PROPOSED CONFINEMENT OF THE 1:100 YEAR FLOODLINE ON THE MONTANA SPRUIT (PORTIONS 28 TO 42 AND 134, 135, AND 137 OF DOORNPOORT 295 JR), TSHWANE, GAUTENG:
Aquatic Assessment

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EXECUTIVE SUMMARY

Strategic Environmental Focus (Pty) Ltd, as independent environmental impact assessment practitioners, was appointed by SSV Consulting Engineers & Project Managers to facilitate the environmental process associated with the proposed confinement of the 1:100 year floodline of the Montana Spruit, Pretoria, Gauteng. This report represents the findings following an aquatic assessment of the Montana Spruit in the vicinity of the Tsamma Road bridge. The field survey was conducted on 27th March 2007.

Based on results obtained following application of the IHAS index during the current study, it can be determined that the sites were of poor quality in terms of aquatic macroinvertebrate biotopes. However, this index is not regarded as suitable to the current study for the purpose of defining biotope availability, as the index was designed for use in perennial rivers. The results should therefore be interpreted with caution.

In terms of aquatic macroinvertebrates, a total of five individuals comprising three families were sampled within the study area. The low abundance and diversity of aquatic macroinvertebrate taxa observed during the current study was attributed to the temporal extent on inundation of the river channel. No fish were observed to be present at the time of the survey, and no Red Data fish species were likely to occur within the area.

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SECTION 1: INTRODUCTION

1.1 PROJECT DESCRIPTION

A rapid increase in development within the Montana Spruit catchment, Pretoria, Gauteng, and dumping in the stream has aggravated the flooding problem in properties adjacent to the Montana Spruit as well as along Breed Street. Tsamma Road crosses the Montana Spruit at a low-level structure consisting of 6 x 450mm diameter pipe culverts. This provides Doornporrt Extension 6 with a secondary access route and local residents of Doornpoort Estate access to schools and shopping centres located within the area.

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1.2 TERMS OF REFERENCE

The terms of reference for the current study were as follows:

- Undertake a basic aquatic assessment of the Montana Spruit.

1.3 ASSUMPTIONS AND LIMITATIONS

In order to obtain a comprehensive understanding of the dynamics of the communities and the presence of fauna and flora within the area, ecological studies should ideally be conducted over a number of seasons. Ideally, monitoring of aquatic macroinvertebrates utilising the SASS5 index, in conjunction with the Invertebrate Habitat Assessment System index, should be conducted at the beginning of the dry season, at the end of the dry season and at the end of the wet season. Assessment of the integrity of the fish population should be monitored twice during the first year (at the end of the dry season and at the end of the wet season) so as to identify any seasonal trends, and once a year thereafter (preferably at the end of the dry season). Furthermore, assessment of the instream and riparian habitat integrity should be conducted once a year. However, due to time and budgetary constraints, such a detailed field survey could not be undertaken.

Due to the fact that the Montana Spruit is a non-perennial river, the SASS5 index could not be applied, and the Present Ecological State in terms of aquatic macroinvertebrates could thus not be determined. No such methodology currently exists for the determination of Present Ecological State of non-perennial rivers on the basis of the faunal composition. The same sampling procedures as those utilised during SASS5 application were, however, retained so as to standardise the sampling protocol between sites and allow for a comparative assessment.

SECTION 2: DESCRIPTION OF THE ENVIRONMENT

2.1 LOCATION

The present study area is located within the municipal boundaries of the City of Tswane Metropolitan Municipality, Gauteng. Doornpoort is located adjacent to the study area, with Tsamma Road bisecting the Montana Spruit so as to provide an access road for the residents of Dorrnpoort (Figure 1). Extensive construction is currently under way upstream of the study area, and several large retail centres are located within the upper catchment of the Montana Spruit.

2.2 BIOPHYSICAL DESCRIPTION

2.2.1 Climate

The area is characterised by erratic and extremely variable summer rainfall ranging from 450mm to 750mm per year. Temperatures within the study area vary from -6℃ to 40℃, with an average of 19℃ (Lo w and Rebelo, 1998).

