Our Reference: 24157.89526
Your Reference: Legacy Way Ground Water Levels - Dec 2016

07 February 2017

EnviroAg Australia

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Mr Greg Freeman
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Dear Greg

Re: Legacy Way Groundwater Levels December 2016

As requested by Egis, EnviroAg Australia undertook the December 2016 quarterly groundwater survey of the existing monitoring bores along the Legacy Way Tunnel alignment. Monitoring of groundwater levels is required as part of the Coordinator Generals conditions for the Operation and Maintenance phase of the Legacy Way Tunnel.

Field work was undertaken on 09 December 2016. NL3-05S located at the Western Freeway roundabout was unable to be sampled due to compost being stockpiled on top of the bore. All other monitoring locations were sampled. Due to several logger failures, loggers for the project are scheduled to be replaced in January 2017

BH205 at the ICB continues to have water level less than 10cm and unable to be used for data logging. Current measurements indicate a level of 2cm in the well. It is recommended that this well is re-developed to clear sediment from the well and filter pack to ascertain if water levels have decreased in this location. NL2-12 has been repaired by Egis in May 2016 and requires redevelopment to remove sediment from the bore.

NL5-4 in Sleath Street Toowong is collapsing due to installation on a 50-degree angle with vehicle and soil weight onto the PVC casing causing joints to slip. As degradation of the joints has been noted previously, this well is recommended to be decommissioned in accordance with the Minimum Requirement for Water Bores in Australia V3 (2012). Monitoring of groundwater in the surrounding area to NL5-4 is adequately covered with the groundwater bores located in Birdwood Terrace, Thorpe Street and within Toowong Cemetery.

Plans to redevelop BH205 and NL2-12, as well as decommissioning NL5-4 are currently planned for early 2017.

Groundwater December 2016

Monthly groundwater monitoring has been conducted in compliance with the Hydrogeology and Groundwater Environmental Management Plan (LWTP-ENV-PLA-005). 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 **Error! Reference source not found.**.

Table 1 – Groundwater Locations

Locality	ID	Reference	Geology	Monitoring
West	NL2-02	Toowong	Bedrock	Groundwater level
	NL3-05S	Toowong	Alluvium	Unable to monitor
	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
	BH313A	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
	BH221	Kelvin Grove	Bedrock	Groundwater level
	BH222	Inner City Bypass	Bedrock	Groundwater level

The groundwater locations in Table 1 had previously been decommissioned. 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 Brisbane City Council.

Table 1 - 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
	BH220	Kelvin Grove	Bedrock	Decommissioned due to damaged casing

Groundwater Monitoring Results

Groundwater Level Monitoring

Groundwater levels below ground surface were collected along the tunnel corridor at 21 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 2.

Table 2 – 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	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
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	29.3	23.9	18.9	25.01	3.8	2.2	5.58
Water Elevation mAHD Dec. 2016	15.46	18.9	19.15	12.36	17.9	6.81	-0.32	-0.21	0.445	-0.39	4.47	0.47	36.15	31.09	NA	NA	17.965	18.35	NA	24.96	-0.04	0.01

