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For the attention of Alison Soper
(by email)

Our ref: 2184.1.FCC.DRB.SV.A0

Date: 12th March 2015

Dear Alison,

Re: Brookhill HRA review 2015

I am writing in relation to the Brookhill HRA review, which is due to be completed by the end of April 2015. We have now had a chance to collate the monitoring data for the site for the review period and to consider the conceptual model. As discussed during our meeting on the 6th November 2014, we present, for comment from NRW, our proposed assessment scenarios and calculation methodology with relevant justification where appropriate.

Site conceptual model

The geology and hydrogeology of the site have been described in detail in the 2008 HRA[1] and subsequently reviewed in the Brookhill Hydrogeological Review 2014[2], and the monitoring data collected since 2008 supports the interpretations made in those reports.

To review the hydraulic containment of the site during the review period the following were considered:

- relevant engineering details (cell base levels and leachate extraction well bases in mAOD);
- currently accepted leachate level triggers (agreed in a meeting between Alison Soper (NRW) and representatives from Flintshire County Council Waste Management Services and Caulmert on the 17th September 2009); and
- leachate and groundwater levels.

These are summarised in Table 1 below. The leachate levels shown are the average of the levels in 2013 and 2014, (the average levels for the whole review period in the LC series wells were not significantly different to those presented below; the apparently high leachate levels in the R-series wells in the period 2010-2013 likely reflect perched leachate, so are not included in this assessment). The groundwater levels shown were recorded during a low-groundwater event in 2011 (highlighted in the Rukhydro report).

[1] Brookhill Landfill Site: Hydrogeological Risk Assessment Review (version 2). November 2008, Egniol Consulting Ltd.
[2] Brookhill Landfill: Hydrogeological Review (2014), 3rd July 2014, RukHydro Ltd.

Table 1. Comparison between average leachate levels and lowest groundwater levels (Sept 2011)

Cell	Cell base mAOD	Leachate well ID	Base of well (mAOD)	Trigger level (m)	Trigger level (mAOD)	Average leachate head (mAOD) 2013 and 2014	Downgradient borehole	Lowest GW (sept 2011) (mAOD)
Cell 1	117	LC1B	118.5	2	119	118.35	GW3A	113.84
		R1b	117.07	2	119	118.04	GW4.1	119.63
Cell 2	113	LC2B	114.5	3	116	114.20	GW1A*	126.58
		R2b	112.2	3	116	113.41		
Cell 3	112	R3	111.71	5.5	117.5	111.74	GW2A	121.18
Cell 4	112	LC4B	113.5	3	115	112.34	GW6.1	120.82
		R4b	112.46	3	115	114.13		
Cell 5	113	R5	114.71	3	116	117.63	GW5A	128.05
Cell 6	120	LC6B	121.29	2	122	121.58	GW1A	126.58
		R6b	120.25	2	122	123.52		

* Nearest borehole. GW1A is upgradient of Cell 2.

The data suggests that Cells 2-6 continue to be managed successfully on the basis of hydraulic containment. Cell 1 was constructed above the groundwater table and engineered to control emissions to groundwater on this basis (according to HRA completed in 2003). Cell 1 was interpreted as being hydraulically contained in the 2008 HRA, however the data since shows that despite being offered hydraulic containment when the groundwater table is high, it appears to be out of containment during drier periods (e.g. Sept 2011 and Sept 2013). It should be noted that leachate levels in this cell have been managed in accordance with the permitted trigger for this cell throughout the review period.

Assessment scenarios

It is proposed that the following scenarios are assessed using numerical modelling:

Scenario	Description	Justification
1	Currently permitted leachate head levels in relation to lowest groundwater levels (representative of worst case scenario) and 95th percentile of concentrations of priority contaminants in leachate over the review period (as was done in the 2008 HRA review).	To assess the potential impact of the site if operated as permitted, considering the increased leachate strength compared to that assessed in 2008.
2	Currently observed leachate head levels where out of compliance with currently permitted levels (Cells 5 and 6) in relation to lowest groundwater levels and 95th percentile of concentrations of priority contaminants in leachate.	To understand what impact the site may be having at present
3	Failure scenario, with leachate levels exceeding groundwater levels by 1m.	To assess the potential impact of the site in current condition if leachate levels exceed the surrounding groundwater levels.

