DWA REPORT NUMBER: P RSA D000/00/18312/1

water affairs
Department:
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DEVELOPMENT OF RECONCILIATION STRATEGIES FOR LARGE BULK WATER SUPPLY SYSTEMS: ORANGE RIVER

INCEPTION REPORT

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DEVELOPMENT OF RECONCILLIATION STRATEGIES FOR LARGE BULK WATER SUPPLY SYSTEMS: ORANGE RIVER*: *INCEPTION REPORT

Prepared by:

WRP Consulting Engineers Aurecon, Golder Associates Africa, and Zitholele Consulting.

Report No. P RSA D000/00/18312/1

Title:	***Inception Report***
Authors:	*Study Team*
Project Name:	***Development of Reconciliation Strategies for Large Bulk Water Supply Systems: Orange River***
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Consultants: WRP Consulting Engineers (Pty) Ltd in association with Aurecon, Golder Associates Africa and Zitholele Consulting

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Development of Reconciliation Strategies for Large Bulk Water Supply Systems: Orange River

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Acronyms

ACRU	Agro hydrological Modelling System
BID	Background Information Documents
BMP	Best Management Practices
CBO	Community Based Organisation
DA	Drainage Area
DM	District Municipality
DPLG	Department of Provincial and Local Government
DWA	Department of Water Affairs
EFR	Environmental Flow Requirement
EMA	Ecological Management Area
EWR	Environmental Water Requirements
GIS	Geographical Information System
GRIP	Groundwater Resource Information Project
IAPs	Interested and Affected Parties
IFR	Instream Flow Requirements
ISP	Internal Strategic Perspective
IWA	International Water Association
IWRM	Integrated Water Resource Management
LHDA	Lesotho Highlands Development Authority
LHWP	Lesotho Highlands Water Project

LLRS	Development of Water of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System
LORMS	Lower Orange River Management Study
NGDB	National Groundwater Database
NGO	Non-Governmental Organisation
RWQO	River Water Quality Objectives
ORASECOM	Orange Senqu River Commission
ORRS	Orange River Replanning Study
SAGDT	South African Groundwater Tool
SMC	Study Management Committee
SSC	Study Steering Committee
STW	Sewer Treatment Works
TDS	Total Dissolved Solids
URV	Unit Reference Value
VAPS	Vaal Augmentation Planning Study
WC	Water Conservation
WC/WDM	Water Conservation and Water Demand Management
WDM	Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WRP	WRP Consulting Engineers (Pty) Ltd.
WRSS	Water reconciliation Strategy Study
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WSA	Water Service Authority
WSAs	Water Service Authorities
WSP	Water Service Providers
WWTW	Waste Water Treatment Works

Development of Reconciliation Strategies for Large Bulk Water Supply Systems: Orange River

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water Affairs (DWA) has identified the need for detailed water resource management strategies as part of their Internal Strategic Perspective (ISP) planning initiative, which recommended studies to identify and formulate intervention measures that will ensure enough water can be made available to supply the water requirements for the next three to four decades.

The DWA Directorate: National Water Resource Planning (NWRP) therefore commenced the strategy development process in 2004 by initially focusing on the water resources supporting the large metropolitan clusters, followed by the systems supplying the smaller urban areas to systematically cover all the municipalities in the country.

As part of this process the need for the Reconciliation Strategy Study for the Large Bulk Water Supply Systems in the Orange River was also defined. Given the location of the Orange River System and its interdependencies with other WMAs as well as other countries (see study area description in **Section 1.3**), various water resource planning and management initiatives compiled during the past few years as well as those currently in progress will form an integral part of the strategy development process.

Major water resource infrastructure in the study area are the Gariep and Vanderkloof dams with associated conveyance conduits supporting large irrigation farming in the provinces of the Free State, Northern Cape and the Eastern Cape - through the Orange-Fish Tunnel. This system is currently almost in balance.

The Caledon-Modder System supplies water to the Mangaung-Bloemfontein urban cluster (largest urban centre in the study area). The 2 200 km long Orange-Senqu River is the lifeline for various industries, mines, towns and communities located along the way until the river discharges into the Atlantic Ocean in the far west at Alexander Bay.

Since 1994, a significant driver of change in the water balance of the Orange River System was brought about by the storing of water in Katse Dam as the first component of the multi-phase Lesotho Highlands Water Project (LHWP). Currently Phase 1 of the LHWP (consisting of Katse, and Mohale dams, Matsoku Weir and associated conveyance tunnels) transfers 780 million cubic

metres per annum via the Liebenbergsvlei River into the Vaal Dam to augment the continuously growing water needs of the Gauteng Province. Phase 2 of the LWHP comprising of Polihali Dam and connecting tunnel to Katse Dam is already in its planning stages and is expected to be in place by 2022. Flows that are currently still entering into Gariep and Vanderkloof dams wil then be captured by Polohali Dam, thus reducing the inflow to Gariep and Vanderkloof dams. This will result in a reduction in yield of the Orange River Project (Gariep and Vanderkloof dams) to such an extent that shortages will be experienced in the ORP system. Some sort of yield replacement is then required in the Orange River to correct the yield versus demand imbalance in the ORP system.

The above description illustrates the complex assortment of interdependent water resources and water uses which spans across various international and institutional boundaries that will be considered in the development of the Orange River Reconciliation Strategy.

1.2 OBJECTIVES OF THE STUDY

The objective of the study is to develop a reconciliation strategy for the bulk water resources of the Orange River System, to ensure that sufficient water can be made available to supply the current and future water needs of all the users up to the year 2040. This Strategy must be flexible to accommodate future changes in the actual water requirements and transfers, with the result that the Strategy will evolve over time as part of an on-going planning process.

Appropriate integration with other planning and management processes, as well as cooperation among stakeholders, will be key success factors in formulating coherent recommendations and action plans.

The outcomes of the Strategy will be specific interventions with particular actions needed to balance the water needs with the availability through the implementation of regulations, demand management measures, as well as infrastructure development options.

1.3 STUDY AREA

As depicted in **Figure A-1** of **Appendix A** (Map of study area), the study will focus on the water resources of the Upper and Lower Orange River Water Management Areas (WMAs), while also considering all the tributary rivers and transfers affecting the water balance of the system. This core area forms part of the Orange-Senqu River Basin, which straddles four International Basin

States with the Senqu River originating in the highlands of Lesotho, Botswana in the north eastern part of the Basin, the Fish River in Namibia and the largest area situated in South Africa.

The focus area of the study comprises only the South African portion of the Orange River Basin, excluding the Vaal River Catchment. The Vaal River is an important tributary of the Orange River, but since the Vaal River Reconciliation Strategy has already been developed, the Vaal River Catchment will not form part of the study area. However, strategies developed for the Vaal River System that will have an impact on the Orange River, will be taken into account as well as the impacts of flows from the Vaal into the Orange for selected Integrated Vaal system scenarios.

The Orange River is an international resource, shared by four countries i.e. Lesotho, South Africa, Botswana and Namibia. Any developments, strategies or decisions taken by any one of the countries that will impact on the water availability or quality in South Africa must be taken into account and will form part of this study. The opposite is also applicable. If this strategy plans anything in South Africa that will impact on any of the other countries, this impact must be considered as part of this study in terms of South Africa's international obligations.

The Orange River, the largest river in South Africa, has its origin in the high lying areas of Lesotho. The river drains a total catchment area of about 1 million km², runs generally in a westerly direction and finally discharges into the Atlantic Ocean at Alexander Bay.

The Caledon River, forming the north-western boundary of Lesotho with the Republic of South Africa (RSA), is the first major tributary of the Orange River. The Caledon and the Orange (called the Senqu River in Lesotho) rivers have their confluence in the upper reaches of the Gariep Dam.

Other major tributaries into the Orange River are:

- The Kraai River draining from the North Eastern Cape;
- The Vaal River joining the Orange River at Douglas;
- The Ongers and Sak Rivers draining from the northern parts of the Karoo;
- The Molopo and Nossob Rivers in Namibia, Botswana and the Northern Cape Province have not contributed to the Orange River in recorded history as the stream bed is impeded by sand dunes; and
- The Fish River draining the southern part of Namibia.

A separate study was also done for the Greater Bloemfontein Area i.e. Water Reconciliation Strategy Study for Large Bulk Water Supply Systems: Greater Bloemfontein Area with it's follow up continuation study currently in process. The recommendations of this strategy and its continuation study will also be taken into account in this study.

Although the Senqu River Catchment in Lesotho does not form part of the focus study area, the development in this catchment impacts directly on the water availability in the study area.

The South African portion of the Orange River Basin is currently divided in two Water Management Areas, i.e. the Upper and Lower Orange WMAs. The Upper WMA stretches from the headwaters of the Caledon River and Lesotho boundary down to the confluence of the Vaal River and the Lower Orange WMA from this point to the sea. (See **Figure A-1 in Appendix A**). It should be noted that the DWA recently proposed that the two WMAs are managed as a unit.

1.4 STUDY TEAMS

The study team consists of four consulting firms namely; **Aurecon South Africa (Pty) Ltd, Zitholele Consulting Engineers (Pty) Ltd, Golder Associates (Ltd) and WRP Consulting Engineers (Pty) Ltd** as the lead Consultant. Each of the firms is contributing various individuals that make up the diverse skills required to successfully undertake the tasks described in the subsequent sections.

2 STUDY PROCEDURE

The study activities have been divided into various tasks as set out in **Table 2.1** and schematically presented in the Logical Flow Diagram as shown in **Figure 2.1**.

The study will be undertaken over a period of 36 months according to the schedule (time line) and duration of the tasks presented in the Gantt chart provided in **Appendix B**.

Table 2.1: Consolidation of tasks

Task No.	Description
1	Compile Inception Report
	• Final description of tasks • Update task & activity flow diagram • Finalise responsibilities and compile study reporting structure • Prepare modular budget for all tasks and disbursements • Detailed schedule of personnel hours and costs • Detail schedule of events, milestones and deliverables • Listing of constraints and risks that may influence the execution of the study plan • Evaluation and agreement of information sources to apply in the study • Define, describe and agree with the client the methods of how information and data generated from the study will be stored and disseminated
2	Compile a Summary Report of Previous and Current Studies

Task No.	Description
	• Obtain and list available studies and reports • Undertake synthesis of all available information • Add perspectives on previously identified intervention options for consideration and assessment in this study • List relevant recommendations and current resource management processes • Collate information on water quality issues • Develop a stakeholder database for this study
3	Preliminary Screening Workshop
4	International Obligations
5	Current and Future Water requirements
6	Urban Water Conservation and Water Demand management (WC/WDM)
7	Opportunities for Water Re-use
8	Irrigation Demands and WC/WDM
9	Value of Irrigation Water
10	Surface Water Hydrology and System Analysis
11	Water Quality
12	Reserve Requirement Scenarios and Scheme Yields
13	Groundwater
14	Review Schemes and Update Cost Estimates
15	Review and Assess Socio and Environmental Impacts
16	Assembly of Information and Formulation of Scenarios (Preliminary)
19	International Support
16	Assembly of Information and Formulation of Scenarios (Final)
17	Final Screening Workshop
	Final Strategy from Tasks 16 & 17
18	Public Participation
20	Study Management
20	Study Termination

Details of the staff requirements for each task are given in **Table C-1** of **Appendix C**.

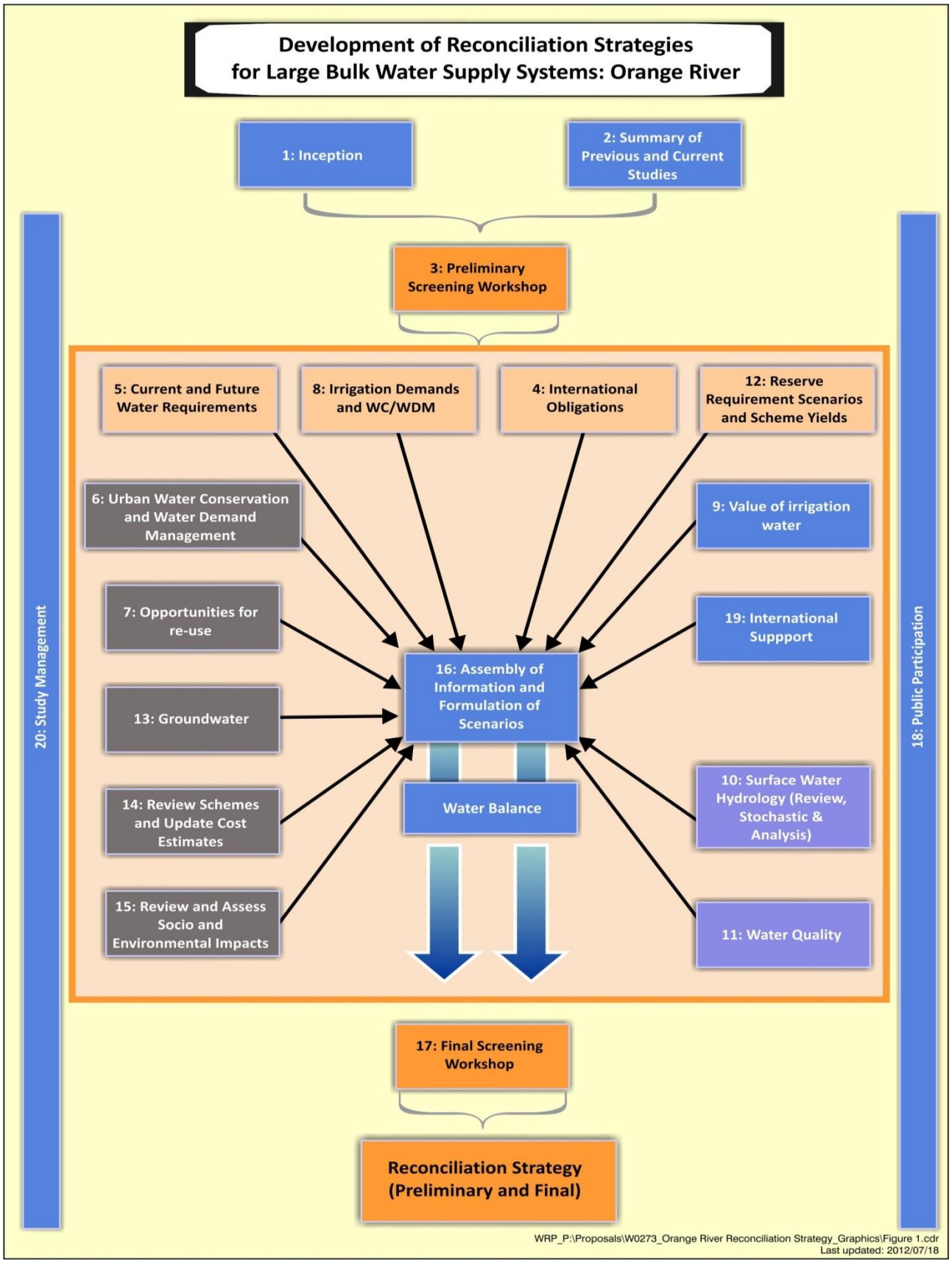


Figure 2.1: Logical Flow Diagram

2.1 TASK 1: INCEPTION REPORT

This task is carried out as the first study activity following the inaugural meetings where the study approach was presented and comments were provided by DWA representatives as part of the Study Management Committee.

The project inception phase involves compiling the Study Plan for the execution of the study which is documented in the Inception Report (this report). Information from other tasks and processes formed the basis of finalising the methodology, budget and schedule (Gantt chart) of tasks in a modular manner with clear milestones for events and deliverables. This was carried out in consultation with the Client and through liaison with key stakeholders to ensure the Study Plan will achieve the objectives and expectations for the study. This Inception Report forms the baseline for monitoring and evaluation of progress during the Study Implementation Phase.

The Inception Report will be presented to the Director: NWRP for his comments and inputs before the document is finalised.

Appropriate administrative arrangements were established such as the formatting of meeting addenda and minutes, progress reports, records of decisions and progress tracking and monitoring.

The inception report includes the following components:

- Final description of the twenty (20) tasks.
- Updated task and activity logical flow diagram - indicating the dependencies of the tasks.
- Finalising the responsibilities and compile a study reporting structure that clearly defines the communication channels and procedures.
- Modular budget for all tasks and disbursements.
- Detailed schedule of personnel hours and costs.
- Detail schedule of events, milestones and deliverables - detail work breakdown structure.
- Listing of the constraints and risks that may have an influence of the execution of the Study Plan.
- Evaluation and agreement of information sources to apply in the study especially where the data differs significantly.
- Define, describe and agree with the Client the methods of how information and data generated from the study will be stored and disseminated.

