REHABILITATION AND FLOODPLAIN RESTORATION PLAN

for

MONTANASPRUIT UPGRADE

Prepared for:
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For
City of Tshwane Metropolitan Municipality

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LIST OF ABBREVIATIONS

EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Plan
EcoMP	Ecological Management Plan
Ha	Hectare
CoT	City of Tshwane
NEMA	National Environmental Management Act
SEF	Strategic Environmental Focus (Pty) Ltd

1. INTRODUCTION

The City of Tshwane Roads and Stormwater department wishes to implement measures to alleviate flooding of properties along the Montana Spruit in Doornpoort, northern Tshwane in the Gauteng province. The location and project is described in chapter 2.

Environmental authorisation is required as the proposed development triggers a number of listed activities in terms of the regulations of the National Environmental Management Act, Act, 1998 (Act 107 of 1998), as amended [NEMA], and the Environmental Impact Assessment Regulations.

A Basic Assessment process was initiated in 2008 and after following the legislated process a Basic Assessment Report was submitted to the Gauteng Department of Agriculture and Rural Development [GDARD] in December 2009. After reviewing the application GDARD requested additional information including a rehabilitation and floodplain restoration plan.

Strategic Environmental Focus (Pty) Ltd (SEF) was appointed by TGM Consulting to prepare a rehabilitation and floodplain restoration plan that addresses the issues raised in GDARD's correspondence.

1.1. PURPOSE OF THIS REPORT

The purpose of this report is to respond to the request by GDARD that a rehabilitation and floodplain restoration plan be prepared that demonstrates how the floodplain will be rehabilitated and restored.

1.2. REFERENCE MATETIAL

This report is informed by the following specialist ecological assessments for this section of the Montana Spruit. The specialist reports are attached in Annexure D:

- Aquatic Assessment for the proposed project area prepared by Strategic Environmental Focus in June 2007;
- Vegetation Assessment of The Montana Spruit for the Proposed Confinement of The 1:100 Year Floodplain, Portions 28- 42, 137 and 138 of Doornpoort 295 JR, Tshwane, Gauteng for the proposed project area prepared by Strategic Environmental Focus in June 2007,
- Montana Spruit Channel Upgrade, Gauteng, Red Data Scan, Specialist Report, for the proposed project area prepared by Strategic Environmental Focus in May 2008,

1.3. Specialist findings and recommendations

1.3.1. Vegetation Assessment (June 2007)

- The site visit was not conducted at an ideal time of year.
- It was evident however that the site hosted distinct vegetation communities see Figure 2 of which the wetland and moist grassland communities are the only highly sensitive habitats on site. They have a High Ecological Function and High Conservation Importance.
- The moist grassland communities are located outside of the section of the spruit that the City of Tshwane intends to modify. The wetland areas are associated with artificial dams which will be retained.

- These sensitive vegetation communities are unsuitable for restructuring activities and must be protected.
- The remaining communities are suitable for the restructuring but mitigation and rehabilitation measures must be undertaken to restore them to an indigenous state.
- Disturbances in the form of alterations made to the spruit, exotic plant invasions, vegetation clearing, dumping in the spruit, cattle grazing, trampling and burning are evident on site.
- The functionality of this system has been and continues to be degraded which was confirmed by a Riparian Vegetation Index [RVI] assessment.
- The flooding on site has caused vegetation removal and has opened a niche (within the floodplain) for colonisation by exotic pioneer plants.
- The timing of the study, out of the flowering season of Red Data plants meant that insufficient Red Data sampling was done and follow-up Red Data scans are recommended in the flowering season. (See Red Data Scan findings below).
- Should the development be approved, sensitive habitats must be maintained and full rehabilitation and restoration of the riparian zone and floodplain is necessary to restore ecological functionality to this site.
- The restructuring activities must take place out of the rainy season.
- The removal of alien invasive plants is legislated and must be carried out with the appropriate method for each species type.

1.3.2. Red Data Scan (May 2008)

The Red listed plant species that are associated with the habitats that occur on site include *Stenostelma umbelluliferum* and *Trachyandra erythorrhiza*. Neither plant specie was recorded on site during the site visit and is not expected to occur within the study area. However, as suitable habitat is present for *Stenostelma umbelluliferum* and *Trachyandra erythorrhiza* along the Montana Spruit, the following measures are recommended:

- An independent Environmental Control Officer (ECO) must be appointed to manage the restructuring activities.
- The ECO must be made aware of the suitable habitat on site for *Stenostelma umbelluliferum* and *Trachyandra erythorrhiza* and of their potential to exist on site. The ECO must then carefully monitor the site for these two species.
- If plants are discovered, positive identification must be made by an ecologist and the relevant authorities must be consulted for removal and protection of the plant.
- Adjacent natural sections of the site must remain undisturbed by the restructuring activities. This can be accomplished by clearly demarcating the study area with wire fencing to prevent any activity spill over in terms of construction materials and workforce.
- Black turf soils are highly susceptible to erosion and careful management of soil piles is necessary to facilitate the rehabilitation process.

1.3.3. Aquatic Assessment (June 2007)

- 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.

- During the time of the field survey [March 2007], water was observed 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.
- The aquatic assessment refers to research that suggests that re-colonisation by macroinvertebrates within non-perennial rivers takes place rapidly after inundation with early pioneers appearing within the fist two weeks and majority of typically occurring species appearing within 4-6 weeks.
- Dams and weirs built in non-perennial rivers may serve as refugia for aquatic macroinvertebrates and fish.
- Floods generally reduce taxa richness in re-colonised non-perennial streams during the wet period, with recovery of the macroinvertebrate assemblages occurring at least two weeks after the initial flood event. The increased frequency of floods resulting from the increasing level of urbanisation in the upstream catchment may cause a decrease in macroinvertebrate diversity in the spruit.
- 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.
- No Red Data fish species are likely to occur within the study area.

The specialist reports included recommended impact mitigation measures which would be included in the project Environmental Management Plan.

2. DESCRIPTION OF PROPOSED PROJECT

2.1. LOCATION

The proposed development is located along the Montana Spruit in Doornpoort, northern Tshwane in the Gauteng province see Figure 1. It traverses a number of properties and is treated as a linear development. The affected properties of the Montana Spruit Channelisation Improvement Project (Section 1) include Portions 28 to 42, 134, 135, and 137 and a remainder of the Farm Doornpoort 295 JR, Tshwane, Gauteng see Figure 4.

A large scale site layout plan is included in Annexure A: Site Layout showing the combined layout of the proposed project covering the study areas of two adjacent sections (Section 1 and Section 2) each with a different applicant and environmental application process.

In response to comments received in the public participation process the proposed project was extended upstream to address stormwater discharge that enters the spruit on the retirement village property portion 257 of the farm Hartebeesfontein 324-JR. This was included based on direct consultation between the project engineer on behalf of the City of Tshwane and the retirement village management.

The co-ordinates of the site are:

- Starting point of the activity 25.662006 S 28.263414 E
- End point of the activity 25.651536 S 28.262900 E

1. GENERAL PROJECT DESCRIPTION

The proposed interventions include:

- Channelisation of Montana Spruit by changing the existing channel through excavating and shaping and widening. This will provide enough space to meet flood conveyance targets, increase vegetation in the channel, improve habitat conditions, and improve water quality in the stream;
- Vertical re-alignment of the crossing of Tsamma Road over the Montana Spruit; and
- Improvement of stormwater management on Breed Street.

Sections illustrating the proposed cross-sectional profile of the modified channel where prepared by the project engineer IR Consulting Engineers. Typical sections are included see Figure 3 illustrating the proposed method of increasing the cross-section of the channel to meet the flood conveyance targets. Hatched areas indicate material to be excavated while the thicker black line indicates the proposed new channel bottom. The existing invert level of the stream will not be exceeded. The existing channel bottom will be protected from further erosion through scouring by a lining of “armorflex”.

The vertical axis of the sections is exaggerated by a factor of 10 relative to the horizontal axis in order to communicate the detail of the section which would otherwise be obscured. The actual depth of excavation is typically 600mm and less. References to the “road centreline” are typing errors and should instead say “channel centreline”.

