Feasibility Study for Foxwood Dam (WP10580)

Inception Report

Final Issue

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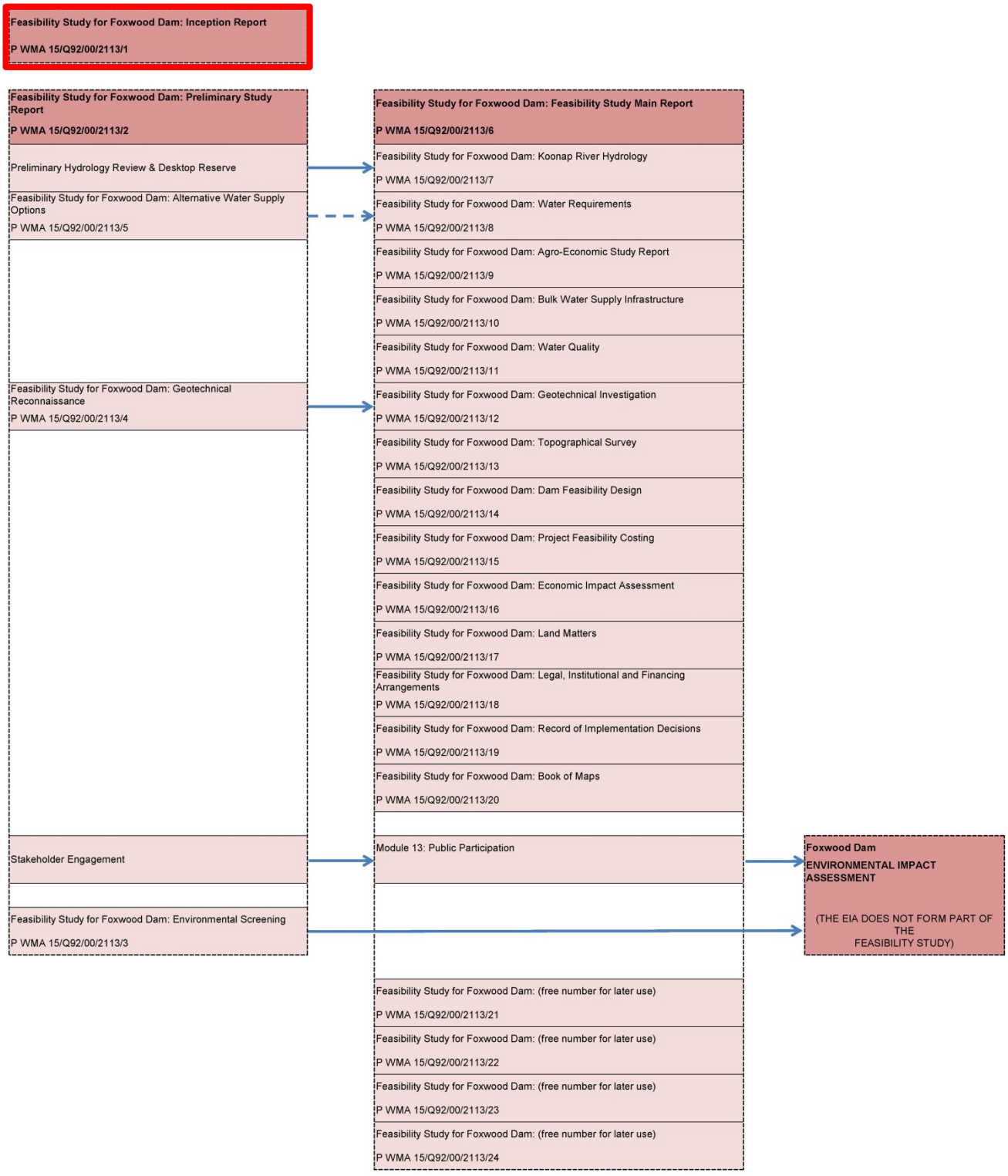
REPORT STRUCTURE



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LIST OF ACRONYMS

CCAW	Coordinating Committees on Agricultural Water
EIA	Environmental Impact Assessment
EWR	Environmental Water requirement
PES	Present Ecological State
DWAF	Department of Water Affairs
RCC	Roller Compacted Concrete
DLDLR	Department of Rural and Land Reform
SAM	Social Accounting Matrix
IDC	Industrial Development Corporation
KRIB	River Irrigation Board
SMC	Study Management Committee
MAR	Mean Annual Rainfall
GIS	Geographical Information Systems
MRU	Management Resource Units
WARMS	Water Authorisation and Use
WC&DM	Water Conservation and Demand Management
MAE	Mean Annual Evaporation
IMS	Information Management System
WRYM	The Water Resources Yield Model
WSDP	Water Services Development Plans
SAIEG	South African Institute for Engineering and Environmental Geology
NOC	Non-Overspill Crest level
PMF	Probable Maximum Flood
RDF	Recommended Design Flood
SANCOLD	South African National Committee on Large Dams
SDF	Standard Design Flood
IFR	Instream Flow Requirements
EFR	Ecological Flow Requirements
URV	Unit Reference Value
IDP	Integrated Development Plan
SAM	Social Accounting Matrix
IDC	Industrial Development Corporation
RID	record of Implementation Decisions
SEF	Safety Evaluation Flood

1 INTRODUCTION

1.1 Appointment of Consultants

Terms of Reference for The Feasibility Study for Foxwood Dam, Department of Water Affairs Contract WP 10580, were published late in 2011 when Professional Service Providers (PSP) were invited to submit bids to undertake the assignment. Arup (Pty) Ltd attended the compulsory briefing meeting on 9 December 2011 and submitted a bid on 26 January 2012. In May 2012 Arup were notified that they were the preferred bidder and discussions concerning a Professional Services Contract commenced. The Commencement Date of the Contract is 1 August 2012.

During the Inception Phase of the assignment the Project Team has liaised closely with the Department of Water Affairs (DWA) Project Manager to initiate the various activities on the Work Programme, including a first visit to the project area when contact was made with the Nxuba Local Municipality, representatives of the DWA Eastern Cape Regional Office and of the Eastern Cape Department of Agriculture and Rural Development. An inspection of the existing water supply sources for Adelaide Town, the water treatment works and the Foxwood Dam site was most valuable in firming up the context of the assignment.

A first Study Management Committee (SMC) meeting was convened on 11October 2012 during which arrangements were made for the administration of the assignment.

This Inception Report is the first deliverable and is submitted in response to Section 2 of the Terms of Reference.

1.2 Background to the Project

1.2.1 Previous studies

The feasibility of a major dam on the Koonap River at the Foxwood site for the purpose of supplying water for domestic use and for irrigation has been investigated since the early 1960's. Records of various investigations by the Koonap River Irrigation Board (KRIB), officials of the then Department of Agriculture and the Department of Water Affairs (DWA) and by consulting engineers Ninham Shand, provide valuable information regarding the development proposals. The report prepared by Ninham Shand in 1998 for DWA is the most recent technical report on the merits of the proposed Foxwood Dam. These reports either incorporated a bulk water supply to Adelaide with a municipal irrigation scheme or solely as a potable water supply for the town. The motivation for the construction of a dam, initially, appears to have been for the town.

The earlier investigations refer to various other dam sites higher up in the Koonap River and include a Report on the Foundation Conditions of the Foxwood Site prepared by the then Geological Survey of the Department of Mines. This Report provides information useful for planning various activities in this study.

Minutes of meetings and other sources indicate that assessments of the suitability of soils along the Koonap River for irrigation were undertaken in the past (probably in the late 1960's) and that the economy of irrigating and marketing various crops was also investigated. Reports on the outcome of these studies have not yet been located; the soils investigation may have produced information that could still be useful for this Feasibility Study.

1.2.2 Environmental Impact Assessment

The Foxwood Dam Feasibility Study is intended to cover aspects which have an influence on the need, desirability, costs, benefits and consequences of implementing the development proposals, bearing in mind the high level objectives of Government to address poverty,

unemployment and inequality in South Africa. The Feasibility Study is designed to provide information to inform and support decision-making at a detailed level concerning the merits of implementing such a project. The next step in the project cycle, if such a project proposal is accepted and the necessary funds are made available, will be to commence with implementation.

While design, institutional development, land acquisition and funding arrangements can commence immediately after approval of such a project, no physical work on the ground can commence until Environmental Authorization has been obtained. For this purpose an Environmental Impact Assessment (EIA) must be undertaken to support an application for such an authorization. The EIA can commence when sufficient progress has been made with the Feasibility Study to provide the information necessary to define the project proposals and the general scope of the Assessment.

1.3 Study Area

The proposed site for Foxwood Dam is located outside the town of Adelaide which falls within the Nxuba Local Municipality in the Amathole District Municipality in the Eastern Cape. Refer to Figure 1 below.

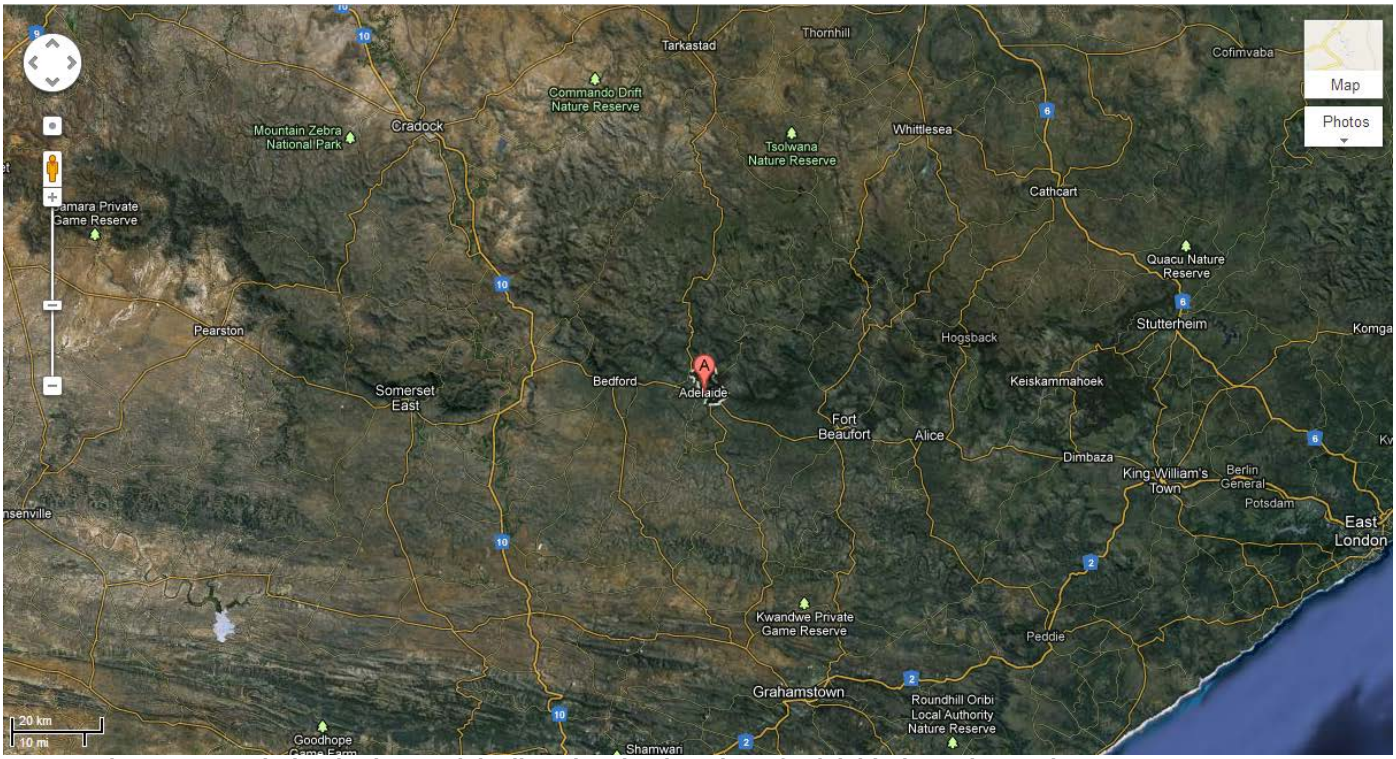


Figure 1: Amathole District Municipality, showing location of Adelaide (Googlemaps)

1.4 Objective, Scope and Organisation of the Study

1.4.1 Objective of the Feasibility Study

The objective of the study is to examine all aspects of the feasibility of constructing a dam at the Foxwood site in the Koonap River for the purpose of augmenting water supplies to Adelaide and to provide reliable water supplies for existing and for new irrigation. The feasibility studies must be undertaken at sufficient detail to provide reliable information to support high level decision-making regarding approval of development proposals.

The Feasibility Study of Foxwood Dam will lead to motivated recommendations to the Department of Water Affairs regarding development proposals which, if acceptable, can be

submitted to the Minister of Water Affairs for approval and to Treasury for funding of that portion of the cost which justifies Government support.

1.4.2 Scope of the Feasibility Study

The Feasibility study will cover all technical aspects such as:

- the availability of water in the Koonap River taking into account the Environmental Water Requirements (EWR),
- the reasonable future demand (or need) for water by the various user sectors,
- the technical details of constructing a dam at Foxwood and transmitting the water to the intended beneficiaries, at a feasibility level of detail adequate for estimating the construction and operating costs at a reliability suitable for capital budgeting, economic analysis and making financing arrangements,
- the capital cost of developing the project, including the cost of the land required and the effective management in perpetuity of all environmental impacts,
- expected operating and maintenance costs,
- the economic and other benefits of developing this water resource,
- the merits of resorting to other water sources as alternatives,
- institutional arrangements for the construction, owning and operating the physical infrastructure,
- compliance with all legal requirements,
- sustainable funding arrangements and the associated cost recovery from water users.

See Figure 2 overleaf for an aerial image indicating the location of the Foxwood Dam site relative to Adelaide. This figure shows projected estimated inundation area based on dam sizing information from Ninham Shand report (1992) Organisation of the study

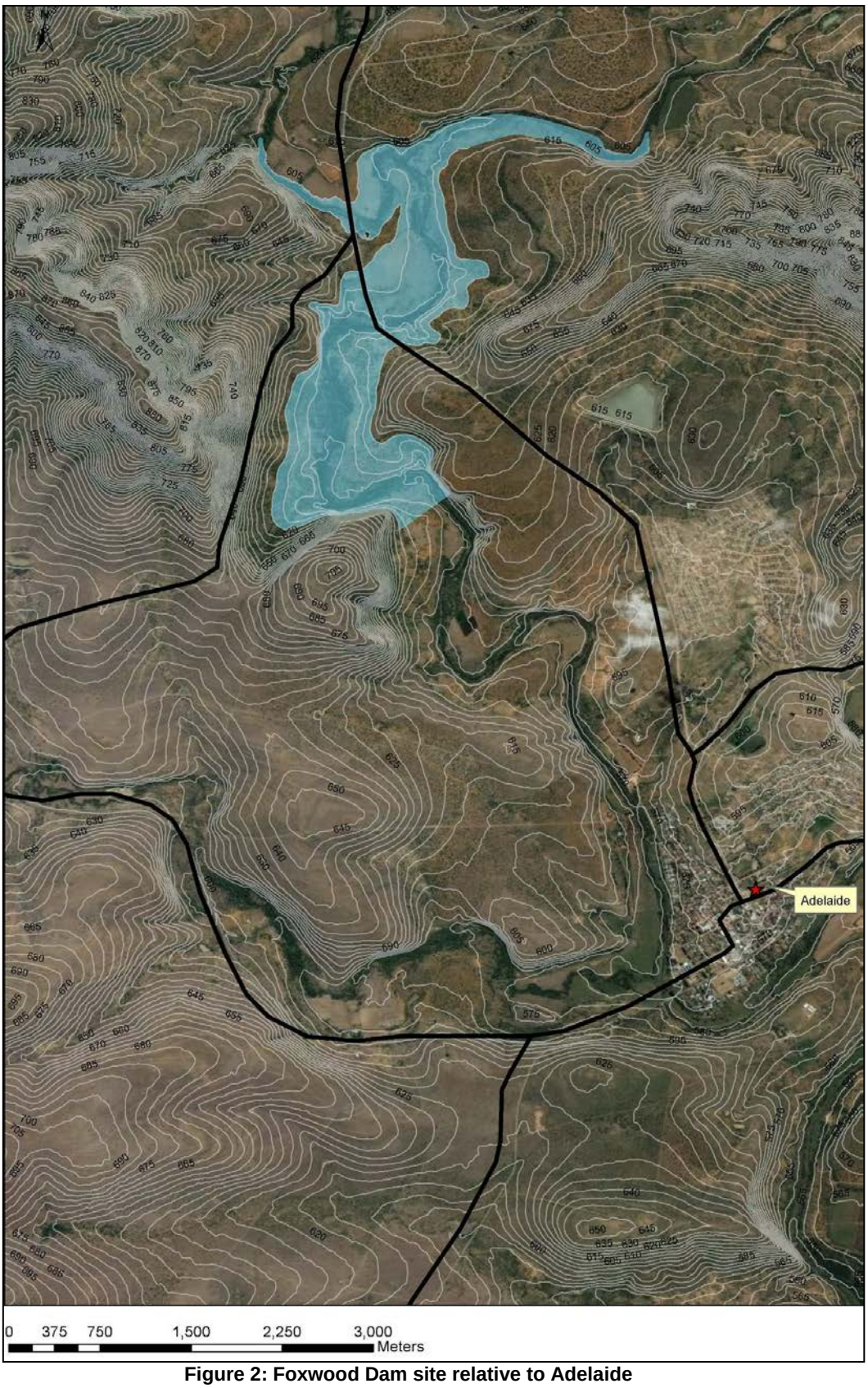


Figure 2: Foxwood Dam site relative to Adelaide

1.4.3 Organisation of the study

The Feasibility Study commenced with an Inception Phase leading to this Inception Report and will be followed by a Phase 1 Preliminary Study and a Phase 2 Feasibility Study. The activities

necessary to carry out the work required in the Preliminary Study are arranged in 5 Phase 1 Tasks and the main Feasibility Study comprises 13 Phase 2 Modules.

The project is programmed over 27 months commencing 1 August 2012:

- Inception Phase – 3 months
- Phase 1 Preliminary Study – 6 months
- Phase 2 – Feasibility Study - 18 months

The programme for the study is attached in Appendix D.

1.5 Governance of the study

The Feasibility Study will be managed in a way designed to maintain effective communication and cooperation between:

- the DWA Project Manager and all relevant Directorates in the Department as Client
- stakeholders in other Government and Provincial Departments
- Local and District municipalities in the Project Area
- other Government agencies
- water users and their associations and
- the PSP's Project Team

Governance of the project will be effected through managing the integration of the various activities and interests, particularly the roles of the DWA Project Manager and the PSP's Project Director and Study Leader, through the structures described below.

An organogram illustrating the governance structure and the organisational structure of the study team are provided in Appendix C.

1.5.1 Project Steering Committee

Effective liaison between the DWA Project Manager and the Project Director and Study Leader and his team will be ensured through the establishment of a Project Steering Committee (PSC). The PSC will be responsible for liaison between DWA(through PSP) and other key stakeholders advising the DWA, on the strategic matters relating to the study and for locating and making available information necessary for the investigations.

Representation at the PSC will include:

- PSP Study Leader (supported by Task Leaders and support staff when relevant)
- National and Provincial Department of Water Affairs
- National Department of Agriculture, Forestry & Fisheries
- National and Provincial Department of Rural Development and Land Reform
- Eastern Cape Office of the Premier
- Provincial Department of Economic Development, Environmental Affairs and Tourism
- Provincial Department of Local Government and Traditional Affairs
- Representatives of the District Municipality, Local Municipality and Amatola Water

Attendance at PSC meetings will be in the study area. Key stakeholders will be copied with documentation of PSC meetings. Attendance at PSC meetings in the study area will be carefully planned to control cost implications. All persons interested in or affected by management of the study will be copied with documentation of PSC meetings.

PSC meetings will be held every four months and could be called at shorter intervals when key decisions are required and feedback from the key stakeholders is required. The Study Team will be responsible for all logistical arrangements for PSC meetings and will provide full secretarial and documentation support.

1.5.2 Study Management Committee

A Study Management Committee (SMC) comprising the DWA Project Manager, other DWA representatives as required and the PSP's Project Director, Study Leader and Project Manager will be convened for the day-to-day coordination and management of the project. The PSP will be responsible for the successful management and administration of the assignment and for the following:

- Monthly invoicing, supported by progress reports, financial control, and HDI participation records;
- Presentations and progress reports to the DWA management when requested by the DWA Project Manager;
- Agendas, Minutes and other documentation for all meetings

SMC meetings will be held every two months throughout the project programme and will be held in the DWA Pretoria offices or PSP's offices in Johannesburg except where there is the opportunity to combine the SMC meetings with the PSC meetings in the study area. The DWA may call for ad hoc meetings as necessary.

2 STRUCTURE OF THE STUDY

2.1 Inception Stage

The Inception Stage of the assignment provides an opportunity for confirming the Terms of Reference, the proposed methodology and for addressing any issues with respect to the tendered submission.

The following activities were carried out during the Inception Stage:

- Obtaining and reviewing of previous study reports and other available information relating to this technical Feasibility study. Refer to References at the end of the report for a list of key references.
- Clarifying the scope of work for the study, in close liaison with the DWA Project Manager and other strategic stakeholders.
- Review and obtain approval by the Client of the activities required in each task of the assignment, work processes and programmes, budget, study management and administrative functions, as well as responsibilities of each key member of the study team.
- Confirm, and if necessary amend, the study team to accommodate changes in personnel since submission of the tender.

The outcomes of the steps listed above are consolidated in this Inception Report. After approval by the Client, the Inception Report will become the revised Terms of Reference for the study against which progress of each task can be monitored and evaluated.

The Inception Stage is of particular importance for the geotechnical and hydrological components of the project for which initial work must be undertaken to confirm future requirements.

2.1.1 Geotechnical Review

A first pass Desk Top study will be undertaken to acquire information relevant to the scheme. This will consist of acquiring information held by Nxuba Local Municipality and other relevant geotechnical information such as geological plans; topographical maps; geohydrological information and previous geotechnical reports such as those undertaken in 1992 by Ninham Shand.

Mr C Forbes of the Dams and Underground Section of the Council for Geoscience has been particularly helpful in this respect and has, on behalf of the consortium, approached the following for assistance:

- Council for Geoscience archives
- DWA Design and Planning Divisions
- Pretoria West Drilling Division of the DWA

So far the Council for Geoscience has recovered a report by a Mr L Danckwerts (1962) which refers to the drilling but only to the effect that some drilling was undertaken at Foxwood and Leeuwdrift Dam Sites but without any geological or geotechnical information. The seven page document deals mainly with irrigation needs and irrigation potential rather than geotechnical aspects.

Also recovered by Forbes is the September 1992 “Water Supply: Proposed Foxwood Dam” by Ninham Shand Consulting Engineers which indicates that seven boreholes were drilled at the proposed Foxwood Dam site. This report is already in the consortium’s hands.

Mr Bob Pullen has received borehole information from DWA. This consists ofa geological report for the site titled “Foxwood: Conditions of the Foxwood Site: Koonap River: Adelaide District, C.P.” by JAH Marais and dated 20 November 1962. The work was undertaken and reported on under the auspices of the Geological Survey: Pretoria.

The report contains useful information including a description of the underlying rock and perhaps more importantly, the depth of unconsolidated material. The borehole descriptions do not provide all the geotechnical information required for centreline investigations but will be very useful in correlating with new boreholes. Drilling will still be required for Lugeon Water Pressure testing; for removal of samples for laboratory testing; and to provide geotechnical description and measure for rock mass characterization. The recovery of these reports will mean a reduction in the number of boreholes required with concomitant savings for the geotechnical investigation.