2.2.2 Geology

Elements of the Rustenburg Layered Suite (part of the Bushveld Igneous Complex) traverse the floodplain of the Montana Spruit in the vicinity of the study area. Minerals primarily associated with these elements include norite and gabbro (both igneous intrusive minerals), and quartzite (metamorphic mineral originating from sandstone).

2.2.3 Soils

Soils located within the floodplain of the Montana Spruit are considered to be deep (>1200mm) black swelling hydromorphic clay, while soils located adjacent to the floodplain are considered moderately deep (600-1200mm) red blocky sandy clay / clay loam / clay (GDACE, 2002).

2.2.4 Associated Water Courses

The study area is located within the Crocodile (West) and Marico Water Management Area. The non-perennial Montana Spruit flows in a north-western direction until it confluences with the perennial Apies River downstream of Bon Accord Dam. Based on the South African National Spatial Diversity Assessment, the Apies River is classified as having a Present Ecological State Category C, indicating the river to be moderately modified and having rehabilitation potential (Nel *et al*., 2004). However, this assessment of Present Ecological State Category was conducted at desktop level using the National Water Situation Assessment Model to depict the integrity of the rivers in South Africa.

Figure 1: Location of study area

The Apies River is regarded as having a conservation status of Critically Endangered due to the fact that the river heterogeneity signature has an intact length of less than their conservation target of 10% of total length (Nel *et al.*, 2004). Furthermore, the classification afforded to the Apies River in terms of conservation status indicates that the system has lost so much of their original natural habitat that ecosystem functioning has broken down, and species associated with the ecosystem have been lost or are likely to be lost (Nel *et al.*, 2004).

Table 1: Summary of general site information

Map Reference	2528CB
Political Region	Gauteng
Level 1 Ecoregion	9. Eastern Bankenveld
Level 2 Ecoregion	9.03
Geomorphic Province	Bushveld Basin
Geology	Rustenburg Layered Suite
Vegetation Type	Clay Thorn Bushveld (Low and Rebelo, 1998) Marikana Thornveld (Mucina and Rutherford, 2006)
Water Management Area	3. Crocodile (West) and Marico
Secondary Catchment	A2
Quaternary Catchment	A23E
Stream	Montana Spruit
Perennial/Non-Perennial	Non-Perennial

2.3 SELECTION OF SAMPLING SITES

Sampling sites were selected so as to identify possible trends regarding the occurrence of species present within the study area, as well as provide a comparative basis by which future impacts can be evaluated. Co-ordinates of the selected sampling sites were determined using a Garmin GPS global positioning device and are listed in Table 2 and presented graphically in Figure 2. Photographs of the selected sampling sites are provided in Appendix 2.

Table 2: Description of sampling sites surveyed

Site name	Co-ordinates	Site description
Montana 1	S: 25°39' 27.8'' E: 28°15' 45.1''	Site located upstream of Tsamma Road on the Montana Spruit
Montana 2	S: 25°39' 20.6'' E: 28°15' 41.2''	Site located downstream of Tsamma Road on the Montana Spruit

