be released to rectify the destruction of habitat and increases the rate at which silt accumulates in the dams.	Reserve implementation and monitoring to be performed by RDM and the Regional Office to maintain Reserve status quo.
iv) The approved preliminary Reserve recommends that a portion of the water intended for downstream water users from Clanwilliam Dam, be released via the Jan Dissels tributary river, to meet Reserve requirements in the tributary.	Operating rules will be determined in consultation with the Regional Office and Directorate: Water Resource Planning Systems.
v) Maintain summer baseflow releases from Bulshoek Weir for the Reserve, to supplement the return flows from irrigators along the Lower Olifants River Canal, to maintain a summer baseflow of about 1.5 m^3/s entering	Operating rules will be determined in consultation with the Regional Office and Directorate: Water Resource

the estuary. To reduce the risk of these releases being intercepted by riparian irrigators further downstream consider releasing these flows as pulses, potentially coinciding with the freshette releases made from Clanwilliam Dam to trigger fish spawning.	Planning Systems.
vi) Develop and implement a detailed riverine monitoring programme.	Reserve implementation and monitoring to be performed by RDM and the Regional Office.
vii) On an ongoing basis, monitor the effectiveness of the proposed ecological releases, and implement refinement of the releases if needed.	Reserve implementation and monitoring to be performed by RDM and the Regional Office
viii) Institute a monitoring programme for the systematic monitoring of the pertinent data for assessing or modelling water quality in the reservoir. This programme should include: – Hourly meteorological data (air temperature, dew point temperature, wind speed, wind direction, and percentage sunshine); – Inflow rates; – Inflow and in-lake water quality; and – Release rates.	Reserve implementation and monitoring to be performed by RDM and the Regional Office.
ix) LORWUA should continue to monitor and control the biomass of filamentous algae by chemical means.	LORWUA to continue compliance monitoring.
x) Measure all abstractions from Clanwilliam Dam down to the estuary. The Clanwilliam WUA should monitor the abstractions from pump stations, as the existing measurement system is not functioning. Water use records should be released to other parties, such as LORWUA, at least monthly so that they can determine the losses for the month.	LORWUA and Clanwilliam WUA responsible for compliance monitoring.
xi) Monitor nutrient loads flowing into the raised Dam. It is also recommended that monitoring of the inflow water chemistry be restored and that the inflowing nutrient loads are examined on an annual basis.	LORWUA to undertake water quality monitoring.
xii) Due to the low confidence of some of the extrapolated results of the preliminary determination of the Reserve, the preliminary Reserve stipulates that results should not be used to evaluate high impact water use activities, except where a high confidence Reserve has been indicated.	Directorate Water Allocation, in consultation with the Regional Office to take this into account.

xiii) The management plan for the Reserve should address approved freshwater biodiversity needs of the catchment, as well as approved non-flow related recommendations.	Address in the water resource protection sub-strategy of the catchment management strategy.

3.14.11 Scheme Financing and Implementation

	Findings	Remarks
i)	The DWA could either cover the infrastructural cost to replace yield lost as a result of the implementation of the Reserve (although this would be a departure from standard Departmental policy), or such cost could be distributed amongst all users, existing and future. The potential waiving of such cost, for new (and possibly existing) farmers should be considered, in order to make the water more affordable to resource-poor farmers.	To be considered further by DWA in terms of its pricing policy.
ii)	Because the existing Clanwilliam Dam is a Government Water Scheme, Treasury will finance the dam safety work. Although the financing of the raising could be undertaken by another financing agency, the institutions involved would possibly not be willing to make funds available without adequate guarantees from the Government. A more pragmatic approach could possibly be for Government funding to be made available for the raising as well. It would be most appropriate to implement the scheme using Government funding because: – Clanwilliam Dam forms part of an existing Government Water Scheme; – Dam safety work must be paid for by Government and is a substantial proportion of the total cost; – The raising of the dam would mainly be undertaken for resource-poor farmers; – It could be appropriate for Government to fund as a form of subsidisation, either writing off the entire capital cost or part of it. This would however not be in accordance with the DWA's pricing policy but could be motivated in terms of the policy as a deserving cause. – Other funders may not be forthcoming because of the perceived risk of non-payment;	Minister approved the dam raising as a Government Water Works. Further funding issues to be considered by DWA in terms of its pricing policy.

– The scheme has already been placed on the Department's Capital Budget.	
iii) The roles and responsibilities of various Government departments, WUAs, municipalities, NGO, etc. in terms of the implementation of the project must be clarified and such organisations need to commit to allocated responsibilities.	Chief Directorate: IWRP is currently investigating institutional arrangements for project implementation and operation. The findings of the study will be shared with Chief Directorate: Infrastructure Development or development agency.
iv) In order to ensure the equitable distribution of the benefits from the raising of the dam, a multi-stakeholder Olifants/Doring River Development Agency should be established. This proposed agency should be responsible for developing a vision for the catchment, identifying possible opportunities and partnerships and preparing a business plan for the equitable allocation of water. Their responsibilities should include co-ordinating the development of the proposed initiatives and monitoring the progress so that changes can be made when necessary or in response to new opportunities that arise.	Department of Agriculture, Forestry and Fisheries and Department of Rural Development and Land Reform to be involved in the setting up of the proposed development agency.

4. OPERATION OF THE OLIFANTS/DORING SYSTEM

4.1 Upstream of Clanwilliam Dam

Farm dam sizes were restricted to 6 000 m^3/ha/a for the areas falling within the previous Government Water Control Area (GWCA). Under the old Water Act a dam of up to 250 000 m^3 could be constructed in the tributaries outside the GWCA without a special permit.

As soon as the Olifants River starts flowing in winter, the farmers can pump water from the river to their dams and they must stop when the flow in the river is insufficient, normally around the end of October. During summer, the farmers abstract water according to a weekly cycle. The abstraction of water by the upstream users obviously impacts on the water available from the Clanwilliam Dam for downstream users.

4.2 Conjunctive operation of the Clanwilliam Dam and Bulshoek Weir

Since about 1935, the Olifants River (Vanrhynsdorp) Government Water Control Area has developed to increase the reliability of the water supply to the irrigators downstream of Clanwilliam despite the increase in consumption in the upper reaches. The Clanwilliam Dam captures a portion of the winter flows of the Olifants River that are later released during summer to the irrigators located further downstream.

Most of the water is released to the Bulshoek Weir 30 km downstream, from where it is diverted to the Lower Olifants Canal, which is the main conveyance system in the area. This canal follows the Olifants River for approximately 80 km. The main canal, which has a capacity of 7 m^3/s, runs on the left bank of the river for approximately 25 km, until it splits and then runs on both banks of the river. These canals continue to the vicinity of Lutzville becoming progressively smaller downstream. Water is abstracted at numerous points along the canal and is distributed from near Lutzville towards the coast by means of secondary canals. The area currently under irrigation is 13 911 ha. The river flow time from Citrusdal to the Clanwilliam Dam is in the order of 23 hours. The lead-time for water from the Bulshoek Weir to the last point (Ebenhaeser) is approximately three days.

A canal was built during 1940 to supply water for irrigation and to Clanwilliam Town. This canal originates at the Clanwilliam Dam wall, passes through town, and crosses the Jan Dissels River. Water is released directly from the Clanwilliam Dam into the Clanwilliam Canal which runs for 12 km along the right bank of the Olifants River. The town of Clanwilliam prefers to use the cheaper water from the Jan Dissels River but when the streamflow is inadequate then the shortfall is obtained from the Clanwilliam Canal. A group of irrigators is also located around the Clanwilliam Dam and pump their water directly from the dam. Another group of irrigators is located between the Clanwilliam Dam

and the Bulshoek Weir and pump from the Olifants River or Jan Dissels River to irrigate their crops.

Historically, about 27% to 30% of the flow (into Clanwilliam Dam and further flow up to Bulshoek Weir) to the Lower Olifants River Canal and Clanwilliam Canal is lost through seepage and evaporation.

4.3 Clanwilliam Dam

Spillway discharge is controlled with 13 vertical spillway gates. The gates are used to provide additional storage above the spillway invert level. Piers support the gates and deck over the spillway, resulting in an effective spillway length of 101 m (ignoring contraction losses). The FSL of the dam is at RL 105,25 m and the crest of the ogee at RL102,20 m. Two outlet pipes of nominal diameter (φ) 1 219 mm discharge into the river. Their inlets are at RL 80,51 m. Discharge is controlled with sleeve valves. The maximum discharge capacity is approximately 10 m^3/s. An additional outlet pipe delivers water to the hydropower plant and the irrigation canal on the downstream right flank.

The outlets need to provide for the outlet requirement of the current system as well as increased demands in certain areas when additional irrigation development took place. It is not expected that a major shift in monthly release patterns will happen due to changes in crops. The outlets to the river need to provide for the required releases to serve the reserve. This needs to be optimised during the design phase.

The existing water entitlements in the dam basin and from the system will be retained unless where there are specific conditions that require a review thereof.

When the dam size is increased, the operation of the Clanwilliam Dam will need to be changed from using almost all of the available water each summer to allowing for a carryover from year to year for drought years.

4.4 Bulshoek Weir

The Bulshoek Weir (**Figure 4.1**) is located 30 km downstream of the Clanwilliam Dam on the Olifants River. The construction of the Bulshoek Weir commenced in 1913 and was completed in 1924. Bulshoek Weir is a stone-masonry gravity structure, with a full supply capacity of 5,8 million m^3. The catchment area of the Bulshoek Weir is 2 679 km^2 in extent. The wall consists of a series of connected arches and buttresses that support a bridge deck and a gantry for the gate hoists. The stoney-gates are positioned on top of the ogee-shaped crests between the buttresses. The weir is operated at close to full supply capacity in order to divert water into the irrigation canal.

Bulshoek Weir is operated at a level of 4.8 m to 5.1 m where possible, except in winter before Clanwilliam Dam fills when it may be dropped to about 3.8 m to create storage to capture flood events.

The following constraints make it difficult to maintain a high level in the Bulshoek Weir:

- Above about 4.8 m strong southerly winds cause spills over the crest gates.
- In winter, before it is certain that Clanwilliam Dam will fill, maintaining as low a level as possible maximises the streamflow from Jan Dissels River that can be intercepted and used and helps minimise the risk from Clanwilliam Dam not filling. A low level also captures the surplus from releases intended for irrigators downstream of the Clanwilliam Dam, particularly if the Bulshoek Canal is closed for maintenance.

The following constraints make it difficult to lower the level too much:

- The irrigators at Langkloof cannot abstract from the dam if it drops below about 4.5 m. Further upstream, Radyn relies on releases from Clanwilliam Dam.
- Below about 3.6 m insufficient water may be supplied to the canal.
- If the weir is below 3.8 m to 4.0 m, there is a concern that winter floods will silt up the dam basin, reducing the volume for storage and the area available for recreation. A minimum level of 4.8 m has also been suggested though this level is more likely to be adopted once it is clear that Clanwilliam Dam will fill.
- A level below 3.8 m to 4 m impacts severely on recreational activities (water skiing / fishing).

The unaccounted-for water (UAW) and leakage at Bulshoek Weir were estimated to equal 34 million m^3/a. It is estimated that leakage from Bulshoek Weir reduced from 1.25 m^3/s down to the current 0.25 m^3/s, as a result of work undertaken by the DWA's Construction Directorate.

Figure 4.1: Bulshoek Weir

4.5 Operation of the ORGWS

4.5.1 Reach between Clanwilliam Dam and Bulshoek Weir

Clanwilliam Dam stores the water for the downstream water users. The water quota allocated to them is calculated from the amount of water available in the dam.

The use from pumps along the Jan Dissels and the Olifants Rivers, together with transmission losses along that reach, is 21.6 million m^3/a.

4.5.2 Use from the Lower Olifants River Canal

The LORWUA currently have a theoretical allocation of water from Clanwilliam Dam/Bulshoek Weir of 116 million m^3/a (9 491 ha, each farmer receiving 12 200 m^3/ha). The average inflow to the canal for the period from 1990 to 2006 was 139 million m^3/a, but after deducting losses of 37 million m^3/a (27%) and non-irrigation use of about 9.6 million m^3/a, the remainder left for irrigation is about 92 million m^3/a, about 80% of the theoretical allocation.

Two quotas are used by LORWUA, namely an annual quota of 12 200 m^3/ha and a weekly quota of 325 m^3/ha. LORWUA have limited the capacity of the balancing dams along the canal to 35% of each farmer's allocation. The Ebenhaeser Balancing Dam near the end of the west branch of the Bulshoek Canal has a capacity of 140 000 m^3.

