REPUBLIC OF NAMIBIA

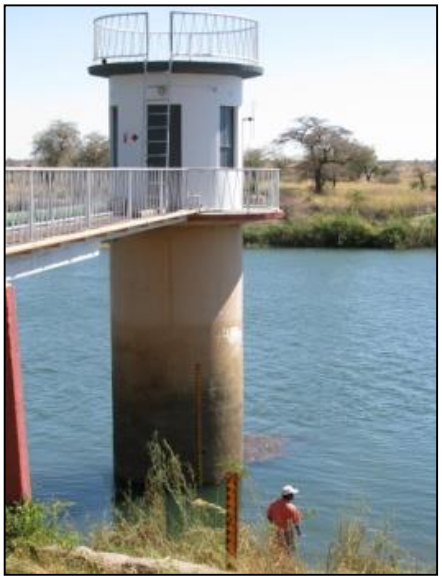
MINISTRY OF AGRICULTURE, WATER AND FORESTRY

EoI 1/18/2 – 02/2011

A PRE-FEASIBILITY STUDY INTO:

THE AUGMENTATION OF WATER SUPPLY TO THE CENTRAL AREA OF NAMIBIA AND THE CUVELAI




ENGINEERING INCEPTION REPORT: *TECHNICAL PORTION*

30 APRIL 2013

SUBMITTED BY:

IN JOINT VENTURE WITH

WITH SUB-CONSULTANTS

AND OTHERS

PREFACE

On 14 July 2011, the Ministry of Agriculture, Water and Forestry openly advertised for expressions of interest from all Namibian registered, reputable, experienced and qualified engineering consultancy firms to form a consortium of all necessary disciplines and submit an Expression of Interest for the feasibility study of the "*Kavango Link to the Eastern National Water Carrier and to the Cuvelai Water Supply Scheme*".

In order to put together a consultancy team with the required capacity and expertise to successfully tackle a project of this nature, Lund Consulting Engineers CC and Seelenbinder Consulting Engineers CC formed a joint venture, into which several other experts (both individuals and companies) were incorporated as sub-consultants. This consortium of experts, collectively termed the Consultant, submitted an Expression of Interest to the Ministry of Agriculture, Water and Forestry, which submission was evaluated by them and by NamWater, and which was ultimately successful. The Consultant was consequently appointed to prepare a Terms of Reference document for the Consultancy Services for an envisaged Feasibility Study into the "*Kavango Link to the Eastern National Water Carrier and to the Cuvelai Water Supply Scheme*".

Following Project Meeting No. 1 with the Ministry of Agriculture, Water and Forestry and NamWater on 15 November 2011, the 1st Draft Terms of Reference were submitted to the Ministry of Agriculture, Water and Forestry on 17 February 2012.

At Project Meeting No. 2 of 20 March 2013, the 1st Draft Terms of Reference were discussed between the Ministry of Agriculture, Water and Forestry, NamWater and the Consultant, as well as the feedback received thereon from other stakeholders. This feedback implied that a re-definition of and a revised approach to the feasibility study would in all likelihood be required. On this basis, and at this Meeting, it was decided that:

1. The environmental (and social) component (investigations and assessments) will be completely separate from the technical / engineering component of the Study. Independent consultancy teams will be appointed to work on these project components,
2. The first phase of this Project will be a desk study, pre-feasibility investigation into alternative water sources for the Cuvelai and Central Areas of Namibia,
3. The title of the Project, at least for the first phase, will be changed to the following: "***Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai***",
4. The 1st Draft Terms of Reference of 17 February 2012 will be discarded and the Consultant will submit a new Terms of Reference on the basis of the above.

On this basis, the Consultant prepared a 2nd Draft Terms of Reference Document, which was submitted to the Ministry of Agriculture, Water and Forestry on 26 June 2012 and which was discussed at Project Meeting No. 3 of 02 November 2012, held between the Ministry of Agriculture, Water and Forestry, NamWater and the Consultant

Following Project Meeting No. 3 and incorporating the feedback received at this Meeting as well as other feedback on the 2nd Draft Terms of Reference, the Final Terms of Reference for the Technical Consultancy Services were submitted to the Project Steering Committee on 19 February 2013.

As agreed with the Ministry of Agriculture, Water and Forestry, these Technical Terms of Reference have been extended into an Engineering Inception Report which is submitted in two parts; a Technical Component and Financial Component. These two components, although submitted as separate documents, should be read conjunctively.

This document consists of the **Technical Component** of the Engineering Inception Report (abbreviated) and contains the salient details of the tasks and activities associated with the Pre-Feasibility Study investigations into "*The Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai*". This document furthermore contains a brief methodology detailing how the Consultant envisages undertaking these tasks and activities.

The Financial Component of the Engineering Inception Report, submitted as a separate document, contains the cost estimates associated with the tasks and activities outlined in this, Technical Component of the Technical Inception Report.

The Inception Reports for the Environmental Component of the Pre-Feasibility Study, also separated into "technical" and financial components, are submitted as separate documents, which should also be read in conjunction with the corresponding Engineering Inception Reports.

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LIST OF ABBREVIATIONS

ARMA	Auto Regressive Moving Average
BCR	Benefit Cost Ratio
BGR	Bundenstalt für Geowissenschaften und Rohstoffe (German Federal Institute for Geosciences and Natural Resources)
BWMP	Bulk Water Master Plan
CAJVC	Central Area Joint Venture Consultants
CAN	Central Area of Namibia
CENORED	Central Regional Electricity Distributor
CNWSA	Central North Water Supply Area (NamWater's term for the area of the Cuvelai supplied by their pipeline and canal infrastructure)
CoW	City of Windhoek
CWSA	Central Water Supply Area (NamWater's term for the Central Area of Namibia supplied by the ENWC and downstream schemes)
DOC	Dissolved Organic Carbon
DPC	Dynamic Prime Cost
DRM	Directorate of Resource Management
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWSSC	Directorate of Water Supply and Sanitation Coordination
EIA	Environmental Impact Assessment
EII	Environmental Impact Identification
ENVES	Environmental Engineering Services CC
EoI	Expression of Interest
EPSMO	Environmental Protection and Sustainable Management of the Okavango River Basin
FoS	Failure of Supply
GDP	Gross Domestic Product
GRP	Glass Reinforced Plastic
IAP	Interested and Affected Parties
IFA	Integrated Flow Assessment
IRR	Internal Rate of Return
ITF	Infrastructure Trust Fund
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Plan
l/c/d	Litres per capita (person) per day
LCE	Lund Consulting Engineers CC
mm	Millimetres
mm/a	Millimetres per annum
Mm^3/a	Million cubic metres per annum
MAR	Managed Aquifer Recharge
MAWF	Ministry of Agriculture, Water and Forestry
MRCE	Manfred Redecker Consulting Engineer

LIST OF ABBREVIATIONS (continued)

NamPower	Namibia Power Corporation
NamWater	Namibia Water Corporation Ltd
NORED	Northern Regional Electricity Distributor
NPV	Net Present Value
pH	Percentage Hydrogen
PI	Profitability Index
PSC	Project Steering Committee
OKACOM	Permanent Okavango River Basin Water Commission
SADC	Southern African Development Community
SAM	Social Accounting Matrix
SEI	Stockholm Environmental Institute
SCE	Seelenbinder Consulting Engineers CC
SSE	Strategic Scoping Exercise
TDS	Total Dissolved Solids
ToR	Terms of Reference
TSA	Time Series Analysis
WEAP	Water Evaluation and Planning System
WMARS	Windhoek Managed Aquifer Recharge Scheme
WDM	Water Demand Management
WMAR	Windhoek Managed Aquifer Recharge
WRYM	Water Resources Yield Model
WTC	Water Transfer Consultants

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CHAPTER 1 : INTRODUCTION

1.1 PROJECT ADVERTISEMENT AND AWARD

On 14 July 2011, the Ministry of Agriculture, Water and Forestry (**MAWF**) openly advertised for expressions of interest from all Namibian registered, reputable, experienced and qualified engineering consultancy firms to form a consortium of all necessary disciplines and submit an Expression of Interest for the feasibility study of the "*Kavango Link to the Eastern National Water Carrier and to the Cuvelai Water Supply Scheme*".

The linking of the Eastern National Water Carrier (**ENWC**) which supplies water to the Central Area of Namibia (**CAN**), to Rundu, in order to augment the supply to the central portions of the country with water abstracted from the Okavango River, is an idea that was mooted some time ago and was investigated in previous studies. A possible link from such a scheme, or from the Okavango River directly, to augment supply to the Cuvelai area of Namibia has however not been investigated in detail in the past.

In order to put together a consultancy team with the required capacity and expertise to successfully tackle a project of this nature, Lund Consulting Engineers CC (**LCE**) and Seelenbinder Consulting Engineers CC (**SCE**) formed a joint venture, into which several other experts (both individuals and companies) were incorporated as sub-consultants. This consortium of experts, collectively termed the Consultant, submitted an Expression of Interest to the Ministry of Agriculture, Water and Forestry on 09 August 2011, which submission was evaluated by them and by NamWater, and which was ultimately successful. The Consultant was consequently appointed to prepare a Terms of Reference (**ToR**) document for the Consultancy Services for an envisaged Feasibility Study into the "*Kavango Link to the Eastern National Water Carrier and to the Cuvelai Water Supply Scheme*".

1.2 TECHNICAL TERMS OF REFERENCE SUBMISSIONS AND PROJECT MEETINGS

1.2.1 Submission of the First Terms of Reference

The first Project Meeting between the MAWF, the Namibia Water Corporation Ltd. (**NamWater**) and the Consultant was held on 15 November 2011 and served to outline the scope of the Project and the tasks and activities required of the Consultant.

The first task of the Consultant was to prepare and submit a ToR for a feasibility study to secure water supply to the Central Area of Namibia, the Cuvelai area and parts of the Otjozondjupa Region. This document was prepared on the basis of investigating a pipeline link from the Okavango River to link up to the start of the ENWC canal near Grootfontein, with an additional or separate link to the Cuvelai area in the north central part of Namibia.

The 1st Draft ToR document prepared by the Consultant was submitted to both the MAWF and to NamWater in electronic format on 17 February 2012.

