

25 August 2015,  
Brett McLennan  
McLennan & Associates

Peter Hatton  
EGIS Road Services

Dear Peter,

As requested by EGIS Consulting (EGIS), McLennan & Associates (M&A) undertook the August 2015 monthly groundwater survey of existing monitoring bores along the Legacy Way Tunnel. Monitoring of groundwater levels is required as part of the Coordinator Generals conditions for both the design and construct, as well as the operational phase of the Legacy Way Tunnel.

Field works were undertaken on 18 and 19 August. All monitoring locations were sampled, with exception of BH220 in Victoria Park Rd, in which the gattic cover was not able to be removed due to sediment cementation. An attempt will be undertaken in the September sampling round to use a pressure cleaner to remove sediment from cover. During this round the coupling and wire were replaced in monitoring well's BH309, BH312, BH311 NL4-HG10 and NL4-A2. Five additional wells will require cable to be installed with the current loggers suspended using nylon rope which is unsuitable for long term monitoring equipment as it is known to easily fray (potentially losing the loggers). The logger in BH320 will require lowering as part of the wire replacement, with data indicating that the logger was above the groundwater level between 16 May and 3 June, 2015.

### **Groundwater August 2015**

Monthly groundwater monitoring has been conducted in compliance with the Hydrogeology and Groundwater Environmental Management Plan (EMP EN-OP-PP0018). Monitoring locations were previously selected due to their location, geology and accessibility along the Legacy Way Tunnel corridor. The monthly groundwater works included measuring standing water levels along the tunnel alignment and downloading data from *in situ* water level loggers. For the purpose of this study the monitoring wells are targeting bedrock (confined) and alluvial (unconfined) aquifers.

### **Groundwater Monitoring Locations**

The monitoring locations assessed during this month's works are outlined in Table 1 below

TABLE 1- GROUNDWATER LOCATIONS

Locality	ID	Reference	Geology	Monitoring
West	NL2-02	Toowong	Bedrock	Groundwater level
	NL3-05S	Toowong	Alluvium	Groundwater level
	NL3-16	Toowong	Alluvium	Groundwater level
Alignment	BH108	Toowong	Bedrock	Groundwater level
	BH320	Toowong	Bedrock	Groundwater level
	NL5-4	Toowong	Bedrock	Groundwater level
	NL2-12	Toowong	Bedrock	Groundwater level
	NL2-14	Auchenflower	Open Bore – Bedrock and Alluvium	Groundwater level
	BH309	Rosalie	Bedrock	Groundwater level
	BH311	Rosalie	Bedrock	Groundwater level
	BH312	Rosalie	Bedrock	Groundwater level
	BH313	Rosalie	Bedrock	Groundwater level
	BH313 A	Rosalie	Alluvium	Groundwater level
	NL4-HG10	Rosalie	Alluvium	Groundwater level
	NL4-HG6A	Paddington	Alluvium	Groundwater level
	NL4-5	Paddington	Bedrock	Groundwater level
	NL4-A2	Rosalie	Bedrock	Groundwater level
	NL2-06	Red Hill	Bedrock	Groundwater level
	NL2-09	Red Hill	Bedrock	Groundwater level
East	BH205	Inner City Bypass	Bedrock	Groundwater level
	BH220	Kelvin Grove	Bedrock	Unable to access
	BH221	Kelvin Grove	Bedrock	Groundwater level
	BH222	Inner City Bypass	Bedrock	Groundwater level

The groundwater locations in **Table 2** had previously been decommissioned during the design and construct phase of the project. It is understood that most have been destroyed since the commencement of the project. The quantity of the remaining monitoring locations is deemed sufficient for the purposes of the groundwater monitoring and no additional replacement wells are planned. Monitoring had previously ceased in the Botanic Gardens following handback of the tunnel conveyor to BCC.

