REPORT NO.: P 02/B810/00/0608/02 Annexure M

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment Report (DEAT Ref No: 12/12/20/978)

Annexure M: Sedimentation Impact Assessment

MARCH 2010

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DECLARATION OF INDEPENDEANCE

Mr Gerrit Basson of ASP Technology (Pty) Ltd., is an independent consultant to ILISO Consulting (Pty) Ltd (for the Department of Water Affairs and Forestry), i.e. he has no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work

REPORT DETAILS PAGE

Project name:	***Groot Letaba River Development Project***
Report Title:	***Environmental Impact Assessment Annexure M: Sedimentation Specialist Study***
Author:	***ASP Technology (Pty) Ltd.***
DWAF report reference no.:	***P 02/B810/00/0708/Volume 2 Annexure M***
ASP Technology (Pty) Ltd.reference no.:	***Groot Letaba EIA Sedimentation***
Status of report:	***Final***
First issue:	***November 2008***
Final issue:	***March 2009***

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EXECUTIVE SUMMARY

Prof GR Basson of ASP Technology (Pty) Ltd was appointed during 2008 to assess the possible impacts of the proposed water resources developments in the Groot Letaba basin on the sediment transport balance in the river system. This report forms part of the EIA to investigate the environmental feasibility of raising Tzaneen Dam, the construction of the proposed Nwamitwa Dam on the Groot Letaba River and associated water infrastructure (water treatment, pipelines, pumpstation, off-takes and reservoirs) in the Limpopo Province.

Field work was carried out to obtain river bed sediment samples and a hydrodynamic model was used to investigate the sediment balance in the Groot Letaba River.

The key findings are:

a) Downstream of Nwamitwa Dam:

- *The dam will cause flood peak attenuation (reduced flood peaks) by about 7 % for large floods (3000 m^3/s), but more for smaller floods: 30 % attenuation for a 1600 m^3/s flood peak and 70 % attenuation for a 270 m^3/s flood peak.*
- *The post-dam river will become narrower due to flood attenuation caused by the dam. Near the dam the main channel width could decrease by 19 % (22 m reduction on 116 m). In the KNP upstream of the Olifants River confluence the reduction of channel width could be about 17 % (70 m on 411 m channel width).*
- *The river bed between the dam and the Klein Letaba River tributary will become coarser due to sediment trapping at the dam: from 0.56 mm median diameter to 0.72 mm median sediment diameter.*
- *Slightly more sediment will be transported down the river in the post-dam scenario due to the narrower river and local bed degradation on the Klein Letaba River near the confluence with the Groot Letaba River.*
- *Local bed degradation (lower bed level) near the dam of at least 2 m is expected.*

b) Upstream of Nwamitwa Dam

The estimated sediment deposition volume in Nwamitwa Reservoir over a 50 year period is 17.5 million m^3 which is relatively small compared to the reservoir storage (1.2 MAR = 187 million m^3) . Deposition of sediment above full supply level has to be

considered in the detailed design and floodline analysis of the reservoir as it would affect flood levels.

c) Flow gauging station downstream of Nwamitwa Dam

The weir downstream of the dam will have a negligible impact on the flow and sediment balance of the river.

d) Tzaneen Dam raising

Small floods will be attenuated more and it is expected that the main channel width downstream of the dam to the first main tributary could decrease by less than 5 % of the current width. The river morphology downstream of Tzaneen Dam is not expected to change significantly.

Elevated flood levels upstream of the reservoir could be expected due to future sedimentation above the raised full supply level. This has to be considered in the floodline assessment.

e) Relocation of roads and proposed dam access roads

As long as the relocated roads and access roads are designed based on the guidelines of the NRA Road Drainage Manual (2007), no significant problems are foreseen in term of sedimentation.

f) Construction aspects related to Nwamitwa Dam

The coffer dam should be designed not to cause river bank erosion or local scour at the dam site. The sediment concentrations 300 m downstream of the dam site should be monitored during construction to ensure present (90 percentile) high sediment concentrations are not exceeded as proposed in Table 12-1.

g) Treatment plant and water reticulation pipelines

The upgrading of the treatment plant and construction of water reticulation pipelines should have limited effect on sedimentation as long as proper stormwater drainage is designed at river crossings and during construction the present stream sediment concentrations based on 90 percentile values should not be exceeded. If required sedimentation basins should be constructed on site.

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ABBREVIATIONS

DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
GLeWaP	Groot Letaba River Water Development Project
MAR	Mean annual runoff
PSP	Professional Service Provider

1. INTRODUCTION

The Department of Water Affairs and Forestry (DWAF) is currently undertaking an Environmental Impact Assessment (EIA) to investigate the environmental feasibility of raising Tzaneen Dam, the construction of a storage dam on the Groot Letaba River and associated bulk water infrastructure (water treatment, pipelines, pump stations, off-takes and reservoirs) in the Limpopo Province.

The project will comprise of the following components:

- The raising of the Tzaneen Dam;
- A new dam at the site known as Nwamitwa;
- A flow gauging weir just downstream of the Nwamitwa Dam;
- Associated relocation of roads at Nwamitwa Dam;
- Access roads to the Nwamitwa Dam;
- Upgrading of the existing Water Treatment Works just north of the Nwamitwa Dam;
- Water reticulation pipelines inclusive of appurtenant infrastructure, namely pump stations and reservoirs.

Prof GR Basson of ASP Technology (Pty) Ltd was appointed during 2008 to assess the possible impacts of the proposed water resources developments in the Groot Letaba River basin on the sediment transport balance in the river.

The proposed Nwamitwa Dam on the Groot Letaba River could have a storage capacity of 1 to 1.5 times the mean annual runoff (MAR). The dam would trap most of the incoming sediment load. Sedimentation would also occur above full supply level in the upper reaches of the reservoir which would raise flood levels.

While the dam wall would only be about 30 m high, the over-year storage capacity could lead to reduced flood peaks (flood attenuation) downstream of the dam. Due to the size of the reservoir, almost all of the sediment load entering the reservoir would be trapped in the reservoir. Flow released from the dam would therefore be relatively free of sediment which could lead to local bed degradation near the dam. Further downstream more sediment deposition in the river is expected downstream of tributaries since flood peaks will be attenuated by the dam.

Both upstream and downstream impacts of the proposed dam on sediment transport, deposition and erosion are discussed in more detail in this report. Other project components listed above and their possible impacts on sedimentation are also discussed.

2. METHODOLOGY TO ASSESS DOWNSTREAM RIVER MORPHOLOGICAL IMPACTS OF THE NWAMITWA DAM ON THE GROOT LETABA RIVER

A one-dimensional hydrodynamic mathematical model was used to assess possible fluvial morphological changes downstream of the proposed dam. For the pre-dam scenario the river was setup from the dam site to inside the Kruger National Park (KNP), upstream of the Olifants River confluence. Tributaries downstream of the dam were combined into one tributary entering the Groot Letaba at the location of the Klein Letaba River. Cross-sectional data of the river was obtained from 1:50000 maps and satellite images.

Sediment input in the model of sand fractions were calculated based on the sediment transport capacity at the boundaries (main channel and tributary).

The inflow record at the dam site was scaled from data at gauging station B8H017. The tributary flow record was generated by subtracting flow records of gauging station B8H018 in the KNP and the flow at the dam site, considering the lag. The inflow records into the model at the dam site and at the tributary are shown in **Figures 2.1** and **Figure 2.2.**