1.2.2 Review of the First Terms of Reference and Altered Project Scope

The 1st Draft ToR of 17 February 2012 was further distributed within MAWF and within NamWater as well as to other stakeholders such as the Kavango Basin Management Committee. Comments from these various stakeholders were received back in early March 2012, scrutinised by the Consultant and grouped into several broad categories, which were described briefly in a submission to the MAWF.

The feedback received on the 1st Draft ToR of 17 February 2012 implied that a re-definition of and a revised approach to the feasibility study would in all likelihood be required. Project Meeting No. 2 between the MAWF, NamWater and the Consultant was held on 20 March 2012 in order to evaluate the feedback received and determine the scope of the project going forward.

Based on the deliberations of Project Meeting No. 2, the following was determined:

1. The Consultant will report to a Project Steering Committee (**PSC**), to be formed between the MAWF and NamWater,
2. The Environmental (and social) Component (investigations and assessments) will be completely separate from the Technical / engineering Component of the Study. Independent consultancy teams will be appointed to work on these project components, as required by the Equator Principles,
3. The first phase of this Project will be a desk study, pre-feasibility investigation into alternative water sources for the Cuvelai and Central Areas of Namibia. This first phase of the Project will therefore consider all realistically available options. This changed emphasis is required for adherence to the Equator Principles,
4. The title of the Project, at least for the first phase, will be changed to the following: "***Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai***",
5. The 1st Draft ToR of 17 February 2012 would be discarded and the Consultant will submit a new ToR on the basis of the above.

1.2.3 Submission of a Second Terms of Reference

Following the changes to the Project Scope agreed upon at Project Meeting No. 2, the Consultant prepared and submitted a 2nd Draft Terms of Reference document, which was submitted to both the MAWF and to NamWater in electronic format on 26 June 2012. This document provided the ToR for a Technical Pre-Feasibility Study into alternative water sources which can be developed to secure the water supply to the Central Area of Namibia, the Cuvelai area and parts of the Otjozondjupa Region.

Project Meeting No. 3 between the MAWF, NamWater, the City of Windhoek (**CoW**) and the Consultant was held on 02 November 2012. This Meeting consisted of a short Microsoft Power Point presentation of the 2nd Draft ToR of 26 June 2012, delivered by the Consultant and thereafter a discussion on the ToR document.

1.2.4 Submission of the Final Terms of Reference Document

The discussion points of Project Meeting No. 3 of 02 November 2012 and the feedback received on the 2nd Draft ToR of 26 June 2012, both at Project Meeting No. 3 and prior to this, from both the MAWF and NamWater, were incorporated into a (final) ToR document. No further comments or feedback on the 2nd Draft ToR document were received subsequent to 02 November 2012.

The (final) ToR document for a Technical Pre-Feasibility Study into "*The Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai*" was submitted to the PSC (now consisting of representatives from the MAWF, NamWater and the CoW) in electronic format on 19 February 2013.

1.3 SUBMISSION OF AN ENGINEERING INCEPTION REPORT

1.3.1 Submission of an Engineering Inception Report Following Approval of the Terms of Reference

The Consultant's second task is to prepare an Inception / Scoping Report to define the scope and cost of services expected for a Pre-Feasibility Study. It was agreed with the MAWF that the following steps would form part of this process:

1. The Consultant would prepare a Terms of Reference (ToR) for the Study,
2. This ToR would be submitted to the PSC for approval,
3. Following the above, the Consultant would expand the ToR into an Inception / Scoping Report which will detail the activities which are to form part of the envisaged Pre-Feasibility Study into the Project. A proposed work plan which includes time frames and a cost estimate for these activities are to be included in the Scoping Report.

Following the submission of the (final) ToR document of 19 February 2013, the Consultant prepared an Engineering Inception Report as envisaged above. This Engineering Inception Report, to be submitted to the MAWF, is submitted in two parts; a Technical Component and Financial Component. These two components, although submitted as separate documents, should be read conjunctively.

1.3.2 Submission of an Engineering Inception Report: Technical Component

This document consists of the **Technical Component** of the Engineering Inception Report (abbreviated), which is based largely on the (final) ToR document of 19 February 2013, setting out the salient tasks and activities which are to be undertaken for the Pre-Feasibility Study investigations into "*The Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai*".

1.4 SUBMISSION OF AN ENVIRONMENTAL INCEPTION REPORT

1.4.1 Separation of the Engineering and Environmental Investigations

The Consultant's expression of interest of 09 August 2011 included both engineering and environmental (and social) components and therefore companies and experts, because this was what was requested in the advertisement of the MAWF. At Project Meeting No. 2 of 20 March 2012, it was decided that in order to comply with the guidelines of "best practice" and the Equator Principles, the Engineering and Environmental (and Social) investigations and assessments must be split and conducted by separate consultancy teams working independently, although information will be exchanged and shared between these two teams. It therefore follows that separate Inception Reports are to be submitted for the Engineering and Environmental Components of the Pre-Feasibility Study.

1.4.2 Submission of the Environmental Inception Report

The Environmental Inception Report is to be submitted to the PSC committee as a separate document. This document will, similarly to the Engineering Inception Report, consist of two parts; a "technical" component and a financial component.

1.4.3 Liaison between the Engineering and Environmental Teams

Liaison between the Engineering and Environmental Consultancy Teams is envisaged to take place at certain key milestones as below, as well as on an ad-hoc and ongoing basis:

1. With the identification of water supply options and the identification of concept water supply schemes,
2. The 1st round of Public Participation meetings, which will consist of information sharing with the public, will be a joint affair between the Engineering and Environmental Teams,
3. The combination of the Engineering (technical and financial) feasibility of the concept water supply schemes and the environmental feasibility (scoping key issues and mitigation measures) of these same schemes in order to prepare an overall feasibility evaluation of the proposed schemes,
4. The 2nd round of Public Participation meetings, which will consist of information feedback and the presentation of water supply options, will be a joint affair between the Engineering and Environmental Teams,
5. Preparation of the Pre-Feasibility Report which will combine the Engineering and environmental evaluations and reports.

CHAPTER 2 : BACKGROUND

2.1 THE WATER SUPPLY DILEMMA IN NAMIBIA

Namibia is the most arid country in Southern Africa with low rainfall and high evaporation rates. Rainfall is erratic, unevenly distributed and often varying localised in extent; varying from less than 25 mm/a over the coastal Namib Desert to slightly more than 700 mm/a in the north-eastern Caprivi Region. Potential evaporation rates (as measured with an A-pan) can exceed 3,800 mm/a and seldom drop below 2,800 mm/a. This leads to a marked water deficit in all months of the year (after WTC, 1997).

Surface runoff in Namibia is both erratic and sporadic following seasonal rainfall; and most of the country's rivers are episodic or ephemeral.

Namibia is in fact characterised by an almost complete lack of perennial rivers or other perennial surface water resources within its borders. Perennial rivers are only found along Namibia's borders; the Orange River along its southern border, and the Kunene, Okavango, Kwando, Linyanti / Chobe and Zambezi Rivers along its northern borders. Namibia's water resources are moreover unevenly distributed over the country and are generally not located near the major demand centres – the perennial rivers along the country's borders are a considerable distance from the major demand centres in the central areas of the country. This presents a major challenge to the authorities responsible for water supply to the major demand centres.

The surface waters supplying the central area of Namibia are dependent on local rainfall and often erratic runoff. Water consumption however has increased steadily in the central areas, driven by population growth and economic development. The recent Master Plan for the Central Water Supply Area (the CAN) completed for NamWater determined that the water sources supplying the CAN are fast approaching their capacity and that a new water source for the CAN is expected to become a necessity by 2020.

2.2 PROJECT BACKGROUND

2.2.1 Importance of the Central Area and the Cuvelai

Both the Central Area of Namibia and the Cuvelai area play a very important role in the social and economic development of the country, as both areas experience population and economic growth rates well above the average for Namibia. Both areas are prone (presently and in the near future) to water supply interruptions which jeopardise prospective new economic growth.

The CAN is the most economically active area in Namibia. Windhoek is the commercial, industrial and political capital of the country and the unavailability of water is a serious constraint to its development. According to the Namibian Economic Policy Research Unit (1996), when compared to the total economic activity of the country as a whole, Windhoek has 51 % of manufacturing, 96 % of utilities, 56 % of construction and trade, 94 % of transport and communications, 82 % of finance and business services and 68 % of community and social services in the country. The city produces 47 % of value added, and private consumption expenditure in Windhoek comprises 35 % of the national total. These figures serve to illustrate Windhoek's importance relative to the country as a whole (NamWater, 2011).

The value of Windhoek and Okahandja's manufacturing output, assuming that they are together responsible for 50 % of Namibia's total output, equates to approximately N$ 22.5 million/day (N$ 5.04 billion/annum) for 2010, calculated over 6 workdays per week. During 2003/2004, the private consumption expenditure in Windhoek and Okahandja amounted to 36% of the total in the country, (after NamWater, 2011). According to the City of Windhoek (**CoW**), the building / construction activities in the capital over the 12 months ending June 2011 exceeded N$ 1.49 billion/annum. This serves to illustrate the importance of security of water supply to the CAN, to ensure its continued economic and political activity.

The Cuvelai area covers the majority of the four north central regions of Namibia, namely the Omusati, Oshana, Ohangwena and Oshikoto Regions. The largest (and central) portion of this area is served by pipeline schemes which transfer and distribute water from the Kunene River to some 700,300 people distributed over an area some 2.6 million hectares in extent (LCE, 2011). The point of abstraction of water from the Kunene River and some vital associated transfer infrastructure (the Calueque Pump Station, the Calueque – Canal Pipeline and the Calueque – Border Canal) are located in Angola and potentially outside the control of Namibian authorities and service providers.

Frequent flooding in the Cuvelai over the past rainy seasons resulted in damage to the Ogongo – Oshakati Canal, which is the main supply artery to all consumers in and downstream of Oshakati. This in turn resulted in water supply interruptions to these consumers, causing hardship to the community and unnecessary economic losses.

Most of the water sources within the CAN and the Cuvelai have been developed and are nearing the limit of their supply potential. Further development and growth in both the CAN and the Cuvelai, and by extension in Namibia as a whole, is dependent on securing the long-term water supply for current and prospective future consumers. Failure to ensure adequate water supplies to these areas will result in reduced economic activity with serious social and economic consequences for the continued development of Namibia and its people (WTC, 1997). Additional or new water sources therefore need to be investigated in order to provide this long-term security.

