Orange-Senqu River Basin

Orange-Senqu River Commission Secretariat
Governments of Botswana, Lesotho, Namibia and South Africa

UNDP-GEF
Orange-Senqu Strategic Action Programme
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Inception Report

Research Project on Environmental Flow Requirements of the Fish River and the Orange-Senqu River Mouth

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UNDP-GEF
Orange-Senqu Strategic Action Programme

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Research Project on Environmental Flow Requirements of the Fish River and the Orange-Senqu River Mouth

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Acronyms and abbreviations

ARTPJMB	Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee	MAWF	Ministry of Agriculture, Water and Forestry
BID	Background Information Document	MRU	Management Resource Unit
CMA	Catchment Management Agencies	NGO	Non Governmental Organisation
CVs	Coefficients of Variance	NWA	National Water Act
CWAC	Coordinated Water Bird Counts	OFBMC	Orange Fish Basin Management Committee
DRFN	Desert Research Foundation of Namibia	ORASECOM	Orange-Senqu River Commission
EC	Ecological Category	ORMIMC	River Mouth Interim Management Committee
EFR	Environmental Flow Requirements	PES	Present Ecological State
EI	Ecological Importance	R4A	Rivers for Africa
EI-ES	Environmental Importance-Ecological Sensitivity	REC	Alternative Ecological Category
EIS	Ecological Importance and Sensitivity	RI	Recurrence Interval
ES	Ecosystem Services	SCDP	Stakeholder Consultation and Disclosure Plan
GE	Google Earth	SCI	Socio-Cultural Importance
GIS	Geographic Information System	SPI	Specific Pollution Index
HFSR	Habitat Flow Stressor Response	TPCs	Thresholds of Potential Concerns
IAP	Interested and Affected Parties	UCT	University of Cape Town
IWRM	Integrated Water Resources Management	WIS	Water Information System
LORMS	Lower Orange-Senqu River Management Study	WReMP	Water Resources Modelling Platform
REC	Recommended Ecological Category	WRYM	Water Resources Yield Model

1 Introduction

1.1 Background

As per the ToR, the Orange-Senqu River riparian States (Botswana, Lesotho, Namibia and South Africa) are committed to jointly addressing threats to the shared water resources of the Basin. This is reflected in bilateral and basin-wide agreements between the riparian states and led to the formation of the Orange-Senqu River Commission (ORASECOM) in 2000. The 'Orange-Senqu Strategic Action Programme' Project supports ORASECOM in developing a basin-wide plan for the management and development of water resources, based on Integrated Water Resources Management (IWRM) principles.

The water resources of the Orange-Senqu River are heavily utilised and the system is highly regulated with 23 major dams within its Basin. It is also connected to other river systems for water import and export via six inter-basin water transfer schemes.

Environmental Flow Requirements (EFR) of the ephemeral but nevertheless significant Fish River, and the Orange-Senqu River, from its confluence with the Fish River downstream to the Orange-Senqu River mouth were not covered in any detail by the completed GIZ study, during 2009-2010. This area is to be the subject of this Research Project. The importance of completing the Environmental Flow Requirements picture is becoming increasingly urgent due to the fact that two large dams, one in the Lower Orange (Vioolsdrift Dam) and one in the Lower Fish (Neckartal Dam), are at an advanced state of planning.

1.2 Study Area

The Orange-Senqu River is the third largest river basin in southern Africa. It is located within the territories of Botswana, Lesotho, Namibia and South Africa. The Orange-Senqu drains into the Atlantic Ocean at the border between South Africa and Namibia, where it forms a large estuarine delta. This estuarine delta (or estuary) represents a unique ecosystem on what is otherwise a wave exposed, hyper-arid coast with few freshwater inputs. The Orange-Senqu River estuary is recognised as an internationally important wetland for migratory birds and was accorded Ramsar Status in 1991 (Cowan 1995). However, in September 1995, the Orange-Senqu River Mouth was placed on the Montreux Record following the collapse of the salt marsh component of the estuary. The rapid degradation of the salt marsh was the result of a combination of impacts, both at and upstream of the wetland. Efforts are currently underway to resolve the management arrangements for the site, in order to institute a comprehensive rehabilitation and management programme.

1.3 Aims and Objectives of this Study

As per the ToR, this Research Project on environmental flows shall:

- Focus on the Fish River and the Orange-Senqu River downstream of its confluence with the Fish River including a particular focus on the Orange-Senqu River Mouth.
- Engage stakeholders.
- Select representative sites. These will be upstream and downstream of the proposed Neckartal Dam on the Fish River. For the Orange-Senqu River, representative sites should be selected on the Orange-Senqu River upstream of the estuary as well as within the estuary itself.
- Research and assess non-flow related impacts.
- Describe the Present Ecological State.
- Define (at the "intermediate" level of detail, where applicable) environmental flows that would be required to maintain a range of ecological states at the representative sites.
- Recommend attainable and satisfactory environmental flows for application.
- Develop and implement a baseline monitoring programme covering flow-related biophysical parameters. The monitoring programme shall cover a wide range of flow conditions in preferably two full hydrological cycles.
- Design a long-term monitoring programme to assess the efficacy of environmental flows and other management interventions.
- Document monitoring results in an environmental flow database.
- Cooperate with, and provide specific inputs to related projects, namely the Vioolsdrift and Neckartal Dam projects, as well as the Orange-Senqu River Mouth Management Plan.

Taking account of the above and the additional detail provided in the ToR, Rivers for Africa (R4A) has summarised these aspects as the following key objectives:

- Develop EFR methodologies with specific emphasis on the ephemeral nature of the Fish River.
- Determine the Present Ecological State (PES) and describe alternative ecological states.
- Set the EFR.
- Address scenarios in terms of the existing and new dams in the Fish and Lower Orange-Senqu River (also providing input to release specifications).
- Value Resource Economics (Ecosystem Services) and provide changes of different scenarios to the Resource Economics.
- Determine monitoring specifications and design a long term monitoring programme.
- Design and apply a stakeholder programme during the duration of the project.

- Design and use a Geographic Information System (GIS) database according to ToR specifications.

1.4 Comments on ToR

The ToR is clear and structured in a logical way resulting in easy interpretation. Minimal issues therefore need highlighting and discussion.

- It is stated that due to the longer period than what was available for the GIZ study, improvements to the current river methods could be investigated and applied. It is however doubtful whether the additional 6 months of this study would aid in this. The main issue is that determining EFRs, is based on a range of holistic methodologies specifically designed for use in Southern Africa, and is now at the point that unless monitoring and implementation is undertaken to confirm the hypothesis used in determining EFRs, there is little point in investing further in developing methods. It is accepted that there is a lack of understanding in biological response to the duration of certain stress situations as well as the frequency of occurrence which these occur at. Research to study these aspects is however extremely long term and it is therefore not surprising that this work has not been the target for post graduate or other studies. One of the major improvements in the approaches that can be made is to provide the quality and quantity driver information in a more user-friendly format. In terms of hydrology, this would mean however that daily modelling of natural and observed flows as well as flow scenarios would be required. This is a highly intensive and complicated task and is also dependant on having sufficient observed data available which is rarely the case. In terms of water quality, there are two major issues:
  - The physico-chemical variables routinely measured are not the most important in terms of what is required for interpretation of biological responses. Examples of these important variables are temperature and oxygen.
  - Cost-effective and user friendly modelling is required to address the water quality changes in all key variables linked to changes in flow scenarios. Without this information, the water quality response to change in the flow regime, and then the biological response to changes in water quality, is usually based on expert judgement rather than quantitative information.

- The ToR refers to the proposed and existing dams and that scenarios must be evaluated – it must be noted that there is a major range of scenarios that can be evaluated in an iterative way. However, in order to keep the scope of work within a manageable range, this proposal allows for 6 scenarios in addition to the natural and present day situation which will be used as the point of reference. If more scenarios are identified then the client will need to prioritise and select the six most appropriate scenarios for evaluation.
- While the ToR indicates that there is a dearth of data on the Orange-Senqu River Mouth, this lack of data has however received significant attention in 2004/5 as part of the BENEFIT /BCLME study (van Niekerk *et al.*, 2008). The survey phase therefore does not need to follow the full scope of the ToR to meet the

requirements of medium to high confidence EFR. The work plan will however include one comprehensive field survey for each estuarine component to familiarise the study team with recent post-flood changes and allow for integration with river studies.

- While the ToR is non-prescriptive on the acceptable EFR method, we propose to apply the South African Estuarine EFR method (DWAF, 2008a). This method has been applied in over 35 estuaries in South Africa at various levels of confidence, over the past decade. In addition the same approach has recently been adopted to assess the health of South Africa's estuaries for the National Biodiversity Assessment 2011 (in press). The study team is familiar with the method (Version 3 of the method is currently under development and aspects of it will be incorporated in this assessment if proven valuable).

1.5 Study Risks and Uncertainties

- Allowance has been made for one round of comments from the Client on reports. The proposal is based on the receipt of comments within 30 days.
- Project timing and budget does not make provision for:
  - Additional unscheduled field trips.
  - Re-survey and hydraulic data collection if fixed stations positioned during the course of the study are removed by flooding or vandalism.
  - Fixing of benchmarks relative to a global co-ordinate system (in elevation and in plan).
  - *Force majeure*.

1.6 Report Production

The budget allows for:

- The first round of comments by the study management (Mr Mohr) and second round of comments from the client, ORASECOM and any external reviewers that may be appointed.
- It is recommended that the time for comments are fixed and do not exceed 4 weeks.
- All draft reports will be provided in electronic format along with 4 hard copies.
- All final reports to be printed by UNOPS/ORASECOM.

2 Approach and Methodology

2.1 Orange-Senqu River

2.1.1 *Available data*

The following work that has been undertaken as part of the GIZ study directly influences the proposed approach on the Lower Orange-Senqu River:

- Desktop assessment of Present Ecological State (PES), Ecological Importance (EI) and Socio-Cultural Importance (SCI) and identification of hotspots.
- Preliminary identification of EFR sites (this was undertaken during the GIZ study proposal stage prior to the study area being changed).
- Identification of EFRs at EFR O4 (Vioolsdrift) which is situated just downstream of the gauging weir upstream of Vioolsdrift town.

The desktop assessment of Present Ecological State, Ecological Importance and Sensitivity and Socio-Cultural Importance resulted in a Very High Environmental Importance for the quaternary catchments of D82J and D82K and a High Environmental Importance for D82L (the most downstream quaternary catchment). These three quaternary catchments cover the Orange-Senqu River downstream of the Fish River confluence to the Orange-Senqu River Mouth (Figure 1). The high evaluation is largely due to the presence of national parks (cross-boundary) and the therefore protected nature of a large section of this park. All three quaternary catchments were identified as the highest level of hotspot rating which mean that they require detailed level of assessment for any further study.

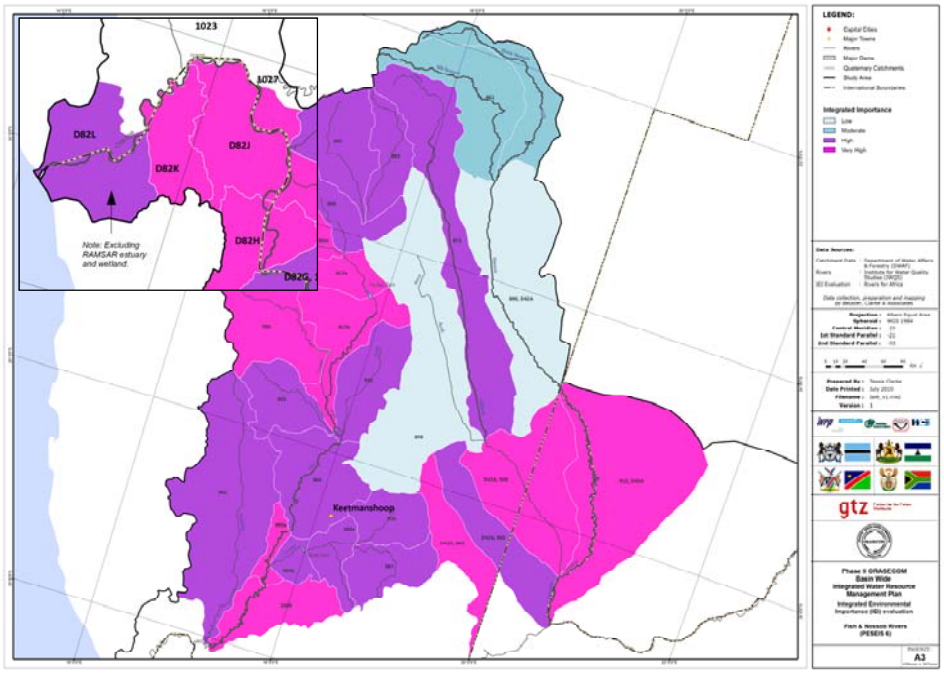


Figure 1 Map indicating the Environmental Importance of the Fish River. The inlay represents the Environmental Importance of the Orange-Senqu River downstream of the Fish confluence.

2.1.2 *Approach and site selection*

One EFR site should be sufficient within this reach as it is highly likely to be delineated as one Management Resource Unit (MRU) which stretches from the Fish River confluence to the start of the Orange-Senqu River Mouth. It is assumed that this will be a single MRU due to the similarity of the following:

- A single geomorphic zone, i.e. Lowland.
- Similar EcoRegion.
- No hydrological changes to the system such as inflow from tributaries.
- No significant change in systems operation in this reach.

Selection of sites are problematic in this area as the critical sites which will include rocky habitat such as riffles and rapids are difficult to access and are not situated close to any gauging structures. Gauging structures in this section are either not functioning or inaccurate as it consists of rated sections with Vioolsdrift gauging weir being the only site with any level of accuracy (however not for low flows).

As the overall outputs should correspond to, and complement those of the recently completed study (as indicated in the ToR) it is proposed that a scenario approach is followed (i.e. top down approach) rather than the traditional setting of EFRs and then matching them to upstream sites. Due to the lack of gauging structures and suitable sites in the Lower Orange-Senqu River, it is likely that the results generated in the Lower Orange-Senqu River will be of lower confidence than that of EFR O4 and that the requirements set at EFR O4 should be used to generate EFR scenarios at the new downstream EFR site.

EFRs for three different ecological states were set at EFR O4 as follows:

- To maintain the PES of a C Ecological Category (EC) (C = moderately modified).
- To achieve an improved state of a B/C EC. The improved state relates to a Recommended Ecological Category (REC) of a B due to the High Environmental Importance, and therefore improvements were required. The scale of change already present in the system limits the restoration potential however, and it was estimated that, considering present operational constraints such as the flooding regime that cannot be improved, only a B/C EC could be achieved.
- A flow regime that will result in an Alternative Ecological Category (AEC) of a D (that is a degraded state from the PES). The reason why this is evaluated is to aid in the evaluation of imposed flow scenarios from future developments.

It is proposed that the above three EFRs be treated as EFR scenarios at the new EFR site. Using a yield model, the EFR O4 scenarios will be modelled taking into account losses and inflows to the new EFR site. Additionally, the EFR set on the Fish River will be 'added' to the three scenarios. For example, the PES scenario for EFR O4 and the PES scenario for the Fish River will be modelled to generate a flow scenario for the new EFR site. This flow scenario will then be evaluated at the new EFR site to determine what the resulting EFRs would be and whether it will maintain the PES at this new site. The approach to evaluate the scenarios would be to use the Habitat Flow Stressor Response (HFSR) method (Hughes and Louw, 2010) to assess the habitat condition and stress associated with each flow scenario, and then to predict, using a range of EcoClassification models (Kleynhans and Louw, 2007), what the ecological state will be at the new downstream EFR site.

2.2 Fish River (Ephemeral)

2.2.1 *Available data (Neckartal Dam Project)*

The Neckartal Dam will be constructed in the Fish River near Snyfontein, some 25 km north of Seeheim and 40 km west of Keetmanshoop, in the Berseba Constituency of the Karas Region. The dam will provide water for irrigation of approximately 5 000 ha of land to the north and south of the Keetmanshoop to Seeheim tarred road. The Dam has a catchment area of 45 620 km^2 with an average annual runoff of 535 million m^3. The dam wall will be a

roller compacted concrete structure with an anticipated full supply wall height of 67.5 m and wall crest length of 520 m. The storage volume is expected to be approximately 841 million m^3 and the full supply area may cover 39 km^2. The project is managed by the Directorate Resource Management of the Ministry of Agriculture, Water and Forestry (MAWF).

Knight Piésold conducted the Environmental and Social Impact Assessment as well as the engineering design for the Neckartal Dam in the Fish River near Seeheim. Furthermore, Knight Piésold will oversee the construction of this impoundment. Available information is listed below.

Aquatic ecology: The Neckartal ESIA contained an aquatic ecology component carried out by Dr Rob Palmer of Nepid Consultants comprising of fish, invertebrate, phytoplankton, diatom and water quality surveys. Two surveys were undertaken, namely August 2009 and February 2010. Two sites in the Fish River downstream of the proposed dam wall were assessed and a further site downstream of Naute Dam, in order to extrapolate the impacts of the Neckartal Dam on aquatic ecosystems.

Terrestrial ecology: The ES component of the EFR study can benefit from the terrestrial ecology studies carried out for the Neckartal Project. This study highlighted various ecosystem processes applicable to the River and riparian corridor.

Water quality: Knight Piésold initiated surface water and groundwater quality monitoring in the Neckartal project area to establish baseline conditions prior to the onset of construction of Neckartal Dam. Sites upstream and downstream of the dam are monitored, as well as a site downstream of the Naute Dam in the Löwen River. Four surface water sites are sampled bi-monthly and analysed for basic parameters to obtain an overview of water quality. On a bi-annual basis, a more detailed analysis is carried out. The water quality data is available from February 2010 and is maintained in a database by Knight Piésold. As far as could be determined at the time of the Neckartal study, no further water quality data is available for the Fish River.