It is considered that the parameters used to predict the time required to increase leachate levels at the site by 1m (Scenario 4 in the 2008 HRA) remain representative for the site.

It is proposed that Scenarios 1 and 2 (Cells 2-5 and Cell 6) are assessed using the EA worksheet for calculating Contaminant fluxes from Hydraulic Containment Landfills (version 1.0). This spreadsheet is not probabilisitic and therefore as a conservative approach the source term will comprise the 95%ile values as described above.

As Cell 1 is considered to be above the water table, it is not appropriate to assess it using this tool. It is further noted that there is no unsaturated zone below this cell, thus the use of LandSim to assess its impact is not appropriate. It is suggested that the possible impact of this cell is assessed using standard equations to calculate the leakage through the base and sides of each phase on the basis of key landfill design parameters and environmental settings of the cell (following the approach used

for Scenario 3 in the 2008 HRA). The inputs will be made probabilistic using the software tool Crystal Ball.

It is proposed that Scenario 3 (failure scenario, leachate levels = groundwater levels + 1m) is modelled using the approach taken for modelling the impact of Cell 1, described above.

Calculating GW quality trigger levels

As discussed at the meeting on the 6th November 2014, the groundwater in the area surrounding the site is of poor quality reflecting historical mining and industrial activities in the area. In addition, no sensitive receptors are identified within 500m of the site. Therefore, it is proposed that trigger levels for non-hazardous substances are set by back-calculating the concentration that would need to be achieved at the compliance point (GW2A and GW3A) to prevent an increase in the background groundwater concentrations of the priority contaminants 250m downgradient of the edge of the site. It is proposed that this is done using the Remedial Targets worksheet (Release 3.2, EA): Hydrogeological risk assessment for land contamination.

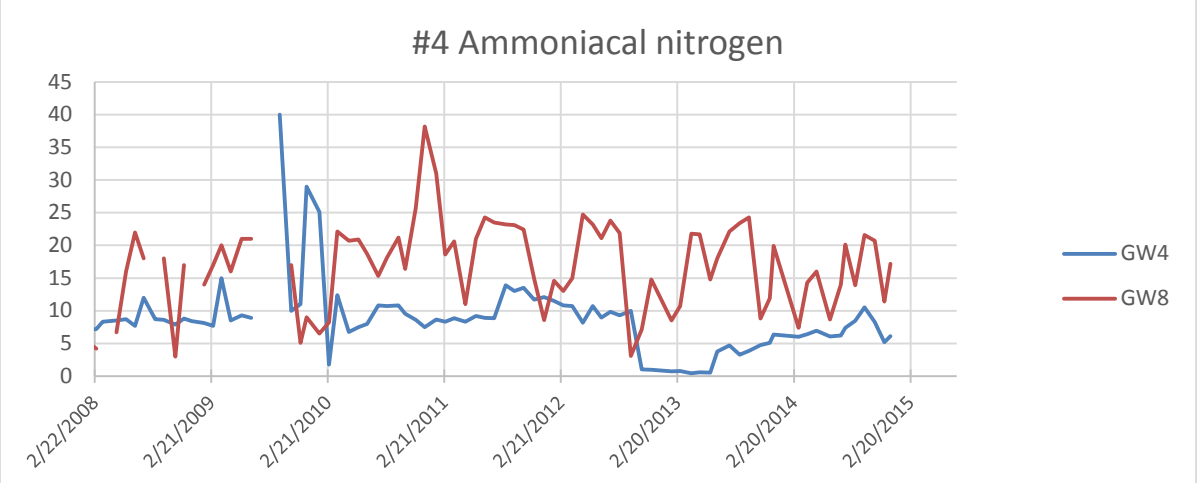
It is proposed that background groundwater concentration is derived using groundwater quality in GW4, GW5, GW6 and GW8, after removal of significant outliers (which are interpreted as either erroneous readings or isolated, uncharacteristic events – the resulting graphs of the concentrations of ammoniacal nitrogen and chloride at those locations are included at the end of this letter for reference). The average concentration of ammoniacal nitrogen in the data pooled in this manner is 7.67 mg/l and the average chloride concentration is 101 mg/l.