2.2.2 The Investigation into Alternative Water Sources

During the 1960s and early seventies, towns in the CAN relied on their own local water supplies. By the late sixties the water demand of the capital city started outstripping the available local supplies and in 1969 the Government started to create bulk infrastructure in ephemeral rivers further from Windhoek to provide water to the City. These were the first phases of implementation of the Eastern National Water Carrier which was designed as the long-term solution to supply water to the central areas of the country.

The Von Bach Dam (48.6 Mm^3) was constructed in 1970, the Swakoppoort Dam (63.5 Mm^3) was completed in 1977, whilst the Omatako Dam (43.5 Mm^3) was completed in 1982. The distances of the three dams to Windhoek are 70, 100 and 200 km respectively. Thereafter the construction of the parabolic, concrete-lined ENWC canal linking Grootfontein to the Omatako Dam started in 1981 and was completed in 1987. These three dams, individually, each have a yield based on a predetermined level of long-term supply assurance. If the three dams are operated conjunctively, the combined yield of the system can be increased by introducing operating rules that will reduce evaporation losses to a minimum. These operating rules, however, still need to ensure a certain level of security of supply by maintaining a minimum volume of water in the dams which must be available during years of low run-off into the dams. Although the conjunctive operation of the three dam system reduces evaporation losses, these losses are still present and remain significant (after CAJVC, 2004[2]).

If the 3-dam system is backed up by and used in conjunction with other sources such as the Karst lV groundwater source, water withdrawn from the Kombat and Berg Aukas mines, and the Windhoek aquifer, the yield of the three dams can be optimised and increased even further since the water can be used as required without having to keep a reserve volume of water in the dams to bridge dry periods. These dry periods can then be supplied from the more assured back-up source. In this way, the evaporation losses in the dams can be reduced even further (after CAJVC, 2004[2]). However, this combination of water sources too has a maximum supply limit at an acceptable level of security of supply, which limit is quickly being approached. The relatively high inflow into surface dams resulting from above average rainfalls over the past 2 rainy seasons rescued the CAN against major supply shortfalls. However, above-average rainfalls should not be relied upon for an acceptable level of security of future supplies.

Whilst the linking of the ENWC to the Okavango River was envisaged already in the 1970s, it is widely acknowledged that it is essential to develop all local sources to their maximum potential and to consider alternative water supply sources which could be developed to postpone for as long as possible the linking of the ENWC to the Okavango River. With this background, several schemes were developed over the last two decades in order to maximise water use efficiency, maximise the use of existing sources and to develop new water sources.

These developments include:

1. The completion, in 2002, of an advanced reclamation plant in Windhoek to allow direct reclamation (the reuse for domestic purposes of treated domestic waste). Windhoek, which has been doing so since 1968, is one of very few places in the world with direct potable water reuse,
2. The upgrading of the Old Goreangab Water Reclamation Plant to increase the re-use of filtered treated effluent from the Otjomuise Wastewater Treatment Plant on sports fields, cemeteries, parks and public gardens in Windhoek. Okahandja also uses unfiltered effluent for the irrigation of sport fields, parks and cemeteries,
3. The development of the Windhoek Aquifer for aquifer recharge and water banking, and
4. The introduction of block tariffs and other Water Demand Measures (**WDM**) in Windhoek, and thereafter in a few other centres.

By managing the water demand and increasing the efficiency of water use and that of the existing sources, these developments have extended the sufficiency period of the existing water sources to the CAN. However, in the light of increasing water demands and the sufficiency limits of these existing sources, NamWater commissioned an extensive study entitled "*The Feasibility Study on Water Augmentation to the Central Area of Namibia*", which was completed in December 2004, which study was to examine further alternatives to water supply to the CAN.

The following augmentation alternatives were considered in this 2004 study:

- Emergency abstraction from the Tsumeb and Karst III aquifers,
- Managed Aquifer recharge of the Windhoek Aquifer with deep well drilling,
- Emergency abstraction from the Okavango River as and when required, and
- Continuous low volume abstraction from the Okavango River to supply water for Managed Aquifer Recharge of the Windhoek Aquifer.

These four alternatives were identified in the initial phases of the 2004 study as the scenarios to be modelled and from which the preferred option would be selected.

An option that was considered with this 2004 study and that was eliminated on grounds of its high cost was the covering of the Grootfontein – Omatako (ENWC) Canal.

Other options that were considered in this 2004 study at a pre-feasibility level and which were not pursued further after an initial inspection of the high development costs, and options that were considered and eliminated in previous studies included:

- Abstraction from the Kunene River,
- Abstraction from the Orange River,
- Desalination of seawater at the coast with transfer to Windhoek,
- Development of the Platveld Aquifer,
- Water from Hardap and Oanob Dams,
- Water from the Friedenau Dam, and

- Large scale development of the Otjiwarongo marble aquifers.

This 2004 study concluded that the development of the Windhoek Managed Aquifer Recharge Scheme (**WMARS**), in conjunction with deep well drilling in the aquifer, was the recommended alternative to secure water supply to Windhoek (after CAJVC, 2004[2]). These recommendations have been partially implemented by the City of Windhoek and NamWater in the period since 2004 and although there is scope to extend the deep well drilling in the aquifer, the growth in water demand over the intervening period means that further sources are required to secure water supply to the CAN for the future.

2.2.3 The 1997 Feasibility Study into the Kavango Link

As the concept of supplying water to the CAN from the Okavango River was proposed in the 1970s already, this idea has been the subject of several studies and investigations, including the Central Area Water Master Plan Study (1993) and the Central Area Water Master Plan Interim Phase System Analysis (1995).

The particularly poor runoff seasons of 1994/95 and 1995/96, resulted in little or no inflow into the major dams supplying water to the CAN. In spite of water demand management measures instituted, particularly in Windhoek, but also elsewhere in the CAN, it was at the time anticipated that if the 1996/97 rainfall year would fail, the CAN would experience a major water crisis with expected shortfalls in excess of 50%. The Berg Aukas scheme was implemented as a short term emergency measure to reduce the expected shortfall during the drought. The DWA further instated emergency measures that would need to be undertaken in a short space of time in order to avoid such a crisis, one of which was the preparation of a feasibility study on measures to augment and secure the water supply to the CAN by completing the Okavango – Grootfontein pipeline link of the ENWC.

A consortium called Water Transfer Consultants, consisting of LCE, Bicon Namibia and Parkman Namibia, was successful in their bid to tackle this project, which commenced in August 1996 and was completed in August 1997, when the findings of the study were published in 6 volumes.

For an estimated capacity of 17.28 Mm^3/a, the proposed Rundu – Grootfontein or *Kavango Link* of the ENWC was estimated to cost (in 1997 terms) N$ 603 million (WTC, 1997[1]).

2.2.4 The Need for this Study

From the above it is clear that the long-term water security for the CAN and the Cuvelai areas and their inhabitants necessitates a further investigation into alternative sources of supply. Such an investigation must be undertaken and the recommended measures implemented before any shortfall occurs, which on the basis of recent demand modelling, is projected to be in the region of 2020.

The 2004 and other previous studies into alternative water sources for the CAN did not include an investigation into augmenting the supply or providing a supply back-up for the Cuvelai area.

Furthermore, during the presentation to NamWater of the Bulk Water Supply Infrastructure Development and Capital Replacement Master Water Plan for the Central Water Supply Area (August 2011), the idea to supply the areas east of Okakarara and north-east of Otjinene from the Eastern National Water Carrier surfaced, due to the limited potential of existing local water sources.

Recent studies into the water supply infrastructure in the Cuvelai area – NamWater's bulk water supply infrastructure {the Water Supply Infrastructure Development and Capital Replacement Master Water Plan for the Central North Water Supply Area (LCE, 2009)} and the MAWF's rural water supply infrastructure {the Combined Regional Rural Water Supply Development Plan for the Oshikoto, Ohangwena Oshana and Omusati Regions (LCE, 2011)} touched on the development of alternative water sources to this area, but did not undertake detailed investigations in this regard.

Several factors have therefore influenced the need to re-investigate the potential of alternative water sources for the CAN and the Cuvelai. First, the requirement from the MAWF that water augmentation be considered for the Cuvelai area of Namibia necessitates the re-assessment of the proposals investigated previously, including new alternative water sources.

Secondly, the supply configuration in Windhoek has changed considerably since the last in-depth investigations into the Kavango Link and alternative water augmentation options were considered (1997 and 2004 respectively), as a result of the increased supply from direct reclamation of domestic effluent and the introduction of the Windhoek Managed Aquifer Recharge Scheme (recommended as the best option to secure water supply to Windhoek by the 2004 study into water supply to the CAN).

Thirdly, several master plans and similar studies have recently been completed for the various areas for which this augmentation is proposed, namely the Cuvelai area (master plans of NamWater's bulk water supply infrastructure and the MAWF's rural water supply infrastructure), the Kavango area (a master plan of NamWater's bulk water supply infrastructure) and the Central Water Supply Area of Namibia (a master plan of NamWater's bulk water supply infrastructure). This means that a substantial amount of work has been done relatively recently, which can form the basis of the feasibility investigations into water supply augmentation.

