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## 5. IMPACTS ON THE RECEIVING ENVIRONMENT

### 5.1 IMPACTS ON SURFACE QUANTITY DURING THE OPERATIONAL PHASE

#### 5.1.1 Louwlandia Stream diversion

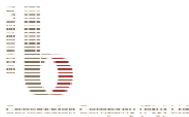

Bombela recommends that the temporary diversion of the Louwlandia be accepted as the permanent alignment of the Stream which was necessitated due to the relocation of the major water and sewage utilities which could not be left in the original position close to the Gautrain track centre line. No significant impacts are expected on the Stream due to the following:

- The hydraulic analyses showed that there would be no significant changes to the flow conditions for the annual flooding predicted (Technical Report appended in **Appendix G**).
- The velocity in the channel is not influenced by the utility culvert.
- The flow velocity in the natural stream at a location next to the utility culvert increases from 4 m/s to 4.5 m/s as a result of the constriction. Erosion protection is to be provided along the embankment covering the culvert. Therefore taking this into consideration no significant impact is foreseen on the Stream.
- Although the high flood level increases by 0.3 m due to the utility culvert it still does not have a significant impact on the flood lines on the adjacent property.
- The area has been landscaped to divert the flood around the front of the utility culvert towards the channel alongside.
- Erosion protection including gabion mattresses and rip rap has been placed or installed in identified areas.
- Protective grass and indigenous plants and hydro seeds has been established on the side slopes and landscaped areas for erosion protection.

### 5.2 IMPACTS ON SURFACE WATER QUALITY DURING THE OPERATIONAL PHASE

Surface water quality monitoring that was undertaken where the Gautrain crosses rivers or water courses, revealed that the rivers have already been significantly degraded prior to the Gautrain Construction. The data also showed that construction temporarily increased the suspended solids, oils and greases and ammonia of the receiving environment. The high ammonia results were as a result of blasting activities.

The biomonitoring survey undertaken in May 2009 (EnviRoss, 2009) indicated that all sites had suffered degradation due to habitat transformation through landscaping, solid waste disposal, development encroachment into the riparian zones and other disturbances that occurred prior to the Gautrain construction commencing. The in

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situ water quality testing undertaken showed a high nutrient load normally attributed to the contamination by raw sewerage effluent in the Jukskei River. The Modderfontein Spruit showed levels of conductivity and pH exceeding the aquatic water quality guidelines. This is attributed to the chemical pollution associated with the Modderfontein industrial complex and not due to the construction activities.

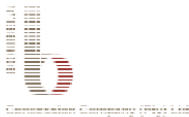

Taking the abovementioned into consideration the construction phase had limited impacts on the surface water quality. However rehabilitation of the rivers, beds and banks has been undertaken to remediate the impact from construction. Any impacts associated with the rehabilitation of the impacted areas will be of a short duration, will cease once rehabilitation is completed and will not be significant.

During the Operational Phase limited impacts on the surface water are expected from operating the Gautrain. Impacts associated with spillages of oil or hydrocarbons during an emergency condition may occur, but are not very likely and in any event likely to be relatively localised. Fluids on board of each train are set out in the table below (ILISO, 2009).

**Table 5-1: Fluids on board of each train**

Origin/System	Product	Volume (litre)	Past Failures
Transformer	Oil	650	No history of failure
Traction motor gearbox	Oil	8	Only at the labyrinth seal which is minimal
Compressed air (brakes) compressor	Oil	5	2 -3 times during the life of the compressor
Motor control module	Distilled water	20	No history of failure
Batteries	Distilled water	30	No history of failure
Line control module & auxiliary control module (one case)	Distilled water	20	No history of failure

The most oil that can be spilled from a train is 663 litres, although the transformer (which contains the bulk of the oil) has no history of failure. In addition, through the processes/controls which are part of the train operating systems, leaks to the transformers and or line converters are automatically flagged by the on-board diagnostic systems allowing for speedy rectification. The planned maintenance programme will ensure that potential leaks and or damage will be identified and addressed as they occur.