The report also agrees with the study team’s initial impressions – site unsighted – that the materials at the Foxwood Dam site would be silty rather than clayey (because of the geological parentage) and that riprap and concrete stone would need to be sourced from elsewhere. They could possibly be sourced from the dolerite terrain upstream. The report suggests that sandstone can be used as riprap but we do not concur since sandstone often undergo conchoidal fracturing over the long term on exposure and will eventually break up. These and other issues such as clay core sources; hard rock quarry site, spillway locations and scour, will be addressed in the geotechnical investigation still to come. Data from the report will be reviewed in detail and the requirements for further physical geotechnical investigation to enable the optimisation and costing of the dam type has still to be identified and agreed with the Client.

Photo 1: Photos showing typical sedimentary formation at dam site

2.1.2 Review of Hydrological Data

The two known sources of hydrology for the Koonap River catchment (Q92) were assessed. Refer to Figure 3 for location of Koonap River catchment.

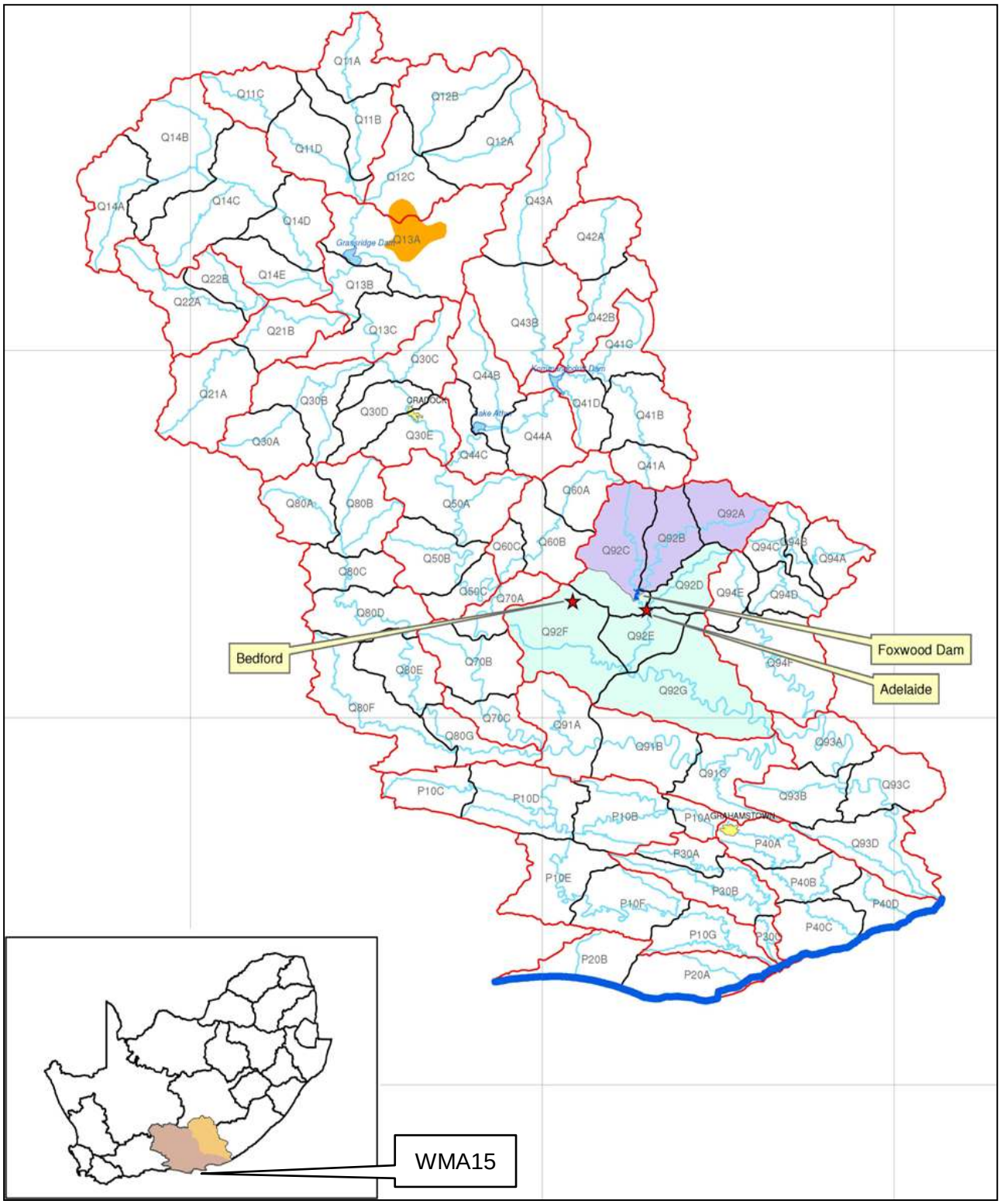


Figure 3: Fish River catchment (Q9) with Koonap Sub-catchment (Q92) (Appendix A)

In the 1992 study by Ninham Shand the flow record at flow gauge Q9H002 was reviewed and adjusted for the Foxwood Dam catchment area. The study did not produce a hydrological time series or calibration for the Foxwood Dam catchment that can be extended to the present time. The methodology used for the Ninham Shand study does not allow for land use changing over time so it does not meet the needs of the present study. Aurecon, now incorporating Ninham Shand, were contacted about the 1992 study. No useful additional information was forthcoming.

The best available and most up to date hydrology for the Koonap River catchment (Q92) is that reported in the Water Resources of South Africa WR2005 study (WRC, 2008). The WR2005 hydrology for the Q92 catchment was assessed by examining the steadiness of the percentage rainfall files for rain zones, Q9B and Q9C (see Figure 4) and the calibration results at flow gauge Q9H002.

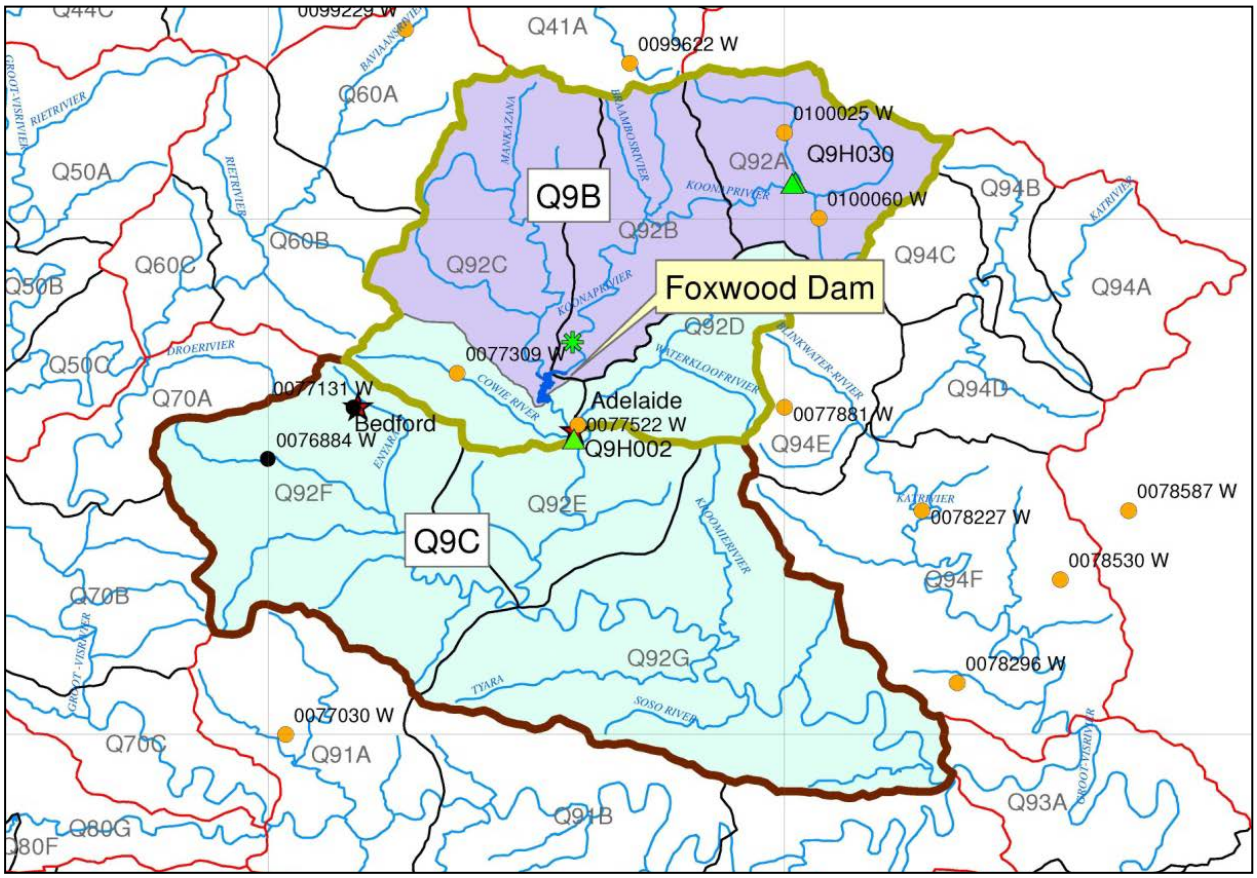
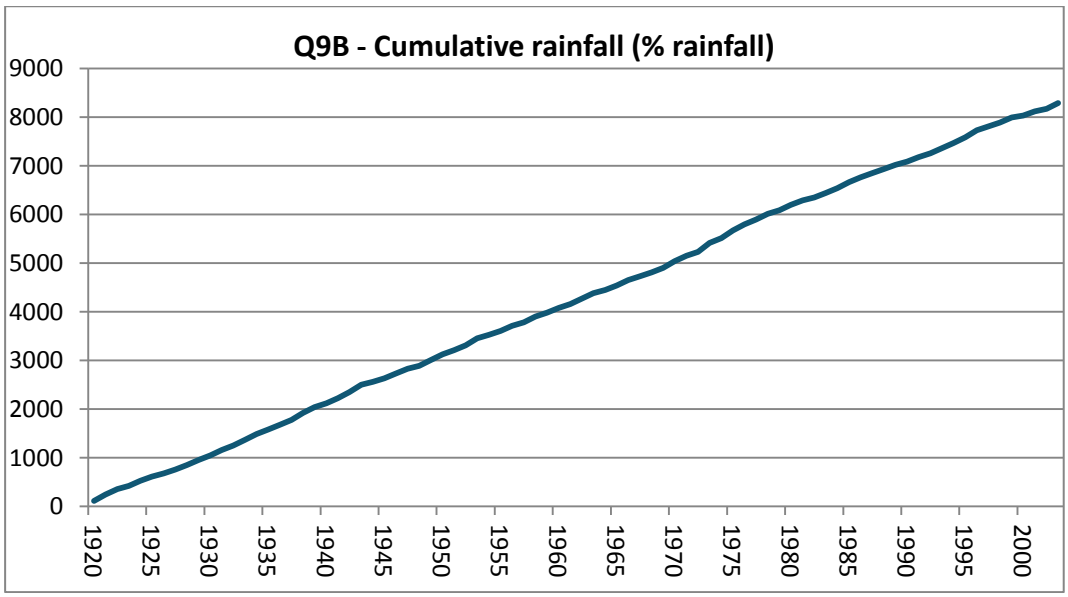


Figure 4: Koonap Sub-catchment (Q92) showing Q9H002 flow gauge location (Appendix A)

The standard validation or stationarity tests are shown as 'single mass plots' and 'Qsum plots' in Figure 5 for rain zone Q9B and in Figure 6 for rain zone Q9C. Changes or breaks in gradient of a mass plot of the cumulative annual totals against time would indicate a break in the stationarity of a dataset and that trends are present. The Qsum plot reflects the cumulative difference of the annual totals from the mean. This is a more sensitive indicator of trends in a data set and reflects climatic variations quite clearly. Dry periods are associated with a negative slope and wet periods with a positive slope.

The stationarity tests of the rain zones show an acceptable pattern for the period 1920 to 2004, indicating that the rainfall gauges used to generate the rainfall zone files were suitable.



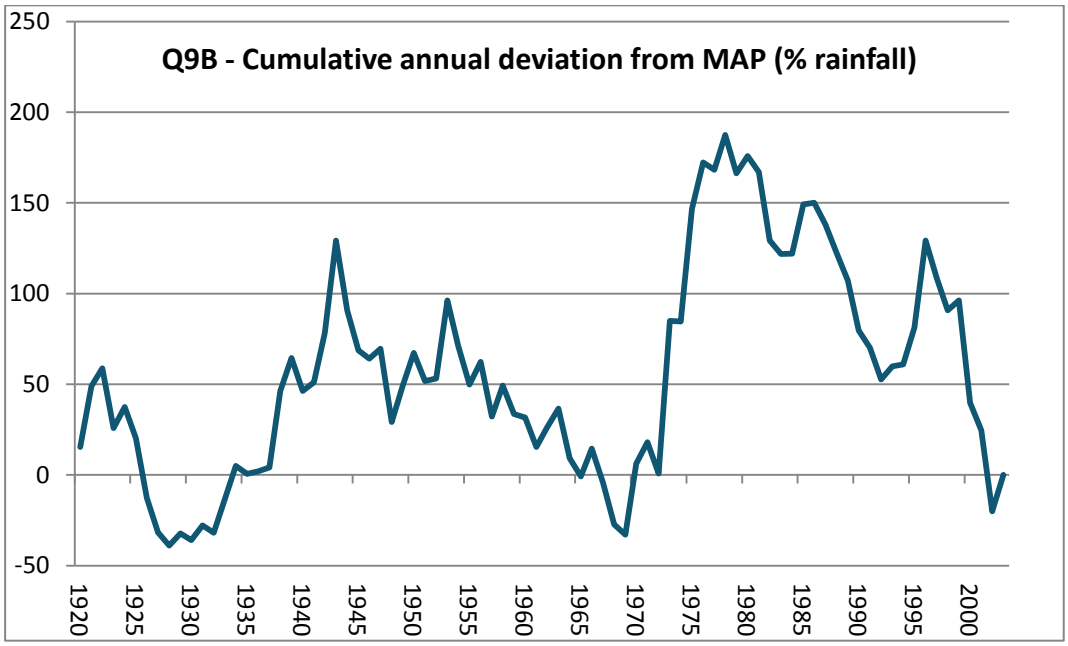
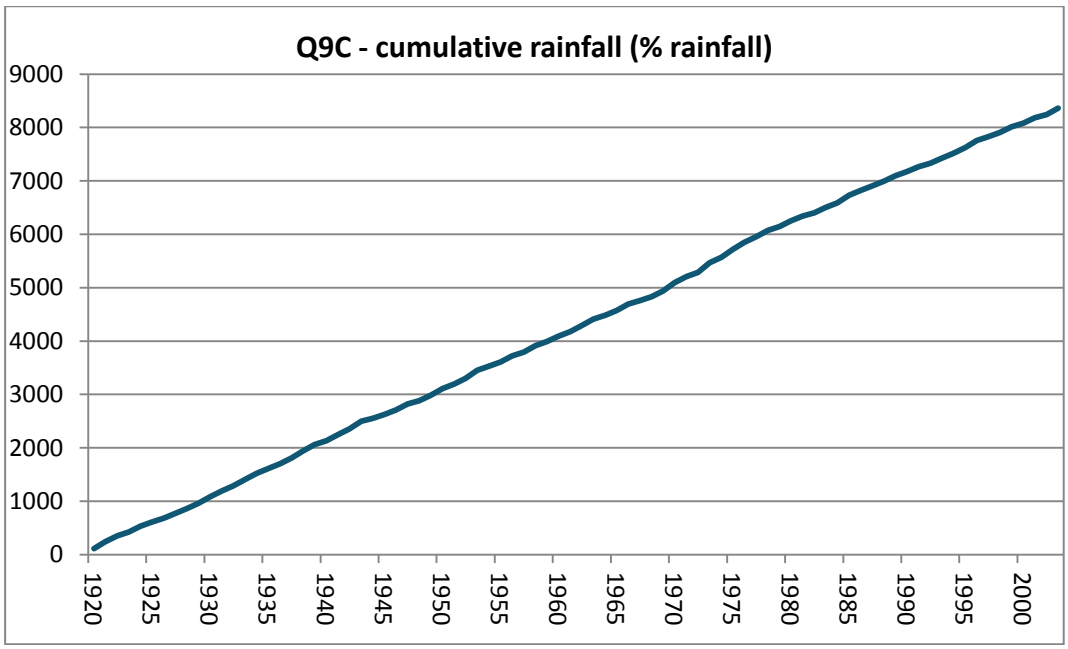


Figure 5: Results of Stationarity Tests for rain zone Q9B (quaternary sub-catchments Q92A, B, C and D)



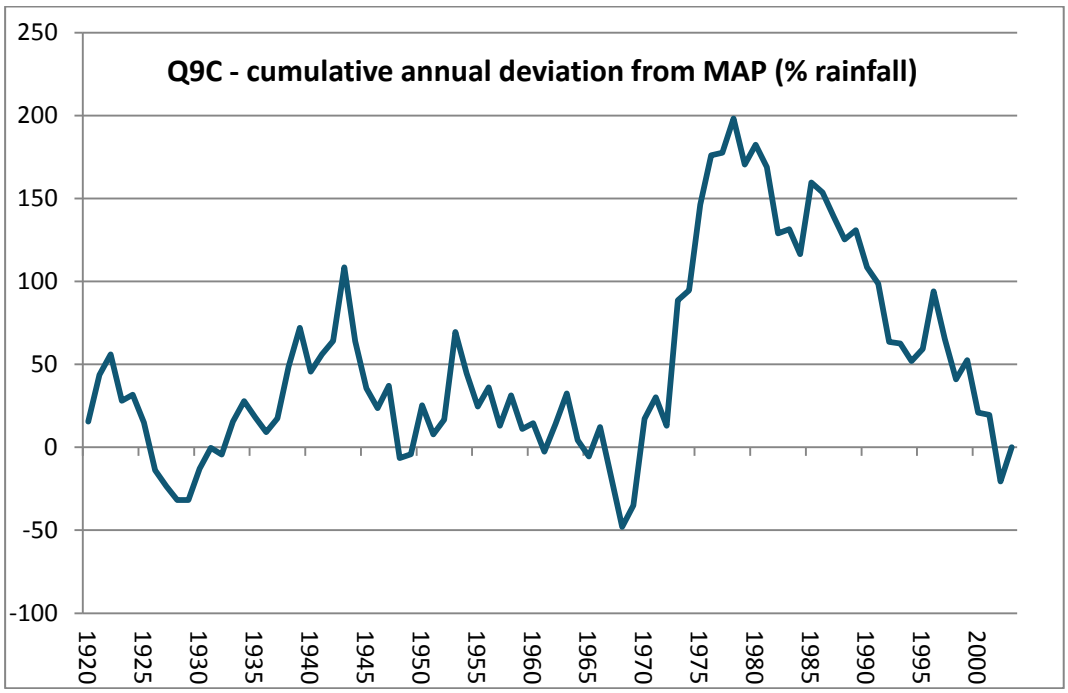


Figure 6: Results of stationarity tests for rain zone Q9C (quaternary sub-catchments Q92E, F and G)

The WR2005 calibration statistics and graphical comparisons between observed and simulated flows for Q9H002 are presented in Table 1 and Figure 7 and compare relatively well. There is, however, a general over simulation of the low season flow as reflected in the average monthly flow plot in Figure 7. This could be a consequence of inadequate provision for the impacts of land use and abstractions from the system as a result of inadequate or incomplete information. For example the diversion from the Koonap River to the off-channel storage dam for Adelaide was not modelled in the WR2005 calibration. This will be addressed when the model is recalibrated using the extended flow record and updated land use information.

Table 1: Simulated and observed flow record statistics at Q9H002

Gauge		Record period	MAR Mill m^3/a	Log mean	Std dev Mill m^3/a	Log Std Dev	Seasonal Index
Q9H002	Observed	1933– 2004	39.05	1.26	43.47	0.64	18.79
	Simulated	1933– 2004	41.90	1.27	55.08	0.63	14.57

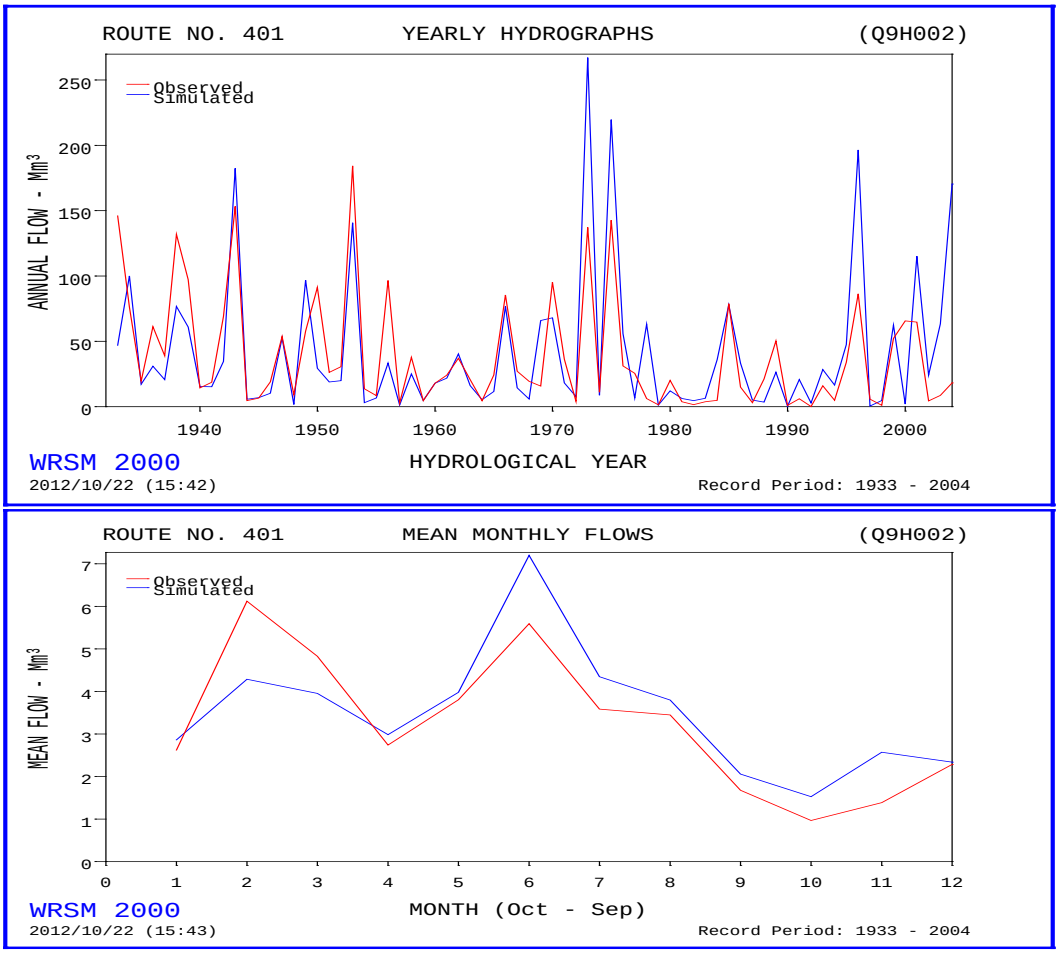


Figure 7: Calibration plots for Q9H002

This overview indicates that the WR2005 calibration of the model for the Koonap River flow gauge is acceptable and the hydrology can be extended to the 2011 hydrological year, i.e. to September 2012.

2.1.3 Ecological Water Requirements

During Phase 2, an Intermediate level of Ecological Water Requirements (EWR) assessment for the Ecological Reserve has to be carried out. To be able to fit this study in the time period, data that is required to be collected during the wet season had to be obtained during the 2012/13 wet season. If this was not collected, the consequences would have been that the EWR work could only be finalised after the 2013/14 wet season. This would not fit into the study programme.

The work consisted of selecting two EWR sites and undertaking the river site cross-sectional and vegetation surveys. The EWR site locations are provided in Table 2 below.