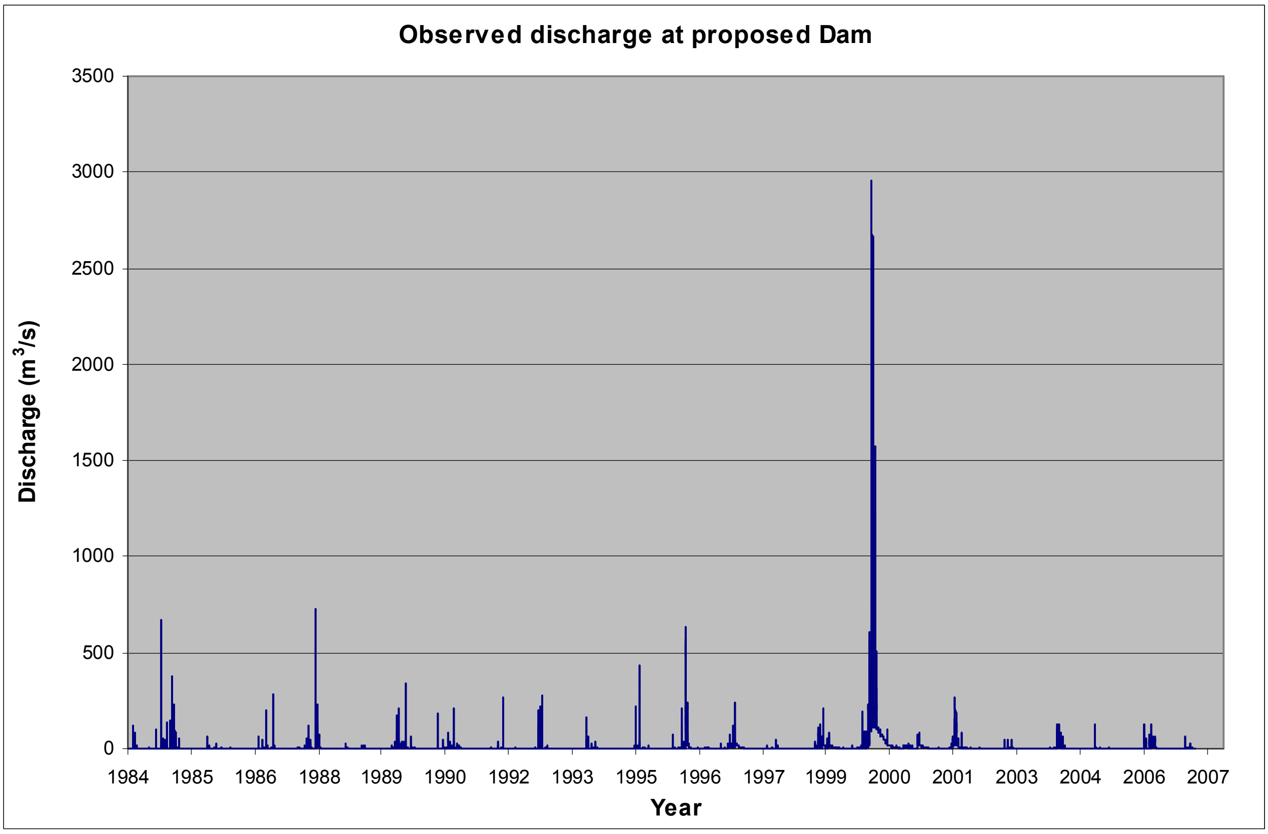

Figure 2.1: Generated inflow record at dam site

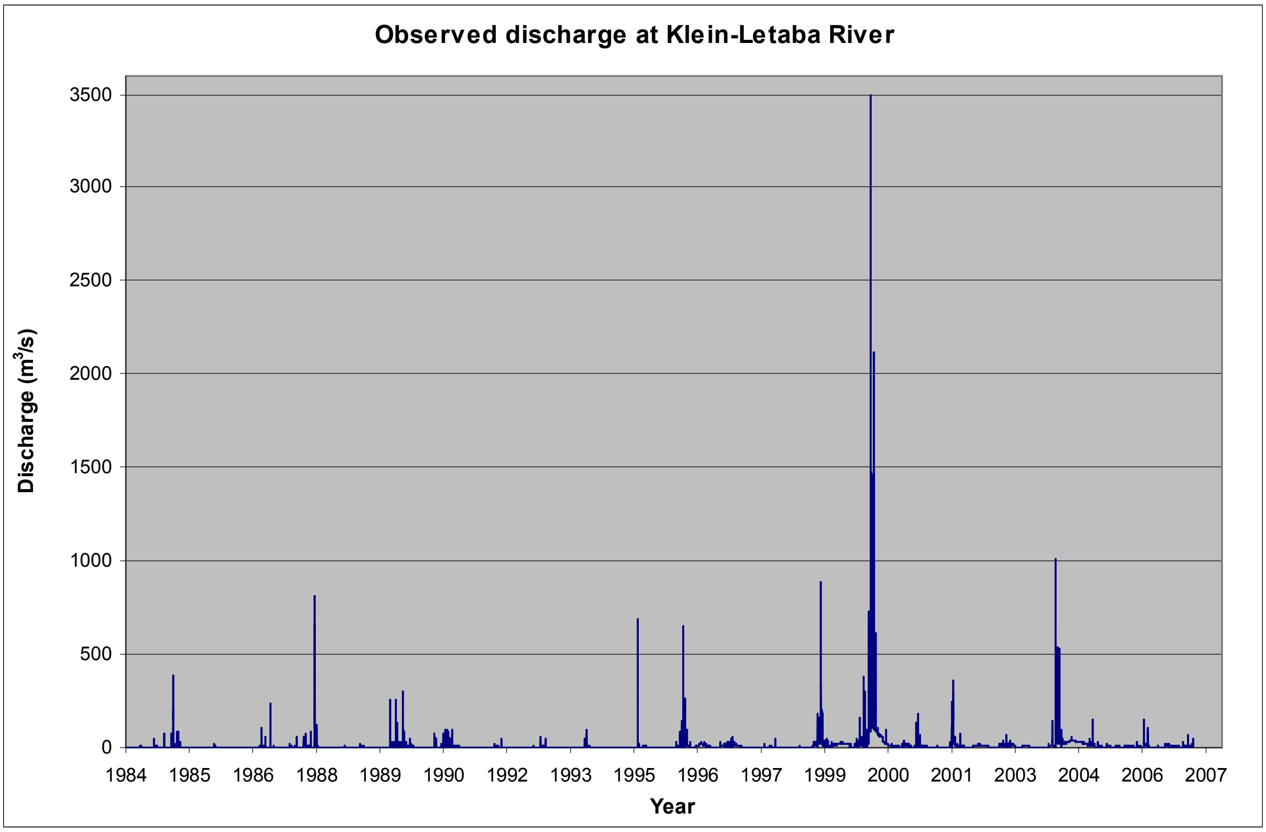

Figure 2.2: Generated inflow record at combined tributaries (Klein Letaba)

The large flood of 2000 was included in the flow record. During this flood the flow gauging stations were washed away in many cases. At the dam site the year 2000 flood peak was reconstructed by extrapolation of the discharge table based on observed water levels. The Probable Maximum Flood (PMF) and Regional Maximum Flood (RMF) at the dam site are in the order of 13000 m^3/s (routed through the dam) and 6500 m^3/s (not routed) respectively (Ninham Shand, 2008).

In the post-dam scenario in this study the effect of the proposed dam was analysed by routing the flow record (**Figure 2.1**) through the dam, with a spillway length of 190 m and assuming a 1.5 MAR storage capacity with a spillway crest level at 486 masl (Ninham Shand, 2008). For this scenario it was assumed all the sediment would be trapped in the reservoir.

3. FIELD WORK

Sediment samples were taken from the Groot Letaba River and grading analyses were carried out on four samples. The samples were taken at the Letaba-Mopani (Road H1-6) and Phalaborwa-Mopani (Road H14) bridges in the KNP, and near the R71 Road Bridge near the proposed dam site. The grading analysis results are shown in **Table 3.1** and graphically in **Figure 3.1**.

Table 3.1: Grading analysis of Groot Letaba River bed samples (cumulative % passing sieve)

Sample No.	<0.075mm (%)	<0.15mm (%)	<0.3mm (%)	<0.6mm (%)	<1.18mm (%)	<2.36mm (%)	<4.75mm (%)	<9.5mm (%)
1	0.2	0.5	2.3	37.0	91.6	99.3	100.0	100.0
2	3.4	10.1	59.2	98.7	100.0	100.0	100.0	100.0
3	0.4	0.8	8.2	68.5	93.9	98.6	99.8	100.0
4	0.3	1.0	9.4	58.9	94.3	98.5	100.0	100.0

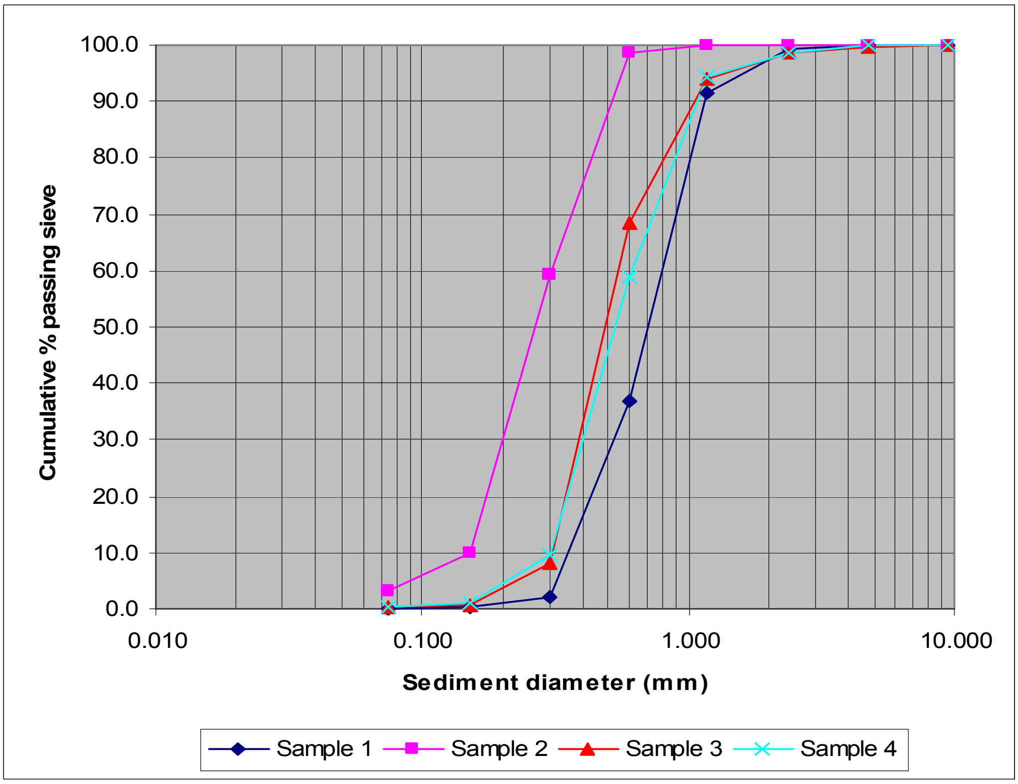

Figure 3.1: Sediment grading analysis of the Groot Letaba River bed sediment

The median sediment sizes of the 3 samples taken range from 0.25 mm to 0.7 mm, which is typical of South African sand bedded rivers. The range of sediment sizes sampled in the bed was generally smaller than 2 mm, with very little silt and clay (< 0.065 mm). Sample 1 was taken at the Road H14 bridge which could have caused flow constriction and local scour during floods leading to a larger median sediment size compared to further downstream near Letaba Camp on the same river. Samples 2 and 3 were taken from the bridge north of the Letaba Camp in the KNP (Road H1-6). Sample 2 was finer than sample 3 due to the river bend effect with higher velocities and sediment transport capacity near the outside of the bend (sample 3) compared to the middle of the river (sample 2). Sample 4 was obtained near the R71 bridge near the dam site and is similar in grading to sample 3.

4. DESCRIPTION OF RIVER

The river has a sandy bed and varies in width from about 100 m at the dam site to about 300 m in the KNP. **Figures 4.1** to **4.7** show more details of the river in and outside the KNP. In most cases the river banks are densely vegetated. There are several existing weirs on the river but their impact on the flow and sediment balance is expected to be small.

Figure 4.1: Downstream view of Groot Letaba River on R71 road near the proposed dam site

Figure 4.2: Upstream view of Groot Letaba River on near Malotsi River tributary

Figure 4.3: Downstream view of Groot Letaba River at Road H14 bridge in KNP

Figure 4.4: Upstream view of Groot Letaba River from Road H1-6 bridge in KNP

Figure 4.5: Groot Letaba River at Letaba Camp in KNP viewed from right bank

Figure 4.6: Groot Letaba River between Letaba and Olifants Camp in KNP with bedrock reach viewed from right bank

Figure 4.7: Groot Letaba River near Olifants River with wide sand bedded main channel viewed from right bank

5. SIMULATION RESULTS: IMPACTS OF THE PROPOSED DAM ON THE DOWNSTREAM FLOODS

The pre- and post-dam scenarios immediately downstream of the dam are shown in **Figure 5.1** and **5.2**. The flood peak is attenuated (reduced peak discharge) by only about 7 % due to the dam during a large flood such as in year 2000, but for smaller floods the attenuation (decrease in peak discharge) is 30 % (**Figure 5.1**) to 70 % (**Figure 5.2**).