2.3 STUDY AREA

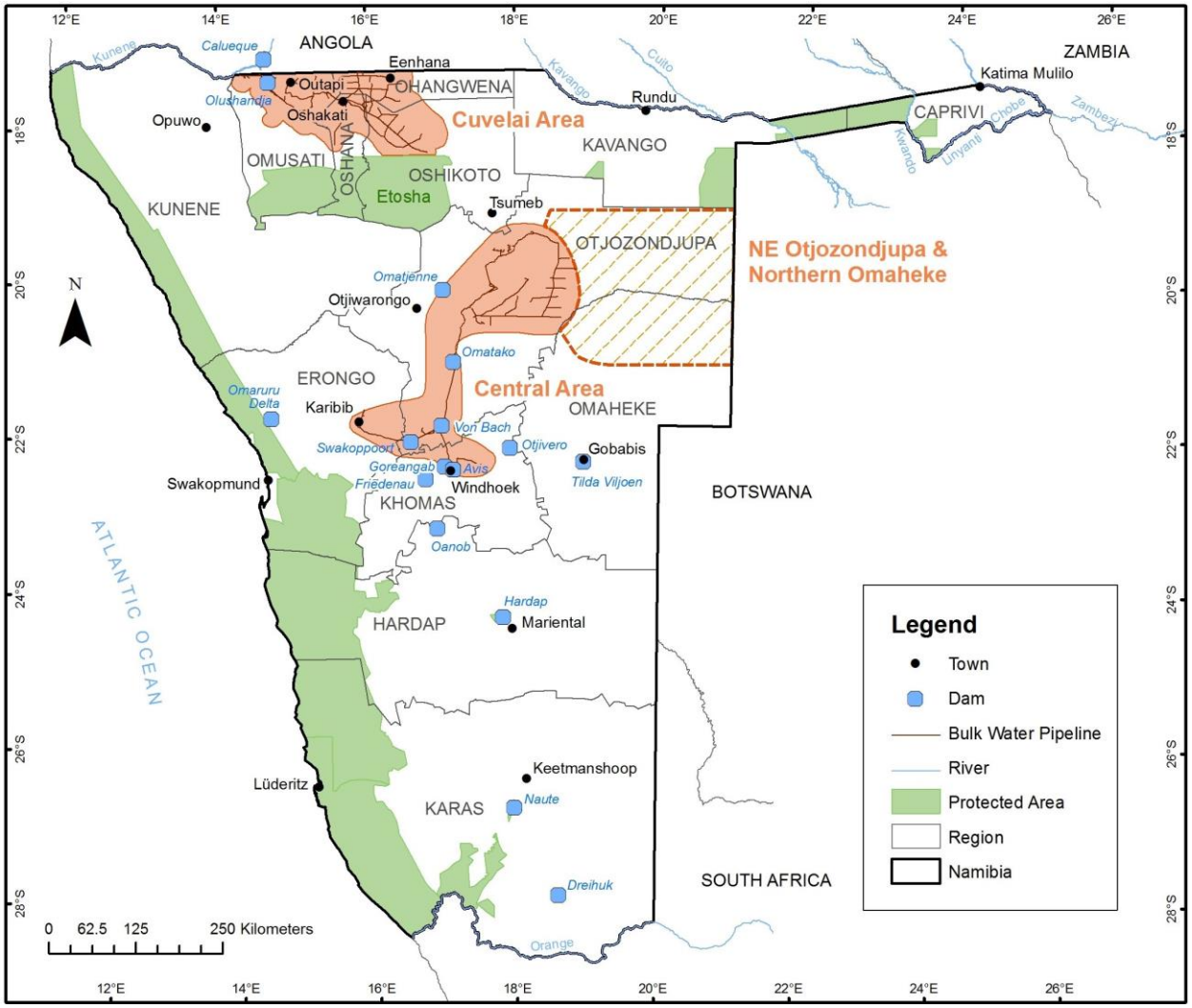
The initial water supply area for the Study consists of the CAN and the Cuvelai area, which latter area corresponds with the largest portion of the four north central regions, being the Omusati, Oshana, Ohangwena and Oshikoto Regions. During a recent discussion with NamWater, it was requested that the area east of Okakarara as far as Gam, as well as Otjinene and the areas south to Rietfontein, be included in the investigation.

This request was discussed during Project Meeting No. 1, as it may imply a constant delivery type of scheme as opposed to an emergency / back-up type of scheme. It was agreed during Project Meeting No. 1 of 15 November 2011, that the calculation of the water demands for this additional area would be included in the Study, but not any infrastructure planning or infrastructure capacity assessments.

At Project Meeting No. 1, when it was envisaged that only the Kavango Link pipeline option was to be investigated, NamWater further requested that the areas along the Okavango River upstream of Rundu and the areas along the proposed pipeline route also be included in the Study Area in terms of water supply. The water demands of these areas can still be quantified in order to have available the total abstraction requirements from the Okavango River if this becomes the best or only remaining supply source.

The various portions of the Study Area are shown in **Figure 2.1** below.

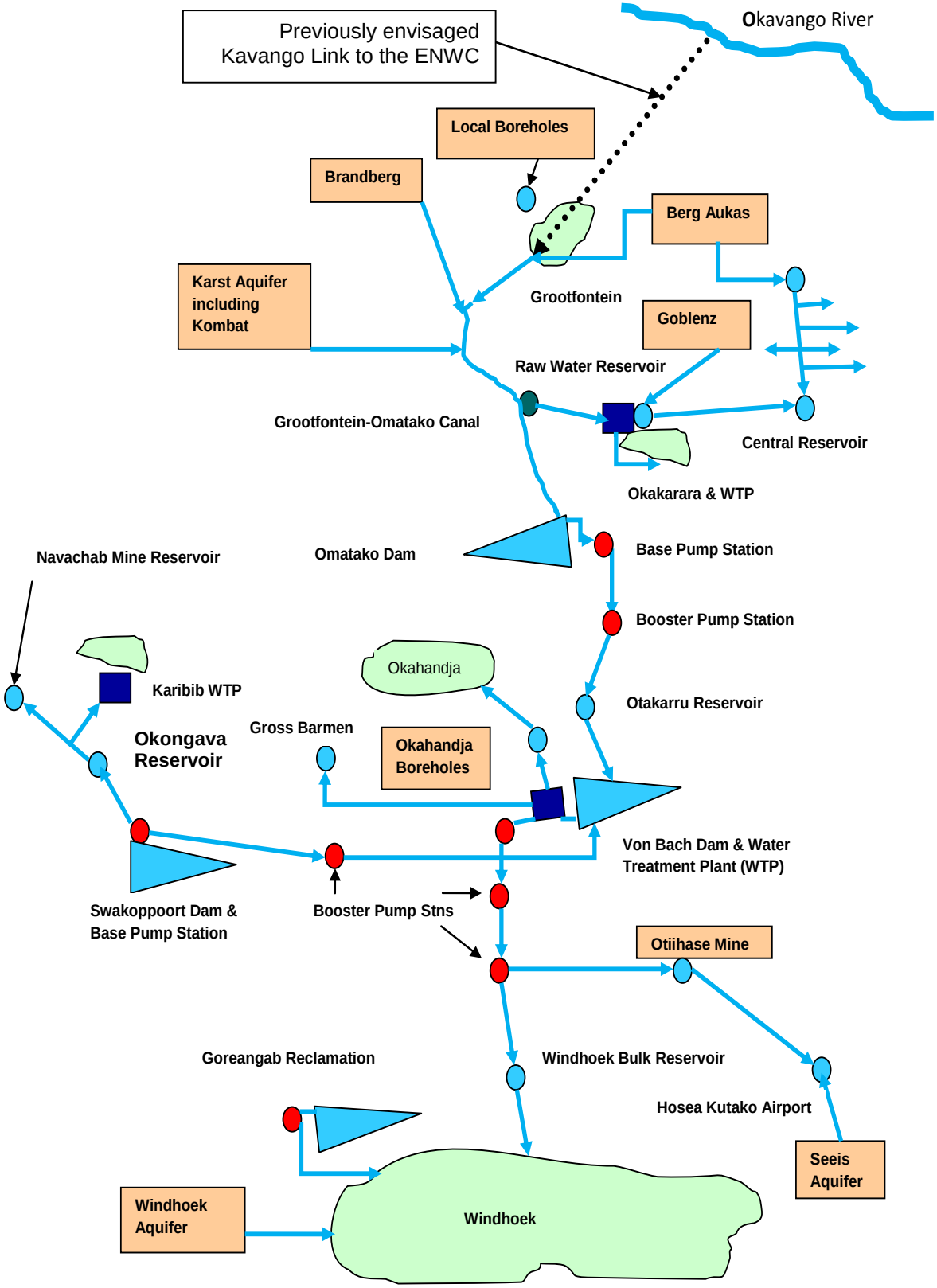
Figure 2.1: Preliminary Extent of the Study Area



2.3.1 The Central Area of Namibia

The CAN corresponds with NamWater's so-called Central Water Supply Area, which encompasses those areas supplied with water by the ENWC Canal (refer to **Figure 2.2**).

Figure 2.2: Schematic Layout of the Bulk Water Supply Infrastructure in the CAN



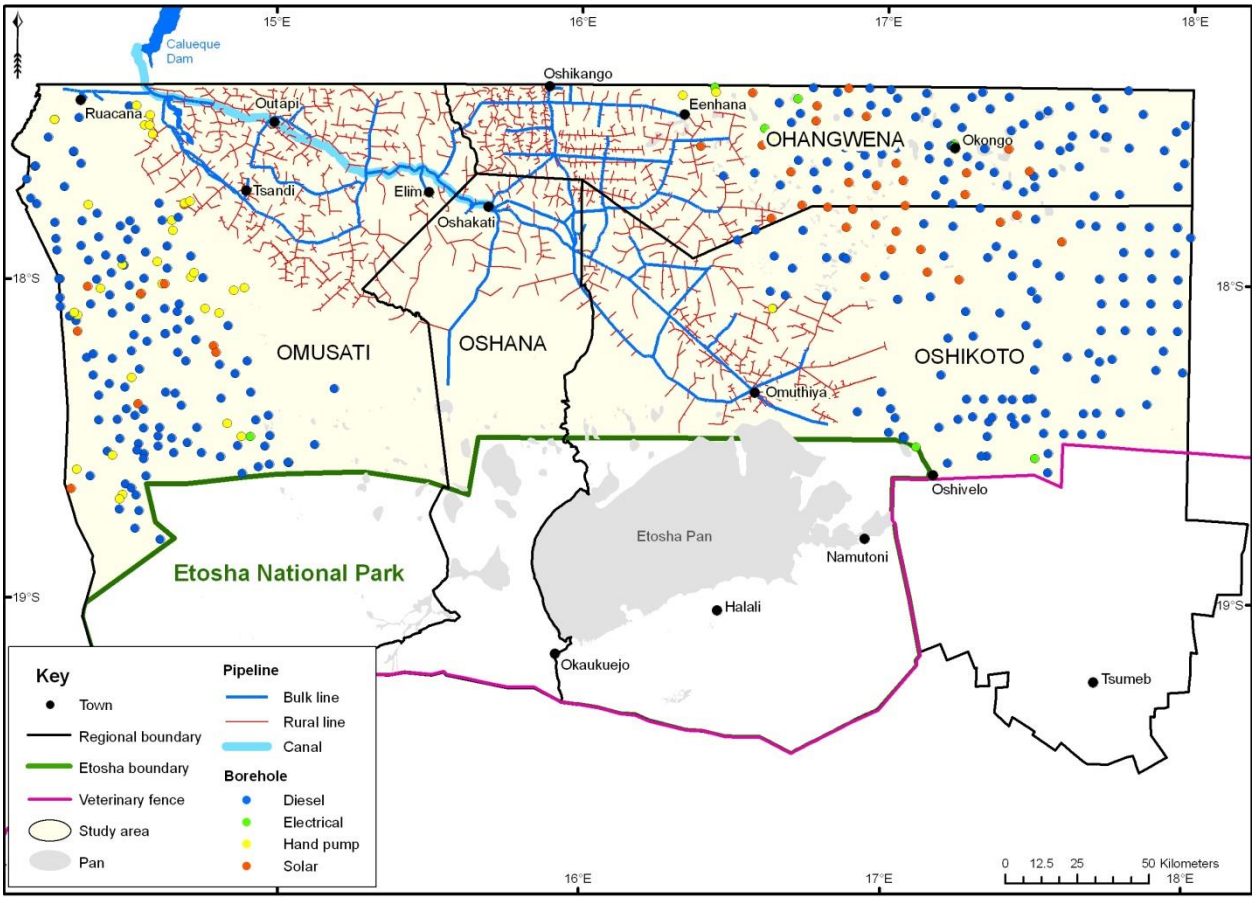
The CAN is supplied with water from dams constructed on ephemeral rivers, groundwater sources mostly in the Karst areas and from reclaimed domestic effluent (in Windhoek only).