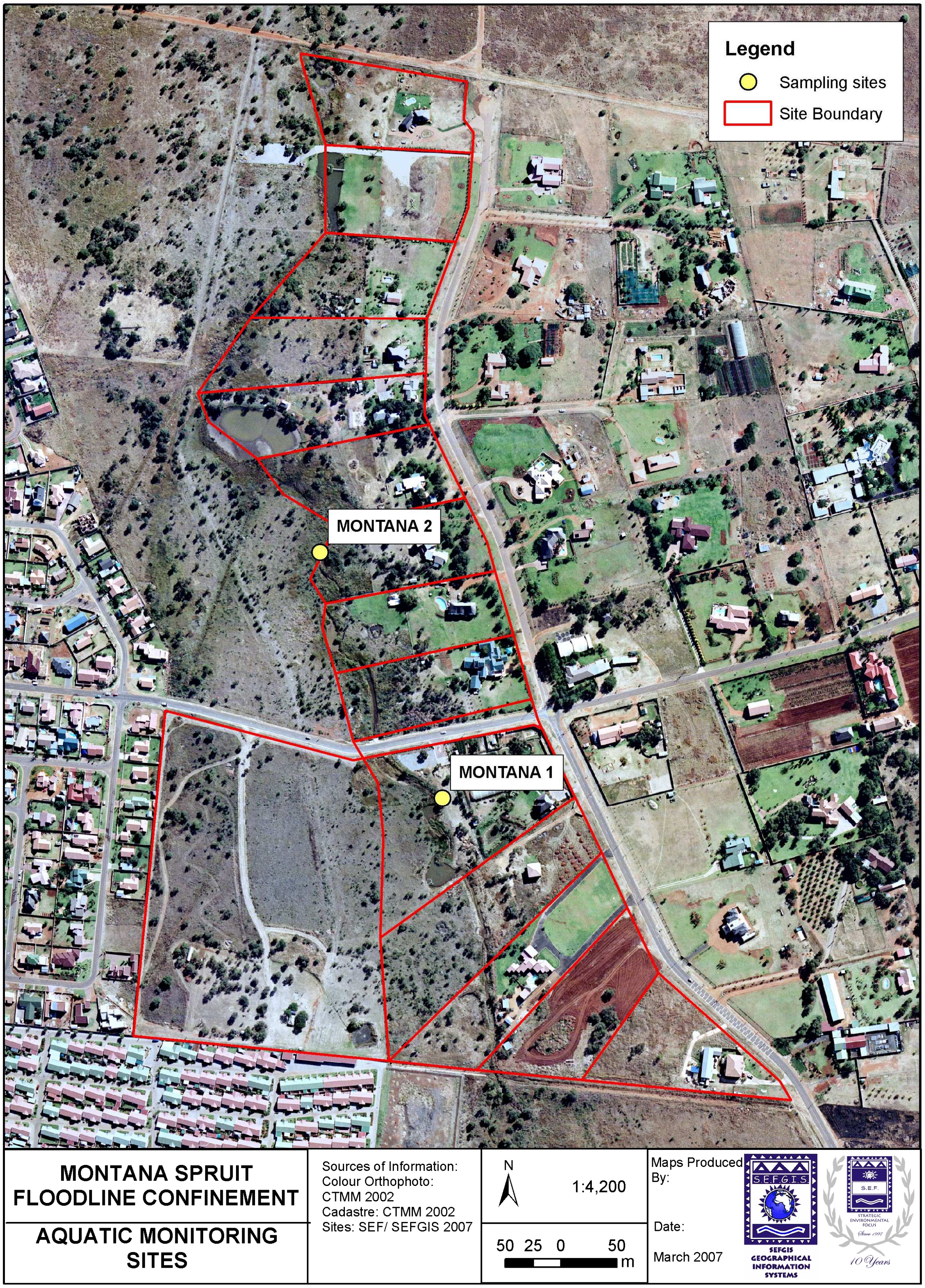

Figure 2: Aquatic monitoring sites assessed during the present study

SECTION 3: RESULTS

3.1 WATER QUALITY PARAMETERS

In situ water quality parameters associated with the Montana Spruit at the time of the field survey are presented in Table 3. These results are considered important when interpreting results obtained from biological assessments, due to the fact that the water quality has an effect on the health, diversity and abundance of biota present.

Table 3: *In situ* water quality parameters measured within the study area during March 2007

Site	Time	Temp (°C)	pH	Electrical Conductivity (mS/cm)	TDS* (mg/ℓ)	Dissolved Oxygen (mg/ ℓ)	Oxygen Saturation (%)
Montana 1	12h00	22.3	7.23	0.47	220	4.55	75.5
Montana 2	14h30	23.3	7.23	0.48	240	3.06	55.2

* Total Dissolved Solids

During the March 2007 field survey, few differences were observed between sites Montana 1 and Montana 2, with only oxygen concentration and saturation showing market differences (Table 3). Prior to the commencement of the field survey, the Montana Spruit was observed to be dry, with little to no surface water present within the river channel. During the time of the field survey, water was observe to be present as isolated pools within the Montana Spruit channel, possibly due to recent rainfall within the catchment or water originating from adjacent land use.