Figure 5.3 shows the simulated long flow record immediately downstream of the dam. This graph should be compared to the pre-dam condition at the dam site (**Figure 2.1**).

Figure 5.4 shows the flow series simulated in the KNP. The tributary inflow upstream of this point (**Figure 2.2**) has cancelled out to a large extent the effect of the proposed dam (**Figure 5.5**).

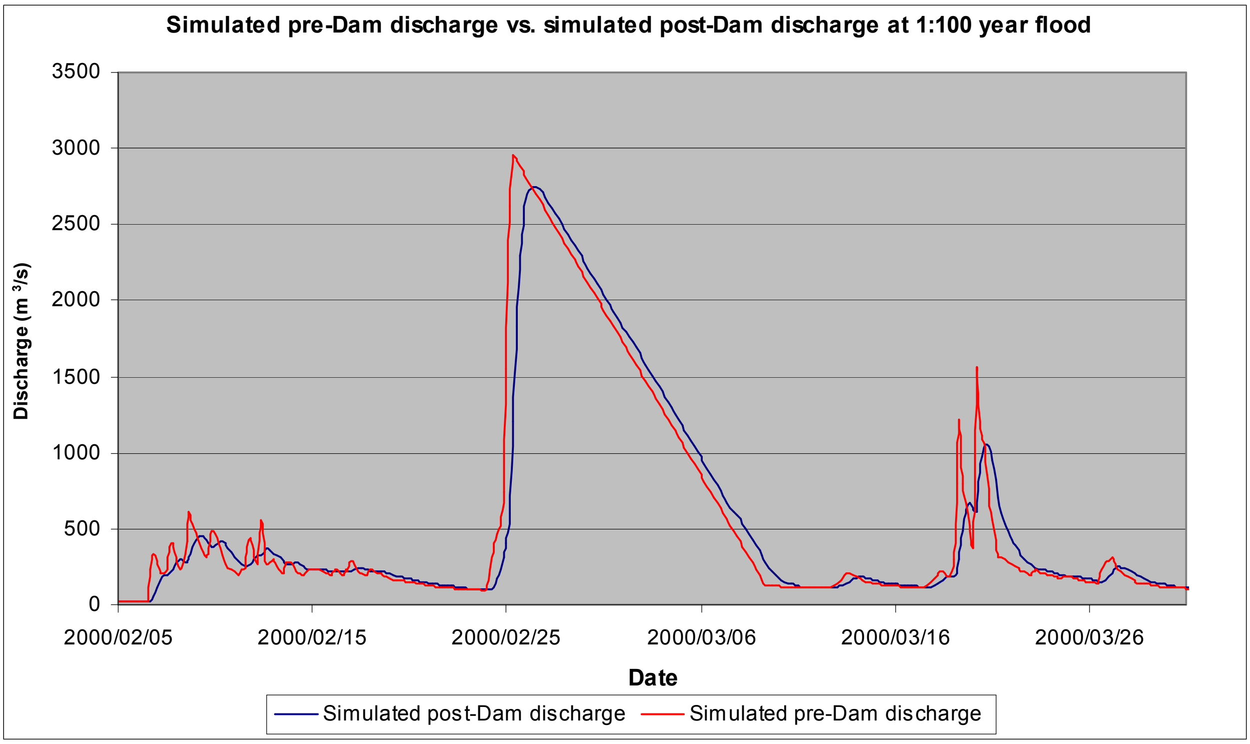

Figure 5.1: Simulated pre- and post dam large flood attenuation caused by the dam immediately downstream of the dam

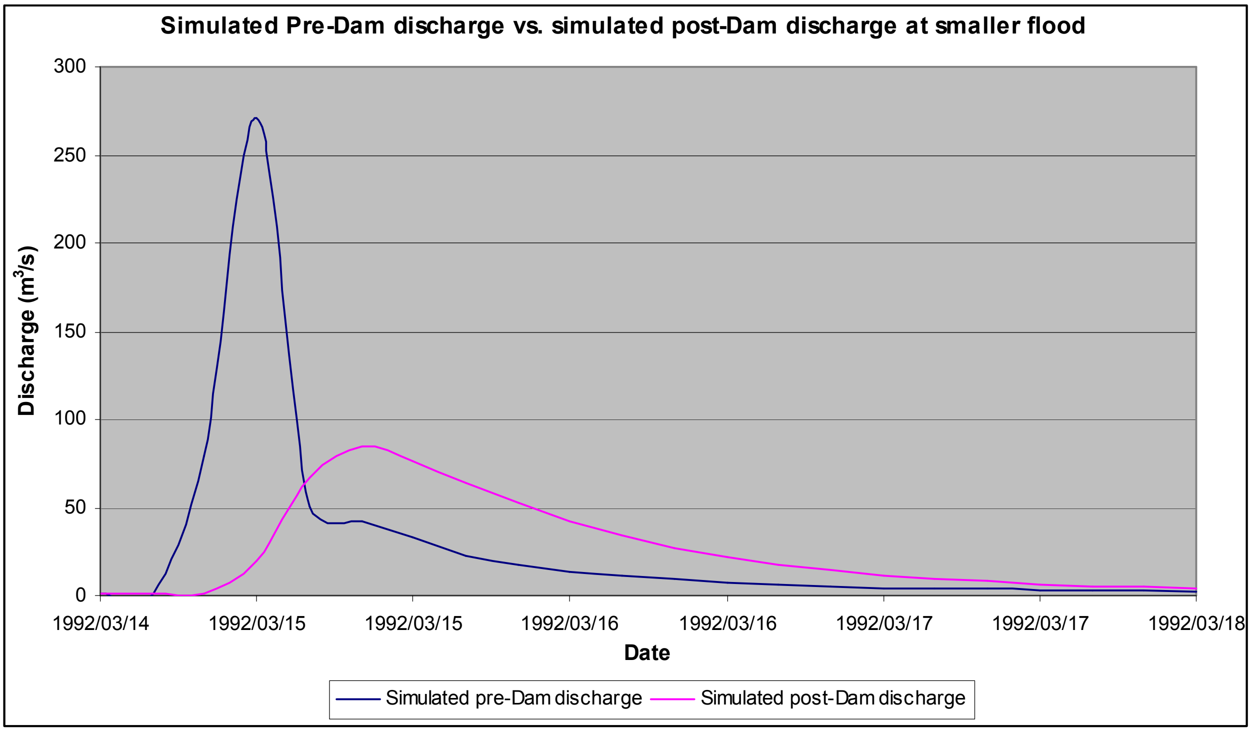

Figure 5.2: Simulated pre- and post dam small flood attenuation caused by the dam immediately downstream of the dam