The groundwater abstracted in the Karst areas is delivered into the ENWC canal, through which it gravitates to Omatako Dam, from where it is pumped to Von Bach Dam. Water drawn from the Von Bach Dam is purified and transferred to Windhoek as well as to Otjihase Mine and the Windhoek International Airport. Water which enters Swakoppoort Dam is pumped westwards to Karibib and the Navachab Mine where it is respectively purified according to its intended use, and is also pumped eastwards to Von Bach Dam for eventual transfer to Windhoek.

2.3.2 The Cuvelai Area

In the Cuvelai area, also referred to as NamWater's Central North Water Supply Area, covers those portions of the Cuvelai (the Omusati, Oshana, Ohangwena and Oshikoto Regions) supplied with water via the bulk (belonging to NamWater) and rural (belonging to the MAWF) pipeline networks. Areas to the west and east of the central pipeline network of the Cuvelai are supplied with ground water via individual borehole installations. The water supply infrastructure in the Cuvelai is shown in **Figure 2.3**.

Figure 2.3: Layout of the Bulk Water Supply Infrastructure in the Cuvelai Area



The water supplied via the pipeline network in the Cuvelai area is drawn from Calueque Dam, which is situated in Angola, some 40 km upstream of the Ruacana Falls and 15 km north of the Namibian – Angolan Border, under an abstraction agreement between the Namibian and Angolan Governments which dates back to 1969.

This water is pumped a short distance, after which it gravitates into Namibia via the Calueque – Oshakati Canal, after which some water is drawn off to supply the Etunda Irrigation Scheme. The remainder of the water gravitates past Olushandja Dam towards Oshakati via the canal, where it is purified for distribution to the north, south and east. Water drawn from the canals between Olushandja and Oshakati is also treated at Olushandja, Outapi (Ombalantu) and Ogongo prior to further distribution. Water is drawn from the canal into Olushandja Dam for emergency storage only.

2.4 OBJECTIVE OF THE STUDY

A link from the Okavango River to the ENWC canal (the “Kavango Link”) is one of the water augmentation options to be considered under this Project. However, the Okavango Delta is a Ramsar Site and an important international wetland which is ecologically very sensitive. Abstraction from the Okavango River will require negotiation with both Angola and Botswana via the Permanent Okavango River Basin Water Commission (**OKACOM**). Before such steps are taken, it is essential that all local sources be developed to their maximum potential and that other, alternative, water supply sources also be considered and evaluated. This Study aims to consider all realistic alternative water sources to the CAN and the Cuvelai.

The main objective of the Study is therefore to examine all the nominally feasible options for augmenting the water supply to the CAN and the Cuvelai areas of Namibia where existing sources might become inadequate in the near future.

The existing water sources will be compared with the projected water demands of these areas in order to determine the expected supply shortfalls. In cases where feasible potential sources are shared with other users such as Rehoboth and Otjiwarongo (Oanob Dam and the Platveld aquifer respectively), the potential resource volumes will be determined after growth in local demand. Realistic water supply options to alleviate these shortfalls are then to be identified. Cost estimates are then to be provided for these options on the basis of supplying the required water volumes up to 2050, where after financial analyses are to be performed on the viable options in order to determine which of the options identified is the most favourable.

In terms of alleviating the supply shortfalls which are expected to occur in the future, additional water sources are to be examined on the basis of augmentation and back-up – i.e. whether the proposed source and / or scheme is to serve for augmentation and / or supply, is to be investigated.

Back-up schemes relate in particular to the Cuvelai area where the fact that this area is dependent on a single source, namely the Calueque Dam and the associated transfer scheme, which is moreover located in Angola, is of concern to the Ministry. An alternative (back-up) source is therefore required for this area.

The different supply areas and supply options are thus:

1. Water supply to the CAN: Augmentation,
2. Water supply to the Cuvelai: Back-up,
3. Water supply to the Eastern Otjozondjupa and Omaheke Regions: Augmentation (possibly).

The Study Area is to be further defined by confirming the extent of the Cuvelai area to be served for back-up purposes.

2.5 CLIENT LIAISON

The MAWF serves as the principal Client for the purposes of this Study. In particular, the Consultant shall report to the Director in the Directorate of Resources Management in the MAWF.

In terms of technical matters, the Consultant will however liaise with the Project Steering Committee (**PSC**) which is to be formed between designated officials from the MAWF, NamWater and the CoW and keep them informed on the progress of the Study.

2.6 UNDERLYING APPROACH TO THE PRE-FEASIBILITY STUDY

The underlying approach proposed with the ToR and therefore approved for the Pre-Feasibility Study, is that of a desk study which will use the information which is available from whatever sources, in particular that from previous studies, updating this information where required, in order to arrive at an up to date and relevant pre-feasibility investigation. It is envisaged that major field work, associated components and more detailed investigations will only become necessary in a later, detailed feasibility or design phase, should the decision be made to proceed with the Project.

CHAPTER 3 : PROJECT SCOPE AND ACTIVITIES

3.1 ESTABLISHING THE PROJECT AREA

The first activity of the Study will be to establish the extent of the Project Area which is to be considered. Whilst the nominal water supply areas are provided in **Section 2.3** above, different areas are to be examined in the light of either providing a back-up to existing water sources or to augmenting existing water sources.

3.1.1 Water Supply Areas in the CAN

With regard to the CAN, the Consultant proposes that all current and potential future consumers who depend on the ENWC link (refer to **Figure 2.2**) be included with regard to the need to augment the existing water supply sources.

With regard to the demand and supply modelling, the Consultant proposes that the following places which experience water shortages from time to time be included:

- Omaruru,
- Otjimbingwe; both urban and rural, including the resettlement farms included in the Otjimbingwe bulk supply,
- Otjiwarongo, after local sources are fully developed, and
- Otjinene (recently proclaimed as a town with water quality concerns and limited local resources).

3.1.2 Water Supply Areas in the Cuvelai

Previous studies into the water supply infrastructure (both bulk and rural) in the Cuvelai area were primarily tasked with a sufficiency assessment of the supply infrastructure and the existing water supply source(s) and did not examine alternative sources in great detail, particularly not from the point of view of providing a back-up source for the Cuvelai.

The Consultant proposes that under the Pre-Feasibility Study, the various pertinent aspects be clarified via, *inter alia*, consultations with the various stakeholders, as represented by the Regional Councils, the MAWF and NamWater. The Consultant proposes that initial consultations on this matter be held with the MAWF in Windhoek, following which a one-day trip be made to Oshakati to meet with the Omusati, Oshana, Ohangwena and Oshikoto Regional Councils and the NamWater Area Manager in their Oshakati Office in order to assemble input from the main stakeholders.

3.2 WATER DEMANDS

3.2.1 Water Demands in the Central Area of Namibia

Water demand will be sectorised as far as possible in the following main categories:

- Domestic consumers divided by income group and spatial distribution including water use in informal settlements,
- Institutions such as schools, hostels and clinics, etc,
- Commercial enterprises shops, farms service industries and mines,
- Irrigation (distinguishing between irrigation in towns and commercial irrigation if applicable),
- Rural and livestock use,
- Any other consumers which have significant potable water demands.

There are several planned mining activities in the vicinity of the ENWC with significant water demands. Some mines, such as the Aurix Gold Mine, may even affect the Marble Aquifer north of Otjiwarongo negatively.

It is suggested that provision be made for:

- Aurix Gold Mine,
- Omitiomire Copper Mine,
- Okandjandje Graphite Mine near Otjiwarongo,
- The new manganese mine near Otavi,
- The possible new Lodestone and Jindal mines near Dordabis,
- Other mines not yet identified.

3.2.2 Water Demands in the Cuvelai Area

3.2.2.1 Water Demands for the Rural Areas

The Consultant proposes that for the Pre-Feasibility Study, the water demands for the rural areas, as determined under the Combined Regional Rural Water Supply Development Plan for the Oshikoto, Ohangwena Oshana and Omusati Regions, be extended to 2050. These water demands are to be based on a unit consumption rate of 25 l/c/d for the rural population, Adjustments can be made for increased consumption due to the increased provision of individual water connections / meters at manifolds, based on the expected implementation schedule which will be requested from the DWSSC.

3.2.2.2 Water Demands for the Urban Centres

The Consultant proposes that the water demand projections for the 35 “urban” centres prepared for the NamWater Central North Water Supply Area Bulk Water Master Plan (LCE, 2009) be extended from 2024/25 until 2050.

3.2.3 Water Demands along the Route of a Possible Kavango Link Pipeline

Both water augmentation to the CAN and back-up to the Cuvelai area will consider the *Kavango Link* (a pipeline drawing water from the Okavango River either at Rundu or elsewhere) among the alternatives to be investigated (refer below). For this particular option, the water demands of the communities living along the potential pipeline routes will also need to be determined in order that these communities are not left out as possible beneficiaries of such a development.

