CROCODILE EAST WATER PROJECT (CEWP)
MODULE 1: TECHNICAL FEASIBILITY STUDY

Stakeholder Engagement Meeting No. 1

Directorate: Water Resource Development Planning (East)

Date: 27 September 2023

WATER IS LIFE - SANITATION IS DIGNITY

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

AGENDA

09:00	**1**	**Welcome and Introduction**	Chairperson
09:10	**2**	**Attendance and Apologies**	Chairperson
09:20	**3**	**Acceptance of Agenda**	All
09:25	**4**	**Purpose of Meeting**	Chairperson
09:35	**5**	**DWS Planning to Implementation Methodology** (10 Minutes)	Mr Kobus Bester / PSP
		Questions/Discussions	
09:55	**6**	**Overview of Study** (25 Minutes) • Motivation for the CEWP • Study Area • Scope of the Study • Study Approach • Methodology, Tasks and Deliverables • Public Relations • Study Programme	Mr Kobus Bester / PSP
		Questions/Discussions	
10:30	**7**	**Comfort Break** (15 Minutes)	
10:45	**8**	**Results of the Phase 1: Pre-Feasibility Study** (45 Minutes) • Yield Analyses • Environmental Screening, including Downstream Ecological Impacts • Geotechnical and Material Investigations • Engineering Investigation • Engineering Economic Analysis • Multi-Criteria Analysis of Dam Options	Mr Kobus Bester / PSP
		Questions/Discussions	
11:40	**9**	**Additions** 9.1 9.2	All
11:45	**10**	**Way Forward / Key Decisions**	Mr Kobus Bester
11:55	**11**	**Date of Next Meeting**	All
12:00	**12**	**Closure**	Chairperson

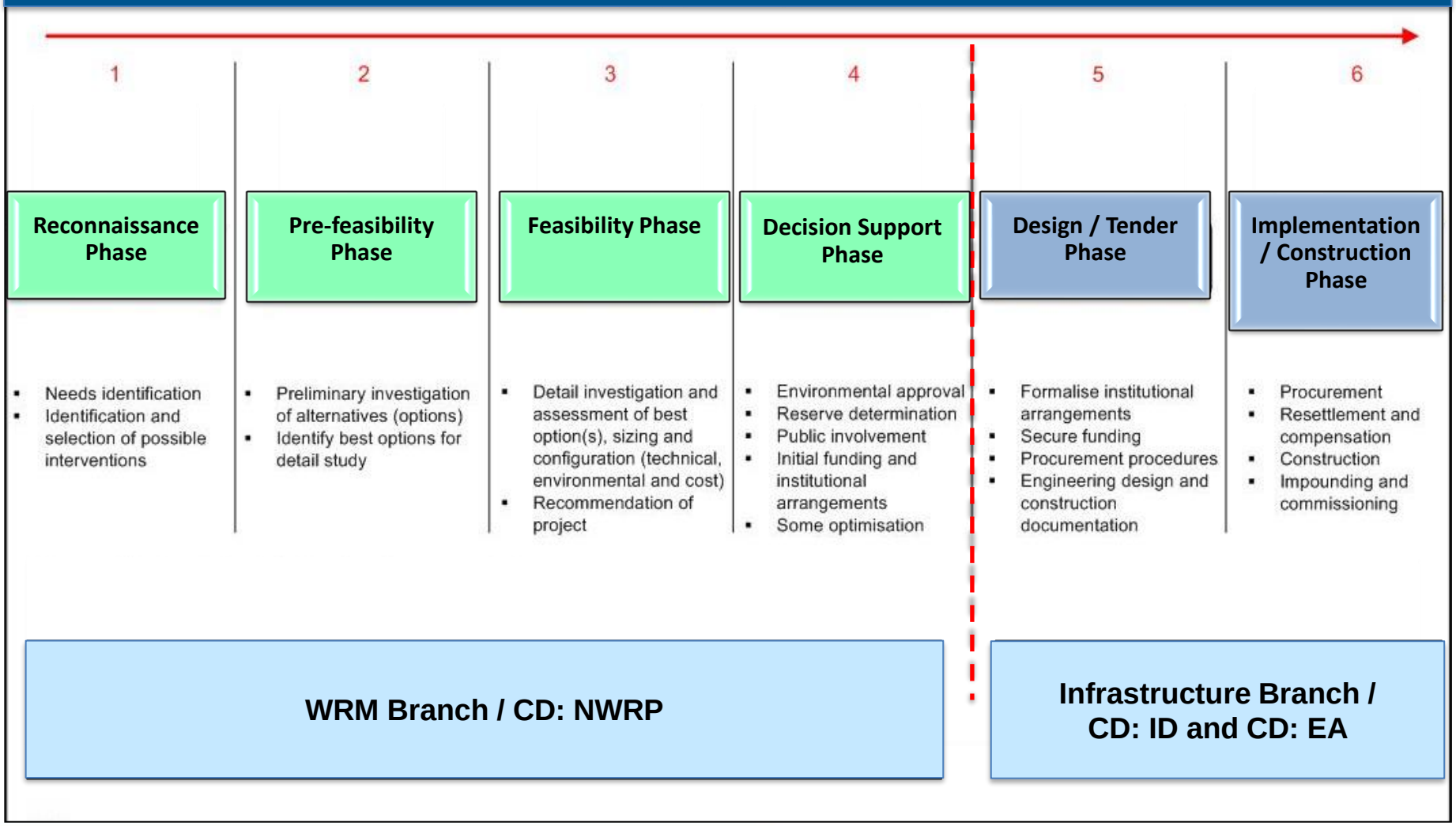
4. PURPOSE OF MEETING

- Present the DWS Planning to Implementation Methodology;
- Provide an overview of the CEWP Study;
- Present the results of the Pre-Feasibility Study.

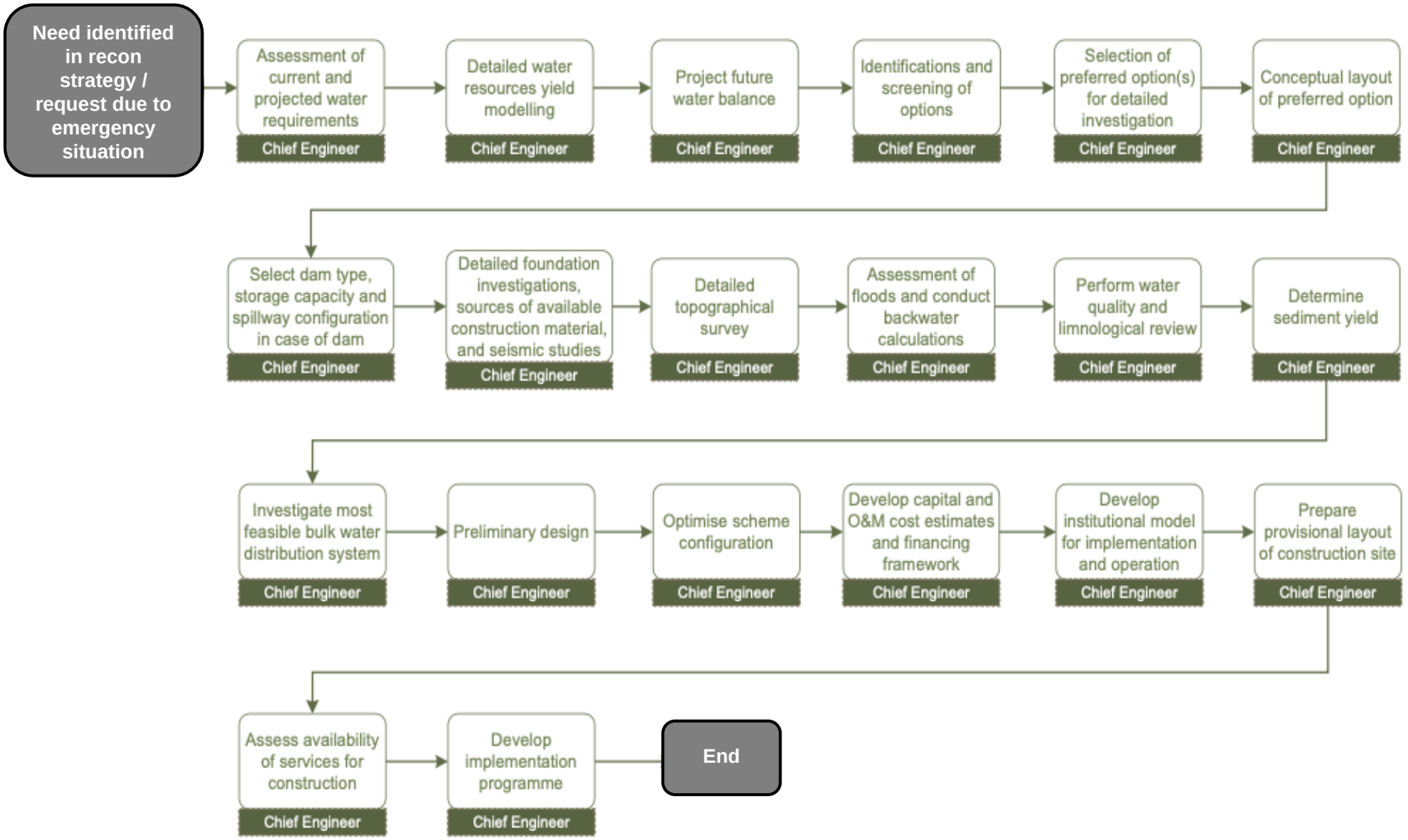
5. DWS METHODOLOGY:

PLANNING TO IMPLEMENTATION

Planning to Implementation Phases for New Infrastructure



TECHNICAL FEASIBILITY INVESTIGATION



Questions/Discussions

6. OVERVIEW OF STUDY

6.1 Motivation for Study (1 of 3)

- Water of the Crocodile River System in Mpumalanga – **fully allocated**
- Water requirements – **continuous growth**

Deficit

- Regular water shortages (domestic, commercial and agricultural sectors)
- Unable to meet environmental requirements
- Pressure from Mozambique to meet minimum cross-border flows

Solution

Proposed Intervention: **A New Dam in the Crocodile River Catchment**

6.1 Motivation for Study (2 of 3)

The following previous studies and investigations related to the Study were completed.