I hope that the information supplied in this correspondence allows you to assess adequately the suggested modelling and calculation approaches and comment as to whether you find them satisfactory for predicting the potential impacts of the site. If you do need any further information at this stage, or require clarification regarding any of the suggested approaches, please do not hesitate to contact me at your earliest convenience. Any recommendations you have regarding any of the above or any other aspect of the HRA review for this site are very welcome.

I look forward to hearing from you.

Yours Sincerely

Diana Brookshaw
Senior Environmental Scientist
On behalf of Caulmert Ltd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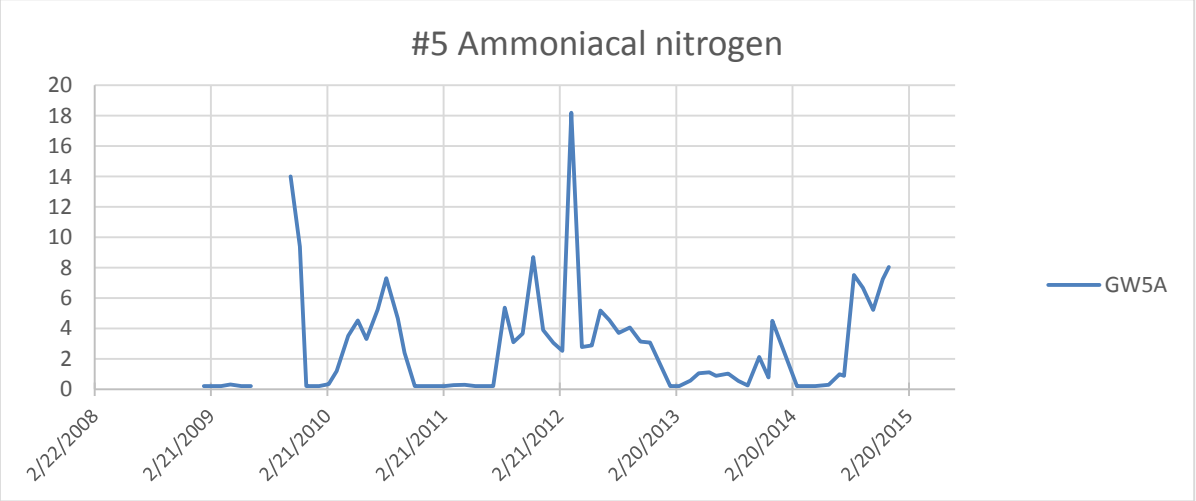