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A potential leak or spillage of oil, during a disastrous event, on surface will be relatively localised and the necessary actions will be implemented to address the impact associated with the incident. Therefore the impact will be of short duration and it is not foreseen that the impact will have a high significance.

However, if the hydrocarbons enter any water courses or stormwater systems the impact could potentially be of a higher significance. The spillage will still be localised to the immediate or local area, cleaned up and remediate immediately and therefore it is not seen as a high significance.

The risk of oil or other pollutants entering the tunnel environment has also been assessed and was determined to be low. Two emergency conditions were identified and assessed that could occur in the tunnels and result in a potential impact on the surface water quality:

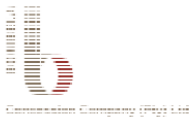

- In case of a disastrous event should all the oil leak or spill, the train will not be able to move further and the event will be immediately known. Under those conditions the discharge from the relevant oil trap will be switched from discharge to the stormwater system to discharge to sewer by closing and opening the relevant valves (ILISO, 2009).
- The second disaster that could potentially take place is that of a fire. The potential of a fire occurring in the tunnel is very low. During the emergency the tunnel drainage will increase due to water from the fire protection system that will be activated in order to contain the fire. Under these circumstances the water will be pumped to the surface and discharged to the oil trap.

The oil trap is designed to retain most of the oil under fire conditions and will allow only 5 ppm through. However this exceeds the allowed concentration of 2.5 ppm and therefore the discharge will be switched from the stormwater system to the sewer system (ILISO, 2009).

An emergency preparedness and response plan forms part of the Environmental Management Plan for the Operational and Maintenance Phase and undertakes to develop a detailed emergency preparedness and response plan for spillages and leaks.

### **5.3 IMPACTS ON THE SURFACE WATER DUE TO DEWATERING OF THE TUNNEL**

ILISO Consulting was appointed to investigate the conditions in the Gautrain tunnel in order to determine the quantity and quality of the water that will be discharged from

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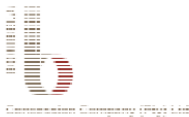

the tunnel drainage system under operational conditions, and the effect this may have on the Sandspruit if it was discharged to the stream (ILISO, 2009). For the detail report refer to **Appendix H**.

Tunnel construction impacted upon the nitrate and electrical conductivity (EC) concentrations as well as the turbidity in the Sandspruit. There was already an elevated level of these constituents and not all the changes are due to the Gautrain tunnel construction. The measurements of water quality of the water discharged during the tunnel construction indicated elevated levels of ammonia, total suspended solids, nitrogen as nitrate and soaps, oils and greases. These impacts can be ascribed to construction activities and were therefore of relatively short duration. Contingencies were made to discharge the water to the Johannesburg sewer system in accordance with specified requirements of the utility owner, following the Directive issued by the DWA to the project on the 11 December 2008 (and subsequently amended on the 17 December 2008), and therefore did not have a significant impact on the receiving water environment.

The Sandspruit catchment area is subject to frequent sewer overflows, while other non-Gautrain construction activities will have added to the turbidity. Since the completion of the tunnel between Sandton and the tunnel portal in Marlboro, the turbidity has reduced again, but not the other constituents. It is therefore likely that other conditions have contributed more to the changes in water quality than the Gautrain tunnel construction (ILISO, 2009).

During the construction the water quality in both the Sandspruit and the Braamfonteinspruit deteriorated however, this did not significantly affect the water quality in the Sandspruit and the Braamfonteinspruit with respect to fitness for use. The very high nitrate concentrations that were initially reported were as a result of the samples being preserved with nitric acid (HNO<sub>3</sub>), and were not a reflection of the true concentrations that were present in the effluent. From the results of the samples collected and analysed by Johannesburg Water, it is however clear that they certainly were not as high as what was reported at the time (ILISO, 2009).

The water quality analysis for the Sandspruit and the Braamfonteinspruit indicated that both streams are affected by frequent sewer spills and/or overflows. This has not affected the groundwater, as the elevated ammonia and phosphate concentrations are not observed in the tunnel drainage water. The rapid flow in the streams due to their steep slopes does not support recharge to the groundwater and the spills and overflows during rainstorm events seem to be of short duration.