- Interim IncoMaputo Agreement (IIMA), Tripartite Technical Committee (TPTC) Mozambique, South Africa & Swaziland – August 2002.
- Inkomati Water Management Area Internal Strategic Perspective (ISP) PWMA 05/000/00/0303 – March 2004.
- Crocodile (East) River Development, Reconnaissance Study, PD Naidoo & Associates – September 2008.
- Inkomati Water Availability Assessment Study, Main Report (IWAAS) PWMA 05/X22/00/0808 – June 2009.
- Progressive Realisation of the IncoMaputo Agreement (PRIMA): Basin Management Alternatives and Feasibility Report: Part B: Inkomati River Basin, Report No: Implementation Activities and Action Plan (IAAP) 3 – April 2011.
- Inkomati Water Management Area: Modelling Support for Licensing Scenarios: Identification of Dam Sites on Crocodile River (East) – 1st Draft 2011.
- Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga.
- Development of Real-Time Operating Rules for the Crocodile River Catchment.
- Water Requirements and Availability Reconciliation Strategy for the Mbombela Local Municipality – February 2014.
- Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area – October 2020.

6.1 Motivation for Study (3 of 3)

Based on previous studies and investigations, the following **four proposed dams** within the Crocodile (East) River Catchment were recommended for further study as part of the **Crocodile East Water Project: Module 1: Technical Feasibility Study:**

- Mountain View Dam on the Kaap River
- Montrose Dam on the Crocodile East River
- Boschjeskop Dam on the Nels River
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers

6.2 Study Area (1 of 3)

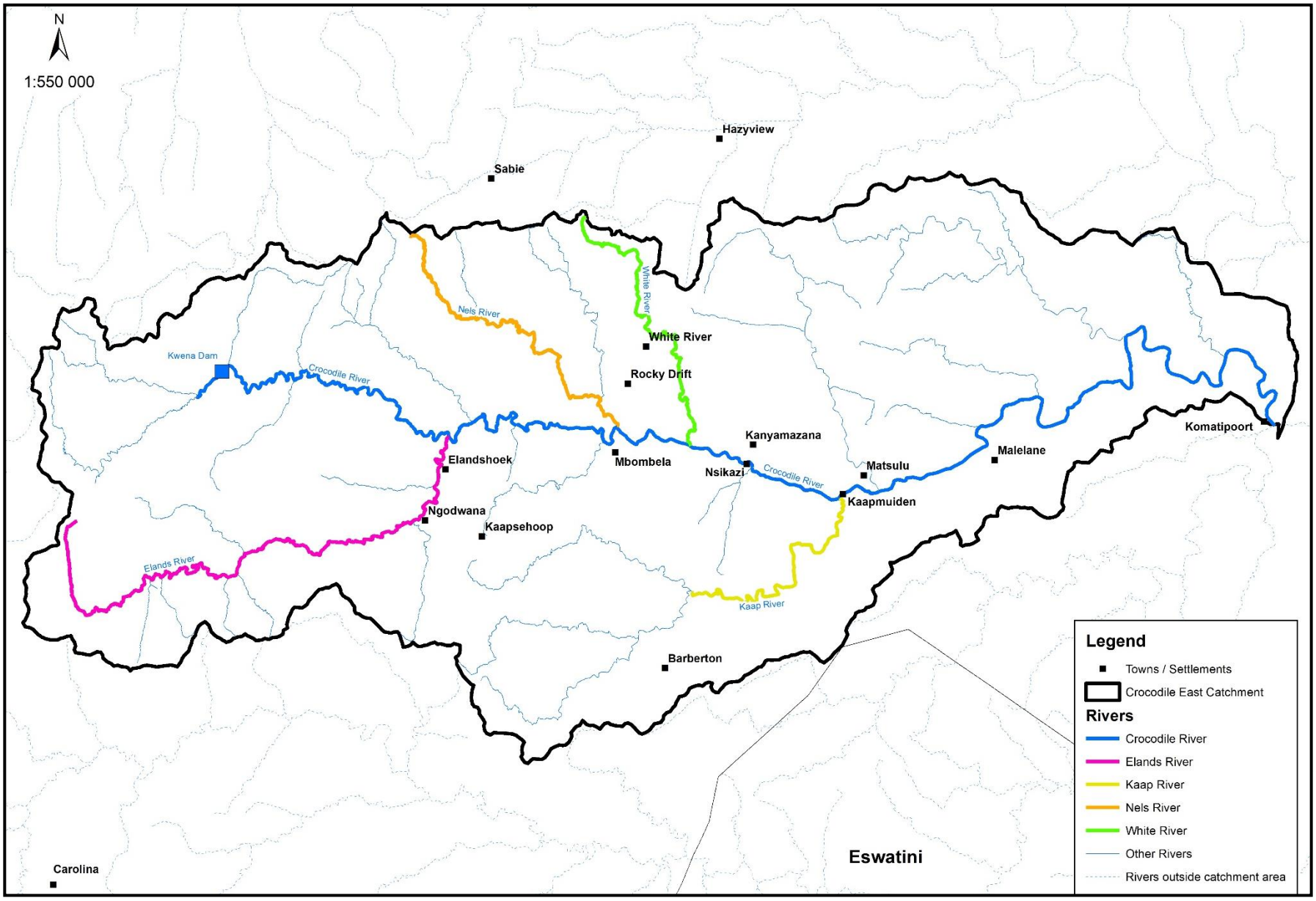
Crocodile (East) River Catchment

- Situated in the north-east of South Africa.
- Part of larger Inkomati River Basin (Basin is shared between Mozambique, South Africa and Eswatini).
- Water of the Inkomati River Basin is shared between Mozambique, South Africa and Eswatini.
- Only major dam in the catchment is the Kwena Dam in the Upper Crocodile River Catchment.

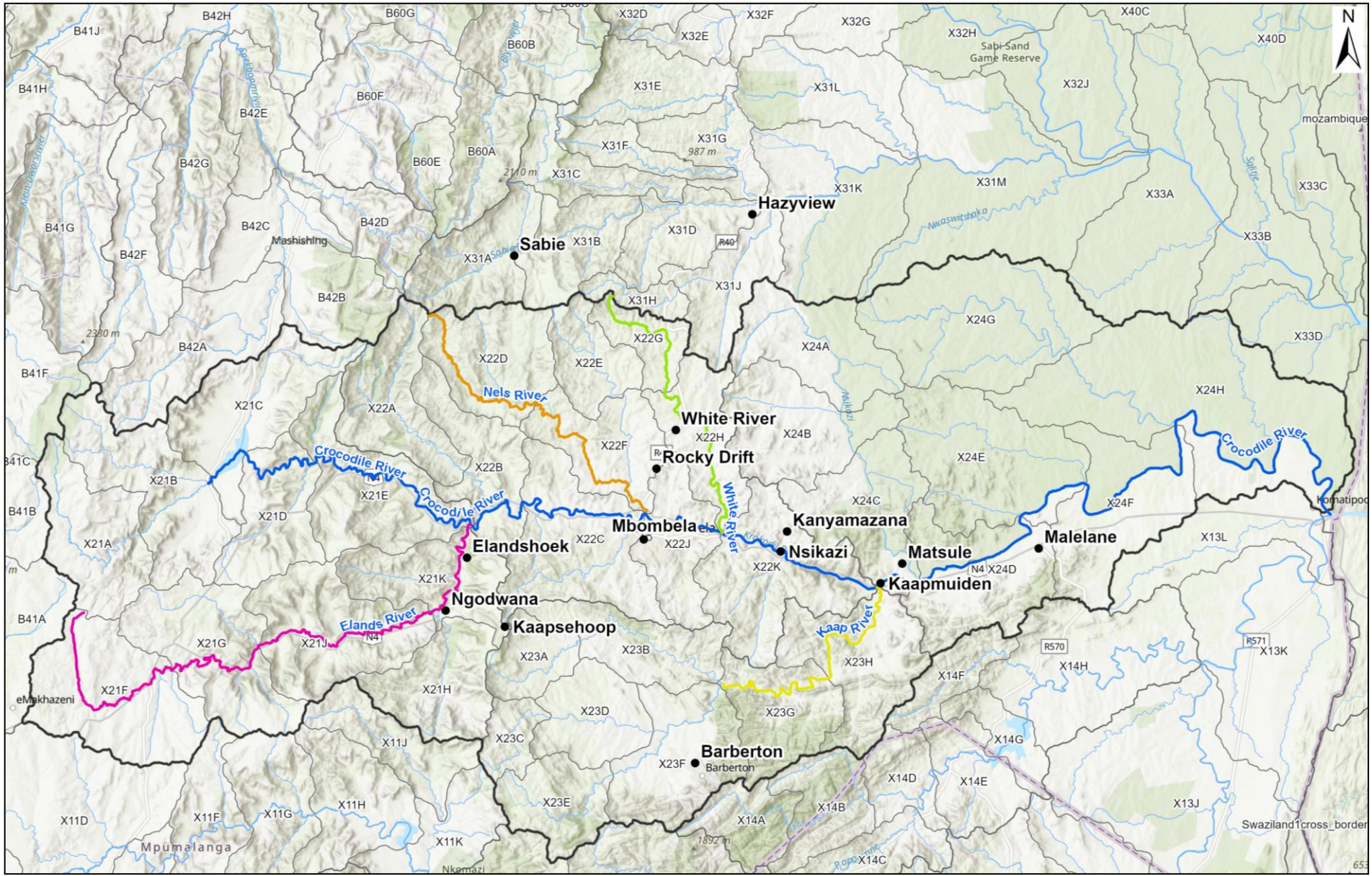
The Crocodile (East) River Catchment comprises of four tertiary catchments:
Upper Crocodile Catchment (X21)
Middle Crocodile Catchment (X22)
Lower Crocodile Catchment (X24)
Kaap Catchment (X23)