Hydrology: The hydrology component of the Neckartal Dam Project was sub-contracted to WRP. A yield analysis and hydrology study was undertaken, based on the Water Resources Yield Model (WRYM) set up for the Fish River system, prepared as part of the earlier Lower Orange-Senqu River Management Study (LORMS). This study showed that the dam can supply 117.7 million m^3/a at a recurrence interval (RI) of failure of 1:50 years (i.e. annual assurance of supply of 98 %). However, should water users be prepared to accept a higher risk of failure of 1:10 years, the dam could provide a yield of up to 149.4 million m^3/a. If releases were made from the dam to support downstream Class D EFRs, the 1:10-year yield

drops by 10.0 million m^3/a to 139.4 million m^3/a. For the Class C EFRs, the 1:10-year yield drops to 133.2 million m^3/a. The commissioning of Neckartal Dam would cause flows in the Fish River downstream of the proposed dam site to decrease, on average, by 121 million m^3/a from 322 million m^3/a to only 201 million m^3/a. Furthermore, the variability of spills from the dam would be far greater than that of the natural situation, with coefficients of variance (CVs) of annual total flows of 2.57 and 1.81, respectively.

Furthermore, a flood hydrology study was undertaken by WRP in order to determine the design floods, spillway arrangement and freeboard allowances. Hydrology data is available for the Seeheim weir from 1961 and includes water level (m) and flow (cumecs) measured several times per day. In addition, monthly flow data is available from 1961. This information was obtained in .txt files from Mr Guido van Langenhove of MAWF.

Stakeholder database: The stakeholder consultation component of this EWR study will benefit from the stakeholder database compiled for the Neckartal Project. The Neckartal consultation process comprised two rounds of public and focus group meetings in Keetmanshoop, Snyfontein and the farming community affected by the irrigation scheme. The database of Interested and Affected Parties (IAPs) includes Non Governmental Organisations (NGOs), environmental organisations, specialists, media organisations and contacts in various government institutions. The project team has also developed a working relationship with the Orange-Fish Basin Management Committee.

2.2.2 *Approach*

Establishing suitable methods for determining EFRs for ephemeral rivers is confused by the possible need to account for both flowing conditions (frequency of flow and channel connectivity) as well as non-flowing conditions (volumes and water quality in static pools as well as groundwater levels within river and valley bottom alluvial systems). Previous work in ephemeral rivers within South Africa suggests that it is possible to provide hydrological and some water quality information using existing modelling techniques, but the question appears to remain whether the information provided by the models is suitable for integration with the available ecological information. Previous experience also suggests that it is critical to have a broad conceptual understanding of the complex dynamics of ephemeral hydrology systems that includes river flow, pool (channel and floodplain) storage and groundwater. Such understanding is necessary to check that any model is generating the correct information, but at the same time developing that understanding is difficult within short period studies with limited budget, human and time resources for field-based observations. It will be important in this study for the various specialists to clearly identify their

information requirements and the gaps (in both data and understanding) that will inevitably exist so that these can be addressed as far as possible given the constraints of the study.

2.3 EFR site selection and proposed EFR sites

EFR site selection follows a well tried and tested approach documented in Louw *et al.*, 1999. EFRs are determined at each of the EFR sites, and it is therefore vital that:

- The sites are selected to provide as much information as possible about the variety of conditions in a river reach.
- The specialists that need to use these sites to set flow requirements for their discipline can relate to the habitat the sites represent.
- The persons involved in selecting the sites understand and are experienced in the use of sites in EFR studies.

The selection of EFR sites is guided by a number of considerations (most important listed in bold), including:

- The locality of gauging weirs with good quality hydrological data.
- The locality of the proposed and existing developments.
- The locality and characteristics of tributaries.
- The habitat integrity or PES of the different river reaches.
- The reaches where people depend directly on a healthy river ecosystem.
- The suitability of the sites for follow-up monitoring.
- The locality of geomorphologically representative sites.
- **The habitat diversity for aquatic organisms, marginal and riparian vegetation.**
- **The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially low flows.**
- **Accessibility of the sites.**
- **An area or site that could be critical for ecosystem functioning. These are often represented by riffle units, where low flow conditions or the cessation of flow constitutes a break in the functioning of the river, and consequently, the biota dependant on this habitat and/or perennial flow are adversely affected. In the Fish River which is ephemeral, perennial pools are likely to be considered critical habitats.**

Information obtained during previous investigations and results of the previous study indicate that riverine EFR sites will be required at the following points along the Orange and Fish Rivers:

- Orange-Senqu River, downstream of the Fish River confluence and upstream of Sendelingsdrift.

- Fish River, upstream of the proposed Neckartal Dam (will address the management of Hardap Dam)
- Fish River downstream of Neckartal Dam (will address the management of the Neckartal Dam which is under construction. It will also address the needs of the National Park and cater for the estuarine requirements.

Ideally, site selection and initial data collection needs to take place in the low flow season (when the river can be accessed), followed by data collection (for hydraulic calibration) during the ensuing high flow season. Since it is not possible to mobilise for the low flow field work prior to the onset of the high flow season, initial EFR sites were selected using Google Earth (GE) as well as available photographs of the river from previous studies. This will allow for high flow hydraulic information to be collated during this high season.

Three potential EF sites, EF site 1, Site 2 and Site 5 have been identified (Figure 3). Note that the numbering is just initial numbers for the purpose of the inception report.

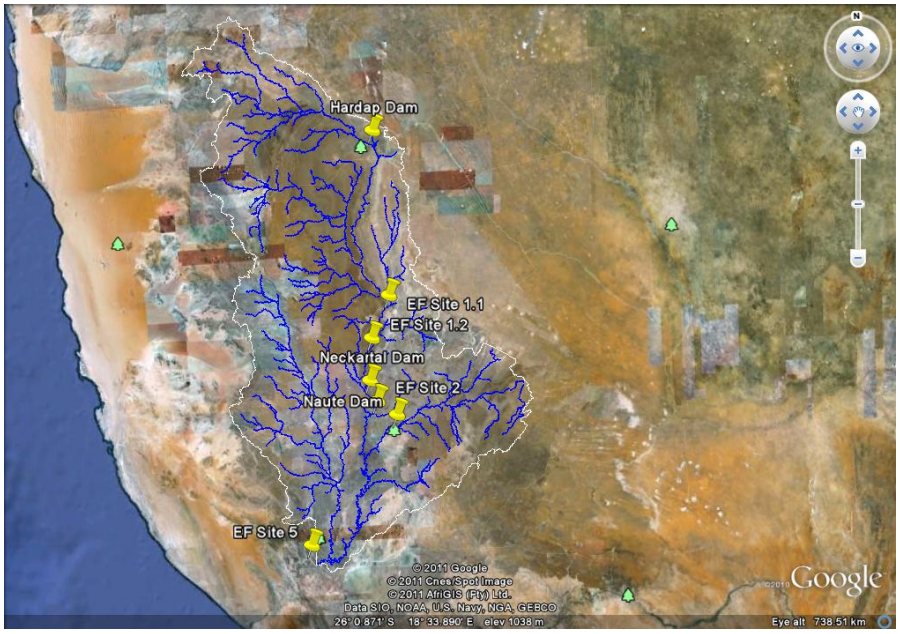


Figure 2 Potential EFR sites within the study area

Two potential EFR sites (EF Site 1.1 and EF Site 1.2) have been identified in the reach between Hardap and the Neckartal Dam site:

a) EF Site 1.1: the road crossing (and high level bridge) on the M98 to Berseba (Figure 4 and 5); and

b) EF Site 1.2: the road crossing (no bridge) approximately 50 km further downstream (Figure 4);

Figure 3 Location of EF Site 1.1 and 1.2

Figure 4 EF Site 1.1

The EFR site in the reach downstream of Neckartal Dam has been selected downstream of Seeheim gauge. The overriding criterion here was the access and proximity to the Seeheim Gauging Weir (Figure 6). The third site, EF Site 5 is located in the reach along the Orange-Senqu River between the Fish River confluence and Sendelingsdrift. A potential site that has been used for baseline monitoring has been identified (Figure 7), but it is proposed that the length of the river be investigated from the road (in Namibia) following the river to select the most appropriate site for EF assessment.

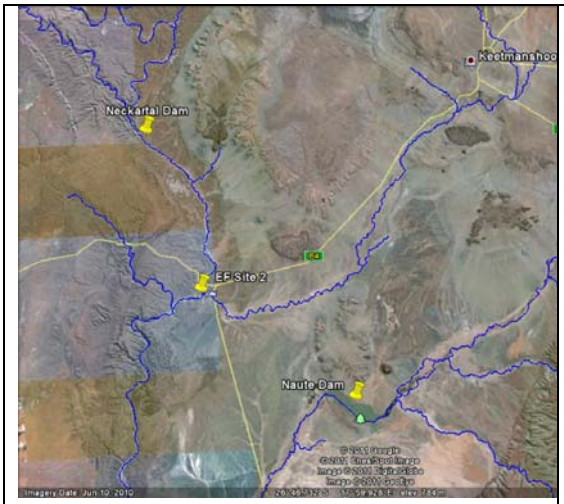


Figure 5 Location of EF Site 2

Figure 6 Location of EF Site 5

2.4 Estuary and Marine environment

The estuary component will set out to determine the Present Ecological State, Importance and Environmental Flow Requirements (quantity and quality) of the estuary based on the recognised SA method (DWAF, 2008a). The workplan will include two field surveys (one for each estuarine component) to familiarise the study team with recent post-flood changes and allow for integration with river studies. The sediment and bathymetry field work will be planned for summer (high flow), while the ecological surveys will be conducted in winter (low flow). Water quality data will be collected during both visits to allow for the most optimum data collection regime.

The marine component of the study will rely on available information, remote sensing and numerically modelling to assess the role of freshwater inflows and associated fluxes in the marine ecosystems. This will be done in order to recommend allowable changes in freshwater inflow into the marine environment within the constraints of maintaining, or improving, the present health status of the marine ecosystem and optimisation of the existing Services provided by the coastal ecosystem.

2.5 Surface Hydrology and Water Resources Modelling

The surface water hydrology of the Lower Orange and the Fish River catchment is already available from previous studies and will be used for scenario analysis using the Water Resources Yield Model (WRYM) model or similar. However, this hydrology is all based on monthly time intervals which are inadequate for estimating floods, their frequencies and volumes. The issue of floods will be dealt with by using observed data in the Lower Orange and in the Fish River catchment to develop flood frequency curves. Based on an analysis of observed floods, daily time series of typical floods (1 in 1, 1 in 5, 1 in 10, etc.) will be generated. These typical floods will be routed through EFR sites in order to estimate the degree of inundation during flood events.

Water resources modelling will be carried out most probably using the WRYM which has already been set up for the study area as part of previous projects. However, should the necessity arise to model complex operating rules associated with varying assurance of supply then the Water Resources Modelling Platform (WReMP) could be setup, although this would be only for the study area and not the whole Orange and Vaal River systems. Inflows into the Lower Orange system, as simulated with WRYM will still be used if this alternative model is deployed.

2.6 Ecosystem Services

Natural habitats and ecosystems provide a huge range of Ecosystem Services (ES) that contribute enormously – and are even essential – to human well-being. Protecting these areas is essential in order to achieve sustainable development. River systems and their associated use values are of particular importance. ES will be examined as follows:

- Based on a literature research, as well as an initial site visit the key ES that form a part of community reliance, livelihoods and subsistence, or provide key non-market related economic functions, will be examined.
- The list of ES will then be further scrutinized to generate an overview of the likelihood that they will change given anticipated trajectories of modification to the system once scenarios are developed. If no change is expected, then further research into the value of these ES will not be pursued.
- The method that will be employed will be linked to EFR sites and then scenario based. In terms of assessment of the impacts of the various scenarios – in this case largely hypothetical notions of deviation from PES at the EFR sites will be examined. This essentially identifies the direction of change (either positive or negative), and estimates the magnitude of the change in benefits and costs that may be experienced within the Lower Orange and Fish River Systems.

The consequences of changes to ES will be written up in light of results emanating from the workshop and as integrated with analysis of the impacts of proposed operational scenarios. Expert opinion will estimate the magnitude of change associated with the base value of the ES deemed to be impacted by operational changes.

2.7 Stakeholder Interaction

For the purpose of this research project, it is necessary to carefully consider the objectives of stakeholder participation and consultation in order to design a suitable methodology. Stakeholders can be divided into two separate groups. The first stakeholder group consists of the various regulatory authorities. These are those stakeholders whose main concern is ensuring that the water resource of the Orange and Fish Rivers are used in such a way that it represents an optimal balance between ecological protection and consumptive utilisation in the interest of economic development. Generally, this group of stakeholders will ultimately be responsible to control the use of water to such an extent that an acceptable ecological flow is retained to protect the river environments as well as the Orange-Senqu River mouth. This group would include but are not limited to stakeholders such as the Orange – Senqu River Commission (ORASECOM), the Orange-Senqu River Mouth Interim Management Committee (ORMIMC), Environmental Ministries of the riparian states, the Orange Fish Basin Management Committee (OFBMC), the Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee (ARTPJMB), and Catchment Management Agencies (CMAs). It is

envisaged that liaison with this group of stakeholders will be continual during the course of the study whereby communication will mainly be electronically based.

The second stakeholder group consists of the users who all cumulatively influence the river and mouth environments and who, through their actions have an influence on the environmental flow in the rivers. These stakeholders include but are not limited to the Ministries responsible for agriculture and water in the riparian states, NamWater , the local authorities who are dependent on the river for their water supply such as Alexander Bay, Oranjemund, Sanddrift, and Sendelingsdrift, various mining operations in both Namibia and South Africa, various irrigation projects on the Fish River in Namibia and the Lower Orange-Senqu River and even the electricity utilities in the two countries. Both these stakeholder groups need to be afforded an opportunity to participate in the research project.

To ensure effective stakeholder participation, the consultant developed a Stakeholder Consultation and Disclosure Plan (SCDP) (Appendix A). This plan provides a final methodology and full programme for stakeholder involvement and consultation. Stakeholder consultation will take place in three phases as follows:

- During the first stakeholder events, the consultant will liaise with stakeholders to share the objectives and methodology of the study, to present and confirm the SCDP and to solicit inputs from them. This would result in all stakeholders being fully informed about the study and its objectives. They will also be invited to make representations to the team if required. It would also serve as a source of information with respect to future development plans which may have an influence on the use and availability of water in the river systems. Following the initial liaison, the project moves into the survey phase where specialists will do the various studies and will be in contact with key stakeholders through the course of their investigations where necessary. The project information will be contained in a Background Information Document (BID) which will be distributed to all stakeholders. The BID will provide the background to and motivation for the study, describe the project components, describe the key methodological issues, provide a broad programme for the study, explain how stakeholders can get involved and how they can register, detail how feedback will be provided and provide an idea of future consultation events. Dissemination will be to all parties on the preliminary stakeholder list via e-mail, normal mail, targeted distribution, the media and the ORASACOM Newsletter.
- The results of the study will be a number of scenarios on the future ecological state of the studied areas. Once these scenarios have been developed, a second round of consultation will take place in the form of meetings and the proposed venues are Vioolsdrift and Windhoek. The Vioolsdrift meeting will cater for local and regional stakeholders and communities while the Windhoek meeting will cater for the authorities, Institutions and NGO stakeholder group. The role of the stakeholders will be to determine what their preferred or desired future state of the river would

be. For each of the scenarios evaluated, the results for the state of the ecosystem as well as for the ability to sustain the production of Ecosystem Services will be presented for consideration by stakeholders. It is anticipated that stakeholders will assist to find the optimal balance between these two considerations.

- Feedback and Disclosure will take place through ORASACOM newsletters, dedicated regular written feedback to organised stakeholder groups, posting on a web site and through media releases as and when required.
- Minutes of the consultation events will be prepared and forwarded to all stakeholders and an issues trail will be kept for the use of all team members.

2.8 GIS and Database

The overall objective of this component is to provide a systematically organized set of spatial data relevant to the project in order to support activities of specialists during the duration of the project and for the use by catchment management organizations after project completion.

3 Project Plan

3.1 Task Structure

The process of setting EFRs for rivers follows a step-wise or sequential approach. The work package has been divided into thirteen discrete tasks and subtasks (Table 1), and the tasks are further described with specific objectives and the associated deliverables provided in Chapter 4. The three phases namely inception, survey and environmental flow requirements are included in Table 1 to indicate which tasks fall within which phase.

Table 1 Tasks and subtasks proposed for this study

Task 1: Management and Coordination
1.1 Administrative and technical management.
1.2 Financial administration
1.3 Logistical arrangements and report edit
INCEPTION PHASE
Task 2: Inception Phase
2.1 Design project plan
a) Fish River ephemeral rivers method
b) General project plan
c) Database and GIS plan
2.2 Stakeholder interaction
2.3 Inception report
SURVEY PHASE
Task 3: Determination of Resource Units
Task 4: ID EFR sites and biophysical survey
4.1: Reconnaissance survey
4.2: Surface groundwater investigations
4.3: Biophysical survey (Fish and Orange-Senqu River)
4.4: ES survey
Task 5: Estuarine/Marine surveys
5.1 Estuary Sediment and Bathymetry surveys
5.2 Estuary Ecological Surveys
Task 6: River: Analysis of data
6.1 EcoStatus models
6.2 Hydrology, Groundwater surface water interaction
6.3 Hydraulics
6.4 River ES identification and qualitative evaluation
Task 7: Estuarine/Marine analysis of data
7.1 Modelling Study
7.2 Estuary Assessment
7.3 Marine Assessment
EFR PHASE
Task 8: EcoClassification, EcoSpecs, EFR, Goods and Services changes

	Specialist meeting and report
	Task 9: Scenario evaluation
	Preparation of scenarios (yield modelling)
	9.1 River Ecological, ES consequences
	9.2 Estuarine evaluation
	9.3 Marine evaluation
	9.4 Integration and preparation of scenarios and consequences for stakeholder meeting.
	9.5 Stakeholder meeting to determine desired state.
	Task 10: Monitoring programme (long term)
	10.1 River
	10.2 Estuary
	Task 11:Data base and GIS
	Task 12:Review and liaison
	Task 13: Main integrated report

The above tasks are summarised in a diagrammatic illustration of the project plan (Figure 2).