**TABLE 2 - DECOMMISSIONED GROUNDWATER LOCATIONS**

Locality	ID	Reference	Geology	Monitoring
West	BH503	Botanic Gardens	Bedrock	Conveyor Tunnel no longer in use - no further monitoring to be conducted
	BH502	Botanic Gardens	Bedrock	Conveyor Tunnel no longer in use – no further monitoring to be conducted
	BH104D	Botanic Gardens	Bedrock	Destroyed
	BHSC1A	Botanic Gardens	Alluvium	Destroyed
	BHSC1B	Botanic Gardens	Bedrock	Destroyed
Alignment	BH314	Toowong	Bedrock	Not located – Note NL2-14 located nearby this location
	BH310	Rosalie	Alluvium	Replaced by BH313A
	BH307	Red Hill	Bedrock	Decommissioned, due to proximity to the alignment
East	NL4-HG4	Brisbane Grammar	Bedrock	Destroyed
	NL4-HG5	Brisbane Grammar	Bedrock	Destroyed
	BH203	Brisbane Grammar	Bedrock	Destroyed

## Groundwater Monitoring Results

### Groundwater Level Monitoring

Groundwater levels below ground surface were collected along the tunnel corridor at 23 locations. All locations monitored were equipped with Solinst Leveltrolls (automated water data) loggers, which were calibrated via the static water groundwater level measurements and corrected for barometric pressure. Static groundwater level measurements are detailed in Table 3.

TABLE 3 - GROUNDWATER ELEVATION

Locality	West	Alignment												East				West	Alignment					
Geology	Bedrock	Bedrock												Bedrock				Alluvium	Alluvium					
Location	NL2-02	BH108	BH320	NL5-4	NL2-12	NL2-14	BH309	BH311	BH312	BH313	NL4-5	NL4-A2	NL2-06	NL2-09	BH205	BH220	BH221	BH222	NL3-16	NL3-05S	BH313A	NL4-HG10	NL4-HG6A	
Units	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD
Ground Elevation mAHD	25.78	23.65	47	20.2	26.07	47.7	4.1	4	4.1	3.8	5.6	2.2	63.9	41.4	23.8	29.4	29.3	23.9	18.9	25.01	3.8	2.2	5.58	
Water Elevation mAHD August 2015	16.56	18.125	18.72	11.59	17.93	2.625	-2.985	-2.89	-0.5	-2.96	4.39	-0.005	35.44	27.63	Dry	NS	17.77	18.295	15.835	16.12	-0.01	0.24	2.28	

### Groundwater Level Results

Figure 1 and Figure 2 demonstrate water level variations in the bedrock and alluvium respectively.