Deliverable for Task 1:

- ***Report (1):*** *Inception report (see above text for description of content).*
- ***Presentation material*** *(Power Point slides) of the Inception Report.*

2.2 TASK 2: SUMMARY OF CURRENT AND PREVIOUS STUDIES

A significant portion of this task will take the form of a literature review. Reports and information from the following studies will be gathered, reviewed and concisely summarised into a Summary Report. Organizations currently engaged on studies in the study area will be identified and the respective managers will be contacted to also include the most up to date information from these studies into the Summary Report. This report will form a point of departure for this study and will also be used as basis to prepare for the first Screening Workshop (Task 3) as well as to assist in the refinement of the scope in the inception report. The following are some of the studies that will be looked into (not all inclusive):

- Orange River Re-planning Study (ORRS);
- Lower Orange River Management Study (LORMS);
- Vaal River Reconciliation Strategy Study;
- Bloemfontein Reconciliation Strategy Study;
- Integrated Water Quality Plan for the Vaal River System;
- WQT Modelling and Water Resources Planning Model (WRPM) Salinity set-up for the Orange River;
- All Town Reconciliation Strategies Study (Central Region);
- Orange River System: Annual Operating Analysis;
- Lesotho Highlands Water Project 2 Feasibility Study;
- Lower Orange Environmental Baseline Monitoring;
- Lower Orange River Joint Feasibility Study (RSA- Namibia) for Vioolsdrift Dam;
- Lower Orange Pilot Study for WC/WDM;
- Taung Dam Utilisation Feasibility Study;
- Lower Orange River Real-Time Modelling;
- Regional Bulk Infrastructure Studies;
- Khalagadi Water Resource Strategy (the Vaal Gamagara pipeline;
- Support to Phase 2 of the ORASECOM Basin-wide Integrated Water Resources Management Plan;
- Trans boundary Action Plan by ORASECOM;

- Orange-Senqu strategic Action Programme: Environmental flows Project by ORASECOM UNDP-GEF;
- Upper Orange Validation Verification Study;
- Algoa Annual Operating Analysis; and
- Water Reconciliation Strategy Study for the Algoa Water Supply.

Brief descriptions of pertinent information necessary for the development of Reconciliation Strategy are provided in the following sections.

2.2.1 Demography: current population and future population growth scenarios

All existing documents and reports will be utilised wherever possible and no work will be duplicated in terms of the demographics or economics. The data required however must be up to date. The Central All Towns Study data and Bloemfontein Reconciliation study will be utilised as the base and compared to the latest data releases by Stats SA.

2.2.2 Current and future requirements

Information on the current and future water requirements will be sourced from past studies, such as the Orange Annual Operating Analysis, Support to Phase ll of the ORASECOM Basin-wide Integrated Water Resources Management Plan, All Town Reconciliation Study (Central Region), Bloemfontein Reconciliation Strategy Study, Lesotho Highlands Water Project 2 Feasibility Study, Lesotho Water Sector Improvement Project, etc. for the following water use sectors:

- Urban/domestic: There are a large number of towns located in the study area, some supplied from surface water resources, some only from groundwater resources and other from a combination of these two sources. The main towns and water supply schemes include Bloemfontein, Botshabelo, Thaba N'chu, Maseru, Aliwal North, Hopetown, Colesberg, Upington, Prieska, Pelladrift water scheme (Pofadder & Aggeneys), Springbok regional scheme (Springbok & Kleinsee), Alexander bay and Port Nolloth supply scheme. Information from the All Town Reconciliation Strategies and Bloemfontein Reconciliation Strategy study will already supply a vast amount of information which will be summarized for the purpose of this assignment. The Water Reconciliation Strategy Study for the Algoa Water Supply and the Algoa system Annual Operating analysis will contain valuable information regarding the volumes that need to be transferred to the Eastern Cape via the Orange-Fish tunnel.
- Irrigation: The Validation and Verification process regarding water use in the Upper Orange has commenced and information available from this study will be utilised as far as possible. No

validation and verification study were carried out for irrigation in the Lower Orange. DWA regional offices do however have readily available and reasonably confidence information on the irrigation quotas and related irrigation areas along the main stream of the Orange as well as for defined irrigation schemes on the larger tributaries. As part of the ORASECOM study detailed work was carried out, to locate irrigation areas using satellite imagery. This information will be summarised. Irrigation demands supplied from the Orange system but located in the Eastern Cape are addressed in a current pilot study for the development of a WC/WDM strategy for WMA 15.

- Industries: Industrial areas are mainly limited to the larger towns except for mining activities along the Lower Orange. Information from the existing reports will be collated and summarised. Information on the water demand projections from the different studies for different water requirement scenarios and water use sectors will be referred to in the summary report for this task. These will be reviewed and assessed to identify gaps and reliability issues with the existing data that need to be addressed in this study as part of **Task 5**.

2.2.3 The Reserve (including international obligations)

As part of the ORASECOM study an Intermediate Ecological Reserve was determined for eight sites in the Orange River catchment. This is the most recent estimation of environmental requirements in the Orange River catchment but excludes the river mouth and the Fish River in Namibia. This will be evaluated and compared against the environmental requirements as determined in the LORMS study where estimations were made for both the river and the river mouth requirements (To be done as part of **Task 12**).

The Comprehensive Reserve Determination Study for the Vaal River WMAs was completed and the relevant information from this study will be used. The Classification of Water Resources Study for the Vaal is currently in process. The relevant information as available will be summarized and utilized for this study. The Reserve as determined by LHDA for the Lesotho Highland project is already included in the system models and will therefore be used.

A Research proposal on the environmental flow requirements of the Fish River and Orange-Senqu mouth in Namibia and South Africa was commissioned by the UNOPS thorough ORASECOM. It is anticipated that results from the environmental study will only be available towards the end of the May 2013 and might be a bit late to include the Preliminary Reconciliation Strategy but will be included when formulating the Final Reconciliation Strategy.

Treaties and Studies addressing international obligations will be obtained and summarized in the summary report. Studies undertaken by ORASECOM as well as studies on the further phases of the LHWP will also add valuable information on international obligations.

2.2.4 Existing water sources and resource capabilities

The existing water resources are well documented in study reports and resource capability information from past studies will be collated, compared and summarised in this task. Water resource system simulations models for resource capability assessments will be reviewed and data collated for application in other tasks. Information on various - intervention options that were investigated in previous studies, which include Bosberg or Boskraai Dam, in the Upper Orange and Vioolsdrift Dam in the Lower Orange will be sourced and summarised. Several possible dams were also identified as part of the Lesotho Lowlands study of which Metolong Dam close to Maseru is already under construction. Information on these and other potential dam sites that have been investigated in previous studies will be reviewed and summarized as options to formulate the reconciliation options and scenarios.

Existing information, local knowledge, the DWA database (quantity and quality) and work done in previous studies to identify groundwater aquifers that can contribute significantly to the reconciliation strategy will be obtained and summarized.

2.2.5 Water Balance situations and reliability of supply

A review of the previous water balance scenarios (including those from the Bloemfontein Reconciliation Study), i.e. comparison of the existing water availability and the water requirements of the different water users (water balance) for all the main water supply areas in the study area will be conducted. The yield determination methods applied in the water balance and the related yield assurance will be documented where information is available. Cognizance will be taken of the Vaal Reconciliation Strategy and the augmentation needs from the Orange Basin will be documented from existing water balance information. The water user priority classifications from previous studies will be summarized and evaluated, as these will provide information on the required reliability of supply.

2.2.6 Plans to rectify deficits

The reconciliation options that have been documented in reports such as the Orange River Replanning Study (ORRS) and the Lower Orange River Management Study (LORMS) will be studied and included in the Summary Report. These reconciliation options will include both management and development options. The groundwater development options that have been documented will also be included in the Summary Report. All possible options will be listed together with the applicable reasons why certain augmentation options recommended for possible future development purposes.

An important resent study is the Bloemfontein Reconciliation Strategy Study and the recommended reconciliation interventions which are documented in the mentioned report, will be incorporated in the Summary Report.

2.2.7 Water Conservation/Water demand management measures

A comprehensive WC/WDM strategy has been developed as part of the Water Reconciliation Strategy Study for the large bulk water supply systems: Greater Bloemfontein Area, whereas smaller studies have been undertaken as part of the All Towns Study and other projects. DWA : Directorate Water Use Efficiency have also been undertaking non-revenue water assessments in both the Free State and Northern Cape to assess the current water loss situation, identify 2014 targets, budget requirements and progress made. The project team will work closely with DWA Regional Offices who has already been tasked with gathering the information as part of the development of a provincial WCWDM plan. This information will be summarized in the report and utilized as input to **Task 6.**

A significant amount of work was carried out on water demand management in the irrigation sector as part of the ORASECOM study (Phase 2 of ORASECOM IWRMP). This will be summarized and utilized as far as possible.

The Algoa reconciliation strategy envisaged significant savings in the NMBM of which some were already achieved. These findings will be included for the purpose of this study.

2.2.8 Institutional capacity

Institutional water-related problems such as consumer ignorance, inadequate budget allocations, the availability of human resources, skills and management capability etc. will be investigated and identified.

Although the focus of this study will fall on institutions within the basin and within South Africa, it is important that cognizance is also taken of existing international water-related institutions such as ORASECOM and institutions in other countries. A sound knowledge of international treaties associated with the Orange River Basin is also necessary. If any reconciliation option is considered, and it will impact on or requires the cooperation of an institution in another country, the capacity of that institution on the other side of the border also becomes important.

Within the two water management areas (and therefore within the boundaries of South Africa) the capacity of the water related institutions will be investigated and documented in the summary report.

Institutional water-related problems such as consumer ignorance, inadequate budget allocations, and the availability of human resources, skills and management capability will be aspects that will be identified and summarized for further evaluation.

2.2.9 Infrastructure constraints

The implementation of the Reserve is an example where the Reserve may require water releases from dams or weirs from time to time. The outlet works of these dams and weirs must however be able to handle such releases, which may either be low flow requirements or high flow. It will be investigated whether there is knowledge about any constraints regarding the outlet capacity of existing infrastructure and documented in the Summary Report.

Another example is where operating rules are developed as an intervention reconciliation measure to reduce water losses. Such operating rules might require a certain outlet capacity on existing infrastructure and existing knowledge about constraints regarding the outlet capacity will be essential for the development of such operating rules.

Other constraints on infrastructure that need to be identified could be capacity constraints in the water supply and reticulation systems.

A further constraint could have arisen as a result of negligence or lack of maintenance where the infrastructure cannot meet its purpose for which it was designed. Examples of such constraints are inoperative outlet gates, leaking canals or pipelines, etc.

Any information in existing reports or from verbal interactions with the local people within the catchment on such constraints will be documented in the Summary Report.

2.2.10 Water Quality and treatment

Reports on water quality status and re-use will be reviewed and pertinent issues that may influence the Reconciliation Strategy will be documented in the Summary Report. Available RWQO data will be collated and water quality guidelines set in the study area will be summarized in the task report.

Deliverables for Task 2

Task 2 will result in the following deliverable: Report (2)

- *Summary Report of Previous and Current Studies, including summary tables of all identified potential schemes and interventions.*
- *Comparison between DWA studies and studies done by other clients, i.e. ORASECOM (to be included in summary report)*

2.3 TASK 3: PRELIMINARY SCREENING WORKSHOP

The objectives of the Preliminary Screening Workshop are to agree with key stakeholders in the study area on what the main issues and concerns are, to identify possible options to solve the concerns and to eliminate those options which should not be given further consideration under this study. Concerns in this context are related to current and predicted future water deficits or water quality problems.

The following steps will be followed each forming a sub-task of Task 3:

- Identify the key stakeholders that need to attend the workshop;
- Identify the main concerns of the key stakeholders;
- Arrange the workshop and distribute to the key stakeholders a workshop starter document;
- Multi-criteria decision analysis; and
- Document workshop proceedings.

Each of these sub-tasks is described below:

2.3.1 Identify Key Stakeholders that need to attend the Workshop

The same stakeholder list that will be developed under **Task 18** for assembling the Study Steering Committee will be used as point of departure. This list will be scrutinised and it will be ascertained that all institutions and interest groups are represented. It is of utmost importance that the attendees of the workshop are people at the correct level in their organisation hierarchy and that they have an aptitude for the technical discussions that will be conducted at the workshop. Whenever the list therefore contains more than one person per organisation, the one who meets the above criteria the best will be included in the invitation list. Any institutions or interest groups

that do not appear on the SSC list will be contacted and requested to nominate the correct person to attend the workshop.

This work will be done in close collaboration with the Task leader of **Task 18**.

The output of this sub-task will be a representative stakeholder list for the workshop.

2.3.2 Identify the Main Concerns of the Key Stakeholders

The main concerns of the key stakeholders will be identified from knowledge gained during the execution of **Task 2** (Summary Report of all relevant previous and current studies) and through interaction with some of the key stakeholders. Concerns will also be raised during the first Study Steering Committee Meeting which will take place before the Preliminary Screening Workshop. These issues and concerns will be carefully minuted. The options for reconciliation will be identified in collaboration with the other Task Leaders and the key information on each will be documented in a Workshop Starter Document.

This document will provide background information on the study area, such as a map of the area, a description of the water resources, the current development and water uses as well as a summary of the identified concerns and possible solutions to address these concerns.

The output of this sub-task will be the Starter Document for the Preliminary Screening Workshop.

2.3.3 Arrange the Workshop and distribute the Workshop Starter Document to the Key Stakeholders

The arrangements for the Screening Workshop will be executed under **Task 18** (See **Section 2.18.4**). An appropriate venue for the workshop, which will be held in Kimberley, will be chosen in consultation with the client. Tea and lunch will be provided from the study budget, but it will be expected from each stakeholder to pay for his/her own travelling accommodation (if required) and per diems.

The Workshop Starter Document will be prepared and will be sent to the key stakeholders one week before the workshop.

A facilitator will be appointed. It is anticipated that the duration of the workshop will be at least a half day. Catering and equipment will be arranged.

2.3.4 Multi-Criteria Decision Analysis

All identified options will be subjected to an initial screening. It will be assessed whether any one of the options contains a fatal flow. Such a flaw could be, for example, unacceptable environmental consequences, major political implications and public health and safety issues.

A multi-criteria decision matrix will then be used to distinguish between the remaining options that have to be screened out and those that need further investigation. First order estimates of the additional yield / water savings, capital and operational costs and conceptual unit reference values (URVs) will be used in the matrix as well as other criteria such as biophysical and social impacts, implementing time and management intensity. The matrix will be used live during the workshop so that the full audience can participate in the process.

An example of such a matrix with two hypothetical options is shown in **Table 2.2**

The values in **Table 2.2** are hypothetical to illustrate how the analysis matrix will look like. More criteria rows can be added if required. Columns can also be added to make provision for all the identified options that are needed. A colour code for the 3 ratings will be used so that the preferred options can be easily identified.

Table 2.2: Example of Multi-Criteria Decision Matrix with hypothetical Values

Criterion	Rating Thresholds	Options 1 ---- n	
		Option 1 – WC/WDM for urban water supply to Bloemfontein	Option 2 – Groundwater well field development for Bloemfontein
		Rating 1 – 3	Rating 1 - 3
Fatal Flaw	**Y/N**	**N**	**N**
Additional yield/water saving million m^3/a	0 - 20 = 1 20 – 100 = 2 >100 = 3	1	2
Capital Cost ®	<R100m = 3 R100m – R100b = 2 >R100b = 1	3	3
Operational Cost (R/a)	<R50 m/a = 3 R50 m/a – R100 m/a = 2 >R100 m/a = 1	2	3
URV R/m^3	<$R1/m^3$ = 3 $R1/m^3$ – $R5/m^3$ = 2 >$R5/m^3$ = 1	3	3
Environmental Consequences	None = 3 Moderate = 2 Severe = 1	3	2
Social Impacts	None = 3 Moderate = 2 Severe = 1	2	3
Institutional Capacity	No support required = 3 Some support required = 2 Significant support Required = 1	2	3
Water Quality Impacts	None = 3 Medium = 2 Severe = 1	3	3
Total Scores		**19**	**22**

2.3.5 Document Workshop Proceedings

The proceedings of the workshop will be accurately recorded together with comments and questions raised, and possible management and infrastructure options to be taken forward will be listed. The reasons for discarding any options will be recorded. The document will outline the focus for the remainder of the study.

Deliverable of this Sub-Task will be the minutes of the workshop and a brief report on the focus for the remainder of the study.

2.3.6 Timeframe

The timeframe for **Task 3** is included in the study schedule in **Appendix B.** The task is scheduled to start in August 2012 and will be completed soon after the Preliminary Screening Workshop with the workshop minutes as output.

2.3.7 Task Deliverables

- Invitee list;
- Starter document for workshop; and
- Workshop proceedings.

2.4 TASK 4: INTERNATIONAL OBLIGATIONS

The Consultant will meet with DWA representatives to SADC, ORASECOM and LHWC and access the latest Treaties and Protocols pertaining to international obligations and rights pertaining to the Water Course States of the Orange River. Inputs will also be obtained from international institutions such as ORASECOM and JPTC.

In this regard a watercourse state is a state “in whose territory part of the watercourse is situated.” In terms hereof Lesotho, South Africa, Namibia and Botswana are all watercourse states with respect to the Orange River, and consequently the schedule of international obligations will refer primarily to the obligation on these states to make water available to other states (eg release water downstream) or to use Orange River water.

The Consultants will review these Treaties and Studies and will compile a short report of each treaty and protocol and will also compile a referenced schedule of international obligations and international rights (water allocations). It will also be highlighted to what extent water quality is included in the current agreements and protocols.

This information will be supplemented by an analysis of the various studies undertaken by ORASECOM and studies on the further phases of the LHWP (see **Task 19** on International Support below).