Table 2: EWR site locations

EWR site number	Sub-quaternary reach	River	Decimal deg S	Decimal deg E	EcoRegion (Level II)	Geomorphic Zone	Altitude (m)	Quaternary	Farm names	Hydrological gauge
EWR Koon1	Q92E_7784	Koonap	S32.76671	E26.28989	18.02	E Lower Foothills	538	Q92E	Koonap Poort	Q9H002
EWR Koon 2	Q92G_8047	Koonap	S32.94719	E26.51870	18.02	E Lower Foothills	340	Q92G	Farm 183/0	

2.1.4 Irrigation Development

The Terms of Reference refer to the Adelaide commonage with a potential 200ha of irrigable lands. There was a further tender clarification referring to land for water swap arrangement. Clarification will be sought from the Department of Rural Development and Land Reform on this matter. Preliminary report back indicates that commercial land purchases are now more geared to enabling the commercial entity to remain and not break the lands up into potentially sub economic units. This matter is referred to further in Modules 3 and 7 of Phase 2 of the Feasibility Study. In the Preliminary Study, the intention will be to carry out a first order desktop study of possible lands suitable for irrigation along the Koonap River.

2.2 Phase 1 Preliminary Study

The Terms of Reference require that the following five Tasks be undertaken in the Preliminary Study.

2.2.1 Stakeholder Involvement

Stakeholder consultation during the Preliminary study will mainly focus on the key stakeholders including Water User Associations, Eastern Cape Coordinating Committee on Agricultural Water (CCAW) and Eastern Cape Provincial Government.

The stakeholder engagement team has worked extensively in the Eastern Cape and, specifically, with organised agriculture within this section of the province. Existing information will be used to develop a clear understanding of existing institutional arrangements to ensure inclusion of any other relevant stakeholders during the consultation process.

Time has also been allocated for the Stakeholder Engagement Task Leader or Support to attend an initial site visit and meet with the study team to establish an understanding of stakeholder groups as well as the key issues prevalent in the study area.

Meetings will be arranged with stakeholders in order to obtain their inputs into the process. This phase will also be instrumental in providing a solid foundation for consultation during the EIA phase (which will be undertaken under a separate contract). One of the key aims of the Stakeholder engagement process will be to provide as much relevant information including a stakeholder database and, if possible, a comments and responses report to the appointed EIA consultants in order to reduce possible duplication and to ensure a smoother EIA process. The stakeholder engagement process which will be followed for this assignment is described hereunder:

2.2.1.1 Initiation of the stakeholder engagement process

Key stakeholders who will be initially identified through internal discussions with the project team and client will be invited to the Stakeholder Forum. The intention is to ensure

representation on the Stakeholder Forum of all relevant interests and sectors of society in the study area. The principles used world-wide to characterize and measure a thorough and legitimate stakeholder participation process, and which will be applied in this process, are noted below.

- Consultation is inclusive. It takes place with all relevant sectors of society and affords a broad range of stakeholders the opportunity to participate.
- Information is accessible and sufficient to enable meaningful contributions.
- Information is presented in various ways, e.g. newsletters, letters, meetings.
- There are opportunities for comment, at relevant stages in the process.

It is noted that during the Inception Stage site visit (September 2012) a meeting was held with Nxuba Local Municipality.

2.2.1.2 Stakeholder Identification and Database Management

The identification of stakeholders will be done at the beginning of the project. In this regard, the identification of stakeholders is important and will be done in collaboration with the Department of Water Affairs.

Stakeholders' details will be captured on an MS Access database, an electronic database management software programme that automatically categorizes every mailing to stakeholders, thus providing an on-going record of communication. In addition, comments and contributions received from stakeholders will be recorded, linking each comment to the name of the person who made it.

Stakeholders representing the following sectors of society will be identified:

- National, provincial and local government (relevant local and district municipalities).
- Relevant agricultural organizations in the water management area.
- Environmental and water bodies, forums, groups, associations and government institutions.
- Private sector (landowners, business, industries, irrigation) in the water management area.
- Civil society.

The draft database will be compiled during the first few weeks of the Preliminary Phase; however, a database is dynamic and will be regularly updated as more information becomes available.

2.2.1.3 Project Announcement

In preparation and prior to the announcement of the project, the following activities will be undertaken:

- Establish contact with stakeholders through a reconnaissance field visit in the study area.
- Interact with the relevant Department of Water Affairs' representatives with the aim of identifying stakeholders, thereby contributing to the establishment of the database.
- All public documents that will be drafted e.g. letters, and proceedings of meetings will be submitted to the Client for approval before distribution.

The study will be announced through the following process:

- Distribution of an introductory letter or background information document, which will explain the need for the project, the context of the study and show the extent of the study area (map).
- Research of where additional information can be obtained and the contact details of the stakeholder engagement team for ongoing communication will be done during the Feasibility Study Phase. This introductory letter will be in the English and in Xhosa languages.

- A comment sheet will accompany the introductory letter and will provide an opportunity for people to register as a stakeholder, provide names of other possible stakeholders and to comment on the study. The registered stakeholder will confirm their preferred method of communication, e.g. email, fax, letter etc. and their language preference.
- Existing projects of DWA in the water management area will be used to create awareness of this project.

2.2.1.4 Comments and Response Report

A Comments and Response Report will be compiled and updated throughout the duration of the project. This report will list all the comments from stakeholders (received through comment sheets, raised at meetings, via telephone calls, faxes and email) and responses from the project team. This is an important document as it captures the comments and concerns of the stakeholders together with the responses from the client and project team. It will allow the project team and appointed EIA consultants with a valuable tool for understanding the key issues and risks which will need to be addressed as the project proceeds.

2.2.1.5 Newsletter

Stakeholders will be regularly updated on the status of the project via a newsletter. The newsletter will be compiled by the Stakeholder Engagement team for review by, and issued under, the authority of DWA. The newsletter will be in addition to the following communication material:

- Personalised update letters to all stakeholders on the database
- Invitation letters to stakeholders to attend Stakeholder Forum Meetings
- Minutes of meetings

Stakeholder fatigue is a concern but the above is not meant to inundate the stakeholders but rather to demonstrate that the project acknowledges their participation in the process and to provide the m with feedback on the status of the project.

2.2.1.6 Stakeholder Forum Meetings

A provision has been made for four Stakeholder Forum Meetings to be held in the study area. The Stakeholder Forum will consist of members from various organisations and sectors, striving for balanced representation to achieve balanced view points and inputs from stakeholders within the study area.

The Stakeholder Forum Meetings will be coordinated to coincide with the PSC meetings where appropriate. The Stakeholder Consultation team will work closely with the Environmental Screening module leader and Irrigation module leader, as required. This coordination is required to minimise duplication in stakeholder consultation, optimise on human resources and achieve the desired timeframes for the various outputs which require stakeholder input.

For each Stakeholder Forum meeting, invitation letters and a proposed agenda will be distributed to members providing them with sufficient information about the status of the project, the purpose of the meeting and what will be expected of them (e.g. read through documents prior to the meeting and the subjects on which to provide inputs and comments).

Following the establishment of contact with stakeholders through a reconnaissance field visit in the study area, the proposed timing and focus of all planned Stakeholder Forum Meetings is presented hereunder:

Stakeholder Meeting 1: Project Commencement
All information/powerpoint presentations provided at these meeting will be signed off by the DWA Project Manager.

The focus of the Introductory Meeting will be to:

- Introduce the study and provide description of the project
- Discuss roles and responsibilities of stakeholders and opportunities for participating in the study
- Present the work programme and future stages of the project.

Stakeholder Forum Meeting 2: Progress Update at the completion of the Preliminary Study
The 2nd Stakeholder Forum Meeting will be aimed at providing feedback on progress of the study and to present information that requires input from stakeholders and will be held at the end of the Preliminary Study. It will focus on the presentation of findings of the Preliminary Study and provide details of future stakeholder engagement upon completion of the Preliminary Study.

Stakeholder Forum Meetings 3 and 4: Feasibility Study
As requested by the Client in the first SMC meeting, a provision has been made for one stakeholder meeting per year, i.e. for the duration of the Feasibility Study. These meetings are aimed at ensuring continuous and meaningful engagement of stakeholders until the EIA PSP has been appointed. It is anticipated that the Stakeholder Meeting 4 would form the first stakeholder meeting of the EIA stakeholder engagement process.
These meetings will be in addition to project update letters and newsletters which will be distributed to stakeholders as and when necessary, depending on the requirements of the project.

2.2.1.7 Ongoing Stakeholder Engagement

Strategies for effective stakeholder engagement will be revisited at each meeting, i.e. assess the effectiveness of the various approaches and progress made. If necessary, the strategy will be changed or adapted to achieve the expected outcomes as the study progresses.
It is also proposed that the DWA website be utilised as a central site for the publishing of all public information (announcement documentation, minutes of meeting, etc) to enable stakeholders with access to electronic media to stay updated.

2.2.1.8 Stakeholder Engagement Deliverables

- Establishment and maintenance of project database.
- Compilation and distribution of a personalized letter informing stakeholders about the project and their roles and responsibilities.
- Invitation letters to Stakeholder Forum Meetings
- Minutes of Stakeholder Forum Meetings
- Meetings with Stakeholders
- Newsletter (for progress and process update)
- Records of all interactions with stakeholders and/or Comments and Response Report
- Stakeholder engagement activities are also subject to the overall programming of the study.

2.2.2 Environmental Screening

An Environmental Screening will be undertaken to identify environmental issues of concern and legal requirements in terms of current environmental legislation and best practice.

The key focus of this study is to identify key environmental and social constraints and opportunities to inform the development strategy and guide decision-making.

The study will entail the following key activities:

- The articulation of a “vision” (which expresses broadly what the project aims to achieve) and the identification of the strategic issues that should be addressed. An understanding of some of these key issues will be gained during the initial site visit and participation in the stakeholder forum meetings where stakeholders will raise some of these pertinent issues;
- An analysis of the existing situation (information gathering - using existing information) – The identification of the social, economic and biophysical resources that should be maintained or enhanced, review of existing environmental legislation and identification of possible permit applications i.e. status quo of the area. There is a clear link between the outputs of some of the other work streams, e.g. the geotechnical and hydrology reviews, and this analysis;
- The identification of the biophysical and socio-economic opportunities and constraints - The identification of environmental “no-go areas”, red flag areas, potential environmental impacts including potential cumulative environmental impacts. Potential health risks and water related risks. Identify any additional specialist studies that may be required. An example of an additional specialist study especially for a project of this nature would be a cultural heritage / archaeological study. However, the need for any additional specialist studies will be understood during the previous steps in the process.
- Upstream and downstream considerations related to biodiversity, tourism and economics, etc - This will be included in the above impact /fatal flaws analysis and will seek to identify what upstream and downstream pros and cons may exist within each of the proposed schemes. Recommendations will be made as to the necessary specialist investigations required and the type of consultative process that should be undertaken should the existing studies be found to be inadequate on which to base a decision.

- Environmental cost and affordability – During the fatal flaws analysis, costs to include various mitigation options will be discussed with the project team and where possible the most cost effective and affordable choices will be made and included in the final Screening Report. This is an iterative process and requires close interaction with the project team and engineers in particular.
- Sustainability in water availability and growth in the region – through the analysis of all of the above mentioned factors and in association with the project team, including the Stakeholders, an informed recommendation will be made as to the sustainability of the proposed scheme and the potential manner in which it could influence growth in the region.
- Scope of work for the EIA – the final component of the screening report will draw on the experience that Arup has in managing and drafting scope of work for large EIA projects such as this. With a team that has worked extensively with authorities on other large EIA projects the team will be ideally positioned to draft the required the scope of work to support the EIA process to follow. The scope will include a library of relevant studies that would have been completed to date including the environmental reserve, stakeholder database and comments and responses report. The aim being to ensure a smooth handover to the appointed EIA consultants and to ensure that the EIA process can be completed as efficiently as possible.

2.2.3 Geotechnical Reconnaissance

The first pass desktop study commenced during the Inception Stage will be further developed and will incorporate data and results of previous investigations. This, together with interpretation of aerial photography including use of Google earth imagery will inform the reconnaissance walk over survey. The borehole logs from the ground investigations of 1962 will prove particularly useful in determining additional detailed investigation requirements.

The reconnaissance walkover survey will be over a period of two or three days and will use the current 5m contour GIS mapping with geological and geotechnical site mapping; preliminary estimates of centreline overburden; rock types; first indication of both rock mass and rock engineering properties; discontinuity sets and their interrelationships; faulting; intrusive dykes and sills; and the presence or absence of regional or perched groundwater. Possible

construction material sources will be identified at this stage as this is likely to be critical for the choice of dam types. An initial visual appraisal will be made of any obvious geotechnical problems such as dispersive clays; active clays; disintegrating rock, etc.

The geotechnical mapping of the dam site line will also provide the basis for further dam site investigation in Module 6.

The walkover survey will concentrate on the main dam site .Following the site visit it was apparent that although Ninham Shand report indicates the possibility of a downstream lower site suitable for reduced demand. This at present does not appear to be more favourable than the upstream site. This will be reported on further in the preliminary reporting phase.

Preliminary desk top studies indicate that the dam centreline and reservoir basin are underlain by sedimentary rocks of the Balfour Formation; Adelaide Subgroup; Beaufort Group; Karoo Supergroup. Rocks consist mainly of grey mudstone and shale with subordinate lighter coloured sandstone.

The valley floors have a covering of colluvial and alluvial soils which vary in depth and type as determined by factors such as geological parentage; distance from source; river gradient and deposition period. The Ninham Shand Report reflects on reddish-brown clayey silt materials encountered in trial hole excavations for a De Beersdrift dam site suggesting this material would be suitable for an earth embankment dam. The location of this site is not indicated but the soil colouration suggests it may be associated with doleritic derived soils some 5 kilometres to the north. This is therefore not necessarily true for the Foxwood Dam site where sedimentary derived soils dominate. Experience of the sedimentary geological formations indicates that soils are often relatively thin and siliceous. This means that extensive materials investigations will still need to be undertaken upstream and downstream of the proposed dam site. Early imagery investigations suggest cultivated lands immediately downstream may have potential as material source but this will require detailed field geotechnical investigation.

Detailed geotechnical investigation requirements are presented in Module 6.

2.2.4 Hydrological Review

The hydrology review undertaken in the Inception Stage will be expanded in order to provide the necessary inputs to the Reserve calculation. The hydrological data will be reviewed and any recommendations for the Feasibility stage will be made to the Client.

2.2.4.1 Desktop EWR estimate

As part of the hydrological review, a desktop EWR estimate is required for preliminary planning estimates. The following is required to provide a desktop EWR estimate and as baseline for the more detailed EWR study during phase 2:

- Management Resource Units: Management Resource Units (MRU) will be identified for the Koonap River (Foxwood Dam to Fish River confluence). The MRUs provide the reach of river for which the EWR set at the EWR sites will be applicable.
- Desktop EcoClassification study (Kleynhans and Louw, 2007): This relates to a scoping study to determine the desktop level Present Ecological State (PES) and Ecological Importance. This information provides a preliminary Ecological Category which is used during the next stage, i.e. to estimate the EWRs. Other aspects such as the Socio-Cultural Importance and the Water Resource Use Importance will also be considered to identify 'hotspots' (Louw and Huggins). Hotspots are areas where detailed work is required for any future development.
- EWR estimate: The Revised Desktop Reserve Model (Hughes *et al* 2012) will be used to estimate the EWR for the PES and the Recommended Ecological Category identified during

the previous stage. Hydrological information in terms of the modelled natural and present day data is required to run the model.

Using the above information and preliminary hydrology obtained during the Inception Phase, a desktop EWR estimate will be generated in order to carry out 1st Order historical yield analyses.

2.2.4.2 Deliverable

Technical report which provides the MRUs, the Desktop EcoClassification, hotspot identification, site selection and desktop EWR estimates.

2.2.5 Assessment of Supply Options

Whilst the overall objective of the study is to carry out a full feasibility investigation of the Foxwood Dam development, a preliminary assessment of future alternative supply options for Adelaide and the surrounding areas will be undertaken. The work will build upon the *1998 DWA study* identifying options for augmenting water supplies to Adelaide.

The assessment will be led by Andre Scheepers and Jacques Barnard of Camdekon Engineers who will be supported by the Dam Engineer, Hydrologist, Water Resource Specialist, Water Quality Specialist, Groundwater specialist and other Technical Staff.

Investigations will be carried out of different supply options as follows:

- Upgrading of the existing off-channel storage dam scheme/supply system by increasing the abstraction , canal and dam capacity (to increase the yield) and even possibly a smaller new second off-channel storage dam system in close proximity to Adelaide. Cognisance is to be taken of the permitted abstraction registered in the WARMS database and will be further addressed with DWA and other stakeholders.
- Upgrading the capacity of the Fish River (Orange River Water) transfere system by increasing the capacity of the existing pump/pipeline infrastructure from the intake close to Cookhouse and via Bedford to Adelaide. Cognisance is to be taken of the water rights and increasing demand from other users for this water and whether additional water for domestic purposes can be obtained by increasing the capacity of the Fish River pumping scheme.
- Groundwater:
  It is widely recognised that groundwater is not necessarily exploited to its full potential in South Africa with surface water resources often perceived as a favourable option. The investigation of options for groundwater exploitation will be based on a desktop study including the following:

  - Accessing existing information on this area including borehole locations and yields
  - Assessing the assured groundwater yield of the area (this will be compared to other "regional" yield estimates such as DWA"s Harvest Potential and GRAII yields.
  - Identifying potential groundwater targets within an economic radius of the town. This will include targets along existing domestic and agricultural water conveyance lines in the area.
  - Identifying potential borehole sites on the favourable drilling targets and estimating their individual and collective or "wellfield" yields.
  - Assessing the groundwater quality of the area.

- Water Conservation and Demand Management (WC&DM):

  WC&DM measures for both domestic and agricultural sectors are to be investigated to include inter alia the following:

- Identify and quantify actual water use including identification of existing water use practices and systems and their impact on sustainable and efficient use of water.
- Determine the extent of water use wastages, losses and inefficient use as a percentage of total water consumption and supply.
- Assess existing irrigation use practices and systems with a view to quantifying the volume of water being lost through such practices and how this can be minimized.
- Identify relevant and applicable WC&DM intervention measures.
- Conduct a cost/benefit analysis for WC&DM measures identified.

The preliminary study will be desktop based and will seek to expand the findings of the recent *Reconciliation Strategy for Adelaide* and other studies together with the principles set out in the National Water Conservation and Demand Management strategy.

In addition any supply options generated through the stakeholder engagement will be investigated as additional scope subject to agreement with the Client.
Close liaison will be held with DWA, Amathole District Municipality, Amatola Water, Nxuba Local Municipality, Adelaide Town officials and other key stakeholders.

The output of the task will be a report outlining the supply options and recommending the alternative schemes together with their proposed implementation dates.

2.2.6 Irrigation Lands Desktop Study

A first order desktop study of potential irrigable lands along the Koonap River will be undertaken to get, an order of magnitude, irrigable potential hectares. This will be based on retrieved reporting, soils mapping and aerial photos.

2.3 Phase 2 Feasibility Study

Following the completion of the Preliminary Phase the study will proceed with the full Feasibility Study for Foxwood Dam.

2.3.1 Module 1 – Water Resources

2.3.1.1 Background

The Koonap River catchment (Q92) is situated in the Eastern Cape Province of South Africa in the Fish to Tsistsikamma Water Management Area (WMA 15). The Koonap River has its origins in the Greater Winterberg Mountain Range and flows though mountainous terrain in its upper reaches and is a tributary of the Great Fish River catchment (Q). The Koonap River from a water resources point of view is considered to be mostly undeveloped.

Table 3 summarises the water resources of the Koonap River catchment according to the WR2005 study. The Koonap River catchment is divided into 7 quaternary catchments (Q92A – Q92G). The headwater catchments of the Upper Koonap, Q92A, Q92B and Q92C, have a catchment area of 1249 km^2 and average rainfall (MAP) of 593 mm/annum and average unit runoff of 40 mm. The Foxwood Dam catchment is located within these catchments with an average rainfall of 598 mm/annum and average unit runoff of 42 mm.

The climatic conditions of the Koonap River catchment is temperate with cool, dry winter months and hot summers with rainfall ranging between 417 to 662 mm/annum. It is, however, situated close to the year-round rainfall zone (coastal catchments) so that heavy rainfall may occur at any time of the year. The average naturalised unit runoff from the catchments ranges from 7 to 63 mm/annum.

Table 3: WR2005 Climate and Hydrology of the Koonap River catchment

Quaternary Catchment		S-pan evaporation		Rainfall (MAP)		MAR	MAR
	Ca area	Evap	MAE	Rainfall	WR2005		Unit runoff
	(km^2)	zone	(mm)	zone	(mm)	(mcm)	(mm)
Q92 (Koonap River) catchments							
Q92A	324	28A	1650	Q9B	662	20.26	63
Q92B	324	28A	1650	Q9B	586	11.57	36
Q92C1	442	28A	1650	Q9B	559	13.41	30
Foxwood Dam catchment	**1090**	**28A**	**1650**	**Q9B**	**598**	**45.24**	**42**
Q92C1	159	28A	1650	Q9B	559	4.83	30
Q9H002 catchment	**1249**	**28A**	**1650**	**Q9B**	**593**	**50.07**	**40**
Q92D	249	28A	1600	Q9B	594	11.41	46
Q92E	287	28A	1600	Q9C	464	3.39	12
Q92F	665	28A	1650	Q9C	415	4.55	7
Q92G	884	28A	1600	Q9C	466	9.83	11
Tertiary Q92	**3334**		**1629**		**513**	**79.25**	**24**

The Koonap River catchments (Q92) are rural in nature with stock farming, some commercial irrigation (coffee, citrus and pastures) and minor areas of commercial forestry. The town of Adelaide is located within this area and abstracts water from Koonap River. Table 4 provides a summary of the land use that impacts the water resources of the Koonap River catchment according to the WR2005 study.

Table 4: WR2005 land use in the Koonap River catchment

Quaternary Catchment	Catchment	Forestry	Alien invasive	Irrigation	Farm dams	
	Area	Area	Plants	Area	Area	Capacity
	(km^2)	(km^2)	(km^2)	(km^2)	(km^2)	(million m3)
Q92A	324	-	0.53	6.22	0.04	0.10
Q92B	324	-	-	6.90		
Q92C	601	-	-	6.31	0.31	1.38
Q92D	249	3.06	0.71	2.24	0.27	1.82
Q92E	287	-	-	3.60		
Q92F	665	-	-	1.14	0.22	0.48
Q92G	884	-	-	0.67	0.07	0.26
Tertiary Q92	***3334***	***3.06***	***1.24***	***27.08***	***0.91***	***4.04***

2.3.1.2 Hydrology

The WR2005 hydrology of the Koonap catchment will be extended from the 2004 to 2011 hydrological year. The main tasks will be to extend the rainfall record in rain zones Q9B and Q9C shown in Table 4 and to generate natural flows for the Q92 or Koonap catchments. Refer to Appendix A for a drawing showing rainfall gauges and stream flow gauges in the Koonap catchment.

The process to update the hydrology will include:

- Obtaining monthly rainfall data for the period up to 2011 from the DWA in the Eastern Cape. Confirmation regarding the availability of rainfall has been obtained. Rainfall gauges that are operational have been identified and are listed in Table 5. **It is of great concern that only 2 gauges within the Koonap catchment remain open.** In addition the gauges are outside the Foxwood Dam catchment area. The Rainfall Information Management System (IMS) will be interrogated to ascertain if there are any new rainfall gauges in the study area. Rainfall gauges from outside the Q92 catchment will also be accessed and used if required.
- Patching of rain gauge data (if necessary) using the Rainfall IMS developed by the DWA.
- Assessing the stationarity of the extended rainfall gauges.
- Generating catchment rainfall files for the Q9B and Q9C rainfall zones.
- Setting up the WRSM2000 model for the Q92 tertiary catchment for the longer record period.
- Obtaining updated recorded flow data for the Q9H002 flow gauge from the DWA in the Eastern Cape. Confirmation regarding the availability of flow record up to 2011 has been obtained.
- Obtaining updated information about current day and historical land use as well as water use within the Koonap catchment and creating a record of the changes since 2004. Much of this information should be available from the DWA in the Eastern Cape from the water authorisation (WARMS) data base. Confirmation regarding the availability of water authorisation information has been obtained.
- Calibrate the WRSM2000 model against observed flows at Q9H002.
- Generate natural and present day flows for each quaternary catchment.