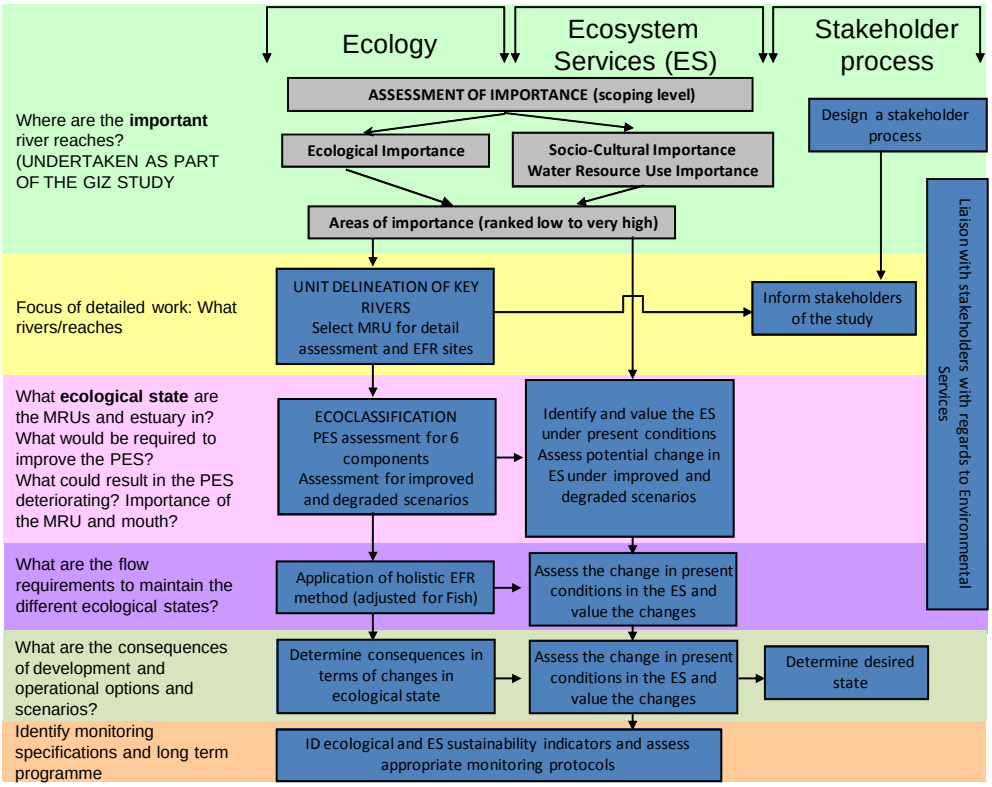


Figure 7 Proposed project plan

4 Task Structure

Note that the scope of work follows the requirements for an Intermediate Reserve assessment for three EFR sites in terms of number of surveys, hydraulic calibrations, number of survey sites, etc.

4.1 Task 1: Management and Coordination

The objective of this task is to ensure effective, efficient and pro-active management. The aim is to ensure that comprehensive technical documents that detail the results of a successful study process, be delivered on time, within budget and as per brief by ensuring general project management and administration, monitoring of progress, internal liaison within the team, liaison with the client or client's representatives.

The management tasks incorporate the following:

- Formalising of the preliminary project plan described in the proposal.
- Coordination and management of a multi-disciplinary team.
- Financial management.

The provision of monthly progress notes as well as detailed progress reports presented at a maximum of 6 progress meetings as well as an inception meeting is catered for in the proposal.

Task responsibility: Louw, Mallory H, Van Niekerk, Louw S, Taljaard

INCEPTION PHASE

4.2 Task 2: Inception Phase

The project plan in terms of Figure 2 and as described in the following tasks will be refined during liaison with the client, meetings with key members of the team and agreement from specialists regarding the envisioned scope of work, timing, programme, deliverables and invoicing structures.

All relevant literature (additional to that already collated for the GIZ study), will be collated during this phase. Specific attention will also be given to formalising the methods that will be applied for EFR assessment. This phase includes a meeting with reference to the

ephemeral rivers method (groundwater-surface water interaction). At this meeting, it will be necessary to identify what can be achieved during this study considering the available methodologies as well as the levels of uncertainty associated with these methods in order to identify any critical gaps in the links between the various specialist disciplines.

With reference to GIS and database requirements, initial consultation with leaders of this task and the client is being planned.

Task Responsibility:
a) Project Plan: Louw D, Birkhead, Huggins, Simon, Van Niekerk, Mallory S, Koekemoer, Briel

b) Fish River ephemeral rivers method: Hughes, Louw D, Bockmühl, Mallory S, Birkhead, Mackenzie, Kotze, Schachtschneider

c) Database and GIS plan: Wolski, Mackenzie, Kotze, Louw D, Van Niekerk

d) Stakeholder Liaison: Simon, Van Dorssen, Briel

e) Inception report: Louw D, Van Niekerk, Taljaard, Koekemoer, Hughes, Birkhead, Simon, Huggins, Wolski, Mallory S, Briel

Information Required: All information on hydrology, stakeholder databases etc. generated through the GIZ study and the Neckartal Feasibility study. All biophysical information collated for the Neckartal EIA.

Actions and deliverables:
a) Project Plan: Internal meeting on 5 and 6 December 2011. Meeting with client to present initial project plan documented in the inception report: 7 December 2011.

b) Fish River ephemeral rivers method: Specialist meeting on 18 and 19 January 2012.

c) Database and GIS Plan: Meeting on 16 December 2011.

e) Inception report: **Deliverable B**: First draft available 20 December 2011.

d) Stakeholder Liaison: Integration of stakeholder database, preparation of the SCDP which will serve as an appendix to the inception report, preparation of a BID - **Deliverable C**: First draft available 31 January 2012; Distribution of the BID of which the layout and printing will be undertaken by ORASECOM.

Responsibility of the Consultant: The consultant cannot include the Fish River ephemeral method within the inception report as the meeting is only taking place during January 2012.

SURVEY PHASE

4.3 Task 3: Determination of Resource Units

A Management Resource Unit (MRU) represents a homogenous area which requires its own specification of the EFR. The purpose of this task is therefore to delineate the Lower Orange and Fish River into MRUs. An established process exists as part of the EFR assessments and the following tools and methods will be used to define the MRUs:

- EcoRegions: Classification that allows for the grouping of rivers according to similar physical characteristics (only available in RSA).
- Geomorphological Zones: Geomorphology provides a basis of classification for the purpose of describing the physical habitat of riparian and aquatic ecosystems, as it encompasses the physical processes which have shaped the river channel.
- Operation of the system: An overview of system management is required to ensure an understanding of the system operation and to interpret biological responses. System operation infrastructure is also often the logical endpoint of a MRU.
- Local knowledge: Local specialist knowledge will be used to aid the process.

Task responsibility: Louw D, Rountree and Mallory S
Information required: South African EcoRegion coverage; Geomorphic zones for South Africa; River reaches for the PES and Environmental Importance-Ecological Sensitivity (EI-ES) project.
Actions: Determine the geomorphic zones for the Fish River; Obtain a description of the hydrological operation of the Orange and Fish Rivers in the study area; Identify the MRUs; Document reasoning and results.
Deliverables and milestones: MRUs (28 February 2012). **Deliverable D**: First draft MRU report (31 March 2012)
Comments: Geomorphological zonation will only be undertaken for Namibia. The geomorphological zonation for South Africa is available from the Directorate: Resource Quality Services and will be used for the Orange-Senqu River. No EcoRegional classification for Namibia will be undertaken.

4.4 Task 4: Biophysical Surveys at EFR sites

Task 4.1 & 4.2: Reconnaissance and Ground-surface water interaction survey/s

A reconnaissance survey will be undertaken with the focus on obtaining a flow calibration for hydraulic purposes and for obtaining information linked to the groundwater-surface water interaction and locality of perennial pools associated with EFR sites. The objective of this visit/s will be to ensure that all issues identified during the inception phase specialist meeting are confirmed and groundtruthed.

Task 4.3: Biophysical Surveys

A detailed biophysical survey will follow at the EFR sites according to the criteria of the intermediate level of EFR assessment. The following surveys will be undertaken:

- Cross-sectional surveys.
- Hydraulic calibration measurements.
- Fish surveys.
- Macroinvertebrate surveys.
- Index of Habitat Integrity surveys.
- Riparian vegetation surveys.
- Geomorphological surveys.
- Photographic monitoring.
- Diatom collection.

An attempt will be made to undertake biological surveys at more sites than just the EFR sites. This will provide additional data to ensure that the results are representative of the MRU and not just the EFR site. Data will be collected according to the required criteria for the Intermediate approach and as described in various manuals as part of the EcoClassification process (see references under Task 6.1).

Task 4.4: Ecosystem Services survey

River Ecosystem Services survey: Recent work in the Orange-Senqu River catchment has highlighted that there are "pockets" or communities for whom the Ecosystem Services provided by the river are critical to sustaining their livelihoods. This may be particularly so for the Fish River and aspects of the Lower Orange associated with the Richtersveld area. As such a short field trip (4 days) is proposed for two teams. One team will examine the Fish River and conduct a limited number of key stakeholder interviews with representatives of those deemed to be directly involved in resource utilisation and the other team will undertake a similar exercises in the Richtersveld area. The methods employed will concentrate on examining resources likely to be affected by potential altered water management regimes for the system.

Estuary and Marine Ecosystem Services: One detailed field survey during a two day site visit (in conjunction with one of the biological field exercises) will be conducted to identify, and quantify where possible, the ecosystem services provided by the Orange Estuary. In addition, data (e.g. commercial catch data) will also be sourced on the marine resources that are potentially responding to freshwater flows from the Orange-Senqu River catchment. This information, in conjunction with the findings of the model study and ecological

findings, will form the basis for a detailed specialist report on the estuarine and marine ecosystem Ecosystem Services.

Task responsibility:
4.1 & 4.2 Louw D, Birkhead, Mackenzie, Hughes, Bockmuhl, Handley
4.3 Louw D, Birkhead, Mackenzie, Kotze, Palmer, Rountree, Koekemoer J, Desai, Deacon
4.4 River Ecosystem services survey: Huggins, Grant, Roberts
Marine and Estuary Ecosystem services survey: Turpie
Information required: All historical and recent results from surveys in the Fish and Orange-Senqu River
Actions and deliverables:
a) EFR site selection (ground truthing): During flooding (possibly March) and May 2012
b) Biophysical Survey: June 2012
c) River Ecosystem services survey: April 2012
d) Marine and Estuary Ecosystem services survey: July to September 2012.
Deliverable E: First draft report (31 October 2012)
Comments: Only three EFR sites can be selected of which two must be in the Fish River. The consultant is responsible for all project team logistics regarding field trips and providing the information timeously to stakeholders who would like to participate. Stakeholders are responsible for their own accommodation arrangements. Consultants are responsible for providing their own equipment. Consultants cannot accommodate any force majeure incidents that have implications for the budget and programme.

4.5 Task 5: Estuarine/Marine Surveys

4.5.1 *Task 5.1: Field surveys*

Estuary Sediment and Bathymetry surveys: One detailed field survey (in summer) will be conducted to gather understanding on the sediment processes relevant to the Orange-Senqu River Mouth. This will include: 1) sampling for sediment grain sizes analysis; 2) detailed bathymetric survey of the Orange-Senqu River Mouth; 3) determination of tidal flows using an Acoustic Doppler Current Profiler and water level recorder(s).

The following components will be surveyed as part of the Orange Estuary ecological survey:

Hydrodynamics: A set of longitudinal salinity profiles will be collected from the Orange-Senqu River Mouth. This will be conducted on two occasions: 1) during the sediment and bathymetry survey (in summer – high flow period) and 2) during this ecological survey (summer – low flow period).

***Water quality*:** Longitudinal water quality data will be collected from the Orange-Senqu River Mouth during a flood tide. This will be conducted on two occasions: 1) during the sediment and bathymetry survey in summer (limited set of samples) and 2) during this ecological survey in winter (detailed set of samples). No samples for toxic substances in sediments will be collected. The following variables will be measured:
- *In situ* system variables (salinity, temperature, pH, turbidity and dissolved oxygen).
- Samples for system variables (suspended solids).
- Samples for dissolved inorganic nutrients (nitrite, nitrate, ammonia, phosphate and silicate).

***Microalgae*:** One detailed survey will be conducted in winter (coinciding with the above) including phytoplankton and benthic microalgae.

***Macrophytes*:** One detailed survey will be conducted in winter (coinciding with the water quality and microalgae surveys) focusing on the macrophyte plant communities. The three permanent transects in the lower, middle and upper region (sampled in previous surveys) will be repeated.

***Invertebrates*:** One detailed field survey will be conducted in winter (coinciding with the above) on estuarine invertebrates. This survey will include sediment grain size analyses and sediment organic content in sediments will be included as part of the invertebrate component.

***Fish*:** One detailed field survey will be conducted in winter (coinciding with the above) on fish using seine and gill-nets. Samples will be collected from the mouth to 20 km upstream.

***Birds*:** One detailed field survey will be conducted in winter (coinciding with the above) on birds.

Task responsibility: Van Niekerk, Diedericks, Theron, Mabile, Vonk, Truter, Taljaard, Lamberth, Wooldridge, Snow, Adams, Turpie

Information required: Measured flow data for the lower Orange-Senqu River from SA DWA website.

Deliverables and milestones

a) Field survey - Estuary Sediment and Bathymetry (January/February 2012)

b) Field survey - Estuary Ecology (July - September 2012)

Responsibility of the Consultant: Coordinate field trips, inform Client of main survey dates at least four weeks in advance, and collaborate with South African and Namibian counter parts to ensure knowledge transfer.

4.6 Task 6: River: Analysis of Data

4.6.1 *Task 6.1: EcoStatus models*

Analysis of all data collated will take place during this task. The EcoClassification models (Kleynhans & Louw, 2007) will be applied at Level 4 (a detailed level) for each EFR site

which represents a MRU. The analysis of all the data collated will consist of individual indices for the driver and response components and the output will be a PES category for each component. A range of available rule-based models will be used to determine the ecological state.

- Fish Response Assessment Index (FRAI, Kleynhans 2007).
- Macroinvertebrate Response Assessment Index (MIRAI, Thirion, 2007).
- Riparian Vegetation Response Assessment Index (VEGRAI, Kleynhans *et al.* 2007).
- Geomorphological Driver Assessment Index (GAI, in press).
- Index of Habitat Integrity (IHI, Kleynhans *et al.* 2009a).
- Physico-chemical Driver Assessment Index (PAI, Kleynhans *et al.*, (2005); DWAF (2008b).
- EcoStatus Level 4 (Kleynhans & Louw, 2007).

Recent EFR studies across South Africa (2007-2010) made it possible to incorporate diatom assessments as part of the EcoClassification process which is an integral part of the Ecological Reserve determination method and of any Environmental Flow Requirement method. The biological assessment of diatom samples will be carried out using the OMNIDIA program (version 8.1) (Lecointe *et al.*, 1993) and based on twelve diatom indices. Diatom results will be based on the Specific Pollution Index (SPI) results as the use (efficacy) of the SPI has been tested in South Africa (De la Rey *et al.*, 2004 and Taylor, 2004).

Task responsibility: Louw D, Birkhead, Koekemoer J, Koekemoer S, Kotze, Palmer, Rountree, Mackenzie, Scherman, Deacon
Information required: Hydrology (qualitative information); Water quality data (current Neckartal monitoring data and DWA database); Range of aerial photographs; Cross-sections.
Actions and deliverables: Analysis of data, EcoStatus models (July to October 2012).
Comment: All methods which have been published will not be described within any of the above reports but will be referred to.

4.7 Task 6.2 Hydrology

Surface water hydrology: The two main sources of hydrology data for this study are the recent feasibility study into the Neckartal Dam and the GTZ study completed in 2010. The former study provides natural hydrology and water resources system models for the Fish River catchment while the latter provides the same data for Orange catchment (including the Fish River). Since the ecologist need to understand the flood regime within the Fish River as well as the Orange-Senqu River estuary, daily observed flow data is also required. This data is available from the Seeheim gauging weir on the Fish River and the Vioolsdrift weir on the lower Orange.

The scenario and flood analysis described under Task 9 will be used to generate monthly time step flow time series at each of the EFR sites as well as the Orange-Senqu River Mouth under natural flow conditions, present day flow conditions, and up to 6 development scenarios.

Surface-groundwater interaction: The information required will depend on the approach agreed on during the latter part of the inception phase. It is expected that some modelling will be required to determine flows required (both surface and groundwater) to maintain pool levels and quality in a required state. The level of detail that can be provided will depend on available data.

Task responsibility: Hughes, Bockmühl, Birkhead, Tanner and Mallory S
Information required: The existing Water Resources Yield Models for the Fish River and Orange will need to be obtained from WRP. These models will contain all the natural hydrology, water use and infrastructure such as dams.
Actions: Obtain model setups and abstract relevant information from these.
Deliverables and milestones: Analysis of data. **Deliverable L:** Specialist report (September 2012)
Responsibility of the Consultant: The consultant will be responsible for obtaining existing WRYM model setups of the Fish and Lower Orange-Senqu River. The consultant will not be responsible for the accuracy of the surface water hydrology since this was carried out and approved as part of previous studies.
Comments: The consultant will not be responsible for a review of the existing hydrology. The consultant will not generate any new hydrology but use the existing modelled data for natural and present day data.Observed data will be used to provide information at a daily scale where information.

4.7.1 *Task 6.3: Hydraulics*

The role of hydraulics in holistic methods (requiring site-specific assessments) is to provide ecologically relevant hydraulic information. This information is provided by a set of relationships between discharge, stage or maximum flow depth, velocity (average cross-sectional). Basic hydraulic information is obtained through the collection of different amounts of field data, and by applying different methods of analysis. The basic hydraulic field data include the following: A cross-sectional survey; a low-flow measured rating (the low-flow measurement is essential, since high flows can generally be modelled more accurately than low flows in rivers with large bed roughness typical of EFR sites); water surface slopes; spatial distributions of depth and depth-averaged velocity; the substrate composition; and the position of marginal vegetation relative to the river topography.

Task responsibility: Birkhead, and Desai
Information required: Locality of gauging weirs; Field data collated during biophysical and other surveys.
Actions and deliverables: Obtaining high flow data by means of photographs at the EFR site and linking to discharges to hydrological gauges (pending flooding condition). Analysis of data; Provision of hydraulic data and cross-sectional profiles with the location of vegetation markers in the standard format required by other specialists. If required, data will also be provided for sediment modelling. Specialist report (September 2012).
Comments: The consultant cannot be held responsible for the loss of hydraulic data arising from the loss of bench marks due to vandalism or flooding. The consultant will not be surveying the bench marks relative to the global coordinate system.