Important tributaries of the Crocodile River include the following:
Kaap River
Elands River
Nels River
White River

6.2 Study Area (2 of 3)



6.2 Study Area (3 of 3)



6.3 Scope of Study

Objective of Feasibility Study: undertake and finalise the planning of a raw water supply scheme comprising a dam(s) and related conveyance infrastructure in the Crocodile (East) River Catchment.

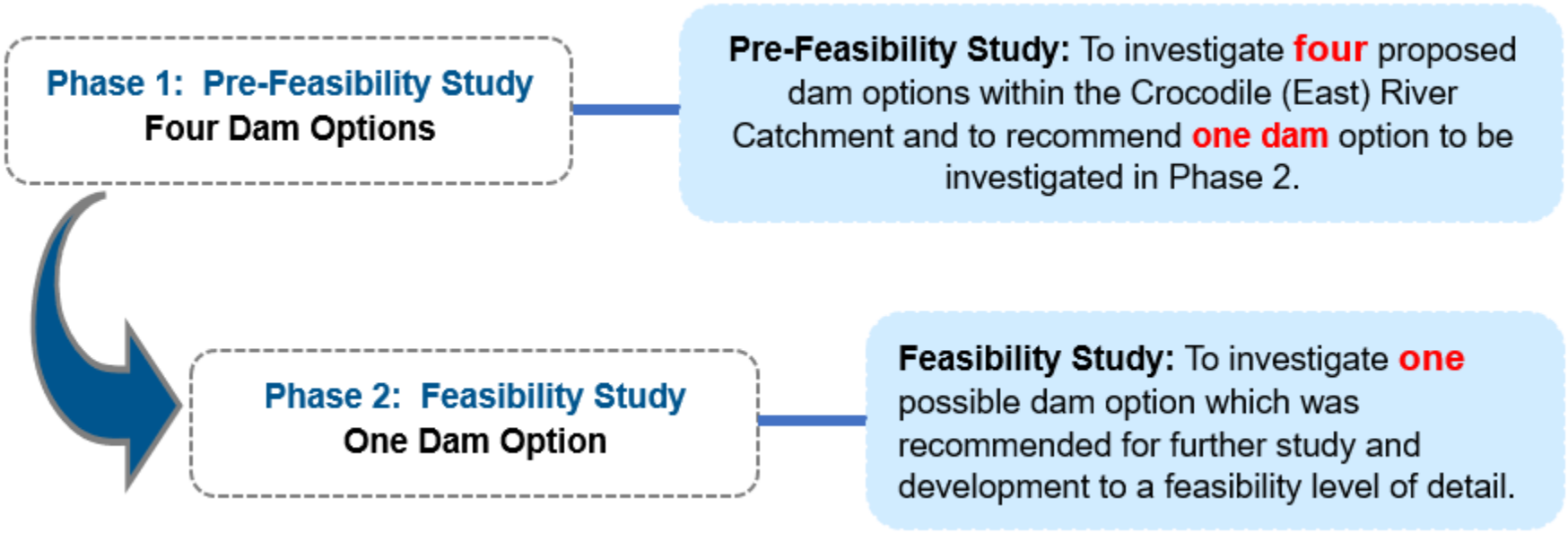
The proposed scheme configuration from a strategic water resource perspective, needs to provide a **long-term regional water supply solution** for the Crocodile (East) River Catchment.

In order to expedite the planning for a dam(s) in the Crocodile River Catchment, the Feasibility Study has been divided in **two** separate interactive and **concurrently** running modules, as follows:

Module 1: **Technical Feasibility Study**	**Module 2:** **Environmental Impact Assessment**
iX engineers (Pty) Ltd was appointed for the Crocodile East Water Project: Module 1: Technical Feasibility Study.	Nemai Consulting CC was appointed to undertake Module 2, which will commence during the Phase 2 of the Module 1 Study.

6.4 Study Approach (1 of 6)

The Module 1: Technical Feasibility Study will be undertaken in two separate phases, as follows:



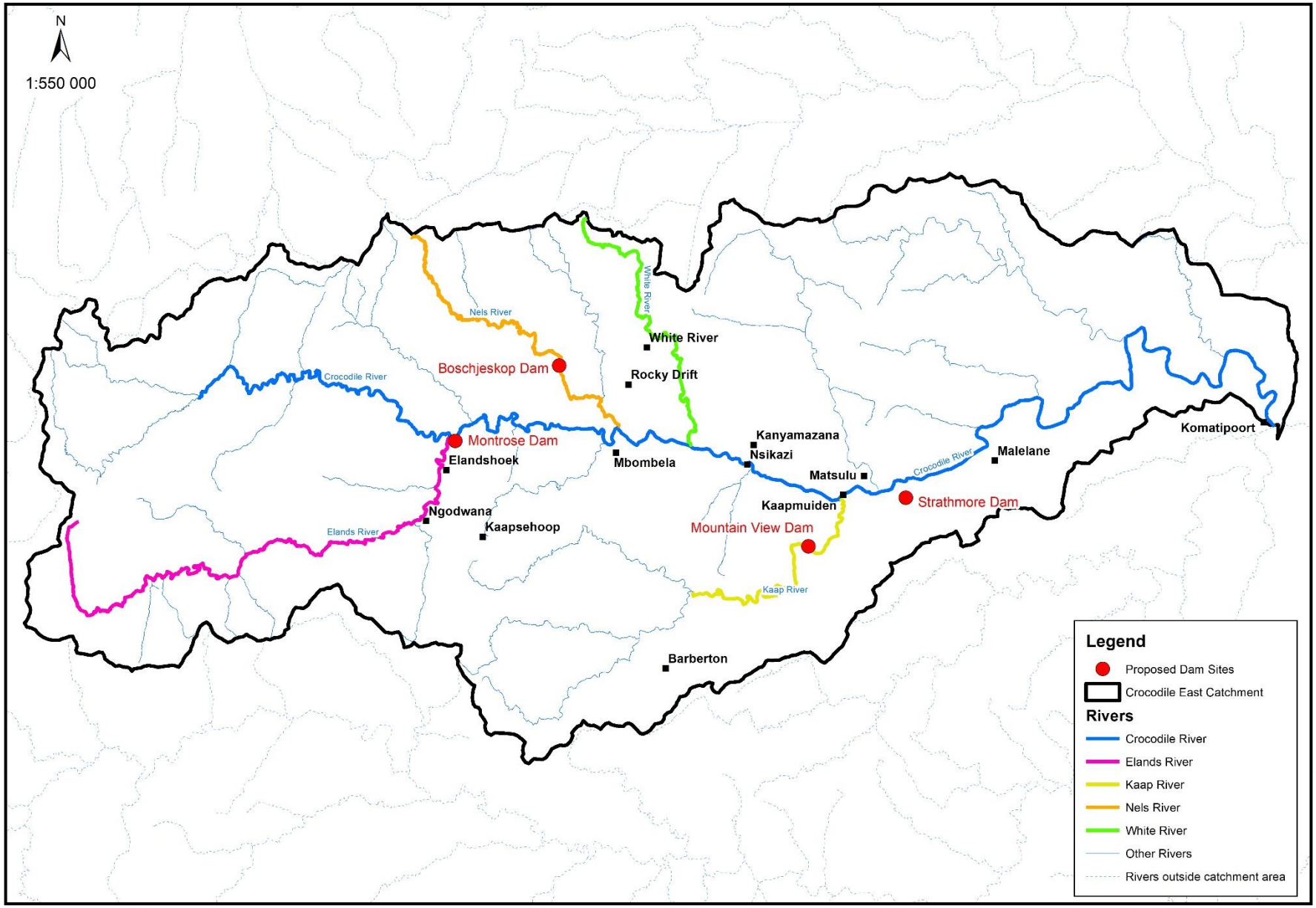
6.4 Study Approach (2 of 6)

Phase 1: Pre-Feasibility Study

Pre-Feasibility Study undertaken for the following **four** dam options:

- Mountain View Dam on the Kaap River
- Montrose Dam on the Crocodile East River
- Boschjeskop Dam on the Nels River
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers

6.4 Study Approach (3 of 6)



6.4 Study Approach (4 of 6)

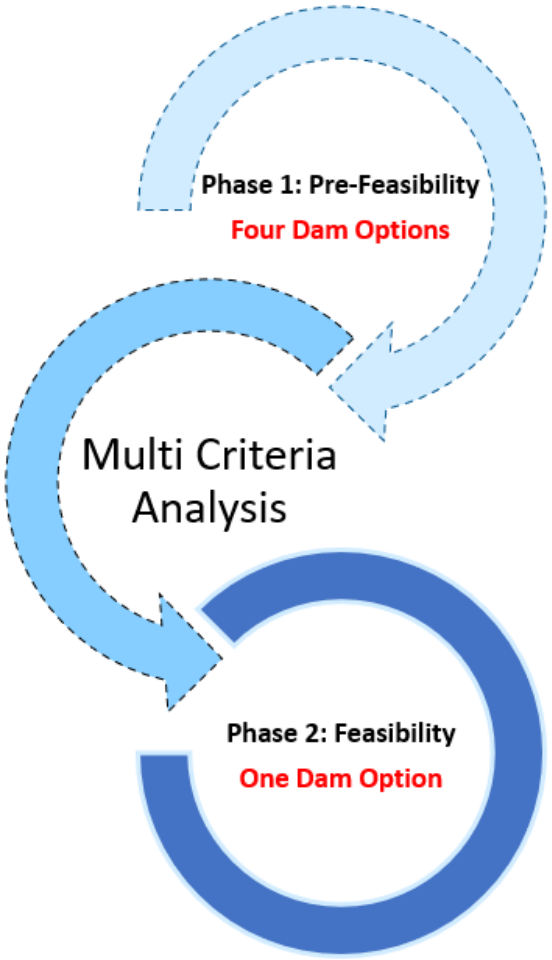
Phase 1: Pre-Feasibility Study

Due to the significant water deficits in the Crocodile (East) River Catchment it is possible that the implementation of more than one dam will be required.

Adopted a ranking/scoring system (**multi-criteria decision matrix**) rather than an elimination process during the execution of the Pre-Feasibility Study.

Application of Multi-Criteria Decision Matrix (ranking system) to all four dams to enable a uniform comparison.

Selection and recommendation of highest ranking/scoring dam option for further investigation and development at feasibility level.



6.4 Study Approach (5 of 6)

Phase 1: Pre-Feasibility Study

Multi-Criteria Decision Matrix (ranking system) typically includes the following:

- Yield analysis (Water Resources)
- Environmental and downstream ecological impacts
- Geological and geotechnical considerations
- Engineering economic analysis (Unit Reference Values and Affordability)

Development of an appropriate ranking/scoring system for each of the above-mentioned criteria.

Worst Score = 1 & Best Score = 5

Highest Score = Best Ranking

6.4 Study Approach (6 of 6)

Phase 2: Feasibility Study

Investigate **one** possible dam option which was recommended in the Phase 1: Pre-Feasibility Study for further study and development to a **feasibility level** of detail in the **Phase 2: Feasibility Study**.

6.5 Study Methodology, Tasks and Deliverables

The proposed Scope of Work has been structured and broken down into various tasks and subtasks.

Phase 1: Pre-Feasibility Study (Four Dam Options)		
	Task	**Deliverable**
1	Study Inception	Inception meeting Site visits to the four dam options Inception Report
2	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	Downstream Ecological Consequences and Potential Impacts on the National Water Resource Class Report
3	Perform/Review Historic Yield Analysis	Yield Analysis Report
4	Environmental Screening and Identification of Fatal Flaws	Environmental Screening Report
5	Perform/Review Geotechnical and Material Investigations	Geotechnical and Material Investigations Report
6	Engineering Investigation	Engineering Investigation Report
7	Topographical Survey and Mapping	Lidar DTM data, Contour and Orthophoto generation, Topographical detail mapping
8	Proposed Scheme Configurations (Engineering Investigation)	Proposed Scheme Configurations Report
9	Engineering Economic Analysis	Engineering Economic Analysis Report
10	Multi-Criteria Analysis	Multi-Criteria Analysis of Dam Options Report
11	Pre-Feasibility Study Report	Pre-Feasibility Study Report which includes information on the findings of the reports mentioned above.

Phase 2: Feasibility Study (Selected One Dam Option)

	Task	Deliverable
1	Environmental Screening	Environmental Screening Report
2	Water Resources, including: • Determine Existing and Future Water Demands • Yield Analysis with the Water Resource Yield Model • Future Water Balance for the Project • Development of Short-term Stochastic Yield Reliability Curves • Water Resources Planning Model (WRPM) • Assessment of the Potential for Hydropower Generation at the Dam (Water Resources)	Water Resources Report
3	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	Ecological Consequences of Dam Operational Scenarios Report
4	Socio-Economic Impacts	Socio-Economic Impacts Report
5	Engineering Investigation, including: • Topographical Surveys and Mapping • Geological and Geotechnical Investigation • Geomorphological and Seismic Investigation • Flood Studies • Feasibility Design of the Selected Scheme • Construction Programming and Costing • Access and Advanced Infrastructure • Flood and Backwater Calculations for the Dam • Climatological Data for the Construction Site • Water Quality and Limnology • Sediment Yield and Sedimentation Investigation • Land Requirements and Associated Costs • Assessment of the Potential for Hydropower Generation at the Dams (Engineering Investigation) • Costing (CAPEX and OPEX) of the Project • Engineering Economic Analysis	Engineering Investigation Report

Phase 2: Feasibility Study (Selected One Dam Option)

	Task	Deliverable
6	Implementation Actions	Project Implementation Programme
7	Record of Implementation Decisions	Record of Decisions
8	Institutional, Financial and Operational Aspects	Institutional, Financial and Operational Aspects Report
9	Feasibility Study Report	Feasibility Study Report which includes information on the findings of the reports mentioned above.

6.6 Public Relations / Study Management

Public Relations Meetings

A full stakeholder engagement and public relations process, where relevant representative stakeholders in the Study will provide inputs into the Study, will be carried out to support the Study.

Project Management Committee Meetings (PMC)

Purpose of PMC meeting is to report on, discuss and capture all activities that have happened on the project for the reporting period preceding each respective PMC meeting and to ensure understanding and buy-in of all members.

Project Steering Committee Meetings (PSC)

The Project Steering Committee's (PSC) main function is to assist the DWS with strategic matters and to coordinate the contributions of other authorities.

6.7 Study Programme

	Start Date	End Date	Duration
Technical Feasibility Study	**6 September 2022**	**30 September 2025**	**36 Months**
▪ Phase 1: Pre-Feasibility Study	6 September 2022	30 September 2023	12 Months
▪ Phase 2: Feasibility Study	1 October 2023	30 September 2025	24 Months

Commencement of Study: 6 September 2022

(Date of Signed Service Level of Agreement)

Questions/Discussions

7. Comfort Break

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8. Results of Phase 1: Pre-Feasibility Study

The results of the Phase 1: Pre-Feasibility Study will be presented as follows:

Phase 1: Pre-Feasibility Study (Four Dam Options)	
1	Yield Analyses
2	Environmental Screening, including Downstream Ecological Impacts
3	Geotechnical and Material Investigations
4	Engineering Investigation
5	Engineering Economic Analysis
6	Multi-Criteria Analysis

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8.1 Yield Analyses

8.1 Yield Analyses (1 of 5)

Approach to Yield Analyses:

When conducting a **system analysis** in the **Crocodile East catchment**, it is important to note that one **cannot** only take the **yield** derived from **Kwena Dam** as the **available water** to be **used** by end-users and or the reserve.

Abstraction point locations, **inflows** from tributaries below Kwena Dam as well as **releases** from Kwena Dam are all factors that affect the **existing system yield**.

Furthermore, the impact of including a proposed New Dam should be considered in the context of improved supply to existing users.

8.1 Yield Analyses (2 of 5)

Volume of Demands (Abstractions) from the Crocodile River

Type	User	Use (million m^3/annum)
Irrigation	Crocodile Irrigation Board (divided into 10 individual point abstractions based on location)	304
Domestic	City of Mbombela for Nelspruit, including Rocky Drift	17.50
Domestic	City of Mbombela for Emoyeni from Crocodile and Karino	0.95
Domestic	City of Mbombela for Nsikazi South	25.40
Domestic	City of Mbombela for Matsulu	6.26
Domestic	Malelane	0.75
Domestic	Hectorspruit	0.22
Domestic	Marloth Park	0.95
Total		**356.03**

8.1 Yield Analyses (3 of 5)

Yield Analyses Results: Individual (Single) Dam Option

Dam	Boschjeskop Storage: 72.7 million m^3 Wall Height: 44.3 m	Boschjeskop Storage: 85.2 million m^3 Wall Height: 47.3 m	Mountain View Storage: 188.3 million m^3 Wall Height: 84.1 m	Mountain View Storage: 259.4 million m^3 Wall Height: 92.5 m	Montrose Storage: 43 million m^3 Wall Height: 59 m	Montrose Storage: 111.7 million m^3 Wall Height: 79 m	Strathmore Storage: 42.5 million m^3 Wall Height: 30 m	Strathmore Storage: 89.4 million m^3 Wall Height: 40 m
HFY (million m^3/annum): Yield Channel at Dam	35	36	50	58	79	106	74	84
New System Yield / Supply to Users (million m^3/annum)	232.2	235.3	282.2	300.9	235.2	269.5	235.2	250.8
Percentage per User Sector including New Dam	100% domestic 59% irrigation	100% domestic 60% irrigation	100% domestic 76% irrigation	100% domestic 81% irrigation	100% domestic 60% irrigation	100% domestic 71% irrigation	100% domestic 60% irrigation	100% domestic 65% irrigation
Net Benefit of New Dam (million m^3/annum)	**40.4**	**43.5**	**93.4**	**109.1**	**43.4**	**77.7**	**43.4**	**59**

Net Benefit of New Dam (million m^3/annum) :

Additional Water that is available due to the New Dam

8.1 Yield Analyses (4 of 5)

Yield Analyses Results: Combined Dam Options

Further analyses were undertaken in order to determine the net system yield benefit resulting from combinations of dams.