Table 5: List of operational rainfall gauges in the Koonap River catchment

Gauge Number	Name	Rain zone	Lat (S)	Long (E)	Start Year	End Year	Length (years)	Elevation (masl)
0076884 W	ALBERTVALE	Q9C	-32.733	26.000	1954	2011	58	701
0077131 W	BEDFORD - MUN	Q9B; Q9C	-32.683	26.083	1993	2011	19	763

2.3.1.3 Deliverable

The main deliverable of this task will be the natural flow time series for each quaternary catchment and developed or present day time series for input to the Reserve study and to the Yield analysis. Another deliverable will be a concise Hydrology Report and all electronic data associated with the hydrological analysis, i.e. WRSM2000 model setup and data files.

2.3.1.4 Gauging Weir

In previous studies (Ninham Shand, 1992, WR2005) the Q9H002 (Q9M02) flow gauge at Adelaide was used to develop an observed flow record for the Foxwood Dam catchment area. Useable flow record dates from 1933 to 2011.

2.3.1.5 Yield Analysis

The WRYM model will be set up for the Q92 catchment at quaternary scale using the WRIMS software package developed by the DWA. This model will include:

- All present day water use
- Stream flow reduction time series for forestry (very limited) and Invasive Alien Plants
- Farm dams
- Releases for Ecological Water Requirements
- Allowance for sediment
- Area – capacity relationship(s) for Foxwood Dam

Historical and firm yield analysis
Historical yields will be determined for a range of dam capacities up to 1.5 x Natural Mean Annual Runoff. This will be done early in the project cycle using the Desktop Reserve generated in Phase 1 and then updated once the Comprehensive Reserve has been completed.

Long term yield analysis
Once the capacity of the dam has been narrowed down through economic evaluation, the assurance of supply for the dam will be determined using stochastic analyses. A long-term yield curve will be generated for the recommended final full supply capacity.

Short term yield analysis
Short-term yield curves will be generated for the selected full supply capacity at various starting storages. The assurance of supply will be decided in consultation with stakeholders.

Sediment analysis
The 1992 study (Ninham Shand, 1992) estimated siltation to be 4.26 million m^3 over a 30 year period for a dam of 87 million m^3 storage capacity. The volume of sediment that is likely to deposit in the dam over 50 years will be reviewed and re-estimated using the latest estimates of sediment yield from the catchment.

Deliverable
The deliverable of this task will be a concise Yield Analysis report and all electronic data associated with the yield analysis, i.e. WRYM-IMS model setup and data files.

2.3.1.6 Environmental Flow Requirements

This task refers to the more detailed EWR assessment which involves an Intermediate Reserve for the river and a rapid estimate for the Fish River Estuary.

Reference should be made to Appendix E for comments on the limit of the scope for the EWR study. These comments are re-produced from the Technical Submission document.

EWR assessment for the river:

Two EWR sites in the river will be identified for the detailed work required for the Intermediate Reserve. One survey to collate fish, invertebrate, riparian vegetation and geomorphological data and two surveys to obtain hydraulic calibration data will be undertaken at these sites.

EWR's for different river states (Ecological Categories) will be determined at the EWR sites and a maximum of 6 operational flow scenarios (e.g. related to different dam sizes or different yield scenarios) will be tested to determine the consequences on the ecological state of the river. The changes on the state of the Goods and Services due to any of the operational scenarios will also be identified and costed.

Hydrology and yield data requirements: Modelled natural and present day data is required at the EWR sites. At EWR Koonap1 the patched observed data from Q9H002 will also be required in daily format. The yield scenarios must be provided for a maximum of 6 scenarios at each EWR site.

Estuary Rapid approach:

As per the Rapid methods for the determination of ecological water requirements for estuaries (DWAF, 2008), the following abiotic and biotic components need to be addressed:

- Hydrodynamics
- Water Quality
- Microalgae
- Macrophytes
- Invertebrates
- Fish
- Birds

No field data collection programme will be undertaken and the studies will be conducted based on available information. Specialists will be required to assess data on their components and to prepare the ecological Reserve templates as required in terms of the methods (DWAF, 2008). Specialist reports are not required for Rapid level determinations.

A 2-day workshop will be convened after completion of the templates, where the following will be provided:

- Present State Category (using the Estuarine Health Index)
- Ecological Importance of the Estuary (based on DWA, 2008)
- Ecological Categories associated with each of the run-off scenarios provided to the estuarine component
- Recommended Ecological Category (using Present Status Category and Ecological Importance)
- Recommended Ecological Flow Scenario.

Hydrology and yield data requirements:
Modelled natural and present day data is required at the estuary. The yield scenarios must be provided for a maximum of 6 scenarios at the estuary. These yield scenarios will only be applicable to changes in the Koonap River. The Fish River present day hydrology will be added to the Koonap River scenarios. If a hydrological gauge is situated reasonably close to the estuary, the patched daily data of this gauge will be required.

Deliverables
The main deliverable of this task will be the EWR Rules Table at the EWR sites. A EWR report will be provided in two volumes, one for the river and one for the estuary. The results and raw data and other information will be made available electronically.

2.3.2 Module 2 – Water Requirements

Existing and future domestic, industrial and irrigation water requirements for Adelaide and the surrounding area will be quantified taking particular cognisance of the recent Reconciliation Strategy for Adelaide. The projections will be made over a period of 30 years from 2020 to 2050.

Information on domestic water requirements are to be obtained from various sources namely:

- Previous water feasibility investigations/studies

- Recent studies with respect to the alternative water sources and investigations
- Water Services Development Plans (WSDP)
- National Water Resources Strategy
- Historical water consumption
- If the 2011 National Census figures become available during the study period they may be incorporated

Water requirements based on urban and rural population figures and water consumption per capita, will be used to assess the current water requirements. Cognisance is to be taken of water usage for other purposes i.e. commercial, industrial, parks and sports field irrigation for the purpose of determining the total current water requirements. Cognisance will also be taken of any existing bulk metering information.

Future water requirements are to be determined using expected population growth rates and increases in the water consumption per capita to determine the total future domestic water requirements over the design horizon of the project.

A review of existing reports and, utilising this data and information gained from Module 3, postulate potential irrigation strategies based on consultation with agricultural stakeholders and further soil investigation where appropriate. It has been noted that the Ninham Shand 1992 report investigated and tabulated potential irrigable land on existing commercial farms indicating an additional 2,103 ha suitable for development. The current status of this land will be checked to verify the irrigation potential of the area.

The capacity of bulk water supply infrastructure is to be such to meet the future water requirements.

2.3.3 Module 3 – Irrigation Development

Following the initial site visit in September 2012 it was not clear what lands will be available for future irrigation, other than the 200ha of municipal lands which may be suitable for market gardening.

In conjunction with DWA a number of meetings have been held with various departments namely:

- Department of Rural Development and Land Reform
- Department of Agriculture, Fisheries and Forestry – Water Use and Irrigation Development
- Provincial Department of Rural Development and Agrarian Reform

These meetings, although positive for the project, were not conclusive with regard to policy on future irrigation development and on where responsibility falls when new water sources are to be made available by resource development. The present irrigation policies are being developed with regard to resource poor farmers and the commercial sector.

It is proposed that for expediting progress of this project the establishment of potential irrigation will be to:

a) Investigate and confirm potential municipal irrigable lands
b) Investigate and identify suitable potential irrigable lands within the commercial farming areas below the Foxwood Dam by utilizing existing reporting and institutional knowledge; stake holder working group engagement and use remote access methods.

An agro economic study for the project will be undertaken to:

- Identify land suitable for intensive production of food crops in close proximity to settlements in the Adelaide Municipality which can possibly be used for economically viable, labour intensive urban agriculture opportunities. Soil testing and analysis will be done to confirm the ability to support different cropping patterns and to ascertain their suitability for irrigation. Specific attention will be given to susceptibility to erosion and to degradation of fertility and drainage resulting from irrigation.
- Identify crop types suitable for production and their potential profitability
- **Assist the Steering Committee in setting up an Agricultural Working Group:** -
  - Identify possible members for the AWG from among the stakeholders, convene Working Group meetings, prepare agendas, initiate discussions with presentations and provide a Secretariate.
  - Facilitate consideration of the following topics (not exhaustive) by the Working Group for advising the PSC:
  - Review optimal land use, current cropping and grazing enterprises
  - Identify the extent of existing irrigated land use
  - Identify existing and potential water management
  - Poll farmer opinions regarding potential new irrigation opportunities
  - Identify approximately 1250ha suitable for possible new irrigation development
  - Identify production constraints
  - Review of social and economic impact of new irrigated land potential, work opportunities, new farmer settlement options
  - Feasibility of municipal food plots and urban agriculture

2.3.4 Module 4 – Bulk Raw Water Supply Infrastructure

The bulk water infrastructure is to consist of:

- Supply of water to the treatment works for domestic consumption.
- Supply of water for irrigation purposes.

With respect to the supply of water for domestic consumption, water is to be pumped from the proposed dam site via the dam inlet/outlet structure to the existing off-channel storage dam via either an existing supply canal or direct to the off-channel dam depending on the final location of the dam site. Water is supplied from the off-channel storage dam to the treatment works and from there to the municipal supply system. An investigation is to be carried out to determine the most cost effective means of supplying water from the dam to the existing water supply system, taking cognizance of the existing infrastructure i.e. raw water supply canal, off-channel storage dam and treatment works and supply system. The capacity and status of the existing Municipal bulk water supply system including the treatment works is to be investigated and recommendations for possible upgrading together with cost estimates is to be completed. Amatola Water are at present carrying out an upgrade on the feeder canal off take and canal. The reporting and final analysis of the improvements will be incorporated in the reporting.

With respect to the supply of water for irrigation purposes, investigations are to be carried out for the supply of water from the dam site via the dam inlet/outlet structure to the proposed areas of irrigation. Alternative means of supplying water are to be investigated such as piping to certain areas with off take points along the pipeline to agreed points of irrigation including the provision of bulk water metering and control systems along the pipeline, a combined canal/piping system to the points of irrigation in the vicinity of the dam, or release of water via the dam outlet structure to irrigation areas further downstream of the dam as well as the supply of water for the irrigation of small plot agriculture purposes.

2.3.5 Module 5 – Water Quality Assessment

Raw water is currently supplied to the treatment works from the Koonap River obtained via an intake weir, canal and tunnel system and off-channel storage dam. The proposed Foxwood dam is be located on the Koonap River, and hence the water quality should be similar. Water samples are to be taken at the proposed dam site and analysed, the optimum treatment of the water is to be assessed, the existing water treatment process is to be assessed and recommendations are to be made regarding possible upgrading of the plant with due cognizance of the water analyses/results and alignment of the existing water plant infrastructure. Purified water quality from the plant shall meet the DWA Guidelines/Standards for drinking water.

2.3.6 Module 6 – Site Investigation

Following on from the desk study and reconnaissance a programme of investigations will be agreed with the Client. At this stage it is very difficult to quantify the extent of input required for these investigations however we note that the Client has specified a **provisional sum of R3m** for the geotechnical investigations and topographical surveys. The location of previously reported on drilling logs, carried out in 1962, would greatly assist in extending this budget. These records are at present being actively sought.

Our professional fees are therefore based on the value of this provisional sum and include for the specification and procurement of investigations, site supervision, interpretation of results and reporting.

As a general rule investigations will comprise of some or several of the following:

General Geotechnical Investigation

- Review of any previous geotechnical investigations
- Aerial photograph interpretation of the site and surrounding area
- Geophysical investigation as necessary
- Seismic risk evaluation for both potential for dam induced seismicity and analysis of the likelihood - or otherwise - of local seismic activity.

Dam Centreline and Spillway Investigation

The level, or extent, of centreline and spillway investigations will very much depend on the complexity of geotechnical conditions and size of the project. Investigations could comprise as follows.

Excavation of trial holes along the dam centreline and within the structure footprint; Terreco Geotechnical cc would undertake soil profiling; removal of samples for laboratory testing; supervise excavations; interpret laboratory data; undertake analyses and report on the findings. Laboratory testing could comprise of:

- Grading; Atterberg Limits; and Proctor Density of centreline soils
- Permeability tests on samples compacted to 85% Proctor Density (to simulate in situ density)
- Shear Strength testing of soils (Shearbox or Triaxial)

- Double Hydrometer; Pin Hole and Crumb test for dispersion
- Drilling Investigations will be required for Centreline; Spillway; Headrace canals; Quarry; Plunge Pool, etc. investigations. This would consist of:
  - Compilation of a drilling contract document
  - Distribution of tender documents to drilling companies
  - Compilation of an adjudication tender report and recommendations for drilling contractor appointment
  - Setting out of boreholes and logging of borehole cores according to South African Institution for Engineering and Environmental Geologists (SAIEG) standards
  - Determination of Lugeon permeability together with estimates of water pressure requirements; supervision and analysis of results
  - Drilling supervision

Materials Investigation
Detailed materials investigations will be undertaken for RCC; earthfill and rockfill dams, or unless specified by the Client, or unless Reconnaissance Investigations indicate an obvious choice in terms of material type and availability.

Core material Investigation
Investigations for the dam core would comprise of geological/ geotechnical prospecting within the dam basin (and surrounds if necessary); selection and supervision for the excavation of trial holes; profiling according to the method of Jennings et al; and removal of samples for laboratory testing.

Dam Shell Material Investigation
Investigations would comprise of selection of trial hole positions and supervision of trial hole excavations in previously identified potential borrow areas; profiling according to the method of Jennings et al; and removal of samples for laboratory testing.

Hard Rock Aggregate Investigation
Hard Rock Aggregate Investigation could include:
- Undertake geological prospecting for a possible hard rock quarry for stone aggregate and riprap
- Investigation of any existing quarry sites in the neighbouring area
- Arrange for drilling of the source including angled boreholes to ensure intersection of conjugate joint sets
- Remove samples for laboratory testing of strength and rock substance durability.

Associated Infrastructure Investigation
The requirements for geotechnical investigations of associated infrastructure will be agreed with the Client. It is recommended that the geotechnical investigations primarily focus on the dam. However, if the provisional sum allowance permits, then physical investigations for associated infrastructure will also be undertaken. For example in identifying pipe bedding material or CBR values for access roads.

Site Survey
For design and construction of the dam and associated works the following survey will be required:

- Dam site and immediate surrounds, 1/500 scale, with 1m contour intervals.
- Basin, to above possible NOC level: 1/5,000 with 2m contour intervals
- When potential borrow areas and quarries have been identified, it will be necessary to plot their positions, and additional survey work may be required. At a later stage, the locations of all geological investigations must be plotted on the site survey plan

There is a requirement for an accurate topographical survey, after visiting the site we will be proposing that the known sites for dam, irrigation and bulk water reticulation be surveyed using

the LIDAR. This may require a two stage approach given uncertainty of available lands. It is proposed that this tender be initiated on sign off of this report. The procurement process should start at this stage.

Deliverable
The output of the geotechnical investigations will be a factual and interpretative report. This will be used to both inform the engineering design and for the final reporting to the Client.
The site survey output will be utilised for the feasibility design.

2.3.7 Module 7 – Dam Technical Details

Site Visit

The site was visited on 18 September 2012:

Attending: Menard Mugumo: Chief Engineer: Options Analysis (South), Department of Water Affairs; Peter van Niekerk: Water Resources Engineering Expert; Solly Mabuda: Chief Director Integrated Resource Planning from the Department of Water Affairs and Bob Pullen, James Bristow and James Hampton from Arup Team. They were accompanied by Ernie Lombard – Councillor Nxuba Municipality and Jan Gouws the services superintendent for Adelaide.
The assumed preferred centre line was walked on both banks. A possible site downstream was also inspected from the right bank only.

Photos from the site visit are provided in Appendix B.

Observations

a. Topography

It is immediately evident that this is a wide U-shaped valley with both left and right bank abutments clearly defined. Left bank falls steeply into the river bed, thereafter there is a relatively horizontal flood plain rising approximately 10m to the right bank abutment formation. The right bank abutment rises steeply through a colluvial sand stone scree. This valley floor is approximately 400m in width.

The Koonap River ox-bows against the left bank abutment and flows over a series of rapids over the centreline and downstream of the potential dam site centreline. Further upstream, still in the basin, there is a masonry pick-up weir founded on competent mudstone. This structure appears to be well established.

The basin looks to be relatively efficient with good volumes being generated once out of the riverbed plane. The basin foot print will almost certainly inundate at least one district road, the R344, which goes to Tarkastad. An alternative route may be required; however there is an alternative road that joins the R344 immediately after the two bridges which could be upgraded if necessary and adds approximately 5 to 10km to the journey. The basin appears to have been used for agricultural purposes with most of the lower basin bush cleared for old fields and grazing.

b. Surface Geology

The left flank comprises of sandstone, with overlying weathered fine grained reddish brown soils. The left bank drops sharply into the Koonap River. Sandstone overlies hard mudstone. The mudstone has open joints exposed at surface but the rockmass appears to be generally competent. The river bed runs over a rapids section of hard mudstone.

The flood plain is covered with a whiter coloured fine grained silt – possibly derived from sandstone – and either of alluvial and/ or colluvial origin. There may be a possibility of

palaeo-channels which will complicate the foundation depths. These could possibly be picked up by seismic survey. The right flank has an impressive rock formation similar to the left but with greater weathering of exposed rockmass and closer joint fracturing. Mudstone as a foundation medium is dependent on the quality of the mudstone, depth of weathering, joint configuration, rock substance strength, bedding, dip of strata, and general quality of the rockmass and potential for kinematic instability.

c. The main concern is wideness of the valley floor which indicates the river has meandered from the right flank cliffs to the left, which could have resulted in sharply varying depths to a competent foundation. There were no dolerite outcrops observed in and around the dam centreline. Initial geological assessments indicate dolerite intrusions located some 4 to 5 kilometers to the north of the dam site.

   An initial appraisal indicates this is not a seismically active area but this must be confirmed during detailed geotechnical assessments.

d. Materials

   The sandstone formation allows for reasonable shoulder materials for an earth embankment. It is reported in the Ninham Shand Report of 1992 that a redder presumably more clay fraction core material is available at the De Beersdrift dam site reasoning that this could also apply to the Foxwood Dam site. This is, however, not necessarily true as previously alluded to, and will take detailed geotechnical investigation to either confirm or deny. The red colouration and perceived clay content may be associated with Dolerite intrusives. Some dolerite was observed at the Koonap / Adelaide water off take weir which is approximately 5km upstream of the proposed dam centre line. This could indicate a prospect for a more clayey fill material in that area. Hardness of the sandstone formation and potential quarry sites must be considered. Experience with these sedimentary rocks is that while they could find potential use as concrete aggregate – if the strength and durability requirements are met – they seldom find use as riprap due to disintegration of mudstone on exposure and long term conchoidal fracturing of sandstone. Dolerite will therefore be the preferred hard rock medium.

   Rockfill suitable for riprap or embankment fill is an uncertainty and will depend on the investigation findings.

e. Preliminary Dam Selection Observations

   The dam site is located on the Koonap River with an approximate catchment of 940km^2 and an estimated run-off of 44mm/annum. The estimated PMF will depend on selected capacity and the basin absorption effect, but will be in the order of 4000- 5000m^3/s. The RDF is estimated to be approximately 700m^3/s. The spillway selection will be critical to viability of the scheme particularly as the base formations are susceptible to erosion.

   The spillway selection will be affected by the dam type selection. If it is a zoned earthfill dam, the spillway will be partially cut out of the left or right bank abutments and will have to be channelled down to river bed level. If the selection is for a RCC dam this would, to a certain extent, cater for the river bed return. The potential for a concrete gravity river bed spillway structure is also a possibility.

   A rockfill option is considered, from the wideness of the valley and the local rock geology, to be the least favourable selection. The RCC will be very dependent on the foundation condition and depth. The earthfill will be affected by the borrow locations and the previously mentioned spillway opportunities.

   In all cases there is a requirement for large volumes of selected materials.

f. Conclusions

This site is located on a good sized catchment which at a MAR/Storage ratio of 1 is 41 million m^3/annum. The site geology can be problematic depending on depth to competency. The valley topography is not particularly efficient. Depending on dam selection and the relative abutment steepness, the abutments will require keying in, which will result in deep excavation.

This can be set off to a certain extent against the spillway location. The road bypass is a further consideration that may add to the overall capital costs depending on whether a new bridge(s) is required. The viability of the site is very much dependent on the amount of water that can be utilised. At present Adelaide has a projected demand of not more than 4 million m^3/annum. The remaining water will need to be commercially viable for the agricultural sector. Alternatively if the supply is only for the town and market gardeners then this site is possibly not optimum.

Dam Sizing

The dam sizing is crucial to the progress of the dam design and as commented on in Module 3, it is proposed, at the preliminary stage, to firstly establish a yield / capacity estimate for various MAR storage ratios. This estimate will include for the reserve assessment and projected Adelaide demand. The remaining water will be for the appropriate risk associated with the crop selection.

Consultation will then be carried out with DWA to confirm what net irrigation area should be potentially supplied from Foxwood Dam. This milestone is incorporated in the Inception Project Schedule. The close out date for this is as previously stated very crucial to the continuation of a number of Modules.

Potential Provincial Road Re-Routing

Depending on the dam capacity selected it is probable that rerouting of the R344 which goes to Tarkastad and has two bridges crossing the potential tail water of the dam will be necessary. This will be a potential scope change given that it was not mentioned in any of the documents issued at time of tender and will require a significant extra detail, depending on the recommendations of the Amatola District Municipality and the stakeholders. A rerouting without raising or reconstructing a bridge is possible but would require approvals as it closes a 5 km section of the R344. Rerouting probably extends the access to Adelaide by a similar amount.

Costing for this operation was not tendered for in the submissions and it is understood this will form part of the EIA study including consultation with SANRAL.

Feasibility design of the selected scheme:

Feasibility design will commence following selection of the final scheme after completion of the previously listed investigations. Three different dam types RCC, earthfill and rock fill will be investigated unless precluded by site conditions and economies of scale. The costing of these options will be based on best information available. An approval gateway has been noted on the programme to reflect this. The feasibility design will run in parallel with the parts of the site investigation. The level of design work will reflect the level of data obtained through the site investigations and will include drawings of all key scheme components.

Spillway

The flood analysis for this dam will be undertaken with due regard to the SANCOLD guidelines for dam safety inspections. Flood peaks will be established for a range of return periods, plus the RMF (Regional Maximum Flood) and PMF (Probable Maximum Flood).

There is a DWA streamflow gauge, station no. Q9H002 which is located in close proximity to the Foxwood Dam site, it has been in operation since 1926. The record of peak annual flows at the gauge will be subject to a frequency analysis to derive a relationship between flood peak and return period for return periods up to 200 years. This relationship will be compared with design floods derived by various established methods to assist in the adoption of a final flood-frequency relationship.

Methods to be used include Rational, SDF (Standard Design Flood), Unit Hydrograph, Hydrological Research Unit (HRU), and Flood Formulae derived by Kovacs whereby factors are applied to the RMF. The PMF will also be estimated using HRU (methodology. The Unit Hydrograph method will be employed to determine hydrograph shapes for an appropriate range of storm durations.

The spillway will be sized according to SANCOLD guidelines for the RDF (Recommended Design Flood) and the SEF (Safety Evaluation Flood) which, in the case of a Category III dam, will require routing of the PMF over the spillway. Hydrographs for a range of storm durations will be routed to determine that which yields the largest peak over the spillway. In the case of the RDF, the freeboard to cater for wave run-up etc. will be determined. (Note that this can be done only when the dam capacity has been established, but that there may be one or two iterations before the final capacity – and wall height – is established).