Note BH205 was less than 0.01m of water, NL3-05S was covered with compost

Groundwater Level Results

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

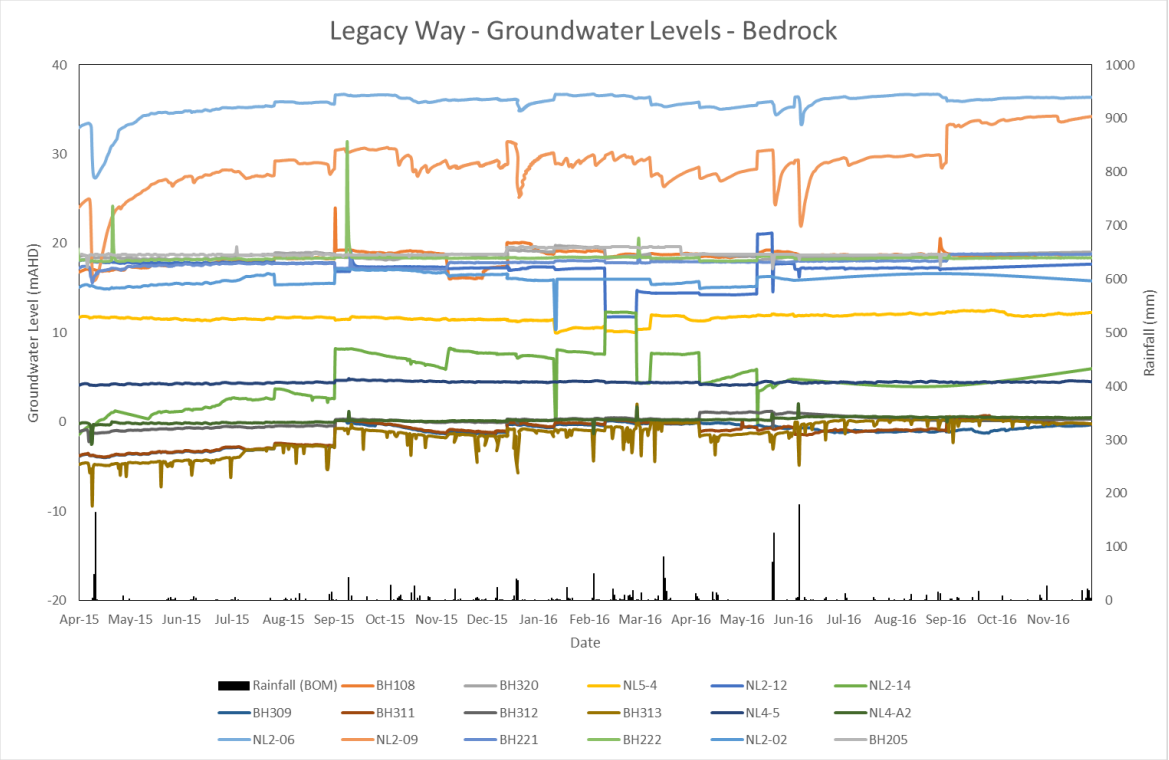

Figure 1 - Groundwater levels – bedrock

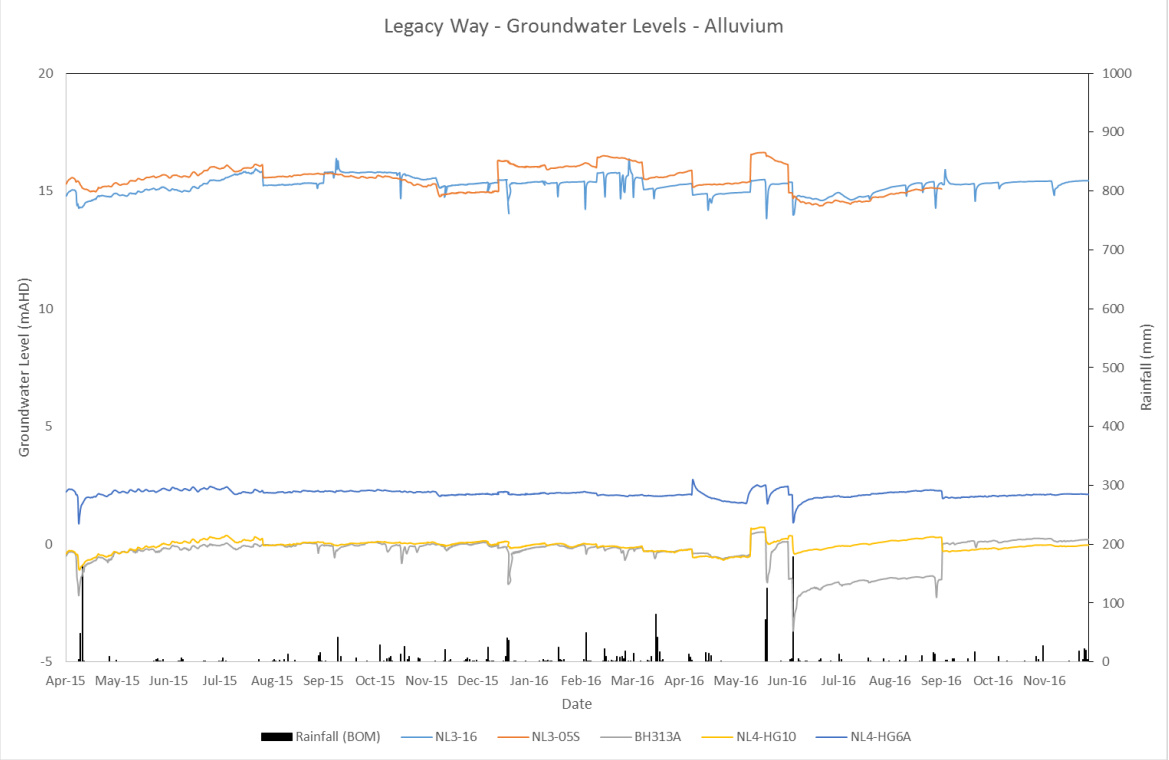

Figure 2 - Groundwater levels - alluvium

Discussion

The standing water levels continue to follow previous trends displayed during the construction phase i.e. relationship of groundwater fluctuations to rainfall levels, with the following of note:

Bores located along Baroona Road in Paddington were potentially compromised due to surface water ingress, with dewatering of surface annulus of the bores was undertaken during sampling.

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 tunnelling activities in close proximity to the boreholes. BH108 has stabilised over the quarter, which correlates with a decrease in rainfall events. BH320 continues to increase since the June 2016 monitoring period, and has historically indicated slow recharge following the rainfall events. NL5-4 continues to increase slowly since the January 2016 monitoring round and is at the maximum observed level over the previous 15 months. Groundwater levels in BH 2-14 dip data indicates an increase in the water level by 1.8m since the September monitoring period and is equivalent to the previous summer period. This well has historically displayed a high variation of up to 3.5m since the March 2016 monitoring period. It is expected that this location will continue to fluctuate based on sessional trends.

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 tunnelling activities in close proximity to the boreholes. These boreholes are assessing water levels in the bedrock, and drawdown from tunnelling operations was predicted in this area. BH313 continues to indicate variations that correspond with rainfall events, indicating that the well might have been compromised due to roadway water ingress into the well. BH309 and BH311 continued to decrease slightly since the June 2016 monitoring event.