For both a pipeline from the Okavango River to the Cuvelai and from the Okavango River to the start of the ENWC at Grootfontein, the pipelines can be expected to traverse areas currently undeveloped because of a lack of water supply. Running a major pipeline artery through such areas might unlock the development potential for irrigation, among other uses. This potential will need to be assessed under these particular supply options. For example, water to be drawn from the Okavango River could be used for irrigation (up to say 60 m above river level, depending on affordable pumping costs) along the possible pipeline route. The Consultant will therefore asses the anticipated future water use, including irrigation, for the areas along the possible pipeline routes.

Water demands along any such pipeline routes will be estimated at a “high level”, based on the areas which could be served and appropriate unit consumption rates per area (for limited irrigation; mostly hot houses further away from the river and livestock watering) and per capita for human demands.

3.2.4 Water Demands for the North Eastern Otjozondjupa and Northern Omaheke Regions

Water demands for the North-Eastern Otjozondjupa and Northern Omaheke Regions are to be determined on the request of NamWater (refer to **Section 2.3** and **Figure 2.1**). Water demands for these areas will be determined on a “high level” for “rural” and “urban” areas.

3.3 ASSESSMENT OF CURRENT AND POTENTIAL ADDITIONAL WATER SOURCES

3.3.1 Current Water Sources in the Central Area of Namibia

The capacity of most of the current water sources in the CAN are reasonably well established and are required as input values for the simulations performed by the CA-Model. In this regard the values most recently adopted for NamWater’s 2011 Water Supply Infrastructure Development and Capital Replacement Master Water Plan for the Central Water Supply Area will be used. However, the capacities of the following sources do require confirmation:

1. The possible extended capacity of the WMARS project towards the east and west (Auas Formation) of the existing water bank,
2. The possible reduction of losses at NamWater’s Von Bach Water Treatment Plant,
3. The expected future use of the Kombat and Berg Aukas Mines and what impact this will have on these supply sources.

3.3.2 Current Water Sources in the Cuvelai

The pipeline network in the Cuvelai area (NamWater's so-called Central North Water Supply Area) is supplied with water from the Kunene River which is abstracted at the Calueque Dam in Angola. The areas to the east and the west of the central pipeline network are supplied by individual borehole installations which typically serve separate community groups or villages (refer to **Figure 2.3**).

3.3.3 Potential Water Sources for the Central Area of Namibia

Several potential sources which could supply water to the CAN have been investigated in the past, some of which will be re-assessed under this Study, following the changes to particularly the water supply situation in Windhoek since the previous such study in 2004 (refer to **Section 2.2.4**).

Options which have been considered in the past include water supply from the Zambezi River, rainfall enhancement by cloud seeding, the transportation of icebergs, the reduction of evaporation losses from open dam surfaces and the covering of the ENWC canal to reduce evaporation losses. These options are however not considered suitable, given either the very high costs or practical considerations and effectiveness, or a combination of both.

Three further options which will be examined at a "high level" are the abstraction of water from the Orange River, the use of desalinated sea water from the coast, with transfer in both instances to link up with existing supply infrastructure in the CAN and development of the Platveld Aquifer. In the latter instance, this is not really expected to be a viable water source for the CAN, but this is to be confirmed.

The more realistic options for water augmentation to the CAN are considered to be one or more (possibly a combination of) of the following:

1. The Tsumeb Aquifer & Karst III Aquifer,
2. Development of the Kalahari Aquifer between Grootfontein and Rundu. Very little is known about this aquifer at this time, beyond its possible potential use for water supply and perhaps artificial recharge. More extensive exploration drilling will in all likelihood therefore be required to determine the abstraction potential (storage volumes seem to be very high) of this aquifer and the feasibility for abstraction and artificial recharge in the long term,
3. Use of water from the Hardap, Oanob and Friedenau Dams to keep the Windhoek Aquifer full,
4. Potential abstraction from the Rehoboth aquifer,
5. Development of the Otjiwarongo Marble Aquifers,
6. Potential abstraction from the Omaruru Aquifer. Details regarding the potential yield of this aquifer will need to be obtained from the MAWF,
7. Potential utilisation of the Otjivero Dam as a possible source for the Eastern Otjozondjupa and Omaheke Regions with regard to determining the water demands for these areas – refer to **Section 2.4**,

8. Further development of the Windhoek Aquifer and the WAMRS project including increasing the capacity of the "water bank" towards the west,
9. Additional use of direct reclamation as a result of the upgrades to the Gammams Waste Water Treatment Plant currently under investigation by the CoW. If the capacity of the Gammams Plant is to be extended, the capacity of the New Goreangab Water Reclamation Plant could be extended, or alternatively, a new plant could be constructed to treat additional volumes of reclaimed water based on advanced reclamation with membrane systems (ultra-pure water),
10. Extensions to the dual pipe system in the Windhoek municipal area following the completion of upgrades performed at the Old Goreangab Water Reclamation Plant in 2010-11 and the proposed new Ujams Water Treatment Plant (construction commenced in the first third of 2013),
11. Water reclamation in other towns (advanced reclamation) in the CAN which use more than 1 Mm^3/a of water,
12. Completion of *Kavango Link* – i.e. linking the start of the ENWC canal at Grootfontein to the Okavango River either at Rundu or elsewhere.

If water from the Otjiwarongo Marble Aquifers and the Hardap and Oanob Dams is to be used, the water demands of respectively Otjiwarongo, Mariental and Rehoboth, which fall outside the CAN, will need to be investigated in order to verify that spare capacity is indeed available from these potential sources.

The potential use of these water sources will be investigated, in order to determine what volumes of water could be supplied to the CAN and at what level of security (where possible). The Consultant proposes that the water demand projections prepared for Rehoboth and Mariental under the Bulk Water Master Plan for NamWater's Central South Water Supply Area be used and extended and that no additional work be performed on assessing the water demands of these centres. Similarly the water demand projections for Otjiwarongo from the Bulk Water Master Plan of NamWater's Central East and Central West Water Supply Area will be used. The Consultant further proposes using the yields of the Hardap and Oanob dams as contained in the Integrated Water Resources Management Plan or as otherwise provided / confirmed by the MAWF.

3.3.3.1 Other Water Sources

Water resources can be classified as conventional and unconventional resources. Conventional resources are surface run-off (dams and rives) and groundwater through the natural recharge of aquifers. In an arid country such as Namibia with very high evaporation rates and few perennial rivers, unconventional water resources do not impinge on conventional resources.

3.3.4 Potential Water Sources for the Cuvelai Area

The options regarding potential additional water sources for the Cuvelai area appear to be somewhat limited. These include:

1. Abstracting water from the Kunene River on Namibian soil below the Ruacana Falls, which although still utilising water from the same source as currently, has the advantage of locating the abstraction and transfer infrastructure entirely on Namibian soil,
2. Development of the deep Ohangwena Aquifer in the area around Eenhana. Very little is known about this aquifer at this time, beyond its possible potential use for water supply and perhaps artificial recharge. More extensive exploration drilling will in all likelihood therefore be required to determine the capacity of this aquifer and the feasibility for abstraction and artificial recharge in the long term,
3. Water reclamation and re-use in the central nucleus of Oshakati, Ongwediva and Ondangwa, which could include direct reclamation, use of semi-purified water through a dual pipe system as in Windhoek, or partial re-use of “grey” water for irrigation purposes,
4. Development of the ground water sources to the east and west of the central pipeline network. This could include linking up the existing individual borehole installations for supply to the central Cuvelai area or developing new well fields for this purpose,
5. The desalination of saline ground water in the central portions and possible in remote parts of the Cuvelai area for human and animal consumption,
6. Use of Lake Oponono,
7. The abstraction of water from the Okavango River.

The Consultant will liaise with the Geohydrology Division of the MAWF and the BGR with regard to their work on the deep Ohangwena Aquifer in order to obtain the most up to date information available.

The potential use of these water sources will be investigated, in order to determine what volumes of water could be supplied to the Cuvelai and at what level of security (where possible).

3.3.4.1 Ground Water

Groundwater is primarily used to supply in the water demand of rural settlements and subsistence farmers living away from the pipeline networks in the Cuvelai area. It is not used for any bulk water supply and can be regarded as hugely under-utilised; the main reasons being that the water quality of deeper aquifers are frequently poor, and until recently, no high yielding aquifers were known to exist in the area.

It has however been known for some years that the Oshivelo Artesian Aquifer in the Oshivelo area hosts groundwater reserves that can potentially be abstracted to either augment water supply to the Cuvelai area, or that can be used as a back-up supply source to the southern ranges of the pipeline network.

The recently discovered Ohangwena II Aquifer in the north-central part of the area certainly has the potential to yield very large quantities of groundwater, but this still needs to be investigated in more detail before this resource can be quantified accurately. Uncertainty also exists regarding the quality of the groundwater to the southern extremities of the aquifer.

For the purpose of the Pre-Feasibility Study, it is proposed that the studies done to investigate or quantify these groundwater resources are revisited and summarised to arrive at the most reliable and accurate estimate of these groundwater reserves. Summarising the various studies will require in-depth literature searches and evaluation of various project reports. Recommendations for further investigations and drilling to better define and test the Ohangwena II Aquifer will be an outcome of the Pre-Feasibility Study.

There are also groundwater resources where the cumulative yield from numerous low-yielding boreholes distributed over extensive areas can significantly contribute to the total water supply. Of specific interest are once again the Kalahari aquifers in the Ohangwena and Oshikoto Regions that are in close proximity to both the existing and possible pipeline routes. The potential of these aquifers are uncertain and needs to be established. For the purpose of the Pre-Feasibility Study, it is recommended that borehole data recorded in the GROWAS database of the Geohydrology Division as well as data from the Directorate of Water Supply and Sanitation Coordination's database in the Ministry of Agriculture, Water and Forestry, be used to identify the areas of medium to high borehole yields. These identified areas can be further delineated to show the areas with highest groundwater potential.