The choice of appropriate spillway type and location is closely linked to dam type and geological conditions. The 1992 study indicates a combination service spillway with a fuse plug. The possibility of a spillway in a central concrete will be dependent on the type of dam selected as well as the results of the geotechnical investigation. The PSP will examine the feasibility and costs of alternative spillway types and locations. The option of an auxiliary spillway, set at a higher level than the service spillway, or an erodible fuse plug spillway will also be examined.

Embankment and Grouting

A grout curtain and possibly blanket and consolidation grouting, will be required below the cutoff trench of embankment dam or concrete gravity structures. The spacings and depths of grout holes will depend on the findings of the exploratory works. Cement, with bentonite or other additive is the most likely medium for grout, but it is noted that it is difficult to inject grout in sandstones even when Lugeon values are high.

It may be necessary to examine more sophisticated methods of sealing the deeper foundation structure by slurry trench or jet grouting techniques. The cost of these more specialized studies has not been included in this bid but could be the subject of negotiation with the Client if necessary or included in the detailed design study.

Outlet works

Design of the dam outlet works will be dependent on the type of dam selected in the river bed section. For a concrete structure, the outlets can be incorporated quite easily within the body of the dam; for an embankment, the outlets would have to be accommodated in either a tunnel through the flank or through a conduit constructed in open cut below the level of hard foundation. Either tunnel or conduit could be utilized for diversion of river flows during construction.

The capacity of the outlets will be sufficient to meet downstream releases to meet the demands of other rivers and Environmental Flow Requirements. If the Environmental Flow Requirements need periodic large volume releases, the outlet works would be of large discharge capacity but they would not be designed to meet targets of rapid emptying of the reservoir, unless specifically requested by the Client.

they would not be designed to meet targets of rapid emptying of the reservoir, unless specifically requested by the Client.

Whatever form the outlet works might take, they would comprise of an upstream service gate, an intermediate closure valve (fully open or fully closed operation) and a terminal regulatory valve, of sleeve type. There will be at least three intake levels on whichever type of intake. The outlets would be duplicated, service and standby. These, together with other possible adaptations, will be analysed and if proved favourable will be discussed with the Client before proceeding to a more detailed design stage.

A site will be selected a short distance downstream of the toe of the dam for construction of a gauging weir. This would be fitted with continuous recorder and would measure either the small seepage flows or the discharge rates of controlled releases.

Diversion during construction

Diversion of river flow during construction is a critical and costly component of the contract work and the dam design should include the means of diversion. The estimated construction period is estimated as one year so the diversion provision will also be sensitive to the start of construction. The return period of the "construction period flood" will be taken as 10 years, unless the Client directs otherwise. If the central section of the dam is concrete, diversion of flows can be accomplished with comparative ease by passing the water over or through a gap in the incomplete structure. If the central river section of the dam is an embankment, either rockfill or earthfill flood flows would either pass over the dam at a low level with reinforced rockfill in the downstream toe, or else through a U-shaped temporary gap in the embankment. An outlet tunnel or conduit could act as a diversion, but only up to a limited discharge capacity – all diversion options will be analysed as part of the selection of dam type.

2.3.8 Module 8 – Cost Estimate and Comparison

Estimates of the Construction Cost and Operation and Maintenance (OandM) Costs will be prepared for each of the dam types considered (including associated bulk supply infrastructure) and for a range of dam sizes. The dam sizes (i.e. storage capacity) adopted for this purpose will be determined from the characteristic storage capacity curve to limit the assessment to a realistic range. Attention will first be focused on the capacity and cost of a dam to meet Ecological Water Requirements and domestic water needs only. Thereafter the incremental cost of providing additional storage to also supply water for irrigation use will be estimated.

Construction cost estimates will include all components such as road and services relocations, land acquisition, environmental impact management costs including mitigating the impacts on heritage resources such as graves and archaeological sites.

Based on the work from Module 3 – Irrigation Development – an assessment shall be carried out of the viability of commercial irrigation, agro-industrial urban agriculture and food plot use in the area taking into account crop types, soil type, topography, grade and other factors. Assess the sustainability of these types of irrigation from a financial point of view. In the event of non-viability or sustainability without subsidy, determine the level of subsidy required to make each feasible.

The cost estimates and cash flow steams will inform a comparison between development alternatives and sizes and will provide essential information for consideration of the financing alternatives for the project. The cost implications of designing for labour intensive construction methods will be investigated.

The Unit Reference Value (URV) method will be used for comparing alternatives and for this purpose realistic projections of the quantities of water supplied to the different user sectors will be determined.

The estimated capital and OandM cost of the preferred scheme will be used to determine the applicable water tariff according to the Pricing Strategy for Raw Water Use Charges payable for domestic supplies. Appropriate tariffs for irrigation water supplies will be investigated.

2.3.9 Module 9 – Land Matters

Acquisition of land

The ownership status of all portions of land affected by the footprint of the dam, associated infrastructure and bulk water infrastructure will be determined. The requirements for acquiring access to this land by way of expropriation for the purpose of implementing the project will be established.

This will include the land required for road relocations on the R344 discussed in section 2.3.7 above. Provision will also be made for temporary rights of access that may be required during construction and for permanent servitudes of access and of water storage (or submergence). Reference will be made to recent land sale transactions to obtain current information on the costs of acquiring land.

Since this is a Feasibility Study leading up to decisions regarding approval and implementation, no steps will be taken to mark the portions of land required or to undertake any cadastral surveys. It is assumed that the setting out costs associated with possible food plots or small scale farms envisaged for new irrigation development are included within the R1.5m provisional sum that the Client has specified to include survey costs.

2.3.10 Module 10 – Regional Economics

Economic Baseline Establishment

The impact of infrastructure development on the regional economic situation needs to be evaluated in order to determine whether, and to what extent a positive economic impact is created through the infrastructure provision. In order to evaluate the project impact the current economic and socio-demographic situation needs to be determined in order to establish the baseline against which the project will be measured. A realistic ten-year forward projection of these indicators also needs to be prepared as a reference point for the additional economic activity which could be facilitated by the project. A set of quantifiable measures and qualitative indicators need to be used to objectively evaluate the impact.

In order to prepare the economic baseline and projection the following preliminary processes will be undertaken:

- Gather socio-economic data and compile regional profiles:
  - Review the Integrated Development Plan (IDP) and any other economic studies which have been undertaken for the region;
  - Liaise with municipal officials to establish socio-economic profiles
    Compile spatial orientation of socio-demographic data
- Analyse sectoral data and compile economic profiles for Amathole District Municipality and Adelaide in the Nxuba Local Municipality

Global Insight and/or Quantec Data to be used for the local information, with StatisticsSA being used for district level data. Socio-economic impacts will be identified and described using the latest Social Accounting Matrix (SAM) or the Industrial Development Corporation (IDC).

These regional and local economic indicators will provide a holistic overview of the socio-economic profile of Adelaide and allow a more meaningful economic impact assessment to be performed.

Economic Impact Assessment

The focus of the economic impact assessment is to apply the project information and set up an economic impact simulation model to fully capture and assess the impact on the local, regional and national levels of the economy. The impact assessment will address the quantification of:

- Investment in infrastructure and capital projects
- Operational revenue streams
- Other relevant transaction flows, including fiscal revenue
- Employment expenditure
- Operational expenditure
- Development spending.

The above imply changes in the economy; the impacts will be identified and captured in an impact simulation model at a local, regional and national level. The resultant economic model will:

- Give a clear economic rationale for the project,
- Identify and quantify the economic consequences of all financial flows and other impacts of the project,
- Identify an appropriate 'no-project' scenario and calculate the associated economic flows, treating them as opportunity costs to the project,
- Detail the calculation for all inputs and outputs, including:
  - Foreign exchange
  - Marginal cost of public funds

  - Opportunity cost of public funds (discount rate)
  - High, medium and low skill labour
  - Tradable and non-tradable inputs
  - Tradable and non-tradable outputs (including consumer surplus, where relevant, based on financial or other model quantities)
- Identify the economic benefits to BEE, and the opportunity costs to BEE of a 'no-project' scenario
- Provide a breakdown of the economic costs and benefits of the project into its financial costs and benefits and various externalities

The following elements could be incorporated into the economic model:

- The economic growth potential of the project
- The impact on the GDP and the ability to raise direct foreign investment
- The impact on the GGP for the Eastern Cape
- The potential tax revenues
- The ability to access leveraged funds and the extent thereof
- The jobs created and their costs

- The social impacts and their costs, e.g. water affairs, housing, healthcare, education, household income
- The environmental impacts and their costs
- The opportunity costs of the project
- The direct and in-direct costs for capital expenditure and operating revenues

The model will include three different scenario's, a high, low and medium outlook; the model's outputs will be evaluated and a sensitivity analysis undertaken. The results will be used to assess the project's ability to leverage private sector investment and sources of public funding. This economic impact methodology will be further formulated in consultation with the project team in order to decide the most important parameters to be modelled and the outputs required by the Client.

2.3.11 Module 11 – Record of Implementation Decisions

At the close out of the project a record of Implementation Decisions (RID) will be prepared as a concise description of the project proposals using the style and content established by the DWA for other recent projects. The RID will focus on uncertainties and risks in the implementation phase, e.g. the impact of unexpected foundation conditions, the lead time required in an implementation programme and the costs of preparatory activities for Environmental Impact Management, guidelines and basic premises for the detailed design, institutional arrangements agreed upon by stakeholders and the financing structures.

A specific focus will be placed on the institutional arrangements that should be put in place in order for implementation to be successful.

The RID will be used as the basis for a submission to the Minister for approval of the project proposals to which can be attached a draft notice in terms of Section 110 of the National Water Act.

2.3.12 Module 12 - Legal, Institutional and Financing Arrangements

This project sits within the Legal, Institutional and Financial context of the government's recently adopted New Economic Growth Path. The role of water as a strategic catalyst in development is critical in the achievement of the economic growth path objectives. The Foxwood Dam project falls within DWA's mandate to invest in bulk infrastructure to support economic growth and to meet the growing social needs.

The Terms of Reference sets out six specific items within this aspect of the study that will be addressed as follows:

Legal provisions

The legal provisions deal with the constitutional requirements relating to –

- environmental protection and equity
- water management and allocation and delivery of water services
- corporate governance, for example who should own, finance and operate the infrastructure
- institutional development, and
- social requirements and communal land ownership implications.

The processes necessary to obtain the authorisations needed for the different activities associated with the project will flow from the assessment of the Legal Provisions.

Institutional analysis

The existing institutional structures will be analysed and an assessment made of their capacity to operate and maintain the scheme. The costs of this resource will be included in the above cost model. The opportunity to move away from a traditional financial management structure to one based on Water Conservation and Demand Management principles will also be considered.

Financial arrangements

A comparative analysis of the various financing options available for the project will be undertaken. Attention will focus on the impact upon project sustainability and institutional capacity. A recommendation in this regard, based upon a thorough analysis of the funding options available, will identify a financing structure and the conditions precedent for implementation.

A financial model will be compiled to take cognisance of the envisaged capital expenditure during implementation, the financing costs and the revenue collection risks associated with willingness and ability to pay. This model will include:

- A monthly cash-flow for project implementation, operation and maintenance;
- Revenue profiles based upon detailed user profiles;
- A matching of costs and water revenue with economic performance and population trend lines for the area;
- Capital cost and maintenance provision profiles for the infrastructure requirements;
- Evaluate municipal revenue collections based upon the prevailing and escalated municipal tariff profiles;
- Establish bulk raw water supply rates, irrigation water tariffs and domestic potable water supply rates;
- Model the infrastructure provision on a 'ring-fenced' basis as well as within the current municipal budgeting framework;
- Determine additional human resources and costs needed for the operation and maintenance of the scheme.
- Undertake a source and application of funds analysis in order to determine potential funding shortfalls;
- Perform sensitivity modelling;

2.3.13 Module 13 – Public Participation

During the preliminary stage of the project the PSP's will establish stakeholder forums and commence the public participation process, as outlined in the methodology in section 2.2.1. The Terms of Reference notes that a comprehensive Public Involvement Programme will be the subject of a separate appointment within the Environmental Impact Assessment scope of work. We understand that this appointment will be made after the Environmental Screening and the PSP's responsibility for leading the stakeholder forum will be handed over to the EIA consultant when this appointment is made. The PSP will arrange a stakeholder meeting every 12 months up until the appointment of the EIA consultant or until the end of the Feasibility Study, whichever is sooner.

However, the PSP's Public Participation team has also budgeted for attendance at the first stakeholder forum of the EIA stage in order to assist with continuity. In addition to this we recognise the need for continuing technical input and attendance at the stakeholder forum and as such we have budgeted for this on the basis of technical input at two stakeholder forums per year during the EIA stage up until the end of the Feasibility Study.

2.3.14 Deliverables and Task Reviews

Table 6 below identifies the studies, assessments and reports that will comprise the total Feasibility Study.

Table 6: Schedule of deliverables

DWA Document Number	Module / Project Stage	Deliverables Schedule
P WMA 15/Q92/00/2113/1	**Inception Stage**	**Inception Report**
P WMA 15/Q92/00/2113/2	**Preliminary Stage**	**Preliminary Study Report**
P WMA 15/Q92/00/2113/3		Environmental Screening
P WMA 15/Q92/00/2113/4		Geotechnical Desk Study
P WMA 15/Q92/00/2113/5		Alternative Water Supply Options Report
P WMA 15/Q92/00/2113/6	**Feasibility Study**	**Feasibility Study: Main Report**
P WMA 15/Q92/00/2113/7	Water Resources	Hydrology Report
P WMA 15/Q92/00/2113/8	Water Requirements	Water Requirements Report
P WMA 15/Q92/00/2113/9	Irrigation Development	Agro-Economic Study Report
P WMA 15/Q92/00/2113/10	Bulk Raw Water Supply Infrastructure	Bulk Raw Water Supply Infrastructure Report
P WMA 15/Q92/00/2113/11	Water Quality	Water Quality Report
P WMA 15/Q92/00/2113/12	Site Investigation	Geotechnical Investigation
P WMA 15/Q92/00/2113/13		Topographical Survey
P WMA 15/Q92/00/2113/14	Dam Technical Details	Dam Feasibility Design Report
P WMA 15/Q92/00/2113/15	Cost Estimate and Comparison	Project Feasibility Costing Report
P WMA 15/Q92/00/2113/16	Regional Economics	Economic Impact Assessment Report
P WMA 15/Q92/00/2113/17	Land Matters	Land Matters Report
P WMA 15/Q92/00/2113/18	Legal, Institutional and Financing Arrangements	Legal, Institutional and Financing Arrangements Report
P WMA 15/Q92/00/2113/19	Record of Implementation Decisions	Record of Implementation Decisions Report
P WMA 15/Q92/00/2113/20	Drawings	Book of Plans

3 STUDY TEAM

3.1 Team Composition

Changes to the study team since the award of the tender are identified in section 3.1.1 below. CV's of all new team members have been provided separately to DWA with further motivation for the required changes and additions (refer letter to DWA, 31 October 2012).

3.1.1 Changes to the Study Team

The following people have been added to the PSP Study Team.

Table 7: Additions to PSP Study Team

Name	Company	Role	HDI Status
James Bristow	Arup	Project Management	White Male
Mirelda Cronje	Arup	GIS	White Female
Daniel Ledwaba	Arup	Administration	Black Male
Mandisa Mzimaze	Arup	Administration	Black Female
Debbie Osullivan	Arup	Secretary	White Female
Adele Samuels	Arup	GIS	Indian Female
Lauren Engler	ACER	Stakeholder Consultant	White Female
Jacques Barnard	Camdekon	Technologist	White Male
Henry Campbell	Camdekon	Dam Infrastructure Engineer	White Male
Jaco Haarsbroek	Camdekon	Technical Assistant	White Male
Thabo Jonga	Camdekon	Technician	Black Male
Neo Lelala	Camdekon	Technician	Black Male
Bubele Mabandla	Camdekon	Technician	Black Male
Pieter Maré	Camdekon	Roads Engineer	White Male
Aphiwe Mqoqi	Camdekon	Technician	Black Female
Likhayia Nkonki	Camdekon	Electrical Engineer	Black Male
Sizwe Nzwana	Camdekon	Technician	Black Male
Edward Packson	Camdekon	Draughtsperson	Black Male
Mike Rivarola	Camdekon	Mechanical Engineer	White Male
André Scheepers	Camdekon	Water Requirements and Bulk Water Supply Module Leader	White Male
Armand Scheepers	Camdekon	Graduate Engineer	White Male
Wayne Selkirk	Camdekon	Water Quality Specialist	White Male

3.2 Study Management

For the purposes of the management of the Study Team the key individuals being provided by Arup are as follows:

Project Director – James Hampton
Project Manager – James Bristow
Project Reviewer – Mark Tindale

3.3 Task Leaders

Table 8: Task Leaders

Module	Module Leader	Company
Inception Stage		
Geotechnical Review	GV Price	Terreco
Review of Hydrological Data	Anne Beater	Independent specialist
Phase 1 Preliminary Study		
Stakeholder Involvement	Bongi Shinga	ACER
Environmental Screening	Yusuf Raja	Arup
Geotechnical Reconnaissance	GV Price	Terreco
Hydrological Review	Anne Beater	Independent specialist
Assessment of Supply Options	Andre Scheepers	Camdekon Engs
Phase 2 Feasibility Study		
Module 1 – Water Resources	Anne Beater	Independent specialist
Module 2 - Water Requirements	Andre Scheepers	Camdekon Engs
Module 3 – Irrigation Development	Murray Clark	Agri Africa
Module 4 – Bulk Raw Water Supply Infrastructure	James Bristow	Arup
Module 5 –Water Quality Assessment	Andre Scheepers	Camdekon Engs
Module 6 – Site Investigation	GV Price	Terreco
Module 7 – Dam Technical Details	James Hampton	Arup
Module 8 – Cost Estimate and Comparison	Bob Pullen	Independent specialist
Module 9 – Land Matters	James Bristow	Arup
Module 10 – Regional Economics	Derek Zimmerman	Rand International Capital
Module 11 – Record of Implementation Decisions	Bob Pullen	Independent specialist
Module 12 – Legal, Institutional and Financing Arrangements	Bob Pullen	Independent specialist
Module 13 – Public Participation	Bongi Shinga	ACER

3.4 Study Team

A revised manpower schedule is provided in Appendix C

3.5 HDI component

Building capacity of historically disadvantaged individuals (HDIs) in the fields of water resource planning and development is viewed as an integral part of the contract. Capacity building entails giving HDIs the requisite practical exposure and background training to be able to participate meaningfully in the study and future projects.

Members of the Study Team and their HDI status are listed in Table 6.2:

Table 9: PSP Team members' HDI status

Name	Company	Role	HDI Status	Total Hours
Engler, L	ACER	Public Participation	White Female	68
Shinga, B	ACER	Public Participation	Black Female	272
Charter C	Agri Africa	Irrigation / Agriculture	White Male	215
Clark M	Agri Africa	Irrigation / Agriculture	Foreign	239
Fyfe T	Agri Africa	Irrigation / Agriculture	Black Male	200
Robinson J	Agri Africa	Irrigation / Agriculture	White Male	0
Barwa, H	Arup	Graduate Engineer	White Male	164
Bristow, J	Arup	Senior Engineer	White Male	354
Cronje, M	Arup	GIS	White Female	88
Hampton, J	Arup	Associate Director - Dams	Foreign	451
Hart, M	Arup	Senior Mechanical Engineer	Foreign	121
Hilton, M	Arup	3D Modelling	White Female	101
Jansen Van Vuuren, C	Arup	Draughtsperson	White Male	5
Ledwaba, D	Arup	Administration	Black Male	20
Mzimaze, M	Arup	Administration	Black Female	20
Naidoo, S	Arup	Environmentalist	Indian Female	100
Nel, M	Arup	Technician	White Female	388
Ntuli, N	Arup	Graduate Engineer	Black Male	502
Olivier, Y	Arup	GIS	White Female	75
Omotoso, T	Arup	Senior Engineer	Foreign	186
Osullivan, D	Arup	Secretary	White Female	96
Potgieter, L	Arup	Senior Planner	White Male	0
Raja, Y	Arup	Associate - Environmentalist	Indian Male	140
Rossouw, J	Arup	Graduate Engineer	White Male	454
Samuels, A	Arup	Gradate Environmentalist	Indian Female	35
Spasjic-Gril, L	Arup	Dam Expert Reviewer	Foreign	86

Name	Company	Role	HDI Status	Total Hours
Tindale, M	Arup	Assocaite - Water	Foreign	297
van de Walt, J	Arup	Senior Technician	White Male	5
Walker, M	Arup	Senior Electrical Engineer	White Male	106
Beater, A	Independent specialist	Water Resources	White Female	346
Barnard, J	Camdekon	Technologist	White Male	112
Campbell, H	Camdekon	Lead Engineer	White Male	24
Haasbroek, J	Camdekon	Technical Assistant	White Male	42
Jonga, T	Camdekon	Technician	Black Male	16
Lelala, N	Camdekon	Technician	Black Male	16
Mabandla, B	Camdekon	Technician	Black Male	16
Mare, P	Camdekon	Roads Engineer	White Male	8
Mqoqi, A	Camdekon	Technician	Black Female	52
Nkonki, L	Camdekon	Electrical Engineer	Black Male	40
Nzwana, S	Camdekon	Technician	Black Male	16
Packson, E	Camdekon	Draughtsperson	Black Male	110
Rivarola, M	Camdekon	Mechanical Engineer	White Male	40
Scheepers, A	Camdekon	Study Leader	White Male	44
Scheepers, Armand	Camdekon	Technician	White Male	48
Selkirk, W	Camdekon	Water quality specialist	White Male	24
Baker, K	Groundwater	Groundwater	White Female	40
Murray, R	Groundwater	Groundwater Specialist	White Male	6
Pitman, B	Independent specialist	Specialist Hydrologist	White Male	76
Pullen, R	Independent specialist	Study Leader	White Male	510
Adams, J	Rivers for Africa	Environmental Reserve	White Female	24
Birkhead, D	Rivers for Africa	Environmental Reserve	White Male	78
Huggins, G	Rivers for Africa	Environmental Reserve	White Male	30
Hughes, D	Rivers for Africa	Environmental Reserve	White Male	104
Huizinga, P	Rivers for Africa	Environmental Reserve	White Male	20
Koekemoer, S	Rivers for Africa	Environmental Reserve	White Female	64
Kotze, P	Rivers for Africa	Environmental Reserve	White Male	54
Louw, D	Rivers for Africa	Environmental Reserve	White Female	178
Mackenzie, J	Rivers for Africa	Environmental Reserve	White Male	64
Mallory, H	Rivers for Africa	Environmental Reserve	White Female	124
Rountree, M	Rivers for Africa	Environmental Reserve	White Male	48
Scherman, P	Rivers for Africa	Environmental Reserve	White Female	56
Taljaard, S	Rivers for Africa	Environmental Reserve	White Female	40
Turpie, J	Rivers for Africa	Environmental Reserve	White Female	16
Uys, AC	Rivers for Africa	Environmental Reserve	White Female	48

Name	Company	Role	HDI Status	Total Hours
Van Niekerk, L	Rivers for Africa	Environmental Reserve	White Male	112
Whitfield, A	Rivers for Africa	Environmental Reserve	White Male	46
Wooldridge, T	Rivers for Africa	Environmental Reserve	White Male	24
Hartley, C	Terreco	Geotechnical	White Male	394
Price, GV	Terreco	Geotechnical	White Male	219
Romans	Terreco	Geotechnical	White Female	42
Thompson, H	Independent specialist	Legal Expert	White Male	40
Watermeyer, C	Independent specialist	Dam Specialist	White Male	300
Zimmerman, D	Independent specialist	Economist	White Male	328

Table 10 summarises the total HDI participation in terms of percentage time and percentage fee.

Table 10: Total HDI participation

	Fee	Hours
% HDI of total (excluding foreign input)	30%	40%

4 STUDY BUDGET

4.1 Professional Fees

The professional fee for the project is unchanged from the agreed fee in the contract: R13,915,082 (including VAT and escalation).