At the alignment borehole locations monitoring the alluvium adjacent to the tunnel alignment - NL4-HG10 and NL4-HG6A displayed a dewatering event around 20 June 2016 (3 days after the June fieldwork) continued to increase to the June 2016 level. NL4-5 and NL4-A2 remained static.

Groundwater monitoring of the Eastern Portal area continued, with slow recovery noted in the bores. BH205 has continued to have less than 10 cm of water and is considered “dry” for automatic logging. BH221 and BH222 remained static since the March 2016 monitoring period with no fluctuation noted due to rainfall events. NL2-06 in upper Clifton Terrace decreased and it is noted that it has been previously influenced by surface water ingress with spikes correlating with rainfall events. NL2-09 has increased to the highest recorded level and was noted to have potential surface water ingress. This bore may be influenced from surface water runoff from local construction works.

At the Western portal, NL2-02 remained stable with a decrease in rainfall intensity over the previous quarter. Levels in this site appear to be impacted by localised rainfall events and have been noted to be potentially influenced from external activities (i.e. Mt Coot-Tha Quarry and the botanic garden ponds). Groundwater in the alluvial bore NL3-05S was unable to be sampled during this period due to compost piled onto the well. This is scheduled to be cleared prior to the next sampling event.

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

Yours sincerely,

Brett McLennan
Principal Environmental Scientist
EnviroAg Australia Pty Limited