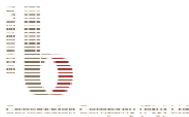



Figure 4-4: Detailed geology between Park Station and the M1 Freeway

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In order to estimate the tunnel water volumes, measurements of the tunnel water have been undertaken utilising v-notch testing. The results were presented in the ILISO Tunnel Discharge to the Sandspruit Report of 2009 (ILISO, 2009) for which modelling was undertaken. The initial measured flows, as well as the estimated flows after a period of 6, 12 and 33 months are shown in **Table 4-4**. The estimated flows were calculated by using observed flows as a starting point and then applying the expected rate of reduction as predicted by the Arup report (2009).

Table 4-4: Measures and predicted flows along the tunnel (excluding the TBM section) (ILISO, 2009)

Tunnel Section	Length (m)	Measured Flows		Predicted Flows (m ³ /d/m) after elapsed time (months)		
		(m ³ /d/m)	MI/d	6	12	33
Park Station to E2 (1)	535	1.80	0.96	1.55	1.31	0.45
Park Station to E2 (2)	2065	1.18	2.44	1.06	0.93	0.51
Rosebank to Sandton	4700	0.07	0.33	0.07	0.06	0.05
Sandton to MFP	500	0.14	0.07	0.12	0.10	0.04
MFP to Portal	4300	0.13	0.56	0.13	0.13	0.13
Total/average	12100	0.36	4.36	0.33	0.29	0.17

As the detail design development and the tunnel construction works progressed, more accurate results became available. The quantity of water discharged from tunnel drainage system reported in July 2009 was 5 011 m³/day.

The volumes of water to be released from the tunnel drainage system after construction were updated and presented in the Iliso Consulting Tunnel Water Discharge report submitted to the DWA on 23 November 2009 with a cumulative discharge volume of 5 400 m³/day for the Sandspruit catchment area.

More recent measurements, using the refill rates and the volumes of the sumps have indicated an increase in the initial discharged volumes. The latest figures are presented below in **Table 4-5**.

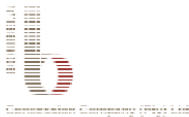

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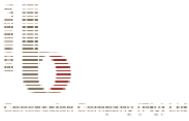

Table 4-5: Measured flows along the tunnel (received from Bombela, September 2011)

Discharge point	Description	Coordinates at the sump	Measured discharged (Ml/day)
1	Sandspruit	S26°05'57"; E28°04'33"	1.32
2	Sandton	S26°06'31"; E28°03'23"	1.28
3	Shaft E4	S26°09'19"; E28°02'46"	0.004
3	Shaft E3	S26°09'49"; E28°02'53"	0.001
5	Shaft E2	S26°10'27"; E28°03'07"	5.51
Total			8.11

The discharge from the section of the tunnel built by use of Tunnel Boring Machine (TBM) at Shafts E4 and E3 is essentially nil, as can be expected. However, for all the other sections an increase in discharge is noticed comparing to volumes measured in 2009. The combined discharge from Sandspruit and Sandton discharge points (2.35 Ml/day) is slightly higher but for all practical purposes equal to the calculated recharge which is 2.32 Ml/day.

The discharge from Shaft E2 discharge point is however higher than the calculated recharge (2.64 Ml/day). This would indicate a continued drawdown of the groundwater level, but this is reflected by the piezometer records which instead show that the groundwater levels have substantially stabilised or have started to rise again in some instances. The continued high quantities of water drained and discharged from the tunnel section between Park Station and Shaft E2 can therefore only be ascribed to an external ingress of water.

Nonetheless, additional engineering work to reduce the flow of groundwater into this section of the tunnel has now commenced. These works include drilling the small diameter holes through the tunnel floor and injecting grout into the surrounding rock. This will reduce the permeability of the rock mass and thus reduce the water which enters the tunnel drains. The targeted reduction in flow is 0.25 litres per meter of tunnel per minute.

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Even without the additional engineering work the water flow is still well within the designed capacity of the drainage systems and does not affect the safe operations of trains, which have been running in the is section of tunnel for several months as part of the Gautrain System testing and commissioning phase. This is confirmed by the certification of the entire Gautrain system by the Railway Safety Regulator.

In terms of findings presented in the ILISO 2010a report the quality of the water remains of drinking water quality, with the presence of free Chlorine detected in the tunnel water in the Shaft E2 section which suggest the external factors of leaking utilities adding to the groundwater regime.

Taking into consideration the impact that leaking utilities as indicated above will probably have on the quantities of water drained and discharged from the Gautrain tunnel as well as seasonal increased recharges, the quantity of water that would need to be discharged from the tunnel can be in the range of 10 Mℓ/day with the maximum peak flow of up to 15 Mℓ/day.