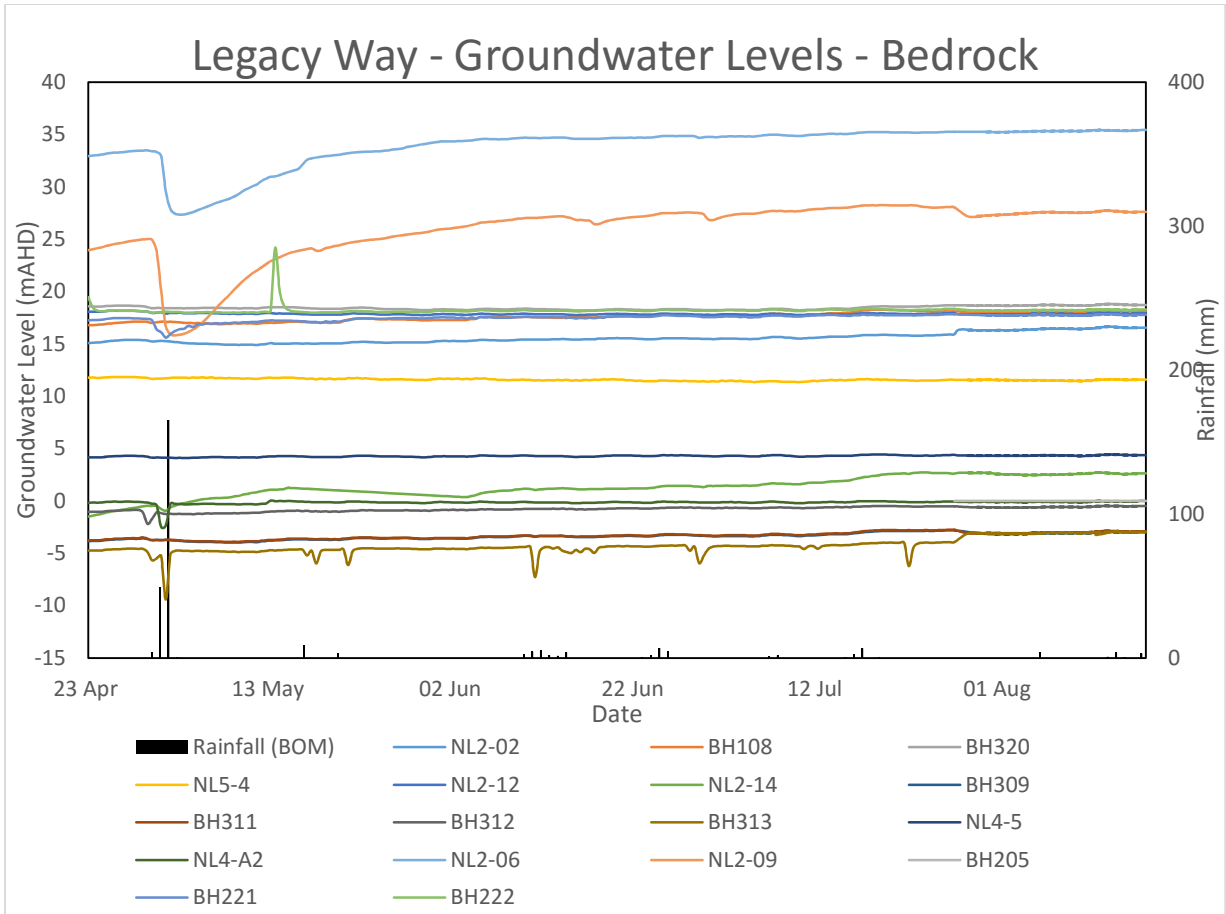


FIGURE 1 - GROUNDWATER LEVELS – BEDROCK

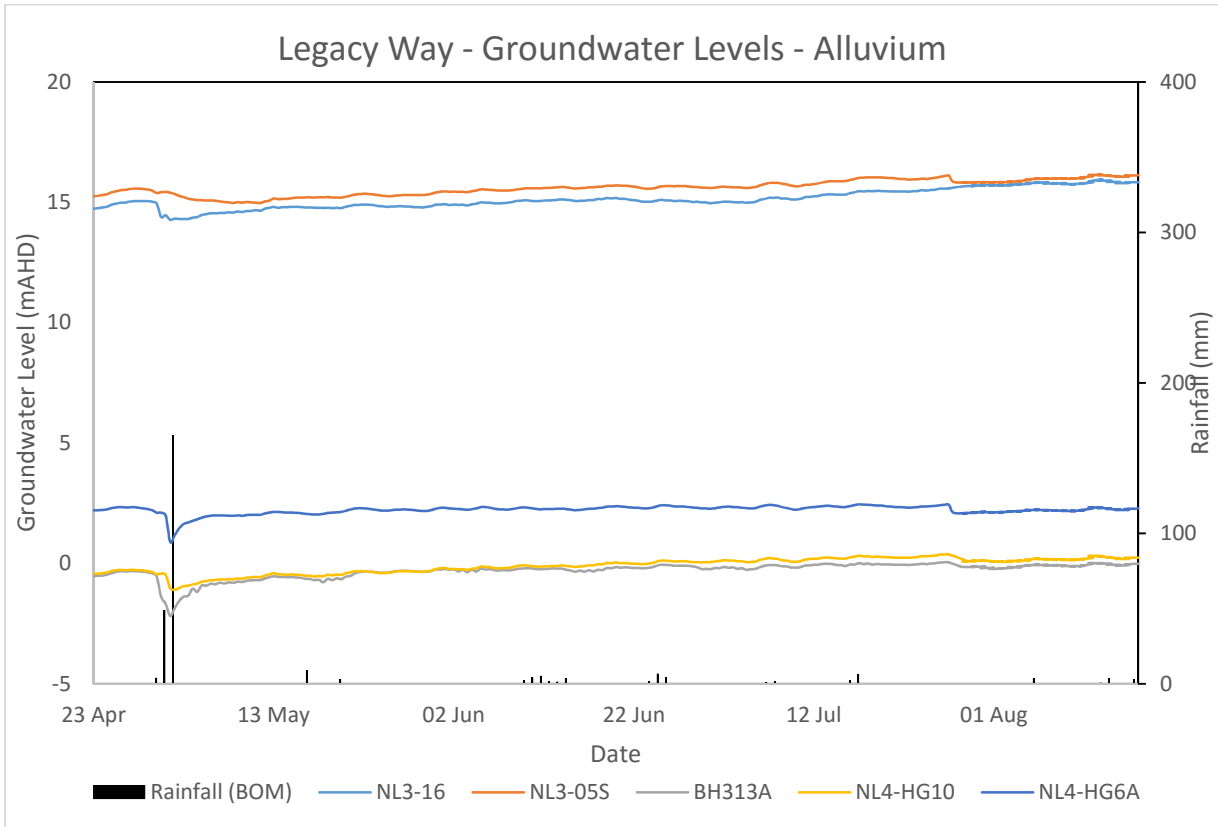


FIGURE 2 - GROUNDWATER LEVELS - ALLUVIUM

The in general the standing water levels generally indicate a continuation of the previous trends shown during the construction phase i.e. relationship of groundwater fluctuations to rainfall levels, with the following of note:

Groundwater in the Toowong Cemetery and surrounds, the groundwater level in boreholes BH108, BH320, NL5-4, NL2-14 had historically been reported as exceeding the 200% of the natural variation and was associated with the tunneling activities in close proximity to the boreholes. No change in the groundwater levels was noted since the July inspection. Ongoing recovery of the bedrock groundwater level is expected to continue during the wet season.

Along the tunnel alignment in Rosalie and surrounding areas, the groundwater level in boreholes BH309, BH311, BH312, BH313 had previously been reported as historically exceeding the 200% of the natural variation and was associated with tunneling activities in close proximity to the boreholes. These boreholes are assessing water levels in the bedrock, and drawdown from tunneling operations was predicted in this area. BH313 had a significant increase in groundwater levels since the previous monitoring round, however this may be due to water seeping in from sewer upgrade works that had recently occurred in the area. This will be re-evaluated during the next monitoring round. Borehole locations NL4-HG10 and NL4-HG6A (monitoring the alluvium north and south of the tunnel alignment respectively) had a small