45
40
35
30
25
20
15
10
5
0
2/22/2008
2/21/2009
2/21/2010
2/21/2011
2/21/2012
2/20/2013
2/20/2014
2/20/2015
GW4
GW8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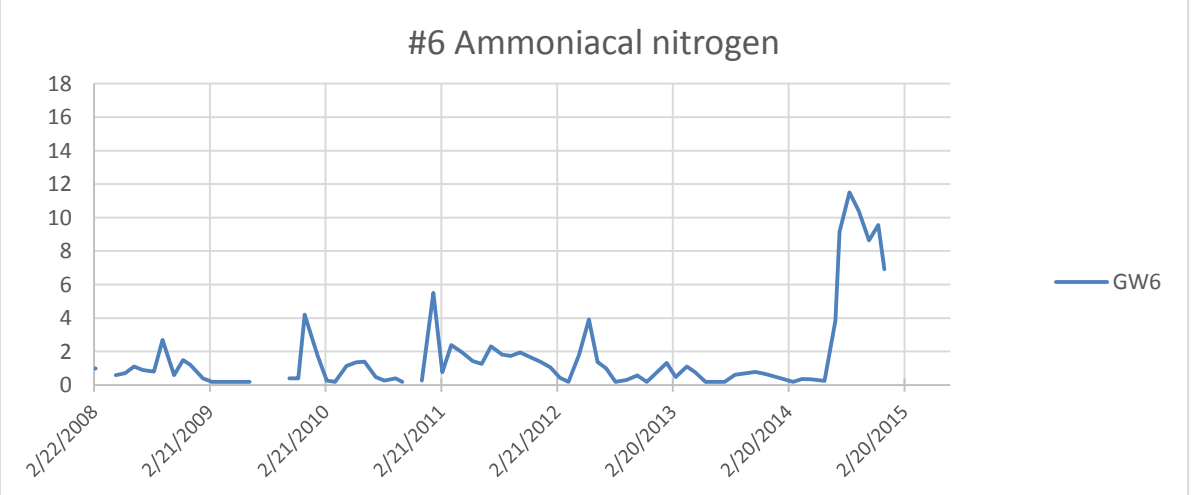
20
18
16
14
12
10
8
6
4
2
0
2/22/2008
2/21/2009
2/21/2010
2/21/2011
2/21/2012
2/20/2013
2/20/2014
2/20/2015
GW5A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18
16
14
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10
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2
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2/22/2008
2/21/2009
2/21/2010
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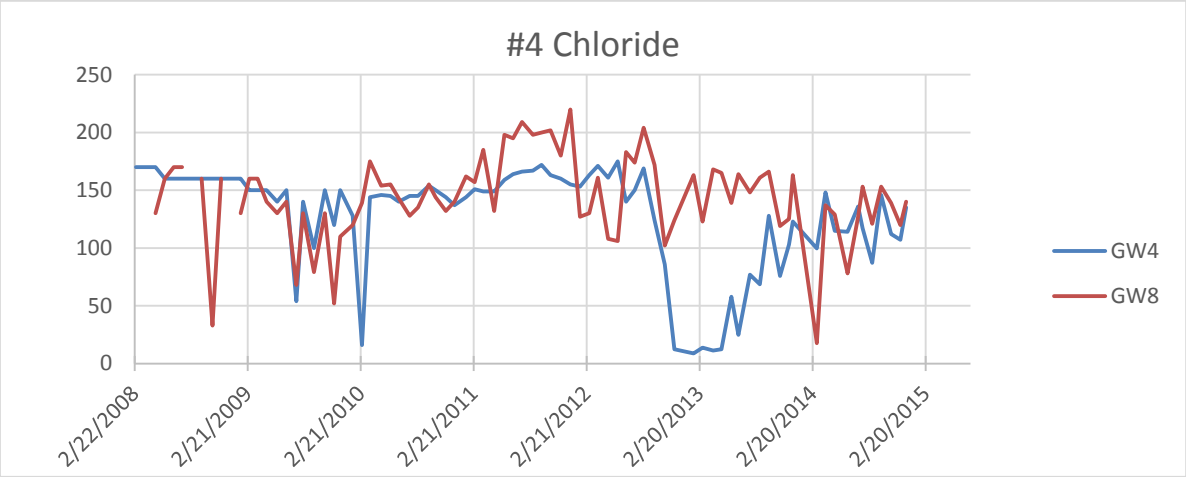
2/21/2012