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The results from the sampling of the tunnel drainage water that was undertaken as part of the study showed that the drained and discharged water will comply with the standards as set in the existing Integrated WUL issued for the project in 2008, and that the set standards are protective of the receiving water body. The only standard that will have to be adjusted by the DWA is the standard for orthophosphate. This should be changed from 10 mg/l to 1 mg/l as reflected in the licence.

The ILISO 2009 report recommended standards to be set for a tunnel discharge of 3.6 Mℓ/ day based on a long-term discharge estimate that could be provided at the time. However, the measurements of water discharged from the tunnel drainage system as reported since indicate an increase which currently amounts to a cumulative volume of 8.11 Mℓ/ day for the entire 16 km tunnel section.

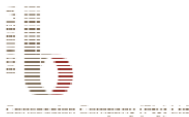

In addition, the ILISO (2010a and 2010b) reports determined that the Sandspruit is seasonal. The currently measured cumulative volume of 8.11 Mℓ/day will add about 25% to the Sandspruit flow during the wet months in an average year, and about 10% in a wet year. In a dry year the Sandspruit flow during the dry months will increase to what it is during a wet year during the dry months due to discharge of the water from the tunnel drainage system. The annual flow pattern in the stream will therefore not be disturbed beyond what occurs naturally. The above mentioned reports determined a maximum allowable discharge of 15 Mℓ/day which is the median flow in January.

Storm flows in the Sandspruit can be severe. The flood intensity and the associated recurrence interval for floods in the Sandspruit at the N1 are:

100 year recurrence	590 m <sup>3</sup> /s
50 year recurrence	420 m <sup>3</sup> /s
20 year recurrence	275 m <sup>3</sup> /s

A discharge of 15 Mℓ/day is equal to a flow of 174 ℓ/s or 0.174 m<sup>3</sup>/s. Therefore, compared to the flood flows the discharge of water from tunnel drainage system will have no impact.

The reports further concluded that a discharge of the water from the tunnel drainage system to the Sandspruit will have no impact on the riverine ecosystem, and may in fact have a beneficial impact in that it will remove extreme low flows during the dry years. The wetland that was identified by EcoSun in the Sandspruit and that is associated with the river may also benefit from this enhanced flow regime.

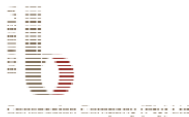

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The water management plan compiled in 2006 also indicated that the decanting water quality is expected to be of a good quality. Under normal operating conditions no contamination from the train is expected, however in order to comply with the precautionary principle, all water discharged from the tunnel drainage system will pass through an oil trap that will effectively remove oils and grease. The water can therefore be discharged to the Sandspruit stream via the stormwater system. The ILISO (2010b) report confirmed that the drainage water quality is well within the limits as determined in the 2009 study and it actually conforms to drinking water quality requirements. Discharging of the water from the tunnel drainage system to the stormwater system will therefore have a beneficial impact on the quality of the water in the Sandspruit, irrespective of the discharge volume.

The discharge of water to the Sandspruit will provide a more sustainable and consistent low flow in the river and will therefore have a beneficial effect on the receiving water body. The Sandspruit discharges into the Braamfonteinspruit just upstream of the confluence with the Jukskei River. At this point water is abstracted by the Leeukop Prison for irrigation. At present, when flow in the Braamfonteinspruit is not sufficient, Leeukop Prison has to resort to the Jukskei River which carries more saline water. Discharging tunnel drainage water to the Sandspruit will mean that there will be a more consistent flow of good quality water available to the prison.