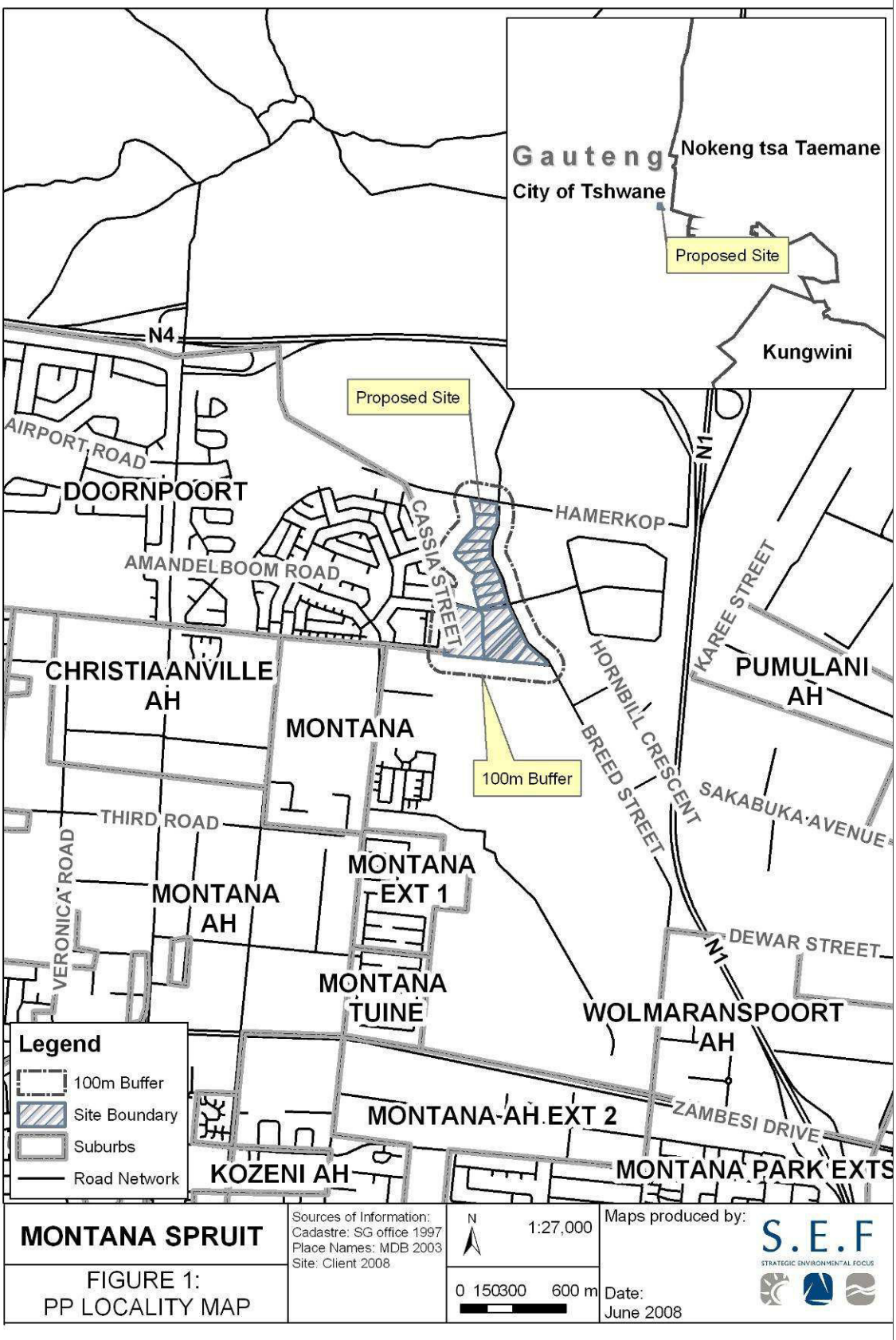


Figure 1: Locality Map

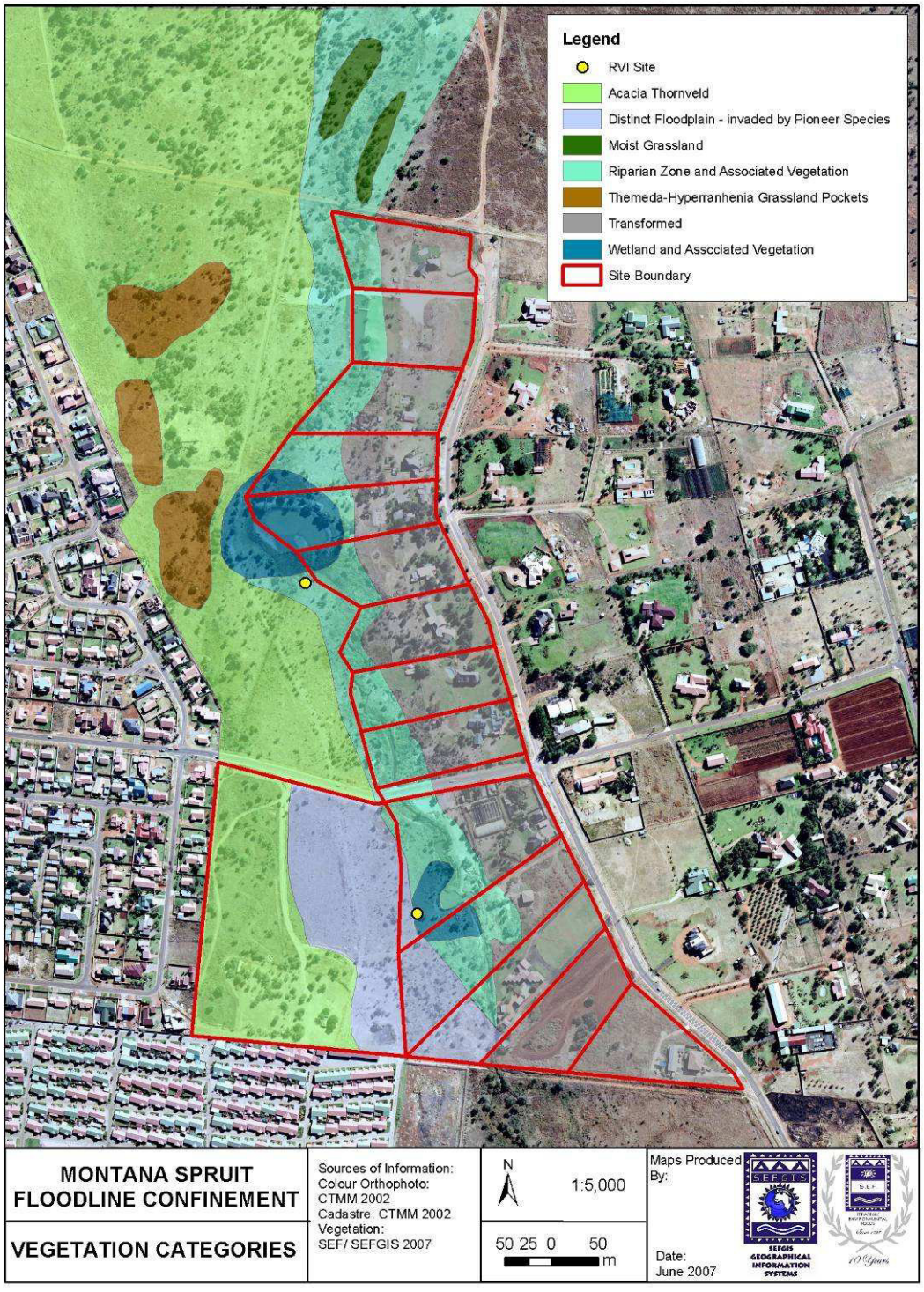


Figure 2: Identified Vegetation Communities

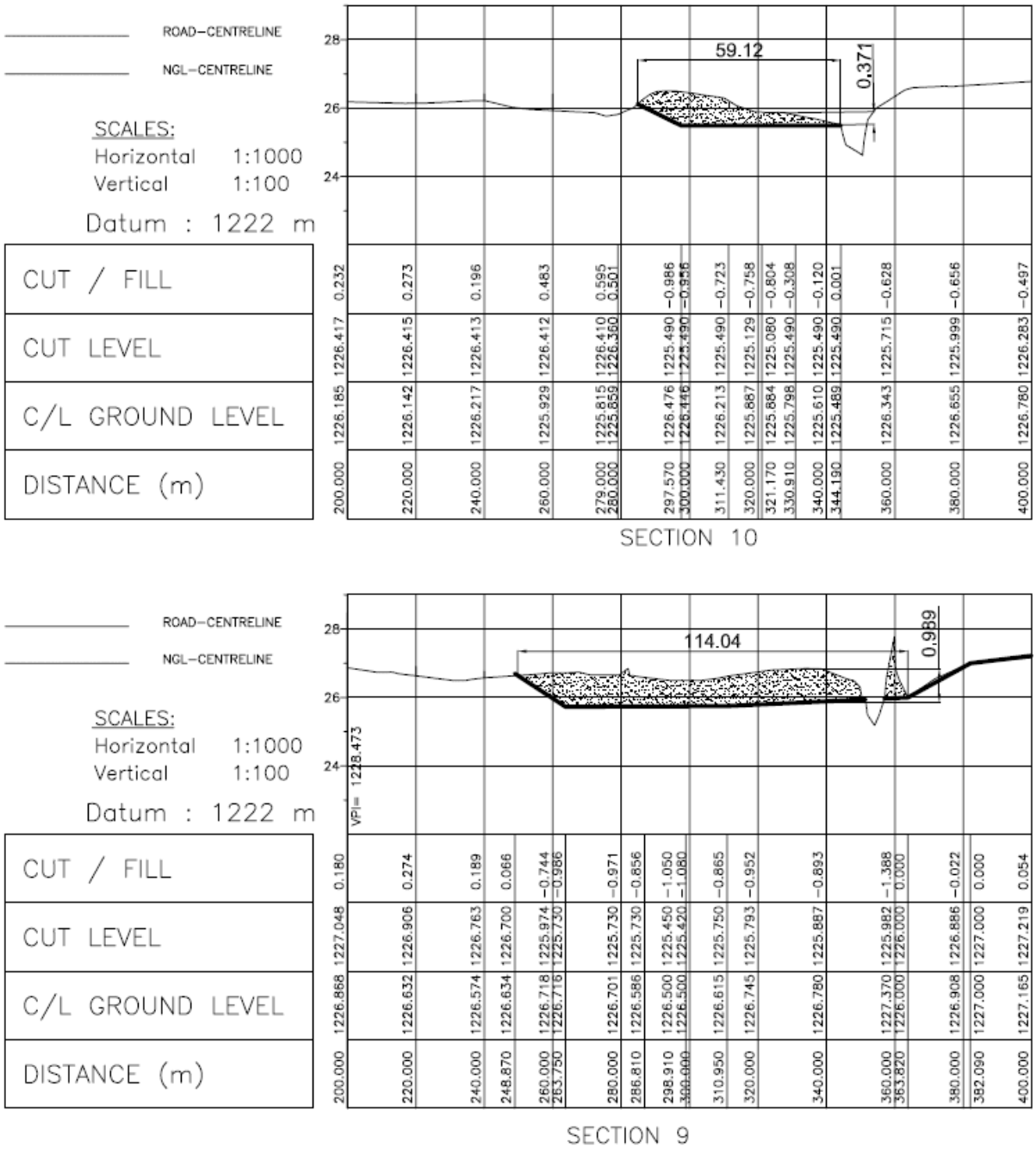


Figure 3: Typical Sections of proposed modification to channel cross-section

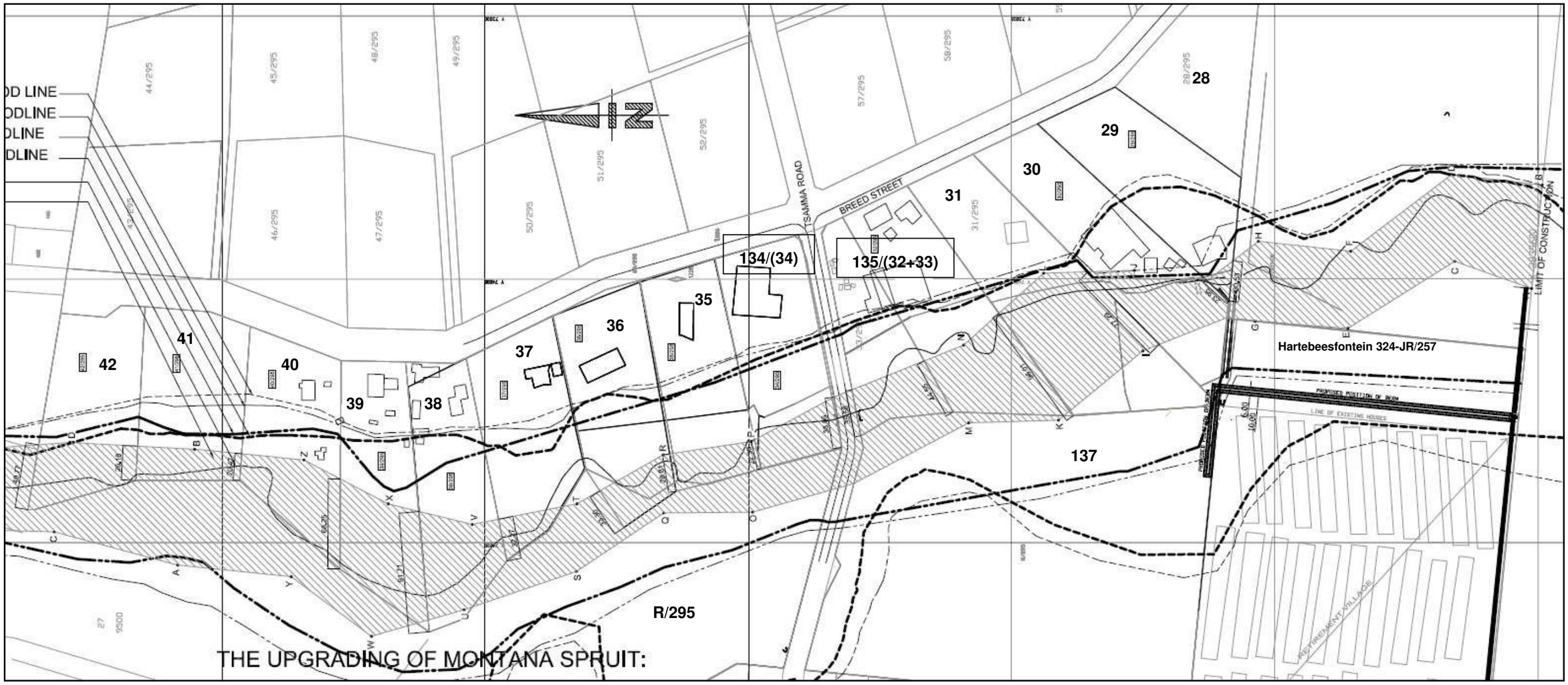


Figure 4: Site Layout

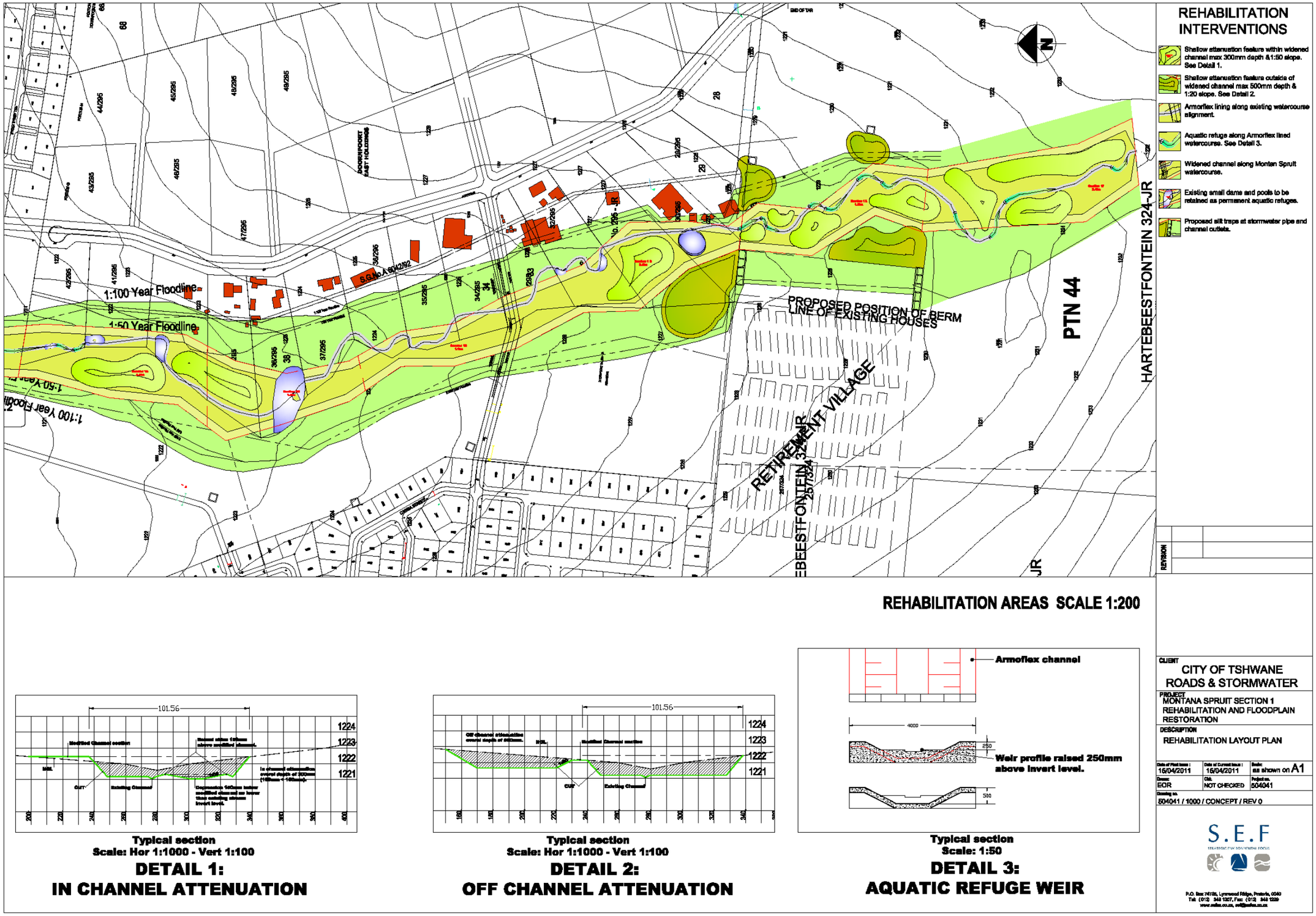


Figure 5: Rehabilitation Layout Plan

3. REHABILITATION PLAN

The rehabilitation and restoration of the floodplain will require the following interventions:

- Protection of sensitive vegetation communities;
- Re-vegetation of areas disturbed during the construction phase according to the respective aquatic, wetland and terrestrial habitats;
- Creation of a series of the following habitats:
    - Shallow in-channel depressions to form seasonal wetlands;
    - Shallow off-channel attenuation ponds;
    - In-stream low weirs to form sediment traps and micro wetlands as aquatic refuges; and
    - Terrestrial grassland areas; and
- Sormwater managements systems at stormwater outlets including silt traps, attenuation ponds and energy dissipaters.

The rehabilitation process must be closely aligned with the construction process which is dictated by the scope of work, site accessibility, weather and site conditions. The following key elements should be implemented in sequence for successful rehabilitation once the contractor has been appointed:

- Construction site plan
- Site establishment plan
- Construction programme
- Setting out the disturbance footprint (construction works)
- Photographic record
- Habitat protection
- Stormwater and erosion management
- Clearing works area.
- Construct temporary diversion channel
- Undertake earthworks
- Construct engineered structures
- Excavate attenuation ponds
- Complete construction.
- Establish topsoil and propagation material
- Surface erosion protection
- Seeding
- Irrigation
- Monitor and remedial action

3.1. Construction site plan

3.1.1. Location

The proposed development is located along the Montana Spruit in Doornpoort, northern Tshwane in the Gauteng province.

3.1.2. Affected Properties

The project site affected Portions 28 to 42, 134, 135, and 137 and a remainder of the Farm Doornpoort 295 JR, Tshwane, Gauteng

3.1.3. Access points

The site can easily be accessed from two adjacent roads:

- Tsamma Street that crosses the Montana Spruit and bisects the site into a southern and northern portion; and
- Breedt Street that converges with the spruit at the northern most point

3.1.4. Site Plan

The appointed contractor must prepare a construction site plan prior to taking over the site that indicates the boundaries of the site that encompasses all construction related activities, access points and disturbance footprint of construction activities. The sections according to the contractor's intended production sequence must be clearly indicated and sequentially labelled. Proposed methods to ensure a balance of material (topsoil and vegetation) between adjacent work sections. This may include modification of the proposed sections and or temporary stockpiles.

3.2. Site establishment plan

This plan must be prepared by the contractor in consultation with the engineer and ecologist / ECO and must include the contractor's camp, material lay down yards, storage yard for construction vehicles and plant, ablution facilities, internal haulage routes, stockpile area(s) for topsoil and vegetation, subsoil and imported soils. Existing 1:50 year floodlines on both sides of the stream must be indicated.

3.3. Construction programme

The construction programme must reflect the separate work sections in chronological order according to the contractor's intended production sequence described on the construction site plan. Rehabilitation activities must be added to the programme to ensure concurrent rehabilitation of completed sections using topsoil and vegetation cleared from the next section in sequence. This must be prepared by the contractor in consultation with the ecologist or ECO and engineer.

3.4. Setting out the disturbance footprint

Prior to commencing with site establishment, clearing of vegetation or earthworks, the contractor must set out the planned works and contractor's site establishment using suitable stakes that must be protected during construction. The following must be set out and clearly marked using colour coding:

- Outer extent of earthworks (embankment crest and working area);
- Toe of the embankments;

- The 1:50 year flood line on both sides of the stream;
- Works sections and transition boundaries;
- The contractor's areas for site establishment:
  - Contractor's camp,
  - Material lay down yards,
  - Storage yard for construction vehicles and plant,
  - Ablution facilities,
- Internal haulage routes,
- Temporary stockpile area(s) for topsoil and vegetation, subsoil and imported soils, and
- Protected vegetation communities and trees.

3.5. Photographic record

The ECO or ecologist must inspect the setting out points and record the location and condition of protected vegetation communities and trees, the vegetation adjacent to the works area relative to the setting out points and condition of the spruit both upstream and downstream of the project area..

3.6. Habitat protection

The ECO or ecologist must ensure that the sensitive wetland area, other vegetation communities and specimen trees that must or can be retained are properly demarcated and enclosed by wire fences.

Where trees are to be retained the wire fence must encircle the drip line of the existing crown of the tree(s) and not just the trunk.