The cost of establishing suitable and sufficient infrastructure for collecting and storing groundwater abstracted over an extensive area can be very high. It is therefore proposed that, once areas have been delineated for the possible abstraction of groundwater from the various aquifers, proper well-field lay-out and design be done in order to minimise infrastructure costs. The well-field design and lay-out will focus on the optimal location of individual boreholes within a well-field to maximise production, along with minimising environmental impacts and energy costs, thus providing the most efficient well-field system in the most cost-effective manner.

3.4 SCHEME CONFIGURATIONS AND COST ESTIMATES

3.4.1 Preparation of Concept Scheme Configurations in Consultation with the Environmental Team

The Consultant will liaise with the Environmental Team with the preparation of the concept scheme configurations in order to ensure that the concept schemes put forward are in principle environmentally acceptable, before time and effort is spent on any preliminary design and costing work. This liaison is envisaged to entail a round table discussion and formulation session incorporating the senior members of both consultancy teams.

3.4.2 Concept Scheme Configurations

Where the potential water sources are found to be suitable or adequate for use either for augmentation or back-up (development is technically feasible), concept water supply schemes will be outlined which will allow the development of these sources and the transfer of the appropriate volumes of water to link up with the existing water supply infrastructure in both the CAN and the Cuvelai, as appropriate. The configuration of these schemes and their constituent components (for example pipeline diameter) will be sized on the basis of preliminary designs and concept layouts and will not be designed in detail and will not be optimised.

The Consultant's proposal is based on preparing and costing *five* concept scheme configurations each for the Cuvelai and the CAN. These concept schemes may consist of a combination of surface water and ground water abstraction components.

3.4.3 Cost Estimates for the Scheme Configurations

Cost estimates for the concept scheme configurations will be prepared on the basis of the sizes of the required infrastructure as determined from the preliminary designs. These cost estimates will be accurate to ±25% and will include capital expenditure and operation and maintenance costs for the expected duration / lifespan of the schemes.

3.4.4 Power Supply

The concept scheme configurations proposed for the development of the potential water sources identified will need to take into account the expected power supply requirements of these schemes. This will require an assessment of the capacity of any nearby existing power supplies and proposals for the development of additional power supplies or transmission lines where existing schemes are found inadequate. The costs of developing such additional power supply schemes will be included in the cost estimates for the concept scheme configurations for each alternative investigated.

3.5 OTHER CONSIDERATIONS

Other considerations may also need to be taken into account during the pre-feasibility investigations, including water quality considerations and the implications of the policy and legislative environment, as well as international agreements pertaining to international rivers.

3.6 FINANCIAL ANALYSES OF THE CONCEPT SCHEME CONFIGURATIONS

3.6.1 Basis of the Financial Analyses

The financial analyses will need to be founded on certain (realistic) assumptions. These basic parameters will need to be determined in conjunction with the MAWF and NamWater. The financial analyses will need to be performed on a comparable basis for all alternatives investigated and be based on the most realistic assumptions available at the time.

3.7 SELECTION OF THE FAVOURED OPTIONS

3.7.1 Receipt of the Environmental and Social Evaluations

The Environmental Consultancy Team will perform an environmental scoping assessment for the *three* most favourable concept water supply schemes put forward for the CAN and the Cuvelai (refer to **Section 3.4.1** and also to **Section 3.8**. The Engineering Consultancy Team will evaluate five options and put forward the three most favourable to the Environmental Consultancy Team). The Engineering Consultant will receive these evaluations from the Environmental Consultancy Team for incorporation into the assessments to select the overall most favourable alternative(s) for water augmentation / back-up for the CAN and the Cuvelai.

3.7.2 Selection of the Favoured Water Options

The final selection of the preferred water supply option(s) or alternative(s) for the CAN and Cuvelai areas will be based on an assessment of the following factors:

1. The financially most favourable alternative based on the lowest Dynamic Prime Cost,
2. The lower risk-favourable alternatives,
3. The environmentally most favourable alternative on the basis of the preliminary environmental assessments conducted and lowest environmental costs,
4. Other consideration such as:
    - Which alternatives provide the best long-term water security to consumers,
    - Which alternatives provide the best wider economic benefit to Namibia,
    - Which alternatives can be implemented the easiest and in the shortest space of time,
    - Other considerations which may become evident during the course of the Study.

In all likelihood, the selection of the preferred water supply option(s) or alternative(s) for the CAN and Cuvelai areas will be based on a compromise or trade-off between the above mentioned considerations in order to arrive at the overall optimum solution. It is also possible that the overall optimum solution may consist of a combination of options or components (for example surface and ground water resources).

The consideration of the various alternatives and the selection of the preferred water supply option(s) or alternative(s) for the CAN and Cuvelai areas will be conducted in close liaison and in conjunction with the PSC.

3.8 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS AND LIAISON

3.8.1 Separate Engineering and Environmental / Social Teams

The Consultant, being the Joint Venture between LCE and SCE, incorporating several other experts (both individuals and companies) as sub-consultants, is a purely engineering team, who will concentrate on the engineering, financial and other technical aspects of this Study. A separate team has been appointed to examine the environmental and social impacts of the various alternatives investigated under this Study. This Environmental Team will function independently from the technical team, as the separation of the technical and environmental assessments is one of the key requirements of the Equator Principles.

The Consultant will provide information on the technical options considered to the environmental / social team and receive from them their evaluations and conclusions.

3.8.2 Environmental and Social Scoping Exercise for this Study

For the purposes of this, preliminary, Study into water augmentation to the CAN and the Cuvelai, the Environmental Team will conduct an Environmental and Social Scoping Exercise into the three most technically favourable options identified for both the CAN and the Cuvelai. This will include an assessment of the key environmental and social issues associated with each option, stakeholder views, avoidance and mitigation measures, costs and benefits. These factors will be analysed, from which a recommendation will be prepared regarding the environmentally and socially most favourable option. The Environmental Team will thereafter prepare the ToR for a more detailed Environmental Impact Assessment (**EIA**) into the selected alternative which is to be investigated in greater detail under a following phase of the Project.

The Environmental / Social Scoping, although initially conducted at a “high level” for the Pre-Feasibility Study, should nonetheless conform to the Equator Principles as far as possible.

A Environmental / Social Scoping is considered important as there may be some water augmentation / back-up alternatives considered for which the environmental impacts are considered unacceptable. An example of this is the abstraction of water from the Karst Area III (Geelong) and Karst Area IV (Abenab) Aquifers which was considered as one of the water augmentation alternatives in the 2004 water augmentation study. The environmental concerns about the draw-down effects of abstraction from this aquifer, the little-understood key ecosystems, the lack of an integrated framework for water use in the area and concerns regarding the potential for contamination of the aquifer from various sources, lead to the exclusion of this alternative on environmental grounds (after CAJVC, 2004[1]).

3.8.3 Functioning of the Environmental Team

With regard to the functioning and responsibilities of the Environmental Team, the following has been agreed upon with the MAWF:

1. The Environmental Team will function independently from the Engineering Team, though there will be liaison and information sharing between the two teams,
2. The Environmental Team will report to and receive instructions from the PSC,
3. The PSC will approve payments to the Environmental Team,
4. The Environmental Team will prepare an Inception Report, similar to this document being prepared by the Engineering Team, for simultaneous submission along with this document for approval to the MAWF. This document will include a methodology statement, programme and cost estimate similar to this document,
5. As with the Engineering Team, the MAWF will decide on the appointment of the Environmental Team following an evaluation of the Environmental Inception Report.

3.8.4 Liaison Between the Engineering and Environmental / Social Consultancy Teams

The Engineering and Environmental / Social Consultancy Teams will liaise and share information on an on-going basis, addressing queries / uncertainties as they arise. However, liaison will be more formal at certain key milestones during the course of the Study as follows:

1. Identification of technical options to address water supply shortfalls,
2. Conducting the 1st Public Participation Meeting,
3. Analysis and combination of the preferred engineering and environmental / social options,
4. Conducting the 2nd Public Participation Meeting.

A representation of the liaison between the Engineering and Environmental / Social Consultancy Teams is shown in **Figure 3.1** below, whilst further details are also provided in **Table 3.1** below and the sections which follow.

Details regarding the Public Participation Meetings are provided in **Section 3.9.1.1** and **Section 3.9.1.2** respectively.

Figure 3.1: Liaison Between the Engineering and Environmental / Social Consultancy Teams