The ILISO studies (2009 and 2010a and 2010b) also evaluated the potential changes to the quality of the water to be discharged from the tunnel drainage system. Potential sources of groundwater pollution were identified which fell within a zone of influence and these may have an impact on the groundwater quality that flows into the tunnel drainage system and needs to be discharged. These included the following:

- The shunting yard of Transnet railway station and include potential oils and grease as potential contaminants. However this is very unlikely because this area is not a service area.
- The light industrial area at Wynberg and Johannesburg Zoo and include potential illegal dumping. This will be relatively small and will probably not be detected in the tunnel drainage.
- Sewer leaks could result in groundwater contamination and resulting in the tunnel drainage water that needs to be pumped out. This must however be fixed and will therefore not have a significant impact on the Sandspruit.

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The ILISO (2010) study indicates that there is currently no evidence based on the measurement of the quality of the tunnel drainage water that any significant pollution is drawn into the tunnel drainage water.

#### 5.4 IMPACTS ON THE GROUNDWATER LEVELS DUE TO DEWATERING OF THE TUNNELS

Because in sections the Gautrain tunnel is situated below the groundwater table the dewatering of the tunnels may potentially lower the groundwater table, impact the baseflow of the minor drainages and reduce the flow of the spring in the MFP and subsequently reducing the flow of the artificial wetland at MFP (AGES, 2006) because it is situated below the groundwater table.

From Park Station to the Emergency Shaft E2 the underground tunnel was designed and constructed as a drained tunnel. It was constructed by means of the drill-and-blast method. From the Emergency Shaft E2 to and including Rosebank Station (approximately 3 km) the tunnel was excavated using a Tunnel Boring Machine (TBM) (Figure 5-1). This section of the tunnel was lined (ILISO 2009).

The tunnel from Rosebank Station to the tunnel portal at Marlboro Gardens is again a drained tunnel constructed in competent rock and therefore traditional drilling and blasting methods of construction was used. During construction of the tunnel where drill and blast was used, holes were drilled along the perimeter of the tunnel in order to ascertain the conditions ahead. If any significant water flow was detected from these holes grouting was injected to seal of the fissure (ILISO, 2009).

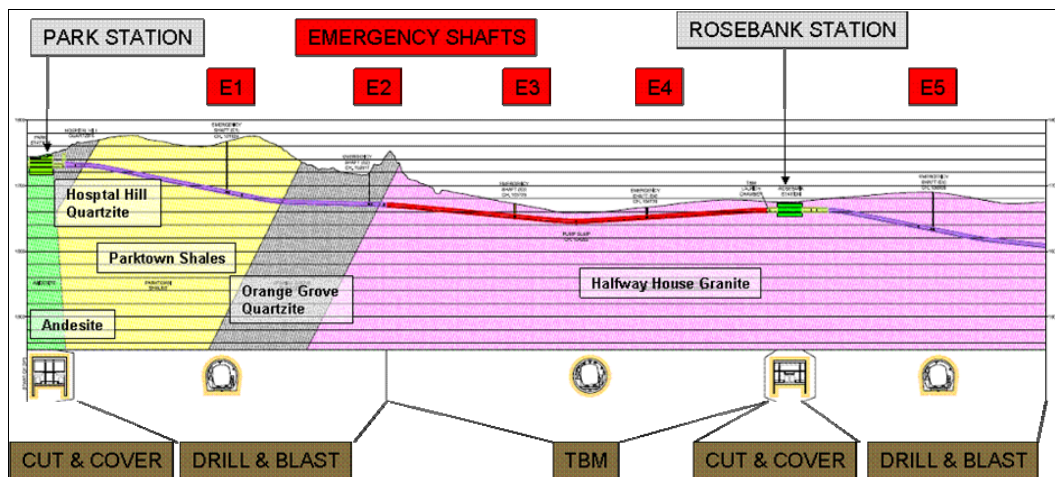
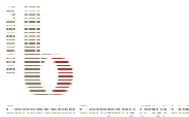



Figure 5-1: Details of tunnel between Park Station and Rosebank Station (ILISO 2010a and 2010b)

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After the tunnel was excavated the bare rock was covered with a shotcrete lining. After completion of the shotcrete cover, sections where significant ingress of water was observed were post grouted. Following this the drainage system was installed (ILISO, 2009). It is therefore anticipated that the tunnel inflows will reduce (by up to 84% over a period of 20 years as estimated in the Arup Report) due to the sealing and grouting of the tunnel. As a result groundwater levels should also locally rebound over time.