The following three combinations were assessed and are presented as the Scenario reference indicated:

- Scenario A: Boschjeskop (85.2 million m^3) and Strathmore (89.4 million m^3);
- Scenario B: Mountain View (259.4 million m^3) and Strathmore (89.4 million m^3);
- Scenario C: Mountain View (259.4 million m^3) and Boschjeskop (85.2 million m^3).

Net System Yield resulting from Combinations of Proposed Dams

Scenario	Net Benefit of New Dam Combinations (million m^3/annum)
A	84
B	134
C	128

The results indicate that the net benefit to the system yield of two dams cannot be determined by adding the net benefits of the individual dams together due to the dynamics in the hydrology and the supply to users.

8.1 Yield Analyses (5 of 5)

Ranked Order of Proposed Dams based on System Yield Benefit

Ranking	Dam	Dam Size (million m^3)	Net Benefit to System Yield (million m^3/a)
1	Mountain View	259	109
2	Mountain View	188	93
3	Montrose	112	78
4	Strathmore	89	59
5	Boschjeskop	85	44
6	Strathmore	42.5	43.4
7	Montrose	43	43.4
8	Boschjeskop	73	40

The large **Mountain View Dam** provides the **greatest yield benefit** to the system. The combination of Strathmore and Boschjeskop Dams yield **less** than the large Mountain View Dam alone. The highest yielding combination is Mountain View Dam operating with Strathmore Dam which provides a net system benefit of 134 million m^3/annum.

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8.2 Environmental Screening & Ecological Impacts

8.2 Environmental Screening & Ecological Impacts

Scoring System (0 = worst, 5 = best)

Highest Score = Best Ranking

Aspect	Montrose	Mountain View	Boschjeskop	Strathmore
Topography				
Change in topography	2	2	3	3
Soil, Land Use, Land Capability and Agricultural Potential				
Land Use	2	2	4	4
Loss of arable land / high land capability / agricultural potential	2	2	1	1
Rivers, Wetlands and Freshwater Ecosystems				
Strategic Water Source Area	1	4	3	4
NFEPA Rivers and Wetlands	1	2	2	3
Impact on Fish	0	2	1	3
Impact on Aquatic Maro-invertebrates	2	2	2	3
Impact on Freshwater Conservation Targets	0	3	2	2
Impact on downstream freshwater ecology	0	2	0	3
Terrestrial Ecosystem				
Impact on Fauna	2	2	3	3
Impact on Flora	2	3	2	3
Impact on Terrestrial Conservation Targets	0	1	2	3
Threat to Protected Areas or NPAES	2	2	4	4
Heritage and Cultural Resources				
Loss of sites of historical, archaeological and cultural significance	2	3	4	4
Overall Score	**18**	**32**	**33**	**43**
Ranking	**4**	**3**	**2**	**1**

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8.3 Geotechnical and Materials Investigations

8.3 Geotechnical and Materials Investigations

Scoring System (1 = worst, 5 = best)
Highest Score = Best Ranking

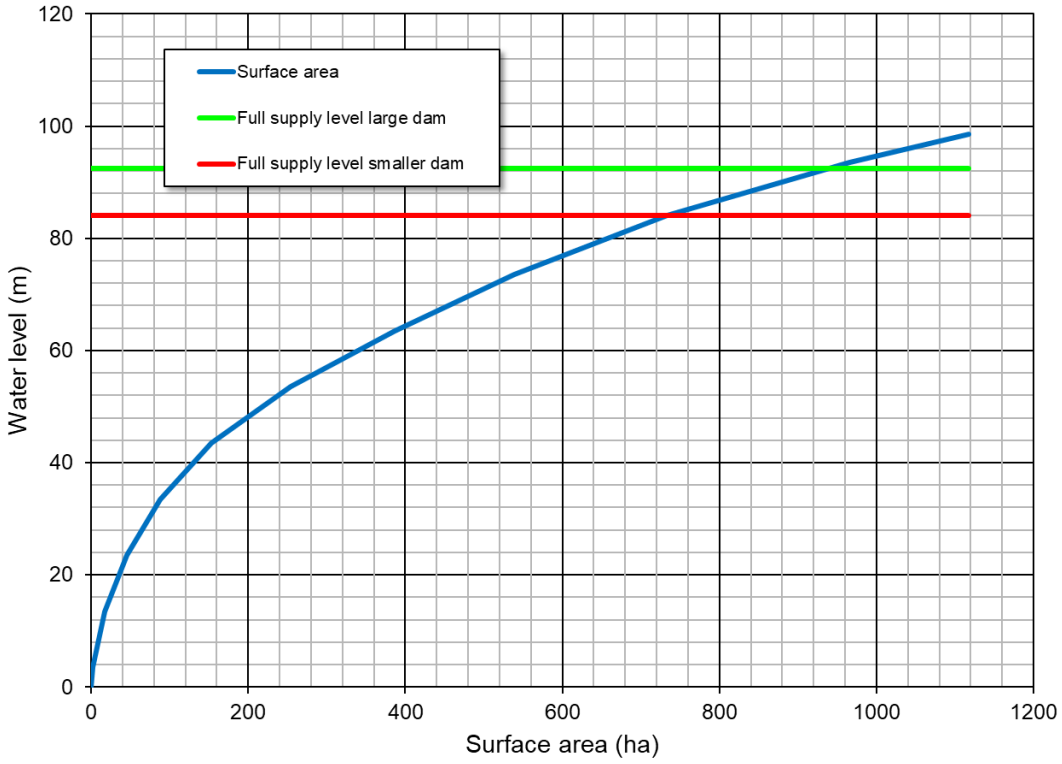
Parameter	Montrose	Mountain View	Boschjeskop	Strathmore
Geology				
Lithology	3	4	4	2
Structural Geology	3	3	3	3
Dam Site				
Rock outcrop distribution	3	4	2	1
River section conditions	2	3	3	1
Rock mass permeability	3	4	3	1
Basin				
Stability	3	3	4	4
Leakage	4	3	3	3
Materials				
Rock	3	4	1	1
Sand	2	2	2	1
Embankment/Rockfill	1	3	4	3
Overall Score	**27**	**33**	**29**	**20**
Ranking	**3**	**1**	**2**	**4**

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8.4 Engineering Investigation