decrease in the water levels since the July monitoring round, while NL4-5 and NL4-A2 (monitoring the bedrock north and south of the tunnel alignment respectively) have not noted any marked changes. This indicates that potential drawdown is likely from localised works. Stabilisation and recovery of these locations is underway since the cross passage works in the vicinity were completed; however, it will be dependent on recharge rates. Recovery of bedrock groundwater levels continues to be recorded in this area via the automated data logger information and correlated with static water level measurements in the area. Assessment of levels at these locations will continue.

Groundwater in the Eastern Portal area continued, with slow recovery noted in the bores. This could be due to low recharge rates over the previous couple of months. BH205 has continued to have less than 10 cm of water and is considered “dry” for automatic logging. This is most likely to be associated with the dewatering of the Eastern Portal. Access to BH221 was not able to be obtained during this reporting period.

At the Western portal, NL2-02 had a increase in the water level since the July monitoring round. This will continue to be assessed to determine if the bedrock in this area continues to recover. Alluvial bores NL3-16 and NL3-05 remained steady over the previous month.

It should be noted that at this stage Egis does not propose any mitigation strategies in regards to fluctuations in groundwater levels. However, ongoing monitoring will be undertaken to assess any impacts and stabilisation of water levels.



Brett McLennan

Senior Environmental Scientist