4.5.3 Use downstream of Bulshoek Weir

There is significant uncertainty about the extent of the concessional use downstream of Bulshoek Weir, despite a study undertaken by DWA to clarify this.

Total return flows from the Lower Olifants River Canal upstream of Lutzville is estimated at approximately 2 m^3/s, of which 0.5 m^3/s were above the confluence with the Doring River. The volume of farm dams downstream of the Bulshoek Weir is relatively small.

4.5.4 Curtailment

The storage of Clanwilliam Dam is currently only about 30% of the present day MAR. The dam spills almost every year and the allocation for the coming year is not only dependent on how much water flowed into the Clanwilliam Dam, but also on how late in the season the last rains came. When Clanwilliam Dam stops spilling a portion of the available storage is kept in reserve and the remainder is distributed amongst the various users to meet their requirements until the start of winter, about mid-May.

5. DESCRIPTION OF THE RAISING OF CLANWILLIAM DAM

5.1 Feasibility Design

5.1.1 Dam Safety Evaluation

Dam safety evaluations of the structure (the most recent in 2005) revealed three aspects that have a detrimental effect on the integrity of the structure:

- The quartzitic sandstone foundation is highly fractured and has a low modulus of elasticity;
- There is doubt about the effectiveness of the prestressed cables used in the 1969 raising;
- Alkali-siliceous reaction (ASR) and/or sulphate attack was identified in the concrete.

Analyses incorporating these factors indicated that the stability of the dam structure under extreme floods is not adequate. It was concluded that remedial work should be undertaken, which would entail major construction works, to ensure the safety of the dam.

5.1.2 Feasibility Design

The remedial work to be undertaken provides an opportunity to also raise the dam more cost-effectively and thereby increase its yield. Implementation of the recently determined Reserve also means that water needs to be released from Clanwilliam Dam/Bulshoek Weir for the ecology. This would require an alternative outlet works arrangement.

A feasibility level design was conducted by DWA Civil Design: Dam Safety Surveillance to determine feasible raising options for the dam and to determine costs and flood levels. Four raising options, namely no raising, and 5 m, 10 m and 15 m raisings were considered. A number of spillway configurations were investigated and an outlet works configuration was proposed.

5.1.3 Design Philosophy

The design philosophy stipulates the strategic functional and performance objectives that the designers addressed during the conceptual phase of the design process. The design philosophy developed for the remedial works and/or proposed raising of Clanwilliam Dam was strongly influenced by experience gained through recent design projects and evaluation of existing South African dams. The following aspects were identified as important considerations:

- Long-term structural reliability: This implies the elimination of any structural components that deteriorate significantly or unpredictably with time. The use of

(unreliable) stressed cables to ensure the stability of the raised concrete gravity section was therefore not considered;

- Minimal operational requirements / predictable operation: This implies that the "operational intelligence" should be "built in" and that the structure should deal safely and predictably with normal and extreme events without the intervention of an operator being required;
- Minimal maintenance requirements: This implies that the spillway and non-overspill crest (NOC) should have little regular or "built in" maintenance requirements. Only the inlet/ outlet works can be expected to require regular maintenance;

5.1.4 Structural Stability

The stability of the structure was evaluated for the different raising options based on the traditional thin beam theory.

The water levels used in the calculations were obtained from the results of the spillway hydraulics calculations. Only the water levels from the existing length ogee spillway were used. These values were the highest and thus provided the most conservative results.

The most important parameter required from the stability analysis was the downstream slope required to provide an adequate factor of safety against shear and over-turning. The extreme values of compression and tension in the concrete also had to be within the prescribed limits. The downstream slope governs the volume of material required to raise the dam and therefore has a major influence on the cost of the project. It was determined that a downstream slope of 0.8 (horizontal):1 (vertical) will ensure a stable structure. All volume calculations were based on this value.

5.1.5 Spillway

At each FSL an ogee and a labyrinth spillway option were investigated. For the three raisings above 105,25 m the option of lengthening the spillway by 21,35 m was also considered. Flood routing was done to determine the various flood levels associated with each raising option for both the existing and lengthened spillway.

5.1.6 Non-overspill Crests

For the purpose of preliminary design the non-overspill crests (NOCs) were raised vertically and waterproof concrete balustrades or parapet walls were added, thus adding to the storage height of the structure. Both the left and right NOCs were assumed to be 4,5 m wide. The crest levels of the NOCs were assumed to be at the maximum water levels. This means that a 0 m freeboard is accepted during the SEF.

5.1.7 Outlet Works

The design of the outlet works for the raising will mainly be influenced by ecological flow requirements and the cost to comply with such requirements. The signed off Preliminary Reserve should be complied with. The current outlet works at the dam draws water from only one level. Aquatic life in the downstream river requires regular flooding of a minimum flow rate and at specific temperatures. To comply with this, water should be drawn from different levels in the dam and be released through adequately sized outlet pipes and valves. Multiple-level draw-down from the dam will also reduce stratification in the dam.

5.1.7.1 Existing Outlet Works

The existing outlet works comprise two φ 1219 mm pipes (RL 79,55) and two φ 914 mm pipes (RL 81,99). Both 1219 mm pipes are located within the spillway section, the one being just left of the existing outlet chamber and the other towards the middle of the spillway. These (φ 1219 mm) pipes are used for releases to the river. Water is discharged by means of two 914 mm sleeve valves, with a combined maximum capacity of 22 m^3/s.

The φ 914 mm pipes exit the dam wall in the outlet chamber, where flow through these pipes is controlled. One pipe is used for water supply to the Clanwilliam Irrigation Board while the other supplies water to a (privately owned) hydroelectric turbine. The existing outlet does not comply with DWA standards and so this shortcoming needs to be rectified in the upgraded structure.

5.1.7.2 New Outlet Works

(Note: All diameters given are nominal)

The proposed feasibility design of the outlet works is shown in **Figure 5.1**. This conceptual design will need to be investigated in more detail and aligned with DWA standards during detailed design.

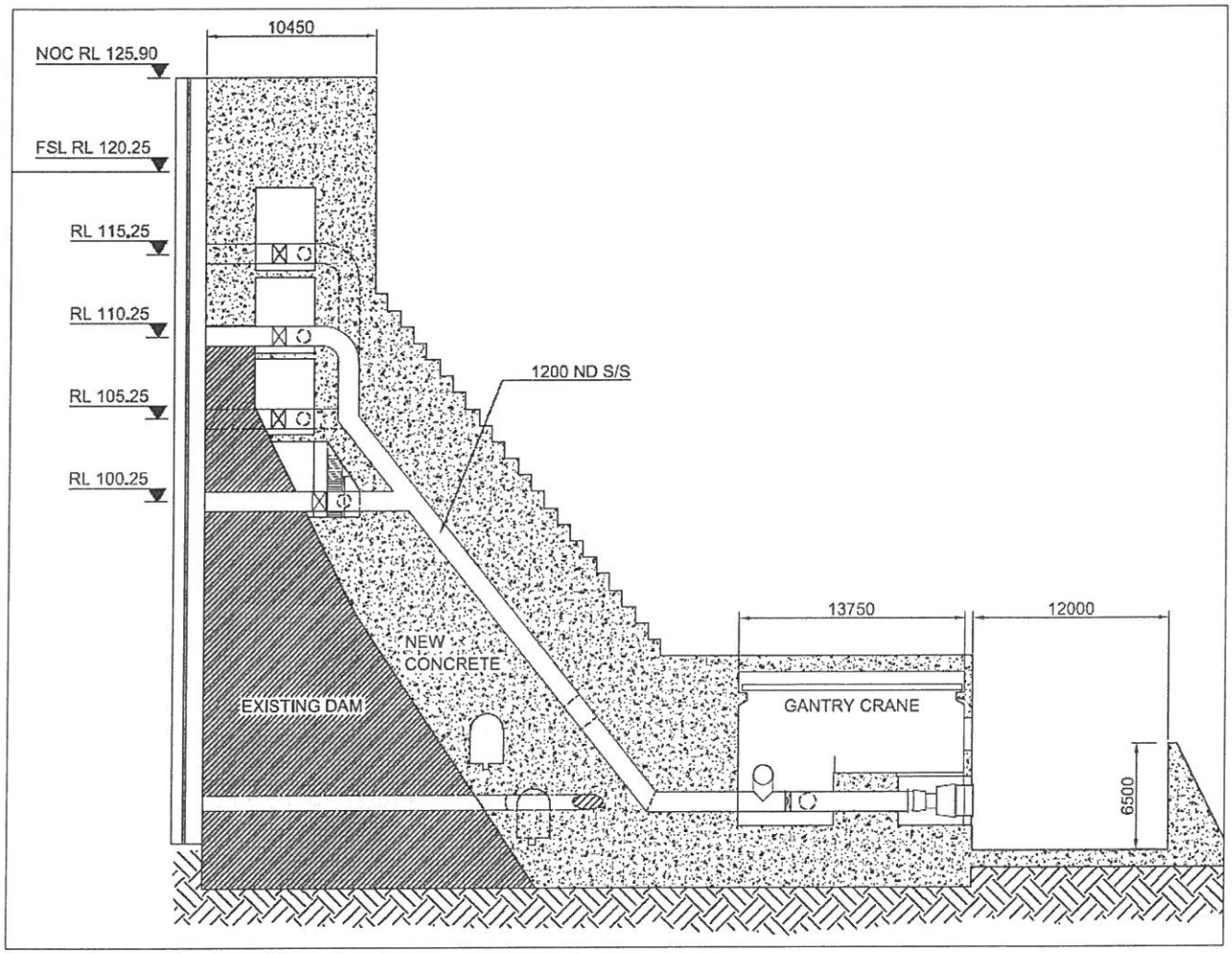

Figure 5.1: Preliminary Design of Outlet Works

5.2 Dam Design Recommendations

The following key recommendations were made in the Feasibility report relating to the design:

i) DWA recommends that Clanwilliam Dam be raised by 13m by constructing an integral mass concrete structure against the downstream face of the existing mass gravity dam. The method of construction and the type of spillway will be finalised during the detailed design phase. The source/availability of sand still needs to be confirmed during further investigations.

ii) That a multi-level outlet structure be built for all dam raising options to ensure that the water quality and temperature requirements of the downstream environment can be satisfied. Since the latest information on the ecological water requirements only became available after the modelling task was completed, it is recommended that a refined release pattern be created for the recommended dam raising height, based on

the operating rules of the dam as well as the ecological requirement and irrigation demands downstream of the dam.

iii) That provision be made for hydropower and for releases to meet the requirements of other downstream users from the future multi-level outlet.

5.3 Geotechnical Investigations

Alkali-aggregate Reaction (AAR) was identified on the surface of the existing structure. For the purpose of this design it was assumed that AAR does not lower the engineering properties of the concrete significantly – It however needs to be attended to during the design phase.

The upper right flank contains a potentially unfavourable siltstone band which could contribute to a failure surface. The siltstone band might require some foundation improvements, but it is not expected to have a major influence on the design of the structure.

Only one leak, approximately 200 m downstream on the left flank, was visible at the time of the feasibility study. Initial drilling results from the current investigations suggest that the foundation is sound. Foundation grouting should be done to provide for the additional pressure head behind the dam and to ensure adequate shear resistance of the foundation. Dowling might also be required.

Some form of apron is recommended. It will serve as both an energy dissipating structure for the spillway and additional shear resistance for the dam structure on the foundation.

For the purpose of stability analyses, 0,075g, 0,15g and 0,30g were accepted as seismic loads for the service, abnormal and extreme loads, respectively.

Results from geotechnical investigations indicate that adequate aggregate is available from an extension of the existing hard rock quarry (see **Figure 5.2**) for the proposed raising by roller compacted concrete (RCC). RCC is the preferred material mainly due to the rapid tempo at which it can be placed, resulting in shorter construction periods and its relatively low heat of hydration. For the purposes of this report the design was based on the use of RCC. The eventual choice of spillway type and construction programme may dictate the use of mass concrete.

Figure 5.2: Existing Quarry to the West of the Dam

5.4 Public Utilities

The raising of Clanwilliam Dam will impact on the existing roads and infrastructure in the basin. The Feasibility investigation assessed the impacts of the raised dam on the existing roads and other infrastructure surrounding the dam. The full extent of this impact needs to be finalised during the design phase. The following infrastructural issues, arising from the proposed raising of the dam wall, were investigated during the feasibility study:

- The re-alignment of Trunk Road 11 Section 3 (hereafter referred to as the N7) to the west of the Clanwilliam Dam.
- The continued provision of access to residences, farmsteads and cultivated land along Divisional Roads 2183 and 1487 and Main Road 539 to the east of the dam. The viability of the farms in terms of the impacts on productive agricultural land is briefly addressed.
- The continued functioning of Divisional Road 2183 as part of an alternative route, in the event that the N7 between Clanwilliam and Citrusdal is temporarily closed.
- The maintenance of access to the Cederberg Wilderness Area, Algeria and other communities in the Cederberg area from the N7 via the causeway across the Olifants River (Main Road 539) and Divisional Road 1487.