3.7. Stormwater and erosion management

- Reduce the potential of erosion due to surface and concentrated stormwater flows:
  - All construction activities should take place during winter when no rainfall is expected to occur;
  - Attenuate flows within the drainage system, to reduce runoff velocity;
  - Minimise the duration of land clearing;
  - Install erosion control measures around the works and construction yard areas prior to the onset of construction;
  - Install temporary diversion channels and silt traps within the stream channel for each section prior to undertaking earthworks adjacent to the existing channel;
  - Identify all stormwater outlets and drainage lines entering the works area and install temporary attenuation ponds of suitable volume to detain and gradually release stormwater thereby avoiding erosion and increased sediment load within the stream in the event of out of season rainfall;
- Temporary stockpiles (including topsoil, spoil, vegetation & imported material):
  - Stockpiles must be located outside of the proposed channel and the 1:50 year flood line;
  - Locate stockpiles away from concentrated flows and divert stormwater around them using sandbags or low earth walls;

  - Stockpiles must not be higher than 2m to avoid compaction,
  - Instead of stockpiles single handling is recommended, strip topsoil and vegetation from a new work section to rehabilitate the previous work section;
- Exposed soil:
  - Reduce run-off over exposed areas by using diversion earth banks, catch drains and silt fences;
  - Use soil saver blankets to protect exposed soil or disturbed vegetation with gradients of 1:5 or greater;
- Contamination of surface water:
  - Construction vehicles are to be maintained in good working order to reduce the probability of leakage of fuels and lubricants;
  - A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
  - Sufficient care must be taken when handling these materials to prevent spillage and pollution;
  - Surface water draining off contaminated areas containing oil and petrol must be channelled towards a sump which will separate out these chemicals and oils before treated water is allowed to enter the sprut;
  - Concrete, if necessary, shall be mixed only in areas which have been specially demarcated for this purpose and should not be mixed on exposed soil;
  - Stormwater shall not be allowed to flow through the batching area with surface runoff diverted around the area by means of sandbags or earth walls;
  - 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;

3.8. Clearing works area

Prior to clearing the works area the following must be implemented and approved by the ECO:

- Only one works section may be cleared of vegetation at a time to reduce the area of exposed soil at any given time;
- Initial removal of alien and invasive plant species:
  - The contractor must identify all occurrences of alien and invasive plant species in the work section using the alien and invasive plant schedule in Annexure B as a reference;
  - The alien and invasive plants must be treated and removed as specified in Chapter 5: Alien Invasive Management - Methodologies And Guidelines of the Ecological Management Plan prepared by SEF dated April 2011;
  - All remaining plant material: leaves branches, roots and seeds must be collected from the soil surface and disposed of in an incinerator or by means of composting process using a high temperature to kill off the propagation material;

  - The ECO or ecologist must inspect the section and accept that all alien and invasive plant infestations have been cleared;
- Preparation, setting out and acceptance by ECO / ecologist:
  - Preparation of the Construction site plan, Site establishment plan and Construction programme;
  - The works area, contractor's site establishment areas, the works sections and protected tree(s) and vegetation communities must be set out by a suitably qualified surveyor and marked with stakes with colour coding;
  - The current works section must be accepted by the ECO or ecologist;
  - The ECO or ecologist must complete the photographic record;
  - All areas of sensitive vegetation communities and trees that are to be retained must be adequately demarcated and protected by means of a fence (HAZARD TAPE MAY NOT BE USED TO DEMARCATE TREES OR VEGETAION TO BE RETAINED);
- Clearing of woody material:
  - All trees and large woody shrubs that are to be removed must be marked with an X on the main trunk using red paint, groups of trees can be marked by surrounding them with hazard tape while the perimeter trees are marked with an X;
  - The ECO must inspect the current work section and accept the trees and shrubs demarcated for retention and those marked for removal;
  - The above ground woody material must be removed and fed through a chipper to create mulch which must be stockpiled for use during rehabilitation;
- Clearing & Grubbing:
  - Once woody material has been removed, the works area for the current works section only, must be grubbed to a depth of 300mm;
  - The mix of topsoil and vegetation must be spread over the exposed soil of the previously completed work section to a depth of 350mm including 'air volume' and allowed to settle;
  - Excess material must be stockpiled where it can be used to rehabilitate the current work section once excavation and shaping are complete.

3.9. Construct temporary diversion channel

Excavation of the embankments either side of the existing channel will disturb large amounts of soil that can enter the stream and result in excessive sediment deposition downstream. This is particularity a concern while the stream is flowing. In addition the black turf soils are very difficult to work when wet. It is therefore advisable both from and ecological and construction perspective to divert any flow in the stream around excavation and shaping activities.

When constructing temporary diversion channels the following must be taken into consideration:

- The alignment of the existing channel must be marked with stakes placed every 10m metres along the length of the channel to orient the project team during earthworks;
- The coordinates of the stakes must be captured on a drawing and the stakes remain in place until the 'armorflex' lining is installed;

- Alternatively earthworks should cease within 1m of the edge of the channel on both sides and the channel with the 1m bank and its vegetation either side left undisturbed until the 'armorflex' is installed;
- A temporary or permanent slit trap must be constructed below the current work section;
- The proposed alignment of the diversion channel must be discussed with and accepted by the ECO to avoid disturbance of protected tree(s) or vegetation communities;
- A diversion channel/trench can then be excavated with an invert level no lower at any point than the existing channel that discharges into the silt trap before discharging into the existing stream channel of the work section downstream.

3.10. Undertake earthworks

- The material within the widened channel must be excavated and removed to a suitable and approved spoil site.

3.11. Construct engineered structures

- All engineered structures such as 'gabion basket walls', 'reno-mattresses', 'armorflex' lining and silt traps must be constructed. All cement, concrete and litter must be removed.

3.12. Excavate attenuation ponds

Two types of attenuation ponds are proposed both of which serve to attenuate flow. The first is a very shallow pond located within the newly widened channel, with a depth of 300mm made up of a 150mm depression and raised crest of another 150mm on average. The crest of the depression must be level.

These attenuation ponds will increase the capacity of the channel to detain water during minor flood events which will encourage the development of wetlands and provide refuges for aquatic species.

A second attenuation pond type is located outside of the widened channel with a depth of 500mm on average. Also constructed by a combination of a depression of 250mm and a raised earth embankment of 250mm. The crest of the depression must be level.

- The location and approximate extent of these attenuation ponds is described on the rehabilitation layout plan see Figure 5. A larger drawing on an A1 sheet is included in Annexure A.
- The contractor must set out the crest and toe of the attenuation ponds which must be inspected by the ECO or ecologist to ensure that no protected trees or vegetation communities are disturbed by the excavation and shaping of the ponds. The outline of the ponds may be revised on site to avoid protected areas or include them as raised "islands" within a pond.
- The gradient of the pond slopes must not be steeper than 1:50.

3.13. Complete construction

- All construction equipment and materials must be removed from the work area. All construction waste and rubble must be removed and final shaping must be completed before rehabilitation of the current work section commences.

3.14. Establish topsoil and propagation material

- The mixed vegetation and topsoil removed from the next work section or from the surplus stockpile of the current work section must be spread to an even depth of 350mm including the 'air volume' and allowed to settle.
- The topsoil must be placed starting with the furthest point first and gradually retreating to exit the work section;
- No heavy construction vehicles are to traverse the newly placed topsoil, only light construction vehicles such as a bobcat loader / grader can be used to shape the topsoil layer.

3.15. Surface erosion protection

The measures describe for stormwater and erosion management must be implemented.

Where soil will be left exposed for more than a month and where no further earthworks or shaping is planned within the next month, and where the rainy season is approaching then the exposed soil must be protected from erosion by establishing a temporary grass cover, by using a soil saver blanket or on steeper slopes using both methods to protect the highly erodible soils from washing into the stream.

3.16. Seeding

- The method of rehabilitation of using stripped topsoil with the embedded seed and propagation material will ensure that a representative mix of plant species that occurred in the area will re-colonise the reshaped channel surface.
- To ensure a more rapid establishment of a vegetation cover to protect the exposed soils it is recommended that the area be seeded either by hand or by hydro-seeding. Once the topsoil has been spread evenly over the works area and any areas disturbed by construction activities, a seed mix comprising of indigenous and non invasive naturalised grass seeds must be spread to at a rate of 40kg per hectare. The seed mix may include the following species, the exact mix will be determined by the availability and suitability of specific seeds at the time of construction and may include seeds of indigenous grasses already occurring on the site:
    - *Bothriochloa insculpta* (Pinhole grass)
    - *Dicanthium annulatum* (Vlei Finger grass)
    - *Leersia hexandra* (Wild rice grass)
    - *Eragrostis tef*
    - *Eragrostis curvula*
    - *Digitaria eriantha*
    - *Chloris gayana*
    - *Cynodon dactylon*

3.17. Irrigation

- Irrigation may be required to encourage early germination of grass seeds where rehabilitated areas are completed during the dry winter months and where the rainy season is a few months away. Without a vegetation cover dust suppression would be required to limit the impact of wind blown dust on adjacent residential buildings.
- Temporary portable irrigation systems must be used.

- No construction vehicles including water carts may traverse rehabilitation areas. Water carts and pumps can be used from adjacent undisturbed areas to provide water to temporary irrigation systems.
- Water may not be extracted from the stream especially from standing pools of water which provide a refuge to aquatic species during the dry period.

3.18. Monitor and remedial action

- An increase in Total Suspended Solids (TSS) and turbidity in the stream may result if exposed soil is transported from the wok areas into the stream;
- Regular monitoring of the water quality in the stream will identify ongoing and consistent washing of soil into the stream;
- Occasional incidents related to accidental deposition of soil in the stream channel will not necessarily be picked up by the water monitoring programme. In these instances the contractor's environmental liaison officer or site manager must identify the source and prevent further washing of soil into the stream;
- Other contaminants of concern are:
  - Oils and greases, metal residues, waste solvents
  - Phosphates;
  - Nitrates and nitrites;
  - Ammonia;
  - Total coliforms, faecal coliforms and E. Coli
- The water monitoring programme included in the approved project Ecological Management Plan must be implemented;
- The ECO or ecologist must inspect areas being rehabilitated once a month to ensure that the intended rate of vegetation establishment is being achieved consistently throughout the rehabilitated area and in areas of no growth instruct the contractor to remedy the situation through supplementary irrigation, seeding or application of topsoil;
- The ECO or ecologist must also monitor the site for re-establishment of alien or invasive plant infestation and where problematic instruct the contractor to undertake follow up eradication actions; and
- The ECO or ecologist must sign off areas where vegetation cover has achieved 75% using nearby undisturbed areas of vegetation as a benchmark.

3.19. Plant species for rehabilitation

A detailed list of plant species that should be used to re-vegetate is included in Annexure C.

3.20. Materials - type and quantity

The re-vegetation method makes use of existing topsoil incorporating seeds and vegetative propagation tissue of existing plants to re-colonise the disturbed areas. The materials used or moved during the modification of the Montana Spruit channel will include the following, the values are estimates and may have to be adjusted to accommodate on site conditions:

- Existing topsoil including seeds & plants (stripped and spread after earthworks) - Balanced cut to fill
- Rock for gabion baskets and reno mattresses - Approximately 10,000m^3 of rock

- Wire mesh for gabion baskets and reno mattresses - Approximately 11,000m^2 of mesh
- 'Armorflex' lining - 8,950m^2 (1,790mx5m)
- Seed mix to establish quick grass cover - 420kg grass seed mix

3.21. Proposed landscaping on the floodplain

With the exception of existing residents gardens, no ornamental landscaping is intended for the floodplain. The floodplain will be re-vegetated using indigenous plant species to create a similar natural habitat as is currently found along the spruit. Where residents have existing ornamental landscapes on their property within the works area these areas will be returned to ornamental landscaping similar to the existing in consultation with the landowners. Where possible landowners will be encouraged to use only indigenous plant species.

4. CONCLUSION AND RECOMMENDATIONS

The proposed project entails modification of the existing stream channel through excavation, shaping to widen the channel and lining of the existing channel bottom using 'armorflex'. This will result in certain significant transformation of the existing channel and its embankments.

Concurrent rehabilitation is essential to restore the vegetation cover including wetland habitats as soon as possible to avoid further degradation through erosion and alien & invasive plant infestation.

This rehabilitation plan requires that the rehabilitation actions be implemented as an integrated part of the overall construction programme and relies on the construction taking place in a series of sections each being cleared, constructed and then re-vegetated in an overlapping sequence. This allows the cleared soil and vegetation from a new section to be used immediately on the just completed section adjacent.

Undertaking the construction work in sections along the length of the stream reduces the extent of soil exposed at any given time.

The success of the rehabilitation plan relies on correct timing of the construction work to coincide with the dry season and regular interaction between the contractor, project engineer and ecologist or ECO.

This report must be read in conjunction with the approved Environmental Management Plan and the Ecological Management Plan.

5. REFERENCES

IR Consulting Engineers (2007). 'CB 357 / 2006: Montana Spruit Channel Improvements – Preliminary Design Report', Draft.

Strategic Environmental Focus (2007). 'Vegetation Assessment of the Montana Spruit for the Proposed Confinement of the 1:100 Year Floodplain, Portions 28- 42, 137 And 138 of Doornpoort 295 Jr, Tshwane, Gauteng.'

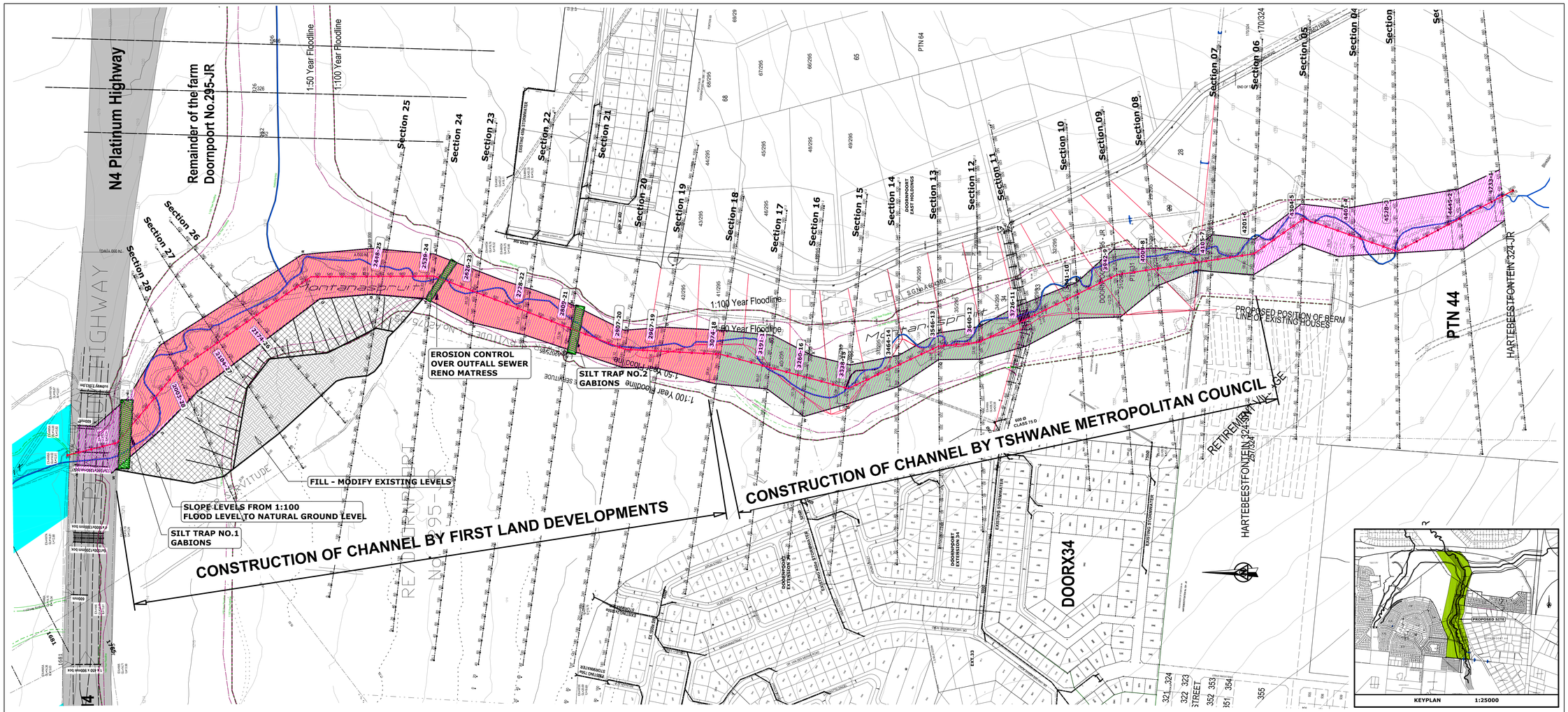
Strategic Environmental Focus (2007). 'Proposed Confinement of the 1:100 Year Floodline on The Montana Spruit (Portions 28 To 42 and 134, 135, and 137 Of Doornpoort 295 Jr), Tshwane, Gauteng: Aquatic Assessment.'

Strategic Environmental Focus (2008). 'Montana Spruit Channel Upgrade, Gauteng. Red Data Scan, Specialist Report.'