It is likely that the following Treaties, and the studies done in terms of these Treaties, and the studies done by the institutions established by these Treaties, will be relevant to developing a schedule of international obligations and rights:-

- United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses, 1997;

- SADC Revised Protocol on Shared Watercourses 2000; Note that the SADC Protocol on Shared Watercourses 1995 was effectively repealed by Revised Protocol);
- Treaty on the Lesotho Highlands Water Project , 24 October 1986 with 6 Protocols;
- Agreement between Botswana and Namibia on the establishment of a Joint Permanent Water Commission (JWPC) 13 November 1990;
- Agreement between South Africa and Namibia on the establishment of a Permanent Water Commission 14 September 1992;
- Agreement between South Africa and Namibia on the Vioolsdrift and Noordoewer Irrigation Scheme 14 September 1992;
- Agreement between Angola, Botswana and Namibia on the establishment of a Permanent Okavango River Basin Water Commission (OKACOM) 15 September 1994;
- Agreement between South Africa, Botswana, Lesotho and Namibia on the establishment of the Orange-Senqu River Commission (ORASECOM); and
- Agreement between Namibia and South Africa on the water available to each country from the Lower Orange River. In 2005 there was a draft Version 12 of this agreement available.

The SADC Protocol on Shared Watercourses promotes the establishment of shared watercourse agreements and institutions and enshrines the principles of reasonable use and environmentally sound development of the resource. It supports Integrated Water Resource Management (IWRM) and the Regional Strategic Action Plan for Integrated Water Resources Development and Management (RSAP-IWRM).

The SADC Protocol supports strengthening the principles of integrated management of shared basins with specific provisions for equitable utilization, planned measures, no significant harm, and emergency situations

The LHWP Treaty is a bilateral agreement and although it is focused on infrastructure development and for the Royalty payments it does have a few provisions dealing with water resource management, eg:

- Article 6(15) - measures to prevent or abate water pollution.
- Article 7(9) - minimum rates of flow to be maintained in the river beds below Katse and Mohale Dam.
- Article 7(11) - minimum flow rates for further phases to be agreed before such phase is implemented.
- Article 7(12) - the parties must agree from time to time on the minimum rate of flow in the Orange/Senqu on the border between the countries.

- Article 7(13) and 7(14) - although the water stored in the reservoirs built for the Project is intended for delivery to South Africa, the parties may agree to release water either downstream of a reservoir or at abstraction points for use in Lesotho.

Deliverable for Task 4

Report (3a) *Brief report summarizing all international obligations regarding water allocations*

2.5 TASK5: CURRENT AND FUTURE URBAN/INDUSTRIAL WATER REQUIREMENTS

The urban/industrial use currently included in the databases of the WRYM and WRPM are in most cases those from the All Town Reconciliation Study and from the Bloemfontein Reconciliation Study. Water requirements located in the Eastern Cape and supplied via the Orange-Fish tunnel are already aligned in the models with those given in the recent Water Reconciliation Strategy Study for the Algoa Water Supply and the Algoa annual operating analysis. This data will be evaluated and improved where possible. Data on the mine water use was not recently updated and it is therefore very important to verify and update this data.

The intention is to extract all usable data from the reports and existing databases and compile comparisons of the different sources of current and projected water requirements and return flow data. The comparison will be used to identify discrepancies that will guide the study team to compile the most appropriate water requirements database to be used for the study.

This task will involve determining the most appropriate data for the historical and future water requirements and return flows. The selection of what future projection to be used will be made in collaboration with the Client and stakeholders. The methodology will include the following activities:

- Demographic component. Domestic water requirements are largely driven by the population and socio-economic circumstances. All data sources and information from past studies will be reviewed. The Central Towns Study data will be utilised as the base and compared to the latest data releases as well as discussions with relevant district and local municipalities. The latest socio-economic trends (population and economic activities) will be determined and compared against any projections and scenarios to ascertain that the most accurate demographic projections are identified.
- Development of a comprehensive record of historical water usage and return flows. Information from All Towns Study will be utilized first. Where necessary information will be drawn from the various local authorities through the information provided in their respective WSDPs, internal

publications, treasury/billing database and interactions with the relevant municipal officials. The databases of the Water Services Directorate and Water Resources Planning Systems in DWA will be used for additional information regarding the water requirements and return flows if required.

- Various scenarios will be developed in consultation with key sector stakeholders for the study area, which will detail the impact on population, demographics and ultimately, water demands. Sector specialists will be consulted during this process, as well as representatives of the identified stakeholders. The objective is to develop scenarios (e.g. high growth and low growth in water requirements) which reflect the trends in a range of variables. It is critical therefore that each scenario clearly sets out the basic assumptions made and which of the driver variable/s selected should be monitored over time to indicate at some point in the future which scenario is actually being played out in the real world. This will assist in identifying the most appropriate intervention needed in the future to balance water requirement with water availability; being informed by actual trends in the market place.

The water demand information will take cognisance of the supply from groundwater since some of the areas are supplied from groundwater and opportunities to further develop and utilise groundwater exist in the study area.

In order to incorporate the domestic water requirements and return flows into the Water Resources Yield and Planning Models the following will be explicitly detailed:

- The historical growth patterns of the domestic water requirements together with the abstraction pattern as well as the sources and locations of any return flows.
- The locations of all major groundwater abstractions and their effective contribution to the overall domestic water requirements will also be assessed.
- Both present and future water uses will be assessed and integrated with the water requirement scenarios.
- Water requirement and return flow scenarios including the effects of Water Conservation and Water Demand Management (WC/WDM) measures will be compiled, using output from **Task 6**.

The existing demand and return flow spread sheet will be updated with the latest information and improved where required.

Deliverables for Task 5:

- Spread sheet summary database of data from different data sources.

- Spread sheet with the proposed water requirement and return flow scenarios.
- Updated data for water resource system analysis models.
- **Report (4)** Water requirements and Return Flow Report. Presenting both the historical information and the scenarios for all water users receiving water from the system.

Activities to be undertaken in the irrigation sector are described in **Section 2.8**.

2.6 TASK 6: URBAN WATER CONSERVATION AND WATER DEMAND MANAGEMENT

The objective of this task is to review the status quo and progress made with water conservation and water demand management (WC/WDM) in the study area.

This task will be undertaken in three sub-tasks of which the details are discussed in the following paragraphs. Information from the All Town Strategies will form an important input to this task and will be updated where appropriate.

2.6.1 Task 6a: Collect and collate previous studies

Existing information, as captured in **Task 2**, will be reviewed with the relevant Water Services Authority to ensure there are no anomalies or gaps in the data set. This will include the updating of the IWA water balance, WRC potential assessment scorecard, budget requirements and progress.

The project team will work closely with DWA Regional Offices who has already been tasked with gathering the information as part of the development of a provincial WC/WDM plan. Relevant information for Eastern Cape requirements supplied from the Orange will be obtained from the recent Algoa Reconciliation Strategy and the most recent Algoa annual operating analysis report.

2.6.2 Task 6b: Broad based assessment of potential savings

Having reviewed the available information, it will be summarized to assess the potential reduction in total demand, non-revenue water, budget requirements, timelines and key interventions.

Costing of the proposed options will done and URV determined to be used as input to **Task 16.**

2.6.3 Task 6c: Review information and scenarios

It is imperative that the targets set in the strategy are realistic and the goals are met as it has a direct implication on future augmentation schemes. The WC/WDM strategies will be reviewed after 18 months to assess whether the targets have been met.

Should it be found that the targets are unrealistic; the WC/WDM will be changed accordingly.

Deliverables for Task 6

Report (5) The deliverable from **Task 6** will include a report on the potential savings in terms of total demand reduction, non-revenue water reduction, budgets and timelines for all municipalities in the supply area.

2.7 TASK 7: OPPORTUNITIES FOR WATER RE-USE

The major wastewater treatment works (WWTW) are located in the Bloemfontein area where the greatest potential for re-use exists. Both indirect and direct re-use has been identified in the reconciliation strategy for the Greater Bloemfontein Area as future sources of water to be used to achieve reconciliation. The use of treated wastewater effluent requires further treatment as well as an understanding of the nature of the sanitation drainage area. Only drainage areas where about 90% of the effluent volume is generated by domestic users can be considered for re-use. Industrial effluent has health implications and can impact on the membrane treatment processes needed for direct re-use. High level costing of re-use options was already carried out as part of the Greater Bloemfontein Reconciliation study, and will be used as valuable input to this task.

The objectives of this task are:-

- To identify WWTW effluents that have potential for re-use and include that in the reconciliation strategy.
- To provide high level costs of additional treatment required for re-use.

The following activities will be undertaken as part of this task:-

- The key WWTW in the study area will be identified. These are likely to be located around the Bloemfontein Metro area.
- Cognisance will be taken of re-use in the Nelson Mandela Bay Metro (NMBM) which receives part of it water from the Orange System. Significant re-use of treated effluent for industrial use is envisaged for the Coega Industrial Development Zone.
- The WWTW and the relevant metros will be visited to collate the current and future water volumes and expected water qualities from the WWTW. An understanding of the nature of the areas feeding the WWTW will also be gained during the visit.
- The data will be evaluated and incorporated as a source into the reconciliation strategy.

- The required additional treatment processes will be determined and costs developed for the process for inclusion into the assessment of options.
- Input to the reports will be provided where required.
- Costing of the proposed options will carried out and URV determined to be used as input to **Task 16**.

Deliverables for Task 7:

*A chapter in **Report 5b** (WC/WDM) describing the findings from this task.*

2.8 TASK 8: IRRIGATION DEMANDS AND WC/WDM

Irrigation is by far the largest consumer of the limited water resources of the catchment and therefore will receive detailed evaluation and assessment based on:

- Reports from previous studies (reference will be made to the **Task 2** data-base);
- ORASECOM study did fairly detailed work to locate irrigation areas using satellite imagery;
- WARMS database;
- Database developed during the validation and verification process if any;
- Local knowledge of DWA officials and Water User Associations/Irrigation Boards and;
- Transfer volume required for irrigation in the Eastern Cape. There is currently a dispute on the 25% losses that also need to be supplied over and above the allocation based on the irrigation area and related quota. This is currently being investigated through the Real Time Model project for the Eastern Cape water supply area. Any available information from the Real Time Model project will be obtained from the consultants and EC DWA offices.

There are indications of possible unlawful irrigation abstractions along the Lower Vaal and Upper and Lower Orange. Actual irrigation areas from the Validation Verification Study as well as satellite imagery identified irrigation areas from the ORASECOM study will be used to compare with the scheduled irrigation areas to highlight potential areas of unlawful irrigation water use.

A summary database spread sheet showing present and projected irrigation water use from various data sources will be prepared and a consolidated and revised schedule will be prepared for the Basin.

Irrigation WC/WDM:

Universally, water resource management policy and strategy is focusing progressively more on decentralized management, operation and maintenance of water delivery through participation by the stakeholders and water users. Also related to this is the practice of focusing water resource

management away from the development of new systems and infrastructure to provide more water, to the improved management of existing water resources and the improvement of water use efficiency and water conservation. These improvements are often implemented through Water Management Plans with a focus on Best Management Practices which in turn is based on internationally recognised benchmarks for the various water use sectors. This can be based on incentive, production, policy and regulation parameters and is generally achieved by the implementation of effective and manageable operating rules.

In a Water Management Plan a water user association or irrigation board (or any other water management body) describes its current water use and conservation measures and sets out how it plans to implement Best Management Practices (BMPs) using accepted benchmarks to improve its water supply to water users and to achieve quantifiable water savings. The main benefits of the Water Management Plan approach is that it is structured for stakeholder and water user participation in planning and implementation and it is conducive to ready integration into a broader Water Resource Management Strategy for the study area as a whole.

Existing initiatives, strategies or studies on WC/WDM in the catchments will be identified and evaluated against standard Benchmarks and Best Management Practice. Any implementation of recommendations of previous WC/WDM studies will be checked and the on-going monitoring /assessment of benefits of various interventions will be evaluated. One should bear in mind that the current strategy as described in the Internal Strategic Perspectives, for any savings in water use by irrigation is to make that available for further use within the irrigation sector.

This information will form the foundation for new or additional recommended approaches to WC/WDM for the irrigation sector in the study area.

Illegal irrigation is a reality in many parts of the catchment and can only be limited by the application of appropriate water controls and management. Effective water management, in turn, is dependent on good water measurement and monitoring by Water User Associations, Irrigation Boards and Irrigation Scheme management committees. The measurement and monitoring process is most likely to be effective where the concept of “Water Management Plans” (as required in terms of the Water Act) is effectively introduced.

An effective and well managed system of irrigation water trading would be a significant contributor to improved water-use efficiency in the catchment, both in terms of efficient water use and in terms of the economic benefits of that water use to the water –stressed region as a whole. This important tool will be evaluated in the study.

Irrigation in the Eastern Cape represents a considerable part of the total irrigation demand imposed on the Orange River Project. Findings from a current pilot project for the development of a WC/WDM strategy for WMA 15 will be utilised for the purpose of this study with reference to the Eastern Cape irrigation requirements.

Deliverables for Task 8

Report 6a will describe the Irrigation Water requirements, the assumptions of the scenarios, the potential for WC/WDM and the contribution of irrigated agriculture to the regional economy.

2.9 TASK 9: VALUE OF IRRIGATION WATER

Detailed gross margins (gross revenue and direct production costs) will be compiled for all the main enterprises in the study area. The gross margins for each enterprise will include the amount of irrigation water that is used in a normal/average production season. In this way the financial return from each cubic meter of irrigation water can be determined. The next step would be to divide the study area into various bioclimatic/economic sub areas and typical farmer models will be compiled for each sub area. In this way farm overhead costs for each farm model can be taken into account and added to the financial model. These mathematical models will then simulate in financial terms the financial value of irrigation water for each farmer type. These can then be compiled together to give an estimate for the whole study area.

It will also be important to estimate the regional economic benefits from irrigation water which will include job creation and the direct, indirect and induced economic benefits that can be attributed to agricultural production in the study area. A Social Accounting Matrix model (SAM) which will include the relevant economic multipliers for the various sectors will be used for this purpose. These benefits can then be added to the financial benefits and the real value of irrigation water can be determined. The value of irrigation can also be used to further explore the possibility of the trading of water use entitlements between sectors as a possible intervention measure.

Deliverables from Task 9

*A chapter in **Report 6** (Irrigation Water requirements) describing the findings from this task.*

2.10 TASK 10: SURFACE WATER HYDROLOGY

2.10.1 Surface Water Hydrology

As part of the recently completed ORASECOM Study ‘‘Support to Phase ll ORASECOM Basin Wide Integrated Water Resources Management Plan” the hydrology for the entire based was extended and improved in some places, now covering the total record period 1920 to 2004 hydrological years.

The hydrology was updated and extended in the ORASECOM study as indicated in **Figure 2.2**. The natural hydrology is in general not available on a quaternary catchment level but is based on larger sub-catchments that in most cases co-inside with key points in the basin such as dams and gauging weirs. The detail of the sub-catchments used is given in **Figure 2.3.**

As part of the “Reconciliation Strategy for Large Bulk Water Supply System: Orange River” the hydrology as obtained from the ORASECOM Study will be reviewed with the focus on the sub-catchments of higher importance for existing and possible future schemes and related Reserve requirements.

The verification and validation tests to be carried out on the stochastic hydrology based on the latest ORASECOM Phase ll hydrology were not carried out as part of the ORASECOM Phase ll study. The verification and validation tests will be carried out as part of **Task 10** under this study. Results from the tests will be evaluated and documented. Suggestions will be made for improvements if required, before the hydrology is accepted for use in the Orange Reconciliation Study. Recommendations from this evaluation will be discussed with the client to decide whether further detail work is required as part of the Orange Recon Study or if the hydrology can be accepted to be used for analysis purposes in this study.

Measures will be taken to correct or improve the stochastic and or historic hydrology for problem catchments, but within the budget constraints.

An updated Param.dat file that represents the final accepted stochastic flow parameters will be created and included in the already updated (updated with ORASECOM hydrology) WRPM data sets from the ORASECOM study.