- The maintenance of access to farms and residential developments to the western side of the dam via minor road 16/2, the so-called Renbaan Road.
- The replacement of other infrastructural elements in the area around the dam such as built structures, pumping systems and boreholes.
- The loss of land.

The predicted 1:50 year flood levels for each dam raising option were adopted as the minimum elevation criteria for the N7, whilst predicted 1:10 year flood levels were used as the minimum elevation criteria for divisional, main and minor roads.

It appears unfeasible to re-align Divisional Road 2183 all the way along the eastern bank of the dam up to the intersection with the road to Algeria (DR 1487) to the south so as to maintain through access. Road DR 2182 and a section of the Algeria road (MR 539/DR 1487) would serve as the alternate through-road to the section of the N7, between the Algeria turnoff and the Clanwilliam turnoff, and would need to be well maintained. A crossing structure that can pass a 1:10 year flood should be constructed, to provide access across the Olifants River.

Other land and infrastructure between the purchase line for the current dam and the purchase lines for the three raising options that would be affected include tourist facilities, residential development, agricultural developments and municipal infrastructure.

The details of the feasibility investigation regarding the affected infrastructure are included as **Appendix D**.

More detailed investigation into the affected utilities is required during the design phase.

5.5 Acquisition of Land

5.5.1 Purchasing of land

At least the following land should be acquired for the Project:

The need to purchase additional land for the dam wall site seems unnecessary but this should be confirmed. The purchase of land for the dam basin is required. The use of State land by others and matters such as access to the water body by non-State entities in the dam basin such as the boat club shall be in accordance with DWA policies and should be based on formal agreements between DWA, Provincial Government and those entities. It is also within the jurisdiction of Provincial Government to sign agreements on State land.

5.5.2 Temporary servitude for construction

A temporary servitude for construction of the raising of the dam may be required. This aspect needs to be investigated further during detail design phase.

5.5.3 Permanent servitude for right of way

A permanent servitude for right of way may be required for the gravel road on the eastern side of the dam that will provide access to the raised dam wall. This aspect needs to be investigated further during the detail design phase.

5.6 Fencing of Project Site

5.6.1 Dam basin

The dam basin shall be fenced off along the purchase line where required in accordance with DWA standards. The size and type of gates, the number and positions required and the type of locks or padlocks to be used shall be decided upon in collaboration with DWA.

5.6.2 Security fencing

Security fencing shall be provided around the dam outlet works, the dam site, the Eskom switch yard, and other sensitive areas as may be necessary. Security fencing shall be in accordance with DWA standards. The type and height of fencing required around DWA infrastructure, the size and type of gates, the number and positions required and the type of locks or padlocks to be used shall be decided upon in collaboration with DWA as this may differ for different types of infrastructure. Eskom will determine the fencing standards for their switch yard if it needs to be upgraded.

5.6.3 Fencing around non-State owned infrastructure

It is anticipated that other non-State entities such as the boat club may construct structures on State land. The use of State land, access to the water body and related issues shall be in accordance with DWA policies and agreements. Any fencing provided around such structures shall comply with DWA fencing standards and agreements with these entities shall incorporate the obligation of the entities to maintain such fences on a regular basis.

6. GENERAL CRITERIA

The Minister approved the Raising of Clanwilliam Dam as a Government Water Works in accordance with Section 109 of the National Water Act, 1998 (Act No. 36 of 1998). The implementation of the project shall adhere to the general criteria prescribed in Chapter 11 of the Act.

6.1 Design guidelines

The Raising of Clanwilliam Dam is a Category 3 dam which requires an Approved Professional Person to be approved by the Minister in consultation with the Engineering Council of South Africa (Section 117 of the National Water Act, 1998).

6.2 Electricity supply

Should there be need for more electricity supply for the raised dam an Agreement should be reached with Eskom so that sufficient permanent power is provided. The details of the required electricity supply need to be finalised during the design phase taking into account the likely pumping requirements for the resource poor farmers to be settled on the scheme.

6.3 Land matters

Land rights (including servitudes) to implement and operate the required infrastructure shall be acquired in accordance with the Expropriation Act (No. 63 of 1975) and the Departmental Policy.

6.4 Construction timing

Any construction work undertaken in the river channel and spillway shall as far as possible take place during the dry season in order to avoid possible flooding and associated damages of the works during the wet season. Any construction on the outlet works should take the arrangement for the supply of water into consideration and the works should be constructed to ensure minimal interference with the water supply.

6.5 Construction housing

The contractor will be responsible for accommodation for his employees during construction.

6.6 RID Agreement between IWRP and Infrastructure Development

The conditions specified in the Memorandum of Agreement between the Chief Directorates Integrated Water Resources Planning (IWRP) and Infrastructure Development dated March 2005 shall be adhered to.

7. COMPLIANCE WITH APPLICABLE LEGISLATION, REGULATIONS AND POLICY

7.1 National Water Act

7.1.1 Government Waterworks

The Minister approved the raising of Clanwilliam Dam by 13 metres on 18 August 2010. A copy of the approval is included in this document as **Appendix A**. This raising of the dam will be implemented as a Government Waterworks in compliance with Section 110 of the National Water Act, 1998 (Act No. 36 of 1998). It will be part of the national water resources infrastructure and is in accordance with the National Water Resource Strategy (NWRS).

7.1.2 Dam Safety Regulations

The raised Clanwilliam Dam will be classified as a Category 3 dam with a high hazard rating. The requirements of the National Water Act and the Dam Safety Regulations must be applied to the level required for this classification.

7.1.3 Water Use Licenses

Water use licences need to be issued to users. The need to issue a licence to the DWA to construct and to store water in terms of section 21(b) of the National Water Act needs to be confirmed through consultation in the Department. Licences for other uses by other users need to be issued in terms of normal departmental processes and procedures.

7.2 Environmental Authorisation

7.2.1 Environmental Impact Assessment

Environmental authorisation was undertaken through the regulatory Environmental Impact Assessment (EIA) process, which comprises two phases, namely the Scoping Phase and the Environmental Impact Report (EIR) Phase. Activities for which environmental authorisation were sought include the raising of Clanwilliam Dam by up to 15 m, re-alignment of portions of the N7 national road and re-alignment of the gravel access road on the eastern side of the dam, to retain maintenance access to the top of the dam wall.

The process was undertaken in terms of Regulation 1182 of the Environment Conservation Act (ECA) (No. 73 of 1989) which identifies certain activities which "could have a substantial detrimental effect on the environment". These scheduled activities require authorisation from the competent environmental authority. D:EA&DP was

delegated by the national Department of Environmental Affairs and Tourism (DEAT) to act as the competent environmental authority for this project. It should be noted that the application was submitted under the ECA regulations. Despite the fact that these regulations have been superseded by the National Environmental Management Act EIA regulations of 2006, the application was allowed under the transitional arrangements to be completed under the ECA process.

The proposed project therefore required authorisation from D:EA&DP in terms of the activities identified under Regulation 1182, by following the prescribed EIA process as detailed in Regulation 1183.

Public participation forms an integral component of the EIA process. The nature of the public consultation during the Scoping and EIR Phase was comprehensive and was undertaken in accordance with the requirements of Regulation 1183. It included advertising in regional and local newspapers, distribution of background information and draft reports, holding of several public meetings and focus group meetings, and capturing issues in issues trails, which are described in the EIA reports.

A Record of Decisions (ROD), authorizing the project, was issued by D:EA&DP on 12 May 2009. The ROD was upheld by D:EA&DP on 22 February 2010 after a period of appeals and the ROD requires construction to commence within five (5) years from this date in order for authorization not to lapse. Chief Directorate: Integrated Water Resource Planning provided copies of the ROD to Capital Betterment Projects and Integrated Environmental Engineering.

7.2.2 Environmental Management Plans

The conditions and process requirements contained in the environmental management plans (EMPs) for the construction period should be incorporated into construction tender documents and compliance should be compulsory for the contractor in terms of the tender documentation.

A framework EMP (DWA Generic EMP) was developed under the feasibility investigation. During the detail design the environmental specifications will need to be developed to ensure that the potential construction impacts of all aspects of the programme and associated works are controlled. A detailed riverine monitoring programme will also need to be developed. The monitoring programme will need to specify all significant monitoring criteria, thresholds and appropriate responses to potential situations during construction.

The conditions and process requirements contained in the EMPs for the construction period relating to any borrow areas and quarries, should be incorporated into any tender documents and be compulsory for any contractor in terms of the tender documentation.

7.3 Permanent Infrastructure at the Dam

Any permanent infrastructure required at the dam will be finalised during the design phase and will be implemented in terms of Departmental policies.

7.4 Statutory Requirements

In addition to the statutory requirements mentioned elsewhere in this document, such as environmental authorisation and dam safety regulations, all applicable legal requirements specified by other pieces of legislation and government regulations and policies shall be complied with.

8. PROGRAMME

The implementation programme is shown in **Appendix B**.

9. PROJECT COSTS

The capital costs associated with a 13 m dam raising are as indicated in **Table 9.1** based on feasibility cost estimates escalated to September 2012.

Table 9.1: Updated dam costs

Description	**Project Costs* (R million)**
Route N7 re-alignment	260.0
Minor Roads	100.6
Land & infrastructure	162.6
Construction of raising	1 243.2
Design of dam raising	7.2
Site supervision	21.0
Graves and archaeology	21.5
ECO	8.4
Communication	5.5
Total Budget	**R 1 830.0**

* *As provided by Tony Moore (Infrastructure Branch), September 2012*

The cost of the raising of the dam is to be shared between the expenditure required for dam rehabilitation and the benefit to the users for the raising of the dam. It is estimated that about 45% of the capital cost is attributed to the required betterments for dam safety reasons. This cost needs to be paid from the Fiscus.

The benefits derived from the raising need to be recovered from the water users. As the existing users will also benefit through an improved assurance of supply, they should also be charged an appropriate tariff for their allocation.

A policy decision needs to be taken in consultation with Directorate: Water Resource Finance and Water Pricing to decide if the cost of dam raising will be recovered from all the users, based on the full yield, or only the users of additional yield. These two options are:

a) Spreading the total cost for the raising only over the *additional* yield from raising the dam; and

b) Spreading the total cost for the raising over the *total* available yield from the raised dam.

10. FUNDING AND INSTITUTIONAL ARRANGEMENTS

10.1 Project Financing Options

Because Clanwilliam Dam is owned by the DWA, all charges, following the dam raising, would be levied in terms of the *Pricing Strategy for Raw Water Use Charges* after allowing for all applicable government subsidies. New farmers would only be given access to irrigation, or existing farmers be allowed to expand, on condition that the full financial cost (O&M plus depreciation plus return on assets) be paid for the development.

A number of options exist for financing of the scheme, as set out in the Pricing Strategy. These include:

- Return on assets (ROA);
- Government schemes funded off-budget but this option is not viable for irrigation schemes;
- Betterment charges;
- Combinations of financing mechanisms;
- Phasing in of charges.

According to current practice, the portion of cost relating to dam safety betterment is not being recovered from the users. In Section 3.14.11 it was motivated that the cost of the dam raising should be funded by Government. In terms of Section 7.1 of the Pricing Strategy "*capital expenditure relating to ... and dam safety betterments on State owned dams will qualify for State funding*". In terms of Section 7.5.1 of the Pricing Strategy, dam safety betterments will be funded through the ROA charges provision. Irrigators however currently do not pay the ROA charge for existing schemes.

The balance of the cost will be recoverable from agricultural and other users in terms of the current pricing strategy and policies relating to the establishment of resource poor farmers.

10.2 Financing Options for Resource-Poor Farmers

A suite of possible options have been recommended, to be considered for the potential use of water from the Clanwilliam Dam, to support the development of resource-poor farmers in the area. The lack of financial support has been highlighted as one of the main hindrances to emerging farmer development. Funding is required for capital expenses as well as to fund equity acquisition in a joint venture. A wide range of potential sources of funding for resource-poor farmers have therefore been identified and evaluated, as shown in Table 10.1.