4.7.2 *Task 6.4: River ES Identification and Qualitative Evaluation*

Natural habitats and ecosystems provide a huge range of environmental ES that contribute enormously, and are even essential, to human well-being. Protecting these areas is essential in order to achieve sustainable development. River systems and their associated use values are of particular importance.

Based on the literature research, as well as an initial site visit as per Task 4.4, the key ES that form a part of community reliance, livelihoods and subsistence, or provide key non-market related economic functions, will be examined. The list of ES will then be further scrutinized to generate an overview of the likelihood that they will change given anticipated trajectories of modification to the system once scenarios are developed. If no change is expected, then further research into the value of these ES will not be pursued.

The method that will be employed will be linked to EFR sites and then scenario based. In terms of assessment of the impacts of the various scenarios (hypothetical notions of deviation from PES) will be examined at the EFR sites. Essentially the direction of change (either positive or negative), and estimating the magnitude of the change in benefits and costs that may be experienced within the Lower Orange and Fish River systems will be identified. This will be linked to Task 8 and results will be integrated.

Task responsibility: Huggins, Grant, Roberts
Actions and deliverables: Deliverable E: First draft report (30 November 2012)

4.8 Task 7: Estuarine/Marine: Analysis of Data

4.8.1 *Task 7.1: Modelling*

A three dimensional numerical model (Delft 3D-FLOW) will be set up and calibrated to simulate fluxes (both flow and sediment) from the Orange-Senqu River catchment to the nearshore marine environment. The long-term sediment equilibrium of the system will also be assessed. Assessments will be conducted for the natural, present (with dam development) and future dam development scenarios (maximum two). While the numerical model will primarily be set up to assess inputs to the nearshore marine environment, it will include the lower 15 km of the Orange Estuary to also enable better quantification of the Orange-Senqu River Mouth's response to changes in river inflow.

Task responsibility: Van Niekerk, van Ballegooyen, Diedericks, Taljaard. Theron
Information required:
a) Simulated monthly flow scenarios to the Orange Estuary for Reference Condition, Present State, 6 - 8 future development scenarios (including 1 or 2 sensitivity testing scenario(s) in which base flows are reduced below 10 m^3/s for three months for about 2 out of 10 years).
b) Low confidence flood hydrographs for Reference Condition, Present State, 6 - 8 future development scenarios for return periods of 1:1, 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100.
c) Water Quality report for lowest EFR site.
d) Sediments report (Neckartal Dam study); and
e) UNOPS Orange-Senqu River Eco-toxicology report.
Actions: The hydrodynamic model will be calibrated on the recorded water level, river flow and tidal flow data. Sediment input from the river could be based on a suspended sediment rating curve (where data are available). Alternatively the sediment transport capacity of the river will be calibrated against the catchment sediment yield to obtain a time series of sediment load. Results from the numerical modelling study will be presented in a separate numerical modelling report. These results will be used in the EFR assessment of the Marine Environment. Results on the responses of the estuary to changes in catchment fluxes will inform the specialist studies on estuarine sediment and hydrodynamics.
Deliverables and milestones: Set up and calibration of hydrodynamic model and preliminary modelling results (February to May 2013) to provide direction to estuary and marine EWR evaluation and assessment tasks.

4.8.2 *Task 7.2: Estuary Assessment*

The main focus of this task is to analyse the individual estuary components' data sets.

Task responsibility: Van Niekerk, Taljaard, Turpie, Theron, Lamberth, Wooldridge, Snow, Adams, Huizinga

Information required:

a) Simulated monthly flow scenarios to the Orange Estuary for Reference Condition, Present State, 6 - 8 future development scenarios (including 1 or 2 sensitivity testing scenario(s) in which baseflows are reduced below 10 m^3/s for three months for about 2 out of 10 years.
b) Low confidence flood hydrographs for Reference Condition, Present State, 6 - 8 future development scenarios for return periods of 1:1, 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100.
c) Water Quality report for lowest EFR site.
d) Sediments report (Neckartal Dam study).
e) UNOPS Orange-Senqu River Eco-toxicology report.
f) River water quality collected by South Africa's DWA on the Lower Orange-Senqu River; Historical data (e.g. Van Niekerk *et al.* 2008).
g) Coordinated Water Bird Counts (CWAC) data from the Avian Demography Unit at the University of Cape Town (UCT). Dr M Anderson will assist bird specialist with queries and data interpretation (where necessary).

Actions: Conduct a literature review, collate available historical and field data and conduct an analysis on the individual ecosystems component's response to changes in freshwater inflows.

Deliverables and milestones: Deliverable L (February 2013): Individual draft specialist reports will be prepared for the following estuarine components by the responsible project team member:

- Abiotic report (including sediment dynamics, hydrodynamics and water quality)
- Separate biotic reports for: Microalgae, Macrophytes, Invertebrates, Fish , Birds

The draft reports will include an assessment of field data in relation to changes in river runoff as well as the completed EFR templates as required in terms of the accepted methodology (DWAF, 2008b).

4.8.3 *Task 7.3: Marine Assessment*

An assessment of the role of freshwater inflow (and associated sediment and nutrient fluxes) to the nearshore marine environment from the Orange-Senqu River Catchment. This will include potential effects of changes in freshwater inflow on the nearshore marine environment.

Task responsibility: Van Niekerk, van Ballegooyen, Diedericks, Turpie, Taljaard, Theron, Lamberth, Meyer, Pulfrich, Luck-Vogel

Information required:

a) Simulated monthly flow scenarios to the Orange-Senqu River Mouth for Reference Condition, Present State, 6 - 8 future development scenarios (including 1 or 2 sensitivity

testing scenario(s) in which baseflows are reduced below 10 m^3/s for three months for about 2 out of 10 years).
b) Low confidence flood hydrographs for Reference Condition, Present State, 6 - 8 future development scenarios for return periods of 1:1, 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100
c) Fisheries catch data.
d) Satellite data on nearshore environment near Orange-Senqu River Mouth.
Actions:
a) Evaluation of the legislation and policies of requirements.
b) Setting of management objectives (e.g. protection of marine living resources, especially those subject to important socio-economic exploitation; protection of coastal and offshore environments utilised for socio-economically important activities); maintenance of ecosystem function and integrity; and maintenance of biodiversity and protection of rare and endangered species.
c) Selection/definition of biogeographic domains or ecosystem extent (e.g. remote sensing)
d) Mapping of recognised resource utilization.
e) Scientific Assessment Studies (including selection of keystone or indicator species; determination of life-cycle and habitat requirements; identification of habitat requirements (drivers; spatial and temporal characterisation of relevant drivers (or habitat requirements).
f) Selection of appropriate assessment methods (e.g. correlation analyses, numerical modelling, remote sensing; Bayesian networks).
g) Identification of information requirements and possible further studies.
h) Definition of environmental objectives.
Deliverables and milestones: Deliverable J: First draft report (31 July 2013). Individual draft specialist reports will be prepared for the following marine components by the responsible project team members: Remote sensing, primary production, invertebrates and fish.

4.8.4 *Task 7.4: Estuarine Resource Economics*

Data collected during the field visit will be augmented by readily available data (e.g. commercial catch data) on the estuarine and marine resources that are potentially responding to freshwater flows from the Orange-Senqu River catchment. This information, in conjunction with the findings of the numerical modelling study and ecological findings, will form the basis for a detailed specialist report on the estuarine and marine Ecosystem Services.

Task responsibility: Van Niekerk, Turpie
Information required: Field trip data collected during 2012
Deliverables and milestones: Deliverable E: First draft report (30 November 2012).

ENVIRONMENTAL FLOW REQUIREMENTS PHASE

4.9 Task 8: River EcoClassification, EcoSpecs, EFR, ES Changes

EcoClassification: The output of the EcoStatus model that integrates all the biophysical model resulting in an integrated state (the EcoStatus) are presented to the specialists at a specialist meeting and refined if necessary. The trend, the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Category (REC) are determined. The alternative Ecological Categories (ECs) for EFR assessment are then established and then all the models rerun in a predictive fashion for each of the ECs to be addressed.

EFR determination: The objective for the Orange-Senqu River EFR determination is to supply a relationship between an index of stress (0 to 10) and habitat availability during different flow conditions. This information is required for the determination of required stresses for different ECs. The information on habitat, collated during the previous tasks as well as the hydraulics will be used to determine the stress indices. These indices form the basis for the determination of low flows using the Habitat Flow Stressor Response (HFSR) method (Hughes and Louw, 2010). The high flows will be assessed by indicating flood requirements based on the biophysical response of the floods. The floods are grouped into flood classes and the number of events required for different EFR scenarios are identified. In this case, the existing EFR O4 results will be used as scenarios and the resulting stress at the lower Orange EFR site will be used to identify the corresponding Ecological Category at this lower site.

The exact approach for the Fish River will be determined during the inception phase. It is however likely that, although utilising different tools to provide driver information, floods will be set based on the same principles contained within the standard EFR methods. The EcoClassification methods to determine and predict the Ecological Category will remain unchanged as these methods are applicable to rivers with any hydrological regime.

EcoSpecs: Ecological monitoring is the collection and analysis of repeated observations or measurements **to evaluate changes in the condition of the resource and the progress towards meeting the management objective (Elzinga *et al.*, 1998)**. In terms of Ecological Water Resources Monitoring, it is the measurement of EcoSpecs (ecological specifications) to determine if the EC is attained (Kleynhans *et al.,* 2009b. EcoSpecs indicate the ecological detail that characterizes the ecological state or EC.

Thresholds of Potential Concerns (TPCs) indicate the values around the EcoSpecs that, if being approached, would initiate more detailed investigation or even management actions.

TPCs are based on the acceptance that there is uncertainty as to the accuracy or validity of EcoSpecs i.e. is deviation from EcoSpecs due to natural variation, sampling error, etc. TPCs are regarded as early warning indicators of potential change from a particular EC to another (lower) EC.

Reference conditions, the PES, REC and AECs have been determined for each EFR site. This information provides the broad level of EcoSpecs for the biophysical components addressed during EcoClassification. The next step is therefore the finalization of detailed EcoSpecs and TPCs for the baseline (present state) of the biological response indicators, water quality and geomorphology. These objectives are used during monitoring, as monitoring is aimed at determining changes from the baseline or present state.

EcoSpecs and TPCs were generated for the EFR sites during the GIZ study and the same process will be followed to generate these at the new EFR sites. The process of defining EcoSpecs and TPCs are independent of whether the river is perennial or ephemeral. More information on the monitoring programme is provided under Task 10.1.

Ecosystem Services changes: The ES will be analysed in conjunction with the ecological specialists at the workshop. The range of ES deemed to be critical per defined resource area will be described and specialists will give their input as to the expected magnitude and significance of changes from the current base value under each of the scenarios mooted. These will be justified where relevant.

Task responsibility: Louw D, Kotze, Koekemoer, J, Palmer, Mackenzie, Rountree, Koekemoer S, Scherman, Hughes, Mallory H, Birkhead, Huggins, and Handley
Actions and deliverables: Specialist meeting (November 2012). **Deliverable F**: First draft EFR Report (February 2013).
Comments: The consultant is responsible for co-ordinating and facilitating the specialist meeting, undertaking the logistical arrangements for the consulting team and providing logistical information to the client and other interested parties. The report will not include explanations of methods which is well-documented and accessible in reports.

4.10 Task 9: Scenario Evaluation

Yield Modelling & Description of operational and new development scenarios: During the previous GIZ study, this phase was not undertaken as future scenarios will only be generated during a next phase. The ToR for this study does however request the analysis of scenarios, focussing on specific developments in the Lower Orange and Fish Rivers only. Therefore, no development scenarios outside of the study area will be assessed. The scenarios will relate to development options on the Fish River and the Lower Orange-Senqu

River and will not cater for development options higher up in the Orange or Vaal River catchments.

A monthly time step water resources model will be set up for the Fish River catchment and validated against observed flow at Seeheim. The following scenarios are suggested but will be confirmed before the modelling is carried:

- Natural flow or reference conditions.
- Present day flow.
- Flow with the Neckartal Dam in place.
- With a raised Hardap Dam.

The existing Orange model will be simplified to model only the lower reaches of the river down to the estuary and including inflows from the Fish River. The following scenarios are suggested but will be confirmed before the modelling is carried:

- Natural flow
- Present day flow
- Flow with Vioolsdrift Dam
- Flow with the Neckartal Dam in place
- With a raised Hardap Dam

In order to obtain an idea of the flood hydrographs at the EFR sites in the Fish River the following approach will be taken. The daily flow time series at Seehiem will be patched to obtain a complete record and then used to disaggregate the monthly flows at the two EFR sites in the daily flow time series. The estuarine ecologists are concerned with how floods at the estuary have changed from reference to present day conditions. This will be done by comparing monthly natural and present day duration curves and extrapolating these differences to floods at various recurrence intervals.

Operational and development scenarios have to be identified and limited to six scenarios.

Task responsibility: Mallory, S, Louw, D.
Information required
a) EFR scenarios to be confirmed by the Client before proceeding with analyses
b) Results of yield modelling in usable format.
c) Daily flow record from the Seehiem gauge
d) Daily flow record from the Vioolsdrift Gauge

Actions and deliverables: Scenario analysis using a monthly time step model; Flood analysis of the Fish River (at two EWR sites) and Orange-Senqu River Mouth. Range of scenarios available for consequences assessment which include time series, flow duration graphs and flood analysis for each scenario (February 2013). The approach and results will be included in the version 2 of the specialist hydrology report - **Deliverable L:** Specialist report (September 2012)
Comment: The consultant will not be generating any additional hydrology but will use the available hydrology setup to generate scenarios. The consultant will therefore not set up or reconfiguring the Water Resource Planning Model (WRPM). The budget does not include setting up or reconfiguring the Water Resource Planning Model (WRPM) and assessing more than 6 scenarios (final scenarios).

4.10.1 *Task 9.1: Ecological & ES consequences (Rivers)*

The main purpose of this task is to predict the resulting consequences in terms of possible change from the Present Ecological State. The first step would be to use all the tools and information that was applied and used to generate the initial EFRs. These tools will again be used within this task to assess the changes in habitat as a result of the different flow scenarios. This information will then be used to predict the changes in ecological state. These changes will be predicted using the suite of EcoClassification rule-based models used during Task 6.1. The driver (geomorphology and physico-chemical variables) responses to the different flow scenarios will be provided first in order to inform the biological response models.

The consequences of changes to Ecosystem Services (ES) will be derived from results emanating from the EFR specialist meeting and integrated with the analysis of the impacts of proposed operational scenarios. Expert opinion will estimate the magnitude of change associated with the base value of the ES deemed to be impacted by operational changes. Where possible this will be quantified and costed.

Task responsibility: Louw D, Kotze, Koekemoer, J, Palmer, Mackenzie, Rountree, Koekemoer S, Scherman, Mallory H, Huggins, Roberts
Actions and deliverables: Predicting the ecological state associated with each scenario as well as the changes in Ecosystem Services during a specialist meeting (March 2013).
Deliverable H: First draft report (31 May 2013); **Deliverable K**: First draft report (31 July 2013)
Comments: As for all specialist meetings, the consultant is responsible for facilitation and logistical arrangements for the study team. The consultant will timeously provide specialist meeting logistical information to other interested parties that would like to participate.

4.10.2 *Task 9.2: Estuarine evaluation*

The focus will be an integrated assessment of the ecological flow requirements of the Orange-Senqu River Mouth based on specialists studies. A two-day specialist workshop will be organised in Stellenbosch to determine the following:

- Reference Condition (before major water resources development in the catchment).
- Present Ecological State.
- Estuarine importance on a national and regional scale.
- Implications of future development scenarios.
- Recommended Ecological Category for the Estuary.
- Ecological water requirements (quantity and quality) for the REC.
- Ecological specifications for the REC; and
- Design of a monitoring programme for future refinement of the EFR findings and auditing implementation of the EFR.

Task responsibility: Van Niekerk, Taljaard, Turpie, Theron, Lamberth, Wooldridge, Snow, Adams, Huizinga
Actions: Conduct a specialist workshop to determine the EFR for the Orange-Senqu River Mouth (May 2013).
Deliverables and milestones: An EFR report will be prepared for the estuary, including individual specialist reports as appendices. **Deliverable K**: First draft report (31 July 2013).

4.10.3 *Task 9.3: Marine Evaluation*

The main objective of this task is to determine the freshwater flow needs of the nearshore marine environment using the outcome of the marine assessment and recommend allowable changes in freshwater inflow to maintain or improve the present health status of the marine environment, and to optimise the existing "ecosystem services", applying the following approach:

- Describe the issues of concern around potential changes in freshwater inflows (and associated fluxes) in the coastal and marine ecosystem.
- Describe the potential freshwater-dependant functional linkages between coastal marine ecosystems and adjacent catchments, and
- Assess the potential risks associated with such changes (including climate change), based on a driver-response modelling approach whereby an assessment will made of the ecological response to primarily abiotic drivers that are likely to be influenced by changed in freshwater inflows (and associated sediment and nutrient fluxes) into the coastal marine ecosystem.

Task responsibility: Van Niekerk, Diedericks, Turpie, Taljaard, Theron, Lamberth, Meyer, Pulfrich, Huizinga, Luck-Vogel, van Ballegooyen

Information required

a) Simulated monthly flow scenarios to the Orange-Senqu River Mouth for Reference Condition, Present State, 6 - 8 future development scenarios (including 1 or 2 sensitivity testing scenario(s) in which baseflows are reduced below 10 m^3/s for three months for about 2 out of 10 years).

b) Low confidence flood hydrographs for Reference Condition, Present State, 6 - 8 future development scenarios for return periods of 1:1, 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100.

c) Water Quality report for lowest EFR site.

d)Sediments report (Neckartal Dam study).

e) UNOPS Orange-Senqu River Eco-toxicology report.

Actions: Conduct a one-day marine assessment specialists workshop to evaluate the responses of the marine environment to freshwater flows and the related ecosystems services (May 2013)

Deliverables and milestones: A separate report will be prepared on the EWR for the Marine Environment summarising the findings of a one-day marine workshop (at CSIR Stellenbosch) and the individual marine specialist reports. **Deliverable J:** First draft report (31 July 2013).