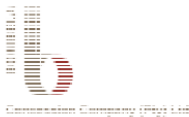

However in the meantime a certain amount of water is expected to ingress into the tunnel drainage system and will have to be removed and discharged at surface, in order to ensure the safe operation of the train service. The dewatering of the tunnel was expected to lower the groundwater level and this was also confirmed in the study undertaken by ILISO attached in **Appendix H** (ILISO, 2010a and 2010b). During the construction and before the tunnel was grouted, the groundwater levels in some places were drawn down significantly. According to the piezometer readings the drawdown of the water is localised and has stabilised (Wilson, 2010, **Appendix H**) and could be attributed to where the tunnel intersected the hydraulic connectivity on which the piezometers or a borehole may have been located.

Since the completion of the tunnel, towards the end of the 2009/2010 summer rainfall season, there has not been enough rainfall for the water levels to recover, as the groundwater flow is away from the tunnel, rather than towards it. This means that the recovery of the groundwater levels is dependent on recharge from rainwater, rather than flow from the regional groundwater body towards the tunnel area.

In general ILISO Consulting made the following observation regarding the drawdown of the water table:

- In all cases, except for the section constructed by means of the TBM, there was a drop in groundwater levels during the construction of the tunnel.
- The groundwater levels have subsequently either stabilised or indicated a slight recovery.
- In some cases a seasonal pattern of recovery and drawdown can be observed, specifically in the section of the tunnel between Sandton Station and Marlboro portal.
- In general the groundwater levels are 10 m to 50 m below the ground level, except in the vicinity of the MFP where the groundwater level is about 5 m below the ground.

It is too early to accurately predict the long-term effect of tunnel drainage on the groundwater levels. As indicated in the EIA undertaken in 2002 and amended in

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2003, monitoring of groundwater levels during dewatering to assess the full scale of impact on the groundwater regime and dependant ecosystems is recommended for a long-term period defined as 5-20 years. Therefore it is only after a number of years of monitoring that the average groundwater level can be determined, as well as the variation around this average. Although baseline measurements were taken before construction of the tunnel started, this does not constitute long-term monitoring that can be used to describe average conditions before the tunnel was constructed.

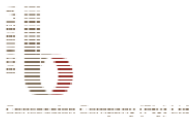

#### 5.4.1 Potential impact on groundwater users due to the lowering of the groundwater levels

Monitoring of groundwater levels took place in the form of piezometer readings as shown in the Geotechnical Instrumentation Report dated March 2010 and July 2011 (**Appendix D**). The potential impact of groundwater draw down on groundwater users can only be determined following at least one rainfall season that would allow to ascertain whether or not the water levels will recover, whether such impact is permanent or what the extent of potential impact will be over time.

The lowering of the groundwater table impacted on the spring in MFP. A study undertaken in May 2010 confirmed that the spring has dried up since the initial visit in March 2006 (Meyer, 2010, **Appendix H**). A likely cause for drying up of the spring is the construction of the tunnel and/or the vertical shaft at MFP. The construction has affected the impermeable nature of the diabase dyke as predicted and to such an extent that groundwater can now migrate freely from the southern to the northern side of the dyke, thereby lowering the pre-construction groundwater head on the southern side of the dyke.

#### 5.4.2 Impact on Aquifer Dependent Ecosystems

There is no evidence in the original EIA (2002 - 2003), as well as subsequent comparative environmental studies for the Sandton variant alignment (2006) that the spring or seepage area bordering MFP sustained Aquifer Dependent Ecosystems. It is considered that the spring flow contributed only marginally to the stream flow of the Sandspruit, and to the source of the dam and associated wetland area in MFP. However, the more luxurious, mainly alien vegetation observed in the seepage area possibly points to partial reliance of the water from the spring. The drying up of the seepage area, whether permanent or not, may potentially impact on the non-indigenous vegetation of MFP only (ILISO, 2010a) and therefore the impact on MFP is considered to be insignificant.