Table 10.1: Potential sources of funding for resource-poor farmers

National Department or Institution	Financial support	Bulk infra-structure	On-farm infra-structure	Water resource charges	Operation and maint.	Other costs
Water Affairs	Capital costs	■	■			
	Operation and maintenance costs			■	■	
	Acquisition of water entitlements					■
	Viability studies					■
	Training of management committees					■
	Rain water tanks					■
Land Affairs	LRAD		■			■
Labour	PAETA					■
Land Bank	Equity finance		■	■	■	■
	Loans		■	■	■	■
	Step up micro loans		■	■	■	■
Provincial and Local Government	MIG funding	■				■

10.3 Institutional Arrangements

In order to ensure the equitable distribution of the benefits from the raising of the dam, a multi-stakeholder Olifants River Development Agency (ODA) could be established. The ODDA would be responsible for developing a vision for the catchment, identifying possible opportunities and partnerships and preparing a business plan for the equitable allocation of water. The ODA would also be responsible for co-ordinating the development of the proposed initiatives and monitoring the progress so that changes can be made when necessary or in response to new opportunities that arise. The CMA, WUAs and relevant State departments are expected to form part of the ODA.

WUAs in the Olifants River catchment are shown in **Figure 10.1**.

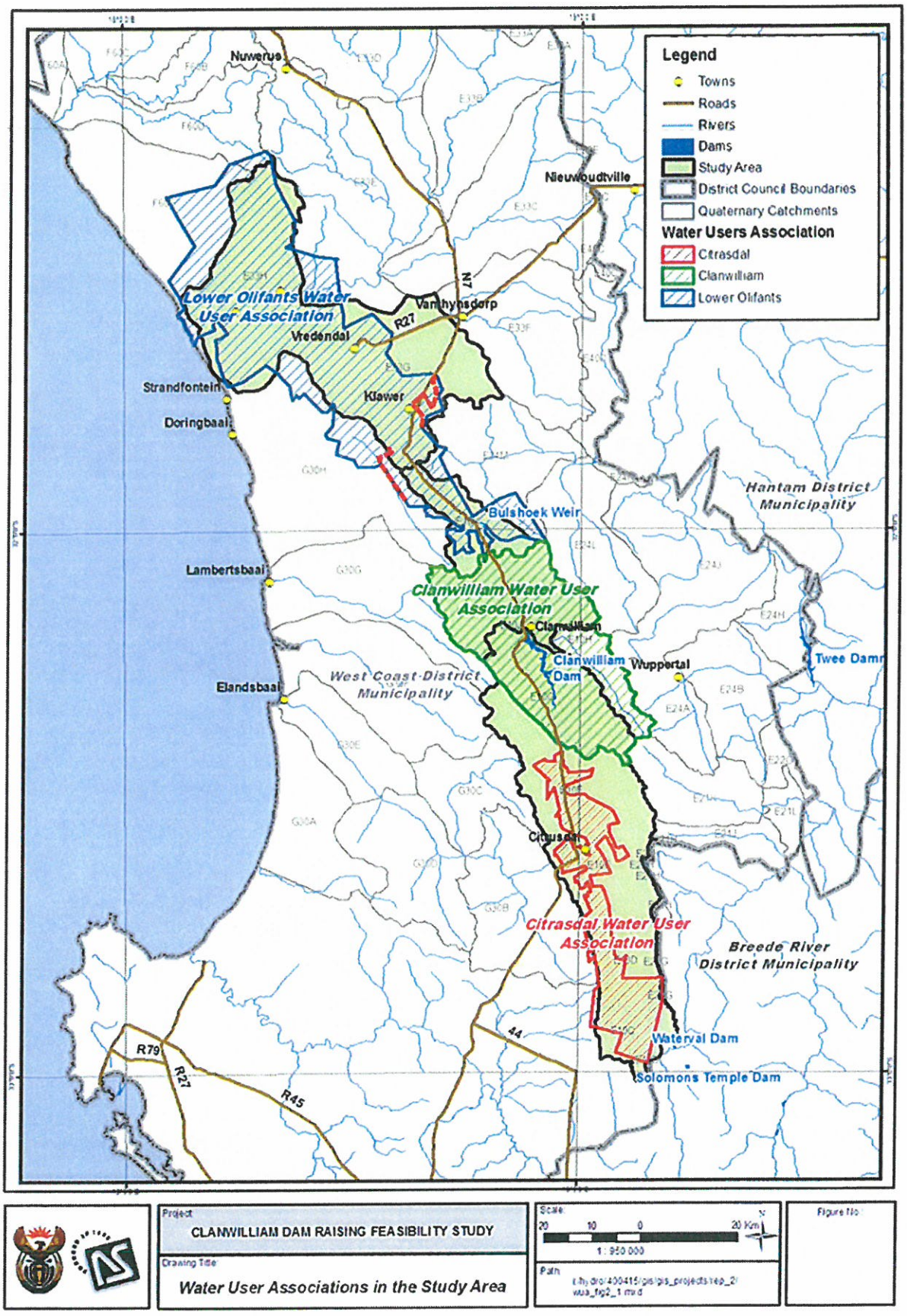

Figure 10.1: Water User Associations

11. REFERENCES

The full list of the reports of the Feasibility Study is shown in **Appendix D** attached hereto.

A Pricing Policy for Raw Water Use Charges, March 2007. Department of Water Affairs and Forestry.

Memorandum of Understanding between Integrated Water Resource Planning (IWRP) and Development, August 2004 – On the division and sharing of responsibilities for the planning and implementation of water resources development projects.

Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP), December 2010 – Record of Implementation Decisions, Phase 1.

Mooi-Mgeni Transfer Scheme Phase 2, October 2008 – Record of Implementation Decisions, Internal Report, Spring Grove Dam.

Olifants River Water Resources Development Project Phase 2, September 2005 – Dam on the Steelpoort River at De Hoop (Phase 2A) Record of Implementation Decisions.

Appendices

Appendix A

Ministers' Approval

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

ENQUIRIES: M Mugumo
TELEPHONE: 012 336 6838
REFERENCE: 14/2/E100/1/2

THE MINISTER OF WATER AND ENVIRONMENTAL AFFAIRS

APPROVAL FOR THE RAISING OF THE CLANWILLIAM DAM: OLIFANTS RIVER, WESTERN CAPE

1. PURPOSE

1.1 To obtain your approval for the Department of Water Affairs (DWA) to raise the Clanwilliam Dam as a Government Waterworks in terms of section 109 of the National Water Act, 1998 (Act No. 36 of 1998).

2. BACKGROUND AND DISCUSSION

2.1 The Clanwilliam Dam was originally built on the Olifants River in the Western Cape near the town of Clanwilliam in 1935. It was later raised in the 1960's to provide for an increasing irrigation demand.

2.2 Over the years, the dam wall had suffered chemical attack which weakened the integrity of the structure, making it unsafe in the medium- to long term. The biggest threat however comes from the manually operated crest gates which make the dam unstable during big floods. According to the Dam Safety Regulations, the dam needs urgent rehabilitation to strengthen and make it safe.

2.3 The opportunity will also be taken to raise the dam, in conjunction with the dam safety work, to create additional yield. The objective of the project will be (a) to establish resource-poor farmers in sustainable farming enterprises, (b) to reduce poverty, improve livelihoods and provide job opportunities, (c) to improve the assurance of supply to existing commercial farmers on the scheme, and (d) to utilise the opportunity of development, created by the additional water, as early as possible in order to maximise the investment by the State.

2.4 A Reserve study for the Olifants/Doring system completed in 2006, recommended that further water resource development should be limited only to the Olifants River and that the Doring River should be preserved in its present, almost pristine condition. In a subsequent feasibility study, the Raising of the Clanwilliam Dam on the Olifants River was found to be the best option for further water resource development.

2.5 The environmental authorisation, granted by the Western Cape Minister of Local Government, Environmental Affairs and Development Planning on 22 February 2010, allows the DWA to raise the dam by a maximum height of 15 m. The authorisation is valid for five (5) years starting in February 2010, being the end of the appeal process.

2.6 The feasibility study recommendation of a 13 m raising provides the basis of planning for implementation currently underway. A dam raising of 13 m will create an additional yield of 69.5 million cubic metres per annum. Out of this yield, about

52 million cubic metres (75%) of water is earmarked for resource-poor farmer development and 18 million cubic metres will be used to improve assurance of supply to the existing users. In all, the additional yield can command in the order of 5 500 ha of new irrigation.

2.7 The potential for irrigation in the area was identified both in the feasibility study for the Raising of Clanwilliam Dam and in the Western Cape Olifants/Doring River Irrigation Study. In order to confirm the findings of these studies, the Western Cape Department of Agriculture will now undertake an assessment of the likelihood that the water that will become available will reasonably be utilised in future. To do this, they will consult with the commercial farmer as well as the resource poor farmer communities, as well as related organisations, to assess the likelihood that all the water created by the raising of the dam by 13 m will be taken up and therefore to provide assurance that the investment will be well spent.

2.8 The capital cost to refurbish and raise the dam by 13 m is estimated at R1 660 million at 2010 prices, broken down into R495 million for the rehabilitation work and R1 165 million for raising the dam. This estimate includes the cost of re-aligning the N7 Road by the South African National Roads Agency Limited (SANRAL), the acquisition of land, compensation for affected infrastructure, as well as VAT and escalation. Funds are provided on the 2010/11 budget and on the Medium-term Expenditure Framework for 2011/12 to 2013/14.

2.9 In addition to the investment in raising the dam, additional investments downstream will be required to improve existing conveyance infrastructure, to create new conveyance infrastructure and to undertake the associated irrigation development. These actions, parallel to the construction of the dam by the DWA, will be required from the relevant agencies (such as the Lower Olifants River Water Users Association), and responsible government departments (such as the Western Cape Department of Agriculture). A coordinating mechanism has been established to clarify roles and responsibilities in this regard. In as far as additional financial support from the DWA may be required (eg financial support to the resource poor farmers), these will be identified and placed on the standard line item budgets of the relevant components of the DWA.

2.10 The proposed water allocation model for joint venture schemes between resource-poor farmers and existing commercial farmers will be guided by the Water Allocation Reform Strategy and the Broad Based Black Economic Empowerment Act, 2003 (Act No. 53 of 2003). Joint venture partnerships are expected to bring the much needed financial resources, skills and expertise from the established commercial farmers for the benefit of the resource-poor farmers. It is implicit, of course, that interested individual HDI commercial farmers will also be considered for water allocation.

2.11 For purposes of soliciting applications from joint equity schemes, a guideline was set that any legal entity with the shareholding of 70:30 HDI (minimum) or BBBEE score of four, or better, will receive preference.

2.12 The project is planned for completion in 2016/17. In order to meet this target, the programme of implementation must start by 2012/13.

2.13 The process to be followed after approval is briefly outlined below:

2.13.1 A notice will be published in the *Government Gazette* as prescribed in section 110 of the National Water Act, 1998 (Act No. 36 of 1998).

2.13.2 The DWA will start preparing detailed designs of the dam raising and rehabilitation

2.13.3 The DWA will inform SANRAL to go ahead with the realignment of the N7 Road affected by the dam raising and the necessary payments will be made.

2.13.4 The Record of Decision of the environmental authorisation will be implemented.

2.13.5 Dam construction and rehabilitation work will commence by 2012/13.

3. IMPLICATIONS

3.1 Financial

3.1.1 The estimated total cost for dam rehabilitation and raising is R1 660 million at 2010 prices.

4. OTHER COMPONENTS CONSULTED

4.1 The other parties consulted in the planning process include the national Department of Rural Development and Land Reform, the Western Cape Department of Agriculture, and the Lower Olifants River Water Users Association.

5. RECOMMENDATION

It is recommended that:

5.1 You grant approval for the raising of the Clanwilliam Dam by the Department of Water Affairs as a Government Waterworks in terms of section 109 of the National Water Act, 1998 (Act No. 36 of 1998).