6. ANNEXURES

ANNEXURE A: DRAWINGS

- Site Plan
- Rehabilitation Layout Plan



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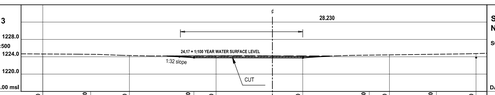
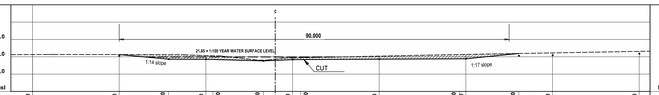


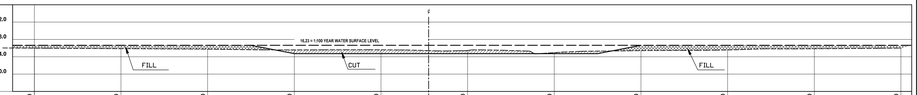
Peg Distance (m)	280.00	299.000	314.880	320.000	328.000	348.000	358.370	368.000	378.850	380.000
Ground level (m)	1224.24	1224.41	1223.78	1224.02	1223.77	1223.74	1223.72	1223.78	1223.80	1223.78
Channel level (m)	1224.40	1224.41	1223.78	1223.82	1223.77	1223.74	1223.72	1223.78	1223.80	1223.78

SECTION 17 NO.3191



Peg Distance (m)	280.00	300.00	311.390	320.000	331.420	333.250	340.000	341.660	370.330	380.000	392.210	400.000
Ground level (m)	1222.23	1222.23	1221.44	1222.00	1221.43	1221.65	1221.34	1221.43	1221.46	1221.54	1223.23	1222.36
Channel level (m)	1222.27	1222.23	1221.44	1222.00	1221.43	1221.65	1222.12	1221.43	1221.46	1221.54	1223.23	1222.36

SECTION 27 NO.2104



Peg Distance (m)	0.000	20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	200.000	220.000	240.000	260.000	280.000	300.000	320.000	340.000	360.000
Ground level (m)	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99	1215.99
Channel level (m)	1216.59	1216.77	1216.94	1217.11	1217.27	1217.44	1217.61	1217.77	1217.94	1218.11	1218.27	1218.44	1218.61	1218.77	1218.94	1219.11	1219.27	1219.44	1219.61

CROSS SECTION NUMBER	NO.28 CH.2700	NO.27 CH.2551	NO.26 CH.2397	NO.25 CH.2255	NO.24 CH.1990	NO.23 CH.1811	NO.22 CH.1628	NO.21 CH.1442	NO.20 CH.1650	NO.19 CH.1666	NO.18 CH.1400	NO.17 CH.1238	NO.16 CH.1060	NO.15 CH.1010	NO.14 CH.1030	NO.13 CH.1130	NO.12 CH.1170	NO.11 CH.1189	NO.10 CH.1325	NO.9 CH.1339	NO.8 CH.1180	NO.7 CH.1228	NO.6 CH.1262	NO.5 CH.1364	NO.4 CH.1337	NO.3 CH.1325	NO.2 CH.1392	NO.1 CH.1387
SECTION CODE	2003	2104	2174	2448	2539	2626	2728	2809	2907	2967	3074	3191	3260	3338	3464	3546	3640	3726	3841	3942	4009	4105	4201	4304	4401	4528	4645	4733
EXISTING Q TOTAL 1:50 year	106.2	106.2	106.2	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3
EXISTING Q TOTAL 1:100 year	161.2	161.2	161.2	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1
EXISTING Velocity (m/s) 1:50 year	2.21	1.29	1.92	0.77	1.14	0.68	0.98	1.13	0.88	0.96	1.37	1.20	0.91	0.94	1.78	0.93	1.21	1.78	1.11	1.22	0.95	1.43	0.89	1.16	1.20	1.21	1.52	1.64
EXISTING Velocity (m/s) 1:100 year	2.43	1.44	1.71	0.86	1.09	0.73	0.64	1.28	1.01	1.10	1.54	1.34	1.03	0.79	1.91	1.06	1.37	1.91	1.22	1.36	1.03	1.62	1.02	1.58	1.31	1.42	1.91	1.19
PROPOSED Q TOTAL 1:50 year	106.5	106.5	106.5	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3	48.3
PROPOSED Q TOTAL 1:100 year	161.2	161.2	161.2	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1
PROPOSED Velocity (m/s) 1:50 year	2.14	1.52	1.21	0.74	1.18	0.80	1.25	1.08	1.47	1.20	1.69	1.68	0.75	0.91	1.36	1.17	1.64	0.96	1.64	1.17	0.94	1.23	0.65	1.15	1.21	1.38	1.89	1.15
PROPOSED Velocity (m/s) 1:100 year	2.36	1.68	1.36	0.87	1.43	1.19	1.49	1.26	1.60	1.46	1.25	1.73	0.90	1.13	1.47	1.46	1.76	1.20	2.08	1.47	1.17	1.62	0.77	1.35	1.55	1.63	1.17	1.37

NOTAS / NOTES

VERNIETIG ALLE VORIGE TEKENINGE MET ONTVANGS VAN GEWYSIGDE PLAN
DESTROY ALL PREVIOUS DRAWINGS ON RECEIPT OF REVISED DRAWING

GENERAL LEGENDS

LEGEND:

- EXISTING STORMWATER
- EXISTING KERB INLET
- PROPOSED STORMWATER
- PROPOSED KERB INLET
- STORMWATER MANHOLE
- GRID INLET
- FIELD INLET

NOTES:

1. SEE TYPICAL DETAIL DRAWING FOR ALL ROADS AND STORMWATER DETAILS.
2. ALL STORMWATER INLETS AND OUTLETS TO BE COVERED WITH VERMIN PROOF GRATING.
3. ALL KERBS FIG. UNLESS OTHERWISE INDICATED.
4. ALL STORMWATER INLETS AND OUTLETS TO BE COVERED WITH VERMIN PROOF GRATING.

No.	DATE	INITIALS	DESCRIPTION
Nr.	DATUM	PARAAF	BESKRYWING

WYSIGINGS AMENDMENTS

JMC CONSULTING ENGINEERS
DEVELOPMENT MANAGEMENT
ENGINEERING CONSULTANTS
Reg. No 2002/017652/07
P.O. BOX 781037
SANDTON, 2146
TEL: 086 111 5842
FAX: 086 677 5222

DRAWING FILE REF.: 0724/ 0723-54LS

PROJEK / PROJECT

DOORNPOORT STORMWATER MANAGEMENT

BESKRYWING / DESCRIPTION

MONTANA SPRUIT UPGRADE

DESIGN VERTICAL ALIGNMENT

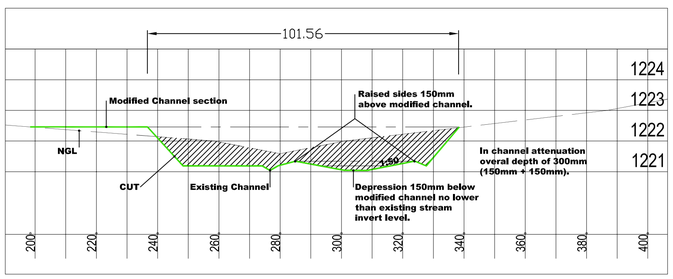
ONTWERP / DESIGN	P ALBERTYN
NAGESIEN / CHECKED	
GETEKEN / DRAWN	IF OOSTHUIZEN
INGENIEUR / ENGINEER	AJ STANDER Pr Eng 810496
DATUM / DATE	30 / 7 / 09
GOEDGEKEUR / APPROVED	
AFDRUK DATUM / PRINT DATE	
KLIENT VERW / CLIENT REF	
SKAAL / SCALE	1 : 2500
TEKENINGNOMMER / DRAWING NUMBER	0723 / 54
	0

DOORNPOORT SW: - MONTANA SPRUIT LIS: - 0723 / 54 (rev.0)

REHABILITATION AREAS SCALE 1:200

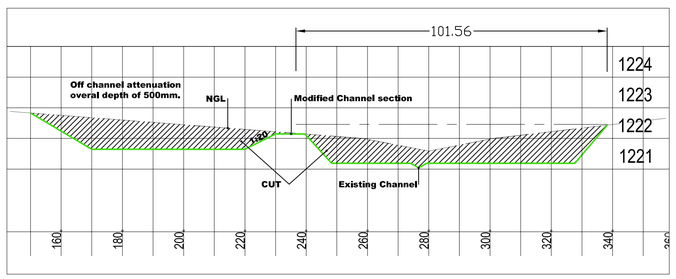
REHABILITATION INTERVENTIONS

- Shallow attenuation feature within widened channel max 300mm depth &1:50 slope. See Detail 1.
- Shallow attenuation feature outside of widened channel max 500mm depth & 1:20 slope. See Detail 2.
- Armorflex lining along existing watercourse alignment.
- Aquatic refuge along Armorflex lined watercourse. See Detail 3.
- Widened channel along Montan Spruit watercourse.
- Existing small dams and pools to be retained as permanent aquatic refuges.
- Proposed silt traps at stormwater pipe and channel outlets.



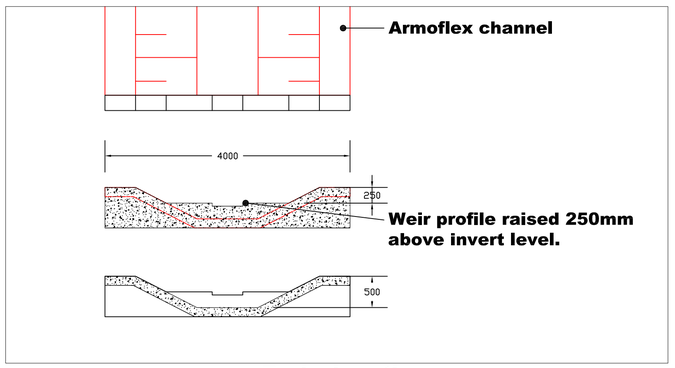
Typical section
Scale: Hor 1:1000 - Vert 1:100

DETAIL 1:
IN CHANNEL ATTENUATION



Typical section
Scale: Hor 1:1000 - Vert 1:100

DETAIL 2:
OFF CHANNEL ATTENUATION



Typical section
Scale: 1:50

DETAIL 3:
AQUATIC REFUGE WEIR

REVISION		

CLIENT
CITY OF TSHWANE
ROADS & STORMWATER

PROJECT
MONTANA SPRUIT SECTION 1
REHABILITATION AND FLOODPLAIN
RESTORATION

DESCRIPTION
REHABILITATION LAYOUT PLAN

Date of First issue :	Date of Current issue :	Scale:
15/04/2011	15/04/2011	as shown on A1
Drawn: EOR	**Chk.** NOT CHECKED	**Project no.** 504041

Drawing no.
504041 / 1000 / CONCEPT / REV 0

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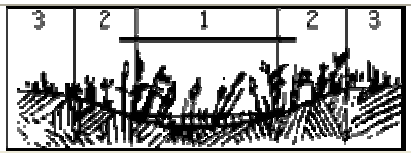
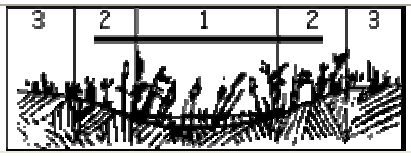
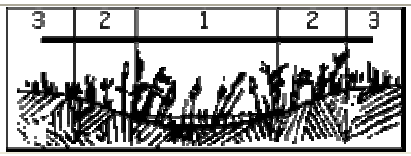
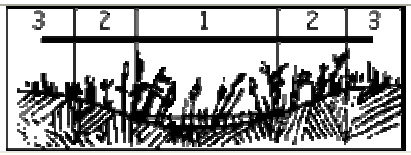
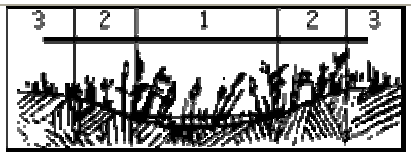
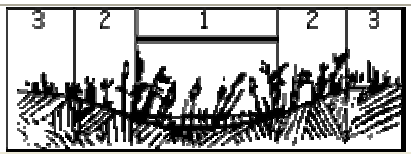
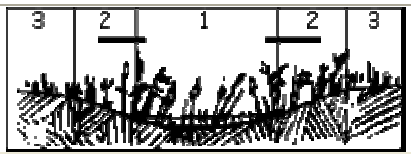
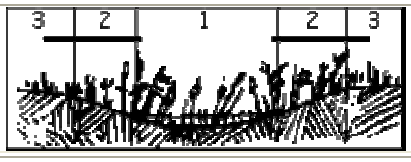
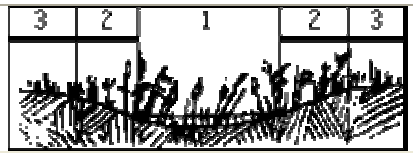
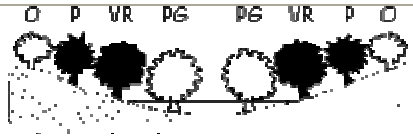
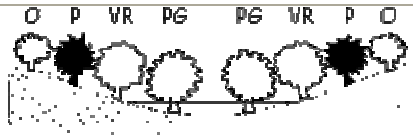
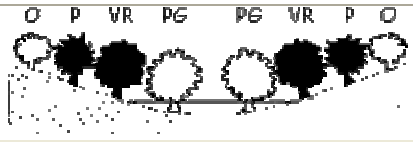
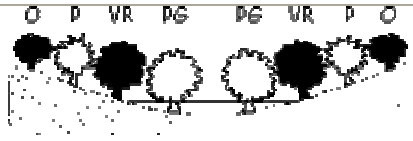
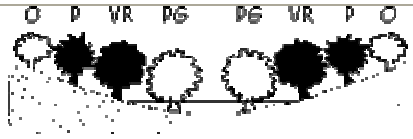
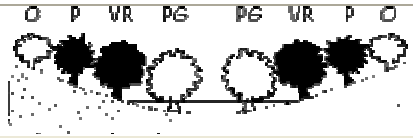
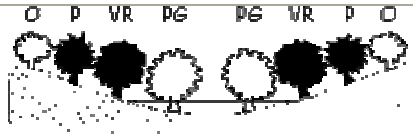
ANNEXURE B: ALIEN AND INVASIVE PLANTS SCHEDULE

Scientific Name	**Common Name**	**Status**	**Declared Invader category**
Agrave americana	American agave	category 2	Invader
Arundo donax	Spanish Reed	category 1	Weed
Asclepias fruticosa	Shrubby Milkweed		
Bidens pilosa	Blackjack		
Conyza albidia	Tall Fleabane		
Conyza bonariensis	Flaxleaf Fleabane		
Conyza canadensis	Horseweed Fleabane		
Cyperus rotundus	Purple nutsedge		
Melia azedarach	Syringa	category 3	Invader
Nothoscordum gracile	Fragrant False-Garlic		
Paspalum notatum	Bahia Grass		
Protasparagus laricinus	Wild Asparagus		
Sesbania punicea	Red Sesbania	category 1	Weed
Solanum mauritianum	Bugtree	category 1	Weed
Verbena bonariensis	Wild Verbena		
Xanthium strumarium	Large Cocklebur	category 1	Weed
Zinnia peruviana	Redstar Zinnia		

ANNEXURE C: PLANT SPECIES FOR REHABILITATION

Indigenous plants suitable for rehabilitation in riparian areas and floodplain (modified from:Wyatt, J., Rennies Wetlands Project 1997 , SECOND EDITION)

Plant name	Distribution	Optimal position in the channel
Dichantium annulatum Vlei Finger Gras		All positions except permanent zone, including adjacent terrestrial zone.
Bothriochloa insculpta Pinhole Gras		All positions except permanent zone, including adjacent terrestrial zone.
Typha capensis **Bulrush**		
Phragmites australis ***P.mauritianus*** **Common reed**		
Echinochloa colona *E. crus-galli* Jungle rice Watergras		
Cynodon dactylon Couch grass Kweek isiFulwane		
Leersia hexandra **Wild ricegrass** **Wilde rysgras**		
Cyperrus papyrus Papyrus		
Juncus kraussli *J.effusus* Juncus iNcema		
Hermarthria altissima Red swamp grass Rooikweek		

Plant name	Distribution	Optimal position in the channel
Imperata cylindrica Cottonwool grass Dousgras um Thente		
Acacia karroo **Sweet thorn** **Soetdoring** **umunga**		
Acacia robusta Splendid thorn Enkeldoring		
Ceitis africana White stinkwood Witstinkhout um Vumvu		
Halleria lucida Tree fuchsia Notsung iMinza		
Llex mitis African holly Without iPhuphuma		
Leucosidea sericea Oldwood Ouhout umTshitshi		
Myrica piluifera Broad-leaved waxberry Breeblaarwasbessie		
Searsia (Rhus) lancea **Willow rhus** **Karee** **& *Searsia (Rhus) pyroides***		

Species that should be included in seed-mix

Scientific name	*Common name*
Bothriochloa insculpta	Pinhole Gras
Themeda triandra	Red grass
Setaria incrassata	Vlei bristle grass
Digitaria eriantha	*Finger grass*
Cynodon dactylon	*Couch grass*
Eragrostis curvula	*Weeping love grass*
Imperata cylindrica	*Cottonwool grass*
Panicum maximum	*Guinea grass*

Vegetation species for rehabilitation of stormwater retention pond and outlet swales

Scientific name	Common name
Shrubs sedges and bulbs	
Berula erecta	
Cyperus spp.	
Gomphostigma virgatum	Otterbossie
Juncus kraussii	
Juncus effuses	Rush
Typha capensis	Bulrush
Melianthus major	
Wachendorfia thyrsiflora	Bloodroot
Grasses:	
Bothriochloa insculpta	Pinhole Gras
Acroceras macrum	Nile grass
Cynodon dactylon	Couch grass
Digitaria eriantha	Finger grass
Eragrostis curvula	Weeping love grass
Eragrostis teff	
Imperata cylindrica	Cottonwool grass
Leersia hexandra	Wild ricegrass
Panicum maximum	Guinea grass
Setaria sphacelata var sphacelata	

ANNEXURE D: SPECIALIST ECOLOGICAL ASSESSMENT REPORTS

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

SEF Ref No.: 500396

Prepared for:

SSV Consulting Engineers & Project Managers
1040 Burnett Street
Hatfield
Pretoria
0083

Prepared by:

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June 2007

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.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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.