2/20/2013
2/20/2014
2/20/2015
GW6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250
200
150
100
50
0
2/22/2008
2/21/2009
2/21/2010
2/21/2011
2/21/2012
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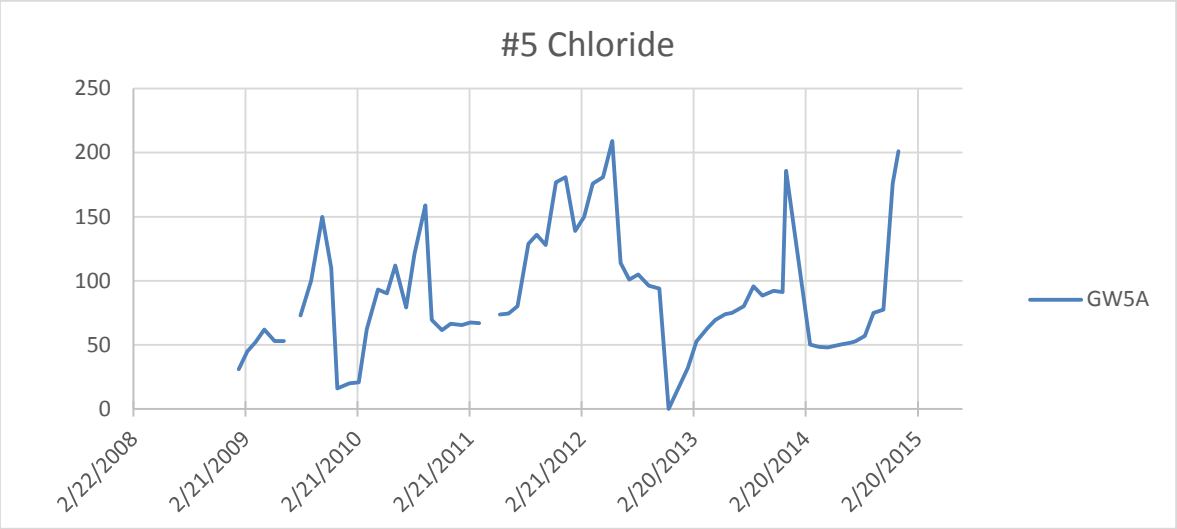
2/20/2014
2/20/2015
GW4
GW8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250
200
150
100
50
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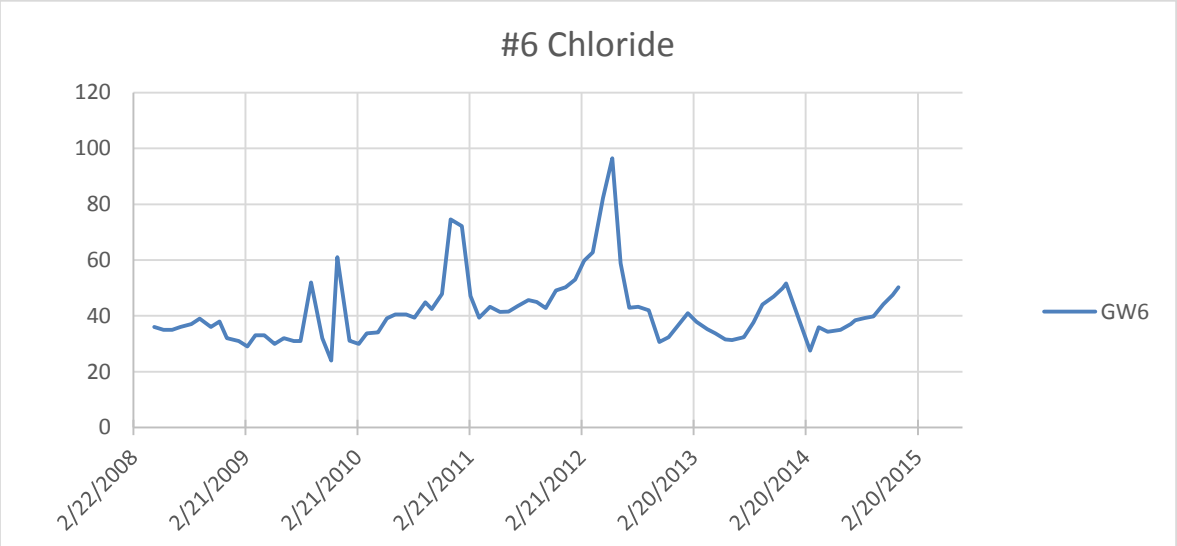
2/22/2008
2/21/2009
2/21/2010
2/21/2011
2/21/2012
2/20/2013
2/20/2014
2/20/2015
GW5A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100
80
60
40
20
0
2/22/2008
2/21/2009
2/21/2010
2/21/2011
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2/20/2013
2/20/2014
2/20/2015
GW6