DIRECTOR-GENERAL (Acting)
DATE:

RECOMMENDATION IN PAR. 5.1
APPROVED/

MS BP SONJICA, MP
MINISTER OF WATER AND
ENVIRONMENTAL AFFAIRS
DATE:

RECOMMENDATION IN PAR. 5.1
NOT APPROVED

MS BP SONJICA, MP
MINISTER OF WATER AND
ENVIRONMENTAL AFFAIRS
DATE:

FINALISED

13 AUG 2010
DDG: P & R

DDG: P & R
27 JUL 2010
RECEIVED

water & forestry
Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

tracking no M2220

DDG: P & R
07 AUG 2010
RECEIVED

ROUTE FORM

BRANCH: Policy & Regulation

Reference No.: Stan/M Mugumo

SUBJECT:
APPROVAL FOR THE RAISING OF THE CLANWILLIAM DAM: OLIFANTS RIVER, WESTERN CAPE

DRAFTING OFFICIAL		SUPERVISOR	
Name:	M Mugumo	Name:	LS Mabuda
Extension:	6838	Extension:	8477
Office No.:	Sed 844	Office No.:	Sed 838
Rank: Chief Engineer	Date: 14/07/2010	Rank: Chief Director	Date: 14/07/2010

Language Practitioner: Signature
Date: 3/8

Rank	Date	Initials	Office No		Rank	Date	Initials	Office No	
CE: OA (S)	14.7.10		5814	▼	CE: OA (S)				▲
Act. D: OA	14.7.10		5844	▼	Act. D: OA				▲
CD: IWRP	23/7/10		5838	▼	CD: IWRP				▲
D: SS	2/08/10		6531	▼	D: SS				▲
Act. DDG: P&R	02/08/10		8944	▼	Act. DDG: P&R				▲
CFO*				▼	CFO*				▲
D: ES				▼	D: ES				▲
COO				▼	COO				▲

* In the case of financial issues

▼ DG ▲

▼ MINISTER ▲

Min Signed 18/8/2010

INSTRUCTIONS/REMARKS BY DIRECTOR-GENERAL: WATER AFFAIRS

13/08/2010

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

ENQUIRIES: M Mugumo
TELEPHONE: 012 336 6838
REFERENCE: 14/2/E100/1/2

THE MINISTER OF WATER AND ENVIRONMENTAL AFFAIRS

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5. RECOMMENDATION

It is recommended that:

5.1 You grant approval for the raising of the Clanwilliam Dam by the Department of Water Affairs as a Government Waterworks in terms of section 109 of the National Water Act, 1998 (Act No. 36 of 1998).

DIRECTOR-GENERAL (Acting)
DATE: 16/8/10

RECOMMENDATION IN PAR. 5.1
APPROVED

MS BP SONJICA, MP
MINISTER OF WATER AND
ENVIRONMENTAL AFFAIRS
DATE: 2010/08/18

RECOMMENDATION IN PAR. 5.1
NOT APPROVED

MS BP SONJICA, MP
MINISTER OF WATER AND
ENVIRONMENTAL AFFAIRS
DATE:

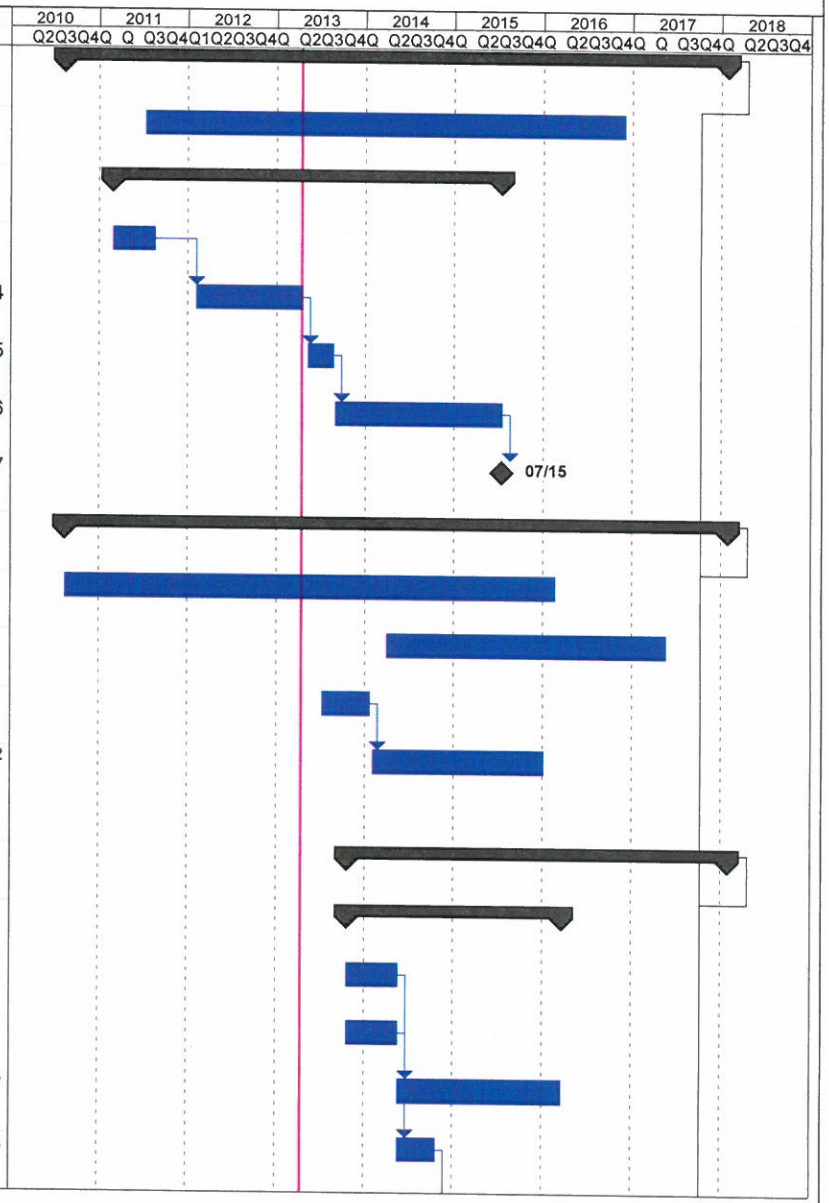
Appendix B

Implementation Programme

THE RAISING OF CLANWILLIAM DAM PROJECT PROGRAMME

REVISION 8 : APRIL 2013

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Raising of Clanwilliam Dam**	**97.34 mons**	**Mon 10/08/16**	**Tue 18/01/30**	
2	Land Acquisation	70.3 mons	Wed 11/07/13	Wed 16/11/30	
3	**Realignment of N7**	**57.1 mons**	**Tue 11/03/01**	**Wed 15/07/15**	
4	Tender for design	6.2 mons	Tue 11/03/01	Fri 11/08/19	
5	Design	15.55 mons	Mon 12/02/06	Mon 13/04/15	4
6	Tender for the Contractor	3.75 mons	Fri 13/05/10	Thu 13/08/22	5
7	Construction	24.45 mons	Fri 13/08/30	Wed 15/07/15	6
8	Road Complete	0 mons	Wed 15/07/15	Wed 15/07/15	7
9	**Dam Raising**	**97.34 mons**	**Mon 10/08/16**	**Tue 18/01/30**	
10	Design of raising by D: CE	72 mons	Mon 10/08/16	Fri 16/02/19	
11	Construction Supervision	40.9 mons	Tue 14/04/01	Thu 17/05/18	
12	Tender for the Grouting Contractor	7 mons	Tue 13/07/09	Mon 14/01/20	
13	Contract for grouting of Clanwilliam dam foundations	25 mons	Tue 14/02/04	Mon 16/01/04	12
14	**Construction of Dam**	**55.84 mons**	**Mon 13/10/21**	**Tue 18/01/30**	
15	**Site Establishment**	**31.56 mons**	**Mon 13/10/21**	**Tue 16/03/22**	
16	Electricity supply	152.63 days	Mon 13/10/21	Wed 14/05/21	
17	Offices, Stores, Workshop, Lab	152.63 days	Mon 13/10/21	Wed 14/05/21	
18	Quarry	478.5 days	Wed 14/05/21	Tue 16/03/22	17
19	Concrete batch plant	110.88 days	Wed 14/05/21	Thu 14/10/23	16



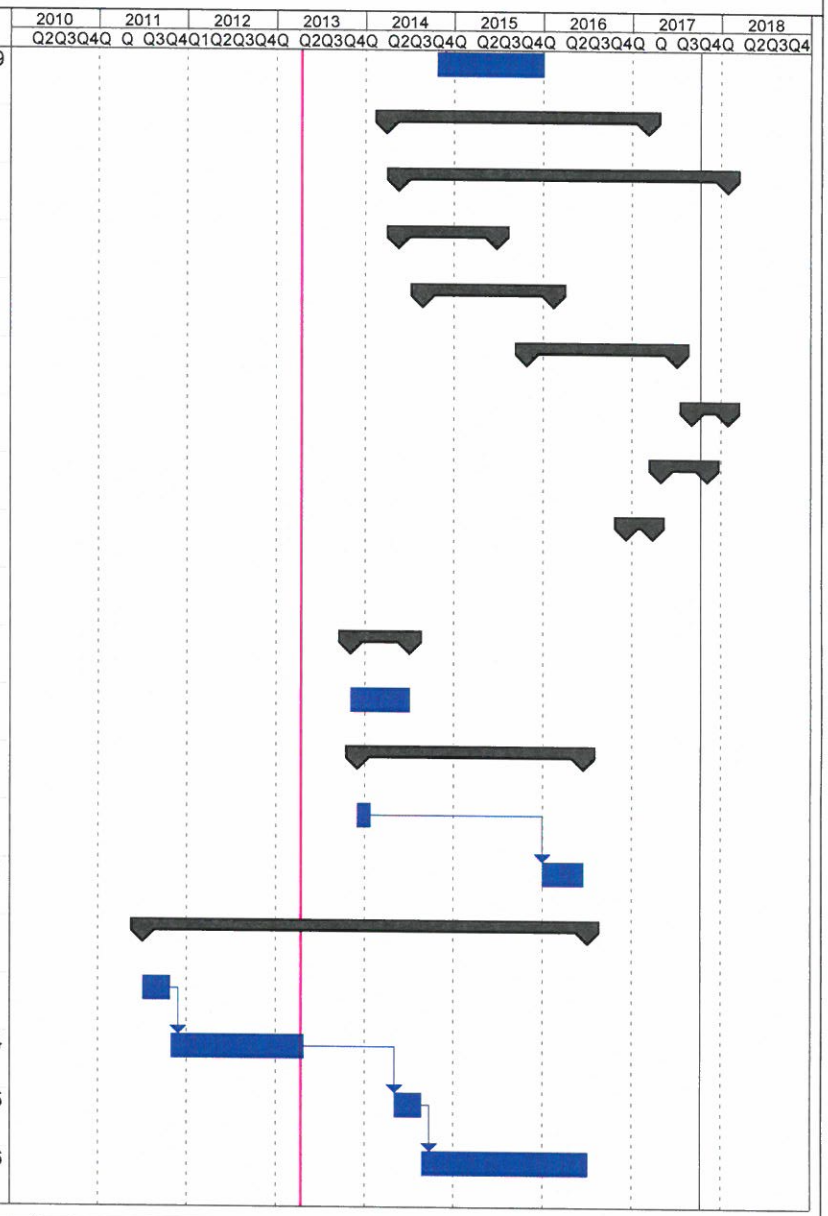
Project: Raising of Clanwilliam Dam (A
Date: Wed 13/04/10

Task | Progress | Summary | External Tasks | Split
Split | Milestone | Project Summary | External MileTask

THE RAISING OF CLANWILLIAM DAM PROJECT PROGRAMME

REVISION 8 : APRIL 2013

ID	Task Name	Duration	Start	Finish	Predecessors
20	Construction housing & other accommodatic	312 days	Thu 14/10/23	Mon 16/01/04	19
21	**Inlet works**	**38.42 mons**	**Tue 14/04/01**	**Fri 17/03/10**	
40	**RCC placing**	**48.34 mons**	**Mon 14/05/19**	**Tue 18/01/30**	
41	**NOC RHS**	**14.46 mons**	**Mon 14/05/19**	**Fri 15/06/26**	
47	**NOC LHS**	**19.22 mons**	**Tue 14/08/26**	**Mon 16/02/15**	
53	**Spillway**	**22.04 mons**	**Wed 15/10/28**	**Wed 17/07/05**	
66	**Apron**	**5.34 mons**	**Mon 17/09/04**	**Tue 18/01/30**	
72	**Site Rehabilitation**	**6.78 mons**	**Mon 17/05/01**	**Mon 17/11/06**	
75	**Demobilsation**	**3.86 mons**	**Fri 16/12/09**	**Tue 17/03/28**	
77					
78	**Bulshoek Dam Grouting**	**8.7 mons**	**Mon 13/11/04**	**Thu 14/07/03**	
79	Grouting by DWA Construction	8.7 mons	Mon 13/11/04	Thu 14/07/03	
80	**Gauging Weirs (Clanwilliam and Bulshoek)**	**33.2 mons**	**Mon 13/12/02**	**Thu 16/06/16**	
81	Design of the gauging weirs by D: H S	2 mons	Mon 13/12/02	Fri 14/01/24	
82	Construction of the weirs	6 mons	Fri 16/01/01	Thu 16/06/16	81
83	**Minor Roads**	**65.25 mons**	**Wed 11/07/06**	**Tue 16/07/05**	
84	Appoint PSP	4 mons	Wed 11/07/06	Tue 11/10/25	
85	Planning and Design of minor roads	19.45 mons	Tue 11/11/01	Fri 13/04/26	84
86	Tender for the Contractor	4 mons	Mon 14/05/05	Fri 14/08/22	85
87	Minor roads construction	24.35 mons	Mon 14/08/25	Tue 16/07/05	86



