SECTION 12 : RECOMMENDED FURTHER INVESTIGATIONS

12.1 INTRODUCTION

The need for further investigations during the detailed feasibility study was identified during this pre-feasibility study. The additional studies include:

- Initiating a full 15 month sediment sampling programme in the event that the sluicing option is pursued,
- Detailed geotechnical survey of the preferred weir sites as well as potential quarry sites,
- Model testing of sediment bypass system,
- Model testing of proposed sediment sluicing method if this method is pursued,
- Detailed design work at the preferred site, and
- Full Environmental Impact Assessment.

12.2 SEDIMENT SAMPLING

The sediment sampling undertaken during this phase of the study cannot be considered to be representative of the average sediment movement over a long period of time. Although it is accepted that a meaningful sediment sampling programme should preferably extend over a full 5 year period with samples taken daily, time constraints limit the sampling programme to that which can be achieved during the feasibility study stage.

It is therefore proposed that both suspended sediment, as well as bedload sediment, be sampled during this period. In the case of suspended sediment, it is proposed that the pump method be used and that each sample should not be less than 100 litres. The process to be followed shall be similar to that used in the June 2003 sampling trip at Divundu (see **Section 4.4.2)**. It is furthermore proposed that samples be taken on a fortnightly basis particularly during the high flow period, at three locations across the river and at depth increments of one metre from the surface down to a point 200 mm above the river bed.

It is furthermore proposed that a reliable person be identified who lives and works in the area, who would be willing to carry out the sampling to reduce the costs.

In the case of bedload sampling, it is recognised that long term results have been obtained using the Helley-Smith sampler albeit in the Okavango Delta rather than in the river at Divundu. Correlation between different methods would be highly beneficial to support long term estimates of sediment transport. The Side Scan Bathymetric survey system was successful in identifying the dune forms during the measurements taken in April 2003, and it is therefore recommended that the Side-scan Sonar and Bathymetric Survey be used, as in the

case in April 2003 at Divundu, for the additional bed load sampling programme during the feasibility study. These results will then be correlated with the earlier bed load surveys undertaken in previous studies on the Okavango with the aim of establishing the best estimate of the variation of sediment transport that would need to be incorporated into the final design. This method is unfortunately costly and it is therefore recommended that only 6 surveys be carried out over a 15 month period at intervals of 3 months with one set of measurements coinciding with the flood peak.

To minimise extrapolation effects, it is recommended that a site be selected where the channel is uniform and in which no rock outcrops occur. It is also recommended that the services of the owner of Shamvura Centre on the Okavango River, Mr Mark Paxton, who was involved on the two sampling programmes undertaken in April and May 2003, be recruited to oversee the proposed sampling programme. It would therefore be beneficial if a suitable section of the river be identified close to his Centre.

Whilst the results of the proposed surveys will still only provide an indication of the variation in sediment movement (bed and suspended), rather than a long term average, they would be beneficial for the model tests to determine the effectiveness of sluicing if that option is chosen.

Although the results of the proposed sediment sampling surveys will be of great value, not only for the determination of the sluicing procedures, but also for the design of the proposed sediment bypass, it is recommended that the necessity as to whether to proceed with such costly surveys, be discussed and determined when the detailed feasibility study phase commences.

12.3 GEOTECHNICAL INVESTIGATION

It is necessary to carry out detailed geotechnical site investigations at each of the preferred weir sites in order to determine founding conditions and to identify suitable quarry sites and borrow pits. This work will include core drilling and water pressure tests. The results of this work will enable the Consultant to prepare accurate preliminary designs and cost estimates of the final preferred option.

12.4 MODELLING OF SEDIMENT REMOVAL METHODS

12.4.1 SLUICING

If it is found that the sediment by-pass system will not function satisfactorily, it is proposed to carry out model testing of the proposed sluicing method.

Model testing is absolutely essential to determine the effectiveness of sluicing and flushing. In this process, the spillway gate action will be modelled as well as sediment movement within the basin and the effects of sediment deposition and erosion downstream. The model tests will show the behaviour of the bedload as well as the suspended sediment as it enters the

basin and the rate at which the sediments settle out. Sluicing and flushing will be modelled to establish the rate at which the sediments are removed and how much of the sediment is removed. The model tests will also show the magnitude of erosion downstream by sediment-deficient water during normal operation of the weir, and the patterns of deposition and movement of sediment downstream of the weir during sluicing operations. It is proposed that the model tests be carried out at the University of Stellenbosch under the guidance of Prof. Albert Rooseboom.

12.4.2 SEDIMENT BYPASS PUMPING

Model tests will need to be carried out of the proposed sediment trap to determine its dimensions which would ensure that the sediment is trapped and that it is conveyed along the trap towards the suction well of the pump station. It will also be necessary to model the way in which the pumped sediments are discharged at the downstream side of the weir and the depositional patterns that might develop.

12.5 ENVIRONMENTAL ASSESSMENT

On the basis of the Preliminary Environmental Assessment (PEA) carried out as part of this pre-feasibility study, there is insufficient information available to permit a conclusion to be made on the environmental acceptability of the project. Therefore it is recommended that a full Environmental Assessment should be carried out in the detailed Feasibility Study phase, with emphasis on the following:

- Sediment transport and the impact of the proposed methods of moving sediment through or around the weir,
- A detailed assessment of the preferred weir site and the FSL,
- A detailed assessment of the operation of the power station and associated structures,
- A detailed assessment of the minimum flow requirements,
- A detailed assessment of the downstream ecology of the Okavango River and its wetlands,
- An environmental assessment of the sites required for construction materials,
- A route selection study for the transmission line,
- An archaeological and cultural resources survey,
- A detailed socio-economic assessment of the project on the local community, the regional economy in Namibia and the tourism industry of Botswana,
- An assessment of the synergistic and cumulative impacts that may result from the presence of the Popa Falls power station.

If the project is ultimately approved, it will also be necessary to draw up a detailed Environmental Management Plan (EMP) for the construction and operational phases of the project. Indeed it is likely that the approval by the Ministry of Environment and Tourism would be contingent upon the development of a comprehensive EMP and the auditing thereof.

12.6 DETAILED DESIGN

The feasibility stage will include the preparation of a detailed design for the recommended preferred scheme. During the feasibility stage, there will be interaction between the Technical team and the Environmental team in order to incorporate the necessary mitigation measures as the potential impacts are better evaluated as part of the more detailed Environmental Impact Assessment. Furthermore, the results of the model tests and geological investigations will have to be available prior to finalising the design. The design will be modified to take into account the results of these studies in the most cost effective way in order to achieve the most beneficial scheme at the same time as minimising impacts.

12.7 PROPOSED WORK PROGRAMME

The proposed sequence of carrying out these investigations is as follows:

- The sediment sampling survey should commence as soon as possible after approval has been obtained for the detailed feasibility study to proceed. This work can proceed independently of all other investigations. In the event that the sediment bypass option has been shown to be a workable option, then all further sediment sampling can be stopped.

- Detailed geotechnical investigations should also commence as soon as possible after the start of the feasibility study. The results of these investigations will show which of the three preferred sites, if any, are not suited for the construction of a weir for reasons of inherent fault zones, and poor founding conditions, etc.

- Model testing of the sediment bypass system can proceed as soon as the results of the geotechnical investigations are available and the preferred site has been identified thereby limiting the number of tests that have to be carried out.

- Although it would be advisable to carry out model tests of the sluicing and flushing procedures only after the preferred weir site has been identified, time constraints may require that the test be carried out for Site 5, which is the preferred site at this juncture. It is therefore proposed that the geotechnical investigations commence at Site 5.