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. 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.

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°C to 40°C, with an average of 19°C (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

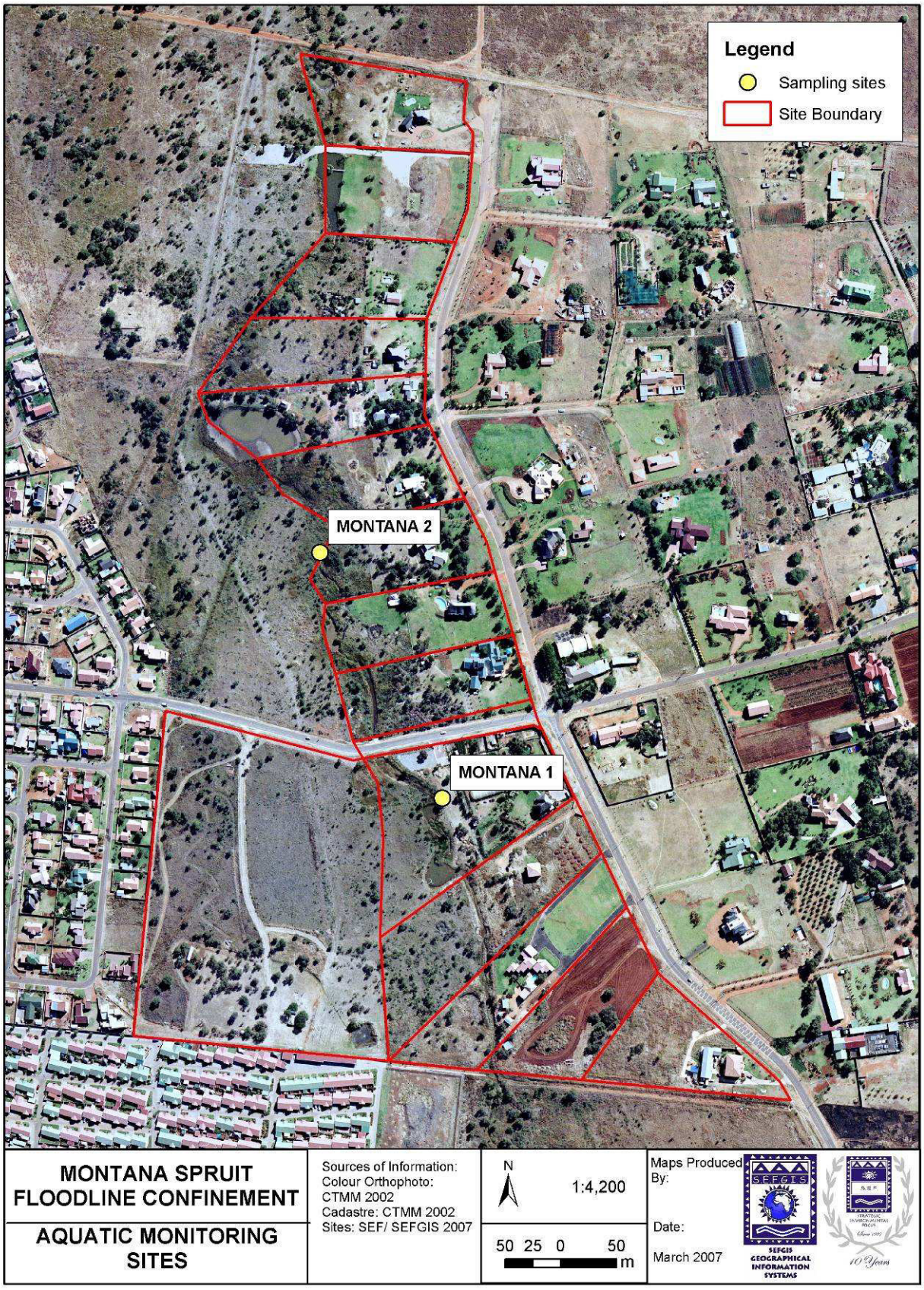

Figure 2: Aquatic monitoring sites assessed during the present study

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

VEGETATION ASSESSMENT OF THE MONTANA SPRUIT FOR THE PROPOSED CONFINEMENT OF THE 1:100 YEAR FLOODPLAIN, PORTIONS 28- 42, 137 AND 138 OF DOORNPOORT 295 JR, TSHWANE, GAUTENG.

DATE: June 2007
SEF Ref No. 500396

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GAUT REF No: 002/06-07/0585

EXECUTIVE SUMMARY

City of Tshwane Metropolitan Municipality (CTMM) have received complaints regarding the flooding of the Montana Spruit in Pretoria since the mid 1990s. The municipality now propose remedial action to prevent this problem. SSV Consulting Engineers and Project Managers (SA) have been appointed to manage this project. The remedial action involves the restructuring of the spruit. These activities will cover Portions 28-42, 137 and 138 of Doornpoort 295-JR, Pretoria.

A GIS scan indicated that the site lies on Marikana Thornveld (Mucina & Rutherford, 2006) which is an extremely threatened vegetation type occurring in Gauteng. The study site has also historically supported Red Data species (C-plan V2, 2005). GDACE has therefore requested that a vegetation assessment of the site be undertaken to identify the presence of primary vegetation, sensitive habitats and Red Data species. Strategic Environmental Focus (Pty) Ltd as independent consultants were appointed by SSV Consulting Engineers and Project Managers (SA) to undertake such an investigation.

Access restrictions were encountered during fieldwork and this limited the sampling that could take place during the first site visit on 27 March 2007. A second site visit was then undertaken on 11 June 2007 when the remainder of the study area was evaluated. Six vegetation communities were identified on site. Two were highly sensitive communities for their important ecological functions. These communities were in a natural state and were less disturbed. The protection of sensitive and undisturbed vegetation communities is also legislated. These communities comprised the moist grassland community and wetland vegetation. Consequently, they are considered to be of *High Conservation Importance* and *High Ecological Function.*

Other communities were identified and comprised the *Acacia* thornveld communities, *Themeda-Hyparrhenia* grassland, riparian vegetation/zone and the pioneer dominated floodplain. Due to the low species diversity, high presence of exotic species, the lack of sensitive habitats and lack of 'ecological services' presented by these communities, they were considered to be of *low Ecological Function* and *low Conservation Importance.*

In conclusion; the sensitive communities are unsuitable for restructuring activities and this must be avoided. If this is not possible; remedial action must be undertaken as far as possible. The remainder of the site is suitable for the restructuring activities.

As the study did not occur within the appropriate flowering season of Red Data plants. It is recommended that a Red Data scan be undertaken in the flowering season before the development is approved. A comprehensive site restoration and rehabilitation plan is necessary to guide restoration of the ecological functionality of the system.

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1. INTRODUCTION

The rapid rate of development in Gauteng means that less suitable land is left available for development, and in turn marginally suitable areas are coming under the strain of development. In numerous instances development occurs too near rivers and even within the 1:100 year floodplain. These developments often then experience serious flooding events.

Within urban areas, storm water runoff can cause the flooding of local rivers as well as of the urban area itself. Urbanization drastically alters the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff. While the impact on major river systems may be minimal, the carrying capacity of small streams may be quickly exceeded, causing flooding and erosion problems. Often, the runoff from intense rainfall exceeds the carrying capacity of the sewer system, creating a backup in the system and hence the flooding of properties and of roads (Environment Canada, 2007).

In the past, planning and developments did not consider the natural environment and this lead to the over-exploitation and destruction of important natural environments. Various legislation has since been passed in order to govern, limit and encourage the best possible use of natural resources to avoid environmental degradation. The most applicable of these to this study are:

- The National Water Act (Act No. 36 of 1998): includes the protection of aquatic and associated ecosystems, biodiversity and the regulation of water use and activities in wetlands, rivers and lakes.

- Nature Conservation Ordinance 12 of 1983: regulates nature conservation in Gauteng.

- National Environmental Management Act (Act 107 of 1998) (NEMA): One of the principles of this act states that development must be socially, environmentally and economically sustainable. Sustainable development requires consideration of all relevant factors including the following:

    - That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; and

    - That pollution and degradation of the environment are avoided, or where they cannot be altogether avoided, are minimised and remedied.

In line with this legislation and the NEMA regulations, developers are now required to

conduct ecological assessments of floral and faunal communities and their associated habitats in order to identify and suitably allocate areas for potential conservation and development.

1.1 PROJECT DESCRIPTION

City of Tshwane Metropolitan Municipality (CTMM) proposes to undertake remedial action for the flooding in the area through the restructuring of the floodplain. Engineering solutions were evaluated and one has been selected from a number of possible alternatives. This option as stated in the technical report (PDNA, 2006) strives to rectify the flooding problem at Tsamma Road Bridge as well as in the properties adjacent to the Montana Spruit.

These proposed restructuring activities will affect the riparian zone. Riparian land is very valuable because it is the most fertile and productive part of a landscape (Land for Wildlife, 2002). The interaction between land and water in the riparian zone provides a range of micro-habitats that support a diverse range of flora and fauna. Highly fertile soils and moist conditions increase the establishment and growth of a diverse range of plant species (Land for Wildlife, 2002).

The study site lies within the Marikana Thornveld vegetation unit (Mucina & Rutherford, 2006). The South African National Spatial Biodiversity Assessment Report (2004) has listed Marikana Thornveld as an endangered savanna type that is poorly conserved. Consequently, SSV Consulting Engineers and Project Managers (SA) appointed Strategic Environmental Focus (Pty) Ltd to undertake a plant and vegetation assessment on the site in search of sensitive habitats and plants.

1.2 TERMS OF REFERENCE

The terms of reference for the study were listed as follows;

1) A vegetation assessment which entailed the following (GDACE, 2006a):

- Location and extent of all plant communities be mapped;
- Determination of ecological sensitivity of each plant community;
- A general Red List plant survey;
- Plant species lists provided for each plant community with medicinal and invasive / exotic status indicted. The numbers of forbs / herbs, grasses, shrubs and tree species indicted for each plant community; and
- The condition of any grassland on site assessed and the location and extent of primary grassland mapped. All primary grassland will be designated as

ecologically sensitive.

2) A plant assessment which entailed the following (GDACE, 2006a):

- A survey for Orange and Red List plant species;
    - The survey should be undertaken during the flowering season of *Eulophia leachii* and *Schizoglossum umbelluliferum*;
    - The surveys must encompass the site and all relevant adjacent properties; and
- Populations of Red and Orange List plants be designated as sensitive in a sensitivity map. Buffers must be consistent with Red List plant buffers.

1.3 LIMITATIONS

The following limitations were experienced whilst conducting the fieldwork;

- *Inacessibility*

a) A limitation to sampling was the inaccessibility of the spruit. The entire spruit along Tsamma Road was fenced off with the only access through adjacent landowner's properties.

b) This was in the form of a legal dispute between the municipality and landowners along the spruit. This meant that landowners were reluctant to grant access to the spruit

- *Site disturbances*

The site had been recently burnt on certain portions making plant and vegetation community identification difficult. Vegetation had also been cleared away with only a few areas of uniform vegetation left to sample

- *Alterations to spruit*

These were caused by illegal dumping and alterations to channel. This meant that there was not a continuous channel in which sampling could take place.

- *Unsuitable timing of study*

The study was not conducted in the flowering period of plants (February/March). This meant that Red Data plants were not in flower, that geophytic plants have their leaves below ground and that grasses have lost their inflorescences. This made plant identification difficult and may have caused important flagship species that are indicators of ecological condition and plant community dynamics to be overlooked.

2. BACKGROUND INFORMATION

2.1 LOCATION

The proposed confinement of the Montana Spruit will be focused on portions 28 to 42, 137 and 138 of Doornpoort 295 JR, Gauteng. This study area is situated within the urban boundary. It runs parallel to Breed Street with Tsamma Road passing through it (Figure 1).

2.2 LAND USE

The current land use along the spruit is residential housing on portions 28 to 42 and 138, with vacant land on portion 137.

2.3 CLIMATE

Data from the nearest weather station (University Experimental Farm) revealed that the study area is characterized by summer rainfall with dry winters. Mean annual precipitation is between 600-700mm and frost can be expected in winter. Average temperatures in summer months reach 35.8°C and in w inter months decrease to -1.0°C.

2.4 GEOLOGY AND SOIL

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).

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).

2.5 REGIONAL VEGETATION

The site falls within an area classified as Marikana Thornveld (Mucina & Rutherford, 2006). Low and Rebelo (1996) classify the area in which the site occurs as Clay Thorn Bushveld of the savanna biome.

Marikana Thornveld

The dominant vegetation is open *Acacia karoo* woodland which occurs in valleys, slightly undulating plains and lowland hills. Shrubs are mostly found in a dense distribution along drainage lines or in habitat protected from fire. It is an endangered vegetation unit with less than 1% statutorily conserved (Mucina & Rutherford, 2006).

Clay Thorn Bushveld

Clay Thorn Bushveld is dominated by various *Acacia* species as well as other woody species such as Buffalo Thorn (*Ziziphus mucronata*), Sicklebush (*Dichrostachys cinerea*) and Wild Raisin (*Grewia flava*) (Low and Rebelo, 1996). Only 0.93% of this vegetation type is formally conserved in South Africa (Low and Rebelo, 1996). The economic uses occurring in this vegetation type are crops, production of wheat, maize and sunflowers as well as livestock farming.

Figure 1. Locality Map

3. VEGETATION ASSESSMENT

3.1 METHODOLOGY

Areas of uniform vegetation were identified from aerial images of the site. A site visit was then undertaken on the 27th March 2007 and again on 11 June 2007 to assess these areas. Sampling was undertaken to determine the following outcomes;

- Plant species lists;
- Ecological condition and functionality;
- Red Data plants;
- Vegetation dynamics;
- Riparian Vegetation Index (RVI); and
- Level of disturbance and transformation.

The methodology involved Braun-Blanquet sampling in 8m x 8m quadrats along the spruit. This was conducted at three locations to evaluate species type and abundance in the riparian zone. An RVI assessment was conducted at two sites according to the guidelines set out by Kemper (2001), and line transects were walked throughout the site.

Braun-Blanquet sampling is a method of measuring cover abundance through estimating the quantity of each species in a vegetation sample (Mueller-Dombois & Ellenberg, 1974).

The RVI technique was developed through the Water Research Commission of South Africa and is a method of assessing the habitat integrity of riparian vegetation consistent with certain criteria. Vegetation can then be classified according to certain ecological classes based on the level of disturbance and transformation.

Stratified line transects entailed walking line transects through the site and noting down the plant species encountered, as well as the vegetation dynamics and ecological condition of the site. During this time, a scan for Red Data plants was also conducted

Based on the above findings, the ecological sensitivities of the study sites were determined. The sensitivity of each site was quantified by assessing the ecological function and conservation importance of the sites. These are defined as follows:

High ecological function: These are sensitive ecosystems that have a low resistance or resilience towards disturbance factors or are highly dynamic systems that are considered to be stable and important for the maintenance of ecosystem integrity and offer ecosystem services. These are therefore not suitable for development and must be protected.