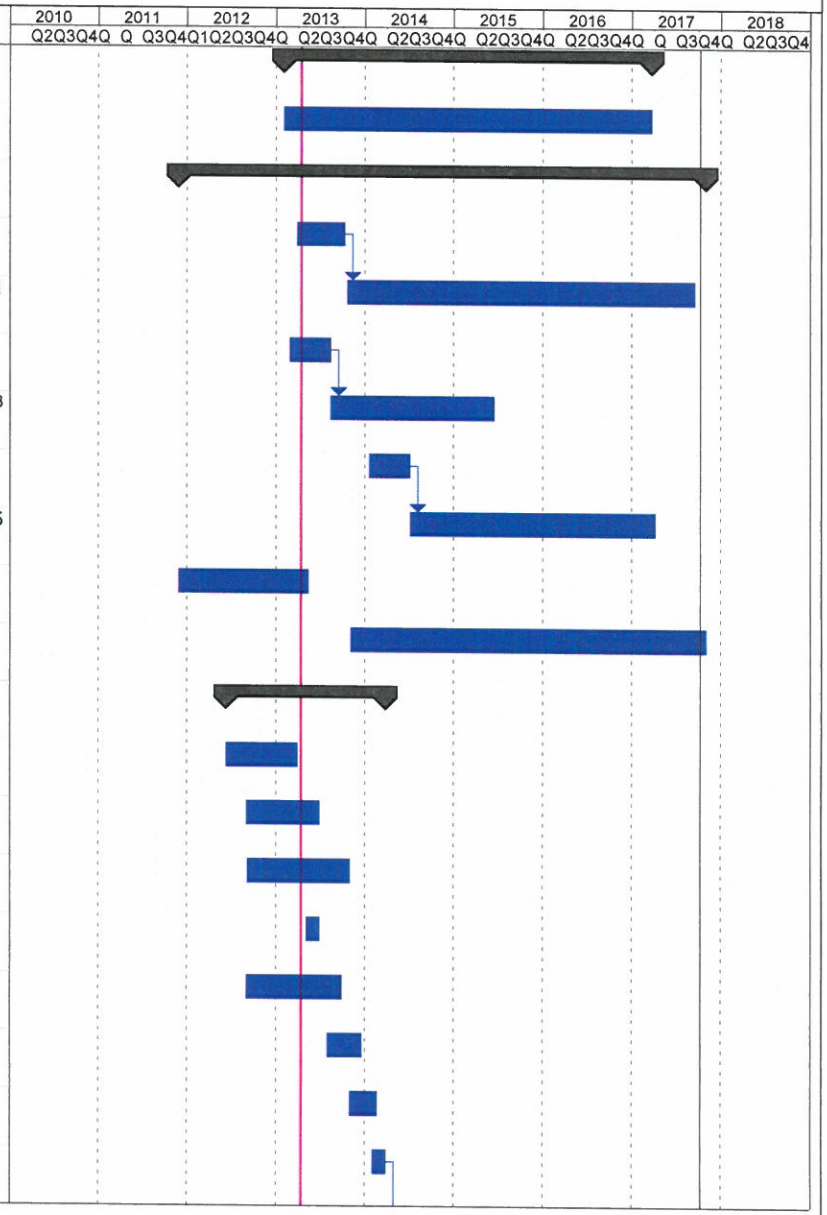
Project: Raising of Clanwilliam Dam (A
Date: Wed 13/04/10

Task | Progress | Summary | External Tasks | Split
Split | Milestone | Project Summary | External MileTask

THE RAISING OF CLANWILLIAM DAM PROJECT PROGRAMME

REVISION 8 : APRIL 2013

ID	Task Name	Duration	Start	Finish	Predecessors
88	**Communication**	**54 mons**	**Mon 13/02/04**	**Fri 17/03/24**	
89	Communication and liaison	54 mons	Mon 13/02/04	Fri 17/03/24	
90	**Environmental**	**77.4 mons**	**Tue 11/11/29**	**Thu 17/11/02**	
91	Tender for ECO	7 mons	Fri 13/03/29	Thu 13/10/10	
92	ECO	51 mons	Mon 13/10/21	Fri 17/09/15	91
93	Tender for the Archaeologist	6 mons	Wed 13/02/27	Tue 13/08/13	
94	Archaeologist Contract	24 mons	Wed 13/08/14	Tue 15/06/16	93
95	Tender for the Graves	6 mons	Mon 14/01/20	Fri 14/07/04	
96	Graves Contract	36 mons	Mon 14/07/07	Fri 17/04/07	95
97	EMP for dam	19 mons	Tue 11/11/29	Mon 13/05/13	
98	Environmental aspects for dam	52.2 mons	Mon 13/11/04	Thu 17/11/02	
99	**Utilisation of Additional Water Study**	**23.5 mons**	**Mon 12/06/11**	**Fri 14/03/28**	
100	Inception Phase	10.5 mons	Mon 12/06/11	Fri 13/03/29	
101	Natural Resourse Development	10.75 mons	Mon 12/09/03	Fri 13/06/28	
102	Bulk Water Infrastructure Development	15 mons	Fri 12/09/07	Thu 13/10/31	
103	Agricultural Production and Farm Development	2 mons	Mon 13/05/06	Fri 13/06/28	
104	Establishment of Resource Poor Farmers	14 mons	Mon 12/09/03	Fri 13/09/27	
105	Financial Viability and Economic Development	5 mons	Thu 13/08/01	Wed 13/12/18	
106	Implementation Strategy and Dev. Agency	4 mons	Fri 13/11/01	Thu 14/02/20	
107	Finalising Reports	2 mons	Mon 14/02/03	Fri 14/03/28	



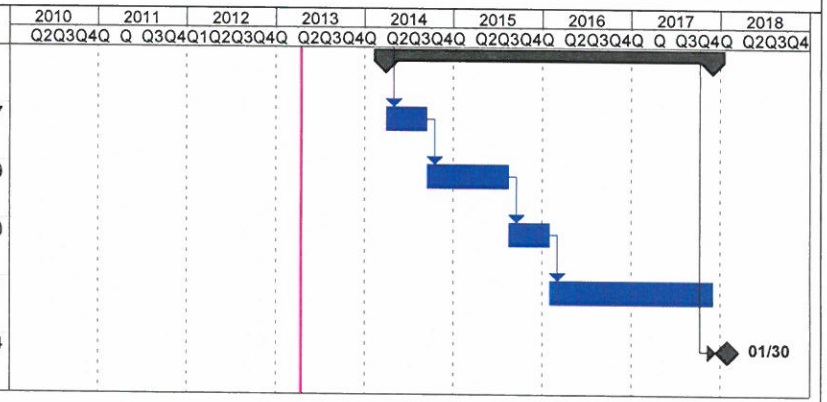
Project: Raising of Clanwilliam Dam (A
Date: Wed 13/04/10

Task | Progress | Summary | External Tasks | Split
Split | Milestone | Project Summary | External MileTask

THE RAISING OF CLANWILLIAM DAM PROJECT PROGRAMME

REVISION 8 : APRIL 2013

ID	Task Name	Duration	Start	Finish	Predecessors
108	**Implementation of Irrigation Infrastructure**	**48 mons**	**Mon 14/03/31**	**Fri 17/12/01**	
109	Appoint PSP for design of infrastructure	6 mons	Mon 14/03/31	Fri 14/09/12	107
110	Design of infrastructure	12 mons	Mon 14/09/15	Fri 15/08/14	109
111	Tender for infrastructure Contractor	6 mons	Mon 15/08/17	Fri 16/01/29	110
112	Construction of infrastructure	24 mons	Mon 16/02/01	Fri 17/12/01	111
113	Site handover	0 mons	Tue 18/01/30	Tue 18/01/30	1,9,14



Project: Raising of Clanwilliam Dam (A
Date: Wed 13/04/10

Task | Progress | Summary | External Tasks | Split

Split | Milestone | Project Summary | External MileTask

Appendix C

Affected Roads and Other Infrastructure

AFFECTED ROADS AND OTHER INFRASTRUCTURE

The purpose of this feasibility investigation was to assess the impacts on the existing roads and other infrastructure surrounding the dam that would result from the raising of the Clanwilliam Dam wall. The extent of this impact depends on the raising option selected.

Infrastructural issues investigated

The following infrastructural issues, arising from the proposed raising of the dam wall, were investigated:

- The re-alignment of Trunk Road 11 Section 4 (hereafter referred to as the N7) to the west of the Clanwilliam Dam (see **Figure D.1**).
- The continued provision of access to residences, farmsteads and cultivated land along Divisional Roads 2183 and 1487 and Main Road 539 to the east of the dam. The viability of the farms in terms of the impacts on usable agricultural land is briefly addressed.
- The continued functioning of Divisional Road 2183 as part of an alternative route in the event that the N7 between Clanwilliam and Citrusdal is temporarily closed.
- The maintenance of access to the Cederberg Wilderness Area, Algeria and other communities in the Cederberg area from the N7 via the causeway across the Olifants River (Main Road 539) and Divisional Road 1487.
- The maintenance of access to farms and residential developments on the western side of the dam via minor road 16/2, the so-called Renbaan Road.
- The replacement of other infrastructural elements in the area around the dam such as built structures, pumping systems and boreholes.
- The loss of land.

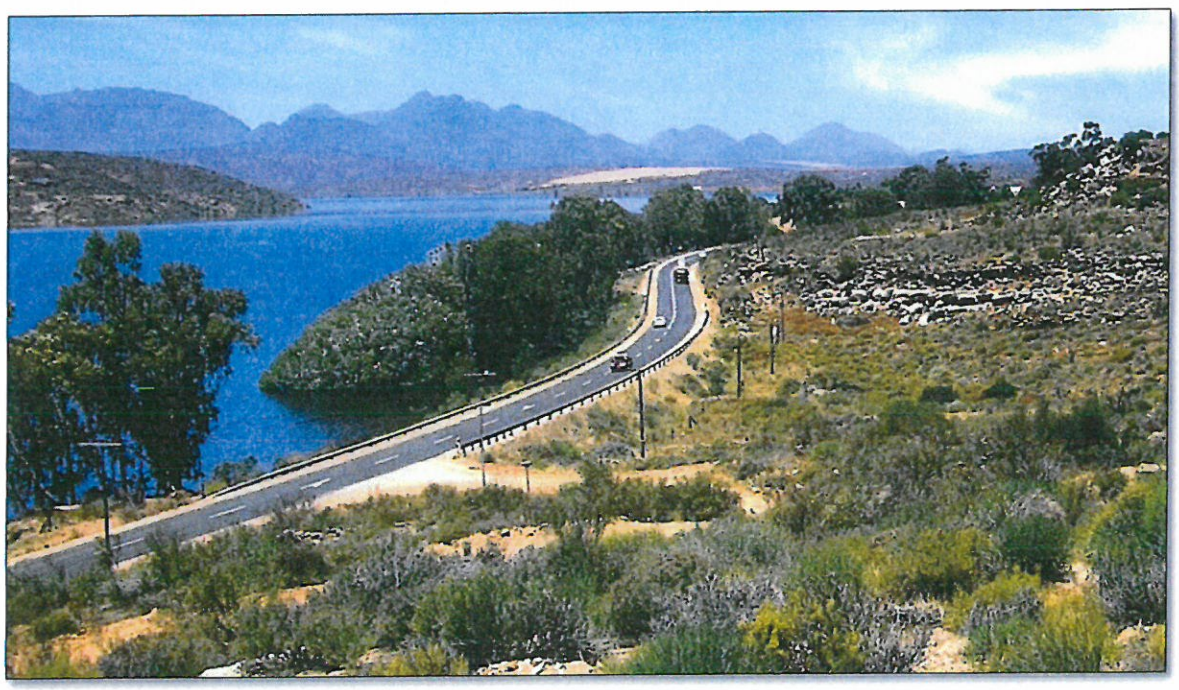


Figure D.1: The N7 to the west of the Dam

Figure D.2: Divisional Road 2183 to the east of the Dam

Trunk road 11, Section 4 (N7)

The predicted 1:50 year flood levels for each dam raising option were adopted as the minimum elevation criteria for the N7. The two affected portions of the N7 are from km 89.32 to 95.92 and km 68.77 to 70.22, respectively (Section 4 of the N7 begins at Piketberg). The affected lengths vary from 1.6 to 3.7 km for the various raising options.