3.2 INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

Results obtained following application of the Invertebrate Habitat Assessment System (IHAS Version 2.2) index on the Montana Spruit during the March 2007 field survey are presented in Table 4. The purpose of the IHAS index is to assess the availability and suitability of the instream biotopes (e.g. stones-in-current, marginal vegetation, etc.) for colonisation by aquatic macroinvertebrates.

Table 4: Results obtained following application of IHAS during March 2007

Site	IHAS value (%)	Description
Montana 1	45	Poor
Montana 2	47	Poor

Based on results obtained following application of the IHAS index during the current study, it can be determined that the sites were of poor quality in terms of aquatic macroinvertebrate biotopes (Table 4). However, this index is not regarded as suitable to the current study for the purpose of defining biotope availability, as the index was designed for use in perennial rivers. The results should therefore be interpreted with caution. Habitat availability during high flows can be diverse, with a very low diversity of habitats available during the dryer periods.

According to a recent study conducted within Mpumalanga and Western Cape, the IHAS method does not produce reliable scores with regard to the suitability of habitat at sampling sites for aquatic macroinvertebrates (Ollis *et al*., 2006). Furthermore, the performance of the IHAS seems to vary between geomorphologic zones and between biotope groups (Ollis *et al.*, 2006). However, more testing of the IHAS method is required before any final conclusion can be made regarding the accuracy of the index.

3.3 AQUATIC MACROINVERTEBRATES

During the course of the study, a total of five aquatic macroinvertebrates, comprising three families, were sampled within the study area (Table 5). Families observed to be present within the Montana Spruit at the time of sampling included Oligochaeta (Aquatic Earthworms), Potamonautidae (Crabs) and Chironomidae (Midges).

Table 5: Number of aquatic macroinvertebrate taxa collected within the study area

Site	Number of Taxa
Montana 1	3
Montana 2	0

The South African Scoring System Version 5 (SASS5) is a measure of the biotic integrity or condition of a water course based on the aquatic macroinvertebrates colonising the available substrate. Each taxon is allocated a score relative to its level of tolerance towards pollution. However, the use of the SASS5 index is limited to perennial watercourses that allow for the establishment and completion of lifecycles of aquatic macroinvertebrate populations. Due to the fact that the Montana Spruit is a non-perennial river, the SASS5 index could not be applied, and the Present Ecological State in terms of aquatic macroinvertebrates could thus not be determined. The same sampling procedures as those utilised during SASS5 application were, however, retained so as to standardise the sampling protocol between sites and allow for a comparative assessment.

Non-perennial rivers are systems which place extreme stress on the organisms inhabiting them by exhibiting highly variable physical and chemical attributes. Therefore, the organisms found within these non-perennial systems have had to develop specific mechanisms to cope and survive in a system that is naturally highly variable. The most important of these is the unpredictable and highly variable flow patterns of the watercourses themselves (Rossouw *et al.*, 2005). For biota to survive in these highly variable and unpredictable systems, they need to be widely tolerant, particularly when critical phases of their lifecycles occur at a time when spates and droughts are probable.

Studies on the recolonisation of non-perennial water courses by aquatic macroinvertebrates are few, but it appears the Chironomidae, Oligochaeta and Simulidae (only in true-running streams) are some of the early colonizers (Rossouw *et al.*, 2005). Harrison (1966) suggested that recolonisation occurs from three sources, namely resting eggs, invertebrate forms capable of aestivation and eggs laid by flying adults. Furthermore, he also found that recolonisation occurs rapidly following inundation, with oligochaetes, small crustaceans and insect larvae appearing within the first ten days (Rossouw *et al.*, 2005). Species typical of permanent streams returned within one month of inundation in pools and within 4-6 weeks in streams (Rossouw *et al.*, 2005). Therefore, as the field survey took place only a number of days after inundation, pioneer colonizers would have been sampled at the time of the survey, thereby accounting for the low diversity of aquatic macroinvertebrates collected. The presence of aquatic macroinvertebrates at site Montana 1 only is likely due to the fact that areas where temporary pools with mud substrate could develop over the dryer periods exist upstream of the Tsamma Road crossing.