Medium ecological function: These are relatively important ecosystems at gradients of intermediate disturbances. An area directly adjacent to sensitive or pristine vegetation may also be considered to be of medium ecological importance as it serves as an important buffer zone. Low density development may often be allowed here, depending on the species occurring.

Low ecological function: These are degraded and highly disturbed sites with little or no ecological function. These are often suitable for development.

High conservation importance: When the species richness of the vegetation is high, this provides a suitable habitat for a number of threatened species. For this reason; these are not suitable for development and should be protected.

Medium conservation importance: Ecosystems with intermediate levels of species diversity and whose vegetation does not support any threatened species are considered to be of medium conservation importance. Here low-density development may be allowed if the suitable mitigation measures are taken to protect important plants.

Low conservation importance: These are areas with little or no conservation potential and are usually devoid of indigenous species. They are dominated by exotic species and are considered suitable for development.

3.2 DESCRIPTION OF AFFECTED ENVIRONMENT

Upon evaluating the landscape, distinct vegetation communities were recorded on site. These were riparian vegetation within the riparian zone, as well as *Acacia* thornveld communities and grassland communities. The *Acacia* thornveld communities were in a variety of states ranging from undisturbed to highly disturbed due to burning and trampling. Grassland communities consisted of *Themeda-Eragrostis-Setaria* moist grassland and *Themeda-Hyparrhenia* communities.

The site appeared to be a matrix of different habitats and vegetation communities which comprised various forbs. This may be due to its location in a water rich environment. There were heavily trampled and grazed areas within the *Acacia* thornveld communities with evidence of cattle grazing in this area.

Protosparagus laricinus was a widespread invader of the *Acacia* thornveld communities with *Asclepias fruticosa* and *Aristida* species being secondary invaders of the bare parts of the floodplain. The RVI assessment revealed that the score at both sites fall between 9-12, within Class D. This means that these sites have largely been modified and a large loss of natural habitat and ecosystem functions have occurred.

The visual representation of the site is shown in the photographs below and all plant

species observed on site are listed in Appendix 1.

Photograph 1: Burnt *Acacia* thornveld vegetation

Photograph 2: *Themeda-Hyparrhenia* grassland

Photograph 3: Moist grassland

Photograph 4: Floodplain invaded by pioneers

Photograph 5: Wetland vegetation

4. RESULTS

4.1 RED DATA AND PROTECTED PLANTS

No red data species were found on site during this study. However, C-plan version 2 listed the site as containing important plant and animal taxa.

Flora

According to GDACE (2006), certain Red/Orange List plant species have been recorded from the quarter degree grid square in which the study site is situated, none of which were seen on site at the time of the study. Of the list released by GDACE (2006), potentially suitable habitat for three species was present on site (Appendix 2). This habitat was, however, negligible and has been disturbed through burning, cattle grazing and trampling. The occurrence of these species is therefore unlikely.

Protected Plants

No plant species that are listed as protected under Schedule 11 (Nature Conservation Ordinance No. 12 of 1983 for the Regional Legislation Service-Gauteng) were observed at the time of the study.

4.2 DECLARED WEEDS AND INVADER PLANTS

Concern is growing over the way in which alien/exotic plants are invading large areas within South Africa. Invasive species are a major threat to the ecological functioning of natural systems as well as the productive use of the land, and should ideally be removed if they are serving no ecological function. In terms of the amendments to the regulations under the Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983), landowners are legally responsible for the control of invasive alien plants on their properties. There are currently 198 alien species listed as declared weeds and invaders, these have been divided into three categories (Henderson, 2001):

- **Category 1 plants** are prohibited and must be controlled.
- **Category 2 plants** (commercially used plants) may be grown in demarcated areas proving that there is a permit and that steps are taken to prevent their spread; and
- **Category 3 plants** (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading there of, except within the flood line of watercourses and wetlands.

The exotic species found within the study area are listed in Appendix 6.

4.3 FAUNA

The investigation of faunal species was not stipulated in the terms of reference. They were included in the scope of the report due to their association with the vegetation communities on site.

Red Data Birds

It was noticed by the ecologist that an abundance of birdlife was present on site. Though no avifauna assessment was undertaken, suitable habitat for Red Listed birds (Appendix 3) was noted on site.

Red Data Herpetofauna (amphibians and reptiles)

According to GDACE (2006), certain Red Data reptiles and amphibian species have been recorded in the area (Appendix 4). None were seen on site at the time of the study. However, suitable habitat for only the Giant Bullfrog (*Pyxicephalus adspersus*) is present on site. This is a near threatened species and suitable habitat warrants

conservation.

Red Data Mammals

A GIS scan picked up that the site was rated as important for mammals by C-Plan (2005). As per GDACE (2006) records, the historically occurring Red Data mammals are listed in Appendix 5. Possible habitat (Minter *et al*. 2004) for the following mammals was present on site; the Juliana's golden mole, water rat, brown hyena, serval, spotted necked otter and rough-haired golden mole. There were no sightings of these animals and their occurrence is unlikely given the disturbances surrounding the study site. However, the study site should be appropriately rehabilitated after the development to encourage the return of any potential mammal inhabitants

Personal communication with land owner, Mr Bernard Green of Portion 30 Doornpoort alerted the ecologist to the presence of the last remaining porcupine in the area, a pair of cane rats and bush babies on his property.

Red Data Invertebrates

An invertebrate assessment was not undertaken.

4.4 CONSERVATION IMPORTANCE & ECOLOGICAL FUNCTION

A number of distinct vegetation communities were present on site. These are described below with the corresponding photographs. Figure 2 illustrates the location and extent of these communities on site.

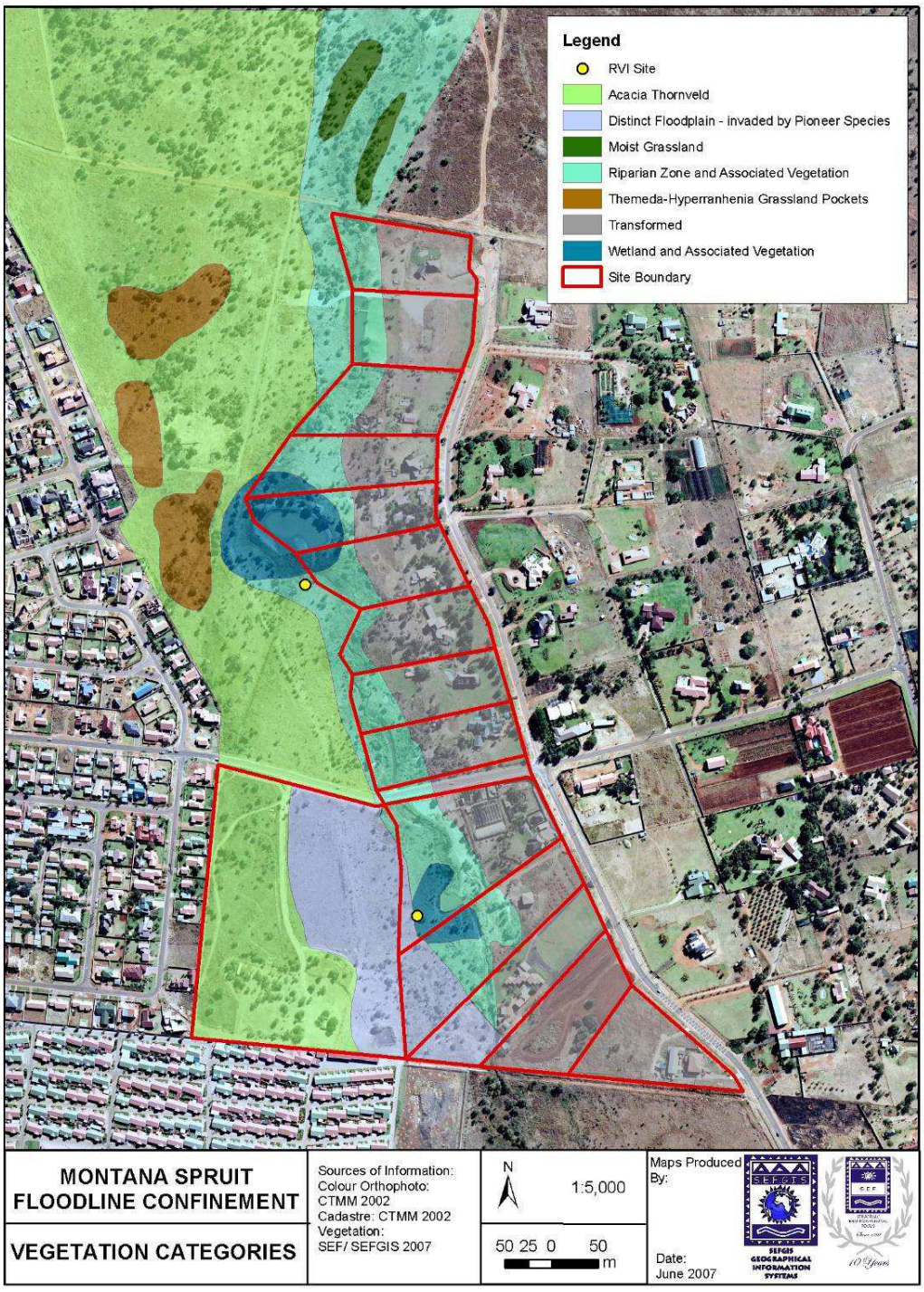

Figure 2: Vegetation communities identified.

Discussion

The *Acacia* thornveld vegetation communities have been heavily disturbed by overgrazing, trampling, burning and exotic plant invasions. The grasses that previously occurred as part of this vegetation community are being excluded leaving the soil bare or with short trampled grass patches. No Red Data plants or habitat were observed within this community and *Protasparagus laricinus* is heavily encroaching on the *Acacia* thornveld communities. Pockets of bush thicket and scattered *Hypoxis* sp. are common occurrences. The *Acacia* thornveld communities are considered to be of ***Low Conservation Importance***.

The wetland communities are made up mainly of tall *Typha capensis* reeds, surrounding the permanently saturated areas such as the dams along the spruit. These sections of the spruit are highly sensitive. Wetlands are valuable for a number of direct and indirect benefits such as water purification, sustained stream flow, flood reduction, ground water recharge / discharge, erosion control, biodiversity conservation, chemical cycling and water supply. Wetlands are also protected under the National Water Act (Act No. 36 of 1998). Consequently these wetland areas have a ***High Conservation Importance*** and ***High Ecological Function***.

The landscaped gardens along the spruit form part of residential developments. They were created through uprooting of natural vegetation and the replacement with landscaped areas. Dumping of soil and dam creation along the spruit has also occurred. From a vegetation perspective, the landscaped areas do not contain any plants that are worthy of conservation. However, they may still provide shelter, nesting sites and movement corridors for fauna. The ***Conservation Importance*** of the landscaped areas is ***low*** but ***Ecological Functionality*** *is* ***Medium***. The landscaped areas are directly adjacent to the riparian zone and serve as an important buffer zone.

Riparian vegetation occurs along the spruit. It has largely been disturbed and invaded by exotics, but some fairly undisturbed pockets still exist. An RVI assessment was undertaken at two sites along the spruit (Figure 2). Results indicated that the riparian vegetation was in a degraded state and largely made up of exotic species. It is mainly composed of trees, bushes, grasses and sedges. Commonly occurring plants include *Acacia karoo, A. nilotica., Conyza albidia, C. bonariensis Pognotharia squarrossa, Berkheya spp., Rhus sp. Setaria sphaecelata sp., Cyperus spp. and Cynodon dactylon.* Evidence of geophytes was also present but identification was difficult out of the flowering season. Riparian vegetation encompasses the stream channel and the portion of the landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables, flooding, or the ability of soils to hold water. This riparian zone is in a degraded state and consequently has a ***Low Ecological Function*** and ***Low Conservation Importance***. The exotic invaders are not able to perform the important functions (flood attenuation, water retention and nutrient cycling) as well as indigenous riparian species. Their presence has degraded the functionality of the

riparian zone. It is recommended that the rehabilitation of this zone be undertaken to restore ecosystem functionality.

There are two main grassland communities within the study area, the moist grasslands close to the spruit and the grassland pockets within the *Acacia* thornveld matrix. The moist grassland is dominated by tall *Themeda-Eragrostis-Setaria* species. The undisturbed state of the moist grassland may offer suitable breeding and nesting habitat for Red Data species, namely the vulnerable Grass Owl and the African Marsh Harrier bird species. These moist grasses may also offer suitable habitat for *Trachyandra erythorrhiza*, a near-threatened Red Data plant. The moist grasslands on site are consequently of ***High Conservation Importance***. Their location surrounded by open areas of the land means they have escaped disturbance, and they serve as refuge sites for faunal species. The moist grasslands have a ***High Ecological Functionality***.

The *Themeda-Hyparrhenia* grassland pockets that occur within the *Acacia* thornveld matrix are ecologically less sensitive. They may be important for temporary faunal inhabitants and for foraging purposes but are entirely surrounded by disturbed or degraded *Acacia* thornveld communities. Their ***Ecological Functionality*** is therefore **Medium**. The ***Conservation Importance*** of these grasslands is **Low** as they do not host any sensitive species or habitat.

A sensitivity map is displayed in Figure 3.

Areas of sensitivity were rated according to ecological functionality and conservation importance. Areas of high sensitivity encompass the wetland vegetation and the moist grassland. These are the two most sensitive vegetation communities on site. Areas of medium sensitivity encompass the *Acacia* thornveld, floodplain and *Themeda-hyparrhenia* grassland communities. Areas of low sensitivity are the transformed residential areas.

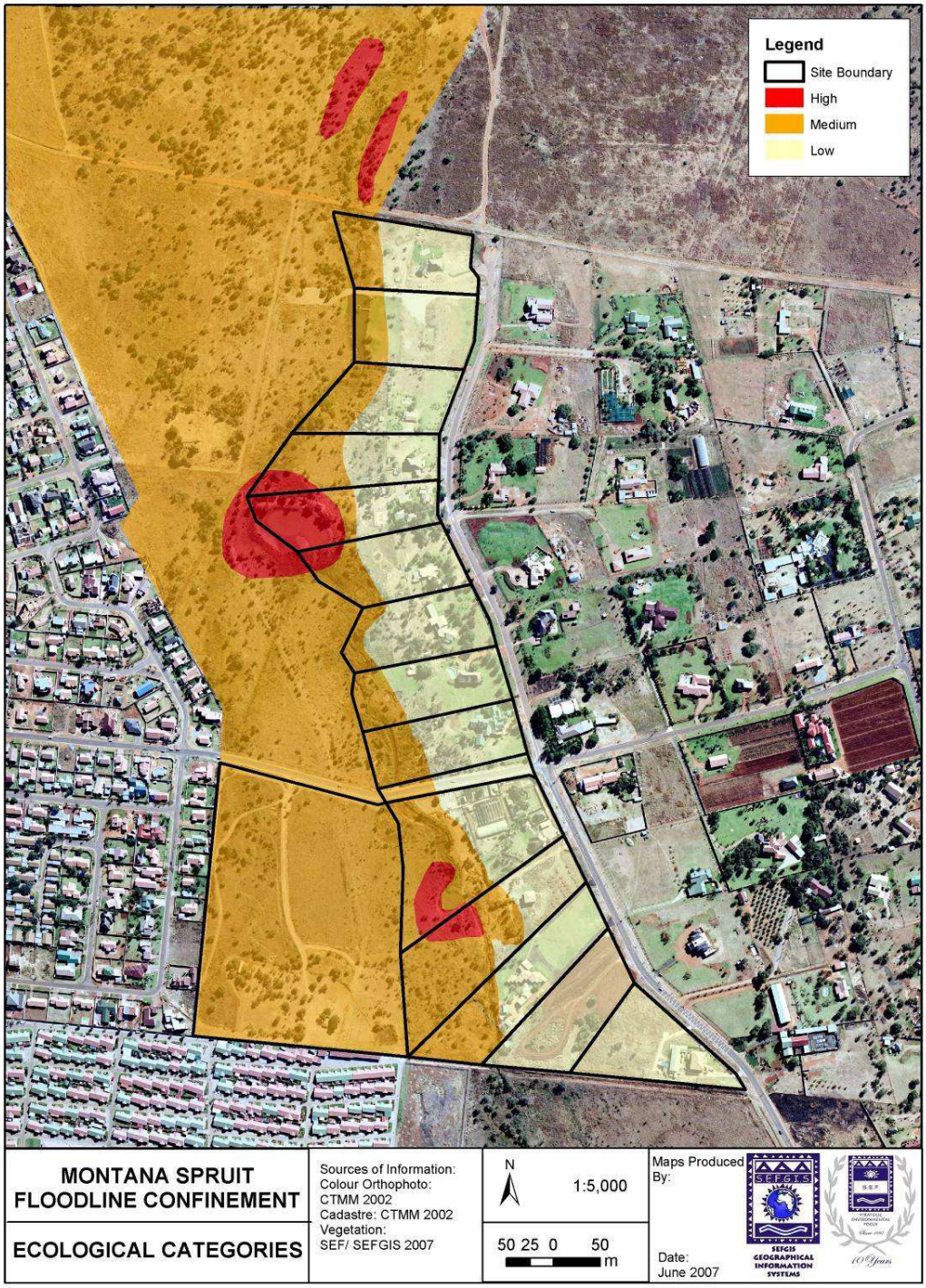

Figure 3: Site Sensitivity Map

5. CONCLUSION AND RECOMMENDATIONS

Although the site visit was not conducted at an ideal time of year, it was evident that the site hosted distinct vegetation communities. The wetland and moist grassland communities are the only highly sensitive habitats on site. They have a ***High Ecological Function*** *and* ***High Conservation Importance****.* They are ***unsuitable for restructuring activities*** and must be protected. The other communities are suitable for the restructuring but mitigation and rehabilitation measures must be undertaken to restore them to an indigenous state.