Affected roads are shown in **Figure D3**.

Three new road re-alignments were evaluated for affected portions of the N7 closest to the dam wall (see **Figure D.4**). The currently envisaged extent of the quarry, from which material for the dam wall is to be obtained, does not impinge directly on any of these re-alignments. The centre-line of Alignment 3, at approximately 41 metres distance, is closest to the edge of the quarry. Alignment 1 does not require any bridge construction but requires the longest deviation from the current alignment. Alignment 2 is closer to the dam and requires less earthworks but the construction of a bridge. The preferred alignment, Alignment 3, is the least costly and also deviates least from the existing alignment, although it requires the construction of a bridge.

The affected portions of the N7 further south would not be re-aligned but the road would have to be raised above its present level in places, to reduce the risk of flooding.

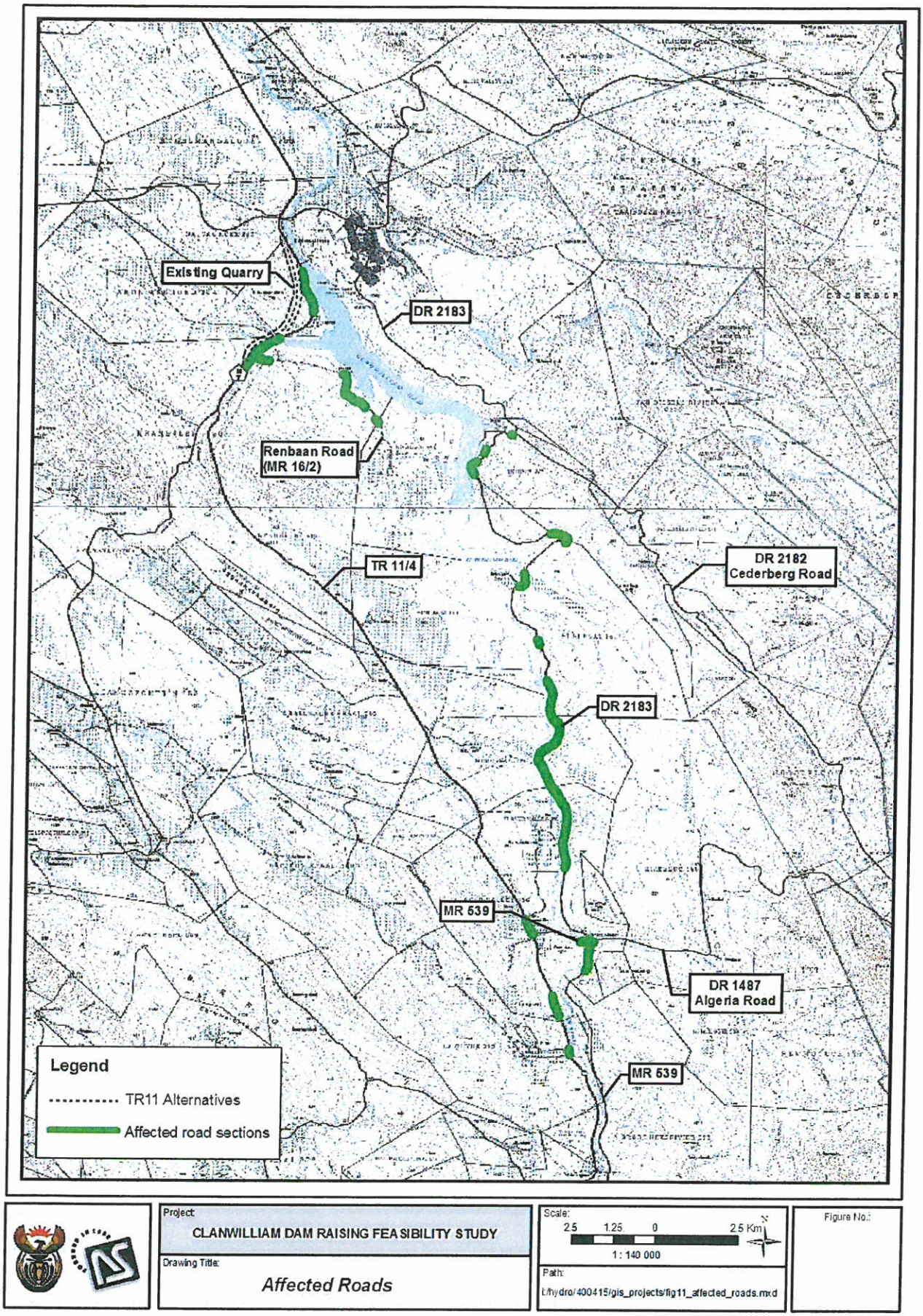


Figure D.3: Affected roads

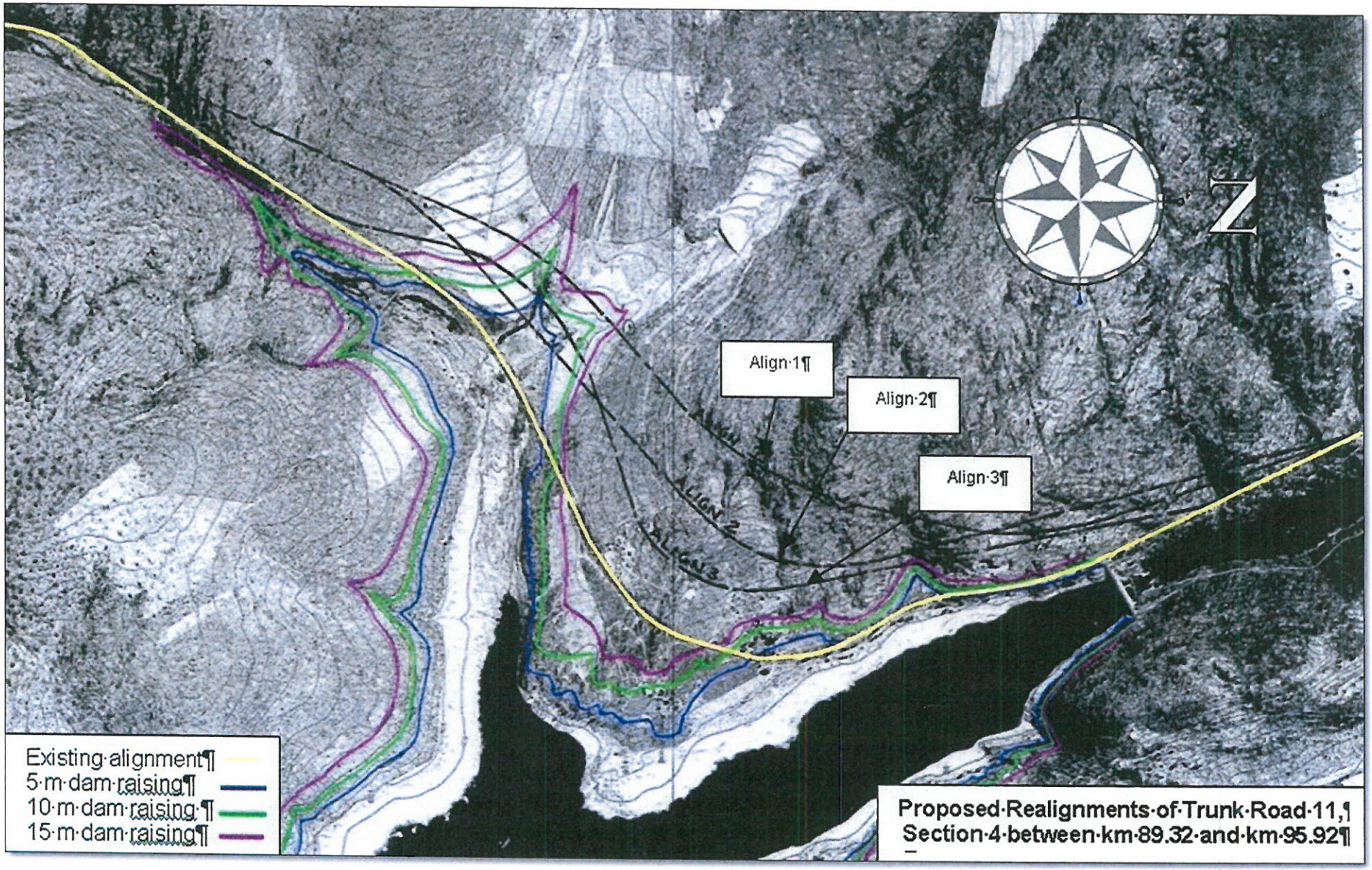


Figure D.4: Alternative re-alignments of the N7

Divisional and minor roads

Divisional Road 2183 (see **Figure D.5** and **Figure D.6**) is an existing gravel road on the eastern side of the dam, running in a southerly direction from Clanwilliam, virtually on the banks of the dam along its southern part. It terminates at the intersection with Divisional Road 1487 and Main Road 539. It provides both local access to the farms and residences on the eastern shore of the dam and operates as part of an alternate route between Clanwilliam and Citrusdal.

Figure D.5: Road DR 2183 at the Rondegat River

Figure D.6: The bridge over the Rondegat River, road DR 2183

Divisional Road 1487 leads in an easterly direction to the Cederberg Wilderness Area. Main Road 539 carries traffic from the "T" junction with the N7 via a causeway across the Olifants River to this intersection and then continues south to Citrusdal. This route, comprising a portion of Main Road 539 and Divisional Road 1487, links Algeria and other communities in the Cederberg to each other and to the N7.

Minor Road 16/2 (Renbaan Road) is a minor gravel road that provides the only access to three farms and three residential developments on the western side of the Clanwilliam Dam.

The predicted 1: 10 year flood levels for each dam raising option have been adopted as the minimum elevation criteria for these roads.

Affected sections along Divisional Road 2183 vary from 4.3 to 8.1 km, for the various raising options. To the north of the farm Kriedoukrantz' "Beeswerf" orchard, it appears not feasible to re-align this section of Divisional Road 2183 and thus to retain its function as a through-road. Affected sections along Divisional Road 1487 (Algeria Road) and Main Road 539 vary between 0 and 0.3 km, for the various raising options. Affected sections along Main Road 539 (to Citrusdal) vary between 0 and 1.0 km, for the various raising options. Affected sections along Minor Road 16/2 vary from 0.1 to 1.9 km, for the various raising options.

Impacts on other infrastructure

Other land and infrastructure between the purchase line for the current dam and the purchase lines for the three raising options that would be affected are tourist facilities, residential development, agricultural developments and municipal infrastructure.

The Clanwilliam Municipality Dam Resort (see **Figure D.9**), Clanwilliam Aquatic Club, and the motel adjacent to the N7 Total Garage Complex on the western side of the dam (known as the "Cedar Inn") would be affected.

Three established major residential developments in the study area, namely Caleta Cove (see **Figure D.7**), Nooitgedacht Nature Resort and Sederview Farm cc. would be affected, as well as the proposed Kransvlei Golf Estate.