8.4 Engineering Investigation (1 of 8)

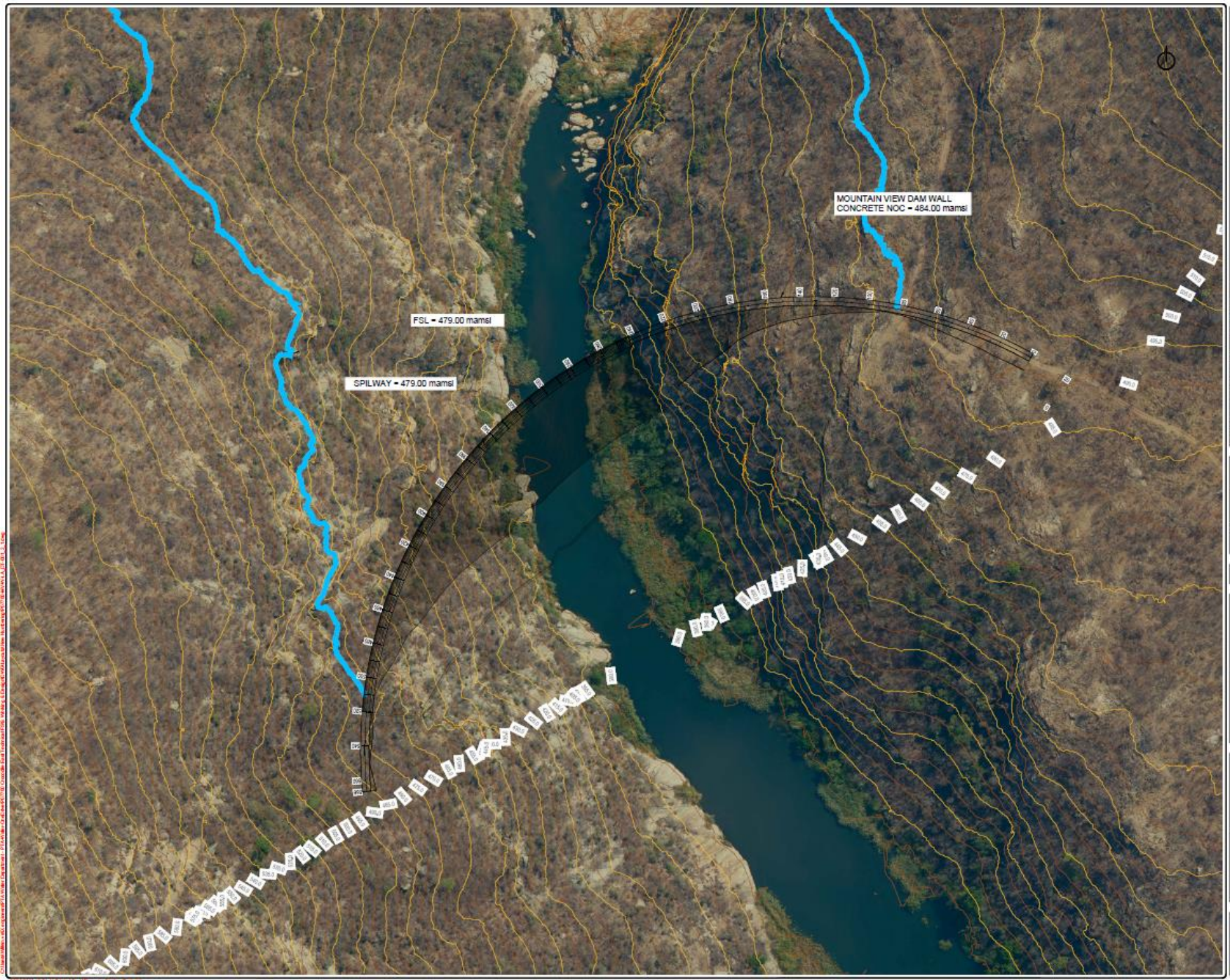
Proposed Mountain View Dam



Mountain View Dam Surface Area versus Water Level

River:	Kaap
Proposed dam:	Mountain View
Spillway type:	A stepped spillway with an ogee control section at its upper portion equipped with a stilling basin at the downstream toe
Spillway length:	265 m
Spillway discharge capacity:	5 788 m^3/s
Freeboard:	5 m
Dam wall:	Roller compacted concrete (RCC) gravity arch type dam
Radius of arch:	261m (large dam); 232 m (smaller dam)
RCC non-overspill crest width:	5 m
Upstream slope:	Vertical
Downstream slope:	1V : 0.5H
Maximum dam wall height :	97.5 m (large dam); 89 m (smaller dam)
Gross storage capacity at FSL:	259.4 million m^3 (large dam); 188.3 million m^3 (smaller dam)
Surface area at FSL:	938.8 ha (large dam); 732.5 ha (smaller dam)
River outlets maximum release capacity:	7.5 m^3/s (large dam); 7.1 m^3/s (smaller dam)

8.4 Engineering Investigation (2 of 8)



SCALE FOR REDUCED PLAN

NOTES

LEGEND

NOC - NON OVERSPILL CREST
FSL - FULL SUPPLY LEVEL
FSL -

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

PRE-FEASIBILITY

CONSULTANT

iX engineers
Infrastructure Excellence

CLIENT

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

PROJECT

WP11393: CROCODILE EAST WATER PROJECT MODULE 1: TECHNICAL FEASIBILITY STUDY

DRAWING DESCRIPTION

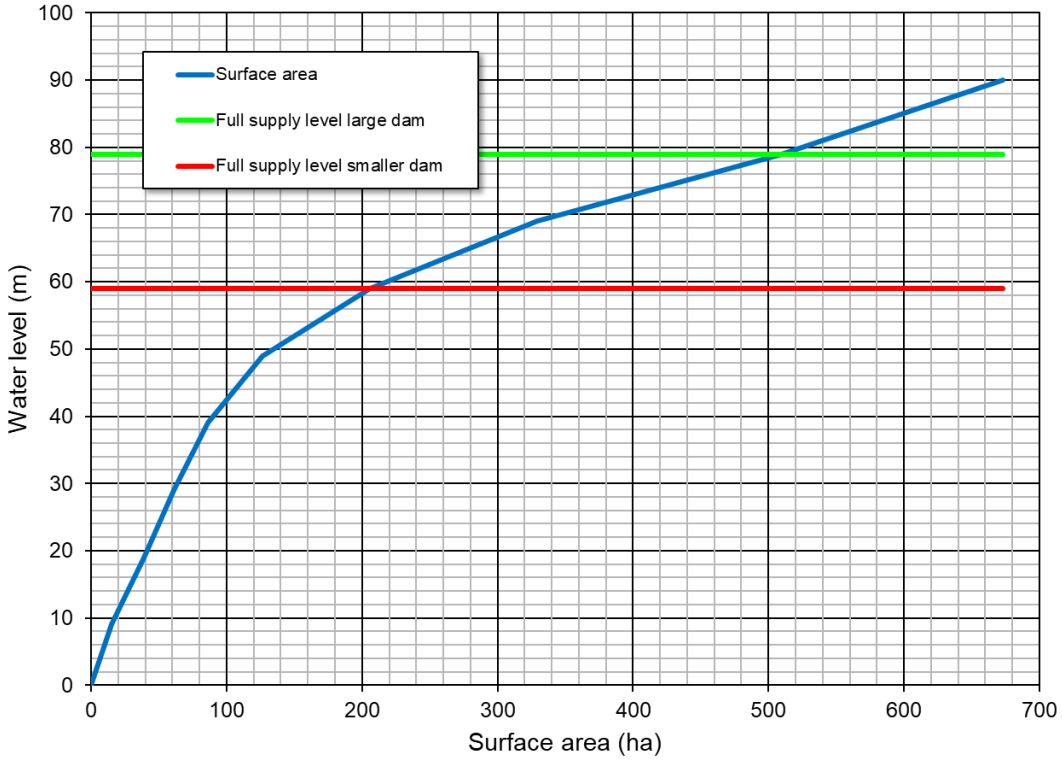
MOUNTAIN VIEW DAM
DAM WALL & CENTERLINE
FSL = 479.00m

DATE	SCALE	ORIGINAL SIZE
2023/06/26	1:1000	A1

DRAWING NUMBER	REV
P07780-MV-W-LA-002	A

8.4 Engineering Investigation (3 of 8)

Proposed Montrose Dam



Montrose Dam Surface Area versus Water Level

River	Crocodile East
Proposed dam:	Montrose
Spillway type:	A stepped spillway with an ogee control section at its upper portion equipped with a stilling basin
Spillway length:	315 m
Spillway discharge capacity:	6 880 m^3/s
Freeboard:	5 m
Dam wall:	Composite dam wall with concrete gravity section including the spillway on the left bank and zoned embankment flank wall on the right bank (wrapped around a tongue wall)
Concrete non-overspill crest width:	5 m
Concrete upstream slope:	Vertical
Concrete downstream slope:	1V : 0.75H
Embankment crest width:	6 m
Embankment upstream slope:	1V : 3H
Embankment downstream slope:	1V : 2.5H
Maximum dam wall height:	84 m (large dam); 64 m (smaller dam)
Gross storage capacity at FSL:	111.7 million m^3 (large dam); 43.0 million m^3 (smaller dam)
Surface area at FSL:	509.3 ha (large dam); 206.0 ha (smaller dam)
Outlets maximum release capacity:	14.3 m^3/s (large dam); 13.0 m^3/s (smaller dam)

8.4 Engineering Investigation (4 of 8)

SCALE FOR REDUCED PLAN

NOTES

LEGEND

NOC - NON OVERSPILL CREST
FSL - FULL SUPPLY LEVEL
FSL -

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

PRE-FEASIBILITY

CONSULTANT

iX engineers
Infrastructure Excellence

CLIENT

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

PROJECT

WP11393: CROCODILE EAST WATER PROJECT MODULE 1: TECHNICAL FEASIBILITY STUDY

DRAWING DESCRIPTION

MONTROSE DAM
DAM WALL & CENTERLINE
FSL = 820.00m

DATE	SCALE	ORIGINAL SIZE
2023/07/11	AS SHOWN	A1

DRAWING NUMBER	REV
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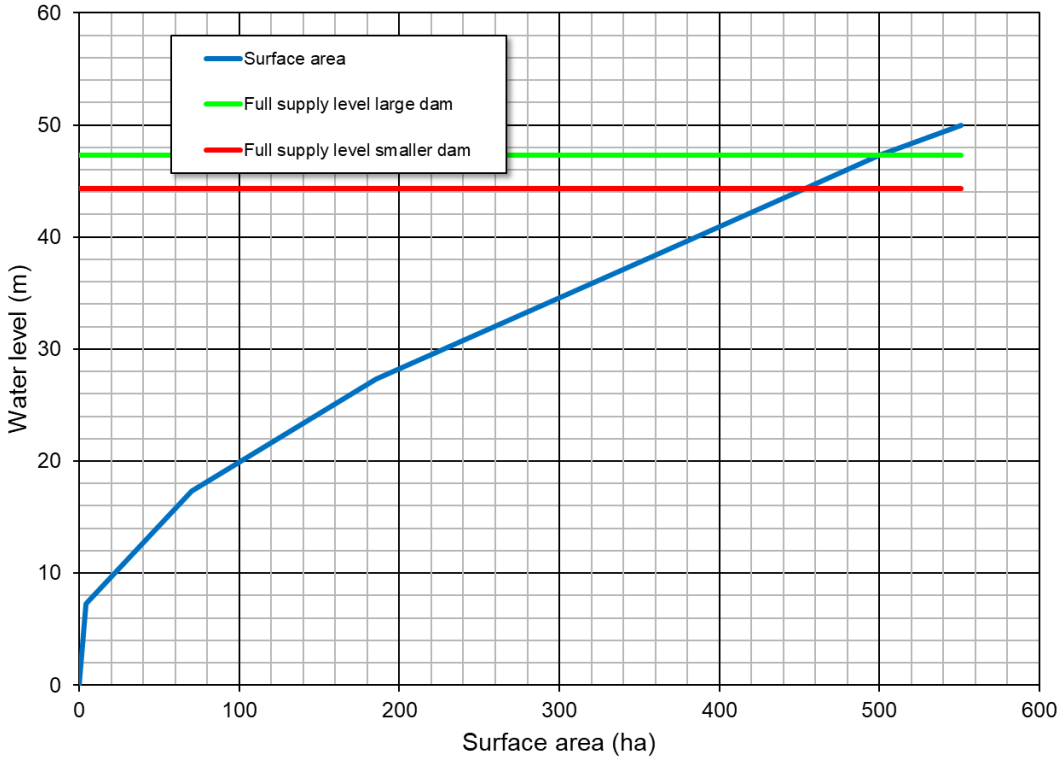
8.4 Engineering Investigation (5 of 8)