Escalation of professional fees

Professional fees are to be escalated as approved by the DWA on 1 August, starting twelve months from the contract effective date by a percentage approved by DWA.

4.2 Disbursements

The sum of disbursements is unchanged from the agreed fee in the contract: R560,500 (excluding VAT)

4.3 Breakdown of Feasibility Study cost by module

Table 11: Professional fee broken down by module

Study section	Hours	Fee (R)	% Fee
INCEPTION PHASE	671.75	541,418	8%
Stakeholder Involvement	334	236,900	4%
Environmental Screening	275	191,000	3%
Geotechnical Reconnaissance	96	85,600	1%
Hydrological Review (incl. first order ER)	254	190,400	3%
Assessment of Supply Options	268	159,700	2%
Module 1: Water Resources	1196	864,340	13%
Module 2: Water Requirements	172	141,600	2%
Module 3: Irrigation Development	310	263,500	4%
Module 4: Bulk Water Supply Infrastructure	342	256,180	4%
Module 5: Water Quality	76	67,800	1%
Module 6: Site Investigations	686.9	486,540	7%
Module 7: Dam Technical Details	2005	1,429,200	21%
Module 8: Cost Estimate and Comparison	104	93,200	1%
Module 9: Land Matters	332	237,400	4%
Module 10: Regional Economics	238	182,550	3%
Module 11: Record of Implementation Decisions	200	186,000	3%
Module 12: Legal, Institutional and Financing Arrangements	220	214,000	3%
Module 13: Public Participation	113	107,750	2%
Module 14: Project Management	932	767,680	11%
TOTAL			100%

4.4 Cash Flow

Table 12 and Figure 8 illustrate the project cash flow over the study duration.

Table 12: Projected Cashflow

Month	Projected Cashflow (ZAR)
Aug 2012	-
Sep 2012	113,430.00
Oct 2012	462,298.50
Nov 2012	521,074.05
Dec 2012	462,059.10
Jan 2013	367,359.30
Feb 2013	323,988.00
Mar 2013	279,180.30
Apr 2013	233,677.20
May 2013	282,423.60
Jun 2013	1,202,460.60
Jul 2013	1,136,306.40
Aug 2013	1,083,621.30
Sep 2013	1,992,848.55

Month	Projected Cashflow (ZAR)
Oct 2013	1,458,811.72
Nov 2013	1,237,390.07
Dec 2013	60,218.25
Jan 2014	65,094.80
Feb 2014	246,523.04
Mar 2014	160,454.63
Apr 2014	251,051.22
May 2014	376,620.88
Jun 2014	267,758.69
Jul 2014	90,991.50
Aug 2014	412,443.79
Sep 2014	266,305.04
Oct 2014	242,712.72
Nov 2014	317,978.94

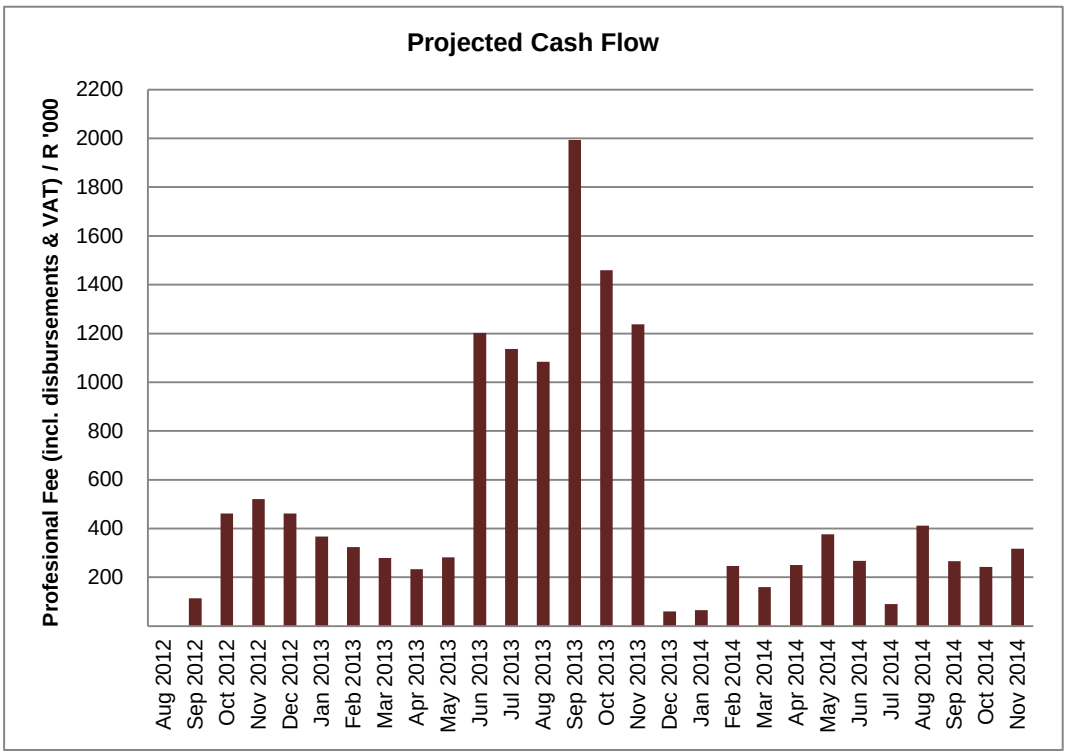


Figure 8: Graph showing projected project cash flow

5 BIBLIOGRAPHY

General References

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b. Adelaide Water Supply: Proposed Foxwood Dam. (Ninham Shand, May 1998)
c. Reconciliation Strategy for Adelaide (Umvoto Africa Ltd, January 2012)

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d. **WR90.** Surface Water Resources of South Africa 1990. WRC report numbers 298/1–6.2/94. (Midgley DC, Pitman WV and Middleton BJ 1994), Water Research Commission, Pretoria.
e. **WR2005.** Middleton BJ and Bailey AK (2005) Water Resources of South Africa, 2005 Study (WR2005), Water Research Commission Report, Contract K5/1491, July 2008.

Environmental Water Requirements References

f. Module A: EcoClassification and EcoStatus determination. In River EcoClassification: Manual for EcoStatus Determination (version 2). (Kleynhans, C.J. and Louw, M.D. 2007) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.
g. Desktop Assessment of the Importance and Ecological State of the Maputo River Quaternary catchments. (Louw, M.D. and Huggins, G. 2007) Produced by Water for Africa as part of the Joint Maputo River Basin Water Resources Study – Moçambique, Swaziland and South Africa.
h. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2. (2008) Department of Water Affairs and Forestry (DWAF), Pretoria. South Africa.

Geotechnical References

i. Foundation Conditions of the Foxwood Site Koonap River, Adelaide District (J.A.H. Marais, November 1962) Department of Mines

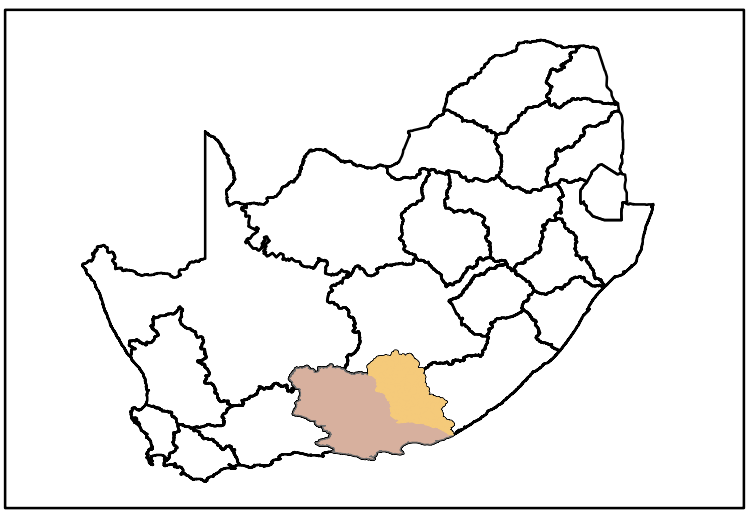
APPENDIX A
Hydrology Plans

A3

25°E 26°E 27°E

31°S 32°S 33°S 34°S

Q11A Q11C Q12B Q11B Q14B Q12A Q11D Q12C Q14A Q14C Q43A Q14D Q42A Grassridge Dam Q13A Q22B Q14E Q13B Q22A Q42B Q43B Q21B Q13C Q41C Q30C Kommandodrift Dam Q44B Q21A Q30B CRADOCK Q30D Lake Arthur Q41D Q41B Q30E Q44A Q30A Q44C Q41A Q60A Q80A Q80B Q50A Q92A Q92C Q92B Q94C Q94B Q94A Q60C Q60B Q50B Q80C Q92D Q94E Q94D Q50C Q70A Q80D Q92F Q92E Bedford Foxwood Dam Q94F Q70B Q80E Adelaide Q92G Q80F Q70C Q91A Q80G Q91B Q93A Q91C Q93C P10C Q93B P10D P10B P10A GRAHAMSTOWN Q93D P40A P30A P10E P40B P30B P10F P40D P40C P10G P30C P20B P20A



Legend

- Foxwood Dam Site
- Tertiary Catchment Boundary
- Quaternary Catchment Boundary
- Q92 Catchment Area
- Foxwood Catchment Area
- Endoreic Areas
- Existing Dams
- Rivers
- Towns
- Q92A Quaternary Number

Issue	Date	By	Chkd	Appd
P0	2012-10-24	MC	AB	JH

ARUP

10 High Street Melrose Arch,
Johannesburg South Africa
Tel +27 11 218 7600 Fax +27 86 674 8513
www.arup.com

water affairs
Department: Water Affairs
REPUBLIC OF SOUTH AFRICA

Client
Department of Water Affairs

Job Title
Foxwood Dam

0 5 10 20 30 40 50 Kilometers

Fish River Catchment with Koonop (Q92) Sub-catchment

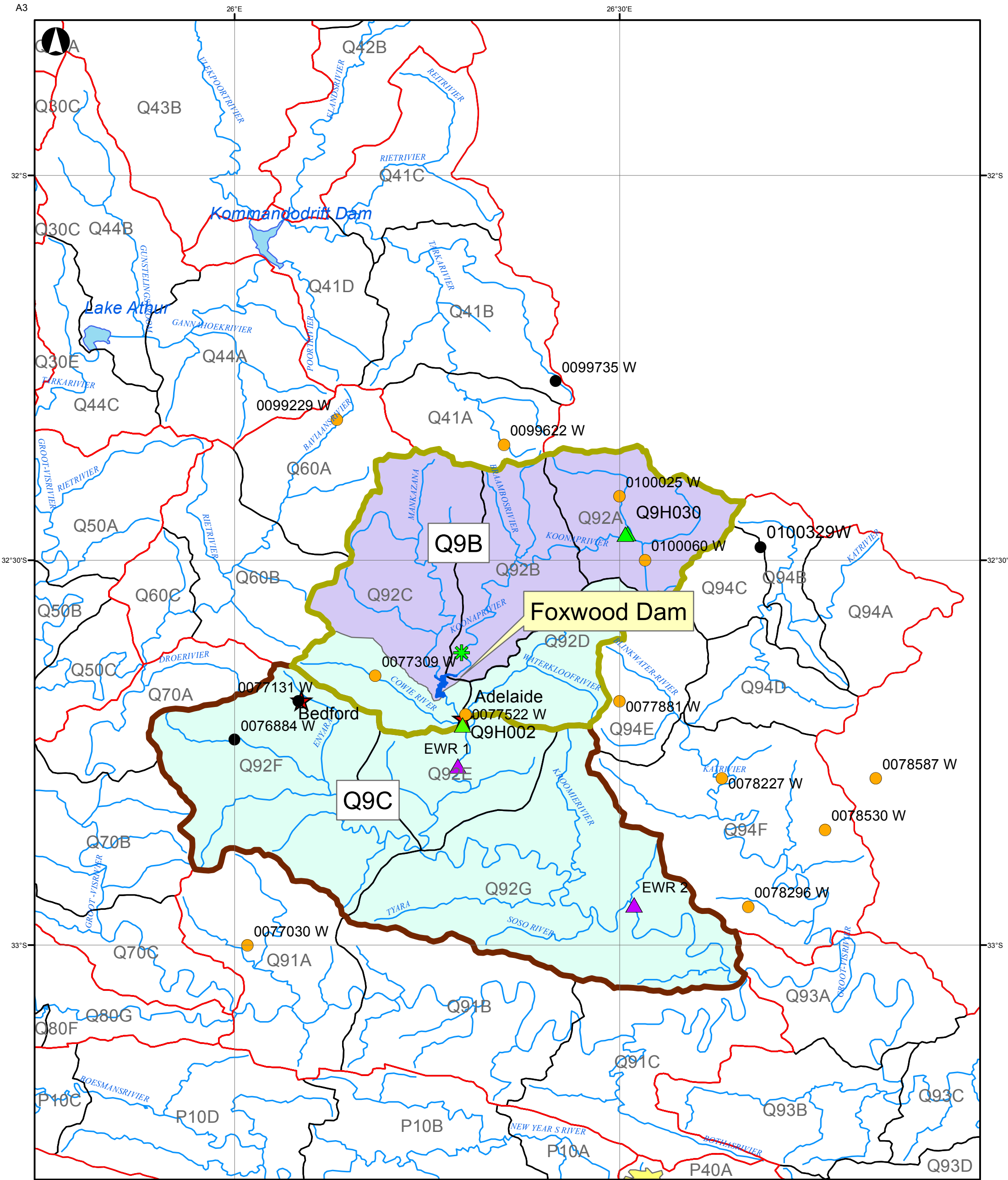
Scale at A3
1:1,200,000

Job No	Drawing Status
225739-00	**Preliminary**

Drawing No	Issue
225739-001	**P0**

MXD Location

A3



Legend

- Off-Take Weir
- Flow Gauge
- Closed Rain Gauge
- Open Rain Gauge
- EWR Site
- Foxwood Dam Site
- Q9B Rain Zone
- Q9C Rain Zone
- Tertiary Catchment Boundary
- Quaternary Catchment Boundary
- Existing Dams
- Towns
- Rivers
- Foxwood Catchment Area
- Q92 Subcatchment

Issue	Date	By	Chkd	Appd
P0	2012-10-24	MC	AB	JH

ARUP

10 High Street Melrose Arch,
Johannesburg South Africa
Tel +27 11 218 7600 Fax +27 86 674 8513
www.arup.com

Client
Department of Water Affairs

Job Title
Foxwood Dam

Kilometers
0 2.5 5 10 15 20 25

Koonap Q92 Sub-catchment showing Rainzones, Raingauge and Flow Gauges

Scale at A3
1:500,000

Job No	Drawing Status
225739-00	**Preliminary**

Drawing No	Issue
225739-002	**P0**

MXD Location

APPENDIX B
Site Visit Photos

1 Adelaide & Foxwood Location Plans & Photos

1.1 Location Plans

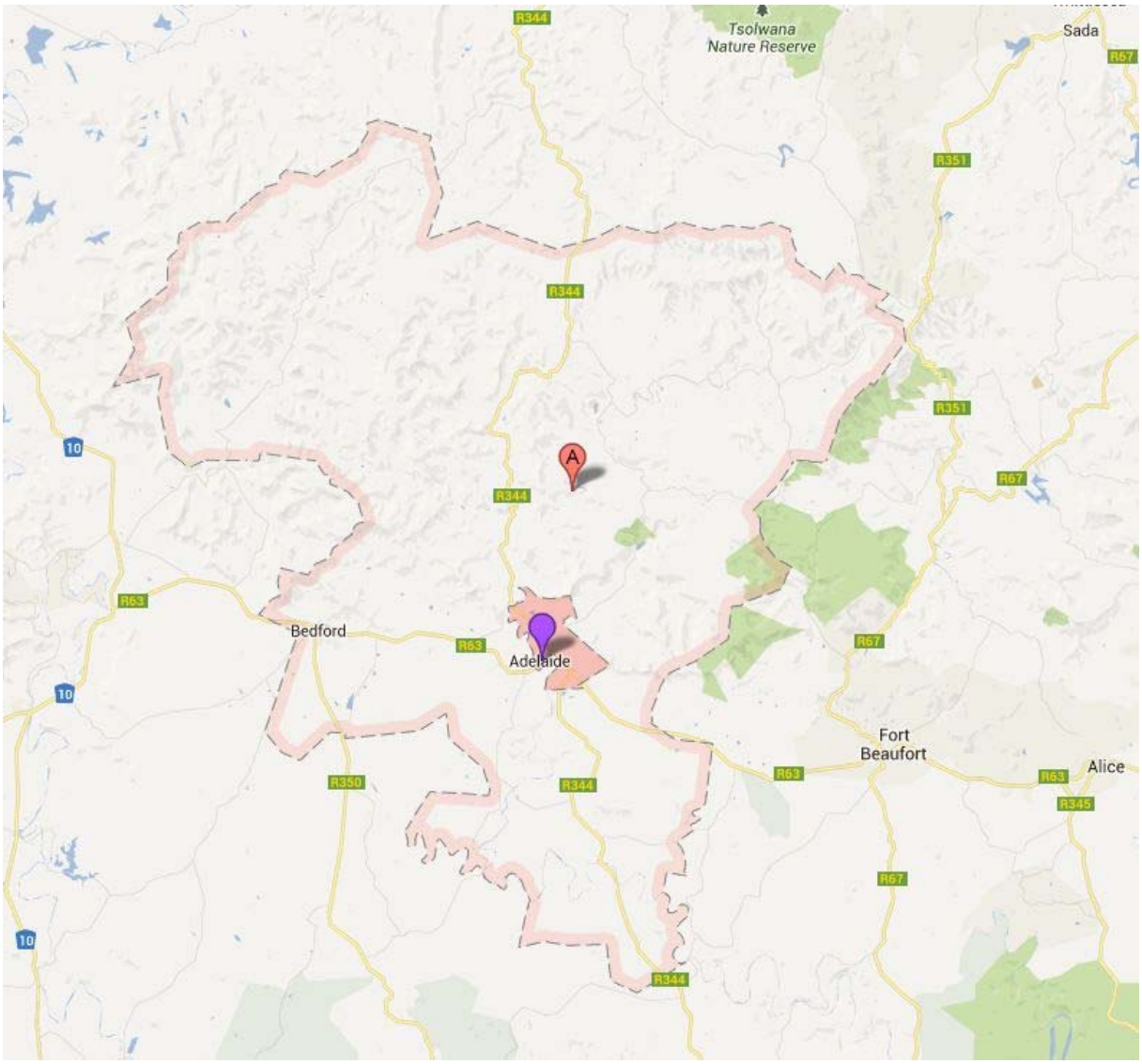
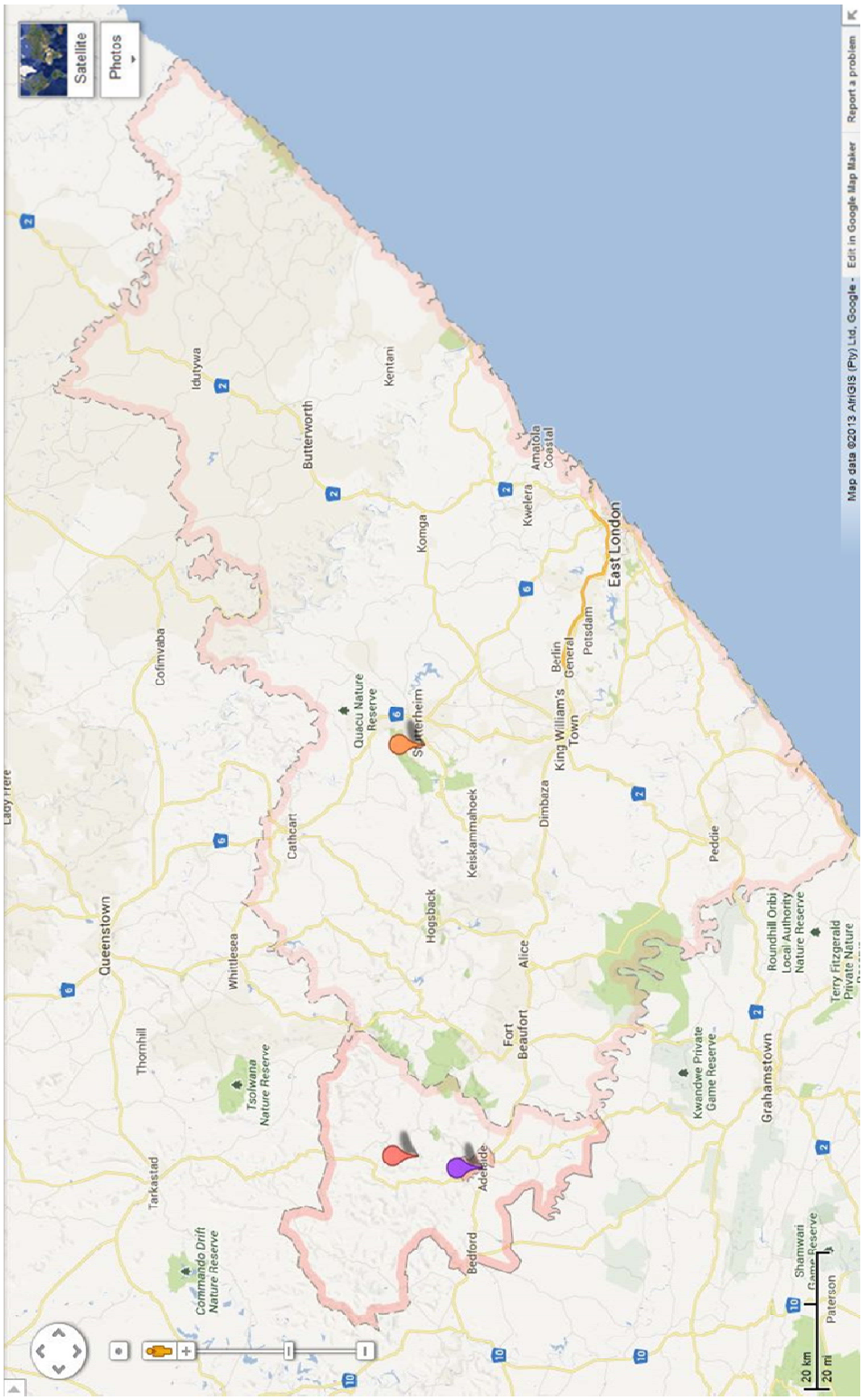