Disturbances in the form of alterations made to the spruit, exotic plant invasions, vegetation clearing, dumping in the spruit, cattle grazing, trampling and burning are evident on site. The alterations to the spruit have caused clearing of riparian vegetation which has opened niches for exotic plant invasion. The functionality of this system has been and continues to be degraded. The RVI assessment was used to confirm this.

Cattle grazing and trampling is causing further degradation on site. This has an effect on the vegetation communities. It depletes the grass component within the system which allows the proliferation of the *Acacia* species above the ecological balance.

The flooding on site has caused vegetation removal and has opened a niche (within the floodplain) for colonisation by exotic pioneer plants.

The illegal activity of dumping and mismanagement of the study site has caused damage to sensitive habitats that previously existed. Only a few pockets of near-pristine grassland still exist. These must be preserved and managed as they provide refuge areas for faunal species within this degraded site.

The timing of the study, out of the flowering season of Red Data plants meant that insufficient Red Data sampling has been done. Follow-up Red Data scans are recommended in the flowering season between September and January, before any development may occur. Should the development be approved, sensitive habitats must be maintained and full rehabilitation and restoration of the riparian zone and floodplain is necessary to restore ecological functionality to this site. If Red Data species are found on site, the relevant authorities must be informed. Should any species be seen on site once construction has began, then construction must be halted and the advice of an ecologist must be sought.

The restructuring activities must take place out of the rainy season. A comprehensive rehabilitation and floodplain restoration plan is also necessary to restore ecosystem functionality, following the spruit restructuring activities.

Overall, though the site has been largely degraded and transformed, its location in a

sensitive aquatic environment means that the preservation of undisturbed vegetation communities and the rehabilitation of disturbed vegetation communities are essential as far as possible. The removal of alien invasive plants is legislated and must be carried out with the appropriate method for each species type.

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7. GLOSSARY

Alien species: Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity

Biodiversity: Biodiversity is the variability among living organisms from all sources including inter alia terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biome: A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.

Conservation: The management of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystem function and integrity.

Ecosystem: Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

Endangered: A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Endemic: Occurring in a particular region, and nowhere else.

Environment: NEMA defines “environment” as “the surroundings within which humans exist and that are made up of the land, water and atmosphere of the earth; micro organisms, plant and animal life; any interrelationships among and between them and the physical, chemical aesthetic and cultural properties and conditions that influence human health and well-being”.

Forb: A herbaceous plant other than grasses

Habitat: Type of environment in which a plant or animal lives.

Indigenous: Any species of plant, shrub or tree that occurs naturally in South Africa

Invasive species: Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas

Rare species: Species, which have naturally small populations, and species, which have been reduced to small (often unstable) populations by man's activities.

Threatened species: Species, which have naturally small populations, and species, which have been reduced to small (often unstable) populations by man's activities.

Red Data: A list of species, fauna and flora that require environmental protection. Based on the IUCN definitions.

Soil: A mixture of organic and inorganic substances, the composition and structure of the latter is derived from the parent rock material. Soil also contains bacteria, fungi, viruses and micro-arthropods, nematodes and worms.

Species diversity: A measure of the number and relative abundance of species (see biodiversity).

Species richness: The number of species in an area or habitat.

8. APPENDICES

Appendix 1. List of plant species occurring within the study area

Scientific Name	Common Name	Medicinal Value	Exotic Inavder
Acacia erioloba	Camel Thorn		
Acacia exuvialis	Flaky Thorn		
Acacia karoo	Sweet Thorn	Yes	
Acacia nebrownii	Water Thorn		
Acacias sp.			
Agrave americana	American agave		Yes
Andropogon schirensis	Stab Grass		
Aristida junciformis	Gongoni Three Awn Grass		
Aristida sp.	Three Awn Grass		
Arundo donax	Spanish Reed		Yes
Asclepias fruticosa	Shrubby Milkweed		Yes
Berkheya radula			
Bidens pilosa	Blackjack		Yes
Conyza albidia	Tall Fleabane		Yes
Conyza bonariensis	Flaxleaf Fleabane		Yes
Conyza canadensis	Horseweed Fleabane		Yes
Cymbopogan excavatus	Broad-Leaved Turpentine Grass		
Cymbopogan plurinodis	Narrow-Leaved Turpentine Grass		
Cynodon dactylon	Couch Grass		
Cyperus rotundus	Purple nutsedge		Yes
Cyperus sp.			
Digitaria eriantha	Common Finger Grass		
Eragrostis bicolor	Speckled Vlei Grass		
Eragrostis plana	Tough Love Grass		
Eragrostis sp.			
Hakea sp.			
Heteropopgan contortus	Spear Grass		
Hyparrhenia hirta	Common Thatching Grass		
Hypoxis sp.			
Mariscus congestus			
Melia azedarach	Syringa		Yes
Nothoscordum gracile	Fragrant False-Garlic		Yes
Panicum maximum	Guinea Grass		
Paspalum notatum	Bahia Grass		Yes
Pennisetum macrorumum	Riverbed Grass		
Pognotharia squarrosa	Herringbone Grass		
Protasparagus laricinus	Wild Asparagus		Yes
Rhus pyroides	Common Wild Currant	Yes	
Rhus zeyheri	Blue Currant		
Schizachyrium sanguineum	Red Autumn Grass		

Scolopia zeyheri	Thorn Pear		
Senecio sp.			
Sesbania punicea	Red Sesbania		Yes
Setaria sphaecalata var sphaecalata	Common Bristle Grass		
Setaria sphaecalata var torta	Creeping Bristle Grass		
Solanum mauritianum	Bugtree		Yes
Sporobolus festivus	Red Dropseed		
Themeda triandra	Red Grass		
Trachypogon spicatus	Giant Spear Grass		
Typha capensis			
Verbena bonariensis	Wild Verbena		Yes
Xanthium strumarium	Large Cocklebur		Yes
Zinnia peruviana	Redstar Zinnia		Yes

Appendix 2: List of Red Data Plants

Scientific Name	Status	Habitat
Ceropegia humifructus	Data deficient	Unknown
Schisoglossum umbelluliferum	Declining	Deep black turf in open woodland mainly in the vicinity of drainage lines
Trachyandra erythorrhiza	Near Threatened	Marsh area, grassland usually in turf marshes

Appendix 3: List of Red Data Birds potentially occurring on site

Scientific Name	**Status**	**Habitat**	**Main Threat**
Lesser Kestrel	Vulnerable	Semi-arid grassland often near urban areas	Habitat loss
Grass Owl	Vulnerable	Rank grassland along the spruit, marshes, sparse acacia woodland	Habitat loss
African Marsh Harrier	Vulnerable	Wetlands and grassland	Habitat loss
Melodius Lark	Near Threatened	Open grassland dominated by *Themeda triandra* or *Hyparrhenia hirta* with a high basal cover	Habitat loss

Appendix 4: List of potential herpetofauna (amphibians and reptiles) on site

Species Name	**Common Name**	**Red Data Status**	**Habitat**	**Suitable habitat on site**
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	Occurs in grassland, savanna, nama karoo and thicket. It breeds in seasonal shallow, grassy pans, non-permanent vleis, margins of waterholes and dams.	wetland, dams
Homoroselaps dorsalis	Striped Harlequin Snake		Prefers grassland and is accociated with termite mounds, it is a secretive and burrowing snake.	None
Python sebae	African Rock Python		Inhabits primarily rock outcroppings on savanna and can also be found alongside streams, rivers, and lakes.	Marginally suitable habitat

Appendix 5: List of Red data mammals that historically occurred on site

Scientific Name	Common Name	Red Data Status	Habitat	Likelihood of occurrence
South African Hedgehog	Atelerix frontalis	near threatened	Temperate habitats with ground cover for nesting	none
Schreiber's long-fingered bat	Miniopterus schreibersii	near threatened	caves and subterranean habitats, savanna, shrubland and grassland	none
Darling's horseshoe bat	Rhinolophus darlingi	near threatened	caves and subterranean habitats, savanna, woodland	none
Geoffroy's horseshoe bat	Rhinolophus clivosus	near threatened	caves and subterranean habitats, savanna, shrubland and grassland	none
Temminck's hairy bat	Myotis tricolor	near threatened	caves, forest, shrubland, savanna grassland	none
Juliana's golden mole	Neamblysomus julianae	vulnerable	Sour lowveld bushveld, clay thorn bushveld, rocky highveld grassland, subterranean habitats and gardens.	possible
Short-eared trident bat	Cloeotis percivali	critically endangered	caves and subterranean habitats, mixed woodland savanna	none
Water rat	Dasymys incomtus	near threatened	wetland areas	possible
Brown hyaena	Hyaena brunnea	near threatened	savanna, shrubland, grassland, somestimes urban areas	possible
Serval	Leptailurus serval	near threatened	savanna, grassland, wetland areas. Its niche is moist savanna and tall grass	possible
Spotted-necked otter	Lutra maculicollis	near threatened	aquatic environments: permanent streams, rivers, creeks and ponds	possible
White-tailed rat	Mystromys albicaudatus	endangered	temperate, requires sandy soils with good cover	none
Rough-haired golden mole	Chrysospalax villosus	critically endangered	subterranean: sandy soils at edge of vleis, wetland areas	possible
Rusty bat	Pipistrellus rusticus	near threatened	savanna, riiparian forest, roosts in crevices of trees	none

Appendix 6. List of exotic and invasive species found on site (Henderson, 2001)

Scientific Name	Common Name	Status	Declared Invader category
Agrave americana	American agave	category 2	Invader
Arundo donax	Spanish Reed	category 1	Weed
Asclepias fruticosa	Shrubby Milkweed		
Bidens pilosa	Blackjack		
Conyza albidia	Tall Fleabane		
Conyza bonariensis	Flaxleaf Fleabane		
Conyza canadensis	Horseweed Fleabane		
Cyperus rotundus	Purple nutsedge		
Melia azedarach	Syringa	category 3	Invader
Nothoscordum gracile	Fragrant False-Garlic		
Paspalum notatum	Bahia Grass		
Protasparagus laricinus	Wild Asparagus		
Sesbania punicea	Red Sesbania	category 1	Weed
Solanum mauritianum	Bugtree	category 1	Weed
Verbena bonariensis	Wild Verbena		
Xanthium strumarium	Large Cocklebur	category 1	Weed
Zinnia peruviana	Redstar Zinnia		

Appendix 7. Riparian Vegetation Biomonitoring Site Assessment Form (Portion 32 of Doornpoort 295-JR).

MEASURMENT	DESCRIPTION	HEIGHT CLASS
CHANNEL DESCRIPTION		
Channel Type	Single	
Active channel width	4m	
RIPARIAN ZONE DESCRIPTION		
Width of potential riparian zone		
LHB	4m	
RHB	5m	
Substrate		
Bedrock	20%	
Rock/cobble	20%	
Soil	20%	
Gravel/sand	20%	
Sediment	20%	
Percentage Vegetation Cover [F1]	51-75%	
SITE CONDITION		
Natural vegetation cover	Medium	
Disturbed vegetation cover	High	
Site disturbances [F2]	High	
Floods, elevated flows	High	
Flow regulation (dam upstream)	High	
Weir / dam (local inundation)	High	
Roads, bridges, other infrastructure	Medium	
Erosion / sedimentation	Low	
Vegetation invasion (exotic,terr,reeds)	High	
Surrounding land-use		
Residential (urban)		
Dumping		
DISTRIBUTION AND EXTENT OF VEGETATION COVER		
Cover		
Trees	20%	
Shrubs	10%	
Reeds	10%	
Sedges	15%	
Grasses	25%	
Bare Ground	20%	
		PERCEIVED REFERENCE
Distribution [F3]	PRESENT STATE	STATE
Trees (S1)	Scattered	Continuous
Shrubs (S2)	Scattered	Clumped
Reeds (S3)	Clumped	Clumped
Sedges (S4)	Scattered	Scattered
Grasses (S5)	Continuous	Continuous
Bare Ground (S6)	Continuous	Sparse
INVASION OF RIPARIAN ZONE [F5, 6, 7]		

Exotic species (dominance by estimated biomass)		
Protasparagus laricinus (terrestrial species)	High	
Asclepias fruticosa (terrestrial species)	Very High	
Bidens pilosa (terrestrial species)	High	
Verbena bonariensis	High	
Xanthium strumanium	High	
Nothocordium gracile	Medium	
Typha capensis	Medium	
Sesbania punicea (terrestrial species)	Medium	
Total extent of invasion	High	
Exotic species (domminance by recruitment)		
Protasparagus laricinus (terrestrial species)	20 individuals	1-2m
Asclepias fruticosa (terrestrial species)	60 individuals	< 1m
Bidens pilosa (terrestrial species)	25 individuals	< 1m
Verbena bonariensis	20 individuals	1-2m
Xanthium strumanium	20 individuals	1-2m
Nothocordium gracile	10 individuals	< 1m
Typha capensis (reeds)	60 individuals	1-2m
Sesbania punicea (terrestrial species)	5 individuals	1-2m
RECRUITMENT OF INDIGENOUS RIPARIAN SPECIES		
Extent of Recruitment [F7]	Medium	
Species richness		
Number of indigenous tree & shrub species	35 individuals	
Number of exotic tree and shrub species	17 individuals	
Total species	60	
ASSESSOR GUT SCORE		
Score	9-12	
Class	D	

Calculation of the RVI

The RVI formula is:

RVI = [(EVC) + ((SI × PCIRS) + (RIRS))]

Where the following sub-indices apply:

EVC is extent of vegetation cover
SI is structural intactness
PCIRS is percentage cover of indigenous riparian species
RIRS is recruitment of indigenous riparian species

Calculation of EVC

EVC (score out of 10) = {EVC1 + EVC2} / 2
EVC1 = F1 = 51-75% = EVC score of 8

EVC2 = F2 = High disturbance = EVC score of 6

EVC= {10 + 6} / 2 = 8

Calculation of SI

SI (score out of 1) = [((SI1+ SI2+ SI3+ SI4+ SI5+SI6)/5) × 0.33]
= [((1+ 2+ 3+ 3+ 3+0)/5) × 0.33]
SI = 0.792

Calculation of PCIRS

PCIRS(score out of 5)= [(EVC/2) – ((exotics × 0.7) + (terrestrial × 0.1) + (reeds × 0.2))]
= [(8/2) – ((7 × 0.7) + (7 × 0.1) + (1 × 0.2))]
= [4 – (4.9 + 0.7 + 0.2)]
= -1.8

Calculation of RIRS

RIRS (score out of 5) = 3 (Medium)

Therefore :*RVI = [(EVC) + ((SI × PCIRS) + (RIRS))]*
= [8 +((0.792 x -1.8) +3]
= 9.5744

RVI Score between 9-12 is a class D. This means that it has largely been modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred (Kemper, 2001)

Appendix 8. Riparian Vegetation Biomonitoring Site Assessment Form (Portion 129 of Doornpoort 295-JR).