Proposed Boschjeskop Dam



Boschjeskop Dam Surface Area versus Water Level

River:	Nels
Proposed dam:	Boschjeskop Dam
Spillway type:	A stepped spillway with an ogee control section at its upper portion equipped with a stilling basin
Spillway length:	108 m
Spillway discharge capacity:	2 344m^3/s
Freeboard:	5m
Dam wall:	Composite dam wall with concrete gravity section including the spillway on the right bank and an embankment flank wall on the left bank (wrapped around a tongue wall)
Concrete non-overspill crest width:	5 m
Concrete upstream slope:	Vertical
Concrete downstream slope:	1V : 0.75H
Embankment crest width:	6 m
Embankment upstream slope:	1V : 3H
Embankment downstream slope:	1V : 2.5H
Maximum dam wall height:	52.3 m (large dam); 49.3 m (smaller dam)
Gross storage capacity at FSL:	85.21 million m^3 (large dam); 72.67 million m^3 (smaller dam)
Surface area at FSL:	499.8 ha (large dam); 453.2 ha (smaller dam)
Outlets maximum release capacity:	5.4 m^3/s (large dam); 5.3 m^3/s (smaller dam)

8.4 Engineering Investigation (6 of 8)

SCALE FOR REDUCED PLAN

NOTES

LEGEND

NOC - NON OVERSPILL CREST
FSL - FULL SUPPLY LEVEL
FSL -

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

PRE-FEASIBILITY

CONSULTANT

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water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

PROJECT

WP11393: CROCODILE EAST WATER PROJECT MODULE 1: TECHNICAL FEASIBILITY STUDY

DRAWING DESCRIPTION

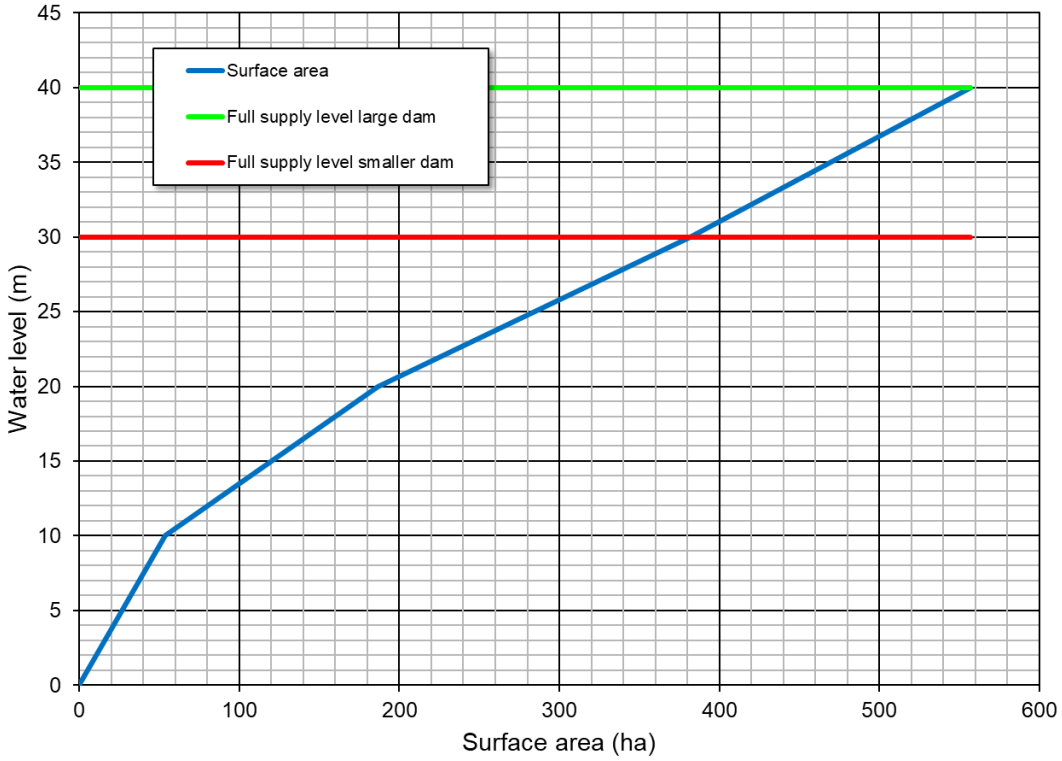
BOSCHJESKOP DAM
DAM WALL & CENTERLINE
FSL = 870.00m

DATE	SCALE	ORIGINAL SIZE
2023/06/22	1:1500	A1

DRAWING NUMBER	REV
P07780-BK-W-LA-002	A

8.4 Engineering Investigation (7 of 8)

Proposed Strathmore Dam



Strathmore Dam Surface Area versus Water Level

River:	Unnamed tributaries of the Crocodile East River
Proposed dam:	Strathmore
Spillway type:	Open channel spillway with crump control structure, lined discharge channel and energy dissipating structure with stilling pool at the downstream end
Spillway length:	75 m
Spillway discharge capacity:	1 139 m^3/s
Freeboard:	4 m
Dam wall:	East and west zoned embankment walls with spillway on the right bank of the eastern embankment
Embankment crest width:	6 m
Upstream slope:	1V : 3H
Downstream slope:	1V : 2.5H
Maximum dam wall height:	44 m (large dam); 34 m (smaller dam)
Gross storage capacity at FSL:	89.45 million m^3 (large dam); 42,53 million m^3 (smaller dam)
Surface area at FSL:	557.0 ha (large dam); 381.3 ha (smaller dam)
Outlets maximum release capacity:	4.8 m^3/s (large dam); 4.3 m^3/s (smaller dam)

8.4 Engineering Investigation (8 of 8)

SCALE FOR REDUCED PLAN

NOTES

LEGEND

NOC - NON OVERSPILL CREST
FSL - FULL SUPPLY LEVEL
FSL -

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | PR No | DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED

PRE-FEASIBILTY

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Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

PROJECT

WP11393: CROCODILE EAST WATER PROJECT MODULE 1: TECHNICAL FEASIBILITY STUDY

DRAWING DESCRIPTION

STRATHMORE DAM
DAM WALL & BASIN
FSL = 380.00m

DATE	SCALE	ORIGINAL SIZE
2023/06/15	NTS	A1

DRAWING NUMBER	REV
P07780-SM-W-LA-002	A

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

8.5 Engineering Economic Analysis

8.5 Engineering Economic Analysis (1 of 6)

An **Engineering Economic Analyses** enables the **COMPARISON** of **Dam Options** with **Different** :

- Infrastructure Components (Dam Types and Sizes)
- Yields (million m^3/annum)
- Capital Expenditure (CAPEX)
- Operations and Maintenance Expenditure (OPEX)

Cost Components

The engineering economic analysis included the following cost components:

- Total Capital Cost (CAPEX)
- Annual Operating and Maintenance cost (OPEX)
- Energy Costs (Electricity)
- Design and Construction Supervision Costs (Professional Fees)
- Cost of Additional Services, Topographical Surveys, Geotechnical Investigations, etc.