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#### 5.4.3 Impacts on the borehole users

An assessment was undertaken on potential impact on existing borehole users within the tunnel drawdown area by ILISO (ILISO, 2010a).

As indicated in the Arup report (2009), the inflow to the tunnel represents a loss of groundwater from the aquifer system which would otherwise discharge naturally into surface drainage channels (for the major part), or be abstracted by wells and boreholes.

A borehole census conducted by KLM Consulting in early 2007 found that there were 19 boreholes on properties along the tunnel alignment.

Monitoring of groundwater levels in dedicated boreholes to assess the full scale of impact on the groundwater regime took place in the form of Piezometer readings, as shown in the Geotechnical Instrumentation Summary dated March 2010 (**Appendix D**). The baseline for groundwater levels is contained in the 2007 Groundwater Report compiled by KLM Consulting.

At this point in time it seems that there has been an impact on some borehole, but not on others. It is still too early to say whether the impact is permanent, and what the extent of the impact will be over time. At least one rainfall season is required to ascertain whether or not the water levels will recover.

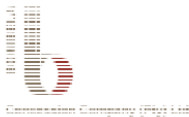

#### 5.5 IMPACTS ON THE AQUATIC ENVIRONMENT

Annual aquatic biomonitoring surveys have been undertaken since the commencement of construction. The aim of the surveys were to ascertain if the construction activities were having an impact on these systems by undertaking riparian vegetation and general habitat assessments as well as surveying the avifaunal (birds), amphibian, ichthyofaunal (fish) and aquatic macro-invertebrate communities at both upstream and downstream sites associated with each railway crossing site.

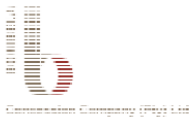

**Table 5-2** provides a summary of the monitoring points.

**Table 5-2: Aquatic biomonitoring sites associated with the Gautrain Rapid Rail Link development (EnviRoss, 2009)**

Site	Site Code	Description	Lat_S	Lon_E
Jukskei River @	G1_US	Jukskei R @ Marlboro Dr crossing	-26.08476	28.10876

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Site	Site Code	Description	Lat_S	Lon_E
Marlboro	G1_DS	Jukskei R @ Marlboro Dr crossing	-26.08346	28.10830
Modderfonteinspruit @ Dam 4	G2_US	Modderfonteinspruit below Dam no 4	-26.05730	28.12114
	G2_DS	Modderfonteinspruit below Dam no 4	-26.05579	28.11999
Tributary of Jukskei R @ Allandale Rd	G3_US	Tributary of Jukskei R @ Allandale Rd crossing	-26.02699	28.12758
	G3_DS	Tributary of Jukskei R @ Allandale Rd crossing	-26.02693	28.12728
Rietspruit	G4_US	Rietspruit @ Olifantsfontein Rd	-25.95428	28.14178
	G4_DS	Rietspruit @ Olifantsfontein Rd	-25.95405	28.14130
Louwardia Stream	G5_US	Louwardia Stream at John Vorster Dr	-25.86561	28.19257
	G5_DS	Louwardia Stream at John Vorster Dr	-25.86364	28.19376
Sesmyspruit @ Supersport Park	G6_US	Sesmyspruit (Hennops R) @ Supersport Park, Centurion	-25.86224	28.19436
	G6_DS	Sesmyspruit (Hennops R) @ Supersport Park, Centurion	-25.86069	28.19188
Fountains stream @ Sunnyside	G7_US	Fountains stream in Sunnyside	-25.75829	28.19578
	G7_DS	Fountains stream in Sunnyside	-25.75599	28.19654
Walkerspruit	G8_DS	Walkerspruit in Sunnyside	-25.75970	28.21999
	G8_US	Walkerspruit in Sunnyside	-25.75652	28.21784
Rhodesfield	G9	Tributary of the Rietvleispruit, selected immediately downstream from the crossing. The upstream section is canalised underground and therefore no upstream site was surveyed.	-26.12408	28.22125
Trib of Modderfonteinspruit @ Founders Hill	G10_US	Modderfonteinspruit @ Founders Hill	-26.09988	28.17516
	G10_DS	Modderfonteinspruit @ Founders Hill	-26.10131	28.17341
Trib of Modderfonteinspruit	G11_US	Modderfonteinspruit @ Chrissies Hill and Park Rd intersection, Founders Hill	-26.09698	28.16213
	G11_DS	Modderfonteinspruit @ Chrissies Hill and Park Rd intersection, Founders Hill	-26.09860	28.15883
Modderfonteinspruit @ Dam 1	G12	Modderfonteinspruit below Dam no 1	-26.09679	28.15164
Sandspruit	G13_US	Sandspruit @ Katherine Dr crossing	-26.09981	28.07573
	G13_DS	Sandspruit @ Ernst Ullman Park, Morningside	-26.08104	28.07351