Dams and weirs built in non-perennial rivers also serve as refugia for aquatic macroinvertebrates and fish, and the water quality in these structures will determine the population of macroinvertebrates the survive the dry period. However, the absence of such dams upstream of the study area would therefore limit the rate of recolonisation of the Montana Spruit by aquatic macroinvertebrates during periods of flow. The presence of dams downstream of the Tsamma Road crossing is likely to increase the rate of recolonisation in the lower reaches of the Montana Spruit below the dams.

The high degree of urbanisation and the increase in the impermeable surfaces within the upstream portions of the Montana Spruit catchment has significantly altered the hydrological regime of the Montana Spruit, increasing the frequency and the volume of flood events within the catchment. Floods generally reduce taxa richness in recolonised non-perennial streams during the wet period, with recovery of the macroinvertebrate assemblages occurring at least two weeks after the initial flood event. However, should the frequency of flooding increase, macroinvertebrate diversity within the watercourse is likely to decrease. Such conditions result in alterations to the macroinvertebrate and fish assemblages within the watercourse beyond what can be classed as natural.

It is difficult to predict the composition of communities of macroinvertebrates present within non-perennial rivers as there are numerous cues needed for recolonisation to take place such as differences in temperature, oxygen content and water quality in general. Therefore, once-off sampling of a particular section of a non-perennial river is regarded as unreliable, and additional studies should be conducted so as to take into account the rate and progression of recolonisation.

3.4 ICHTHYOFAUNA

Assessment of the fish species occurring within the Montana Spruit at the time of the field study was not feasible as a result of the short period of inundation and the lack of longitudinal connectivity. A desktop study was therefore conducted.

Indigenous fish species likely to occur within the study area are presented in Table 6. This selection of fish species is based on historical records, habitat preferences, migratory behaviour and relative tolerance. In addition to the indigenous fish species, several exotic fish species are likely to occur within the study area, namely *Cyprinus carpio* (Carp), *Micropterus salmoides* (Largemouth Bass) and *Gambusia affinis* (Mosquitofish).

Table 6: Indigenous fish species likely to occur within the study area

Scientific name	Common name
Barbus unitaeniatus	Lonbeard Barb
Barbus paludinosis	Straightfin Barb
Barbus anoplus	Chubbyhead Barb
Oreochromis mossambicus	Mozambique Tilapia
Tilapia sparrmanii	Banded Tilapia
Pseudocrenilabrus philander	Southern Mouthbrooder
Clarias gariepinus	Sharptooth Catfish

Droughts and floods are natural disturbances and can be major factors in the structuring of lotic communities (Rossouw *et al.*, 2005). For aquatic biota to persist in such variable systems, adequate refugia should be available for utilisation, which convey spatial and temporal resilience and resistance for biota. Such refugia might not only include instream biotopes or habitats, but may also include impoundments. Impoundments are, however, seen to decrease the fish diversity by acting as a migratory barrier to fish species.

Dams observed to occur downstream of the Tsamma Road crossing provide refugia for fish species at times when the surface water availability within the Montana Spruit channel is limited or non existent during times of low rainfall. Such dams are highly likely to support populations of *Oreochromis mossambicus*, *Tilapia sparrmanii, Pseudocrenilabrus philander* and *Clarias gariepinus*, all of which have a high preference for slow-shallow water bodies and are considered tolerant to modified water quality. Additional species likely utilising the dams as refugia during such times include *Barbus unitaeniatus*, *B. paludinosis* and *B. anoplus*. However, the likelihood of occurrence for barb species is considered less than that of the other species due to the lack of overhanging vegetation within the dam, as this is the preferred cover utilised by the barbs. Furthermore, the potential presence of exotic fish species will further decrease the possibility of barbs utilising the dams as refugia.