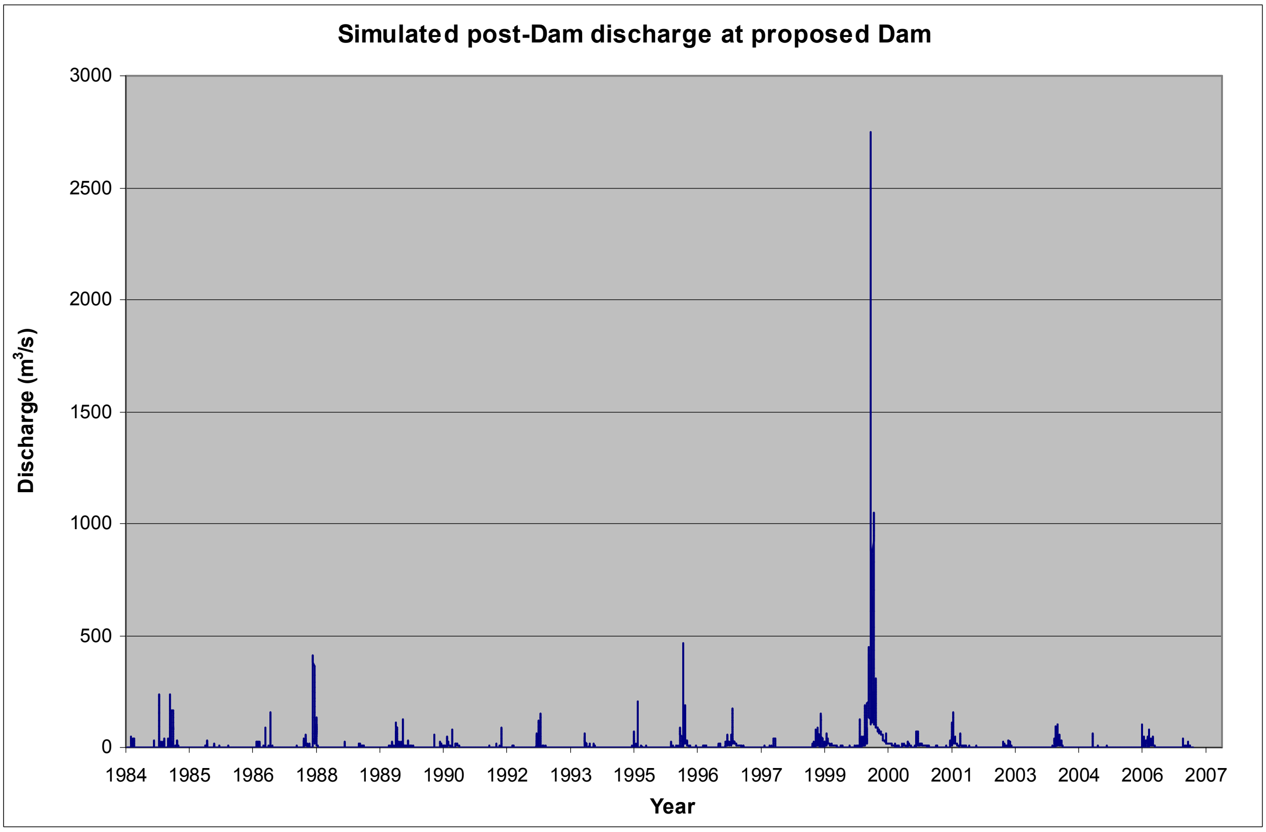

Figure 5.3: Simulated post-dam discharge at proposed dam

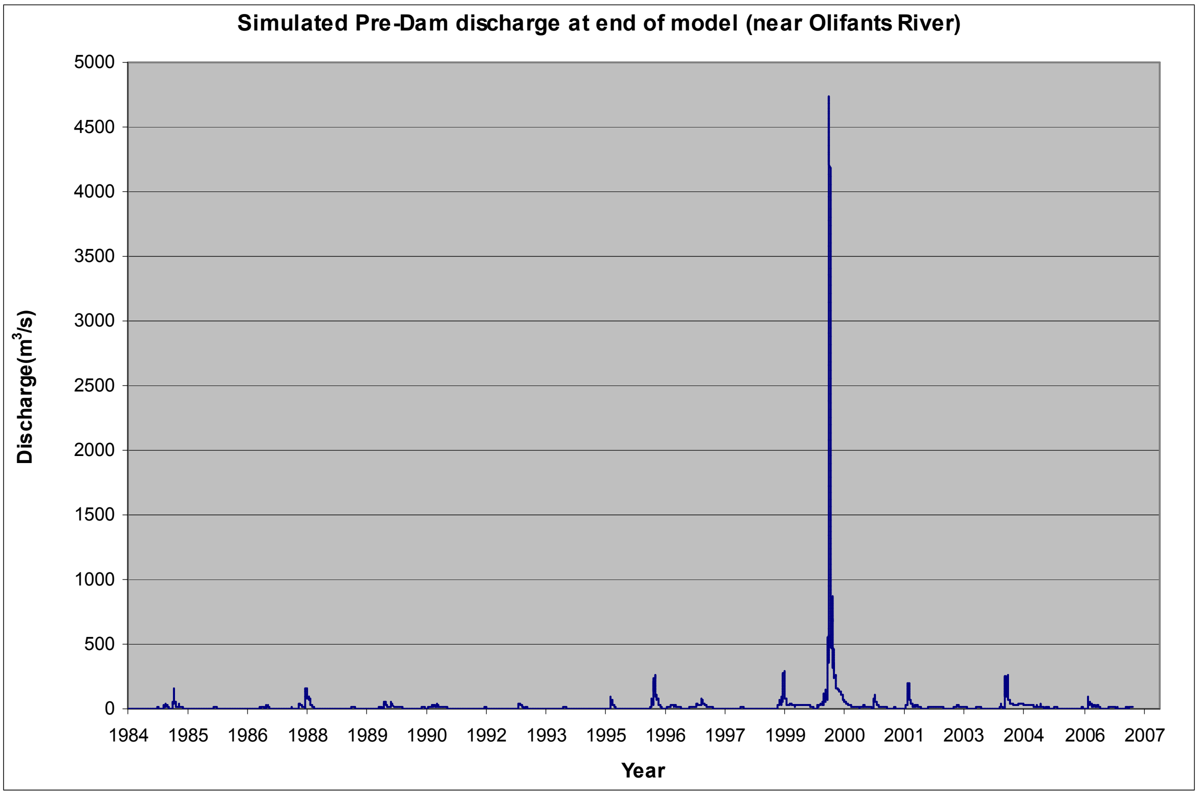

Figure 5.4: Simulated Pre-Dam discharge at downstream end of model (near Olifants River)

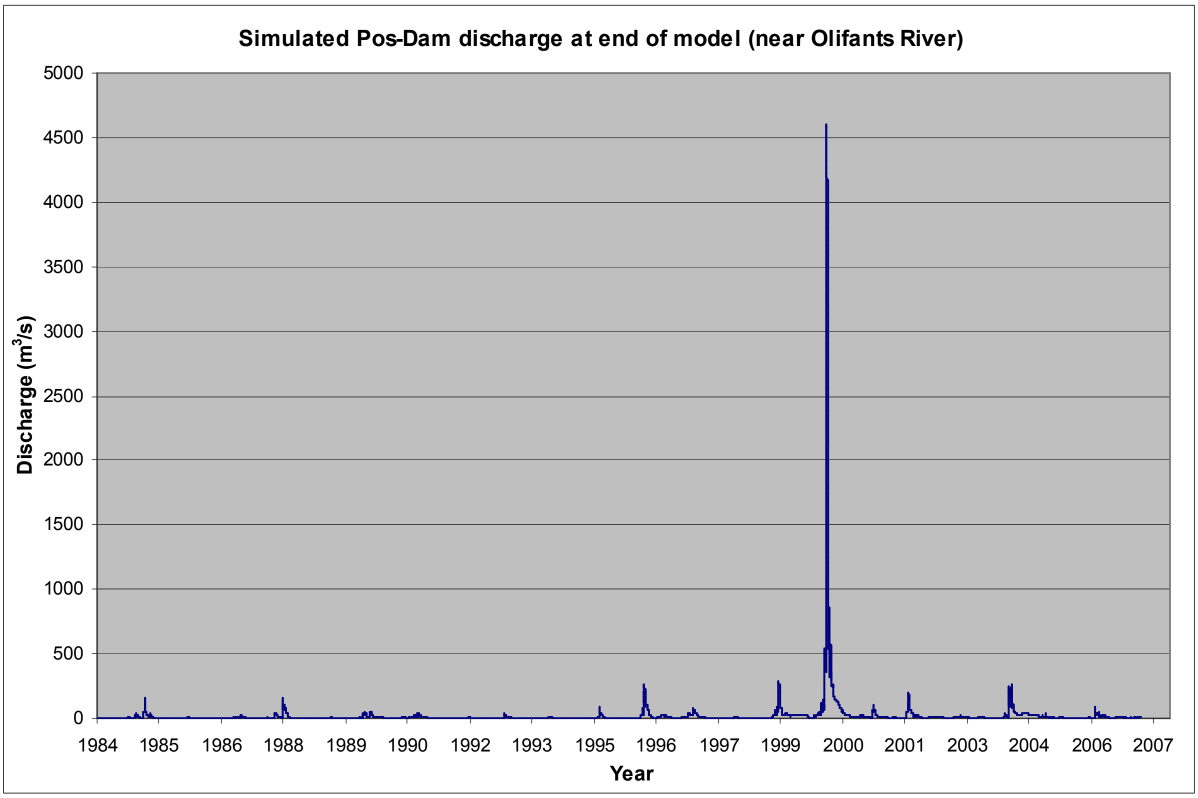

Figure 5.5: Simulated Post-Dam discharge at downstream end of model (near Olifants River)

6. SIMULATION RESULTS: IMPACTS OF THE DAM ON THE DOWNSTREAM RIVER MORPHOLOGY

The reduced flood peaks caused by the dam will cause a reduction in the river width downstream of the dam. From empirical data for South Africa this reduction can be calculated with the following equations (Beck and Basson, 2003):

$$B_2 = -3.40 + 0.856 \cdot B_1 + 0.142 \cdot MAR_2 - 0.0013 \cdot Q_{p1} \quad (1)$$

$$B_2 = -1.02 + 0.805 \cdot B_1 + 0.183 \cdot MAR_2 - 0.00036 \cdot Q_{a1} \quad (2)$$

With:

- Pre- and post-dam widths (B_1/B_2) in m
- Post-dam mean annual runoff (MAR_2) in m^3/s
- Pre-dam mean annual maximum flood peaks (Q_{a1}) in m^3/s
- Highest flood peak for the pre-dam period (Q_{p1}) in m^3/s

Table 6-1 shows the observed and calculated river widths for the pre- and post dam scenarios at various locations downstream of the dam.

With the inflow data the calculated reduction in river channel width will be 19 % near the dam, which is a 23 m reduction on a 116 m channel width. Downstream of the Klein Letaba River confluence the width reduction caused by the dam will be about 17 %, or 70 m on 411 m channel width. These reduced channel widths were taken into account in the post-dam scenario. **Figures 6.1** and **Figure 6.2** show two the observed and predicted post-dam river widths downstream of the proposed dam.

Table 6.1: Calculated river widths for post-dam scenario

Description	Chainage downstream of dam (km)			
	1	96	102	189
B_1 (m) (observed)	116	180	250	411
MAR_2 (m^3/s)	9	9	20	20
Q_{pl} (m^3/s)	2926	2431	4936	4743
Q_{al} (m^3/s)	356	168	401	504
B_2 from eq.1 (m)	93	149	207	345
B_2 from eq.2 (m)	94	146	204	333
Average B_2 (m)	93	147	206	339
B_2/B_1 ratio	0.81	0.82	0.82	0.83

Note:
Chainage 1 located at dam site immediately downstream of dam
Chainage 96 located upstream of Klein Letaba tributary
Chainage 102 located immediately downstream of Klein Letaba tributary
Chainage 189 located near downstream end in KNP, upstream of Olifants tributary