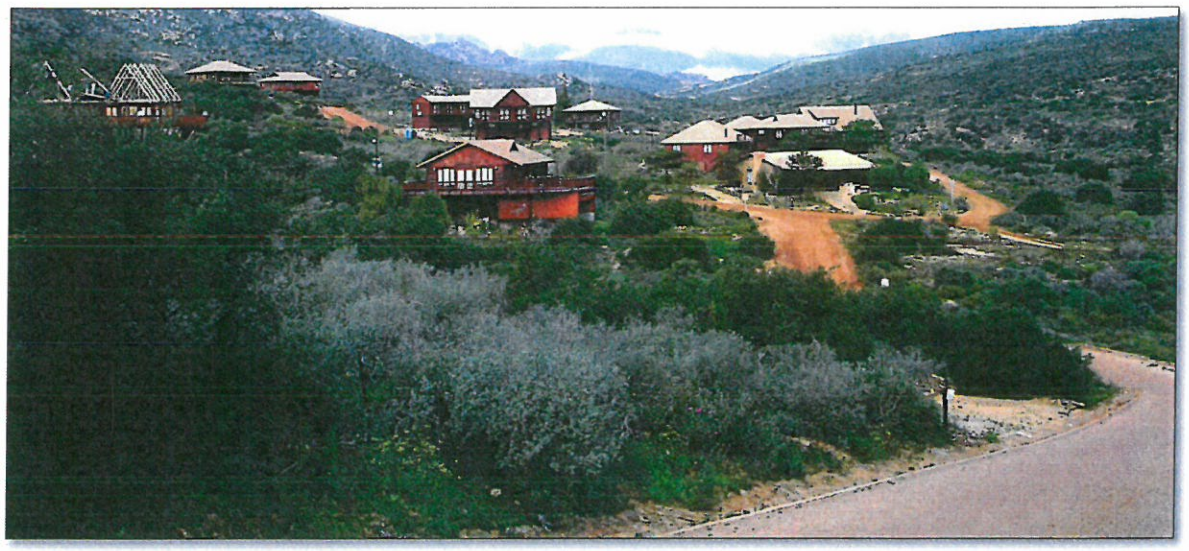


Figure D.7: Caleta Cove

Agricultural development that would be affected comprises farm houses (from 1 to 10 houses), labourers' cottages (from none to 11 affected) (see **Figure D.8**) and irrigation infrastructure. Affected irrigation infrastructure is composed of farm dams (3 to 5), boreholes (4), pump houses (7 to 10) and pipelines connecting the irrigated fields to their respective water sources.

The extent of agricultural land to be expropriated was determined, classed under orchards, other cultivated lands and uncultivated lands.

A section of the pipeline route from the Cederberg Municipality pump station to their reservoirs may be marginally affected by the raising of the dam.

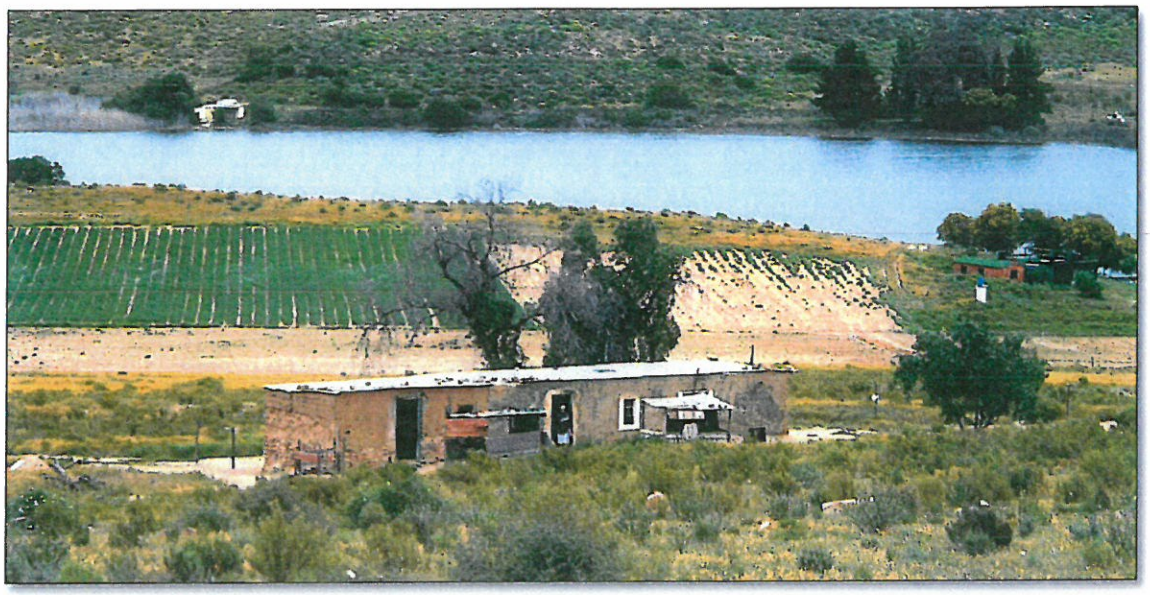


Figure D.8: Farm worker's house

Figure D.9: Municipal caravan park

Cost estimate

The consolidated cost estimate for mitigating the impacts on both the roads and other infrastructure are shown in **Table D.1**, based on 2006 rates for earthworks operations and road construction. The costs include provisions for preliminary and general items, contingencies and VAT.

Table D.1: Consolidated mitigation cost estimates for roads and other infrastructure in R million

Description	Dam raising option		
	5 m	10 m	15 m
Sub-total for the N7	87.5	91.8	97.2
Sub-total for minor roads	13.7	40.8	56.4
SUB-TOTAL FOR ROADS	**101.2**	**132.6**	**153.6**
Tourist facilities (land costs not included)	2.2	8.2	8.8
Residential developments (land costs included)	7.6	20.4	35.9
Municipal infrastructure	0.3	0.3	0.3
Agricultural developments (land costs not included)	10.3	22.7	32.4
Expropriation of agricultural land	4.6	8.6	12.9
SUB-TOTAL FOR OTHER INFRASTRUCTURE	**25.0**	**60.2**	**90.3**
CONSOLIDATED TOTALS	**126.2**	**192.8**	**243.9**

Findings

Technically feasible re-alignments can be achieved for those sections of the N7 affected by the raising of the dam wall. Of the three re-alignment alternatives investigated for the section of the N7 between km 89.32 and km 95.92, Alignment 3 is preferred, as it deviates least from the existing alignment and appears to be the cheapest to construct. The position of the quarry will not impinge directly on the three alignments, but the phasing of the construction of the road and of the dam will have to be carefully planned so that access for traffic on the N7 is maintained, and conflicts between construction traffic hauling material between the quarry and the dam wall and the traffic on the N7 are minimised. Ideally the road should be constructed before dam construction commences.

It appears not feasible to re-align Divisional Road 2183 all the way along the eastern bank of the Dam up to the intersection with the road to Algeria (DR 1487) to the south so as to maintain through access. Access to the following two farms would be from the north only (or alternatively via a new road, that links to road DR 2182):

- Rondegat 269 (Portion1) and
- Lebanon Citrus Farm (Portion of Rondegat 269).

Kriedouwkrans (Portions of Klawervlei 350, Krieberg 360 and others) will retain access from the south only, up to their "Beeswerf" orchard (see **Figure D.7**).

Road DR 2182 and a section of the Algeria road (MR 539/DR 1487) would serve as the alternate through-road to the section of the N7, between the Algeria turnoff and the Clanwilliam turnoff, and would need to be well-maintained.

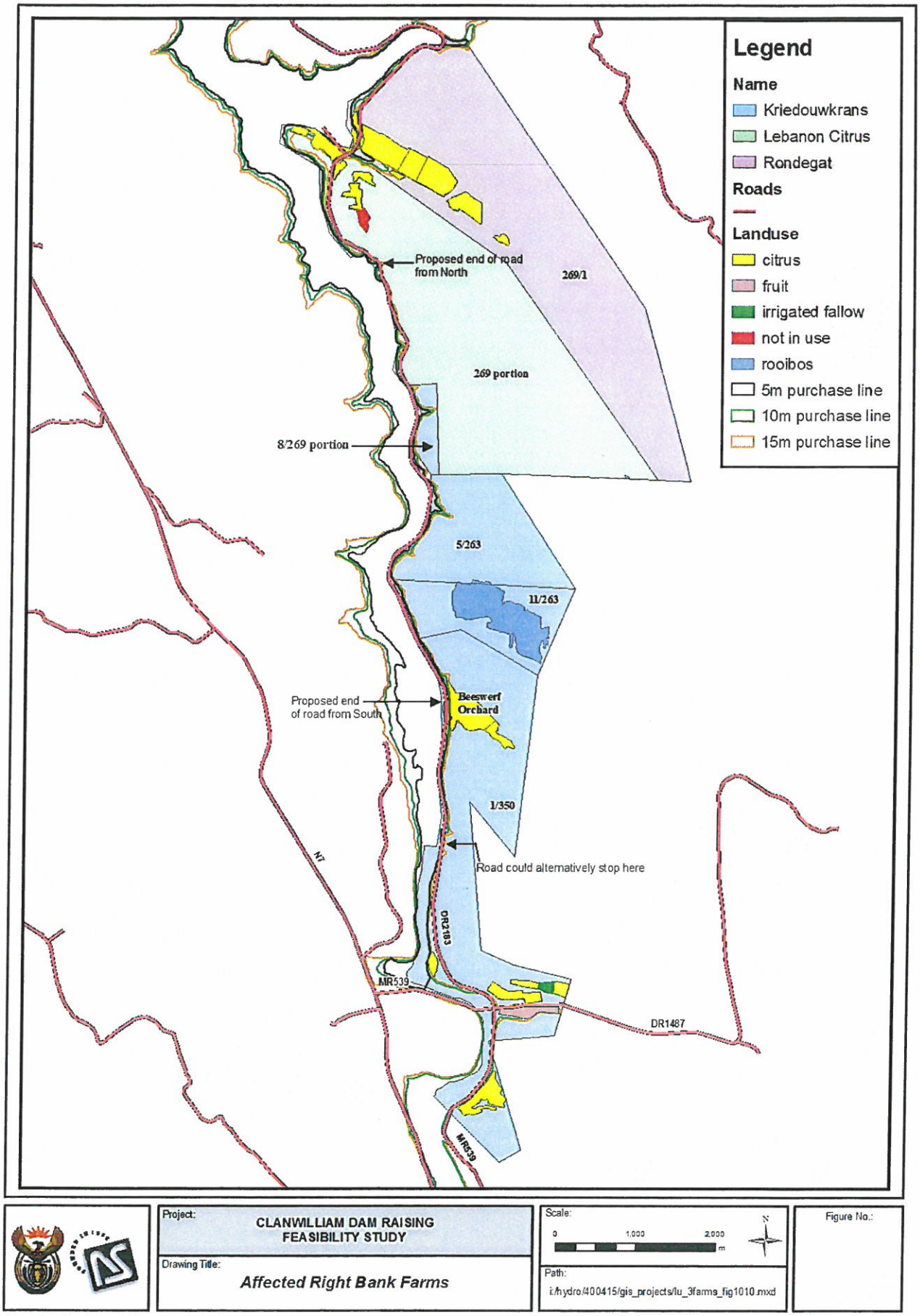


Figure D.10: Affected right bank farms

Affected portions of the Algeria Road (MR 539/DR 1487) should be re-aligned and a structure that can pass a 1:10 year flood should be constructed, to provide access across the Olifants River.

Expropriation of any affected farms in their entirety does not seem necessary. It needs to be considered whether the optimum course is to expropriate parts of these farms, and to compensate their owners. This specifically applies to sections of Lebanon Citrus Farm and Kriedoukrantz that may no longer be accessible.

Affected portions of the Renbaan Road (MR 16/2) should be re-aligned.

The road to Citrusdal from the Algeria Road (MR 539) is needed in order to provide an alternative route in the event of the N7 being temporarily closed. The affected portions of the road should therefore be re-aligned.

The level of detail adopted in this study is sufficient for assisting to indicate the preferred raising option. However, once the preferred raising option has been identified, the impacts on the infrastructure should be investigated in greater detail and confirmed with a detailed survey of the affected areas adjacent to the dam. Only such an investigation can yield sufficiently accurate information for determining the compensation payable to affected owners adjacent to the dam.

Appendix D

List of Feasibility Study Reports

List of Feasibility Study Reports

DWA Report Number	Report Title
No report number	Inception Report
P WMA 17/E10/00/0405	Screening of Options
P WMA 17/E10/00/0509	Water Quality
P WMA 17/E10/00/0609	System Analysis
P WMA 17/E10/00/0709	Groundwater Resources
P WMA 17/E10/00/0805	Environmental Scoping
P WMA 17/E10/00/0907	Environmental Impact
P WMA 17/E10/00/1109	Soils, Water Requirements and Crops
P WMA 17/E10/00/1209	Water Management Plan for the Olifants-Doorn Catchment Management Area
P WMA 17/E10/00/1309	Opportunities for the Supply of Water to Resource Poor Farmers
P WMA 17/E10/00/1409	Irrigation Development and Water Distribution Options
P WMA 17/E10/00/1509	Impacts on Roads and other Infrastructure
P WMA 17/E10/00/1609	Financial Viability of Irrigation Farming
P WMA 17/E10/00/1709	Socio-economic Impact Assessment
P WMA 17/E10/00/1809	Financial Evaluation
P WMA 17/E10/00/1907	Main Report
-	Feasibility Design of Raising (Engineering Design) and Design Report Addendum
-	First Engineering Geological Materials Report (Course Aggregate) For Proposed Raising (Council for Geoscience)
-	Farm Dams (Options Analysis): included under System Analysis report as Appendix