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The survey included an upstream and downstream point at all the river crossings where the Gautrain alignment crosses drainage lines. Observations from the May 2009 survey indicated that all of the sites that were sampled suffered degradation due to habitat transformation through landscaping, solid waste disposal, development encroachment and domination. The degraded nature of the riparian habitat meant that no Red Data Listed (RDL) floral species were observed or would be expected to occur. The majority of aquatic and riparian habitat degradation was noted to be due to poor catchment management rather than from activities pertaining to the Gautrain development (EnviRoss, 2009 refer to **Appendix I** for detailed report).

The aquatic systems pertaining to the Gautrain development area were already highly impacted due to poor catchment management and therefore the negative impacts from the Gautrain development on the overall ecological integrity of these systems can be regarded as minimal.

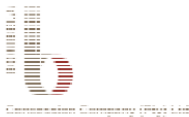

No Red Data Listed (RDL) riparian faunal or floral species were noted during the field assessment and due to the highly degraded nature of the riparian habitat; no such species are expected to occur within the river reaches of the sites surveyed.

*Riparian vegetation assessment:*

The riparian vegetation at all sites showed degradation and transformation due to pre-existing impacts imposed by surrounding developments, solid waste disposal, landscaping and alien vegetation encroachment. Riparian vegetation has been rehabilitated at all sites following completion of the construction phase of the Gautrain development.

*Aquatic habitat descriptions:*

The aquatic habitat at all sites showed signs of transformation and degradation typical of urban-managed systems. Habitat degradation through siltation as a consequence of terrestrial soil erosion impacted on the majority of the biomonitoring sites due to pre-existing poor catchment management. Impacts directly related to the Gautrain construction activities were most noteworthy at Sites 3 and 4 (Allandale and Olifantsfontein Roads) and could be regarded as being a limiting factor to supporting aquatic species. At Site 3 the roadway bridge and roadway construction have altered all natural components of the aquatic and riparian habitat at this site, with the consequence that soil erosion and exotic vegetation domination are major contributing factors to habitat transformation.

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However the study regarded further factors within the catchment area that have a more significant impact on the overall ecological integrity at this site. The Gautrain activities were therefore regarded as having an insignificant impact on the overall integrity of the system at this site. Aquatic habitat integrity, however, was not viewed to be a limiting factor to aquatic macro-invertebrate inhabitation at the remainder of the sites as adequate habitat was observed.

*Water quality:*

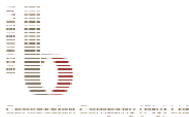

The results from the in situ water quality parameter testing indicated that the only limiting factor pertaining to those water quality parameters tested for was oxygen content at Site 1 (Jukskei River). This is typically an indicator of a high nutrient load normally attributed to the contamination by raw sewerage effluent. The conductivity and pH at some sites associated with Modderfontein Industrial Complex was shown to have values exceeding guideline values for aquatic environments. This is typically due to chemical pollution within the water. These limiting water quality parameters are, however, not as a consequence of the construction activities pertaining to the Gautrain development. These construction activities as cited by the Enviro Ross Report (2009) were viewed to be having an insignificant impact on the water quality of the river systems associated with it. Poor catchment management is cited for poor water quality at the various survey sites. Poor water quality rendered some sites within Kempton Park and Modderfontein completely unsuitable for aquatic organisms.