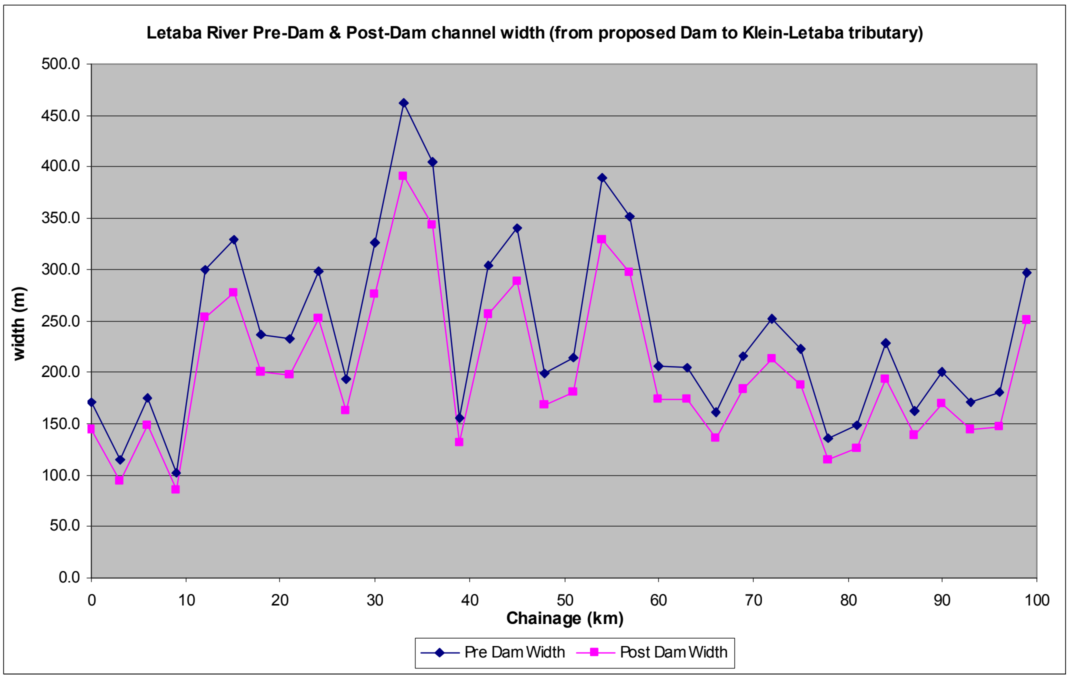

Figure 6.1: Letaba River predicted main channel river widths downstream of the proposed dam to the Klein Letaba River

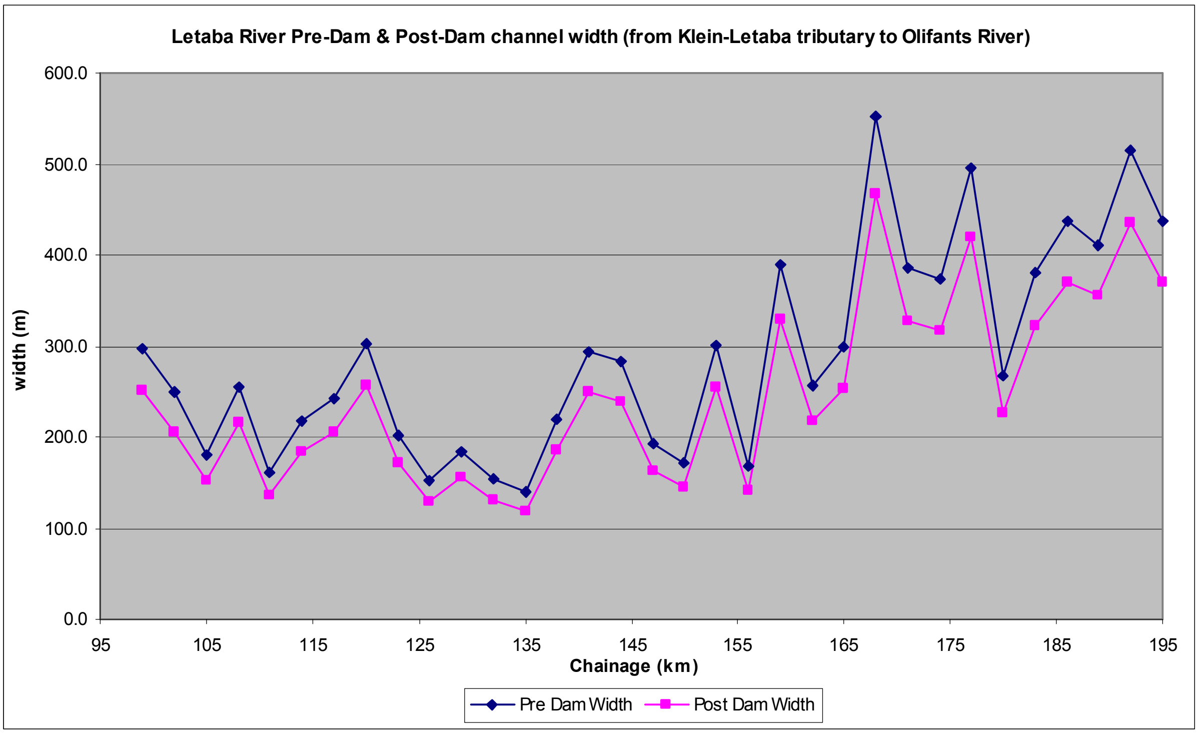

Figure 6.2: Letaba River predicted main channel river widths downstream of the Klein Letaba River to the Olifants River in the KNP

Near the dam the sediment in the bed would tend to coarsen as the fine sediment is removed during floods in a post-dam scenario. In the model the initial bed fractions were taken as 0.3 mm (50 %) and 0.82 mm (50 %). The post-dam simulation upstream of the Klein Letaba tributary indicated that over time the 0.3 mm fraction will decrease to about 20 %, with 0.82 mm sediment forming about 80 % of the bed material.

Normally a dam reduces the sediment transport in a river downstream of it, but this depends on many local hydraulic factors. In the case of the Groot Letaba River upstream of the Klein Letaba tributary, **Figure 6.3** shows that there could be a small increase in sediment transport in the post-dam scenario, probably because the narrowing of the river dominates over the flood attenuation caused by the dam. The difference in sediment transport is however very small: 100000 m^3 (bed load and suspended load) over a 23 year period, which is a 23 % change from the current condition. The higher sediment transport in the post-dam scenario indicates scour downstream of the dam. Near the dam the model indicates bed degradation (lower bed level) of at least 2 m. This degradation depends on large floods but the new equilibrium is typically established 7 to 10 years after completion of a dam.

Figure 6.4 shows the cumulative sediment transport downstream of the Klein Letaba tributary, near the downstream end of the model (upstream of the Olifants tributary).

In this case the post-dam scenario indicates even higher sediment transport than in **Figure 6.3**. This is due to the narrower main channel, but also changed hydraulic conditions at the Klein Letaba – Groot Letaba confluence which leads to more scour of the bed of the Klein Letaba River near the confluence.

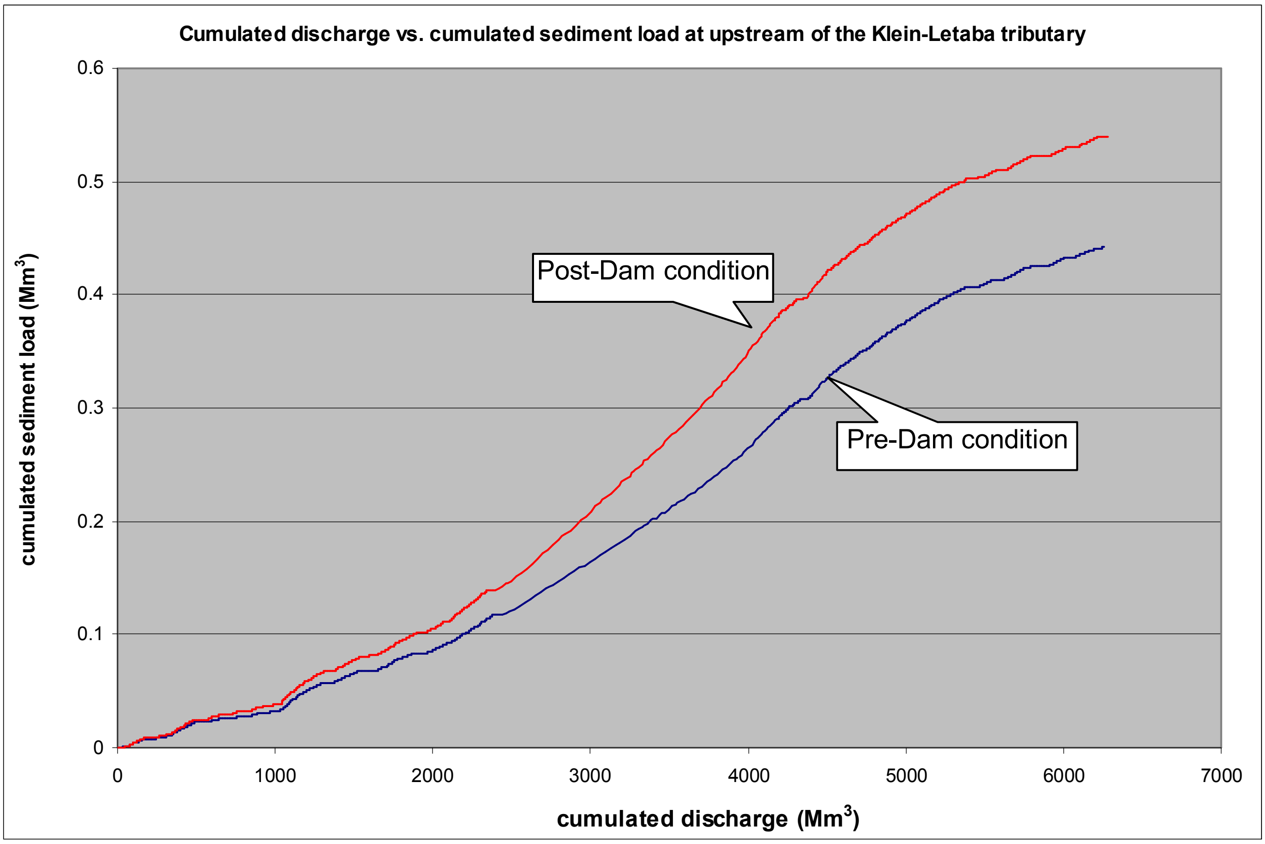

Figure 6.3: Cumulative discharge vs. cumulative sediment load upstream of the Klein-Letaba tributary