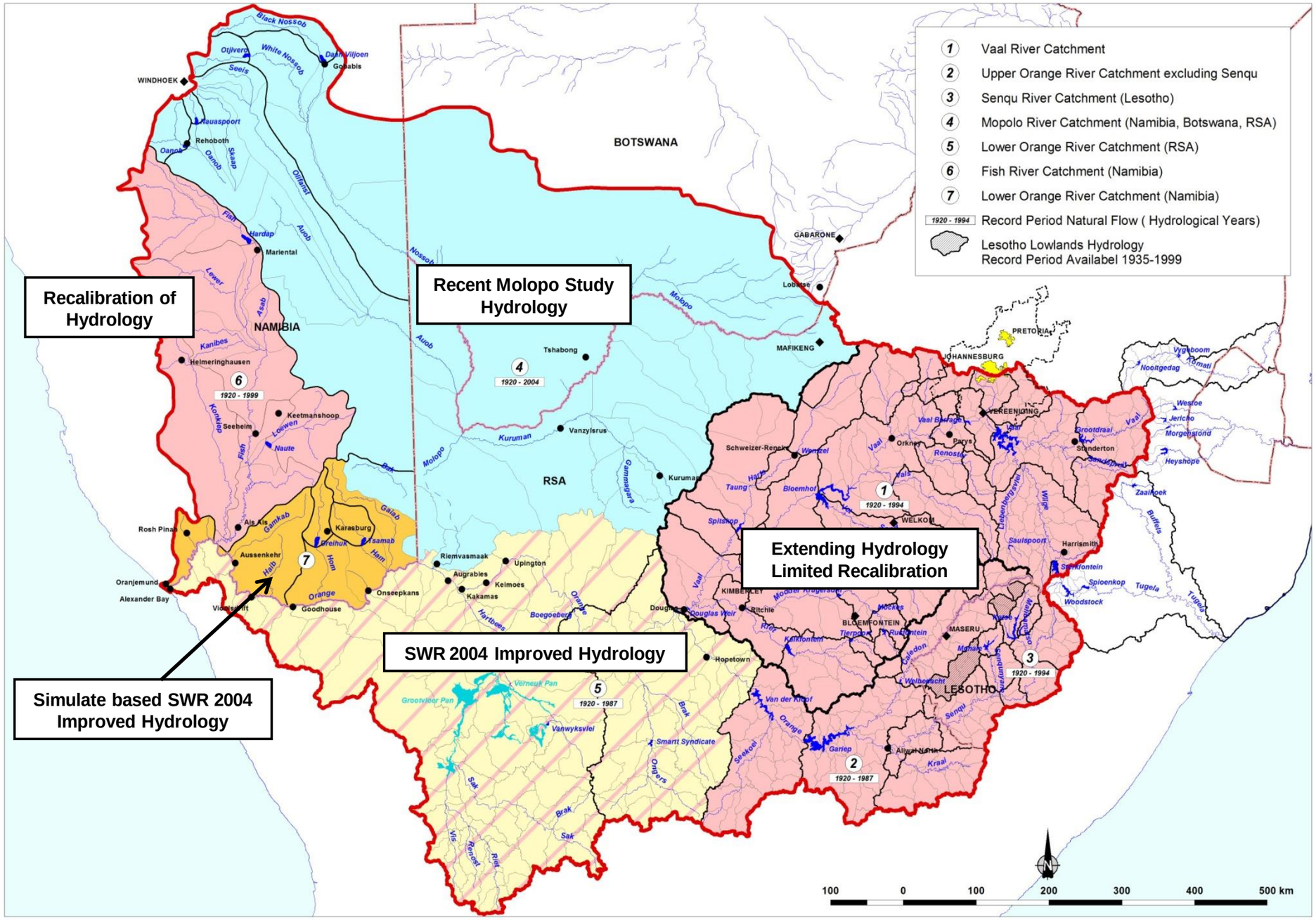


Figure 2.2: Spatial distribution of actions taken to improve the hydrological database in ORASECOM Study

2.10.2 System Analysis

The WRPM and WRYM were both updated with the ORASECOM hydrology as part of the ORASECOM Study. Results from these models might differ from that obtained from previous assessments and the reasons for these differences need to be clarified and motivated where necessary, before the models are applied for the system analyses required for the Orange Reconciliation Study.

The WRYM will be used to confirm the yield of the schemes identified for further investigations, as part of **Task 3.** The Historic Firm Yield will be determined for each of the systems and options.

The Vaal system is operated as a separate system and is not used to support the Orange River system. A significant volume (115 million m^3/a) of operating requirements is however released from Vaalharts Weir in support of users in the Lower Vaal, upstream of the Douglas Scheme. Some of this water is most probably entering Douglas Weir resulting in less water being transferred from the Orange. There are currently uncertainties on the actual situation and flows downstream of Douglas Weir in the Vaal River. This will be addressed in the modelling process to improve the reliability of the modelling results in this particular area.

Figure 2.3: Senqu-Orange Catchment Delineations

Based on the final accepted yield results it will be decided if further detailed analyses are required for all schemes or only for a few selected schemes. These schemes will then be carried over for further analyses as part of **Task 12**.

Deliverables from Task 10

Deliverables from this task will include:

- *Review of the hydrology of selected sub-catchments.*
- *Carry out the Verification and Validations tests. Evaluate the findings from the tests.*
- *Yield analysis (historic analyses only) to compare with previous study findings.*
- ***Report (7)** Writing of a Report on the review and evaluation with related recommendations and to document findings from the yield analyses and related comparisons.*
- *Updated/refined WRPM and WRYM data sets.*

2.11 TASK 11: WATER QUALITY

The objectives of the water quality task are:-

- To understand the water quality profile and pollution sources in the study area to inform the interventions proposed in the reconciliation strategy;
- To compile a set of interim Resource Water Quality Objectives (RWQOs) which can be used to identify the water quality issues in the study area and can be used to assess the water quality impacts of the reconciliation interventions.

The activities that will be undertaken under this task are:-

- Collate available RWQOs and water quality guidelines set in the study area to propose a set of guidelines/RWQOs for use in the study. These can be revised in the current water quality study;
- Analyse the available water quality data and compare to RWQOs to identify water quality variables of concern and possible water quality issues;
- Identify potential sources of pollution, related to the measured water quality in the river system;
- Provide inputs to the reconciliation interventions regarding water quality impacts that can be expected.

Deliverables from Task 11

Report 8 describing the findings from this task.

2.12 TASK 12: RESERVE REQUIREMENT SCENARIOS AND SCHEME YIELD

The existing schemes as well as the options identified from the Preliminary Workshop and further evaluated as part of **Task 10** will be evaluated in **Task 12** as the initial list of scenarios that requires further detailed analyses. The effect of Phase 2 of the Lesotho Highlands Project (Polihali Dam) on the Orange River Project yield will also be determined, considering different operating rules, as these rules can have a significant impact in the yield reduction experienced in the Orange River Project System. The latest EWR for the LHWP as defined by the LHDA's method are already included in the WRYM and WRPM as updated through the ORASECOM study. The EWR applicable to Polihali Dam as determined from the feasibility study for Phase 2 of the LHWP will also be utilised for analysis purposes.

The implication of the latest Vaal Reserve estimations and most recent available EWRs on current and proposed options will be determined. Results from the Vaal EWR studies as well as the EWRs determined from the ORASECOM study will be used for these scenarios. If data is already available from the Research proposal on the environmental flow requirements of the Fish River and Orange-Senqu mouth in Namibia and South Africa, it will be used as the requirement at the river mouth. If not, the river mouth requirement from the LORMS will be considered as a possible option. Discussions with the client and the River Mouth Study Group will be held to obtain guidance and to make the final selection on the most appropriate river mouth environmental requirement to be used for the purpose of this study. These impacts on the yield will be determined for the most likely Reserve classifications as well as for higher and lower classifications. The historic firm yield will be determined for the relevant schemes. The results will be evaluated and discussed with the client. This might result in the elimination of some of the scenarios.

Long-term stochastic yield analyses will then be carried out for selected options, as in agreement with the client. These analyses will provide answers regarding the assurance of the yield. This is required to be able to determine whether the yield available from a resource will be able to supply the users at their required assurance. Results from these analyses will be evaluated to determine if all the schemes should proceed to the next level of analysis, which will be short-term stochastic yield analysis and WRPM analyses. The short-term stochastic analyses form the basis for the drought restriction rules and the analysis to project the risk of restrictions to determine the date when augmentation will be required.

The timing of the intervention options is essential in particular for the purpose of the cost estimations and the calculation of URV. The WRPM will be used to simulate the growing demands

and infrastructure changes over time until 2040 as defined by the selected scenario definitions. Analysis will be carried out to determine the dates when intervention are required in future. The WRPM has been configured for the entire Orange and Integrated Vaal systems and will therefore take into account the complexity of changes in transfers and support from one sub-system to another as well as restriction of demands during dry periods. Analysis with the model will simulate the interdependencies of all the water resource components and operating rules over the planning period. The allocation module of the WRPM requires multi-risk user priority definitions for each used sector and priority class definitions as the basis for simulating drought restriction rules. The User Category and Priority Classification Definition currently applied for the Orange River system is shown in **Table 2.3**. These will be confirmed through discussions with the client and key stakeholders.

For budgeting purposes it is assumed that the number of scenarios to be analysed with the WRPM will not exceed fifteen (15).

Results from the WRPM analyses will be used to prepare annual water balance graphs at key points in the system as required and agreed on with the client.

Table 2.3: Orange River System User Category and Priority Classification

Category	% of the water demand to be supplied		
	1: 200 year (99.5%)	1: 100 year (99%)	1:20 year (95%)
Irrigation	10	40	50
Urban	50	30	20
Losses	100	0	0
Environmental	68	0	32

Deliverable for Task 12:

Deliverables from this task will include:

- *Summary of reserve classifications of rivers affected by possible schemes;*
- *Scheme yields and effect or reserve and developments in Lesotho on yields;*
- *Timing of future schemes.*
- ***Report (7)** Additional chapters in **Report 7** describing the work and related results from this task.*

2.13 TASK 13: GROUNDWATER

The work proposed for the groundwater task will be undertaken at the desktop level where the primary objective is to determine the role that groundwater can play in the reconciliation of water availability and the bulk water requirements. The approach will be to use existing information, local knowledge, the DWA database (quantity and quality) and work done in previous studies to identify groundwater aquifers that can contribute significantly to the reconciliation strategy.

The aspects that will be addressed in the task include:-

- Expected water quality of any potential groundwater to be utilized for reconciliation.
- Impact of proposed groundwater development on groundwater quality. This could be due to potential mixing of the good quality water in the upper aquifers with the poorer quality water in the lower aquifers.
- Any groundwater reserve requirements previously undertaken will be collated and reviewed for consideration in the development of any aquifer systems.
- Inputs to the engineering of the infrastructure required to develop the aquifers.

The costs to develop the infrastructure to exploit the aquifers will be determined in the engineering tasks with input from the groundwater task.

Deliverables for Task 13:

*The task deliverable will be input to the groundwater section of the reconciliation report (**Report 10**).*

2.14 TASK 14: REVIEW SCHEMES AND UPDATE COST ESTIMATES

The objectives of this task are to identify and review possible development options, to prepare updated cost estimates for them and to prepare unit reference values (URVs) for a planning period up to 2040.

Our understanding of the term “schemes” is that it will include only the possible development interventions, and that the costs and URVs of the management options (e.g. Water conservation and water demand management) will be determined under the other relevant tasks.

2.14.1 Sub-Task 14.1: Re-assess the configurations of the identified schemes

Information on possible schemes identified in previous studies such as the Orange River Development Project Replanning Study (ORRS) and the Lower Orange River Management Study (LORMS) will be reviewed. The configurations of these schemes will be re-assessed in the light of any new developments (e.g. an added need to combine a dam with a hydro power station might necessitate the consideration of an alternative dam site).

Any newly identified scheme other than described in the existing ORRS and LORMS reports that seems a worthwhile option will be investigated at desk top level.

Intervention scenarios comprising different combinations of scheme options will then be identified and passed on to **Task Team No 12** for yield assessments. This team will also determine the impact of the Reserve on the yield of each intervention scenario.

Details of the schemes will be summarized for the Preliminary Screening Workshop (**Task 3**), which will select a shortlist for further consideration. The selected schemes will then be analysed in more detail. It is for example possible that schemes identified before the Preliminary Screening Meeting will need to be re-sized, possibly with alternative sizes to account for different Reserve scenarios. Such re-sizing will be done only to a reconnaissance level of detail.

2.14.2 Sub-Task 14.2: Update cost estimate of schemes

Costing of scheme options will generally be done using a costing model similar to what was used for the Vaal Augmentation Planning Study (VAPS model), except where previous schedules of quantities can be used unchanged, in which case only rates will be updated to an agreed common base date. Particular attention will be given to the cost of infrastructure required to convey the water to major users as this is often also a major portion of the scheme cost (e.g. a feeder canal from a dam).

2.14.3 Sub-task 14.3: Prepare Unit Reference Values (URVs)

URVs will be calculated using the VAPS model. This will be done in such a way that if necessary, the values can be readily updated to assess the impacts of different demand growth rates and different sequences of implementation. The scheme size with the lowest URV will not necessarily be the size selected, when considered together with subsequent more expensive schemes.

2.14.4 Sub-Task 14.4 Documentation of Scheme Information

A brief description of each scheme option, its yield, cost estimate and URV will be made available for the Starter Document of the Preliminary Screening Meeting as described under **Task 3**.

A brief report on the schemes as screened during the Preliminary Screening Meeting, their cost estimates and URV values will be produced. The Starter Document for the Final Screening Meeting (See **Task 17**) will inter alia be based on information contained in this report

2.14.5 Timeframe

This task has to be carefully synchronised with the Preliminary and Final Screening Workshops as they are dependent on this task's information. The task will be done in two stages – indicative cost estimates and URVs will be prepared for the Preliminary Workshop, while refined values will be prepared for the Final Workshop. The timing of both stages is shown on the Project Schedule in **Appendix B.**

Deliverables for Task 14:

Brief report (**Report 11**) on possible development interventions, their costs, and URVs

2.15 TASK 15: REVIEW OR ASSESS SOCIAL AND ENVIRONMENTAL IMPACTS

The objective of this task is to assess the social and environmental impacts of possible schemes.

2.15.1 Sub-Task 15.1: Social Impacts

The socio-economic impact assessment will evaluate both positive and negative impacts associated with the development of infrastructure aimed at addressing water needs for the population living in the Upper and Lower Orange River Water Management Areas.

The assessment will review social impacts of schemes previously identified and assessed by earlier studies in order to evaluate whether circumstances have changed.

A social Assessment at desktop level will be done for possible new schemes for which no previous assessments are available.

To achieve this, the following will be required:

- A desktop study and literature review of all relevant documentation will be conducted to collect as much information as possible to obtain a better understanding of the situation in the study area.
- Undertake a desktop assessment with the aid of DWA's most recent aerial colour photographs or, if necessary, visit scheme sites in the Water Management Areas (WMAs) and itemise the key issues and concerns.

2.15.2 Sub-Task 15.2: Environmental Impacts

The following processes to be followed:

- A desktop study and literature review of all relevant documentation, including any Reserve Determinations, if any, to obtain an understanding of the environmental status of the river.

The outcome of the desktop study and literature review will be a report on the key environmental and social issues in the areas relevant to the possible interventions evaluated for the development of detailed reconciliation strategies for the Upper and Lower Orange River Water Management Areas.

2.15.3 Timeframe

This task is dependent on **Task 3**, the Preliminary Screening Workshop where the possible management and development options will be selected and will therefore only commence after the screening workshop. By that time some information of the ORASECOM: UNDP-GEF Orange-Senqu Strategic Action Programme might become available. This study inter alia covers the EWR of the Orange River and if sufficient data is available by that time, this can also be taken into consideration. The duration of **Task 15** is approximately 85 days and the task is included in the study schedule in **Appendix B.**

Deliverables for Task 15:

- *Key social impacts of identified schemes;*
- *Key environmental drivers in the river; and*
- *Summary of findings on social and environmental impacts. To be included as a chapter in the Reconciliation Scenarios Report (**Report 9**).*

2.16 TASK 16: ASSEMBLY OF INFORMATION AND FORMULATION OF SCENARIOS

The objective of this task is to integrate the work of preceding tasks into a report summarizing the results and presenting a preferred Scenario to reconcile the water requirements with water availability.

The water reconciliation strategy will be developed in two stages. Firstly the preliminary reconciliation strategy will be developed with the purpose of building an understanding of the reconciliation possibilities and identifying the information gaps that need to be investigated further. The final reconciliation strategy will then be an improved version of the preliminary strategy after the missing/incomplete information has been collected and used to reassess the preferred implementation scenario.

2.16.1 Sub-Task 16.1: The Preliminary Reconciliation Scenario and Strategy

It is foreseen that alternative preliminary intervention scenarios will be complete just before the final screening workshop. This estimated timing has taken into account the time it will take for the approval of this Inception Report and the fact that the strategy is dependent on some basic information that will be collected and developed under the other tasks.

The alternative intervention scenarios and eventually the Preliminary Water Reconciliation Strategy will be derived from information outputs of the various task teams of this study. The following information will be obtained from the various teams:

- From **Task Team no 3:** The screened list with possible reconciliation options.
- From **Task Team No 4:** International obligations that, together with the Reserve, must first be satisfied before water allocations can be made. The quantities in terms of international water will therefore be subtracted first from the available water and will in effect reduce the system yield.
- From **Task Team No 5:** Current and future water requirements. High and Low growth water requirements over the planning horizon of 20 years per water use sector and per sub-catchment will be obtained from this team.
- From **Task Team No 6:** Water conservation and water demand management (WC/WDM) for urban water use. The estimated water savings and the time scale over which these savings can be achieved will be obtained from this task team. This team will also provide cost estimates and URVs for implementing WC/WDM in the urban water use sector.
- From **Task Team No 7:** Opportunities for water reuse: Possible water reuse schemes, their expected yields, cost estimates and URVs will be obtained from this team.
- From **Task Team No 8:** WC/WDM in the irrigation water use sector. The estimated water savings and the time scale over which these savings can be achieved will be obtained from this task team. This team should also provide suggestions on how to prevent farmers from

expanding their irrigation horizontally with their saved water. The saved water should become available for allocation. The team will also provide cost estimates and URVs for implementing WC/WDM in the irrigation water use sector.