8.5 Engineering Economic Analysis (2 of 6)

Capital Costs and Yields of Dams

Dam	Capital Cost (million R)	Net Benefit to System Yield (million m^3/a)
Boschjeskop		
Small Dam (Height = 44.32 m)	1569.68	40.4
Large Dam (Height = 47.30 m)	2100.91	43.5
Mountain View		
Small Dam (Height = 84.08 m)	3142.79	93.4
Large Dam (Height = 92.50 m)	4085.56	109.1
Montrose		
Small Dam (Height = 59.00 m)	2394.88	43.4
Large Dam (Height = 79.00 m)	4821.47	77.7
Strathmore		
Small Dam (Height = 30.00 m)	1726.32	43.4
Large Dam (Height = 40.00 m)	2274.42	59

8.5 Engineering Economic Analysis (3 of 6)

Unit Reference Values

The calculation of a **Unit Reference Value (URV)** involves the following:

- Discounting of Total Annual Costs (capital, annual O&M (including annual energy), etc.) to a Present Value (**C**)
- Discounting the Annual Series of Water Supply to a Present Value (**W**)

Calculation of URV: **URV (for selected discount rate) = C/W**

Engineering Economic Analysis

Unit Reference Values

Individual (Single) Dam Options

Cost Component	Discount Rate		
	6 %	8 %	10 %
Boschjeskop (Small Dam, Height = 44.32 m)			
URV (R/m^3)	**2.9**	**3.8**	**4.7**
Total discounted cost (million R)	1450.35	1365.46	1293.60
Total discounted yield (million m^3)	496.79	360.42	272.50
Boschjeskop (Large Dam, Height = 47.30 m)			
URV (R/m^3)	**3.6**	**4.7**	**5.9**
Total discounted cost (million R)	1933.41	1821.92	1727.13
Total discounted yield (million m^3)	534.91	388.08	293.41
Mountain View (Small Dam, Height = 84.08 m)			
URV (R/m^3)	**2.5**	**3.3**	**4.1**
Total discounted cost (million R)	2890.97	2724.54	2582.95
Total discounted yield (million m^3)	1148.52	833.25	629.98
Mountain View (Large Dam, Height = 92.5 m)			
URV (R/m^3)	**2.8**	**3.6**	**4.6**
Total discounted cost (million R)	3748.25	3534.62	3352.32
Total discounted yield (million m^3)	1341.58	973.32	735.87
Montrose (Small Dam, Height = 59.00 m)			
URV (R/m^3)	**4.1**	**5.4**	**6.7**
Total discounted cost (million R)	2210.88	2081.89	1972.60
Total discounted yield (million m^3)	533.68	387.19	292.73
Montrose (Large Dam, Height = 79.00 m)			
URV (R/m^3)	**4.6**	**6.0**	**7.5**
Total discounted cost (million R)	4417.42	4166.95	3952.87
Total discounted yield (million m^3)	955.46	693.19	524.08
Strathmore (Small Dam, Height = 30.00 m)			
URV (R/m^3)	**3.3**	**4.2**	**5.2**
Total discounted cost (million R)	1762.50	1622.96	1514.18
Total discounted yield (million m^3)	533.68	387.19	292.73
Strathmore (Large Dam, Height = 40.00 m)			
URV (R/m^3)	**3.2**	**4.0**	**5.0**
Total discounted cost (million R)	2292.25	2116.66	1978.67
Total discounted yield (million m^3)	725.51	526.36	397.95

8.5 Engineering Economic Analysis (5 of 6)

Unit Reference Values

Combined Dam Options

Cost Component	Discount Rate		
	6 %	8 %	10 %
Mountain View & Strathmore (Large dams)			
URV (R/m^3)	3.7	4.7	5.9
Total discounted cost (million R)	6047.84	5656.61	5335.02
Total discounted yield (million m^3)	1647.77	1195.46	903.82
Mountain View & Boschjeskop (Large dams)			
URV (R/m^3)	3.6	4.7	5.9
Total discounted cost (million R)	5681.66	5356.55	5079.45
Total discounted yield (million m^3)	1573.98	1141.93	863.35
Strathmore & Boschjeskop (Large dams)			
URV (R/m^3)	4.1	5.5	6.6
Total discounted cost (million R)	4233.00	3943.91	3709.82
Total discounted yield (million m^3)	1032.93	749.39	566.58

8.5 Engineering Economic Analysis (6 of 6)

Ranking of Individual (Single) Dam Options based on Unit Reference Values

Ranking	Cost Component	Discount Rate		
		6 %	8 %	10 %
	Boschjeskop (Small Dam, Height = 44.32 m)			
3	URV (R/m³)	2.9	3.8	4.7
	Boschjeskop (Large Dam, Height = 47.30 m)			
3	URV (R/m³)	3.6	4.7	5.9
	Mountain View (Small Dam, Height = 84.08 m)			
1	URV (R/m³)	**2.5**	**3.3**	**4.1**
	Mountain View (Large Dam, Height = 92.5 m)			
1	URV (R/m³)	**2.8**	**3.6**	**4.6**
	Montrose (Small Dam, Height = 59.00 m)			
4	URV (R/m³)	4.1	5.4	6.7
	Montrose (Large Dam, Height = 79.00 m)			
4	URV (R/m³)	4.6	6.0	7.5
	Strathmore (Small Dam, Height = 30.00 m)			
2	URV (R/m³)	3.3	4.2	5.2
	Strathmore (Large Dam, Height = 40.00 m)			
2	URV (R/m³)	3.2	4.0	5.0

From an engineering economic point of view the Dam Option with the **lowest** Unit Reference Value (URV) will be the preferred option.

8. RESULTS OF PHASE 1: PRE-FEASIBILITY STUDY

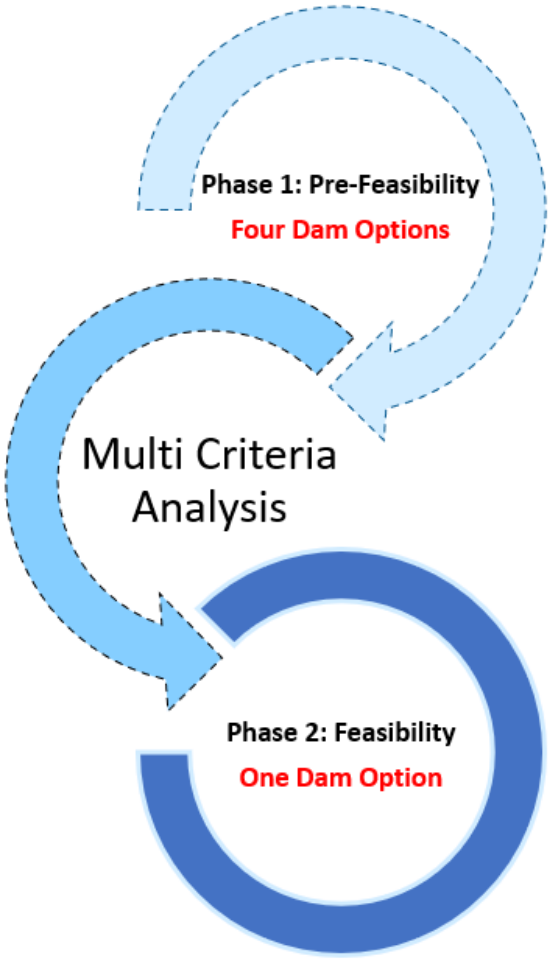
8.6 Multi-Criteria Analysis

8.6 Multi-Criteria Analysis (1 of 5)

Due to the significant water deficits in the Crocodile (East) River Catchment it is possible that the implementation of more than one dam will be required.

Therefore a ranking/scoring system (**multi-criteria decision matrix**) rather than an elimination process was adopted during the execution of the Pre-Feasibility Study.

The highest ranking/scoring dam option will be recommended for further investigation and development at feasibility level.



8.6 Multi-Criteria Analysis (2 of 5)

The following parameters were used in the decision matrix to compare the dam options with each other:

- Net benefit to the system yield.
- Environmental and downstream river impacts.
- Geological and geotechnical considerations.
- Operational risks (Pumping, electrical supply interruptions, loadshedding).
- Engineering economic analysis (URV's and Affordability).

A scoring system was used to determine the **relative merit** of each comparison parameter for each of the dam options.

Each of the comparison parameters was assigned points in the range of **1** to **5** for each of the dam options.

8.6 Multi-Criteria Analysis (3 of 5)

Decision Matrix: Scoring of Individual (Single) Dam Options

Comparison Criterium	Boschjeskop		Mountain View		Montrose		Strathmore	
	Small	Large	Small	Large	Small	Large	Small	Large
Net benefit to system yield (Weight = 1.0)	1.0	1.1	3.3	3.9	1.1	2.6	1.1	1.8
Environmental and downstream river impact (Weight = 1.0)	3.4	3.4	3.2	3.2	1.0	1.0	5.0	5.0
Geological/Geotechnical considerations (Weight = 1.0)	3.8	3.8	5.0	5.0	3.2	3.2	1.0	1.0
Operational risks (Pumping, electrical supply) (Weight = 1.0)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	3.0
Engineering economic analyses (URV) (Weight = 2.0)	4.3	2.9	5.0	4.6	1.9	1.0	3.7	4.0
Total Score	**21.7**	**19.2**	**26.5**	**26.3**	**14.1**	**13.7**	**17.5**	**18.7**
Ranking	**3**	**4**	**1**	**2**	**8**	**7**	**6**	**5**

8.6 Multi-Criteria Analysis (4 of 5)

Decision Matrix: Scoring of Combined Dam Options

Comparison Criterium	Mountain View Strathmore	Mountain View Boschjeskop	Strathmore Boschjeskop
	Large	Large	Large
Net benefit to system yield (Weight = 1.0)	5.0	4.7	2.9
Environmental and downstream river impact (Weight = 1.0)	4.1	3.3	4.2
Geological/Geotechnical considerations (Weight = 1.0)	3.0	4.4	2.4
Operational risks (Pumping, electrical supply) (Weight = 1.0)	3.0	5.0	3.0
Engineering economic analyses (URV) (Weight = 2.0)	2.9	2.9	1.7
Total score	**21.0**	**23.3**	**15.9**
Ranking	**2**	**1**	**3**

8.6 Multi-Criteria Analysis (5 of 5)

Highest Ranking/Scoring Dam Options:

Individual (Single) Dam: Mountain View Dam (Score = 26.3 – 26.5)

Combined Dams: Mountain View and Boschjeskop Dams (Score = 23.3)

Questions/Discussions

Thank You