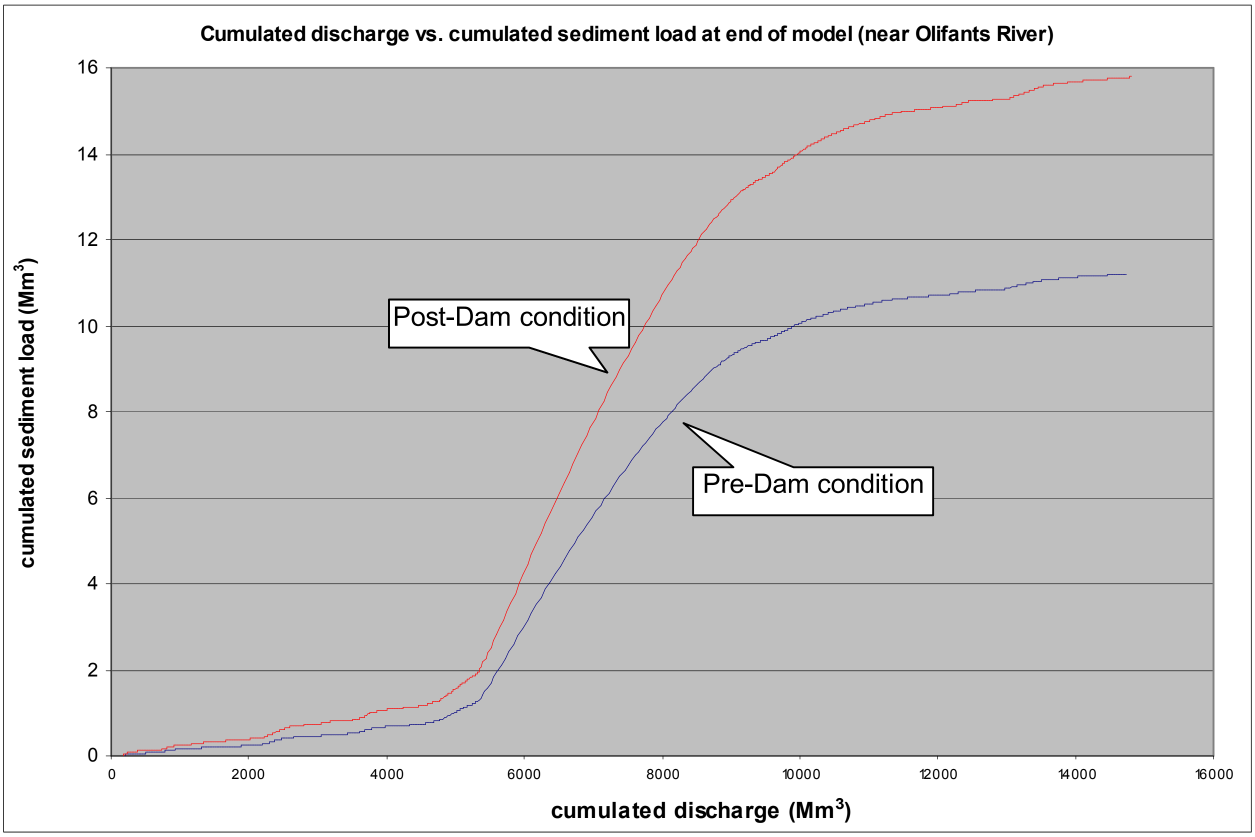

Figure 6.4: Cumulative discharge vs. cumulated sediment load at downstream end of model (near Olifants River)

Figures 6.5 and **6.6** show the simulated sediment transport in the Groot Letaba River downstream of the proposed dam, for pre- and post-dam scenarios. In both scenarios the sediment loads on the Groot Letaba River upstream of the Klein Letaba tributary are similar. In the post-dam scenario more sediment will be scoured from the Klein Letaba River near the confluence resulting in a 41 % higher sediment load (bed load and suspended sediment only) in the post-dam scenario on the Groot Letaba River in the KNP. The additional sediment transport in the KNP in the post-dam scenario is mainly due to scour (bed degradation near the confluence) of the Klein Letaba River.

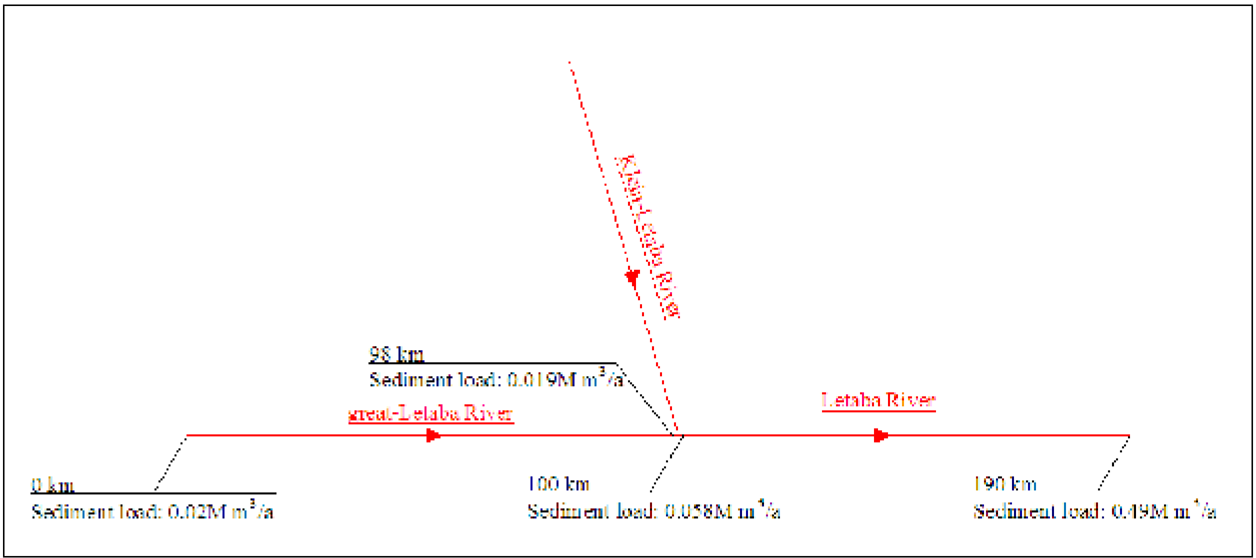

Figure 6.5: Pre-dam sediment balance on the Groot Letaba River

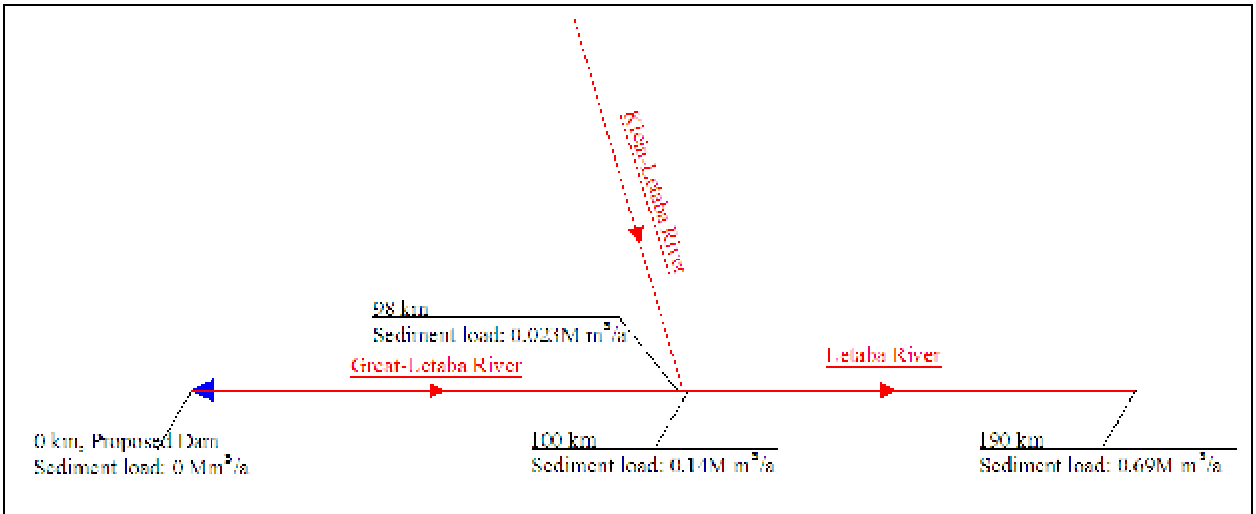

Figure 6.6: Post-dam sediment balance on the Groot Letaba River

Figures 6.7 and **6.8** show the simulated river bed levels downstream of the Nwamitwa Dam in the post-dam scenario. Letaba Camp in KNP is at about 155 km and the Klein Letaba River tributary at 99 km.

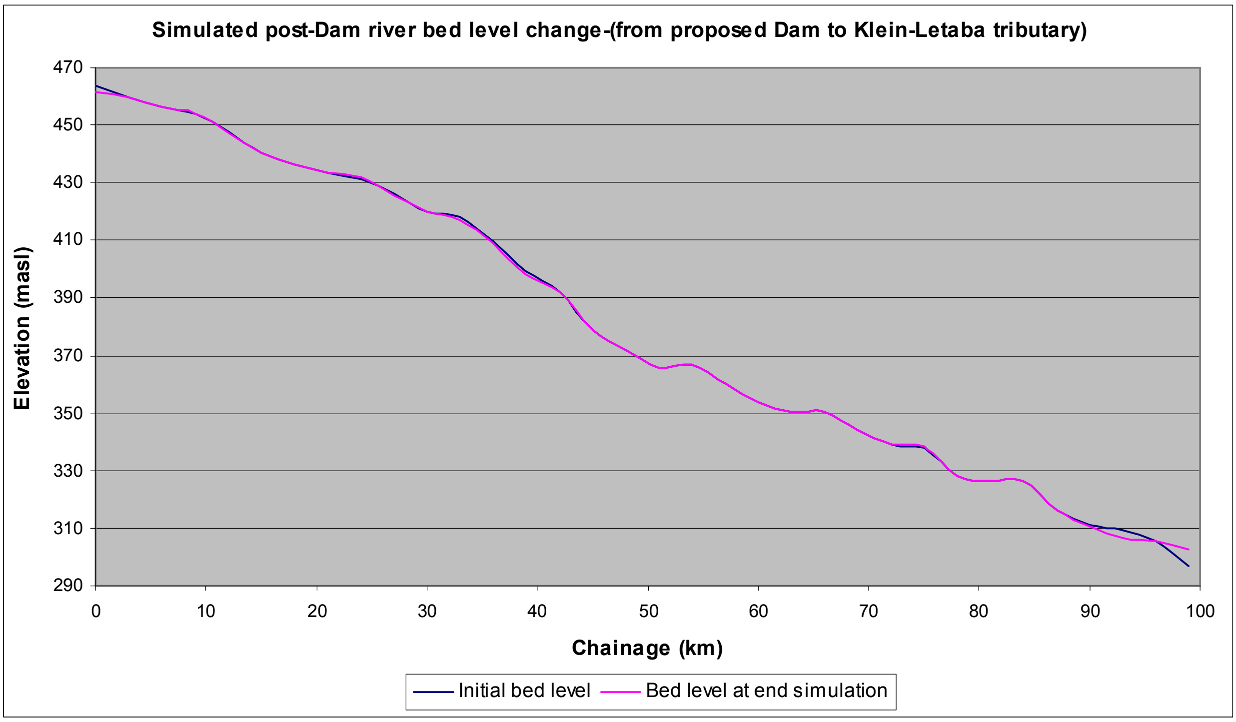

Figure 6.7: Groot Letaba River bed levels from the dam to Klein Letaba River simulated based on 23 year historical flow record