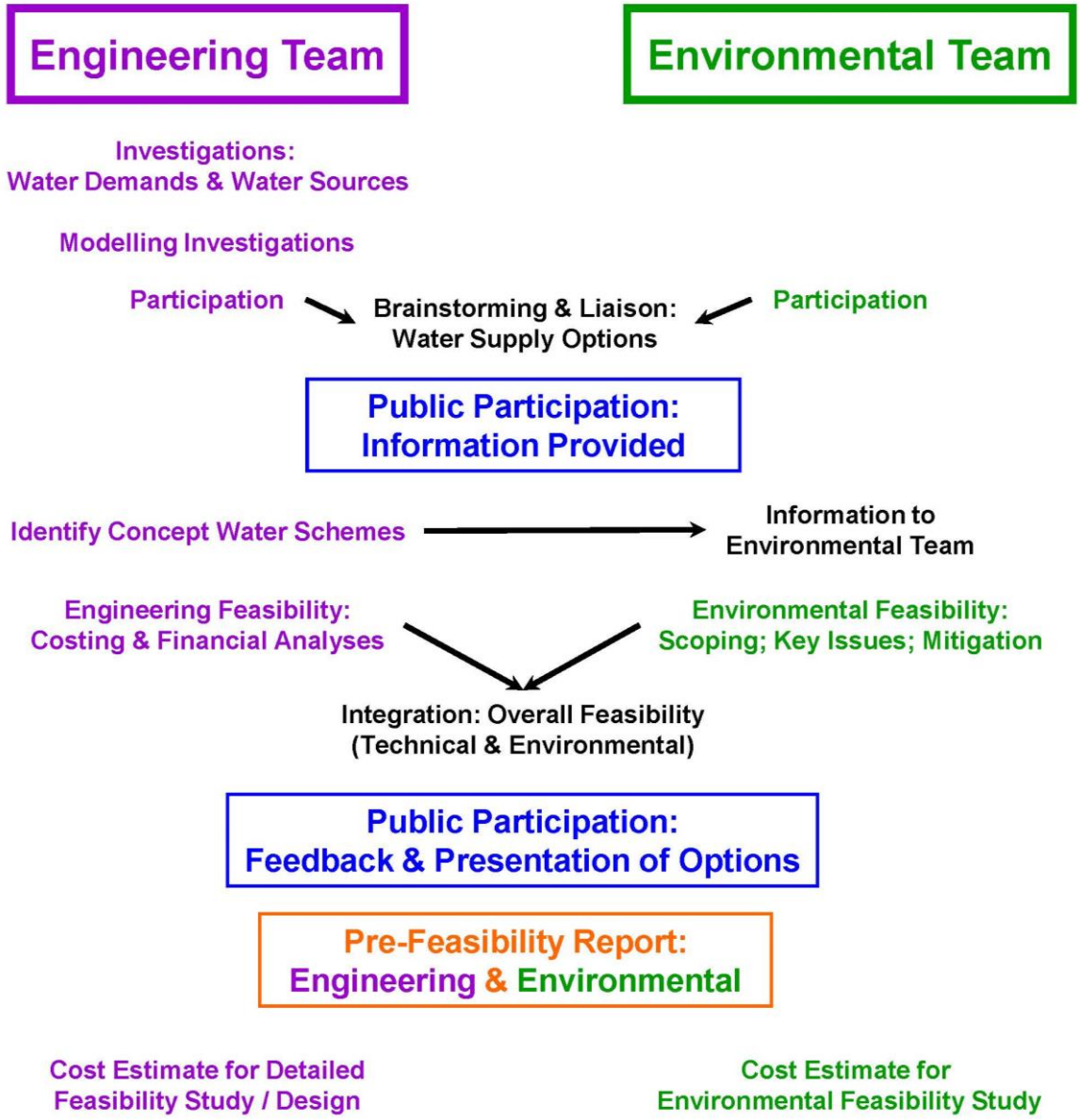


Table 3.1: Liaison Between the Engineering and Environmental / Social Consultancy Teams

Step	Engineering	Environmental / Social
1	Inception Report, agreement with Client, project launch.	Ditto.
2		Press conference / press release, formal notification to OKACOM, establishment of project website.
3	Determine time-based water needs in CAN & Cuvelai and thus shortfalls.	Review findings of Engineering Team.
4	Identify technical options to address shortfalls.	Work with Engineering Team to help ensure all options are on table.
5	Critically analyse technical options, including combinations and hybrids.	Work with Engineering Team to ensure full understanding of issues and to start flagging environmental issues. Hold 1st Public Participation meeting to (a) present rationale for project to IAPs, (b) explain water needs, (c) discuss potential options and (d) list initial potential environmental impacts and issues (including social issues).
6	Based on above, determine preferred technical option(s).	Work with Engineering Team to ensure full understanding of all options (and combinations or hybrids) and their potential implications and issues, and develop a matrix specific to the preferred options.
7	Analyse and synthesise technical and environmental information and develop an integrated preferred option or options. Hold 2nd Public Participation meeting to (a) remind IAPs / stakeholders of the rationale of the project and the approach, (b) the options identified, (c) the preferred options and why, (d) the environmental (including social) issues identified and (e) invite participants to give their input.	
8	Work input from PP meeting into Engineering Report and finalise the Pre-Feasibility Report.	Work input from PP meeting into environmental "Scoping" Report and finalise the Pre-Feasibility Report.
9	Prepare cost estimate for a possible Detailed Feasibility Study / Detailed Design Phase to follow.	Prepare cost estimate for a possible Detailed Feasibility Study Phase to follow.

Note: IAP = Interested and Affected Parties

3.8.4.1 Identification of Water Supply Options

The Engineering Consultancy Team will liaise with the Environmental / Social Consultancy Team when the basic water supply options to meet the identified shortfalls for the CAN and the Cuvelai are drawn up. This will take the form of a round-table joint consultative session between senior members of the two consultancy teams (refer also to **Section 3.4.1**).

The main purpose behind this liaison will be to ensure that the engineering / technical alternatives put forward by the Engineering Consultancy Team are in principle acceptable in terms of environmental and social concerns. This will aim to avoid the situation whereby time and effort is spent in subsequent phases of the Study (preliminary design, costing, financial analyses) examining an alternative which is immediately disqualifiable in terms of the possible environmental and social impacts.

A further benefit of this liaison will be ensuring that both consultancy teams are informed regarding the possible advantages and disadvantages of the various alternatives to be examined separately by the two teams. This is believed to be beneficial to the cohesion of Project with regard to the 1st Public Participation Meeting which will be held following the formulation of the water supply options (refer to **Section 3.9.1.1**).

3.8.4.2 Analysis and Combination of the Preferred Engineering and Environmental / Social Options

Following the identification of the water supply (augmentation and / or back-up) alternatives, and the 1st Public Participation Meeting and the feedback received thereon, the Engineering Consultancy Team will conduct technical and financial analyses of the three options for each of the CAN and the Cuvelai to determine the technically most favourable alternatives. Similarly, the Environmental / Social Consultancy Team will conduct evaluations of the possible environmental and social impacts of the different options, including mitigation measures, and determine the most favourable alternatives.

The engineering (technical and financial) and environmental / social evaluations will need to be combined in order to derive the overall most favourable alternatives. It is proposed that these two separate evaluations be discussed and combined during a round-table joint consultative session between senior members of the two consultancy teams.

A further benefit of this liaison will be ensuring that both consultancy teams are informed regarding the considerations behind the separate evaluations of the water supply alternatives and the factors weighed and the considerations behind the combination of these separate evaluations and the formulation of the overall most favourable water supply alternatives. This is believed to be beneficial to the cohesion of Project with regard to the 2nd Public Participation Meeting which will be held following the formulation of the water supply options (refer to **Section 3.9.1.2**).

3.9 PUBLIC PARTICIPATION AND STAKEHOLDER CONSULTATION

3.9.1 Public Participation

Public participation and an awareness campaign will also form an important component of the Study. In accordance with the Environmental Management Act, 2007, the public participation and the involvement of Interested and Affected Parties (**IAP**s) will be driven by the Environmental / Social Consultancy Team. Full details of the processes to be followed are contained in their Inception Report.

The Engineering Consultancy Team will however be involved with both the 1st and 2nd rounds of Public Participation Meetings in order to provide information on the engineering evaluations conducted and answer any questions in this sphere of the Project. Both sets of meetings will be conducted in Windhoek (to address the CAN component of the Study), Oshakati (to address the Cuvelai component of the Study) and Rundu (to address the Okavango Link component of the Study).

It is suggested that public participation workshops be attended by PSC representatives and agreed key members of the Consultant's team. It suggested that these workshops be restricted to mornings, being of 4 to 5 hours' duration. It is further recommended that the public participation workshops be opened by an official from the MAWF (either from Windhoek or the Regional Office) who is the initiating party behind the Project.

The Consultant has assumed that for the Pre-Feasibility Study, only Namibian IAPs need to be engaged and therefore that meetings in Maun or elsewhere to engage Angola and Botswana will not be required. The Consultant has assumed that OKACOM will be kept informed of the Project via the official channels through the MAWF (refer to **Section 3.9.4**).

3.9.1.1 1st Round of Public Participation Meetings

The 1st round of Public Participation Meetings will be held following the formulation of the water supply options and concept schemes, which will be done as a joint exercise between the Engineering and Environmental / Social Consultancy Teams.

The purpose of this 1st round of Public Participation Meetings will be to:

- Present the rationale for project to IAPs,
- Explain the water needs,
- Discuss the potential water supply / augmentation / back—up options, and
- List the initial potential environmental impacts and issues (including social issues).

3.9.1.2 2nd Round of Public Participation Meetings

The 2nd round of Public Participation Meetings will be held following the combination of the technical and financial analyses performed by the Engineering Consultancy Team and the evaluations of the possible environmental and social impacts of the different options, including mitigation measures, performed by the Environmental / Social Consultancy Team and the formulation of the overall most favourable alternatives. These meetings will also be conducted as a joint exercise between the Engineering and Environmental / Social Consultancy Teams.

The purpose of the 2nd round of Public Participation Meetings will be to remind IAPs / stakeholders of:

- The rationale of the Project and the approach followed,
- The options identified,
- The preferred options and why,
- The environmental (including social) issues identified and
- To invite participants to give their input.

3.9.2 Stakeholder Consultation

It is important to involve as many stakeholders as possible in order to achieve a holistic planning approach and to avoid any shortcomings and gaps in the planning and investigations. The Basin Management Committees should also be invited to participate as stakeholders. A preliminary list of stakeholders is as follows

- OKACOM,
- NamPower,
- NORED,
- CENORED and possibly ERONGORED,
- Namibian Chamber of Commerce and Industry,
- Regional Councils (Omusati, Oshana, Ohangwena, Oshikoto, Kavango, Otjozondjupa, Omaheke, Khomas, Erongo),
- City of Windhoek,
- The relevant town councils (Rundu, Grootfontein, Otjiwarongo, Okakarara, Okahandja, Karibib, Omaruru, as well as the larger centres of Oshakati, Ondangwa and Ongwediva in the Cuvelai),
- Ministry of Regional, Local Government, Housing and Rural Development,
- Ministry of Environment and Tourism,
- Ministry of Mines and Energy,
- Department of Agriculture,
- Large consumers,
- Basin Management Committees (the Cuvelai, Okavango and Omaruru Committees).

These stakeholders and any other parties which register as IAPs will be specifically invited to the two public participation meetings.

3.9.3 Information to Cabinet

Since this Project is of long-term strategic national importance, it will be very important to keep politicians and other decision makers informed throughout the duration of the Project. At Project Meeting No. 3 of 02 November 2012, it was decided that the PSC (consisting of delegates from the MAWF, NamWater and the CoW) will be responsible for informing the Minister of the MAWF, key decision makers and the Namibian Cabinet. The Consultant shall assist the PSC when required by providing the necessary information and data.

The Environmental / Social Consultancy Team shall, as an important component of the Study, also oversee, with the involvement of the PSC, the public participation and stakeholder consultations.

3.9.4 Information Sharing with the Permanent Okavango River Basin Water Commission

The Consultant assumes that OKACOM will be kept informed and up to date with the progress and various components of this Pre-Feasibility Study via the official channels through the MAWF. The Consultant shall assist the PSC (MAWF representatives) when required by providing the necessary information and data for forwarding to OKACOM.