During times of high flow, fish species will swim upstream from their place of refuge (i.e. dams), some for the purpose of reproduction and some for the purpose of colonisation. Following high flows, receding water levels will concentrate the fish in pools, and competition and decreasing water quality within isolated pools will lead to local elimination of fish species within the pools, with barbs being the first to be eliminated.

The disappearance of surface water from the majority of the river channel has major ecological consequences to aquatic biotia, particularly fish. Puckridge (cited in Rossouw *et al.*, 2005) found that fish species richness within a watercourse is positively correlated to the long-term permanence of the surface water. The absence or discontinuity of surface water between pools, the transient nature of pools and the absence of significant cover are thus regarded as unsuitable for the long-term support of significant fish populations. Although such systems are important for fish movements, it is preferable to place more emphasis on aquatic macroinvertebrates, riparian vegetation and the terrestrial vertebrates when doing flow requirement studies.

3.4.1 Red Data Fish Assessment

No Red Data fish species are likely to occur within the study area.

SECTION 4: IMPACT DESCRIPTION, ASSESSMENT AND MITIGATION

Any development in a natural system will impact on the surrounding environment, usually in a negative way. This purpose of this phase of the project was therefore to identify and assess the significance of the impacts likely to arise during the construction and the operational phases of the project, and provide a short description of the mitigation required so as to limit the impact of the proposed development on the natural environment. Due to the fact that a final development plan was not available at the time of writing, the impact assessment should therefore be considered generic and not based on design parameters. Table 7 and Table 8 present generic impacts on the aquatic environment associated with development. All impacts referred to below assume that the floodplain will be reshaped according to description provided within Option 2 (PDNA, 2006).

Table 7: Possible impacts arising during construction phase

Possible impact	Source of impact
Increased stormwater runoff volume and velocity	Increase of hard impermeable surfaces and clearing of vegetation
Erosion of drainage lines, riparian zone and floodplains	Movement of vehicles Movement of workforce Construction method
Increased sediment input	Movement of vehicles Movement of workforce Clearance of ground cover
Surface water pollution	Oil and fuel spills from construction vehicles Construction material (i.e. concrete, solvents, paints etc.) Workforce activities

Table 8: Possible impacts arising during operation phase

Possible impact	Source of impact
Erosion of drainage lines	Ineffective rehabilitation

4.1 CONSTRUCTION PHASE

4.1.1 Increases stormwater runoff volume and velocity

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Moderate	Highly probable	High	Low	Medium

Description of Impact

The presence of bare soils as a result of the removal of floodplain vegetation will result in an increase in storm water runoff volume due to the lack of stormwater attenuation. This would, however, be of limited significance if the recommended mitigating measures are implemented.

Mitigation Measure

- All construction activities should take place during winter when no rainfall is expected to occur; and
- Aseasonal incidences of water runoff from the surrounding premises should be identified and contained or diverted prior to entering the floodplain during the period of alteration.

4.1.2 Erosion of drainage lines, riparian zone and floodplain

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Regional	Short	High	Probable	High	Low	High

Description of Impact

The clearance of vegetation will reduce the capacity of the land surface to retard the flow of surface water, thus decreasing infiltration, and increasing both the quantity and velocity of surface water runoff and erosion. Human activities which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can result in increased susceptibility to erosion. Roads and pathways created during the construction phase have the potential to become preferred drainage lines, resulting in gully erosion.

Mitigation Measures

- Appropriate flow diversion and erosion control structures i.e. earth embankments must be put in place where soil may be exposed to high levels of erosion due to steep slopes, soil structure etc.;

- Should a freak storm displace the temporary earth embankments or other erosion control structures, a visual inspection of the site must be made and any damage be recorded. Any damage and loss of soil resulting from a storm is to be remedied immediately. Should the temporary walls collapse due to construction error, the contractor is to fund the remediation process;

- Storm water at the construction crew camps must be managed so as to reduce the silt loads in the stream channel. Measures must be implemented to distribute storm water as evenly as possible to avoid point sources of erosion;

- Construction on steep slopes and in soft or erodable material will require erosion control measures and correct grassing methods;

- All construction areas should be suitably top soiled and vegetated as soon as is possible after construction. Vegetation should be indicative of pre-development status; and

- Disturbed surfaces to be rehabilitated must be ripped, and the area must be backfilled with topsoil or overburden.