- From **Task Team No 9:** Value of irrigation water. The value of water in each sub-catchment in R/m^3 and number of jobs/m^3 will be obtained from this team.
- From **Task Team No 10:** Surface water hydrology. The current and future available yield as modelled for each sub-catchment and for the entire system will be obtained from this team. The yield will be provided in an agreed assurance of supply.
- From **Task Team No 11:** Water Quality. The current and future water quality information will be obtained from this team. If dilution is needed to mitigate any water quality problem, the quantity of water needed for achieving the water quality objectives will be passed on by the team.
- Task **Team No 12:** Reserve requirement scenarios and scheme yields. The Reserve requirements for each sub-catchment and the system as a whole will be provided by this team. Modelling results on how Reserve requirements for specific development options (e.g. new dams) will impact on the yield of such options will also be provided by the team.
- From **Task Team No 13:** Groundwater. Available groundwater per sub-catchment will be determined by Team 13 and passed on.
- From **Task Team No 14:** Cost estimates and URV information will be made available by this task team. This will enable Team 16 to compare different intervention scenarios with each other if a water balance can be achieved for more than one intervention scenario.
- From **Task Team No 15:** Information on socio- and environmental impacts will be made available by Team 15. It will then be possible to apply these criteria as well when comparing two or more intervention scenarios.

The information flow from the various Task Teams for the formulation of intervention scenarios and the development of the preliminary water reconciliation strategy is shown in **Figure 2.4.**

A preliminary water balance will be conducted by developing a number of water requirement scenarios based on best information available and weighing this up against the water availability, i.e. (both surface water and groundwater resources taken into account). Assurance of supply required for the different water uses will also be taken into account.

Other selection criteria such as the costs and URVs, **(Task 14**) the socio- and environmental impacts (**Task 15**) and the value of water (**Task 9**) will also be factored in to decide on the preferred implementation scenario on which the preliminary reconciliation strategy will be based. A planning horizon of 20 years will be used for the water balance projections.

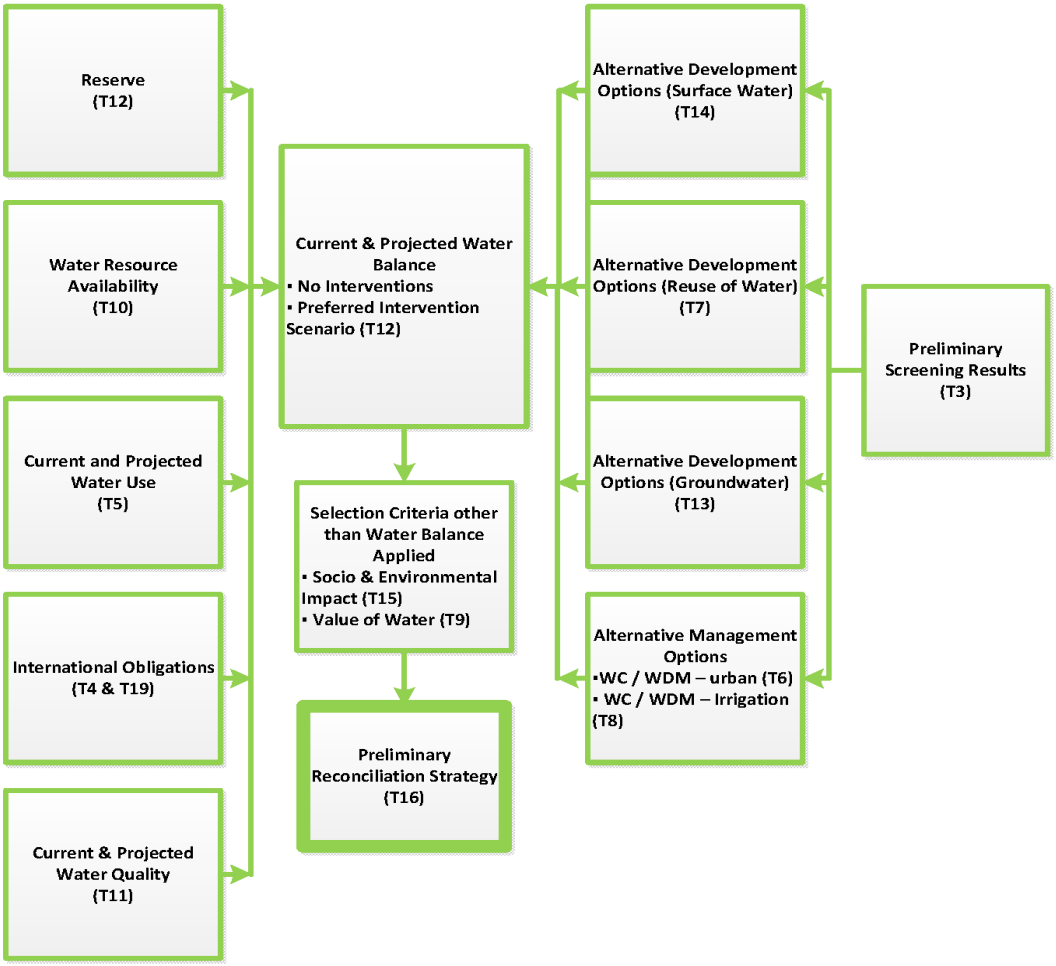


Figure 2.4: Information flow for the formulation of intervention scenarios and developments of preliminary water reconciliation strategy

The Preliminary Reconciliation Strategy will first be assessed by the Study Management Committee and a list of information gaps will be compiled. It will also be considered which of the parallel studies, such as ORASECOM UNDP-GEF "Orange-Senqu Strategic Action Programme", "WQT Calibration Study", "Development of Integrated Water Quality Management Plan (Orange River)", "Maintenance of the Vaal River Reconciliation Strategy", the "Vaal River System Classification Study" and the "Verification and Validations of existing Water Use"' can improve the information used for the Preliminary Reconciliation Strategy. All mentioned studies run parallel to this reconciliation strategy study and may have progressed to such a point where they can provide improved information. It must however be made clear that this study team have no control over the progress of the mentioned studies and should the progress not be as expected and the information not be ready for incorporation into the final reconciliation strategy. The strategy is however treated by DWA as a living strategy and new information can always be added in the follow up maintenance study.

The preparation of the preliminary Scenarios will guide the work required to develop the final Scenarios.

Information gaps will be identified which, if obtained, will improve the preliminary reconciliation strategy when moving ahead towards the final reconciliation strategy.

2.16.2 Sub-Task 16.2: The Final Reconciliation Scenarios and Strategy

The Preliminary Reconciliation Strategy, list of information gaps and possible sources of improved information will be presented to the Study Steering Committee (SSC).

The comments of the SSC will then be taken into account and the Preliminary Recon Strategy will then be reworked with the improved information. This reworked version will become the Final Reconciliation Strategy which will again be presented to the SSC, and after their comments have been incorporated and the report has been approved by the DWA, this will then be regarded as the final product of the study.

2.16.3 Timeframe

The Preliminary Reconciliation Strategy is highly dependent on the outputs/information from other Task Teams. The assembly of information and formulation of scenarios will therefore only start when this information becomes available. This sub-task is also dependent on the outcome of the Preliminary Screening workshop **(Task 3).**

The Final Reconciliation Strategy will effectively start after the missing information has been collected and after the final Screening Workshop **(Task 17)** has been held.

The timeframe for the two sub-tasks are shown on the Study Schedule in **Appendix B.**

Deliverables for Task 16

- *Preliminary Reconciliation Strategy Report (**Report 10**).*
- *Final Reconciliation Strategy Report (**Report 11**).*
- *Layman-friendly Executive Summary (**Report 12**)*

2.17 TASK 17: FINAL SCREENING WORKSHOP

The objectives of the Final Screening Workshop are the following:

- To obtain the views and also the agreement of the Key Stakeholders on the most favourable future reconciliation options and the Scenarios for implementation.

- To prioritise future investigations to reduce uncertainties, and
- To enable more definitive medium to long term reconciliation planning to be undertaken.

The objectives will be attained by performing the following sub-tasks:

2.17.1 Sub-Task 17.1: Prepare a Starter Document

A starter document of not more than 10 pages will be prepared that will briefly explain the process of how the most favourable future reconciliation Scenarios were selected, the main features of the reconciliation options and their recommended sequence of implementation. This document will be sent out in electronic format to all confirmed attendees one week before the workshop.

2.17.2 Sub-Task 17.2: Arrange the Final Screening Workshop

The arrangements for the Final Screening Workshop will be executed under **Task 18** (See **Section 2.18.4**). The same stakeholder database as the one for the Preliminary Screening Workshop will be used.

2.17.3 Sub-Task 17.3: Conduct the Workshop

The proposed reconciliation strategy and its reconciliation interventions will be explained to the Stakeholders and ample opportunity will be given to them to raise their views. These will be carefully recorded and where necessary, the draft Final Reconciliation Scenario will be amended. All efforts will be made to reach consensus amongst the Key Stakeholders on the selected reconciliation options and their timing. Consensus will also be sought on the future investigations and studies for the purpose of long term reconciliation planning.

2.17.4 Sub-task 17.4: Document the proceedings of the workshop

The proceedings of the Final Screening Workshop will be summarized and this summary will be bound together with the starter document and the final recommendations on the most likely reconciliation Scenario, the reconciliation options forming part of the reconciliation scenario, their sequence of implementation and future recommended investigations.

2.17.5 Timeframe

The final screening workshop will be held after all the missing information, identified at the completion of the Preliminary Reconciliation Strategy, has been collected and the final reconciliation scenarios have been formulated. The work on the final Reconciliation Strategy will commence immediately after the final screening workshop.

The timing of the Final Screening Workshop can be seen on the Study Schedule in **Appendix B.**

Deliverables for Task 17

- *Invitation letters*
- *Starter document for workshop*
- *Summary document with workshop proceedings and final recommendations.*

2.18 TASK 18: PUBLIC PARTICIPATION

Stakeholder engagement for this study will feed into the existing public participation exercises that are currently being, or will soon be undertaken.

2.18.1 Database of Interested and Affected Parties

Identification of stakeholders will take place by way of contact with local municipalities, communities, networking and referral. Furthermore, reply / comment sheets accompanying any mailing will provide space for stakeholders to add the names of their colleagues or friends. The database will be maintained in good order as the process proceeds, and updated as new information becomes available. Representatives (relevant to the study) of the following sectors of society will be identified so as to afford them the opportunity to comment (the database will be categorized accordingly) and participate on the project.

- National, provincial and local government;
- Reference groups in the catchment (e.g. WUAs);
- Agriculture and farmers' organizations;
- Regional and local media;
- Business and commerce;

- Environmental bodies, both as authorities and NGOs and
- Community representatives, CBOs, development bodies.

2.18.2 Announce the project

The project to develop the Strategy and its public participation process will be widely announced. A Background Information Document (BID) will be prepared as a basis for discussion with stakeholders about the project. The BID will communicate information about the:

- Background to the project (who, why, where) and motivation for the Strategy and
- Description of the project; process that will be followed (who can participate in the process, how and when).

The BID will be accompanied by a comment sheet, inviting stakeholders to provide their comments upfront and also to name additional stakeholders that should participate in the study.

2.18.3 Study Steering Committee

The project team is proposing the establishment of a Study Steering Committee (SSC) for the development of the Water Reconciliation Strategy. This committee will be a representative body of various sectors in the study area. Its purpose would be to provide guidance in the progressive development of the Strategy. Members of the committee will be nominated at the first public meeting to be held early in the process.

Four SSC meetings have been scheduled for the study. Two meetings have been scheduled before each of the public meetings (See **Section 2.18.5**) and then the other two meetings will be scheduled in conjunction with the preliminary and final screening workshops. It is assumed that meetings will be held in large towns such as Kimberley or Upington.

2.18.4 Workshops

Workshops required for the study will be planned or scheduled in conjunction with the Study Steering Committee and Study Management Meetings (see **Sections 2.3.3, 2.17.2 & 2.18.3**).

An invitation letter with an information leaflet on the contents of the workshop will be sent out to the key stakeholders identified in **Section 2.3.1**., approximately one month before the workshop with a request to RSVP their attendance.

The workshops will be arranged at a central and easy accessible venue in one of the two Orange River Water Management Areas. Record will be kept of all attendees who confirmed their attendance.

2.18.5 Public meetings

Two public meetings will be arranged. One will be scheduled near the beginning of the study, after **Task 2** and **Task 3** have been finalised. The second public meeting has been scheduled towards the end of the project where the final draft Strategy will be presented to the public for their review and comment.

Critical requirements to which we will attend to strive for successful and useful workshops and a public meeting are as follows:

- Clear definition of the aims and objectives of the meetings and the sharing of these with stakeholders in advance of the actual meetings;
- Advance notification, i.e. four weeks, to advise stakeholders of the meetings;
- Formal advance registration procedures, including acknowledgement to I&APs that they are registered to attend;
- Advance provision of meeting materials to registered stakeholders and
- A dry run meeting with the project team to strategize for questions that may be raised and to align presentations.

Proceedings of the workshops and the public meeting will be compiled as an issues and response report and distributed to stakeholders who attended the meetings, as well as upon request.

2.18.6 Newsletters

Apart from verbal presentation of information during meetings, information about the study will be presented in other formats such as newsletters. Newsletters (two editions) will afford the broader body of stakeholders to continue to be informed of progress with the study and to provide them with the opportunity to make comments on the milestones and findings.

2.18.7 Web access

All public information will be made available to DWA to upload on the Department's website. The web site address will be made known to all stakeholders to use for access to all public reports.

2.18.8 Translation of public documents

All public documents (BID, newsletters, invitations to meetings) will be translated into the language as required for the study area.

2.19 TASK 19: INTERNATIONAL SUPPORT

ORASECOM is undertaking a joint assessment of all the resources of the Orange River basin, and their uses, with the aim of developing an IWRM plan.

In this regard ORASECOM has presented a portfolio of projects to its international cooperating partners including the World Bank, the African Development Bank, the United Nations and especially the EU–Water Initiative (EUWI). These projects relate to the harmonisation of the legislation in the riparian countries, a study of trans-boundary aquifers, water demand management, a basin information system, capacity development, and stakeholder participation.

Most of the study information required for this task will be access from internal sources as the Team participated in various LHWP and ORASECOM projects. Meetings will also be held with the ORASECOM Secretariat and with the DWA members responsible for ORASECOM studies and for the LHWP further phases studies to supplement and confirm own information.

A short report will be compiled on the results of each study, focusing primarily on the demand for water, the likely storage of water, and on the allowances made for downstream releases.

This analysis will be supplemented by the analysis of International Obligations under **Task 4** above.

Deliverables for Task 19:

Report (3) *Chapter in* ***Report 3*** *of* ***Task 4*** *containing relevant information from this task*

2.20 TASK 20: STUDY MANAGEMENT

2.20.1 Task 20-1: Client liaison (SMT meetings)

Liaison with the DWA Study Manager will include the following activities:

- Arrange, attending and provide secretarial services for meetings of the Study Management Committee (SMC) at approximately 6-weekly cycles (total of approximately 16 meetings). A Technical Progress Report and Financial Report will be presented at each of these meetings.
- Arrange meetings of the Study Steering Committee (SSC) on a 6-montly cycle (3 in total) in the study area.
- Establishing interim communication (between meetings) to advise the Study Manager of, inter alia, important events or problem situations, possible changes to the scope of work, appointment of sub-consultants, etc.
- Compiling and updating the "Record of Decisions" and "Record of Administrative Requests" and ensuring that all recorded actions are attended to within the specified budget and recorded time limits.
- Motivating the appointment of prospective new members of the consultant team to the Study Manager as and when required.
- Motivating the appointment of sub-consultants and/or co-consultants and specialists to the Study Manager.
- Implementing the appointment of the sub-consultants and/or co-consultants and specialists after approval by the Client.

2.20.2 Task 20-2: Coordination of Consultant Team

The designated study management functions will be carried out as follows:

- The Study Leader will be responsible for providing the direction to the Study Team in the execution of the tasks and interaction with the Client and stakeholders.
- The Task Coordinator will be responsible for the day-to-day coordination of the Consultant Study Team and activities will include:
    - Serving as link between DWA Study Manager and Consultant Team on administrative matters.
    - Ensuring that the sub-consultants and/or co-consultants and specialists are properly briefed by the Task Leaders prior to commencing with work.
    - Convene regular meetings with the Task Leaders as dictated by programme and progress.
    - Rendering guidance and assistance to the Task Leaders.
    - Monitoring and control of performance, programming and cost of study, including revision of the Study Plan if and when necessary.

2.20.3 Task 20-3: Performance monitoring

A performance monitoring system will be instituted whereby all key activities under each main Task will be assigned milestone dates against which progress will be monitored. The monitoring system will basically be in bar chart format for ease of reference.

The system will allow for detecting potential problem areas at an early stage to enable remedial measures to be instituted to ensure that the study remains on course.

2.20.4 Task 20-4: Financial control

A budget monitoring system comprising basically an interactive spread sheet model will be used to monitor and control costs. Budgets will be assigned to the key activities (sub tasks) under each main Task. Actual costs incurred will be correlated with completion targets to ensure compliance with progress.

Should deviations from the allocated costs for the key activities become evident, the Study Leader shall assess the reason/s and impact of such deviations and institute corrective action as required.

Where additional work may be required, the Study Leader shall obtain a detailed motivation and budget (both time and costs) from the relevant Task Leader for such additional activities for assessment and submission to the Study Manager for consideration and approval. *No additional expenses outside the approved budget will be allowed without the prior written approval of the Client.*

The Study Leader will submit progress report to the Client outlining costs against progress for each Task in a format as prescribed by the Study Manager.