4.10.4 *Task 9.4: Integration and preparation of scenarios and consequences in preparation for stakeholder interaction*

Prior to the stakeholder meetings, the project leader will oversee the preparation of the scenario presentations. This will be followed by a team meeting with key specialists to agree on the recommendations as will be presented to stakeholders, and to finalise the presentations that will be presented to stakeholders.

Task responsibility: Simon, Louw, van Niekerk, Huggins/Turpie, Mallory S, van Dorssen
Information required: Final results of the study (Task 9)
Deliverables and milestones: Prepare powerpoint presentations for stakeholder meetings.
Deliverable N: July 2013

4.10.5 *Task 9.5: Stakeholder meeting to determine desired ecosystem state*

This task represents the second round of stakeholder contact and it is important that both identified stakeholder groups be involved. The various scenarios generated during Task 9 will be presented to the stakeholders together with an assessment of the implications of each scenario on the ecosystem and the ES derived from it.

Based on the information provided by the specialists, the role of the stakeholders during this meeting will be to determine what their preferred future state of the rivers and estuary would be and would seek an optimal balance between ecological and ES considerations.

It is proposed to have two meetings at the proposed venues which are Vioolsdrift and Windhoek. The targeted stakeholders for the dedicated consultative events will take place with the Orange – Fish River Basin Management Committee (OFBMC), the Orange-Senqu River Mouth Interim Management Committee (ORMIMC), the Joint Vioolsdrift/Noordoewer Irrigation Authority and ORASACOM. The makeup of the two stakeholder groups is outlined in the Stakeholder Consultation and Disclosure Plan (SCDP) attached as Appendix A.

The methodology to be used during these meetings will be to firstly to present the various scenarios identified as a result of the specialist studies, together with the key implications of each for the various affected groups. This will be followed by a free discussion and question session to clarify any unclear issues and methodological considerations. This will then be followed by a card writing exercise affording the group the opportunity to consider the positive and negative aspects of each scenario and then agree on the preferred scenario. Obviously, it is unlikely to get full consensus, but the methodology will assist in highlighting various arguments and force stakeholders to consider various opinions before expressing a preference.

Task responsibility: Simon, Louw, van Niekerk, Huggins/Turpie, Mallory S, van Dorssen
Information required: Six scenarios with the requisite presentations
Actions: Arrange the meetings and invite stakeholders; Facilitate meetings; Record and publish meeting proceedings.
Deliverables and milestones: Successful meetings and full minutes of the meetings.
Deliverable O – July 2013
Comments: The budget does not include travelling and accommodation costs for meeting attendees.

4.11 Task 10: Monitoring Programme (long term)

4.11.1 *Task 10.1: Rivers*

Many monitoring programmes have been designed in terms of frequency of monitoring as well as the components that requires monitoring and the detail needed. However, many monitoring programmes fail as they are too expensive and detailed. The National Water Act (NWA, Act No. 36 of 1998) requires the establishment of a national monitoring system that must provide for the collection of appropriate data and information necessary to assess water

resources. Such a system must ensure the collection of relevant information that contributes to the management of the resource in a desirable ecological condition

A monitoring programme must be designed according to the principles of Adaptive Management Framework and within a Decision Support System that provides guidance on how to address issues if the EcoSpecs and TPCs are exceeded. EcoSpecs and TPCs will be available as set during Task 8. Guidelines regarding a monitoring programme will be provided during this task.

Task responsibility: Louw D, Kotze, Palmer, Mackenzie, Rountree, Koekemoer S, Scherman
Actions and deliverables: Provide guidance on long term monitoring programmes. Integrate EcoSpecs, TPCs and monitoring programme guidelines into a report. **Deliverable M:** First draft report (30 June 2013).
Comment: The design of a monitoring decision support system and detailed costing of the programme does not form part of this project.

4.11.2 *Task 10.2: Orange-Senqu River Mouth*

During this Task the design of the existing Orange Estuary monitoring programme will be re-evaluated and updated to reflect findings and data gaps highlighted by this study.

Task responsibility: Van Niekerk, Adams, Lamberth, Taljaard, Theron, Wooldridge, Snow, Huizinga, Turpie
Actions and deliverables: Deliverable M - First draft report (30 June 2013).
Comment: The design of a monitoring decision support system and detailed costing of the programme does not form part of this project.

4.12 Task 11: Data Base and GIS

The TOR did not provide detailed description of the database apart from the requirement of compatibility with ArcGIS 9. According to the ToR, the GIS database was to be designed, implemented and populated within the Project. However, during the inception phase of the Project, ORASECOM has informed the Project that a basin-wide geographically-referenced database has already been implemented in the form of Water Information System (WIS) and is accessible through an internet portal wisp.orasecom.org. In view of that, the Database and GIS component will focus on:

1. Collation of generic geographic datasets such as thematic maps and satellite imagery that are relevant to the specialist studies and future management process but not yet incorporated into WIS. These datasets will include :

a. A set of suitably organized data layers containing basic characteristics of the study area, such as: topography, land use/land cover, vegetation, hydrography, geology, geomorphology, infrastructure, administrative and land management boundaries. These could include archival maps and products such as SRTM digital elevation model, and will be stored as thematic (or categorical) raster and vector data and continuous numeric raster data.
b. A set of suitably organized raster data layers allowing for derivation and analyses of time-varying characteristics such as vegetation, land cover, geomorphology and climate. These could include time series of satellite images (MODIS, Landsat), climate products describing long-term climate such as CRU and UDEL rainfall and temperature datasets, and products describing near-real time climatic conditions such as TRMM or RFE satellite-based rainfall fields. These will be stored as continuous numeric raster data.

2.Organization of geographically-oriented data that are generated within the Project by the specialists. These will include results of once-off campaigns directed towards mapping of G&S and ecological status of the river. These data will be stored as vector data with attributes.
3.Incorporation of the above into the ORASECOM WIS.

The ORASECOM WIS portal has a character of a high level database, and as such it is able to accommodate not just various spatial/temporal data but also objects such as files, documents, references to external datasets, metadata etc. Spatial/temporal data included in WIS can have a range of formats, and conversion scripts can be implemented in order to translate data into XML and XSD standards. The XML and XSD descriptors allow access to and transferability of data and datasets. These principles will guide development and incorporation of the Project datasets into WIS.

After consultation with project leaders, specialists and the ORASECOM WIS manager it has been agreed that:

- Specialist reports and data sheets are to be included into the WIS database as geographically-located reference documents.,
- Geographic objects such as sampling point locations, or survey transect location will be stored as ESRI shapefiles. Tools allowing for conversion of datasets into XML format (KML) are to be prepared.
- Raw attribute data from specialist data sheets are to be extracted and incorporated into WIS in the form of a MySQL database. Tools allowing for conversion of datasets into XML format are to be prepared. In this way, data can be:

- reused within various applications, within and outside of the project scope;
- visualized within the map server environment provided by WIS; and
- incorporate into future environmental monitoring system.

- The development of a sophisticated database front end allowing for input, viewing and interpretation of monitoring data is not necessary during the project. This is because the project objective is only to recommend monitoring activities and indices, rather than to initiate and design a monitoring programme.
- The duplication of datasets stored in external databases and available through their respective web interfaces is to be avoided. Instead links to these data are to be provided/stored within the Project's WIS area.

Project survey activities are to cover the following areas: hydrodynamics, water quality, microalgae, macrophytes, fish and birds. Surveys will be carried out both within the estuary and at selected river cross-sections of upstream rivers. Only several measurements such as water levels will have a character of continuous, high temporal resolution monitoring. Other surveys will be periodic, but not too frequent campaigns - once or twice during the project, repeated after several years. Importantly, surveys both within the project and after its completion, are to be carried out at geographically fixed locations. To accommodate spatio-temporal aspects of the generated datasets, the following structure of the attribute database is envisaged:

- Attribute data table is to be created for each group of spatial entities where similar measurements/surveys are carried out.
- Records in that table will correspond to individual geographic entities and survey campaigns.

Task responsibility: Wolski

Information required: All maps, data and reports used in the study and generated within the study. These are to be provided by specialists working on thematic tasks of the study.

Actions:

1. Initial consultation with leaders of thematic tasks of this study: This will involve detailing of datasets to be included in the database, discussion on nature of datasets generated during project surveys and monitoring activities. Outcome: Detailed description of datasets needed in the project and structure of data generated within monitoring and survey activities
2. Determination of database model: Outcome: Structured database model accommodating various data types to be included in the database.
3. Collation of relevant GIS layers from open access sources (internet) and from relevant data providers (government departments in riparian countries).
4. Implementation and populating of project spatial database (raster and vector data) in WIS. This will involve conversion and organization of data in a coherent manner and preparation of metadata. Outcome: Functional and structured spatial data database.

5.Implementation of interfaces between web database and Excel-based databases used in environmental flows assessment framework (as described above).

Deliverables and milestones: Tasks 1 and 2 will be summarized in a milestone: formulated database structure and WIS database populated with external datasets (**Deliverable 29P**). Tasks 3, 4 and 5 will contribute to a deliverable: Database of project spatial data and database report (**Deliverable 30P**).

Responsibility of the Consultant: Collation of data relevant to the project that are not available through WIS already; Uploading data in an organized manner to WIS.
Comments: The budget does not include the preparation of monitoring system front end.

4.13 Task 12: Review and Liaison

Many specialists are involved in all aspects of the Lower Orange and Fish River. To ensure that this local knowledge can be utilised, various specialists are incorporated under this liaison task. These are Dr Mary Seely who is involved in the Desert Research Foundation of Namibia (DRFN) and has extensive experience in ephemeral systems. Carole Roberts, also from DRFN, is also involved and will provide specialist input in both stakeholder liaison tasks as well as the ES.

Ms Amelia Briel managed the Environmental Impact Assessment for the proposed Neckartal Dam in the Fish River and is also involved in this task (amongst others), to ensure that all knowledge gained during the impact assessment is transferred.

Wayne Handley from Ministry of Environment and Tourism (Namibia) will act as liaison between this ministry and the work that will be undertaken as part of this study. He has extensive local experience on how the Fish River system has been managed in recent years and will be able to provide valuable information to the study team. Furthermore, he and Dr Andrew Deacon from SANPARKS will be able to provide the liaison role within this study between the two departments and also provide valuable biodiversity insights related to the Richtersveld Ai-AisTransfortier Park. Dr Deacon will be retiring during 2012, but Dr Hugo Bezuidenhout from SANPARKS based in Kimberley who was involved in the GRZ study can fulfil this role.

Bernt Rydgren was part of the team of the GIZ study and with his extensive experience in many specialist fields specifically in Africa, he is ideally suited to undertaken an internal review of key technical reports to ensure that they are clear and user-friendly.

Task responsibility: Louw, Briel, Rydgren, Seely, Roberts
Information required: All reports generated during the course of the study.

Actions: Rydgren, Seely: Provide a comprehensive review of all reports produced during the study.
Comment: Ensure all documentation is provided to reviewers; Incorporate reviewers comments and finalise reports.

4.14 Task 13: Main Integrated Report

As can be seen in the deliverables and milestones (Chapter 6), many technical reports and appendices will be produced during the course of this study. The main report will represent a summary report which will focus on the results and conclusions generated during each of the 12 Tasks outlined in this chapter.

Task responsibility: Louw D, Van Niekerk, Koekemoer S, Simon, Van Dorssen, Huggins, Mallory H.
Information required: Results from all the previous tasks.
Actions: Collating all existing project data and results.
Deliverables and milestones: Deliverable Q: First draft report available (August 2013).

5 Study Team

The proposed study team (key specialists and support) are provided in an organogram (Figure 8). The study has the following team leaders:

- Rivers team leader – D Louw
- Estuarine and Marine team leader – L van Niekerk
- Goods and Services: Resource Economics – G Huggins
- Stakeholder participation – E Simon

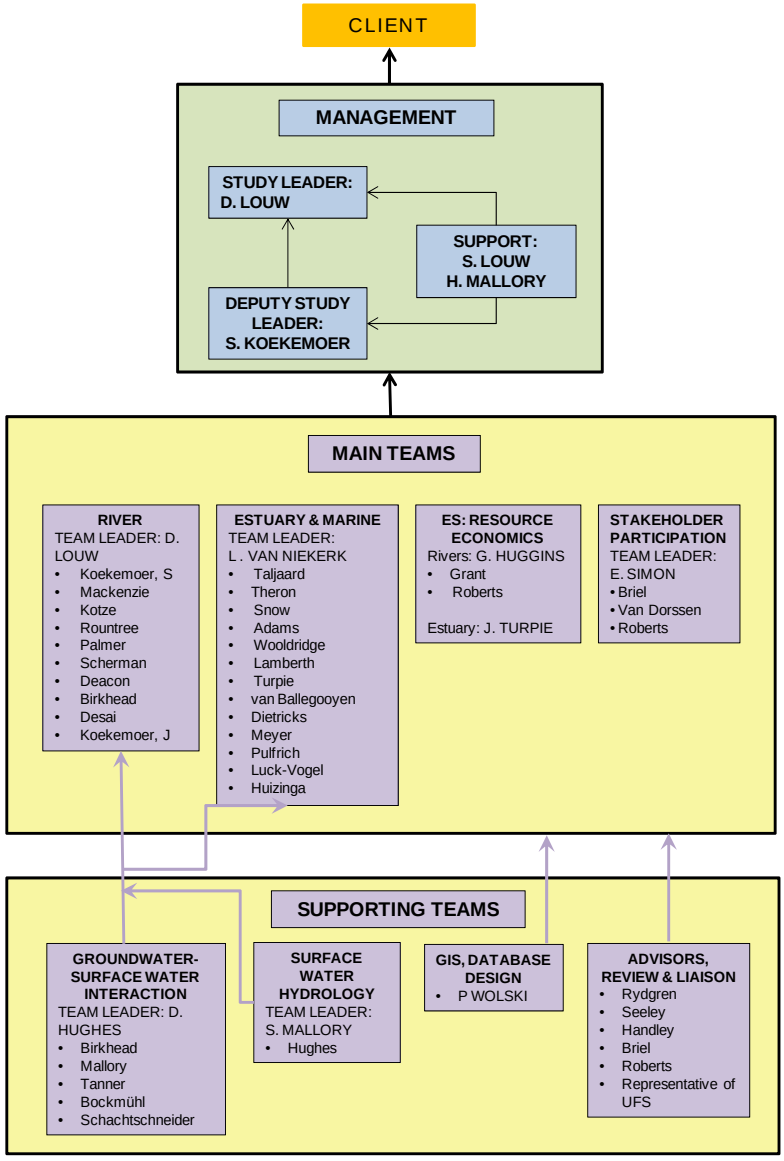


Figure 8 Proposed Study team

6 Programme, Milestones and Deliverables

6.1 Key Milestones and Deliverables

The milestones and deliverables listed in Table 2 are in task sequence, rather than in date sequence. The milestone numbers and deliverable letters are correlated to those indicated on the Gantt chart (Table 3).

Table 2 Milestones and deliverables

MILESTONES and description		DELIVERABLES and description	
1	Coordination and management of a multi-disciplinary team.	A	Monthly progress notes, detailed progress reports
2	Method to determine Fish River EFR.	B	INCEPTION REPORT Appendix 1: Stakeholder and Consultation Disclosure Plan
3	Formulated database structure and GIS.		
4	SCDP.		
5	Initial Stakeholder liaison: Newsletters, Emails etc.	C	BACKGROUND INFORMATION DOCUMENT
6	Delineation of the Lower Orange and Fish River into MRUs.	D	MANAGEMENT RESOURCE UNIT REPORT
7	Reconnaissance field trip		
8	Fish River hydrology: Verification of perennial pools		
9	Rivers: Biophysical survey		
10	Ecosystem Services		
11	Estuary Sediment and Bathymetry survey data collated		
12	Estuary Ecological survey data collated		
13	EcoStatus models: Analysis of field data.		
14	Hydrology analysis, groundwater surface water interaction.		Included in Deliverable G.
15	Hydraulic modelling.		
16	Identified River Ecosystem Services evaluation.	E	RIVERS AND ESTUARY: GOODS AND SERVICES: INDENTIFICATION AND IMPORTANCE
17	Set up of hydrodynamic estuary model		Included in Deliverable L.
18	Estuary Assessment: Data analysed	I	ESTUARY: ORANGE ESTUARY ECOLOGICAL FLOW REQUIREMENTS

MILESTONES and description		DELIVERABLES and description	
		L	SPECIALIST REPORTS FOR SCENARIO ASSESSMENT
19	Set up of hydrodynamic estuary model	J	ESTUARY: AN ASSESSMENT OF THE ROLE OF FRESHWATER INFLOWS UNDER ASSOCIATED FLUXES IN THE COASTAL MARINE ECOSYSTEM OF THE ORANGE-SENQU RIVER ESTUARY AND THE POTENTIAL AFFECT OF CHANGES IN FRESHWATER FLUXES
		L	SPECIALIST REPORTS FOR SCENARIO ASSESSMENT
20	Rivers: EcoClassification, EcoSpecs, EFR and Ecosystem Services specialist meeting.	F	RIVERS: EFR REPORT
		G	RIVERS: EFR SPECIALIST REPORT
21	Development scenarios	L	SPECIALIST REPORTS FOR SCENARIO ASSESSMENT
22	Rivers: Ecological, and Ecosystem Services consequences specialist meeting.	H	RIVERS: ECOLOGICAL CONSEQUENCES OF DEVELOPMENT SCENARIOS
23	Orange Estuary Ecological Flow Requirement	I	ESTUARY: ORANGE ESTUARY ECOLOGICAL FLOW REQUIREMENTS
		K	RIVERS AND ESTUARY: GOODS AND SERVICES CONSEQUENCES OF DEVELOPMENT SCENARIOS
		L	SPECIALIST REPORTS FOR SCENARIO ASSESSMENT
24	Assessment of the role of freshwater inflows and associated fluxes in the coastal ecosystem of the Orange-Senqu River Estuary and the potential effects of changes in the freshwater-related fluxes into this ecosystem	J	ESTUARY: AN ASSESSMENT OF THE ROLE OF FRESHWATER INFLOWS UNDER ASSOCIATED FLUXES IN THE COASTAL MARINE ECOSYSTEM OF THE ORANGE-SENQU RIVER ESTUARY AND THE POTENTIAL AFFECT OF CHANGES IN FRESHWATER FLUXES
25	Stakeholder meetings	N	PowerPoint presentations
26	Stakeholder desired state available: Outcomes of meeting.	O	Minutes of stakeholder meetings
27	EcoSpecs and Long term monitoring programme for rivers.	M	RIVERS AND ESTUARY MONITORING REPORT
28	EcoSpecs and Long term monitoring programme for estuary.		
29	Formulated database structure and WIS database populated with external datasets.	P	Web page and guideline document.
30	Database of project spatial data and database report.		
31		Q	MAIN INTEGRATED REPORT

6.2 Gantt Chart

According to the information provided by the Client, the study is to be completed within a 24 month period. A Gantt chart (Table 3) which links to the list of mile stones and deliverables (Table 2) are provided below.