4.1.3 Increased sediment input

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Regional	Short	High	Probable	Medium	Low	High

Description of Impact

Clearance of existing vegetation and reshaping of the channel will expose the upper layers of the soil horizon to soil erosion. The transport of eroded soil into surrounding surface water resources will increase the Total Suspended Solids (TSS), which may adversely affect the aquatic fauna in a number of ways. These include the alteration of substrate composition and changing the suitability of the substrate for certain taxa, the increase of invertebrate drift (the rate at which aquatic macroinvertebrates move by floating downstream) due to sediment deposition, or substrate instability, the affect on the respiration due to the deposition of silt on the gills of biota, the affect on the feeding activities by impeding of filter feeding, reduction of the food value of the periphyton and reduction of density of the prey organisms, reduction in the suitability of spawning habitat and the hindering of the development of eggs, larvae and juveniles, modification of migration patterns and the interference with hunting efficiency of fish. The movement of construction vehicles and personnel can also result in the onset of erosion and associated sedimentation of streams and rivers. The stockpiling of excavated earth and construction materials can result in contamination of runoff, as a result of erosion of stockpiles.

Mitigation Measures

- To prevent erosion of material that is stockpiled for long periods, the material must be retained in a bermed area;
- All topsoil must be removed and stockpiled on the site;
- The temporary storage of topsoil, inert spoil, fill etc. should be above the 20 year floodline or at least 20 m from the top of the bank of any drainage lines, whichever is the maximum or as agreed with the ECO;
- Mulch, roughen or sterile grass seeding can be used on any batter or topsoil stockpile that is to be maintained for longer than 28 days;
- Construct an earth bank around the upslope portion of any stockpiles in order to redirect runoff and prevent scouring of stockpiles;
- Erect a silt fence around any stockpiles in order to trap sediment and prevent stockpile sediment loss;
- Stockpiles should not be higher than 2m to avoid compaction, and single handling is recommended; and
- Dust suppression is necessary for stockpiles older than a month – with either water or a biodegradable chemical binding agent.

4.1.4 Surface water pollution

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Medium	Probable	Medium	Low	Medium

Description of Impact

Hydrocarbons-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surrounds to be contaminated by raw sewage.

Mitigation Measures

- Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants;

- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc.;
- Sufficient care must be taken when handling these materials to prevent pollution;
- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- Oil residue shall be treated with oil absorbent such as Drizit or similar and this material removed to an approved waste site;
- Concrete, where needed, is to be mixed on mixing trays only, not on exposed soil;
- All concrete and tar that is spilled outside these areas shall be promptly removed by the Contractor and taken to an approved dumpsite;
- After all the concrete mixing is complete all waste concrete shall be removed from the batching area and disposed of at an approved dumpsite;
- Storm water shall not be allowed to flow through the batching area. Cement sediment shall be removed from time to time and disposed of in a manner as instructed by the Consulting Engineer;
- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Under no circumstances may ablutions occur outside of the provided facilities;
- At all times care should be taken not to contaminate surface water resources;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs must be informed immediately;

- Where construction in close proximity to sewer lines is unavoidable then excavations must be done by hand while at all times ensuring that the soil beneath the sewer lines is not destabilised;

- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;

- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;

- The construction site should be cleaned daily and litter removed;

- Conduct ongoing staff awareness programs so as to reinforce the need to avoid littering; and

- Backfill must be compacted to form a stabilised and durable blanket; and the current load above the sewer lines must at no time be exceeded.

4.2 OPERATIONAL PHASE

4.2.1 Erosion of drainage lines, riparian zone and floodplain

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Regional	Long	Moderate	Probable	Medium	Low	Medium

Description of Impact

Should rehabilitation not occur in the appropriate manner, vegetation will be stripped off with the first summer rainfalls. Furthermore, human activities which disturb the soil structure, such as the compaction of soil along footpaths and vehicle tracks, and the disturbance of soil structure through movement of soil, can result in increased susceptibility to erosion. Roads and pathways created during the construction phase have the potential to become preferred drainage lines, resulting in gully erosion.