2.20.5 Task 20-5: Study administration

Study administration duties to be performed will include:

- Compiling, certifying and submitting monthly invoices to the Client from input received from the Task Leaders. The Client will be presented with only one invoice monthly from the Consultant Study Team. The Study Leader will arrange payment to the other members of the Study Team after receiving same from the Client.
- Keeping minutes of meetings with the Client and other stakeholder bodies and distribution thereof to the interested parties.

- Ensuring that all project files are kept up to date and accessible to the Client if and when required.
- Coordinating the “close-out” procedures for the Study that will, inter alia, include compilation and submission of project data for record purposes as required by the Client.

The **Study Leader** will provide a secretariat to perform the required duties for the Study Management Committee.

Deliverables from Task 20:

- *Progress and financial reports will be submitted to the Study Manager throughout the duration of the study.*
- *Minutes of meetings as well as lists of administrative and study decisions will be maintained throughout the duration of the study.*

3 STUDY DELIVERABLES AND PROGRAMME

Table 3.1: List of Study Deliverables

Deliverable type	Name or description		Associated task
Reports, hard and electronic copies.	1)Inception report	Chapter on the main study objectives, background study area	1
	(Report 1)	Study procedure Chapter on each task	1
		Study deliverables and study programme	1
		Study Team details	1
		Study costs and cash flow projection	1
		Study risks	1
	2) Literature review report (Report 2)	Summary of current & previous studies information assessment task Literature Review Report	2
		DVD with Previous reports in electronic format	2
	3)Preliminary Screening Workshop	Workshop starter document	3
		Document containing the proceedings and recommendations of the workshop	3
		List of schemes (interventions) to investigate in the study	3
	4) International obligations	Detailed appraisal of the international water-related aspects of the WMA	4
	(Report 3)	Report describing findings from this task	4
		Input into the Main Strategy Report	4
	5)Current & Future Water Requirements	Water requirements and Return Flow Report	5
	(Report 4)	Updated database of water use and return flows	5
		Water requirement and return flow scenario database	5
	6) WC/WDM Urban	Demand management scenarios, alternative water use projections (urban industrial)	6
	(Report 5)	Report describing the assumptions and scenario results	6
	7)Water re-use (Report 8)	Chapter in Report 8 detailing the options assessed and the data collected.	7
	8) Irrigation Demands and WC/WDM	Report describing the Irrigation Water requirements and the assumptions of the scenarios	8
	(Report 6)	The potential for WC/WDM	8
		Contribution of irrigated agriculture to the regional economy	8
	9) Value of Irrigation Water	A chapter in Report 6 (Irrigation Water requirements) describing the findings from this task	9
	(Report 6)		9

Deliverable type	Name or description		Associated task
	10) Surface Water Hydrology	Review ORASECOM Hydrology	10
	(Report 7)	Stochastic hydrology validation verification	10
		Historic Yield analysis	10
		Report on the review and evaluation and document findings from the yield analyses and related comparisons	10
	11) Water Quality	Report describing the findings from this task	11
	(Report 8)	Compile a set of interim Resource Water Quality Objectives	11
		Identify the water quality issues	11
	12) Reserve Requirement Scenarios & Scheme Yield	Summary of reserve classifications of rivers affected by possible schemes Yield Analysis Report (Chapters in Report 7) Timing of future schemes	12
	(Report 7)	WRYM data in ASCII and WRYM-IMS database format	12
	13) Ground Water	Input to the groundwater section of the reconciliation report	13
	(Report 10)		
	14) Review schemes and update cost estimates	Report on possible development interventions, their costs, and URVs	14
	(Report 9)	Re-assess the configurations of the identified schemes	14
	15)Review & Assess social & environmental Impacts	Summary of findings on social and environmental impacts A chapter in the Reconciliation Scenarios Report	15
	(Report 10)	Key social impacts of identified schemes	15
		Key environmental drivers in the river	
	16) Assembly of Information and formulation of Scenarios	Reconciliation Scenarios Report integrating the finding of the previous tasks and recommended development / management options	16
	(Report 10)	Preliminary Strategy Report	16
	(Report 11)	Final Strategy Report	
	(Report 12)	Layman-friendly executive summary	
	17) Final Screening Workshop	Starter document for workshop	17
		Summary document with workshop proceedings and final recommendations	17
	18) International Support	Chapter in report 3 of Task 4 containing relevant information from this task	19
	(Report 3)		
Models	WRYM-IMS Integrated Water Resources Yield Model		10
	WRPM Integrated Water resources Planning model		12

Deliverable type	Name or description	Associated task
Data on CD/DVD	Previous reports in electronic format	2
	All the study reports	All tasks'
	Data sets and input data for all the models used	10, 12
	Water demand and return flow data base	6 & 8
Presentation Material on CD	Presentations at first stakeholder meeting	18 & others
	Final Public meeting	18 & others
	Presentations at SCC	18 & others
Stakeholder engagement:	Two public meetings	18
	Present the findings of the preliminary and final workshops	18
	Four Study Steering Committee meetings	18
	Two newsletters	18
Workshop 1	Workshop starter and proceedings document (SSC 2)	3
	List of options and schemes to include in strategy	3
Workshop 2	Workshop starter and proceedings document (SSC 3)	17
	List of options and schemes to include in strategy	17

4 STUDY TEAM

The names and rates of the team members involved with the *Development of Reconciliation Strategies for Bulk Water Supply Systems: Orange River* are presented in **Tables 4.1**.

Table 4.1: Study team members for Reconciliation Strategies Study for the Orange River Bulk Water Supply Systems

Name	Responsibility Level	Position in team	Hourly Rate (R/hr)	Rate Base
Aurecon				
Tanner A	E	Task Leader	R1 300.00	Negotiated
Beumer J	E	Task Leader	R1 100.00	Negotiated
Smit B	E	Task Leader	R1 100.00	Negotiated
Van Wyk D	E	Dam Specialist	R1 100.00	Negotiated
Chemaly A	E	Dam Specialist	R1 100.00	Negotiated
Levin M Dr	E	Geohydrologist	R1 100.00	Negotiated
Timm D	E	Specialist	R1 100.00	Negotiated
Small R	D	Specialist	R1 100.00	Negotiated
Botha P Dr.	D	Key Support	R1 069.45	Negotiated
Botha L	B	Support	R 283.00	16.5c/100
Sebego T	D	Key Support	R 650.00	17.5c/100
Blaauw C	D	Key Support	R 603.37	17.5c/100
Lötter K	B	Support	R 338.00	16.5c/100
Perold J Dr	D	Key Support	R 730.00	17.5c/100
Stroebel L	D	Key Support	R 862.43	Negotiated
Van Zyl J	C	Key Support	R 361.09	16.5c/100
Vogel SC	E	Key Support	R1 100.00	Negotiated

Fölscher J	B	Support	R 300.00	16.5c/100
Rorke N	B	Support	R 250.00	16.5c/100
Mahumela M	B	Support	R 202.10	16.5c/100
Ekolo L	C	Key Support	R 609.48	17.5c/100
Golder Associates Africa (Pty) Ltd				
Coleman T	E	Task Leader	R 1 100.00	Negotiated
De Wet N	D	Key Support	R 900.00	Negotiated
Du Toit J	C	Key Support	R 680.00	17.5c/100
Du Toit I	B	Support	R 550.00	16.5c/100
Howcroft J	E	Task Leader	R 1 100.00	Negotiated
Hubert G	E	Task Leader	R 1 100.00	Negotiated
Molete O	B	Support	R 550.00	16.5c/100
Moodley P	C	Key Support	R 880.00	17.5c/100
Rutherfoord J	E	Specialist	R 850.00	Negotiated
van Niekerk A	E	Specialist	R 1 300.00	Negotiated
Wiegemans F	E	Task Leader	R 1 100.00	Negotiated
WRP Consulting Engineers (Pty) Ltd				
Aird R	E	Specialist	950.00	Negotiated
de Sousa P	B	Support	475.00	16.5c/100
Mabuza N	B	Support	252.00	16.5c/100
Mare HG	E	Task Leader	1 100.00	17.5c/100
Neethling C	B	Support	362.00	16.5c/100
Ramsden P	E	Specialist	1 100.00	Negotiated
Renke R	B	Support	495.00	16.5c/100
Scheepers H	B	Support	420.00	16.5c/100
Seago C	C	Key Support	1 000.00	17.5c/100
Siqalaba Z	C	Key Support	880.00	17.5c/100
Talanda C	C	Key Support	880.00	17.5c/100
van Rooyen PG	E	Project Manager	1 300.00	Negotiated
Wegelin W	E	Task Leader	1 100.00	Negotiated
Zitholele Consulting				
Venter N	C	Task Leader	R600.00	17.5c/100
Mnqokoyi P	B	Support	R420.00	16.5c/100
Rambuda F	B	Support	R420.00	16.5c/100

5 STUDY COSTS

5.1 PROFESSIONAL FEES

The breakdown of the input by task for each team member is indicated in the, “Human Resources and Time Schedule Chart” in **Table C-1** of **Appendix C**. A summary of the proposed professional fees for the various tasks is provided in **Table 5.1**. It should be noted that the professional fee rates at the time of tendering for the study were based on prevailing cost as at the end of August 2011, after which they will be subject to an annual increase based on the CPIX escalation which will take effect on the **1st September** each year following 2011 for negotiated rates. Salary increases will apply for non-negotiated rates in the month of the year that each consulting firm reviews its annual

salary increases, normally the 1 April of each year. For the purpose of cost estimate, an annual escalation rate of 5% has been used.

Table 5.1: Summary of professional fees by task.

Task		Professional Fees (R)			% of Total
No.	Description	Excl. VAT	VAT	Incl. VAT	
1	Inception report	337 520	47 253	384 773	5%
2	Summary of previous and current studies	206 683	28 936	235 618	3%
3	Preliminary screening workshop	368 393	51 575	419 968	5%
4	International obligations	171 325	23 986	195 311	3%
5	Current and future water requirements	317 638	44 469	362 107	5%
6	Urban water conservation and water demand management	195 833	27 417	223 249	3%
7	Opportunities for water re-use	188 870	26 442	215 312	3%
8	Irrigation demands and WC/WDM	261 564	36 619	298 183	4%
9	Value of irrigation water	125 269	17 538	142 807	2%
10	Surface water hydrology andsystem Analysis	275 453	38 563	314 016	4%
11	Water quality	286 913	40 168	327 081	4%
12	Reserve requirement scenarios and scheme yields	360 392	50 455	410 846	5%
13	Groundwater	210 800	29 512	240 311	3%
14	Review schemes and update cost estimates	417 742	58 484	476 226	6%
15	Review or assess social and environmental impacts	265 692	37 197	302 889	4%
16	Assembly of information and formulation of scenarios	934 763	130 867	1 065 629	14%
17	Final screening workshop	225 624	31 587	257 211	3%
18	Public participation	354 642	49 650	404 292	5%
19	International Support	155 002	21 700	176 702	2%
20	Study management	1 041 362	145 791	1 187 152	16%
	Total	**6 701 478**	**938 207**	**7 639 685**	**100%**

A summary of the allocation of professional fees to each participating entity is given in **Table 5.2**.

Table 5.2: Professional fees allocated to each participating entity.

Company	Hours	Professional fees '®			% of Total
		Excl. VAT	VAT	Incl. VAT	
Aurecon	2 374	2 060 594	288 483	2 349 078	31%
Golder	1 397	1 254 478	175 627	1 430 105	19%
WRP	3 162	2 855 304	399 743	3 255 047	43%
Zitholele	812	411 101	57 554	468 656	6%
All (training)	120	120 000	16 800	136 800	2%
Total	**7 865**	**6 701 478**	**938 207**	**7 639 685**	100%

5.2 HDI INVOLVEMENT

The breakdown of professional fees allocated to each team member is provided in **Table 5.3**, which highlights the extent of involvement of Historically Disadvantaged Individuals (HDI). From **Table 5.3** a total of 25% of the professional fees has been allocated to HDI Study Team members.

Table 5.3: Breakdown of professional involvement according to HDI status.

Consulting Firm / Name	HDI Status	Professional Involvement		
		Hours	Fees (R, excl. VAT)	% of Fees
Aurecon				
Beumer J	White Male	322	365 346	5.5%
Blaauw C	White Male	205	127 730	1.9%
Botha L	White Female	47	13 359	0.2%
Botha P	White Male	62	69 060	1.0%
Chemaly A	White Male	16	17 903	0.3%
Folscher J	White Female	155	48 825	0.7%
Levin M	White Male	56	64 680	1.0%
Lötter K	White Female	159	56 277	0.8%
Mahumela M	Black Female	158	33 528	0.5%
Perold	White Male	64	49 078	0.7%
Smal R	White Male	160	183 920	2.7%
Smit B	White Male	106	120 670	1.8%
Stroebel L	White Male	15	13 583	0.2%
Tanner A	White Male	498	671 294	10.0%
van Wyk D	White Male	16	17 903	0.3%
van Zyl J	White Female	232	86 055	1.3%
Vogel SC	White Male	107	121 385	1.8%
Sub-total		**2 374**	**2 060 594**	30.7%
Golder				
Coleman T	White Male	188	212 465	3.2%
de Wet N	White Male	268	249 683	3.7%
du Toit J	White Male	125	89 464	1.3%
du Toit I	White Female	96	55 151	0.8%
Howcroft J	White Male	31	35 805	0.5%
Hubert G	White Male	78	87 670	1.3%
Molete O	Black Male	144	83 160	1.2%
Moodley P	Black Female	173	157 168	2.3%
Rutherfoord J	White Male	213	185 629	2.8%
van Niekerk A	White Male	16	20 898	0.3%
Wiegemans F	White Male	67	77 385	1.2%
WRP				
Aird R	White Male	96	92 720	1.4%
de Sousa P	White Male	16	7 695	0.1%
Mabuza N	Black Male	142	37 019	0.6%
Mare HG	White Male	571	644 683	9.6%
Neethling C	White Female	200	74 138	1.1%
Ramsden P	White Male	278	319 128	4.8%
Renke R	White Female	238	120 483	1.8%
Scheepers H	White Female	348	160 560	2.4%
Seago C	White Female	427	440 200	6.6%
Siqalaba Z	Black Female	166	97 269	1.5%
Talanda C	White Male	49	44 088	0.7%
van Rooyen PG	White Male	495	662 058	9.9%
Wegelin W	White Male	138	155 265	2.3%
Zitholele				
Venter N	White Female	329	203 067	3.0%
Mnqokoyi P	Black Female	280	120 918	1.8%
Rambuda F	Black Female	202	87 116	1.3%
Sub-total		**812**	**411 101**	6.1%
All (Training)				
All (Training)		120	120 000	1.8%
Total		**7 865**	**6 701 478**	100%
HDI Component		**3 494**	**1 874 293**	**28%**

5.3 DISBURSEMENTS

The estimated disbursement costs for the various tasks are summarised in **Table 5.4**. The proposed tariffs for reimbursable expenses remain as outlined in the proposal.

Table 5.4: Summary of disbursement costs.

Task		Disbursement Cost (R)			% of Total
No.	Description	Excl. VAT	VAT	Incl. VAT	
1	Inception report	13 392	1 875	15 267	1.8%
2	Summary of previous and current studies	15 692	2 197	17 889	2.1%
3	Preliminary screening workshop	24 000	3 360	27 360	3.2%
4	International obligations	4 419	619	5 037	0.6%
5	Current and future water requirements	9 546	1 336	10 882	1.3%
6	Urban water conservation and water demand management	16 720	2 341	19 061	2.2%
7	Opportunities for water re-use	9 896	1 385	11 281	1.3%
8	Irrigation demands and WC/WDM	14 250	1 995	16 245	1.9%
9	Value of irrigation water	33 000	4 620	37 620	4.4%
10	Surface water hydrology andsystem Analysis	9 896	1 385	11 281	1.3%
11	Water quality	7 528	1 054	8 582	1.0%
12	Reserve requirement scenarios and scheme yields	3 800	532	4 332	0.5%
13	Groundwater	18 024	2 523	20 547	2.4%
15	Review or assess social and environmental impacts	31 000	4 340	35 340	4.1%
16	Assembly of information and formulation of scenarios	32 992	4 619	37 611	4.4%
17	Final screening workshop	15 700	2 198	17 898	2.1%
18	Public participation	24 800	3 472	28 272	3.3%
19	International Support	3 500	490	3 990	0.5%
20	Study management	121 149	16 961	138 110	16.2%
	Venue hire rates	144 900	20 286	165 186	19.3%
	Printing and report reproduction	90 679	12 695	103 374	12.1%
	Miscellaneous rates	71 648	10 031	81 678	9.6%
	Total	**749 091**	**104 873**	**853 963**	**100.0%**

5.4 CONTINGENCIES

No allowance for contingencies has been made and any additional costs due to change in scope of work will be motivated as additional work with the Client requesting approval for an variation order to cover the additional professional fees and disbursements. This will however be avoided as far as possible.

5.5 SUMMARY OF COSTS

A summary of the costs for the *Development of a Reconciliation Strategies for Bulk Water Supply Systems: Orange River* is provided in **Table 5.5**. This includes professional fees, disbursements and office infrastructure costs. Please note that this does not include any additional work still to be approved by the Client.

Table 5.5: Summary of costs.