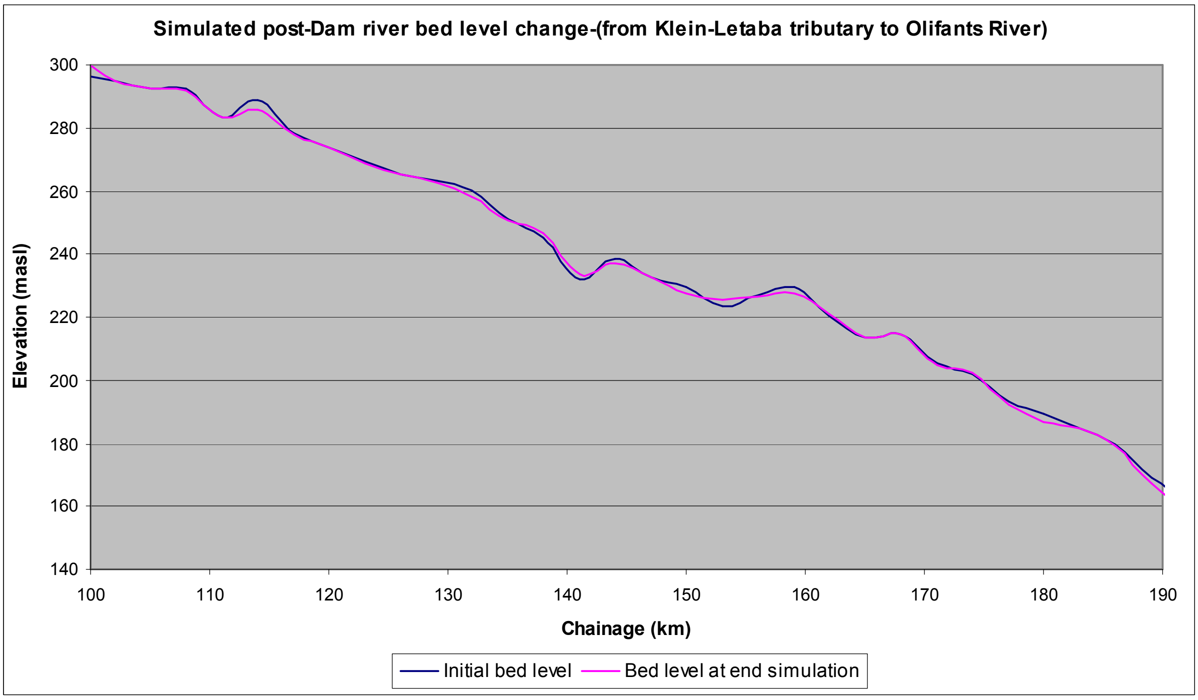

Figure 6.8: Groot Letaba River bed levels from Klein Letaba River to near the Olifants River in the KNP simulated based on 23 year historical flow record

7. RESERVOIR SEDIMENTATION UPSTREAM OF THE PROPOSED NWAMITWA DAM

7.1 SEDIMENT YIELD DETERMINATION

7.1.1 Previous studies

Rooseboom (1990) in the Letaba Basin Study proposed the following maximum sediment yields:

Nwanedzi River	:	320 t/km^2.year (220 km^2)
Thabina River	:	350 t/km^2.year (150 km^2)
Letsitele River	:	360 t/km^2.year (170 km^2)

The proposed sediment yields were based on observed sedimentation rates of existing reservoirs in the region.

In the Letaba Water Resource Development: Pre-feasibility Study of 1994, Rooseboom reviewed his 1990 sediment yields, based on a regional method development for the SA Water Research Commission (Rooseboom, 1992). Based on this method the predicted average sediment yield for the Nwamitwa Dam site was 280 t/km^2.a, for a 1352 km^2 effective catchment area and reservoir storage capacities that ranged from 58.7 to 192 million m^3. This sediment yield estimation was based on observed sedimentation rates of existing reservoirs in the region. Basson (2007) carried out a Reservoir Sedimentation study for DWAF as part of the Groot Letaba River Water Resources Development Project. The key findings of that study are discussed here in sections 7.1.2 to 7.2.

7.1.2 Sediment yields of existing dams

The latest reservoir basin survey data were obtained from DWAF and observed sediment yield data of dams (**Figure 7.1**) near the proposed dam site are shown in **Table 7.1.**

Figure 7.1: Dams and gauging stations located in the region of Nwamitwa dam site

Table 7.1: Observed sediment yields based on reservoir surveys

Dam	River	Effective catchment area (km²)	First survey	Last survey	Sediment yield (t/km².a)*
Ebenezer	Groot Letaba	156	1959	1986	155
Magoebaskloof	Politsi	64	1970	2000	93**
Dap Naude	Broederstroom	14	1961	1987	357***
Tzaneen	Groot Letaba	419	1976	1990	285
Massingir	Olifants	41480	-	-	245****
Middel Letaba	Middel Letaba	1799	1986	2001	293

Notes: * A 100 % sediment trapping efficiency was assumed in the reservoirs.

** The sediment yield of Magoebaskloof Dam is not reliable due to the small storage capacity – mean annual runoff ratio at the dam of only 0.13, which makes it difficult to estimate the sediment trapping efficiency of the reservoir.

*** The Dap Naude Dam sediment yield was found to be the highest, but the dam has a very small effective catchment area of only 14 km^2. In larger catchments the sediment delivery ratio is usually reduced due to more sediment deposition occurring.

**** Massingir Dam in Mozambique was included since it is located downstream the proposed Nwamitwa Dam site. Basson (2002) determined the sediment yield of Massingir Dam based on suspended sediment data and reservoir basin surveys. The catchment area of Massingir Dam is very large compared to the 1352 km^2 of Nwamitwa Dam, and covers a large catchment area to the south of the Nwamitwa Dam site.

From Table 7-1 the data of Tzaneen Dam, Middel Letaba Dam and Massingir Dam are probably most applicable to the proposed Nwamitwa Dam. Ebenezer Dam has a relatively small catchment area and is located upstream of Tzaneen Dam. The latter dam has a much higher sediment yield than Ebenezer Dam.

7.1.3 Sediment yield based on suspended sediment data

Suspended sediment grab samples are taken at some DWAF flow gauging stations in South Africa. Data were obtained at the gauging stations listed in **Table 7.2**.

Table 7.2: Suspended sediment data at flow gauging stations

Station	Location	Total catchment Area (km^2)	Sampling period	Max Q (m^3/s)	Max concentration (mg/l)
B8H008	Letaba Ranch on Groot Letaba	4710	1981-1982; 1998-1999	149	2072
B8H009	Junction on Groot Letaba	851	1981; 1999	55	123
B8H010	Letsitele River	477	1981-1982; 1998	9	2172

Figure 7.2 shows the data of these three stations. From Table 7-2 it is clear that data were only obtained for relatively short periods in the past, and that the data sets are very small. Only the data of B8H008 could be used since it had a relatively large recorded discharge in the sediment load-discharge relationship. The sediment load-discharge relationship was integrated with the observed flow record of B8H008 to obtain a sediment yield for the period 1966 to 2002. The sediment load-discharge relationship represents a “high probable” curve in order to obtain a conservatively high sediment yield. The sediment yield calculated at B8H008 is 278 t/km^2.a, and

takes into account bedload and non-uniformity in suspended sediment transport which was added by adjusting the suspended sediment concentration data by a factor of 1.25. The sediment yield obtained by this method is in agreement with the data obtained with reservoir basin surveys, but it is based on very limited suspended sediment data, obtained at relatively small flows and floods.

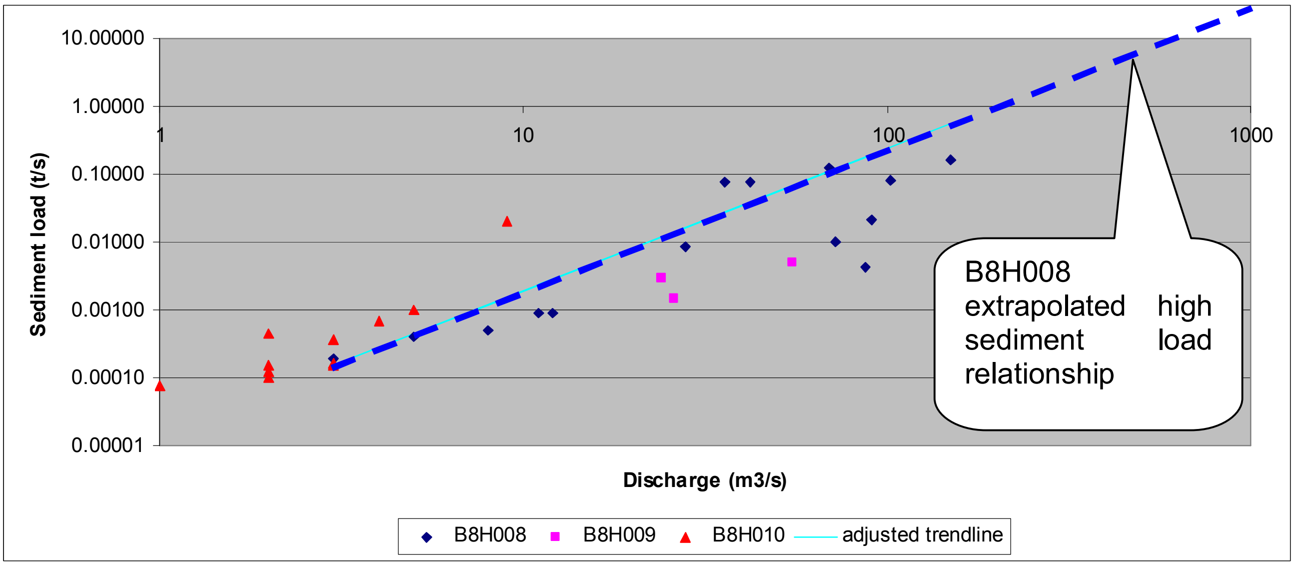

Figure 7.2: Sediment load-discharge relationships

7.1.4 Proposed sediment yield

The methods described above yielded the following sediment yields:

a) Rooseboom (1992) regional empirical method: 280 t/km^2.a at proposed dam site

b) Reservoir basin surveys: 245 to 293 t/km^2.a

c) River suspended sediment samples: 278 t/km^2.a at Letaba Ranch

It seems that the above methods resulted in very similar sediment yields. (The method in (a) is of course based on data of (b); method (c) had very limited suspended sediment data and the sediment load-discharge relationship had to be extrapolated for larger floods).