Mitigation Measures

- Ensure continuous monitoring of rehabilitated vegetation cover and address all problems as they arise.

4.3 DECOMMISSIONING PHASE

No decommissioning phase is expected for the proposed reshaping of the Montana Spruit floodplain.

SECTION 5: CONCLUSION AND RECOMMENDATIONS

The increase of impermeable surfaces created upstream of the Tsamma Road crossing has lead to increases in the frequency of flooding and the volume of water as a result of increased runoff within the catchment. Of the three options proposed to alleviate the flooding problem, the reshaping of the floodplain is regarded as the best possible measure providing that the reshaping of the floodplain occurs during winter when no rainfall is expected. Furthermore, the success of this option will depend greatly on the implementation of the correct rehabilitation measures.

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SECTION 7: APPENDICES

Appendix 1: Methodology

Appendix 2: Site photographs

Appendix 3: Aquatic Macroinvertebrates

Appendix 1: Methodology

WATER QUALITY PARAMETERS

During the field survey, *in situ* water quality parameters were measured at each site using a Hanna Instruments HI991301 combination meter. Parameters measured included pH, conductivity, total dissolved solids (TDS), dissolved oxygen and temperature. The time of day during which the water quality parameters were taken was noted.

INVERTEBRATE HABITAT ASSESSMENT SYSTEM

The Invertebrate Habitat Assessment System (IHAS, Version 2.2), developed by McMillan (1998), has routinely been used in conjunction with the South African Scoring System (SASS) as a measure for the variability in the amount and quantity of aquatic macroinvertebrate biotopes available for sampling. During the course of the present study, the IHAS was applied to each site so as to compare the difference in the representative biotope sampling effort for aquatic macroinvertebrates and the condition of the habitat availability.

It has, however, become clear that the IHAS requires field validation and testing, and results obtained should be interpreted with care. Nevertheless, the IHAS does still provide a convenient and rapid method to record details about aquatic macroinvertebrate biotopes sampled during SASS application.

Table 9: Description of IHAS scores obtained (McMillan, 2006)

IHAS Score (%)	Description
>75	Very good
65-74	Good
55-64	Adequate / Fair
<55	Poor

AQUATIC MACROINVERTEBRATES

Aquatic macroinvertebrates were sampled utilising methodology based on the qualitative kick method called SASS5 (South African Scoring System, version 5). The SASS5 method takes into account the various habitats available to macroinvertebrates (Gravel/Sand/Mud, Stones and Vegetation) and attempts to record the diversity and abundances of the macroinvertebrates utilizing those habitats by means of representative sampling.

The collection of aquatic macroinvertebrates by means of the SASS5 method is done by churning up the sediment/gravel, kicking over stones and disturbing both aquatic and marginal vegetation, where available. Organisms are then collected by means of sweeping a 1000 micron net mounted on a 300mm square net over the disturbed area, and identified to family level (Thirion *et al*., 1995; Davies & Day, 1998; Dickens & Graham, 2001; Gerber & Gabriel, 2002).

Due to the fact that the Montana Spruit is a non-perennial river, the SASS5 index could not be applied, and the Present Ecological State in terms of aquatic macroinvertebrates could thus not be determined. The same sampling procedures as those utilised during SASS5 application were, however, retained so as to standardise the sampling protocol between sites and allow for a comparative assessment.

Appendix 2: Site Photographs

Montana 1

Montana 2

Appendix 3: Aquatic Macroinvertebrates

List of aquatic macroinvertebrate fauna samples in the study area
Abundances were estimated on the following scale:
1= single individual; A= 2-10; B= 11-100; C= 100-1000; and D > 1000

Taxon	Common Names	Montana 1	Montana 2
ANNELIDA			
Oligochaeta	Aquatic earthworm	A	
CRUSTACEA			
Potamonautidae	Crabs	A	
DIPTERA			
Chironomidae	Midges	1	
NUMBER OF TAXA:		3	0