Cost Item	Cost (R)			% of Total
	Excl. VAT	VAT	Incl. VAT	
Professional Fees	6 701 478	938 207	7 639 685	89.9%
Disbursements	749 091	104 873	853 963	10.1%
Office infrastrusture costs	0	0	0	0.0%
TOTAL	**7 450 568**	**1 043 080**	**8 493 648**	**100%**

5.6 COMPARISON OF COSTS

The estimated cost as included in the Inception report remained unchanged to that given in the proposal. No detail comparison is therefore included

6 STUDY RISKS DUE TO UNCERTAINTIES

A number of factors have been identified that may influence the execution and completion of the study. These factors can influence both the cost and the timing of the Study. **Table 6.1** provides a summary of the possible delays and an explanation of these.

Table 6.1: Possible delays to the study programme resulting from Study uncertainties.

No.	Task description	Possible Delay (weeks)
	Current and Future water requirements & Irrigation demands	
1	Land use data from the Validation verification study. The information from this study might not be available in time for use in this study	3

7 REFERENCES

WRC (1994) **Surface Water Resources of South Africa 1990**. Suite of reports compiled by the Water Research Commission, Pretoria, South Africa.

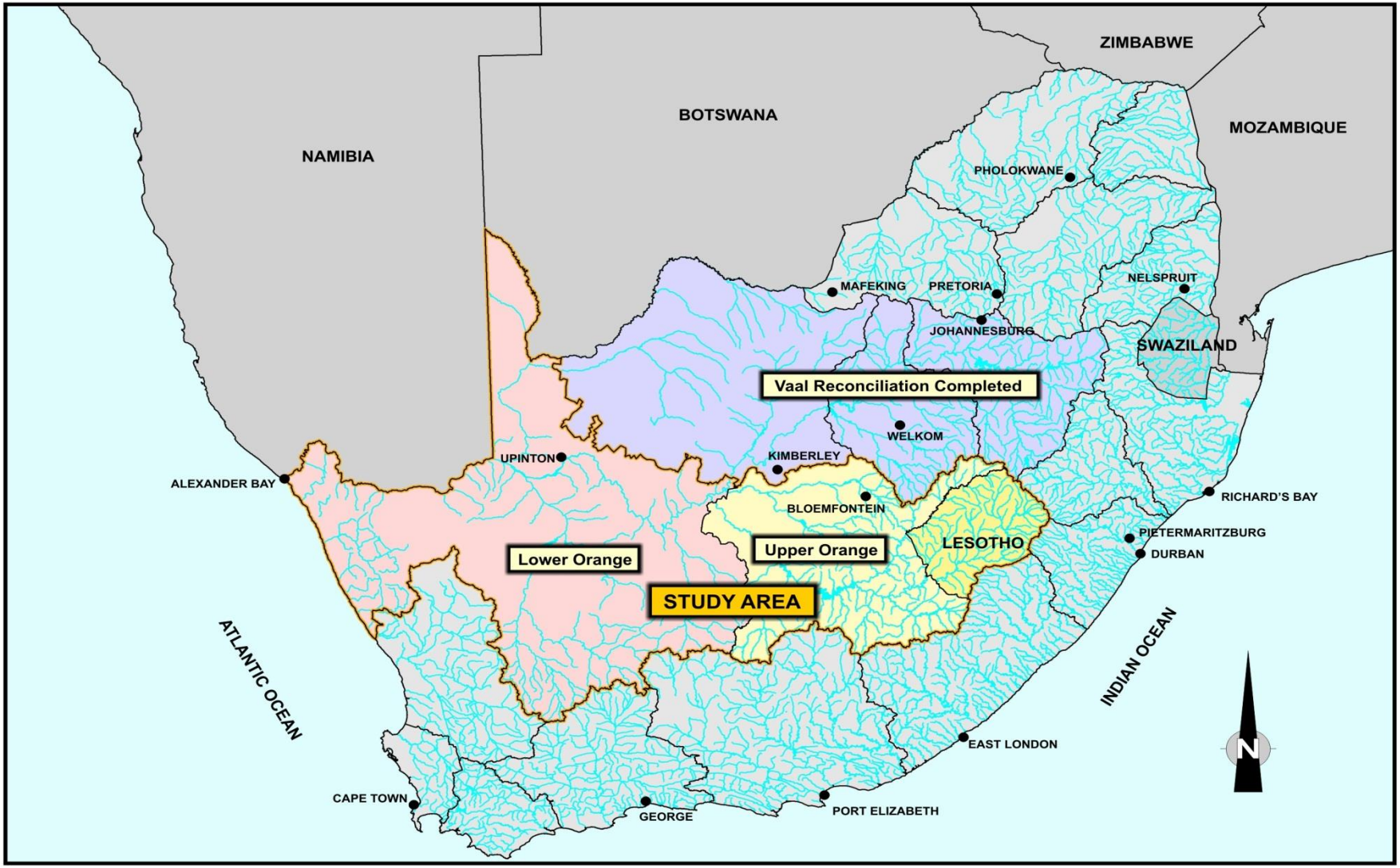
Authors: Midgley, DC, Pitman, WV and Middleton, BJ

DWA (2009) **Vaal River System: Large Bulk Water Supply Reconciliation Strategy**. Prepared by DMM, Golder, SRK, WRP & Zitholele for DWAF, RSA. Report no. P RSA C000/00/4406/08

DWA(2012) **Water Reconciliation Strategy Study for Large Bulk Water Supply Systems: Greater Bloemfontein Area**. Prepared by Aurecon for DWA, RSA. Report no.

Appendix A

Map of the Study Area



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DEVELOPMENT OF RECONCILIATION STRATEGIES FOR
LARGE BULK WATER SUPPLY SYSTEMS: ORANGE RIVER: PROPOSAL

Study area locality map

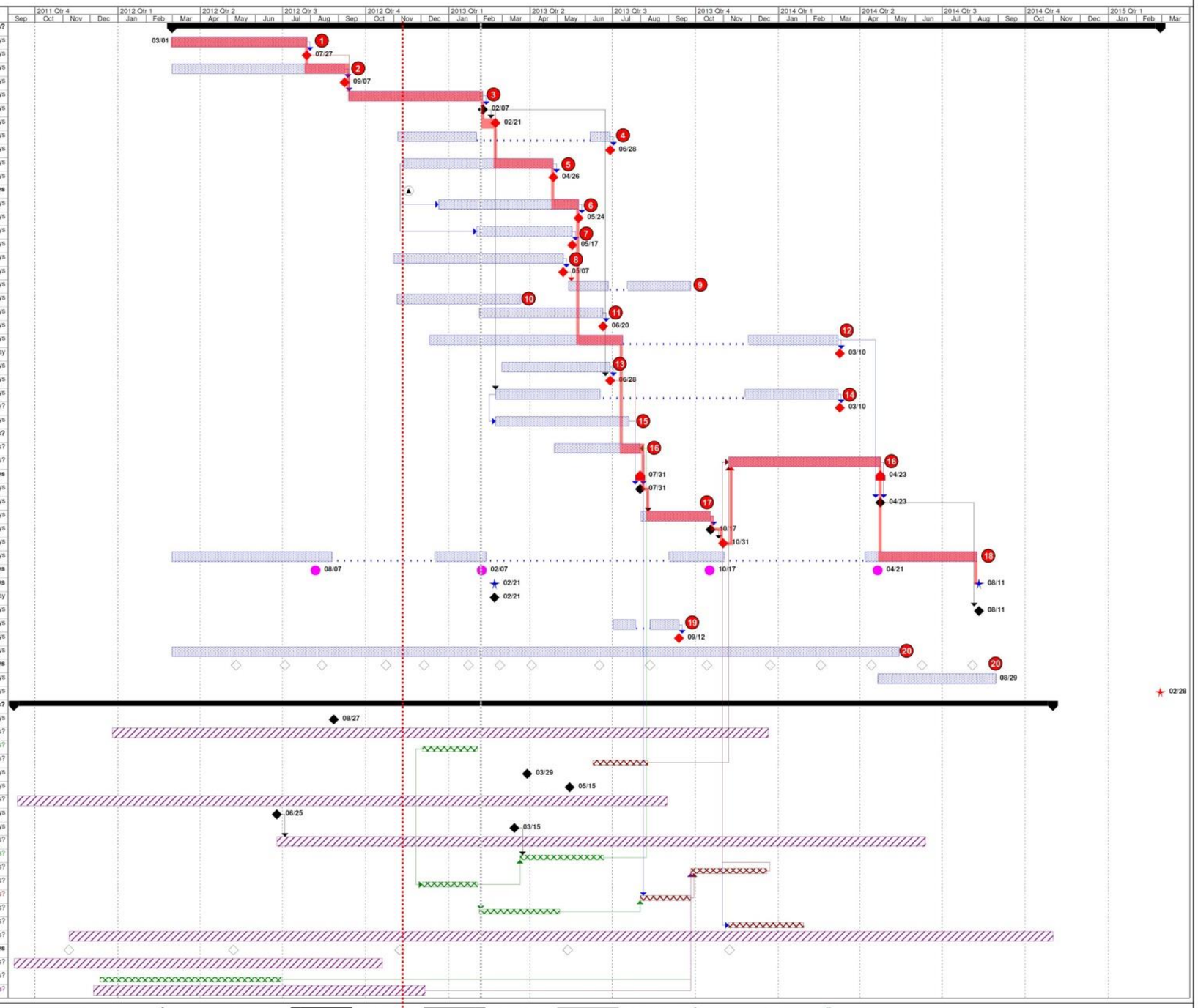
Appendix B

Bar-Chart of Study Programme

DEVELOPMENT OF RECONCILIATION STRATEGIES FOR LARGE BULK WATER SUPPLY SYSTEMS: ORANGE RIVER

(INCEPTION PROGRAMME)

ID	Task Name	Start	Duration
1	**Reconciliation Study for the Orange River System**	**Thu 12/03/01**	**789 days?**
2	**Task 1: Inception Report**	Thu 12/03/01	107 days
3	Inception Report (1)	Fri 12/07/27	0 days
4	**Task 2: Summary of Previous and Current Studies**	Thu 12/03/01	138 days
5	Summary Document (2)	Fri 12/09/07	0 days
6	**Task 3: Preliminary Screening Workshop (preparation)**	Thu 12/09/13	107 days
7	Preliminary Screening Workshop & starter document (a)	Thu 13/02/07	0 days
8	Workshop Proceedings (b)	Thu 13/02/21	0 days
9	**Task 4: International Obligations**	Tue 12/11/06	80 days
10	International Obligations Report (3a)	Fri 13/06/28	0 days
11	**Task 5: Current and Future Water Requirements**	Mon 12/11/12	121 days
12	Water requirements and Return Flow Report (4)	Fri 13/04/26	0 days
13	**Updated Database**	**Sun 12/11/18**	**0 days**
15	**Task 6: Urban Water Conservation and Water Demand Management**	Fri 12/12/21	112 days
16	Urban WC/WDM Report (5a)	Fri 13/05/24	0 days
17	**Task 7: Opportunities for re-use**	Fri 13/02/01	77 days
18	Reuse Report (5b)	Fri 13/05/17	0 days
19	**Task 8: Irrigation Demands and WC/WDM**	Thu 12/11/01	136 days
20	Irrigation Report (6a)	Tue 13/05/07	0 days
21	**Task 9: Value of irrigation water**	Tue 13/05/14	82 days
22	**Task 10: Surface Water Hydrology (Review, Stochastics & Analysis)**	Mon 12/11/05	100 days
23	**Task 11: Water Quality**	Mon 13/02/04	100 days
24	Water Quality Report (8)	Thu 13/06/20	0 days
25	**Task 12: Reserve Requirement Scenarios and Scheme Yields**	Tue 12/12/11	229 days
26	System Analysis Report (7a + 7b)	Mon 14/03/10	1 day
27	**Task 13: Groundwater**	Fri 13/03/01	87 days
28	Groundwater options Report (10)	Fri 13/06/28	0 days
29	**Task 14 Review Schemes and Update Cost Estimates**	Fri 13/02/22	161 days
30	Scheme Report (11)	Mon 14/03/10	1 day?
31	**Task 15: Review and Assess Socio and Environmental Impacts**	Fri 13/02/22	107 days
32	**Task 16: Assembly of Information and Formulation of Scenario's**	**Sun 13/04/28**	**262 days?**
33	Scenario 1: Preliminary (9a)	Sun 13/04/28	69 days?
34	Scenario 2: Final (9b)	Thu 13/11/07	123 days?
35	**Integrated Strategy Reports (Preliminary and Final) (9b)**	**Wed 13/07/31**	**193 days**
36	Integrated Strategy Report 1	Wed 13/07/31	0 days
37	Integrated Strategy Report 2	Wed 14/04/23	0 days
38	**Task 17: Final Screening Workshop Preparation**	Fri 13/08/02	55 days
39	Workshop & Starter document (c)	Thu 13/10/17	0 days
40	Workshop Proceedings (d)	Thu 13/10/31	0 days
41	**Task 18: Public Participation**	Thu 12/03/01	305 days
42	**Strategy Steering Committee Meetings - (four)**	**Tue 12/08/07**	**449 days**
47	**Public Meetings - (two)**	**Thu 13/02/21**	**387 days**
48	1	Thu 13/02/21	1 day
49	2	Mon 14/08/11	0 days
50	**Task 19: International Support**	Tue 13/07/02	43 days
51	International Study Contribution Report (3b)	Thu 13/09/12	0 days
52	**Task 20: Study management**	Thu 12/03/01	581 days
53	**Study Management Meetings**	**Fri 12/05/11**	**588 days**
70	Study termination	Mon 14/04/21	96 days
71	End date	Sat 15/02/28	0 days
72	**Parallel Water Management Activities**	**Thu 11/09/08**	**829 days?**
73	**ORASECOM Phase 2 (Fish River Hydrology)**	Mon 12/08/27	0 days
74	**ORASECOM: UNDP-GEF Orange-Senqu Strategic Action Programme**	Mon 11/12/26	523 days?
75	Ecological water quality requirements (Timing uncertain)	Mon 12/12/03	45 days?
76	EFR Scenarios for evaluation (Timing Uncertain)	Mon 13/06/10	45 days?
77	Ecological water requirements (river)	Fri 13/03/29	0 days
78	Estuary water requirements	Wed 13/05/15	0 days
79	**WQT Calibration Study**	Mon 11/09/12	518 days?
80	Data for use by other processes	Mon 12/06/25	0 days
81	WRPM Calibrated	Fri 13/03/15	0 days
82	**Development of Integrated Water Quality Management Plan (Orange River)**	Mon 12/06/25	521 days?
83	Evaluation of water quality options (1st iteration)	Thu 13/03/21	68 days?
84	Evaluation of water quality options (2nd iteration)	Thu 13/09/26	60 days?
85	Development of RWQO (1st iteration)	Mon 12/12/03	45 days?
86	Development of RWQO (2nd iteration final)	Thu 13/08/01	40 days?
87	IWQPM and Preliminary Strategy	Mon 13/02/04	66 days?
88	IWQPM and Final Strategy	Thu 13/11/07	60 days?
89	**Maintenance of the Vaal River Reconciliation Strategy**	Tue 11/11/08	786 days?
90	Strategy Steering Committee Meetings	**Tue 11/11/08**	**526 days**
96	**Vaal River System Classification Study**	Thu 11/09/08	293 days?
97	Scenario Evaluation	Mon 11/12/12	145 days?
98	**Acid Mine Drainage Feasibility Study (Vaal)**	Mon 11/12/05	265 days?