MEASURMENT	DESCRIPTION	HEIGHT CLASS
CHANNEL DESCRIPTION		
Channel Type	Single	
Active channel width	4m	
RIPARIAN ZONE DESCRIPTION		
Width of potential riparian zone		
LHB	20m	
RHB	10m	
Substrate		
Bedrock	20%	
Rock/cobble	20%	
Soil	20%	
Gravel/sand	20%	
Sediment	20%	
Percentage Vegetation Cover [F1]	76-100%	
SITE CONDITION		
Natural vegetation cover	Very High	
Disturbed vegetation cover	Low	
Site disturbances [F2]	High	
Floods, elevated flows	High	
Flow regulation (dam upstream)	High	
Weir / dam (local inundation)	High	
Roads, bridges, other infrastructure	Medium	
Erosion / sedimentation	Low	
Vegetation invasion (exotic,terr,reeds)	Low	
Surrounding land-use		
Residential (urban)		
Dumping		
DISTRIBUTION AND EXTENT OF VEGETATION COVER		
Cover		
Trees	6-25%	
Shrubs	0%	
Reeds	26-50%	
Sedges	0%	
Grasses	26-50%	
Bare Ground	0%	
Distribution [F3]	PRESENT STATE	PERCEIVED REFERENCE STATE
Trees (S1)	Clumped	Continuous
Shrubs (S2)	Scattered	Scattered
Reeds (S3)	Clumped	Clumped
Sedges (S4)	Continuous	Continuous
Grasses (S5)	Continuous	Continuous
Bare Ground (S6)	Sparse	Sparse

INVASION OF RIPARIAN ZONE [F5, 6, 7]		
Exotic species (dominance by estimated biomass)		
Bidens pilosa (terrestrial species)	Low	
Verbena bonariensis	Low	
Xanthium strumanium	Low	
Protasparagus laricinus (terrestrial species)	20 individuals	1-2m
Arundo donax	Low	
Sesbania punicea (terrestrial species)	Low	
Total extent of invasion	Low	
Exotic species (domminance by recruitment)		
Bidens pilosa (terrestrial species)	5 individuals	< 1m
Verbena bonariensis	5 individuals	1-2m
Arundo donax	5 individuals	1-2m
Protasparagus laricinus (terrestrial species)	20 individuals	1-2m
Sesbania punicea	5 individuals	1-2m
RECRUITMENT OF INDIGENOUS RIPARIAN SPECIES		
Extent of Recruitment [F7]	High	
Species richness		
Number of indigenous tree & shrub species	35 individuals	
Number of exotic tree and shrub species	10 individuals	
Total species	45	
ASSESSOR GUT SCORE		
Score	17-18	
Class	B	

Calculation of the RVI

The RVI formula is:

RVI = [(EVC) + ((SI × PCIRS) + (RIRS))]

Where the following sub-indices apply:

EVC is extent of vegetation cover
SI is structural intactness
PCIRS is percentage cover of indigenous riparian species
RIRS is recruitment of indigenous riparian species

Calculation of EVC

EVC (score out of 10) = {EVC1 + EVC2} / 2
EVC1 = F1 = 76-100% = EVC score of 10

EVC2 = F2 = Medium disturbance = EVC score of 6

EVC: {10 + 6} / 2 = 8

Calculation of SI

SI (score out of 1) = [((SI1+ SI2+ SI3+ SI4+ SI5+SI6)/5) × 0.33]
= [((2+ 3+ 3+ 3+ 3+3)/5) × 0.33]
SI = 1.122

Calculation of PCIRS

PCIRS(score out of 5)= [(EVC/2) – ((exotics × 0.7) + (terrestrial × 0.1) + (reeds × 0.2))]
= [(8/2) – ((5× 0.7) + (3 × 0.1) + (1 × 0.2))]
= [4 – (3.5 + 0.3 + 0.2)]
= 0

Calculation of RIRS

RIRS (score out of 5) = 4 (High)

Therefore :*RVI = [(EVC) + ((SI × PCIRS) + (RIRS))]*
= [8 +((1.122 x 0) +4]
= 12.0

RVI Score between 9-12 is a class D. This means that it has largely been modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred (Kemper, 2001).

MONTANA SPRUIT CHANNEL UPGRADE, GAUTENG.

Red Data Scan, Specialist Report

SEF Project Code: 502079

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1. INTRODUCTION

Due to alterations to the river channel and damming activities upstream, the Montana Spruit has experienced flooding since the early 1990s at the Tsamma Road crossing and surrounding properties. The City of Tshwane Municipality now proposes the upgrade of the Montana Spruit channel to combat the flooding problem. As rivers, waterways and riparian areas are sensitive for biodiversity and hydrological functions, Strategic Environmental Focus (Pty) Ltd was appointed to undertake specialist studies along the Montana Spruit.

Riparian areas along wetlands and waterbodies offer sensitive habitat to Red Data plant species in Gauteng Province, and a Red Data floristic scan was therefore undertaken to establish if suitable habitat for Red Data species and/or Red Data species were present on site. This report provides the results of a two day site visit.

2. BACKGROUND AND TERMS OF REFERENCE

2.1 Study Terms of Reference

The terms of reference for the Red Data Scan were as follows;

- Assess the site and surrounds for Red Data plants species, focusing on *Stenostelma umbelluliferum*; and
- Report on the findings indicating the presence of Red Data plants or suitable habitat.

2.2 Study Location

The site, referred to as the study area is located on portions 28 to 42, 137 and 138 of Doornpoort 295 JR, Gauteng. This study area is situated within the urban boundary. It runs parallel to Breed Street with Tsamma Road passing through it (Figure 1).

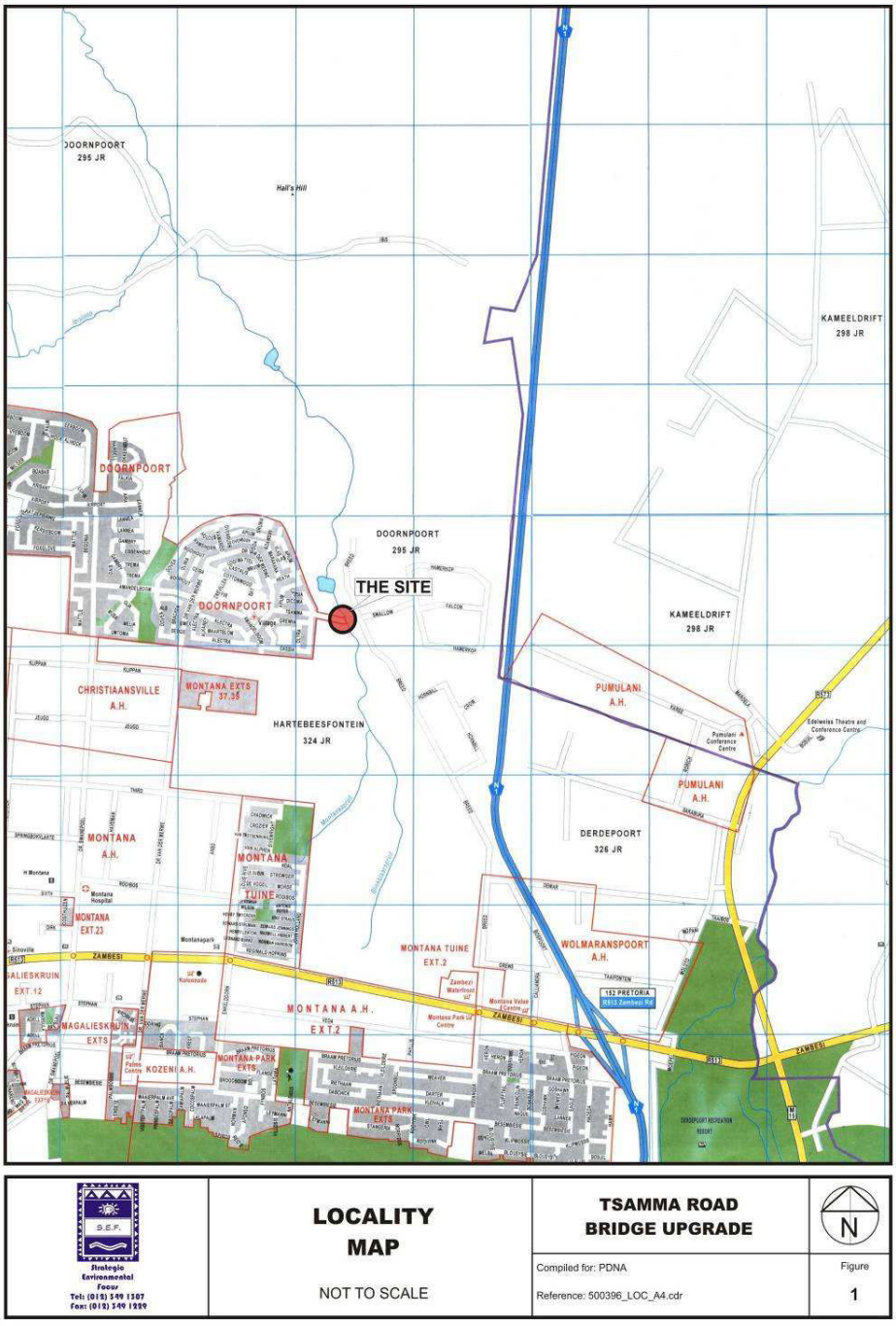

Figure 1. Locality Map

2.3 Project Limitations

Certain limitations were experienced in the current study, and these are discussed in further detail below.

As Red Data species are often cryptic, being very small in size and only flowering for very short time periods, repetitive site visits in one season and repetitive visits annually across different seasons are more successful in recovering individuals on a site.

Some Red Data plants, and particularly *Stenostelma umbelluliferum,* grow from bulbs and as such a large part of their structure is underground. As a result, they may lie dormant for lengthy time periods until conditions are suitable for them to emerge. Suitable conditions are often created by disturbance events such as fire, heavy rainfall and soil movement, and site visits conducted after such disturbance events are more likely to recover plants. For example, two new populations of *Stenostelma umbelluliferum* were discovered after a grader cleared an area of land.

The dense vegetation layer on site and access restrictions to properties along the spruit limited the areas covered during the site visits.

3. BACKGROUND INFORMATION

Stenostelma umbelluliferum, previously known as *Schizoglossum umbelluliferum*, was reclassified after the discovery of two sub-populations at the foot of the Magaliesberg in the Montana area of Pretoria. The discovery enabled the re-assessment of the genetic position, neotypification and re-circumscription of the species.

Stenostelma umbelluliferum is recognised as a perennial geophytic herb which exudes milky latex from its leaves and stems when harvested. A large part of the plant occurs underground making its above ground parts difficult to see even when flowering. Literature lists different flowering times for the plant with GDACE (2006) listing its typical flowering period between September and April and Bester & Nicholas (2006) listing flowering times between August and May, peaking between October and January. Fruiting time is typically between September and May.

4. METHODOLOGY

Background research was conducted prior to visiting the site to become acquainted with the appearance and characteristics of the plant. Consultation with the senior Asclepiadoideae (plant family) specialist, S.P Bester, at the South African National Botanical Institute (SANBI) was undertaken. During this time, plant specimens were viewed, pictures were taken and relevant published literature was perused.

A site visit was then undertaken on the 29th March and 04th April 2008. Line transects of 100m in length were walked across the site in search of the plant *Stenostelma umbelluliferum.* During this time, notes were made on the conditions and suitable habitat for the plant on site.

5. RESULTS

No individuals of *Stenostelma umbelluliferum* were discovered during the site visit. However, suitable habitat for the plant was present along the riparian zone of the spruit channel. The riparian zone is characterised by rich black turf soils with evidence of calciferous nodules distributed throughout the site. This is a clear indication of typical black turf soil conditions. Bester & Nicholas (2006) report on two populations that have been located approximately 200m away from the site. Although the soil and habitat conditions within the present study area matched conditions at these two sites, Bester (2008) informed that previous sampling on several occasions along the Montana Spruit, and within the study area, had not recovered any individuals of *Stenostelma umbelluliferum.* Certain factors may affect the plant's distribution; these include a shift in geological structure and development within the riparian zone.

Van Wyk (pers comm., 2007) stated that bulbous plants sprout following a burning event and good rainfall. Communication with the residents of 35 Breed Street informed that the site was last burnt in August 2007, seven months prior to the site visit. As these plants all flower at the same time following a disturbance event, any specimens present within the study area would have flowered after the August burn event and would no longer be visible above ground during the March-April period.

Seven additional Red Data plants have been recorded within the quarter degree square of the study site. These plants, their flowering times and habitat requirements are listed in Table 1. No individuals were recorded on site; however suitable habitat was present on site for *Trachyandra erythorrhiza* and *Cucumis humifructus*.

Table 1. Red Listed plants recorded within the quarter degree square (2528CB)

Species Name	Conservation Status (GDACE, 2007)	Habitat (GDACE, 2007)	Habitat on site
Aloe peglerae	Endangered	Rocky places often on gravely quartzite, confirmed on Magaliesburg slopes	None
Bowiea volubilis subsp. *volubilis*	Vulnerable	Shady places, steep rocky slopes and in open woodland, under large boulders in bush or low forest	None
Ceropegia deciduas subsp. *pretoriensis*	Vulnerable	Direst sunshine or shaded situations, rocky outcrops of quartzitic Magaliesberg mountain series, in pockets of soil among rocks in shade of shrubs and low trees, can be seen in twining around grass spikes	None
Cucumis humifructus	Vulnerable	Woodland and grassland on deep soil	Present
Holothrix randii	Near Threatened	Grassy slopes and rocky ledges	None
Macledium pretoriense	Extinct	Hillsides	None
Trachyandra erythorrhiza	Near Threatened	Marshy areas, grassland usually in black turf marshes	Present

Trachyandra erythorrhiza has been discovered in similar habitats within the grassland areas of Gauteng. No individuals were recorded during the survey, however, limitations prevented access to certain sections of the riparian zone, where this plant may be present during peak flowering times, i.e. from September to November (GDACE, 2007).

The plant *Cucumis humifructus*, also known as aardvark cucumber, has evolved intricately with the aardvark, and its pollination, reproduction and flowering are reliant on an aardvark presence. Aardvarks are very adaptable and widely distributed animals that occur throughout Southern Africa, in areas where the soil is not very compact and sufficient termites are present (Cillie, 2007). They are only absent from the dry west coast of South Africa and Namibia. As no indicators of aardvark droppings, spoor or burrows were observed on site, they are unlikely to occur. Furthermore these solitary animals would be excluded due to the altered and developed environment along the spruit, and the continuous anthropogenic influences on site. The *Cucumis humifructus* plant is therefore also unlikely to occur on site, and no individuals were recorded during sampling.

6. CONCLUSIONS & RECOMMENDATIONS

Stenostelma umbelluliferum was not recorded on site during the site visit and is not expected to occur within the study area. Previous sampling within the study area and along the Montana Spruit confirms this. However, as suitable habitat is present for *Stenostelma umbelluliferum* and *Trachyandra erythorrhiza* along the Montana Spruit, the following measures are recommended:

- An independent Environmental Control Officer (ECO) must be appointed to manage the restructuring activities. This ECO must be made aware of the suitable habitat on site for *Stenostelma umbelluliferum* and *Trachyandra erythorrhiza* and of their potential to exist on site. The ECO must then carefully monitor the site for these two species. If plants are discovered, positive identification must be made by an ecologist and the relevant authorities must be consulted for removal and protection of the plant.
- Adjacent natural sections of the site must remain undisturbed by the restructuring activities. This can be accomplished by clearly demarcating the study area with

wire fencing to prevent any activity spill over in terms of construction materials and workforce.

- Black turf soils are highly susceptible to erosion and careful management of soil piles is necessary to facilitate the rehabilitation process.

This report must be viewed in association with a previously compiled ecological report. The ecological report was prepared by Strategic Environmental Focus (Pty) Ltd for SSV Consulting Engineers and Project Managers in June 2006.

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GLOSSARY

Red Data Species: A species that occurs on the IUCN list of declining species and is protected nationally and internationally by legislation. The presence of this species in an area warrants the conservation of that area.

GDACE: Gauteng Department of Agriculture, Conservation and Environment.

Asclepiadoideae: A former plant family now treated as a subfamily (subfamily Asclepiadoideae) in the Apocynaceae. They form a group of perennial herbs, twining shrubs, lianas, or rarely trees. They also contain a significant number of leafless stem succulents.