Figure 1 Nxuba Local Municipality

Figure 2 Amathole District Municipality



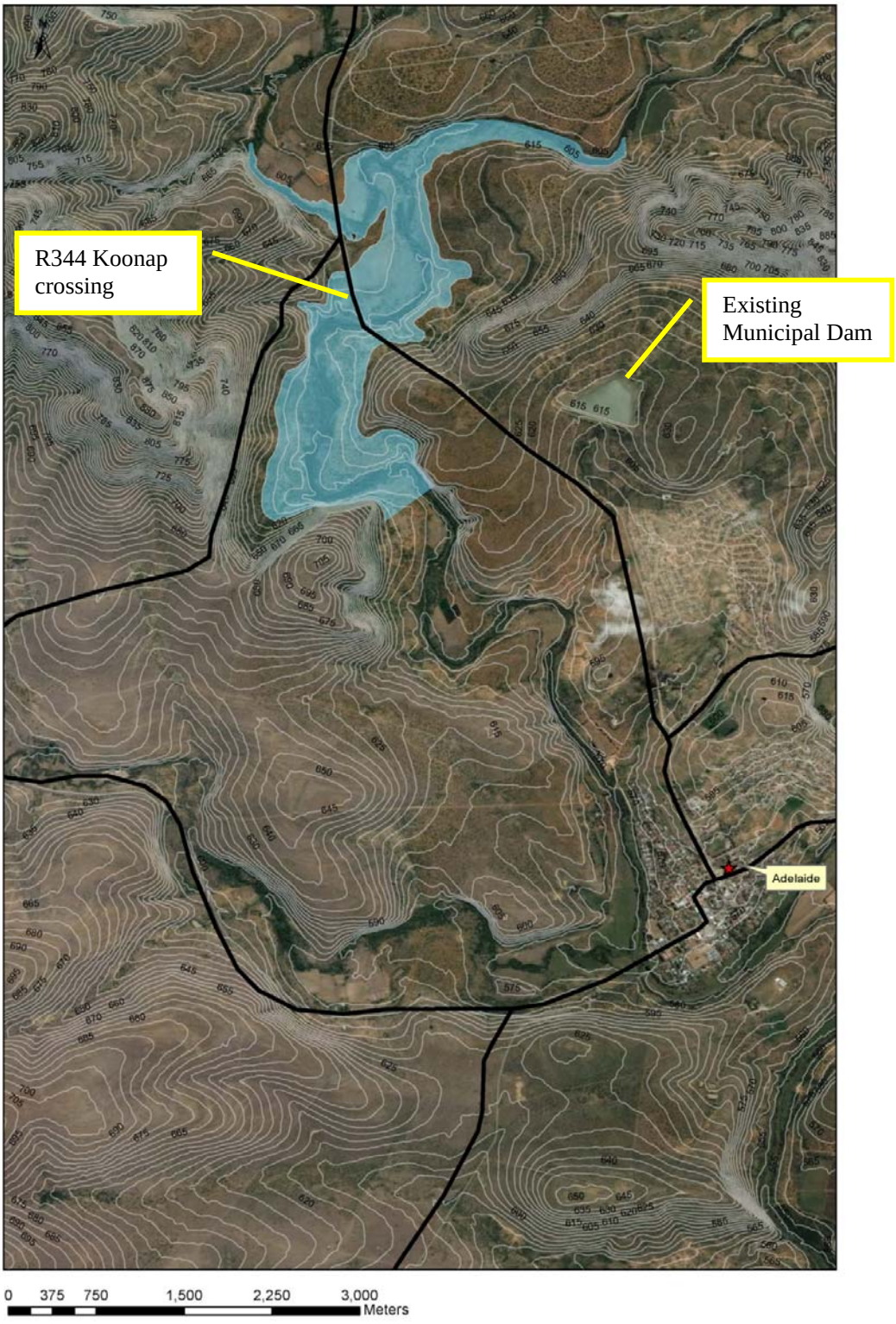


Figure 3 Estimated Inundation Area based on operating level of +605m

1.2 Site Photos

Photo 1 View towards dam site from west

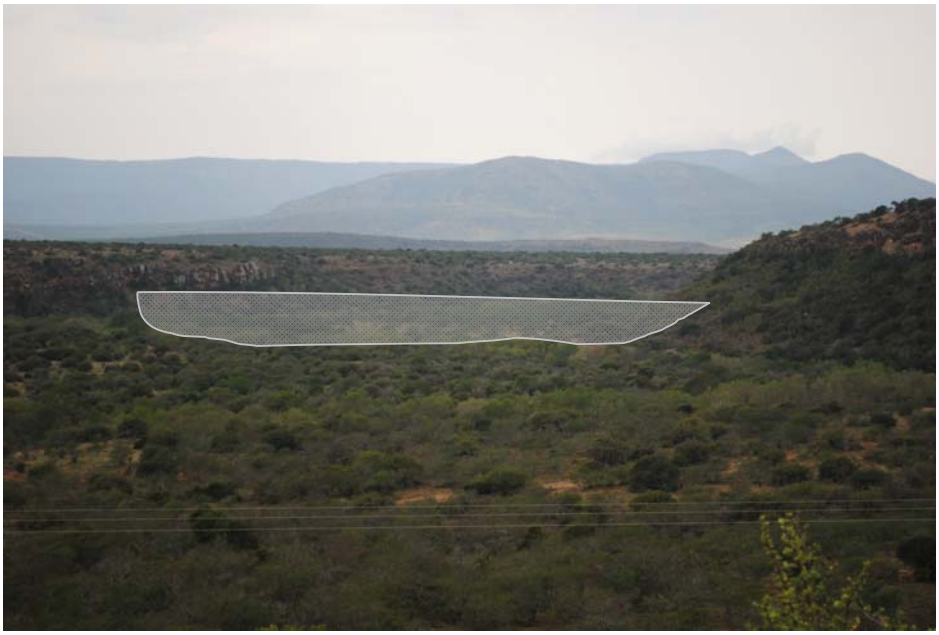


Photo 2 Indicative dam location

Photo 3 View towards west from eastern abutment

Photo 4 View upstream of existing masonry pick-up weir

Photo 5 View downstream at approximate location of masonry pick-up weir close to dam site

Photo 6 View north-west along R344 road to Tarkastad

Photo 7 View north west along R344 main bridge crossing of Koonap River

Photo 8 View upstream towards R344 main crossing of Koonap River

Photo 9 View north along R344 at location of minor bridge crossing of Koonap tributary

Photo 10 View of bridge crossing of Koonap tributary

Photo 11 View upstream of existing take-off weir supplying Adelaide Municipal Dam

Photo 12 View downstream towards take-off weir

Photo 13 Section of canal supplying Adelaide Municipal Dam

Photo 14 Outlet of canal at point of discharge to Adelaide Municipal Dam

Photo 15 Adelaide Municipal Dam

Photo 16 Extraction column within Adelaide Municipal Dam, supplying water treatment works

Photo 17 Adelaide Municipal water treatment works

Photo 18 Adelaide Municipal water treatment works

Photo 19 Adelaide Municipal water treatment works

Photo 20 QM902 Gauging Weir in Adelaide Town

Photo 21 Qm902 Gauging Weir in Adelaide Town

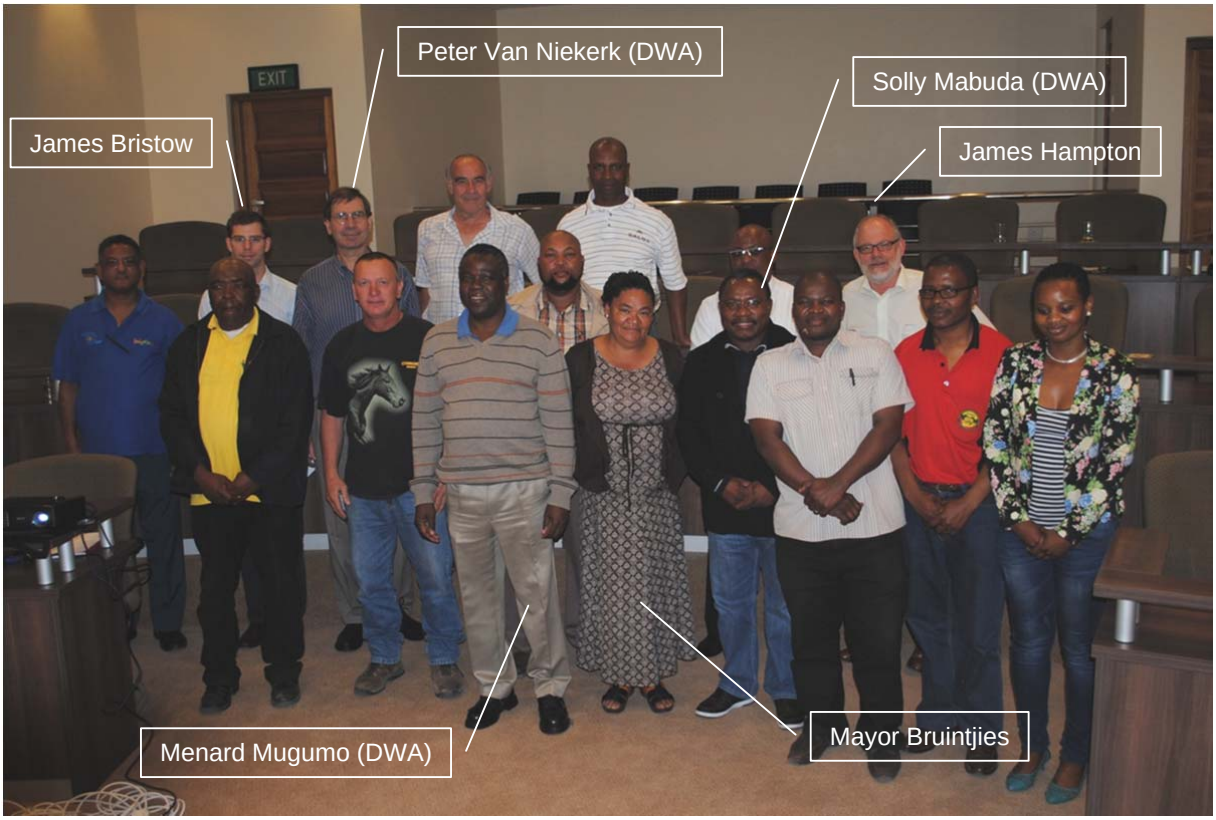
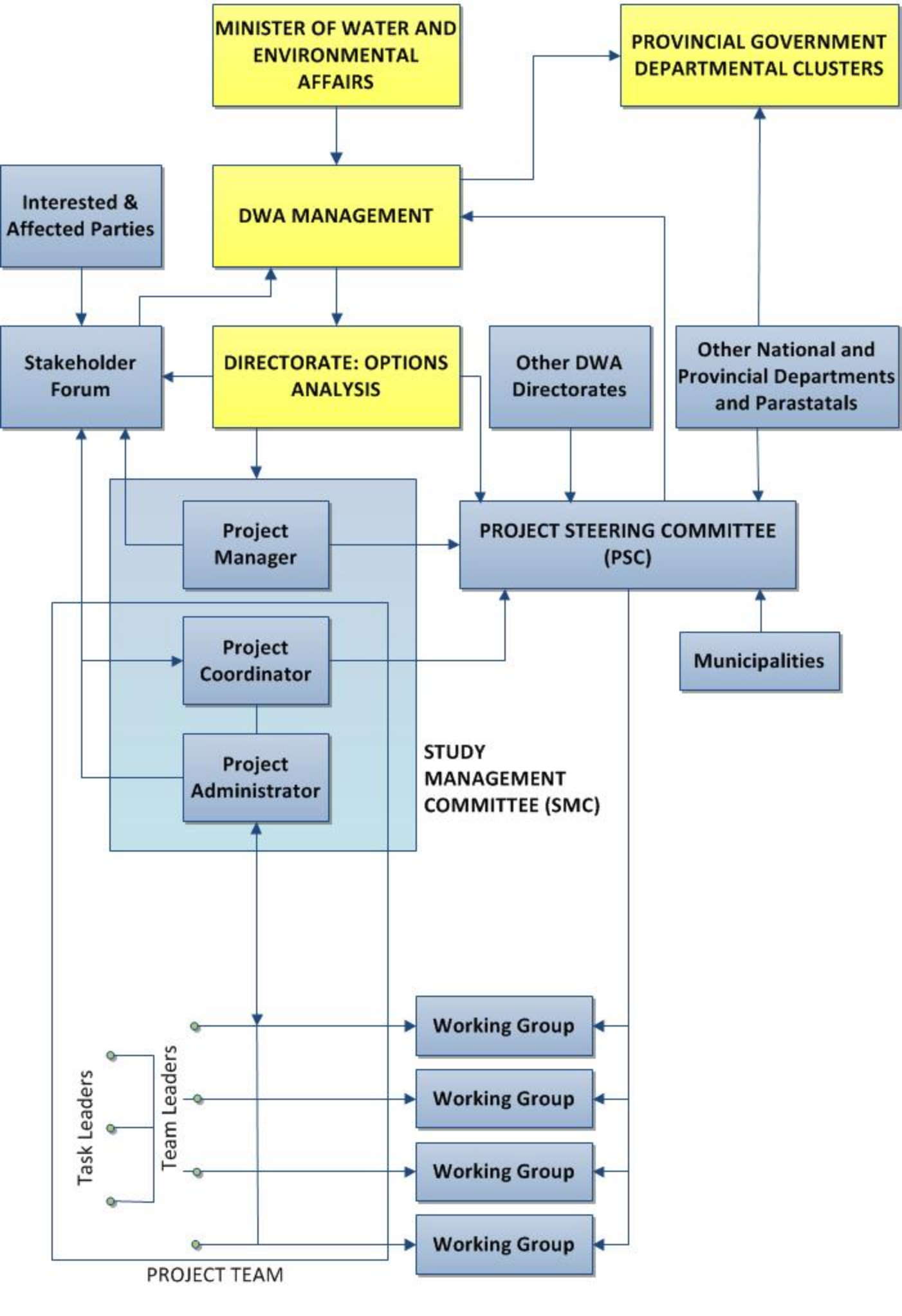
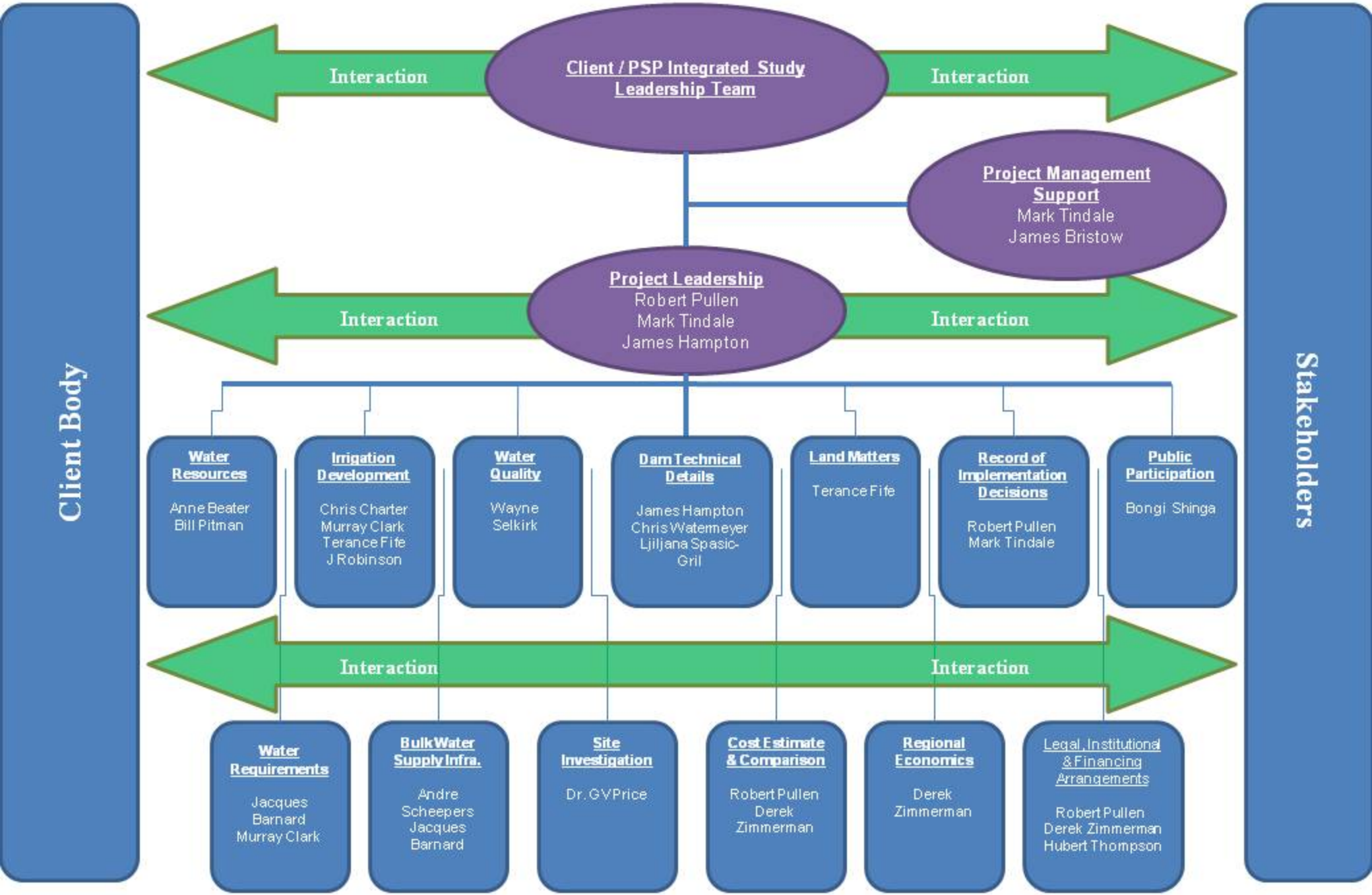


Photo 22 Attendees of DWA / Arup / Nxuba Mayor & Councillors meeting (Bob Pullen taking photograph). Photo taken after DWA Cradock representatives had left,

APPENDIX C
Project Organogram and Manpower Schedule

PROJECT ORGANIZATION STRUCTURE




Client Body
Stakeholders
Interaction
Client / PSP Integrated Study Leadership Team
Interaction
Project Management Support
Mark Tindale
James Bristow
Project Leadership
Robert Pullen
Mark Tindale
James Hampton
Interaction
Interaction
Water Resources
Anne Beater
Bill Pitman
Irrigation Development
Chris Charter
Murray Clark
Terance Fife
J Robinson
Water Quality
Wayne Selkirk
Dam Technical Details
James Hampton
Chris Watermeyer
Ljiljana Spasic-Gril
Land Matters
Terance Fife
Record of Implementation Decisions
Robert Pullen
Mark Tindale
Public Participation
Bongi Shinga
Interaction
Interaction
Water Requirements
Jacques Barnard
Murray Clark
Bulk Water Supply Infra.
Andre Scheepers
Jacques Barnard
Site Investigation
Dr. G V Price
Cost Estimate & Comparison
Robert Pullen
Derek Zimmerman
Regional Economics
Derek Zimmerman
Legal, Institutional & Financing Arrangements
Robert Pullen
Derek Zimmerman
Hubert Thompson