Table 3 Gantt chart

TASKS	INCEPTION				SURVEY PHASE								EFR PHASE										
	2011			2012												2013							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Task 1: Management and Coordination																								
1.1 Administrative and technical management.				1				1			1				1				1			1		1
1.2 Financial admin																								
1.3 Logistical arrangements & report edit																								
INCEPTION PHASE																								
Task 2: Inception Phase																								
2.1 Design project plan																								
a) Fish River ephemeral rivers method				2																				
b) General project plan																								
c) Database and GIS plan			3B																					
2.2 Stakeholder interaction (SCDP)			4B																					
2.3 Inception report			B																					
Initial Stakeholder liaison (BID)				5C																				
SURVEY PHASE																								
Task 3: Determination of Resource Units					6	D																		
Task 4: ID EFR sites and biophysical survey																								

TASKS	INCEPTION			SURVEY PHASE									EFR PHASE										
	2011			2012												2013							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.1 Reconnaissance survey								7																
4.2 Surface groundwater investigations								8																
4.3 Biophysical survey (Fish and Orange)									9															
4.4 ES field survey												10												
Task 5: Estuarine/Marine surveys																								
5.1 Estuary Sediment and Bathymetry survey					11																			
5.2 Estuary Ecological Surveys												12												
Task 6: River: Analysis of data																								
6.1 EcoStatus models													13											
6.2 Hydrology												14G												
6.3 Hydraulics													15G											
6.4 River ES identification & qualitative evaluation														E16										
Task 7: Estuarine/Marine analysis of data																								
7.1 Modelling					17														17L					
7.2 Estuary Assessment																			18IL					
7.3 Marine Assessment																			19JL					
EFR PHASE																								
Task 8: EcoClassification, EcoSpecs, EFR, ES																								

TASKS	INCEPTION			SURVEY PHASE									EFR PHASE										
	2011			2012									2013										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
changes																								
Specialist meeting														20										
Report																	21							
Task 9: Scenario evaluation																								
Preparation of scenarios																			21L					
9.1 River Ecological, ES consequences																		22FG				22K		
Report																				22H				
9.2 Estuarine evaluation																						23KL		
9.3 Marine evaluation																						24J		
9.4 Presentation of results to Stakeholders																						25N		
9.5 Stakeholder meeting to determine desired state.																							26O	
Task 10: Monitoring programme																								
10.1 River																						27M		
10.2 Estuary																						28M		
Task 11: Data base and GIS																								
11.1 Database format and population									29P															
11.2 Web page and GIS																					30P			
Task 12: Review and liaison																								
Task 13: Main integrated																								31Q

TASKS	INCEPTION			SURVEY PHASE								EFR PHASE										
	2011			2012											2013							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
report																								

6.3 Field surveys, specialist meetings and reports

The planned activities for the project are outlined in Table 4 and a schedule and timeline of reports are provided in Table 5.

Table 4 Outline of field surveys and specialist meetings planned for the project

No	Field surveys and specialist meeting	Action	Date
1	Estuary sediment bathymetry survey:	Collection of cross-sectional survey data by technician team. Sediment specialist – collection of grab samples along the length estuary.	Jan – Feb 2012
2	Ecosystem Services field survey	Preliminary data collection to confirm utilisation of Riverine Ecosystem Services. Identify, and quantify, the ecosystem Ecosystem Services provided by the Orange-Senqu River Mouth.	Apr 2012 Jun - Sep 2012
3	Fish River hydrology: Verification of perennial pools	Details of site visit will be available after January 2011.	7-11 May 2011
4	Reconnaissance field trip	Groundtruth EFR sites and calibration of hydraulic model.	Mar or 7-11 May 2011
5	Rivers: Biophysical survey	Data collection at EFR sites: This includes cross-sectional surveys, fish, macroinvertebrate, riparian vegetation, fluvial geomorphology and diatom data collection.	11-20 Jun 2011
6	Estuary: Ecological surveys	Data collection at estuary: This includes hydrodynamics, water quality, microalgae, macrophytes, invertebrates, fish and birds.	Jul – Sep 2012
7	Rivers: EcoClassification, EcoSpecs, EFR and Ecosystem Services specialist meeting	Analysis of data to determine the PES, EIS, flow requirements and role of Ecosystem Services.	Nov 2012
8	Rivers: Ecological, and Ecosystem Services consequences	Determining the consequences of development scenarios at the EFR sites.	Mar 2013
9	Estuary: EFR assessment	Determine the PES, importance, implications of development scenarios, desired state for the Estuary, the EFR (quantity and quality) for the desired state.	May 2013
10	Marine assessment	Recommend probable allowable changes in freshwater inflow into the marine environment within the constraints of maintaining or improving the present health status of the marine ecosystem, and the optimisation of the existing "ecosystem services" provided by the	May 2013

No	Field surveys and specialist meeting	Action	Date
		coastal ecosystem.	
11	Stakeholder meetings	Target specific stakeholders and invite to meetings. Determine what the stakeholders' preferred future state of the rivers and estuary.	Jul 2013

Table 5 Schedule and timeline of specialist reports

Delive-rable	Report	Date
B	INCEPTION REPORT Appendix 1: Stakeholder and Consultation Disclosure Plan	20 Dec 2011
C	BACKGROUND INFORMATION DOCUMENT	End Jan 2012
D	MANAGEMENT RESOURCE UNIT	Mar 2012
E	RIVERS AND ESTUARY: ECOSYSTEM SERVICES: INDENTIFICATION AND IMPORTANCE	Nov 2012
F	RIVERS: EFR REPORT	Feb 2013
G	RIVERS: EFR SPECIALIST REPORT	Sep - Oct 2012
H	RIVERS: ECOLOGICAL CONSEQUENCES OF DEVELOPMENT SCENARIOS	May 2013
I	ESTUARY: ORANGE ESTUARY ECOLOGICAL FLOW REQUIREMENTS	Jul 2013
J	ESTUARY: AN ASSESSMENT OF THE ROLE OF FRESHWATER INFLOWS UNDER ASSOCIATED FLUXES IN THE COASTAL MARINE ECOSYSTEM OF THE ORANGE-SENQU RIVER ESTUARY AND THE POTENTIAL AFFECT OF CHANGES IN FRESHWATER FLUXES	Jul 2013
K	RIVERS AND ESTUARY: CONSEQUENCES OF DEVELOPMENT SCENARIOS ON ECOSYSTEM SERVICES	Jul 2013
L	SPECIALIST REPORTS FOR SCENARIO ASSESSMENT Hydrology – February 2013; all Estuary specialist appendices – July 2013	Feb – Jul 2013
M	RIVERS AND ESTUARY MONITORING REPORT	Jul 2013
N	STAKEHOLDER PARTICIPATION MEETING PREPARATION: POWERPOINT PRESENTATIONS	Jul 2013
O	STAKEHOLDER DESIRED STATE	Jul 2013
P	DATA BASE AND GUIDELINE DOCUMENT	Jul 2013
Q	MAIN INTEGRATED REPORT	Sep 2013

7 References

Burton, J. and Gerritsen, J. 2003. A Stream Condition Index for Virginia Non - Coastal Streams. USEPA Office of Science and Technology, Office of Water, Washington, DC.

Cowan, G.I. 1995. Appendix 1. Wetlands of International Importance listed by South Africa. In: Wetlands of South Africa (Cowan, G.I. ed.). Department of Environmental Affairs and Tourism, Pretoria. pp12 – 20.

De la Rey, P.A., Taylor, J.C., Laas, M.A., Van Rensburg, L and Vosloo, A. 2004. Determining the possible application value of diatoms as indicators of general water quality - A comparison with SASS 5. *Water SA* **30** (3) 325-332.

Department of Water Affairs and Forestry (DWAF) 2008a. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2. Pretoria.

Department of Water Affairs and Forestry, South Africa (DWAF). 2008b. Methods for determining the Water Quality component of the Ecological Reserve. Prepared by Scherman Consulting.

Elzinga, C.L., Salzer, D.W., and Willoughby, J.W. 1998. "Measuring and monitoring plant populations". BLM Technical Reference 1730 - 1, BLM/RS/ST - 98/005+1730.

Hughes, D.A. and Louw, D (2010). Integrating hydrology, hydraulics and ecological response into a flexible approach to the determination of environmental water requirements for rivers. Environmental Modelling & Software 25: 910-918.

Kleynhans, C.J., Louw, M.D., Thirion, C., Rossouw, N. and Rowntree, K. 2005. River Ecoclassification: Manual for EcoStatus Determination.

Kleynhans, C.J. and Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kleynhans, C.J. 2007. Module D: Fish Response Assessment Index. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kleynhans, C.J., Mackenzie, J and Louw, M.D. 2007. Module F: Riparian Vegetation Response Index. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kleynhans C.J., Louw, M.D. and Graham, M. 2009a. Module G: Index of Habitat Integrity (Section 1, Technical manual). In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kleynhans, C.J., Louw, M.D., Birkhead, A.L., Thirion, C., Deacon, A., Angliss, M., Maseti, P., Rodgers, S and Weston, B. 2009b. On the way to implementation: Ecological reserve Monitoring. International Conference on Implementing Environmental Water Allocations (IEWA), Port Elizabeth – South Africa 23 - 26 February 2009.

Lecointe, C., Coste, M and Prygiel, J. 1993. "Omnidia": Software for taxonomy, calculation of diatom indices and inventories management. Hydrobiol. **2691/270**: 509-513.

Louw MD, Kemper N and Birkhead AL. 1999. Procedure for selecting sites in intermediate and comprehensive determination of the ecological reserve (water quantity component). Appendix 18 in Resource Directed Measures for Protection of Water Resources: River Ecosystems. Published by Department of Water Affairs, South Africa.

Taylor, J.C. 2004. The Application of Diatom-Based Pollution Indices in The Vaal Catchment. Unpublished M.Sc. thesis, North-West University, Potchefstroom Campus, Potchefstroom.

Thirion, C. 2007. Module E: Macrinvertebrate Response Assessement Index. In River EcoClassification: Manual for Ecostatus Determination (version 2). Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Van Niekerk, L., Neto, D.S., Boyd, A.J. and Holtzhausen, H. 2008. Benguela Current Large Marine Ecosystem Programme (BCLME) Project BEHP/BAC/03/04: Baseline Surveying of Species and Biodiversity in Estuarine Habitats. For the United Nations Office for Project Services (UNOPS) contracted to Benguela Environment Fisheries Interaction & Training Programme (BENEFIT), (Namibia), subcontracted to the Instituto Nacional de Investigação Pesqueira (INIP), Angola on behalf of the Benguela Current Large Marine Ecosystem Programme (BCLME).

APPENDIX A: DRAFT STAKEHOLDER CONSULTATION AND DISCLOSURE PLAN

Prepared by Ernst Simon

Environmental Flow Requirements of the Fish River and the Orange-Senqu River Mouth

DRAFT STAKEHOLDER CONSULTATION AND DISCLOSURE PLAN

December 2011

TABLE OF CONTENT

1 INTRODUCTION

The Orange-Senqu River riparian States (Botswana, Lesotho, Namibia and South Africa) are committed to jointly addressing threats to the shared water resources of the Basin. This is reflected in bilateral and basin-wide agreements between the riparian states and led to the formation of the Orange-Senqu River Commission (ORASECOM) in 2000. The 'Orange-Senqu Strategic Action Programme Project' supports ORASECOM in developing a basin-wide plan for the management and development of water resources, based on Integrated Water Resources Management (IWRM) principles.

The water resources of the Orange-Senqu River are heavily utilised and the system is highly regulated with 23 major dams within its Basin. It is also connected to other river systems for water import and export via six inter-basin water transfer schemes.

Environmental Flow Requirements (EFR) of the ephemeral but nevertheless significant Fish River and the Orange River from its confluence with the Fish River downstream to the Orange River mouth were not covered in any detail by the GIZ study, completed during 2009-2010. This outstanding work is the subject of this Research Project. The importance of completing the Environmental Flow Requirements picture is becoming increasingly urgent due to the fact that two large dams, one in the Lower Orange (Vioolsdrift Dam) and one in the Lower Fish (Neckartal Dam), are at an advanced state of planning. Clearly, these reservoirs will have a major impact on, as well as a role to play in the maintenance of environmental flows. Further to this, the Orange River Mouth Interim Management Committee (ORMIMC), a transboundary body comprising of the Environment Departments of Namibia and South Africa as well as other stakeholders, is now moving towards establishing a Management Plan for the Orange-Senqu River Mouth. ORMIMC sees this as an operational plan of three to five years duration, with prioritised discrete actions towards remediating the degradation of the Ramsar site and eventually getting it off the Montreux Record

2 OBJECTIVES OF THE PCDP

This document outlines the Public Consultation and Disclosure Plan for the Research Project on Environmental Flow Requirements of the Fish River and the Orange-Senqu River Mouth. It seeks to define a technically and practically appropriate approach to and programme for public consultation and disclosure. It is a live document and will be subject to amendment as and when it is regarded as necessary. The objectives of the plan are:

- To ensure that all stakeholders are included in the consultation and disclosure process.
- To ensure that initial information disclosure about the project is appropriate and comprehensible to non-technical stakeholders and the local population.
- To ensure that adequate and timely information is provided to project stakeholders.
- To ensure that all stakeholders are given sufficient opportunity to voice their opinions and concerns.
- To ensure that these opinions and concerns influence project decisions.
- To ensure that regular feedback is provided to project-affected people.

3 PROJECT OVERVIEW

The 'Orange-Senqu Strategic Action Programme' Project supports ORASECOM in developing a basin-wide plan for the management and development of water resources, based on integrated water resources management (IWRM) principles. The Project currently finalises a Transboundary Diagnostic Analysis (TDA). This TDA will serve as the scientific basis for developing a set of interventions under the framework of a basin-wide Strategic Action Programme (SAP) and associated National Action Plans (NAPs) in the riparian States. In addition, Research and Demonstration Projects focus on:

- Environmental flows for the Fish River in Namibia and the Orange-Senqu River Mouth, shared by Namibia and South Africa.
- Community based rangeland management, with sites in Botswana and Lesotho; and
- Water resources management in the irrigation sector, with sites in Namibia and South Africa.

The water resources of the Orange-Senqu River are heavily utilised. Water supply in terms both of quantity and quality for basic human needs is being outstripped by the demands within and outside of the Basin. Meeting the water supply needs of rapidly growing towns and cities at the same time having sufficient water of an acceptable quality to meet existing and proposed irrigation and other demands (including environmental demands) further downstream challenges planners, decision makers and stakeholders. The Orange River System is highly regulated with 23 major dams within its Basin. It is also connected to other river systems for water import and export via six inter-basin water transfer schemes. As a result of the impoundments and inter-basin transfers, it is currently estimated that the mean annual runoff (MAR) reaching the Orange-Senqu River Mouth, has been reduced to about 43% of the natural MAR (some 10,800 million m3). Operational management of the Orange-Senqu River (reservoir releases, transfers etc) is a continuous process and has to be done with great care making use of a complex water resource simulation model (Water Resource Planning Model, WRPM) to ensure that the different users around the basin have an assured supply of water. Downstream users, including the environment, are dependent on releases from upstream dams, releases which takes several days to reach them. While assuring these downstream demands, management must equally assure that no more water than necessary is sent downstream, especially in times of water shortage. Good management depends, amongst other things, on an accurate knowledge of flows in the river and its tributaries. As the resource gets more limited the need for better accuracy and precision water management becomes even greater. As a result South Africa and Namibia to are busy establishing three new gauging stations in the Lower Orange to accurately measure low flows. The new gauging stations will make it easier to ensure that the required amounts of water for supporting the environment in the Lower Orange are left in the river. In 2009, in preparation for the design and implementation of a basin-wide IWRM plan, ORASECOM, with the support of the GIZ, commissioned a study into environmental flow requirements in the Orange-Senqu River Basin (WRP et al., 2010 and 2011). This study was recently completed and has defined both the present ecological state and the environmental flows that would be required to maintain a range of ecological states at eight representative sites upstream of the confluence of the Fish and Orange Rivers. This represents an important step forward towards the ultimate goal of agreeing and monitoring environmental flows to be maintained in the future

4 INTERNATIONAL AND NATIONAL REGULATIONS AND REQUIREMENTS

Although this study cannot be classified as a project, its results will have an influence on the future availability and management of water resources in the area stretching from Vioolsdrift/ Noordoewer to the Orange River mouth. It would therefore have an impact on both the authorities who will utilise the information for management purposes and for the users and producers of goods and services, those that use the water from the river. It is therefore important to ensure that the public consultation and disclosure process satisfy international best practice. To this end a number of international guidelines shall be adhered to in the SCD process for this project. These include the International Finance Corporation, the Equator Principles, Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes.

4.1 EQUATOR PRINCIPLES

The principles state that "We believe that adoption of and adherence to these Principles offers significant benefits to ourselves, our borrowers and local stakeholders through our borrowers' engagement with locally affected communities".

Key principles that are relevant to stakeholder engagement include Principle 2: Social and Environmental Assessment which highlights the requirements for "consultation and participation of affected parties in the design, review and implementation of the project". Principle 5: Consultation and Disclosure states that:

> *"For projects with significant adverse impacts on affected communities, the process will ensure their free, prior and informed consultation and facilitate their informed participation as a means to establish, to the satisfaction of the EPFI, whether a project has adequately incorporated affected communities' concerns.*
>
> *The assessment documentation and technical summaries thereof, will be made available to the public by the borrower for a reasonable minimum period in the relevant local language and in a culturally appropriate manner. The borrower will take account of and document the process and results of the consultation including any actions agreed resulting from the consultation. For projects with adverse social or environmental impacts, disclosure should occur early in the Assessment process and in any event before project construction commences, and on an ongoing basis."* (The Equator Principles Association, 2006)

Equator Principle 3, which relates to applicable Social and Environmental Standards, states that for projects located in non-OECD countries the Social and Environmental Assessment will refer to the applicable IFC Performance Standards.