The future land use could affect the sediment yield. The current land use consists mainly of forestry, irrigated commercial farming, urban areas and subsistence farming. The catchment area of the Nwamitwa Dam falls in the high and medium soil erosivity regions of the Rooseboom (1992) method. If due to future land degradation the medium region changes to high erosivity, the maximum possible sediment yield would be 350 t/km^2.a based on a 95 percentile assurance. Possible maximum sediment yield values in the order of 350 t/km^2.a were also proposed in the 1990 study by Rooseboom.

Due to possible future land degradation and the effect of climate change, it was recommended that a sediment yield of 350 t/km^2.a is used for the design of Nwamitwa Dam (Basson, 2007).

7.2 ESTIMATED RESERVOIR SEDIMENT DEPOSITION IN NWAMITWA RESERVOIR

Based on the Brune (1953) sediment trapping efficiency relationship, it was assumed the proposed reservoir would trap 100 % of the incoming sediment load. The sediment density of deposited sediment was assumed to be 1.35 t/m^3 after a 50 year period. An effective catchment area of 1352 km^2 was used for Nwamitwa Dam. **Table 7.3** shows the sediment volumes expected as deposited sediment in Nwamitwa Reservoir in future.

Table 7.3: Estimated Nwamitwa Reservoir sedimentation

Sediment yield (t/km^2.a)	Effective catchment area (km^2)	Estimated sediment volumes (million m^3)		
		After 10 years	After 20 years	After 50 years
350	1352*	6.9	11.5	17.5

Note: * From the Rooseboom (1994) study.

If the storage capacity of the proposed dam is 1.2 MAR which is equal to 187 million m^3 (Ninham Shand, 2008), the 50 year sediment volume will only fill 9 % of the reservoir, which is relatively low for South Africa. The average rate of sedimentation of the reservoir will be 0.19 %/year compared to the average rate for South African dams of 0.4 %/year.

Although the sediment deposition volume in Nwamitwa Reservoir is expected to be small over a 50 year period, deposition above full supply level will result in elevated flood levels in the river upstream of the reservoir which should be considered when floodlines are determined during the design of the dam. In many reservoirs in South Africa the observed sediment deposition above the full supply level in the river upstream of the reservoir is as much as 10% to 30% of the total sediment volume deposited in the reservoir (Basson and Rosseboom, 1996).

8. FLOW GAUGING WEIR JUST DOWNSTREAM OF NWAMITWA DAM

The proposed flow gauging station downstream of the dam will have a negligible impact on the flow and sediment balance of the river.

9. RAISING OF TZANEEN DAM

Raising of Tzaneen Dam will not significantly alter the sediment trapping efficiency of the dam and most of the incoming sediment load will be trapped in the reservoir. Sediment deposition in the live storage will however occur further upstream than before.

Raising of Tzaneen Dam will increase the storage capacity which could attenuate small and medium floods more. Large floods will not be attenuated significantly more than in the current condition. Therefore the river morphology downstream of the dam is not expected to change significantly. It is estimated that the river width downstream of the dam will decrease by less than 5% after the raising of the dam.

10. RELOCATION OF ROADS AND PROPOSED DAM ACCESS ROADS

As long as the relocated roads and access roads are designed based on the guidelines of the NRA Road Drainage Manual (2007), no significant problems are foreseen in term of sedimentation.

11. TREATMENT PLANT AND WATER RETICULATION PIPELINES

The upgrading of the treatment plant and construction of new pipelines should have limited impact on the river sediment balance, if:

- Stormwater drainage is properly designed; and
- Low sediment concentrations are discharged offsite into the local streams/rivers. Sedimentation basins should be constructed on site if required.

12. CONSTRUCTION ASPECTS RELATED TO NWAMITWA DAM

During construction of the dam a coffer dam will probably be constructed to divert flood flow around the construction site. The river should not be constricted too much since this could lead to local scour.

When work is carried out in the river the suspended sediment concentrations downstream of the dam site should not exceed the sediment load-rating values shown in Table 12-1. Regular water grab samples (or calibrated turbidity meter readings to convert to mg/l) have to be taken say 300 m downstream of the dam site during construction. This table is based on limited data and none at the dam site. If more pre-dam samples could be obtained at the dam site before construction starts the limiting values could be recalibrated.

Table 12.1: Proposed 90 percentile suspended sediment concentrations 300 m downstream of the dam site

River discharge (m^3/s)	Suspended sediment concentration (mg/l)
5	130
10	240
50	1000
100	1900
250	4300
500	8100
1000	15000

13. PUBLIC PARTICIPATION

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in July 2007 to elicit comment from and register I&APs from as broad a spectrum of public as possible. The announcement was done by the following means:

- the distribution of Background Information Documents (BIDs) in four languages,
- placement of site notices in the project area,
- publishment of advertisements in regional and local newspapers,
- publishment of information on the DWAF web site,
- announcement on local and regional radio stations; and
- the hosting of five focus group meetings in the project area.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Draft Scoping Report (DSR) (Appendix A). The DRS was made available for public comment in October 2007. A summary of the DSR (translated into four languages) was distributed to all stakeholders and copies of the full report at public places. Two stakeholder meetings were held in October to present and discuss the DSR. The Final Scoping Report was made available to stakeholders in December 2007.

The Draft Environmental Impact Assessment Report, its summary (translated in four languages), the various specialist studies, the Environmental Management Plans and Programmes were made available for a period of thirty (30 days) for stakeholders to comment. Stakeholder comments were taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority.

14. CONCLUSIONS AND RECOMMENDATIONS

This study investigated the impacts of the proposed Nwamitwa Dam on the sediment transport balance in the Groot Letaba River. The upstream impacts were analysed by analytical and empirical methods while the downstream impacts were assessed by mathematical hydrodynamic modelling. Other aspects of the development such as access roads and raising of Tzaneen Dam were also addressed.

The key findings are:

a) Downstream of Nwamitwa Dam:

- The dam will cause flood peak attenuation (reduced flood peaks) by about 7 % for large floods (3000 m^3/s), but more for smaller floods: 30 % attenuation for a 1600 m^3/s flood peak and 70 % attenuation for a 270 m^3/s flood peak.
- The post-dam river will become narrower due to flood attenuation caused by the dam. Near the dam the main channel width could decrease by 19 % (22 m reduction on 116 m). In the KNP upstream of the Olifants River confluence the reduction of channel width could be about 17 % (70 m on 411 m channel width).
- The river bed between the dam and the Klein Letaba River tributary will become coarser due to sediment trapping at the dam: from 0.56 mm median diameter to 0.72 mm median sediment diameter.
- Slightly more sediment will be transported down the river in the post-dam scenario due to the narrower river and local bed degradation on the Klein Letaba River near the confluence with the Groot Letaba River.
- Local bed degradation (lower bed level) near the dam of at least 2 m is expected.

b) Upstream of Nwamitwa Dam

The estimated sediment deposition volume in Nwamitwa Reservoir over a 50 year period is 17.5 million m^3 which is relatively small compared to the reservoir storage (1.2 MAR = 187 million m^3) . Deposition of sediment above full supply level has to be considered in the detailed design and floodline analysis of the reservoir as it would affect flood levels.

c) Flow gauging station downstream of Nwamitwa Dam

The weir downstream of the dam will have a negligible impact on the flow and sediment balance of the river.

d) Tzaneen Dam raising

Small floods will be attenuated more and it is expected that the main channel width downstream of the dam to the first main tributary could decrease by less than 5 % of the current width. The river morphology downstream of Tzaneen Dam is not expected to change significantly.

Elevated flood levels upstream of the reservoir could be expected due to future sedimentation above the raised full supply level. This has to be considered in the floodline assessment.

e) Relocation of roads and proposed dam access roads

As long as the relocated roads and access roads are designed based on the guidelines of the NRA Road Drainage Manual (2007), no significant problems are foreseen in term of sedimentation.

f) Construction aspects related to Nwamitwa Dam

The coffer dam should be designed not to cause river bank erosion or local scour at the dam site. The sediment concentrations 300 m downstream of the dam site should be monitored during construction to ensure present (90 percentile) high sediment concentrations are not exceeded as proposed in **Table 12.1**.

g) Treatment plant and water reticulation pipelines

The upgrading of the treatment plant and construction of water reticulation pipelines should have limited effect on sedimentation as long as proper stormwater drainage is designed at river crossings and during construction the present stream sediment concentrations based on 90 percentile values should not be exceeded. If required sedimentation basins should be constructed on site.

15. REFERENCES

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APPENDIX A: Issues and Responses

The issues below have been extracted from the Issues and Responses (Version 2) that was submitted to DEAT with the Scoping Report.

ISSUES related to the environmental impact assessment

9.1 Issues related to the EIA process and specialist studies

ISSUE	RAISED BY	SOURCE	RESPONSE
a. That sedimentation (likelihood of that in the dam and downstream) be investigated.	Mr Sean O'Beirne, EIA peer reviewer. Dr TK (Thomas) Gyedu-Ababio, Kruger National Park.	Comments as part of a peer review of the Draft Scoping Report. Written submission (DSR comment sheet) and attendance of the public meeting on 12 October 2007 in Tzaneen.	Will be considered by the Technical Study Module in the Impact Assessment Phase of the project.