Feasibility Study for Foxwood Dam

ARUP

Manpower Schedule

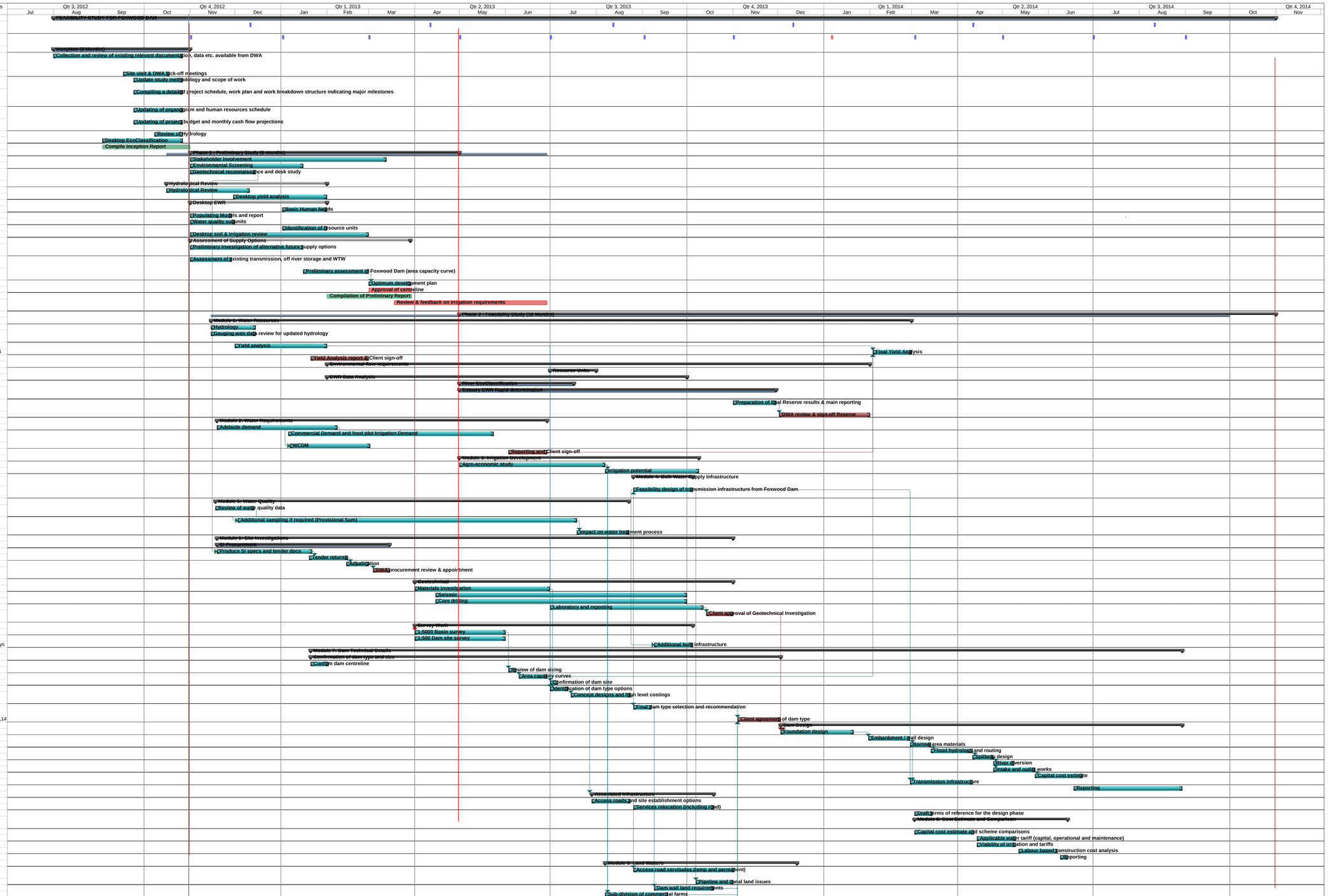
Prelim | Feasibility

Tasks

No. Ref. TOR	Description	Person	Aug 2012 Month 1	Sep 2012 Month 2	Oct 2012 Month 3	Nov 2012 Month 4	Dec 2012 Month 5	Jan 2013 Month 6	Feb 2013 Month 7	Mar 2013 Month 8	Apr 2013 Month 9	May 2013 Month 10	Jun 2013 Month 11	Jul 2013 Month 12	Aug 2013 Month 13	Sep 2013 Month 14	Oct 2013 Month 15	Nov 2013 Month 16	Dec 2013 Month 17	Jan 2014 Month 18	Feb 2014 Month 19	Mar 2014 Month 20	Apr 2014 Month 21	May 2014 Month 22	Jun 2014 Month 23	Jul 2014 Month 24	Aug 2014 Month 25	Sep 2014 Month 26	Oct 2014 Month 27	Total Hours
2	**INCEPTION PHASE**																													
		Pullen, R			40																									40
		Tindale, M			32																									32
		Bristow, J	18	28	27																									73
	Env Reserve Review	Louw, D		8																										8
		Huggins, G		2																										2
	Hydrological Review	Beater, A			24																									24
		Pitman, B		8																										8
	Stakeholders	Shinga, B			6																									6
	Dam Aspects	Oliver, Y																												
		Hampton, J		32	40																									72
		Watermeyer, C		40	40																									80
		Tindale, M		32																										32
		Dimitriau, T		60																										60
		Rossouw, J		70	40																									110
		Hilton, M																												
		Nel, M		40	40																									80
		Gumbi, M		70	10																									80
	Geotechnical Aspects	Price, GV			20																									20
	Sub-total		**18**	**330**	**324**																									**672**
3	**PHASE 1: PRELIMINARY STUDY**																													
3.1	**Stakeholder Involvement**																													
		Shinga, B				16	36	10	10	10	10	36	4	4	4	4	4	36	4	4	4	4	4	4	4	6	36	4	4	4	266
		Fogler, L				4	16					16						16									16				68
	Sub-total				**22**	**52**	**10**	**10**	**10**	**10**	**10**	**52**	**4**	**4**	**4**	**4**	**4**	**52**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**6**	**52**	**4**	**4**	**4**	**334**
3.2	**Environmental Screening**																													
		Reja, Y		12	20	32	24	16	12	12	12																			140
		Naidoo, S				16	30	24	10	10	10																			100
		Gerhardt, A			4	16	10	4	8	8	8																			56
	Sub-total			**12**	**24**	**64**	**64**	**44**	**30**	**30**	**30**																			**296**
3.3	**Geotechnical Reconnaissance**																													
		Price, GV				10	17																							27
		Romans					5																							5
		Hampton, J				8	16																							24
		Oliver, Y																												
		Crompton, M				20	20																							40
	Sub-total					**38**	**58**																							**96**
3.4	**Hydrological Review (incl. first order ER)**																													
		Beater, A																												
		Hampton, J				16	10																							26
						8	8																							8
		Louw, D		4		34	10	10	8	8	8																			92
		Mallory, H		8		4	8	4	4	4	4																			34
		Huggins, G		12	16																									28
		Kotze, P			8	10																								18
		Mackenzie, J			6	6																								12
		Uys, AC			6	6																								12
		Sirkhead, D			8	8																								16
		Reuntree, M			6	6																								12
		Scheroes, P			4	4																								8
	Sub-total			**20**	**60**	**96**	**18**	**14**	**12**	**12**	**12**																			**254**
3.5	**Assessment of Supply Options**																													
		Beater, A					24																							24
		Hampton, J					8																							8
		Murray, R					6																							6
		Baker, A					40																							40
		Nel, N					40																							40
		Schepers, A				3	4																							7
		Barnard, J				16	8																							24
		Maqsud, Ansaral				16	8																							24
		Nxweni, S				16																								16
		Mpepi, A				8	16																							24
		Hlaadonak, J					8	8																						16
		Peckson, E					16	16																						32
	Sub-total					**65**	**177**	**27**																						**269**
4	**PHASE II: FEASIBILITY STUDY**																													
4.1	**Module 1: Water Resources**																													
		Beater, A				40	10	60	30				8	8	8				8		20	60									292
		Pitman, B																												32
		Louw, D					2	8	4	4	2	4	10	2	20	28			6											88
		Kotze, P						8	4	4					20															36
		Adams, J													24															24
		Uys, AC					4	4	8						20															36
		Reuntree, M					4	4	8						20															36
		Mackenzie, J					4	4	8						36															52
		Mallory, H					2	2		2	2	10	10		36	36														90
		Huggins, G					8	4	4						36			8												60
		Sibanda, S													40															40
		Kotze, J													10															10
		Sirkhead, D										10		20	32															62
		Koelemeyer, S					16								40			8												64
		Hughes, D								16					28	64														108
		Van Niekerk, L													112															112
		Nxolinga, P													20															20
		Woodridge, T													24															24
		Whitfield, A										8	8	8	20															40
		Huggins, G																												
	Sub-total					**40**	**70**	**102**	**56**	**36**	**20**	**40**	**36**	**38**	**532**	**116**		**16**	**14**	**20**	**60**									**1196**
4.2	**Module 2: Water Requirements**																													
		Pullen, R										10			16															26
		Clark M										40																		40
		Charter C										40																		40
		Beater, A					8																							8
		Schepers, A				2	4	2																						8
		Barnard, J				10	6																							16
		Lotlis, N				8																								8
		Jonga, T					8	8																						16
		Hlaadonak, J				10																								10
	Sub-total					**30**	**26**	**10**				**90**		**16**																**172**
4.3	**Module 3: Irrigation Development**																													
		Clark M						16							64	20														116
		Charter C						16							64	35														115
		Fyfe T													80															80
		Robinson J																												
	Sub-total							**32**							**208**	**75**														**315**
4.4	**Module 4: Bulk Water Supply Infrastructure**																													
		Ntuli, N																					20	22						42
		Hart, M																												
		Bristow, J													10	15	15	6												52
		Campbell, H													4	4														8
		Hilton, M													4	12	4													20
		Schoeders, Armand													4	12	5													21
		Lotlis, N													8															8
		Mpepi, A													16															16
		Rwende, M													10	20	10													40
		Nkonki, L													10	20	10													40
		Peckson, E													20	40	20													80
	Sub-total														**80**	**137**	**72**	**6**					**20**	**22**						**342**
4.5	**Module 5: Water Quality**																													
		Selkis, W										8	8			8														24
		Schepers, A										2				2														4
		Barnard, J										8	8																	16
		Mabandla, B												4	4	4														16
		Hlaadonak, J														8														8
	Sub-total											18	16		4	22														**76**
4.6	**Module 6: Site Investigations**																													
		Price, GV				16			28	28	20	28	28	28	28	16														172
		Romans							11							26														37
		Hartley, C				16			66	54	50	46	46	50	50	24														398
		Watermeyer, C							28			28																		56
		Hampton, J							24			4																		28
		Barnard, J																												
	Sub-total					**32**			**135**	**74**	**70**	**100**	**60**	**78**	**78**	**76**														**687**
4.7	**Module 7: Dam Technical Details**																													
	Confirmation of dam type and size	Hampton, J						36				6	6	12	12															72
		Watermeyer, C																		36										36
		Sysdic-Grid, L																		22										22
		Tindale, M																		20										20
		Jansen van Vuuren, C																						5						5
		Ntuli, N											36	36	36															108
		Bristow, J										6	6	6	6					6	6	6	6	6	6	6				66
		Hilton, M											14																	14
		Nel, M													36															36
		van de Wall, J																								6				6
	Dam Design including capital cost estimate	Hampton, J														28	28						28							112
		Watermeyer, C																					72	36						144
		Sysdic-Grid, L																					32							64
		Sndale, M																												24
		Hart, M																						45	40					121
		Walker, M																						45	40					105
		Crestner, T											36	36	36															108
		Hilton, M																					36	27	23					86
		Nel, M																					72	100	100					272
		Watermeyer, J																					72	100	100	72				344
		Campbell, H																				6								6
		Mare, P																				6								6
		Pitman, B																			26									26
		Banes, H																			26	36	36	26	10	10				164
	Sub-total							**36**				**12**	**98**	**90**	**138**					**182**	**92**	**278**	**461**	**333**	**92**	**169**				**2882**
4.8	**Module 8: Cost Estimate and Comparison**																													
		Pullen, R																									32			32
		Clark M																									30			30
		Charter C																									30			30
		Zimmerman, D																									12			12
	Sub-total																										**104**			**104**
4.9	**Module 9: Land Matters**																													
		Fyfe T														80	40													120
		Clark M															30													30
		Charter C															30													30
		Ntuli, N														80	40													120
		Schepers, A														8	8													16
		Barnard, J														8	8													16
	Sub-total															**96**	**156**	**100**												**352**
4.10	**Module 10: Regional Economics**																													
		Zimmerman, D							16	16																	32	32	64	160
		Oliver, Y																									16	32		48
		Crompton, M							12	11																				23
	Sub-total								**28**	**27**																	**47**	**72**	**64**	**238**
4.11	**Module 11: Record of Implementation Decisions**																													
		Pullen, R																											80	80
		Sndale, M																											80	80
	Note: Input is provided under modules within reporting code	Oliver, Y																											40	40
	Sub-total																												**200**	**200**
4.12	**Module 12: Legal, Institutional and Financing Arrangements**																													
		Pullen, R				20																						40		60
		Zimmerman, D				15																					30	40	30	120
		Thompsen, H				10																							30	40
	Sub-total					**65**																					**30**	**80**	**100**	**220**
4.13	**Module 13: Public Participation**																													
	Dam Envirnon	Hampton, J							8							8											8			24
	Institutional and Economic	Zimmerman, D														8											8			16
	Land Matters	Bristow, J							8							8											9			25
	Agro/Economic Matters	Clark M							8							8											8			24
	Env. Reserve: time allowed under water resources module																													
	Study leadership time allowed under Module 14																													
		Barnard, J							12																					12
		Mpepi, A							12																					12
	Sub-total								**88**							**32**											**33**			**113**
	Module 14: Project Management																													
		Pullen, R	15	25	40	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	272
		Tindale, M	27	28	22	4			4		4				4	4			4		4		4				4			107
		Hampton, J	10	10	10		4	4		4		4	4	4		4	4	4		4		4		4	4	4		4	4	107
		Bristow, J	30	28	10	8	2	2	2	2	2	2	2	2	2	2	2	2	8	2	2	2	2	2	8	8	8	8	8	139
		Ntuli, N				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	192
		Faulkner, D				8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	96
		Mokmare, M		4			4						4						4							4				20
		Ledwaba, D			4				8																					20
	Sub-total		**82**	**86**	**76**	**32**	**26**	**26**	**34**	**26**	**30**	**26**	**26**	**26**	**26**	**34**	**26**	**26**	**36**	**26**	**26**	**26**	**26**	**30**	**32**	**32**	**32**	**40**	**892**
Total hours per month:			**100**	**450**	**514**	**489**	**447**	**302**	**294**	**212**	**260**	**290**	**264**	**224**	**1161**	**567**	**304**	**52**	**54**	**232**	**173**	**309**	**491**	**385**	**147**	**399**	**252**	**205**	**244**	**8826**

APPENDIX D
Detailed Project Programme Gantt Chart

ID	Task Name	Start	Finish	Predecessors
1	**FEASIBILITY STUDY FOR FOXWOOD DAM**	**Wed 8/1/12**	**Fri 10/31/14**	
2	**Project Management Committee meetings**	**Tue 12/11/12**	**Mon 8/11/14**	
9	**Study Management Committee meetings**	**Thu 11/1/12**	**Mon 9/1/14**	
22	**Inception (3 Months)**	**Wed 8/1/12**	**Wed 10/31/12**	
23	Collection and review of existing relevant documentation, data etc. available from DWA	Wed 8/1/12	Fri 10/26/12	
24	Site visit & DWA kick-off meetings	Mon 9/17/12	Wed 10/17/12	
25	Update study methodology and scope of work	Mon 9/24/12	Fri 10/26/12	
26	Compiling a detailed project schedule, work plan and work breakdown structure indicating major milestones	Mon 9/24/12	Fri 10/26/12	
27	Updating of organogram and human resources schedule	Mon 9/24/12	Fri 10/26/12	
28	Updating of project budget and monthly cash flow projections	Mon 9/24/12	Fri 10/26/12	
29	Review of Hydrology	Mon 10/8/12	Fri 10/26/12	
30	Desktop EcoClassification	Mon 9/3/12	Fri 10/26/12	
31	Compile Inception Report	Mon 9/3/12	Wed 10/31/12	
32	**Phase 1 : Preliminary Study (6 months)**	**Thu 11/1/12**	**Tue 4/30/13**	
33	Stakeholder Involvement	Thu 11/1/12	Tue 3/12/13	
34	Environmental Screening	Thu 11/1/12	Tue 1/15/13	
35	Geotechnical reconnaissance and desk study	Thu 11/1/12	Fri 12/14/12	
36	**Hydrological Review**	**Tue 10/16/12**	**Thu 1/31/13**	
37	Hydrological Review	Tue 10/16/12	Mon 12/10/12	
38	Desktop yield analysis	Fri 11/30/12	Thu 1/31/13	
39	**Desktop EWR**	**Thu 11/1/12**	**Thu 1/31/13**	
40	Basic Human Needs	Wed 1/2/13	Thu 1/31/13	
41	Populating Models and report	Thu 11/1/12	Wed 11/28/12	
42	Water quality subunits	Thu 11/1/12	Fri 11/30/12	
43	Identification of resource units	Wed 1/2/13	Thu 1/31/13	
44	**Desktop soil & irrigation review**	Thu 11/1/12	Thu 2/28/13	
45	**Assessment of Supply Options**	**Thu 11/1/12**	**Thu 3/28/13**	
46	Preliminary investigation of alternative future supply options	Thu 11/1/12	Tue 1/15/13	
47	Assessment of existing transmission, off river storage and WTW	Thu 11/1/12	Wed 11/28/12	
48	Preliminary assessment of Foxwood Dam (area capacity curve)	Wed 1/16/13	Thu 2/28/13	
49	Optimum development plan	Fri 3/1/13	Thu 3/28/13	48
50	Approval of centreline	Fri 3/1/13	Fri 3/29/13	
51	**Compilation of Preliminary Report**	Fri 2/1/13	Fri 3/29/13	
52	Review & feedback on irrigation requirements	Mon 3/18/13	Fri 6/28/13	
53	**Phase 2 : Feasibility Study (18 Months)**	**Wed 5/1/13**	**Fri 10/31/14**	
54	**Module 1: Water Resources**	**Thu 11/15/12**	**Fri 2/28/14**	
55	Hydrology	Thu 11/15/12	Fri 12/14/12	
56	Gauging weir data review for updated hydrology	Thu 11/15/12	Fri 12/14/12	
57	Yield analysis	Sat 12/1/12	Thu 1/31/13	
58	Final Yield Analysis	Mon 2/3/14	Fri 2/28/14	79,57,84,114
59	Yield Analysis report & Client sign-off	Mon 1/21/13	Thu 2/28/13	
60	**Environmental flow requirements**	**Fri 2/1/13**	**Fri 1/31/14**	
61	**Resource Units**	**Mon 7/1/13**	**Wed 7/31/13**	
63	**EWR Data Analysis**	**Fri 2/1/13**	**Mon 9/30/13**	
70	**River EcoClassification**	**Wed 5/1/13**	**Tue 7/16/13**	
74	**Estuary EWR Rapid determination**	**Wed 5/1/13**	**Fri 11/29/13**	
78	Preparation of final Reserve results & main reporting	Fri 11/1/13	Fri 11/29/13	
79	DWA review & sign-off Reserve	Mon 12/2/13	Fri 1/31/14	78
80	**Module 2: Water Requirements**	**Mon 11/19/12**	**Fri 6/28/13**	
81	Adelaide demand	Mon 11/19/12	Thu 2/7/13	
82	Commercial Demand and food plot Irrigation Demand	Sun 1/6/13	Thu 5/23/13	
83	WCDM	Mon 1/7/13	Fri 3/1/13	81
84	Reporting and Client sign-off	Mon 6/3/13	Fri 6/28/13	
85	**Module 3: Irrigation Development**	**Wed 5/1/13**	**Tue 10/8/13**	
86	Agro-economic study	Wed 5/1/13	Tue 8/6/13	
87	Irrigation potential	Wed 8/7/13	Tue 10/8/13	86
88	**Module 4: Bulk Water Supply Infrastructure**	**Mon 8/26/13**	**Fri 10/4/13**	
89	Feasibility design of transmission infrastructure from Foxwood Dam	Mon 8/26/13	Fri 10/4/13	117
90	**Module 5: Water Quality**	**Sun 11/18/12**	**Thu 8/22/13**	
91	Review of water quality data	Sun 11/18/12	Thu 12/13/12	
92	Additional sampling if required (Provisional Sum)	Mon 12/3/12	Thu 7/18/13	91
93	Impact on water treatment process	Fri 7/19/13	Thu 8/22/13	92
94	**Module 6: Site Investigations**	**Mon 11/19/12**	**Thu 10/31/13**	
95	**SI Procurement**	**Mon 11/19/12**	**Thu 3/14/13**	
96	Produce SI specs and tender docs	Mon 11/19/12	Mon 1/21/13	35
97	Tender returns	Sun 1/20/13	Thu 2/14/13	96
98	Adjudication	Thu 2/14/13	Thu 2/28/13	97
99	DWA procurement review & appointment	Mon 3/4/13	Thu 3/14/13	98
100	**Geotechnical**	**Mon 4/1/13**	**Thu 10/31/13**	
101	Materials investigation	Mon 4/1/13	Sun 6/30/13	
102	Seismic	Mon 4/15/13	Mon 9/30/13	
103	Core drilling	Mon 4/15/13	Mon 9/30/13	
104	Laboratory and reporting	Mon 7/1/13	Fri 10/11/13	
105	Client approval of Geotechnical Investigation	Mon 10/14/13	Thu 10/31/13	104
106	**Survey Work**	**Mon 4/1/13**	**Fri 10/4/13**	
107	1:5000 Basin survey	Mon 4/1/13	Fri 5/31/13	50
108	1:500 Dam site survey	Mon 4/1/13	Fri 5/31/13	
109	Additional bulk infrastructure	Mon 9/9/13	Fri 10/4/13	89SS+10 days
110	**Module 7: Dam Technical Details**	**Mon 1/21/13**	**Fri 8/29/14**	
111	**Confirmation of dam type and size**	**Mon 1/21/13**	**Mon 12/2/13**	
112	Confirm dam centreline	Mon 1/21/13	Fri 2/1/13	
113	Review of dam sizing	Mon 6/3/13	Fri 6/7/13	107
114	Area capacity curves	Mon 6/10/13	Fri 6/28/13	113
115	Confirmation of dam size	Mon 7/1/13	Fri 7/5/13	114
116	Identification of dam type options	Mon 7/1/13	Fri 7/12/13	114,101,57
117	Concept designs and high level costings	Mon 7/15/13	Fri 8/23/13	116
118	Final dam type selection and recommendation	Mon 8/26/13	Fri 9/6/13	117
119	Client agreement of dam type	Mon 11/4/13	Mon 12/2/13	118,142,143,14
120	**Dam Design**	**Tue 12/3/13**	**Fri 8/29/14**	
121	Foundation design	Tue 12/3/13	Mon 1/20/14	119,105
122	Embankment / wall design	Fri 1/31/14	Thu 2/27/14	121
123	Borrow area materials	Fri 2/28/14	Thu 3/13/14	122
124	Flood hydrology and routing	Fri 3/14/14	Thu 4/10/14	123
125	Spillway design	Fri 4/11/14	Thu 4/24/14	124
126	River diversion	Fri 4/25/14	Thu 5/8/14	125
127	Intake and outlet works	Fri 4/25/14	Thu 5/22/14	125
128	Capital cost estimate	Fri 5/23/14	Mon 6/23/14	127
129	Transmission infrastructure	Fri 2/28/14	Thu 4/10/14	89,122
130	Reporting	Wed 6/18/14	Fri 8/29/14	
131	**Associated Infrastructure**	**Mon 7/29/13**	**Fri 10/18/13**	**116**
132	Access roads and site establishment option	Mon 7/29/13	Fri 8/23/13	
133	Services relocation (including road)	Mon 8/26/13	Fri 10/18/13	
134	Draft terms of reference for the design phase	Mon 3/3/14	Fri 3/14/14	
135	**Module 8: Cost Estimate and Comparison**	**Mon 3/3/14**	**Fri 6/13/14**	
136	Capital cost estimate and scheme comparisons	Mon 3/3/14	Fri 4/11/14	
137	Applicable water tariff (capital, operational and	Mon 4/14/14	Fri 5/9/14	
138	Viability of irrigation and tariffs	Mon 4/14/14	Fri 5/9/14	
139	Labour based construction cost analysis	Mon 5/12/14	Fri 6/6/14	
140	Reporting	Mon 6/9/14	Fri 6/13/14	
141	**Module 9: Land Matters**	**Wed 8/7/13**	**Fri 12/13/13**	
142	Access road servitudes (temp and permanent)	Mon 8/26/13	Fri 11/1/13	132
143	Pipeline and canal land issues	Mon 10/7/13	Thu 10/31/13	89
144	Dam wall land requirements	Mon 9/9/13	Fri 10/18/13	118
145	Sub-division of commercial farms	Wed 8/7/13	Tue 9/17/13	86
146	Food plots	Wed 8/7/13	Tue 9/17/13	86
147	Proposals for allocating farms and food plots in	Wed 8/7/13	Tue 9/17/13	86
148	Cost estimates for land and servitudes	Mon 11/4/13	Fri 12/13/13	142,143,144,14
149	**Module 10: Regional Economics**	**Fri 2/1/13**	**Fri 8/29/14**	
150	Economic context, socio-demographics and institution preparation	Fri 2/1/13	Fri 3/15/13	
151	Financial and Economic Analysis	Fri 8/1/14	Fri 8/29/14	
152	Module 11: Record of Implementation Decisions	Mon 9/1/14	Tue 9/30/14	
153	**Module 12: Legal, Institutional &Financing Arrangements**	**Mon 6/16/14**	**Fri 7/11/14**	
154	Framework legal & institutional context	Fri 2/1/13	Fri 2/15/13	
155	**Module 13: Technical support to Public Participation**	**Mon 6/3/13**	**Wed 6/4/14**	



Project: Project PROGRAMME v5
Date: Wed 10/31/12

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Progress | Deadline | Label

APPENDIX E
Environmental Reserve Notes

KOONAP PROPOSAL SECTION:

The Ecological Water Requirement (EWR) study for the river will follow the Intermediate Ecological Reserve Methodology as prescribed by DWA allowing for the DWA approved changes recommended in recent years to be incorporated. The study area for the river Reserve component will not include the Fish River. The Fish River estuary will be evaluated following the Rapid methodology.

Intermediate Rivers approach:

Phase 1: Resource Units in the river will be selected using the approved DWA approach. Available information such as the PES and EI-ES if available will be used to support this assessment. Additional to this, the Socio-Cultural Importance will be undertaken as part of a Desktop EcoClassification study for the Koonap River only. The output of this work is the identification of 'hotspots' which are areas where detailed work is required for any future development. The results are based on an overlay of the estimated Present Ecological State. Ecological Importance, Socio-Cultural Importance, and Water Resource Use Importance. Using this information as well as any other existing EWR information, input will be provided for the preliminary screening of options.

Phase 2: Two EWR sites in the river will be identified for the detailed work required by the Intermediate method. One survey to collate fish, invertebrate, riparian vegetation and geomorphological data and two surveys to obtain hydraulic calibration data will be undertaken at these sites.

EWRs for different river states (Ecological Categories) will be determined at the EWR sites and a maximum of 6 operational flow scenarios (eg related to different dam sizes or different yield scenarios) will be tested to determine the consequences on the ecological state of the river. The changes on the state of the Goods and Services due to any of the operational scenarios will also be identified and costed.

A range of reports will be provided to document the results and raw data and other information will be made available electronically if required.

Estuary Rapid approach:

As per the Rapid methods for the determination of ecological water requirements for estuaries (DWAF, 2008), the following abiotic and biotic components need to be addressed:

- Hydrodynamics
- Water Quality
- Microalgae
- Macrophytes
- Invertebrates
- Fish
- Birds.

No field data collection programme will be undertaken and the studies will be conducted based on available information. Specialists will be required to assess data on their components and to prepare the ecological Reserve templates as required in terms of the methods (DWAF, 2008). Specialist reports are not required for Rapid level determinations.

A 2-day workshop will be convened after completion of the templates, where the following will be provided:

- Present State Category (using the Estuarine health Index)
- Ecological Importance of the Estuary (based on DWA, 2008)
- Ecological Categories associated with each of the run-off scenarios provided to the estuarine component
- Recommended Ecological Category (using Present Status Category and Ecological Importance)
- Recommended Ecological Flow Scenario.

A report on the Ecological Water Requirements of the Great Fish Estuary will be prepared in the required format as per the methods (DWAF, 2008).

Constraints:

The budget and approach is based on key aspects only to allow for competitive bidding. As no clear instructions are provided by RDM or DWA regarding the detail to be included, only the absolute necessary components to provide input for planning and decision-making regarding dam options and preliminary design input have been provided. The following are some of the components that would normally be part of a dedicated Reserve study which have been excluded:

- Groundwater component of the Reserve
- Catchment wetland assessment
- Economic consequences of different scenarios with relevance to the Reserve.
- Wider catchment assessment than just the main Koonap River.
- Estimation or extrapolation to biophysical or hydronodes other than the EWR sites.
- Input into any stakeholder or public participation programme.
- Separate Ecological consequences workshop with detailed analysis of operational scenarios. It is assumed that these operational scenarios will be provided to the ecological consultant and will be relevant for the overall objectives for this specific study. I.e., different operational scenarios with its resulting flows at the EWR sites will be provided for assessment of the resulting Ecological Category. No process of optimising the EWRs can be accommodated as this would require a detailed analysis of different dam operating rules, dame size, sluice size etc.
- Decision-making process in DWA regarding the preliminary Management Class in the absence of a Resource Classification Study. RDM will have to advice on the Ecological Category for which the Reserve must be signed off based on the available information generated during this study only.
- EWR sites in the Fish River to provide river scenarios for estuary assessments.