4.2 IFC PERFORMANCE STANDARDS

4.2.1 Performance Standards for Stakeholder Engagement

Although all of the Performance Standards have relevant social aspects to them the key ones considered when designing the SCDP and in working towards the Stakeholder Engagement Plan are summarised in Table 1. (International Finance Corporation, 2011).

Table 1: Summary of IFC Performance Standard Requirements for Stakeholder Engagement

Standard	Key Components
Performance Standard 1: Social and Environmental Assessment and Management Systems	• Pertains to projects with social and environmental risks and impacts that ought to be managed in the early stages of project development and be ongoing throughout the life of the project. This approach necessitates the participation of IAPs in the process.
Performance Standard 4: Community Health, Safety & Security	• Recognises that project activities, equipment and infrastructure bring benefits to communities including employment, services and opportunities for economic development. However, the project can also increase the potential for community exposure to risks from development. • Where project activities pose risks of adverse impacts on the health and safety of affected communities the developer is required to make available relevant information (including the details of an Action Plan), in an appropriate form, to affected parties and government authorities so that they can fully understand the nature and extent of the risks.
Performance Standard 5: Land Acquisition and Involuntary Resettlement	• In such instances the developer will undertake extensive consultation and negotiation with affected parties. Such communication will include transparent access to project related information in a timely fashion to enable people to plan for the future. Here public participation will include the establishment of appropriate representative forums through which resettlement and compensation are discussed. Most of this consultation is part of the SIA and Resettlement Action Plan but it should be recognised as a component of the PCDP.
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	• Recognises that protecting and conserving biodiversity in all its forms is fundamental to sustainable development. • Where the project has potential impacts on legally protected or critical habitats consultation with relevant authorities, specialists and communities must be undertaken.

4.2.2 Grievance Resolution

The Equator Principles and IFC Performance Standards also place emphasis on the establishment of a grievance mechanism. Key requirements for developing and implementing a grievance mechanism are highlighted in each of the Performance Standards:

PS1 - Social and Environmental Assessment and Management

> *"The client will respond to communities' concerns related to the project…will establish a grievance mechanism to receive and facilitate resolution of the affected communities' concerns and grievances about the client's environmental and social performance"*

PS4 - Community Health, Safety and Security

> *"A grievance mechanism should allow the affected community to express concerns about the security arrangements and acts of security personnel"*

PS5 - Land Acquisition and Involuntary Resettlement

> *"The client will establish a grievance mechanism …to receive and address specific concerns about compensation and relocation that are raised by displaced persons or members of host communities…"*

4.3 CONVENTION ON THE PROTECTION AND USE OF TRANS-BOUNDARY WATERCOURSES

The main objective of this convention is to prevent, control or reduce any trans-boundary impact resulting from the pollution of trans-boundary waters caused by human activity. Article 16 of the convention contains requirements for public information. Under these requirements, the parties have to ensure that information on the condition of trans-boundary waters, measures taken to control, reduce and mitigate trans-boundary water pollution and effectiveness of these measures are made available to the public. The information that has to be made available to the public includes:

- Water quality objectives (see guidelines for developing Water Quality Objectives and Criteria in Annex III of the Convention)
- Permits issued and the conditions required to be met; and
- Results of analysis of water sampling carried out for monitoring and assessment, and results of checking compliance with water quality objectives.

The parties have to ensure that the information is made available to the public of their states and is free of charge. Copies of the information must be provided to the riparian parties for reasonable payment.

5 ROLES AND RESPONSIBILITIES

This section confirms the roles and responsibilities of those involved in the execution of the stakeholder consultation and disclosure process.

5.1 ROLES AND RESPONSIBILITIES OF THE PROJECT PROPONENT

The Governments of Botswana, Lesotho, Namibia and South Africa, through the Orange-Senqu River Commission (ORASACOM), are responsible for ensuring that conditions are conducive for a transparent and efficient stakeholder participation and disclosure process. In particular they must:

- Support the consultants by giving them free access to national, regional and local government structures;
- Provide information freely to the consultants;
- Remove unnecessary administrative and bureaucratic hurdles;
- Assist the Consultant Team to respond to technical questions and queries about the project in a neutral and non-defensive way; and
- Issue all press releases.

5.2 ROLES AND RESPONSIBILITIES OF THE STUDY TEAM

The Study Team will take full responsibility for all stakeholder participation, consultation and disclosure activities related to the study.

This responsibility includes but is not limited to:

- Identification of the key stakeholders and preparation of the Stakeholders list.
- Preparing the SCDP and confirming this plan as acceptable to stakeholders.
- Ensuring appropriate and effective public disclosure of all information pertaining to the Study.
- Arranging for and facilitating all public consultation, participation and disclosure events.
- Setting up effective channels of communication with all stakeholders and use existing forums for discussions when appropriate.
- Providing regular feedback to all stakeholders with respect to the findings of the consultation process and the recommendations of the specialists.

Following the identification of the key stakeholders and the social and natural assets likely to be affected, the Study Team is responsible to prepare a SCDP to constructively engage the stakeholders in the project. Consultation is critical in contributing to a sense of ownership of the project and/or its outcomes by the stakeholders.

On a practical level, the Study Team will take responsibility for the organisation of all aspects of consultation meetings and workshops inclusive of minute taking and recording of issues raised and commitments made. The team is also responsible for the distribution of all documents for review and comment.

The team will actively participate in all consultation events and will also be responsible to respond to concerns and ideas raised through public consultation and to ensure that all stakeholder consultation and disclosure requirements of international agencies are met, inclusive of the documentation of results.

The Study Team, within this context is further responsible to advise the proponent on the structure of the consultation process where requested by the project proponent.

6 CONSULTATION AND DISCLOSURE METHODOLOGY

6.1 OVERVIEW

This methodology sets the objectives and specific actions required to reach the objectives related to specific elements of stakeholder consultation and disclosure regarded as essential to ensure a rigorous consultation and disclosure process which can withstand local and international scrutiny and satisfy international best practice principles. The key elements addressed are:

- Broad based and effective stakeholder consultation and participation
- Managing stakeholder participation communications
- Participation in decision making
- Stakeholder and media management

6.2 BROAD BASED AND EFFECTIVE CONSULTATION AND PARTICIPATION

6.2.1 Objectives

To ensure broad based and effective consultation and participation, a number of objectives need to be achieved. These are ensuring that all who wish to partake can do so easily, ensuring that there is adequate capacity within directly affected communities to participate meaningfully, and focusing on the correct consultation area.

6.2.2 Methodology

6.2.2.1 Comprehensive Stakeholder List

Stakeholders are identified to determine all of the organisations and individuals who may have a stake in the study and who may be able to contribute to the programme of work due to their expert knowledge of and/or experience in the project area. In order to develop an effective stakeholder involvement programme, it is necessary to determine exactly who the stakeholders are. This is due in part to recognition of the fact that different methods may be required to effectively involve the various stakeholder groups. In addition, different issues are likely to be of prime concern for each of these stakeholder groups.

In the case of this study, two key stakeholder groups were identified. The first stakeholder group consists of the various regulatory authorities. These are those stakeholders whose main concern is ensuring that the water resource of the Orange and Fish Rivers are used in such a way that it represents an optimal balance between ecological protection and consumptive utilisation in the interest of economic development. Generally, this group of stakeholders will ultimately be responsible to control the use of water to such an extent that an acceptable ecological flow is retained to protect the river environments as well as the Orange-Senqu River mouth. This group would include but are not limited to stakeholders such as the Orange – Senqu River Commission (ORASECOM), the Orange River Mouth Interim Management Committee (ORMIMC), the Environmental Ministries of the riparian states, the Electricity utilities of these states, the Orange Fish Basin Management Committee (OFBMC), the Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee (ARTPJMB), and Catchment Management Agencies (CMAs). It is envisaged that liaison with this group of stakeholders will be continual during the course of the study whereby communication will mainly be electronically based.

The second stakeholder group consists of the users who all cumulatively influence the river and mouth environments and who, through their actions, have an influence on the environmental flow in the rivers. These stakeholders include but are not limited to the Ministries responsible for agriculture and water in the riparian states, the local authorities who are dependent on the river for their water supply such as Alexander Bay, Oranjemund, Sanddrift, and Sendelingsdrift, various mining operations in both Namibia and South Africa, various irrigation projects on the Fish River in Namibia and the Lower Orange River and tourism operators who utilise the river for various activities. Both these stakeholder groups need to be afforded an opportunity to participate in the research project.

In order to ensure that all potential stakeholders are identified and effectively consulted, the team will ensure that all stakeholders in the following categories in both countries are included in the list:

Table 2: Potential Stakeholders by Group

Institutional Stakeholder Group	Local Stakeholder Group
Orange – Senqu River Commission (ORASECOM)	Local Communities
Orange River Mouth Interim Management Committee (ORMIMC)	Local CBOs
Environmental Ministries of the Riparian States	Local NGOs
Electricity utilities of the Riparian States	Mining Companies
Ministries of Agriculture of the Riparian States	Tourist Organisations
Water Utilities of the Riparian States	Local Governments
Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee (ARTPJMB)	Regional Governments
Orange Fish Basin Management Committee (OFBMC)	Irrigation Farmers
Catchment Management Agencies (CMAs)	
Academic and research institutions	
United Nations and Bilateral Agencies	

To ensure that all individuals and organisations are included under these categories, the team will, based on stakeholder lists of the previous project and other existing stakeholder lists, prepare a preliminary stakeholder list. This list will then be forwarded to various organisations to check it for completeness and to add any additional stakeholders.

6.2.2.2 Enabling effective participation

Effective participation can only happen if adequate information is made available. The stakeholder engagement plan provides detail on how each of the identified stakeholder groups will be reached and how information will be disseminated to them. Various stakeholders may require different methods and means of information dissemination to ensure that information are accessible and understandable within the given context. To ensure that the needs of all stakeholders are considered and that dissemination methodologies address these needs, a stakeholder engagement plan will be prepared. This plan will consider the specific needs of the various stakeholder groups and will detail an appropriate disclosure methodology for each of these groups. The stakeholder engagement plan and programme is discussed under section 7 of this plan.

Managing the issues that are raised is important to ensure that none are forgotten or not recorded. Stakeholders must be sure that the issues they raise are regarded as important and are considered. To ensure that nothing falls through, the manager of the public participation process will record all issues in an issues list kept centrally for that purpose. This will not only remain a list but each issue will be checked for consideration and a statement will be made in the list as to how and where each of these issues has been dealt with. It will eventually form part of the SCD report.

6.2.2.3 Identifying the consultation area

The study has a clearly defined area which includes the Ephemeral Fish River from the proposed Neckartal Dam to the confluence with the Orange and the Orange River from Vioolsdrift to the Estuary where it runs into the sea. The consultation area therefore covers all stakeholders and activities which take place within the influence area of these two rivers.

6.3 MANAGING PUBLIC PARTICIPATION COMMUNICATIONS

6.3.1 Objectives

The objective of this element is to ensure that communication with stakeholders is effective and that specific emphasis is placed on the particular constraints and requirements of the various stakeholder groups. The study will have two stakeholder consultation events. The first will be the dissemination of information about the study and the second will be two stakeholder meetings, one at Vioolsdrift and one in Windhoek. The Vioolsdrift meeting will cater for the local stakeholder group while the one in Windhoek will cater for the institutional stakeholder group. The information dissemination will take place through the distribution of a Background Information Document (BID) which will provide the background to and motivation for the study, describe the project components, describe the key methodological issues, provide a broad programme for the study, explain how stakeholders can get involved and how they can register, detail how feedback will be provided and provide an idea of future consultation events.

6.3.2 Methodology

6.3.2.1 Local Stakeholder Groups

The distribution of the BID to the local stakeholder group must be able to reach these stakeholders effectively and will require the use of local newspapers, local radio stations, e-mail, surface mail and the placing of the BID at key places where people could collect it. Notice of the Meeting will be given through the same methods.

6.3.2.2 Institutional Stakeholder Group

The institutional stakeholder group is easier to reach and the BID will be sent via e-mail as well as surface mail depending on the situation. Specific individuals such as chairpersons of commissions and responsible individuals in other organisations will be targeted. Notice of the meeting will also be disseminated in the same way.

6.3.2.3 Media Releases

All communication related to the project will also be advertised in the local press in all states. This includes invitations, advertorials about the study, notifications of meetings, summaries of key results and notifications of the places where information can be obtained throughout the duration of the study. These will all be done jointly between the study team and ORASACOM to ensure that both parties are in agreement on the information so published. Media releases will target local and institutional stakeholder groups in all four countries and will be issued by ORASACOM. The study team will take responsibility for preparing press releases for approval and issuing by ORASACOM.

6.3.2.4 Web Site

In addition to using the press to convey information, a project website will be developed and all public information will be posted to this web site. This will make information accessible to all stakeholders, nationally and internationally, who have access to the internet. The web address will be made known to all stakeholders through the BID, media releases and personal contacts.

6.3.2.5 Feedback

In studies like this, stakeholders invariably ask for feedback about the outcomes of their inputs as well as about the decisions and the recommendations that resulted from the study. All of the above media as well as individual e-mail reports will be used to provide feedback to stakeholders. Feedback will be provided in the form of minutes of all meetings and resolutions of all consultative sessions and workshops throughout the duration of the study.

6.4 PARTICIPATION IN DECISION MAKING

6.4.1 Objectives

Public consultation and disclosure, in this case, go beyond public meetings and feedback. The study team will use a scenario approach to identify the various flow regimes of the two rivers. These scenarios then need to be considered and the most appropriate scenario selected. It will be expected of stakeholders to participate in this decision. The objective of this element is therefore to ensure that stakeholders have a realistic opportunity to influence decisions and recommendations resulting from the study.

6.4.2 Methodology

6.4.2.1 Participation of Stakeholders

The role of the stakeholders will be to determine what their preferred or desired future state of the river would be. For each of the scenarios evaluated, the results for the state of the ecosystem as well as for the ability to sustain the production of Goods and Services will be presented for consideration by stakeholders. It is anticipated that stakeholders will assist to find the optimal balance between these two considerations.

6.4.2.2 Demonstrating influence

Participation without actually influencing or perceived inability to influence decisions leads to resentment and negative perceptions about the process. It is therefore important that the Study Team, throughout all aspects of the study allow the inputs and contributions of stakeholders to actually influence decision making. This must also be demonstrated to stakeholders to show how much their inputs are valued and considered. The entire team will take care to continuously point out how important stakeholder inputs are and will demonstrate through specific reference, how their inputs influenced decisions in this study.

The issues trial will also be used to demonstrate this through accurate record keeping on who raised the issue, when and where it was raised, how it was considered, how it was resolved and the influence of stakeholder participation in finding the most suitable solution or response to the specific issue.

6.5 STAKEHOLDER AND MEDIA MANAGEMENT

6.5.1 Objectives

Neglecting stakeholders and the media often lead to both these groups using their own resources and contacts to obtain information on which to base their opinions and reactions. This in turn can easily lead to inaccurate information being presented as fact and the formation of opinions and positions based on these inaccurate "facts". The objective of stakeholder and media management is therefore to ensure that all stakeholders and the media have open access to accurate project related information.

6.5.2 Methodology

6.5.2.1 Transparency

Perhaps the most important requirement to limit possible misinformation is to keep all aspects of the project as transparent as possible. No information resulting from the study is regarded as confidential. Every aspect should be in the public realm and the Study Team will make sure that both stakeholders and the media are regularly kept up to date on progress and about the progress with and issues raised during the study. No hidden agendas will be allowed to develop or influence the process or the decision making during the assessment. This undertaking also ensures that stakeholders will have full disclosure of all information which will provide them with a basis for their own assessment and participation.

6.5.2.2 Accessibility

A statement that all information will be publicly available only carries weight if such information is practically accessible. To ensure accessibility to all stakeholder groups, suitable dissemination methodologies will be used to ensure that information is accessible to all. This will include the availability of hardcopy reports and translated summaries at public libraries serving the areas where stakeholders are located, postings on the web site, newspaper advertorials and direct e-mail messages to the entire stakeholder group.

6.5.2.3 Personal Contact

Personal contact of the manager of the process with the media normally also creates an environment where the media and other stakeholders have the freedom to make contact with the team to get news releases or to confirm facts about the assessment. The manager of the stakeholder participation process will arrange initial meetings with the local papers and agree on a methodology to release news about the assessment and to ensure that accurate information is published, especially when this may come from other sources which may have pre-determined agendas.

6.5.2.4 Pro-active communication

Poor communication from the Study Team may lead to the media scouting for news at the wrong places and it is necessary for the team to keep the media informed all the time. In this way they would have adequate and accurate information available for publication which will contribute to more effective dissemination of information and news about the study. Press releases will be issued by ORASACOM from time to time to ensure that the public is kept up to date with progress on the study.

6.5.2.5 Effective Reporting

Effective reporting forms the basis of keeping all stakeholders and the public informed about participation events and the results of these. To ensure effective reporting, the public participation manager will make all minutes of stakeholder engagement events available to the public and stakeholders through the various methods as described.

7 STAKEHOLDER ENGAGEMENT PLAN AND PROGRAMME

As stated before, various stakeholder groups have different concerns and different issues are likely to be of concern for each of the stakeholder groups. Different methods are therefore required to reach these various stakeholder groups and communicate with them effectively. This section provides a brief outline of the methods that will be used to reach the various stakeholder groups.