*Macro-invertebrate sampling:*

The macro-invertebrate community structures from the SASS5 sampling scored overall low to critically low values. The study area incorporated river systems that drain the commercial and industrial heart of the country and is therefore highly impacted upon due to runoff urban surface waters and industrial and sewerage effluents that have all had adverse effects on the water quality at all of the sites that were surveyed. The poor water quality rather than poor aquatic habitat integrity is therefore perceived to be the limiting factor to aquatic macro-invertebrate inhabitation and overall ecological integrity.

*Fish sampling:*

The fish survey showed typically poor fish inhabitation of the various sites. These results were expected given the highly-impacted nature of the urban-managed rivers and streams. Fish species that were sampled were all known to be highly tolerant of a certain degree of water pollution and habitat degradation. No RDL fish species occur within the catchment pertaining to the Gautrain development. Construction activities pertaining to this development have also not impacted on the river systems

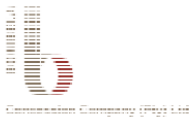

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to transform or degrade existing habitat that is suitable for fish inhabitation. Therefore, the Gautrain development is viewed not to have had a significant impact on overall fish conservation within the region to date.

**Table 5-3** presents a summary of the results of the overall habitat and biological sampling at each site.

**Table 5-3: Summary of the physical habitat and biological integrity at each survey site.**

Site	SASS score	IHAS score	IHI score	Overall site class
G1_US	F	B	D	E
G1_DS	F	C	D	E
G2_US	E	A	D	D
G2_DS	E	B	D	C
G3_US	F	D	D	E
G3_DS	F	C	D	E
G4_US	F	D	E	E
G4_DS	E	D	E	E
G5_US	E	C	D	D
G5_DS	E	C	D	D
G6_US	E	A	C	C
G6_DS	D	A	C	C
G7_US	CANAL			
G7_DS	CANAL			
G8_US	E	B	D	C
G8_DS	CANAL			

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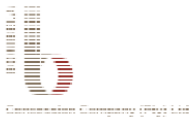

Site	SASS score	IHAS score	IHI score	Overall site class
G9	F	C	E	D
G10_US	F	C	E	D
G10_DS	F	D	E	E
G11_US	F	C	E	D
G11_DS	F	C	E	D
G12	D	A	D	C
G13_US	D	B	D	C
G13_DS	F	B	D	D

The aquatic study concludes that the Gautrain development did not have any significant impacts on the overall ecological integrity of the already highly impacted and degraded river systems associated with it. Various historical and existing extrinsic anthropogenic factors have led to the majority of the river systems suffering critically modified and degraded ecological integrity classes that have lost basic ecological functionality. These results were expected due to the highly-urbanised nature of the respective river catchments.

Once the rehabilitation of the river crossings are completed it is not expected that the project will have any further impacts on the aquatic environment provided that there is not an accident and oils and greases are released to the environment.

The findings of the May 2009 Aquatic biomonitoring report was confirmed again in a separate biomonitoring survey undertaken in October 2009 to determine the impact associated with the groundwater discharge into the Sandspruit. Two biomonitoring points were chosen, one upstream and one downstream of the discharge point to assess the Present Ecological State (PES) of the river.

The study concluded that the PES of the Sandspruit at the discharge point suffers from various historical and present degradation features which means it suffers a “poor or seriously impaired” modified state. The discharge water that was sampled did not show any toxicity threat to the system and the chemical screening showed that the chemical water parameters fall mostly within the DWAF (1996) Target Water Quality Guideline values for Aquatic Ecosystems. The discharge of the water found in the tunnels into the Sandspruit is therefore viewed as having an insignificant impact on the overall ecological integrity at the site (EnviRoss, 2009)<sup>2</sup>.

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**Table 5-4: Summary of the biological and physical habitat data fro the upstream and downstream sites:**

Site	SASS score	IHAS score	IHI score	Overall site class
SSP_US	F	C	D	E
SSP_DS	F	C	D	E