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

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Appendix C

Detail Cost Tables

Table C-1: Human resources and time schedule

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
1	**Inception report**								
		Mare HG	WRP	E	17.5c/100	Task Leader	28	1 100	30 800
		van Rooyen PG	WRP	E	Negotiated	Project Manager	16	1 300	20 800
		Wegelin W	WRP	E	Negotiated	Task Leader	44	1 100	48 400
		Seago C	WRP	C	17.5c/100	Key Support	24	1 000	24 000
		Ramsden P	WRP	E	Negotiated	Specialist	24	1 100	26 400
		Rutherfoord J	Golder	E	Negotiated	Specialist	24	850	20 400
		Coleman T	Golder	E	Negotiated	Task Leader	24	1 100	26 400
		Venter N	Zitholele	C	17.5c/100	Task Leader	16	600	9 600
		Beumer J	Aurecon	E	Negotiated	Task Leader	24	1 100	26 400
		Tanner A	Aurecon	E	Negotiated	Task Leader	16	1 300	20 800
		Smit B	Aurecon	E	Negotiated	Task Leader	24	1 100	26 400
		Aird R	WRP	E	Negotiated	Specialist	24	950	22 800
		Hubert G	Golder	E	Negotiated	Task Leader	24	1 100	26 400
		Renke R	WRP	B	16.5c/100	Support	16	495	7 920
	Sub-total for Task 1						**328**		**337 520**
2	**Summary of previous and current studies**								
		Mare HG	WRP	E	17.5c/100	Task Leader	31	1 100	34 100
		van Rooyen PG	WRP	E	Negotiated	Project Manager	16	1 300	20 800
		Wegelin W	WRP	E	Negotiated	Task Leader	16	1 100	17 600
		Scheepers H	WRP	B	16.5c/100	Support	42	450	18 743
		Seago C	WRP	C	17.5c/100	Key Support	16	1 000	16 000
		Ramsden P	WRP	E	Negotiated	Specialist	8	1 100	8 800
		Rutherfoord J	Golder	E	Negotiated	Specialist	16	850	13 600
		Moodley P	Golder	C	17.5c/100	Key Support	24	880	21 120
		Beumer J	Aurecon	E	Negotiated	Task Leader	16	1 100	17 600
		Tanner A	Aurecon	E	Negotiated	Task Leader	4	1 300	5 200
		Smit B	Aurecon	E	Negotiated	Task Leader	8	1 100	8 800
		Aird R	WRP	E	Negotiated	Specialist	8	950	7 600
		Hubert G	Golder	E	Negotiated	Task Leader	8	1 100	8 800
		Renke R	WRP	B	16.5c/100	Support	16	495	7 920
	Sub-total for Task 2						**229**		**206 683**

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
3.0	**Preliminary screening workshop**								
		Beumer J	Aurecon	E	Negotiated	Task Leader	80	1 100	88 036
		van Rooyen PG	WRP	E	Negotiated	Project Manager	32	1 300	41 600
		Mare HG	WRP	E	17.5c/100	Task Leader	16	1 100	17 600
		Tanner A	Aurecon	E	Negotiated	Task Leader	32	1 300	41 730
		Coleman T	Golder	E	Negotiated	Task Leader	16	1 100	17 160
		Mnqokoyi P	Zitholele	B	16.5c/100	Support	7	420	3 024
		Venter N	Zitholele	C	17.5c/100	Task Leader	26	600	16 115
		Blaauw C	Aurecon	D	17.5c/100	Key Support	64	603	38 773
		Botha L	Aurecon				47	283	13 359
		Smal R	Aurecon	D	Negotiated	Specialist	24	1 100	26 840
		van Zyl J	Aurecon	C	16.5c/100	Key Support	104	361	37 537
		Hubert G	Golder	E	Negotiated	Task Leader	16	1 100	17 820
		Vogel SC	Aurecon				8	1 100	8 800
	Sub-total for Task 3						**471**		**368 393**
4.0	**International obligations**								
		Ramsden P	WRP	E	Negotiated	Specialist	112	1 100	129 556
		Tanner A	Aurecon	E	Negotiated	Task Leader	31	1 300	41 769
	Sub-total for Task 4						**143**		**171 325**
5.0	**Current and future water requirements**								
		Mare HG	WRP	E	17.5c/100	Task Leader	48	1 100	53 900
		Talanda C	WRP	C	17.5c/100	Key Support	49	880	44 088
		Scheepers H	WRP	B	16.5c/100	Support	60	450	27 698
		Seago C	WRP	C	17.5c/100	Key Support	57	1 000	58 450
		Aird R	WRP	E	Negotiated	Specialist	64	950	62 320
		Renke R	WRP	B	16.5c/100	Support	30	495	15 147
		de Sousa P	WRP	B	16.5c/100	Support	16	475	7 695
		Vogel SC	Aurecon				40	1 100	44 440
		van Rooyen PG	WRP	E	Negotiated	Project Manager	3	1 300	3 900
	Sub-total for Task 5						**367**		**317 638**

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
6.0	**Urban water conservation and water demand management (WC/WDM)**								
		Wegelin W	WRP	E	Negotiated	Task Leader	54	1 100	61 545
		Siqalaba Z	WRP	C	17.5c/100	Key Support	166	567	97 269
		Mabuza N	WRP	B	16.5c/100	Support	142	252	37 019
	Sub-total for Task 6						**362**		**195 833**
7.0	**Opportunities for water re-use**								
		Coleman T	Golder	E	Negotiated	Task Leader	48	1 100	55 000
		van Niekerk A	Golder	E	Negotiated	Specialist	16	1 300	20 898
		de Wet N	Golder	D	Negotiated	Key Support	121	900	112 973
	Sub-total for Task 7						**184**		**188 870**
8	**Irrigation demands and WC/WDM**								
		Rutherfoord J	Golder	E	Negotiated	Specialist	143	850	124 854
		de Wet N	Golder	D	Negotiated	Key Support	147	900	136 710
	Sub-total for Task 8						**290**		**261 564**
9.0	**Value of irrigation water**								
		Howcroft J	Golder	E	Negotiated	Task Leader	31	1 100	35 805
		du Toit J	Golder	C	17.5c/100	Key Support	125	680	89 464
	Sub-total for Task 9						**156**		**125 269**
10.0	Surface water hydrology andsystem Analysis								
		Seago C	WRP	C	17.5c/100	Key Support	106	1 000	106 550
		Scheepers H	WRP	B	16.5c/100	Support	118	450	53 640
		Mare HG	WRP	E	17.5c/100	Task Leader	61	1 100	68 475
		van Rooyen PG	WRP	E	Negotiated	Project Manager	26	1 300	34 710
		Renke R	WRP	B	16.5c/100	Support	24	495	12 078
	Sub-total for Task 10						**335**		**275 453**
11.0	**Water quality**								
		Coleman T	Golder	E	Negotiated	Task Leader	60	1 100	67 705
		Moodley P	Golder	C	17.5c/100	Key Support	149	880	136 048
		Molete O	Golder	B	16.5c/100	Support	144	550	83 160
	Sub-total for Task 11						**353**		**286 913**

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
12.0	**Reserve requirement scenarios and scheme yields**								
		Seago C	WRP	C	17.5c/100	Key Support	148	1 000	155 400
		Scheepers H	WRP	B	16.5c/100	Support	107	450	50 558
		Mare HG	WRP	E	17.5c/100	Task Leader	91	1 100	105 105
		van Rooyen PG	WRP	E	Negotiated	Project Manager	27	1 300	36 855
		Renke R	WRP	B	16.5c/100	Support	24	495	12 474
	Sub-total for Task 12						**397**		**360 392**
13.0	**Groundwater**								
		Wiegemans F	Golder	E	Negotiated	Task Leader	67	1 100	77 385
		Levin M	Aurecon	E	Negotiated	Geohydrologist	56	1 100	64 680
		Stroebel L	Aurecon	D	Negotiated	Key Support	15	862	13 583
		du Toit I	Golder	B	16.5c/100	Support	96	550	55 151
	Sub-total for Task 13						**234**		**210 800**
14.0	**Review schemes and update cost estimates**								
		Beumer J	Aurecon	E	Negotiated	Task Leader	94	1 100	108 570
		Vogel SC	Aurecon				43	1 100	49 665
		Tanner A	Aurecon	E	Negotiated	Task Leader	27	1 300	36 855
		Blaauw C	Aurecon	D	17.5c/100	Key Support	141	603	88 958
		van Wyk D	Aurecon	E	Negotiated	Dam Specialist	16	1 100	17 903
		Chemaly A	Aurecon	E	Negotiated	Dam Specialist	16	1 100	17 903
		van Rooyen PG	WRP	E	Negotiated	Project Manager	39	1 300	52 553
		Mare HG	WRP	E	17.5c/100	Task Leader	24	1 100	27 143
		van Zyl J	Aurecon	C	16.5c/100	Key Support	48	361	18 194
	Sub-total for Task 14						**446**		**417 742**

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
15.0	**Review or assess social and environmental impacts**								
		Smit B	Aurecon	E	Negotiated	Task Leader	50	1 100	57 750
		Botha P	Aurecon	D	Negotiated	Key Support	62	1 069	69 060
		Mahumela M	Aurecon	B	16.5c/100	Support	158	202	33 528
		Perold	Aurecon				64	730	49 078
		Lötter K	Aurecon				159	338	56 277
	Sub-total for Task 15						**492**		**265 692**
16.0	**Assembly of information and formulation of scenarios**								
		Tanner A	Aurecon	E	Negotiated	Task Leader	190	1 300	259 350
		van Rooyen PG	WRP	E	Negotiated	Project Manager	64	1 300	87 360
		Mare HG	WRP	E	17.5c/100	Task Leader	32	1 100	36 960
		Beumer J	Aurecon	E	Negotiated	Task Leader	40	1 100	46 200
		Ramsden P	WRP	E	Negotiated	Specialist	16	1 100	18 480
		Wegelin W	WRP	E	Negotiated	Task Leader	24	1 100	27 720
		Coleman T	Golder	E	Negotiated	Task Leader	40	1 100	46 200
		Rutherfoord J	Golder	E	Negotiated	Specialist	30	850	26 775
		Scheepers H	WRP	B	16.5c/100	Support	21	450	9 923
		Seago C	WRP	C	17.5c/100	Key Support	76	1 000	79 800
		Hubert G	Golder	E	Negotiated	Task Leader	30	1 100	34 650
		Smit B	Aurecon	E	Negotiated	Task Leader	24	1 100	27 720
		Venter N	Zitholele	C	17.5c/100	Task Leader	37	600	23 310
		Mngokoyi P	Zitholele	B	16.5c/100	Support	10	420	4 410
		Folscher J	Aurecon	B	16.5c/100	Support	155	300	48 825
		Smal R	Aurecon	D	Negotiated	Specialist	136	1 100	157 080
	Sub-total for Task 16						**925**		**934 763**
17.0	**Final screening workshop**								
		Beumer J	Aurecon	E	Negotiated	Task Leader	68	1 100	78 540
		van Rooyen PG	WRP	E	Negotiated	Project Manager	32	1 300	43 680
		Tanner A	Aurecon	E	Negotiated	Task Leader	40	1 300	54 600
		van Zyl J	Aurecon	C	16.5c/100	Key Support	80	361	30 324
		Vogel SC	Aurecon				16	1 100	18 480
	Sub-total for Task 17						**236**		**225 624**

No.	Description	Manpower, Time and Cost Schedule							
		Name	Company/ Firm	Fee Category	Rate Base	Study Position	Time Schedule (Manhours)	Hourly Rate (Rand/hour)	Costs Excl VAT (Rand)
18.00	**Public participation**								
		Venter N	Zitholele	C	17.5c/100	Task Leader	250	600	154 042
		Rambuda F	Zitholele	B	16.5c/100	Support	202	420	87 116
		Mnqokoyi P	Zitholele	B	16.5c/100	Support	263	420	113 484
	Sub-total for Task 18						**715**		**354 642**
19.00	**International Support**								
		Ramsden P	WRP	E	Negotiated	Specialist	118	1 100	135 892
		Tanner A	Aurecon	E	Negotiated	Task Leader	14	1 300	19 110
	Sub-total for Task 19						**132**		**155 002**
20.00	**Study management**								
		van Rooyen PG	WRP	E	Negotiated	Project Manager	240	1 300	319 800
		Mare HG	WRP	E	17.5c/100	Task Leader	240	1 100	270 600
		Neethling C	WRP	B	16.5c/100	Support	200	362	74 138
		Renke R	WRP	B	16.5c/100	Support	128	495	64 944
		Tanner A	Aurecon	E	Negotiated	Task Leader	144	1 300	191 880
		Trainer	All				120	1 000	120 000
	Sub-total for Task 20						**1072**		**1 041 362**
Totals:							**7865**	**-**	**6 701 478**

Table C-2a : Cash flow projection (month 1 to 12)

Task	Description	Mar 2012	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
1	**Inception report**				89 560	86 960	64 200	96 800					
2	**Summary of previous and current studies**			40 440	33 540	32 860	36 443	30 400	33 000				
3	**Preliminary screening workshop**								56 877	52 584	41 546	75 422	98 946
4	**International obligations**												
5	**Current and future water requirements**										50 540	47 375	72 565
6	**Urban water conservation and water demand management (WC/WDM)**												58 773
7	**Opportunities for water re-use**												32 000
8	**Irrigation demands and WC/WDM**											30 500	64 600
9	**Value of irrigation water**												
10	**Surface water hydrology andsystem Analysis**									38 760	39 100	47 900	64 160
11	**Water quality**												64 460
12	**Reserve requirement scenarios and scheme yields**												
13	**Groundwater**												
14	**Review schemes and update cost estimates**												
15	**Review or assess social and environmental impacts**												
16	**Assembly of information and formulation of scenarios**												
17	**Final screening workshop**												
18	**Public participation**	11 580	16 320	21 893	22 200		26 280		14 280			24 652	22 200
19	**International Support**												
20	**Study management**	18 296	41 456	39 856	47 896	41 456	50 256	37 496	51 856	47 896	41 456	50 256	42 752
Total professional fees		29 876	57 776	102 189	193 196	161 276	177 179	164 696	156 013	139 240	172 642	276 105	520 456
Disbursement costs		43 758	43 758	43 758	43 758	43 758	43 758	43 758	43 758	43 758	43 758	43 758	43 758
Total cost excl. VAT		73 634	101 534	145 947	236 954	205 034	220 936	208 454	199 771	182 997	216 399	319 862	564 213
Total cost incl. VAT		**83 942**	**115 748**	**166 379**	**270 127**	**233 738**	**251 867**	**237 637**	**227 739**	**208 617**	**246 695**	**364 643**	**643 203**
Cumulative total cost incl. VAT		**83 942**	**199 690**	**366 070**	**636 197**	**869 935**	**1 121 802**	**1 359 439**	**1 587 178**	**1 795 795**	**2 042 490**	**2 407 133**	**3 050 336**

Table C-2b : Cash flow projection (month 13 to 24)

Task	Description	Mar 2013 Month 13	Apr 2013 Month 14	May 2013 Month 15	Jun 2013 Month 16	Jul 2013 Month 17	Aug 2013 Month 18	Sep 2013 Month 19	Oct 2013 Month 20	Nov 2013 Month 21	Dec 2013 Month 22	Jan 2014 Month 23	Feb 2014 Month 24
1	Inception report												
2	Summary of previous and current studies												
3	Preliminary screening workshop	43 019											
4	International obligations		61 740	70 945	38 640								
5	Current and future water requirements	75 369	71 789										
6	Urban water conservation and water demand management (WC/WDM)	60 276	34 377	42 406									
7	Opportunities for water re-use	33 600	56 753	66 518									
8	Irrigation demands and WC/WDM	67 305	33 915	65 244									
9	Value of irrigation water				32 088	61 450	31 731						
10	Surface water hydrology andsystem Analysis	34 650	50 883										
11	Water quality	66 528	72 765	41 580	41 580								
12	Reserve requirement scenarios and scheme yields	76 844	77 779	76 188	65 888							5 313	19 320
13	Groundwater	41 580	54 692	39 178	33 495	41 855							
14	Review schemes and update cost estimates			55 971	67 047	57 288				83 381	47 754	38 514	67 788
15	Review or assess social and environmental impacts				62 792	61 044	66 869				37 583	37 405	
16	Assembly of information and formulation of scenarios						144 480	119 490	132 615	113 610			
17	Final screening workshop										64 199	57 899	48 659
18	Public participation												
19	International Support				54 600	54 600	45 802						
20	Study management	31 824	29 226	31 824	29 226	24 999	29 226	33 084	45 501	33 189	31 824	31 824	14 470
Total professional fees		530 996	543 917	489 854	425 355	301 236	318 107	152 574	178 116	230 180	181 360	170 956	150 237
Disbursement costs		14 000	14 000	14 000	14 000	14 000	14 000	14 000	14 000	14 000	14 000	14 000	14 000
Provisional Sum													
Total cost excl. VAT		544 996	557 917	503 854	439 355	315 236	332 107	166 574	192 116	244 180	195 360	184 956	164 237
Total cost incl. VAT		**621 295**	**636 025**	**574 394**	**500 865**	**359 370**	**378 602**	**189 895**	**219 012**	**278 365**	**222 711**	**210 849**	**187 230**
Cumulative total cost incl. VAT		**3 671 631**	**4 307 656**	**4 882 050**	**5 382 915**	**5 742 285**	**6 120 886**	**6 310 781**	**6 529 793**	**6 808 158**	**7 030 868**	**7 241 718**	**7 428 948**

Table C-2c : Cash flow projection (month 25 to 31)

		Month 25	Month 26	Month 27	Month 28	Month 29	Month 30	Month 31	
1	**Inception report**								337 520
2	**Summary of previous and current studies**								206 683
3	**Preliminary screening workshop**								368 393
4	**International obligations**								171 325
5	**Current and future water requirements**								317 638
6	**Urban water conservation and water demand management (WC/WDM)**								195 833
7	**Opportunities for water re-use**								188 870
8	**Irrigation demands and WC/WDM**								261 564
9	**Value of irrigation water**								125 269
10	**Surface water hydrology andsystem Analysis**								275 453
11	**Water quality**								286 913
12	**Reserve requirement scenarios and scheme yields**	13 020	13 020	13 020					360 392
13	**Groundwater**								210 800
14	**Review schemes and update cost estimates**								417 742
15	**Review or assess social and environmental impacts**								265 692
16	**Assembly of information and formulation of scenarios**		118 283	88 620	106 418	111 248			934 763
17	**Final screening workshop**	54 867							225 624
18	**Public participation**			38 997	35 847	35 217	48 447	36 729	354 642
19	**International Support**								155 002
20	**Study management**	17 355	20 660	21 180	37 214	36 369	18 674	12 765	1 041 362
Total professional fees		85 241	151 962	161 817	179 479	182 833	67 121	49 494	6 701 478
Disbursement costs		14 000	14 000	14 000	14 000				749 091
Provisional Sum									
Total cost excl. VAT		99 241	165 962	175 817	193 479	182 833	67 121	49 494	7 450 568
Total cost incl. VAT		**113 135**	**189 197**	**200 431**	**220 566**	**208 430**	**76 518**	**56 423**	**8 493 648**
Cumulative total cost incl. VAT		**7 542 083**	**7 731 280**	**7 931 711**	**8 152 277**	**8 360 707**	**8 437 225**	**8 493 648**	

Title:	***Inception Report***
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