7.1 METHODOLOGIES TO ENSURE PARTICIPATION OF VARIOUS STAKEHOLDER GROUPS

7.1.1 Local communities

These communities reside in the project area and have particular requirements to ensure effective participation. Methods to be used to reach them include:

- Radio messages
- Local newspapers
- Surface mail
- E-mail
- Targeted distribution of hardcopies of the BID to places accessible to local communities
- Meeting at Vioolsdrift

7.1.2 Community Based Organisations (CBOs)

A number of community based organisations such as conservancies, and development organisations exist in the project area. They require slightly different methods of engagement and the following methods will be used:

- E-mail
- Surface mail
- Radio messages
- Local newspapers

7.1.3 Local and National Non-Governmental Organisations

The same strategy as for local CBOs will be followed to engage local NGOs namely:

- E-mail
- Surface mail
- Radio messages

- Local newspapers

7.1.4 International Organisations, Academic and Research Institutions and Individual Experts

These are generally sophisticated and electronic means can be used to involve and communicate with them. Methods to be employed will be:

- Posting information on the project web-site and keeping it up to date.
- Direct e-mails to contact persons within such organisations, especially those that have been involved in or has been critical to the previous assessment

7.1.5 The Governments of the Riparian States and its various Ministries, Local and Regional Authorities and Project Partners

The Study Team has a contractual responsibility to keep these stakeholder groups informed about all aspects of this project. The most direct link of the Study Team will be with ORASACOM. Other institutional bodies working with the river and its environment and line ministries will be involved through

- Posting information on the project web-site and keeping it up to date.
- Direct e-mails to contact persons within such organisations, especially those that have been involved in or are critical to the study.
- Meeting in Windhoek.

7.2 PROGRAMME FOR ENGAGEMENT OF STAKEHOLDERS

The programme overleaf provides a preliminary schedule for stakeholder engagement during the study.

Table 3: Stakeholder Engagement Programme

Activity	Dates	Description/attendants
Distribution of the BID		
Mail, e-mail, publish, distribute, the BID to all stakeholders.	February 2012	Distribute the BID to all individuals/organisations on the stakeholder database. Run advertisements and radio announcements about the study and describe where information will be available.
Stakeholder Consultation Meetings		
Arrange and invite local/regional stakeholders to the Meeting at Vioolsdrift using all the media as identified to reach this particular stakeholder group.	Approximately July 2013	To be attended by Local Communities, Local CBOs, Local NGOs, Mining Companies, Tourist Organisations, Local Governments, Regional Governments, Irrigation Farmers.
Arrange and invite institutional stakeholders to the Meeting in Windhoek using the means as identified to effectively reach this stakeholder group.	Approximately July 2013	To be attended by ORASECOM, ORMIMC, Environmental Ministries, Electricity utilities, Ministries of Agriculture, Water Utilities, Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee, Orange Fish Basin Management Committee, Catchment Management Agencies, Academic and research institutions, and United Nations and Bilateral Agencies.

Background Information Document:

Research Project on Environmental Flow Requirements of the Fish River and the Orange-Senqu River Mouth

Orange-Senqu River Basin

Orange-Senqu River Commission Secretariat: Governments of Botswana, Lesotho, Namibia and South Africa

NOTIFICATION OF A RESEARCH PROJECT ON ENVIRONMENTAL FLOW REQUIREMENTS OF THE FISH RIVER AND THE ORANGE SENQUE RIVER MOUTH.

This Background Information Document (BID) provides interested and affected parties with information on the study and invites them to participate in the stakeholder consultation process.

You are invited to register as an interested and affected party (I&AP). There will be additional opportunities in the future for you to participate and provide comments. See contact details at the end of the document.

PURPOSE OF THIS DOCUMENT

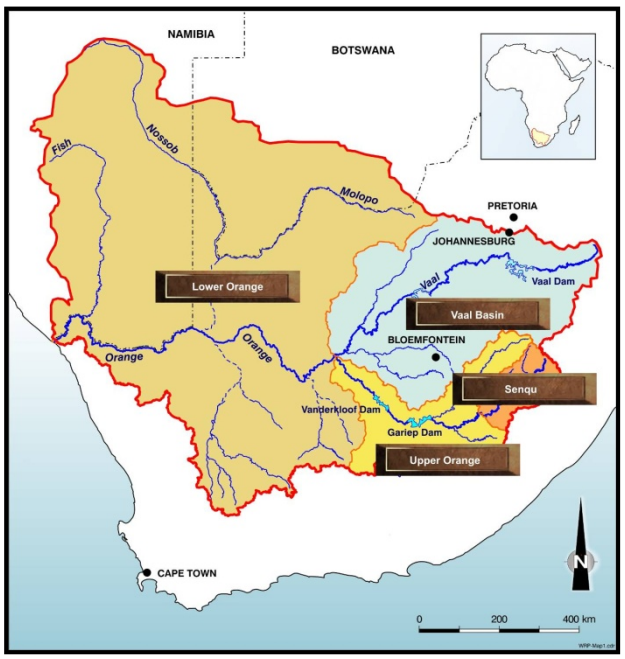
This Background Information Document (BID) provides initial information to Interested and Affected Parties (I&APs) and stakeholders about a research project on the Environmental Flow Requirements (EFR) for the Fish River and the Orange-Senqu River Mouth.

The aim is to allow for a conceptual understanding of the project and to allow for input into the process. An important element of the research project is the public participation process because it allows a range of stakeholders to engage in the project, provide valuable local information which may influence the project, and identify specific aspects that need to be addressed further in the study. By registering as an Interested and Affected Party (I&AP), you will be kept up to date on all developments in the process.

BACKGROUND

The Orange-Senqu Basin spans four southern African countries (Botswana, Lesotho, Namibia and South Africa) and is one of the largest river basins in southern Africa, covering an area of 985,000 km². Almost 59% of the basin falls within South Africa, 26% in Namibia, 12 % in Botswana and 3% in Lesotho.

The relatively scarce surface and groundwater resources in the Orange-Senqu Basin are critical for the sustainable social and economic development of each country. Existing patterns of land and water use have reached the point where great care is needed to ensure that the scarce and vulnerable water resources are not over-exploited.



An increasing awareness of this situation has led to the need for a co-ordinating body to advise on the management of the resources at a multi-national level. As such, on 3 November 2000 the Orange-Senqu River Commission (ORASECOM) was established between the four Basin States. The ORASECOM agreement reached in 2000 is the first multilateral basin-wide agreement between all four riparian states and the ORASECOM that was established by the agreement is seen as a major step towards international cooperation on matters relating to the utilisation and management of the Orange-Senqu River Basin.

ORASECOM promotes the equitable and sustainable development of the resources of the Orange-Senqu River and provides a forum for consultation and coordination between the riparian states to promote integrated water resources management and development within the basin. The highest body of ORASECOM is the Council with equal representation of all four basin states. This is supported by various Task Teams to manage projects, and a full-time Secretariat, based in Pretoria, South Africa. The overall goal of the ORASECOM Programme is to improve the environmental protection of the Orange–Senqu River Basin system through the promotion and implementation of water conservation and pollution prevention strategies and relevant priority projects. At the same time, the implementation of the programme should facilitate co-ordinated socio-economic development within the different communities of the four riparian states. The Programme has three objectives:

- Objective 1: Institutional Strengthening.
- Objective 2: Development of capacity building and integrated river basin management tools.
- Objective 3: Implementation of priority projects and development of water conservation and environmental strategies and policies.

The Programme is being implemented with the support of the Governments of the four basin states, Botswana, Lesotho, Namibia and South Africa and a number of international partners including the GIZ, DFID, EU, FGEF and GEF with this support ORASECOM regularly contracts consultancies to undertake priority work aimed at the achievement of these objectives.

In 2009, in preparation for the design and implementation of a basin wide IWRM plan, ORASECOM, with the support of GIZ, commissioned a study into the environmental flow requirements in the Orange–Senqu River Basin. This study was recently completed and has defined both the Present Ecological State (PES) and the environmental flows that would be required to maintain a range of ecological states at eight representative sites upstream from the confluence of the Fish and Orange Rivers.

Environmental Flow Requirements of the ephemeral but nevertheless significant Fish River, and the Orange River, from its confluence with the Fish River downstream to the Orange River mouth, were not covered in any detail by the completed GIZ study, during 2009-2010. This area is to be the subject of this Research Project. The importance of completing the Environmental Flow Requirements picture is becoming increasingly urgent due to the fact that two large dams, one in the Lower Orange (Vioolsdrift Dam) and one in the Lower Fish (Neckartal Dam), are at an advanced state of planning. Further to this, the Orange River Mouth Interim Management Committee (ORMIMC), a transboundary body comprising of the Environment Departments of Namibia and South Africa as well as other stakeholders, is now moving towards establishing a Management Plan for the Orange–Senqu River Mouth. ORMIMC sees this as an operational plan of three to five years duration, with prioritised discrete actions towards remediating the degradation of the Ramsar site and eventually getting it off the Montreux Record.

Rivers for Africa, e-Flows Consulting (PTY) LTD, has been appointed to undertake the study, with the requisite specialists required to deliver the work at the required levels of accuracy and quality incorporated into the team.

WHAT IS ENVIRONMENTAL FLOW REQUIREMENT (EFR)?

An Environmental Flow Requirement is the amount of water required within a river, wetland or coastal zone to **maintain ecosystems** and the **goods and services** derived from the system. It is closely related to the concept of Integrated Water Resources Management (IWRM) which promotes the co-ordinated development and management of water, land

and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Environmental Flow Requirements describe a flow or set of flows in a river, which are then linked to a description of the condition or health of the river that this flow supports. Ecological health is described in terms of the degree to which the ecology of the river has changed from reference (or natural) conditions. This is required because changes to natural flow regimes, for example following the construction of a dam, represent unnatural disturbances to river ecosystems. Flow regulation of a river, i.e. altering the natural flow variaility during the annual cycle, has an effect on the health of the river. These disturbances increase in severity as flow regimes become more altered. Responses of the ecosystem become more extreme as disturbance increases, and can take many forms. For instance, flows at a particular time of the year that trigger fish spawning or seed germination may occur at the wrong time of the year or not at all, resulting in the affected species perhaps failing to reproduce. Seasonal reversal of wet and dry season low flows could mean that hydraulic and thermal conditions become mismatched with life-cycle requirements, again causing species to decrease in numbers and abundance. Other species, sometimes including those regarded as pests (e.g. black flies), are able to take advantage of such environmental conditions, or the weakening of competition from the affected species, and increase in abundance. This can all negatively impact on the sustainable utilisation of the river with specific reference to the provision of Ecosystem Services (also referred to as Goods and Services)

The determination of Environmental Flow Requirements for rivers and streams has been carried out in North America for the past 50 years and has been used increasingly in South Africa for the past three decades. Lesotho, as one of the other basin countries, has also undertaken Environmental Flow Requirement studies. Earlier methods used elsewhere, applied statistical analysis of historic hydrological data to determine minimum flows for fisheries or other specified ecological features. Subsequent methods, including the ones used for this study, use a more holistic approach. These methods consider various components of whole river systems when advising on environmental flows. The methods typically

- Allow the flow requirements to be assessed for all major components of the riverine ecosystem (e.g., riparian vegetation; fish, channel form etc.);
- assess the flow requirements for several rivers;
- address both water quality (volume) and quantity requirements for the rivers;

- allow several potential flow regimes to be described, each with its predicted consequences (i.e., a scenario-based approach);
- incorporate a comprehensive and structured socio-economic component.

Ultimately, Environmental Flow Requirements exercises are carried out to better understand what changes may occur, how these will affect the river and to design mechanisms to mitigate the potential impacts of river flow alterations on river dependant ecosystems. Management and mitigation is usually recommended to occur in one, or a combination, of three ways.

- By reserving some water for ecosystem maintenance - in general, the closer to natural the desired condition of the river, the greater the volume of the flow regime required for the environmental maintenance of this condition.
- By ensuring that the reserved water is made available to the ecosystem at the times when it is most appropriate for river maintenance - for instance, if large floods are needed in a river to maintain beaches and backwaters, or small floods to stimulate fish spawning, then the recommended flows would stipulate the magnitude, duration, timing and frequency of the required floods.
- By defining water quality, physical habitat and biotic communities that characterise specific river conditions - in this manner, the environmental flows would be linked to measurable goals that can be used to assess (through monitoring) whether the desired river condition is being achieved.

WHAT ARE THE OBJECTIVES OF THIS STUDY?

The main objectives of this study is to assess Environmental Flow Requirements (EFR) at selected key sites in the Orange-Senqu River Basin downstream from the confluence with the Fish River, at the Orange River Mouth and in the ephemeral Fish River. Using holistic methods, the following main tasks to be carried out are relevant for this study:

- Focus on the Fish River and the Orange-Senqu River downstream of its confluence with the Fish River including a particular focus on the Orange-Senqu River Mouth.
- Engage stakeholders.
- Select representative sites. These will be upstream and downstream of the proposed Neckartal Dam on the Fish River. For the Orange River, representative sites would be selected on the Orange River upstream of the estuary as well as within the estuary itself.
- Research and assess non-flow related impacts.
- Describe the Present Ecological State.
- Define (at the “intermediate” level of detail, where applicable) environmental flows that would be required to maintain a range of ecological states at the representative sites.

- Recommend attainable and satisfactory environmental flows for application.
- Develop and implement a baseline monitoring programme covering flow-related biophysical parameters. The monitoring programme shall cover a wide range of flow conditions in preferably two full hydrological cycles.
- Design a long-term monitoring programme to assess the efficacy of environmental flows and other management interventions.
- Document monitoring results in an environmental flow database.
- Cooperate with, and provide specific inputs to related projects, namely the Vioolsdrift and Neckartal Dam projects, as well as the Orange-Senqu River Mouth Management Plan.

The following variables will be rated in terms of Water Resource Use and the analysis of importance of the water resources:

- Current water balance of catchment contributing flow to the river reach;
- utilization of the river reach for operational purposes;
- likely future developments and/or water use expected in the catchment;
- water quality related problems, and assimilative capacity.

Of importance to stakeholders is the examination of the Ecosystem Services provided by the system. Environmental resources (or Goods and Services) is a term used to describe those uses and values that people and/or society derive from the environmental processes in an area. Practitioners typically divide these resources into several groups, depending on how they serve communities and individuals. These uses and values of the environmental resources can be both direct, such as food, water etc., or indirect as with cultural heritage, sites of worship etc. The uses and values sometimes easily translate into monetary values through various valuation tools, but sometimes the values are more of the existence or inherent types, and are impossible or at least very difficult to translate into monetary terms.

Changes in a river system, such as dam and reservoir construction, irrigation-water abstractions etc., will inevitably change the nature of the river and, therefore, also the environmental resources that people can derive from the river. Some services might be improved by the changes, and some may be negatively affected, or even lost entirely.

WHEN WILL THIS STUDY BE DONE?

The study commenced during December 2011 and is expected to be completed by September 2013. A large number of technical studies are required and these will commence during January 2012.

WHY IS STAKEHOLDER PARTICIPATION IMPORTANT?

The determination of the value of Ecosystem Services that exist in a river catchment and the determination of the most suitable EFR scenarios is an exercise that needs thorough consultation with stakeholders at all levels of society. The key stakeholders for this study have been identified and divided into two stakeholder groups as follows:

Institutional Stakeholder Group	Local Stakeholder Group
Orange – Senqu River Commission (ORASECOM)	Local Communities
Orange River Mouth Interim Management Committee (ORMIMC)	Local CBOs
Environmental Ministries of the Riparian States	Local NGOs
Electricity utilities of the Riparian States	Mining Companies
Ministries of Agriculture of the Riparian States	Tourist Organisations
Water Utilities of the Riparian States	Local Governments
Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee (ARTPJMB)	Regional Governments
Orange Fish Basin Management Committee (OFBMC)	Irrigation Farmers
Catchment Management Agencies (CMAs)	
Academic and research institutions	
United Nations and Bilateral Agencies	

Local Stakeholders are normally the ones who are dependent on the Ecosystem Services provided by the system. Environmental resources are used, amongst others, for livelihood purposes, economic activities, utility services, or cultural and heritage purposes. At the same time, socio-economic activities also impact on the environmental health of the system through impacts such as water consumption, water return, leaching from irrigation activities, and tourism activities. It is therefore important that the interests of local stakeholder groups are duly considered in order to arrive at realistic EFRs which do not only satisfy environmental requirements but also allow for the social and economic activities supported by the river systems.

Institutional stakeholders on the other hand are mostly the custodians of the systems with an interest in ensuring that the integrity and health of the ecological systems are ensured while still allowing for socio-economic activities and development. It is therefore extremely important that both these stakeholder groups are consulted in the process of determining

the EFRs and the resultant flow regimes to be implemented and enforced by the concerned governments.

HOW WILL STAKEHOLDERS BE INVOLVED?

The aim of the stakeholder participation process and communication strategy is to inform key parties, who are either affected or may be interested, about the environmental flows and subsequent demand and to enable stakeholders to provide input and comment at key milestones. This Background Information Document is the first step in the participation process.

The study team prepared a comprehensive stakeholder list. During February and March 2012, information about the study will be distributed to all stakeholders. Distribution will be via e-mail, surface mail, articles in local newspapers, radio messages, placing of documents at places accessible to local communities, placing in the ORASECOM Newsletter and posting on the ORASECOM Web Page (www.orasecom.org).

Stakeholders are invited to provide written responses to this document and to request additional information if so desired.

Following the completion of the various specialist studies, a number of EFR scenarios will be developed. These will need to be assessed in consultation with the two stakeholder groups. To achieve this, two separate stakeholder consultation events will be hosted by the study team. The first of these, targeted at local stakeholders, will take place at Vioolsdrift in mid 2013. Groups that will be invited to this meeting will include Local Communities, local CBOs, local NGOs, Mining Companies, Tourist Organisations, Local Governments, Regional Governments and Irrigation Farmers.

The second will take place in Windhoek directly after the first meeting. It is envisaged that this meeting will be attended by ORASECOM, ORMIMC, Environmental Ministries, Electricity utilities, Ministries of Agriculture, Water Utilities, Ai Ais-Richtersveld Trans-frontier Park Joint Management Committee, Orange Fish Basin Management Committee, Catchment Management Agencies, Academic and research institutions, and United Nations and Bilateral Agencies.

The precise nature and timing of these meetings will be made known to stakeholders as the project progresses. It should be noted that this study only concentrates on certain parts of the river and as such while comments from all stakeholders are welcome, the public

participation process is designed to cover the area downstream from Vioolsdrift as well as the Fish River, downstream from the proposed Neckartal Dam project.

For the purposes of comment the following contact details are provided:

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