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Paul Williams
Natural Resources Wales,

By e-mail

Our ref: 3428-CAU-XX-XX-CO-V-9101.A0-C1
16th October 2018

Dear Paul,

Re: Review of chloride levels in W1

Further to the previous email of 10th August 2018 and your subsequent discussions with Andy Stocks please find detailed below further information to support the Applicant's request to remove the chloride compliance limit at groundwater monitoring borehole. W1 which routinely exceed the current compliance limit.

Groundwater monitoring location W1 is situated near the site entrance adjacent to the B4518 Llanidloes to Tywlch road. Both groundwater and perimeter gas are monitored at this location.

Water quality at W1 is subject to compliance limits set within the Environmental Permit for the site (number EPR/BU7766IC/V004). The permit stipulates that the compliance limit for chloride at all groundwater monitoring locations around the site is 69 mg/l. The concentrations at W1 were below the permit level only on 3 occasions since 2005, in September 2006 and June and September 2007. All other concentrations recorded at W1 to date have exceeded this limit. Historically, chloride concentrations at this location peaked at 727 mg/l in March 2010, and since 2013 fluctuate typically between 200 mg/l and 500 mg/l (see historic data for this location compared to chloride concentrations in the other groundwater monitoring locations around the site, shown in Figure 1 below).

The purpose of this correspondence is to review the available information, evaluate the possible reason for the elevated chloride concentrations at this location and propose a variation to the conditions of the permit in relation to chloride in W1.

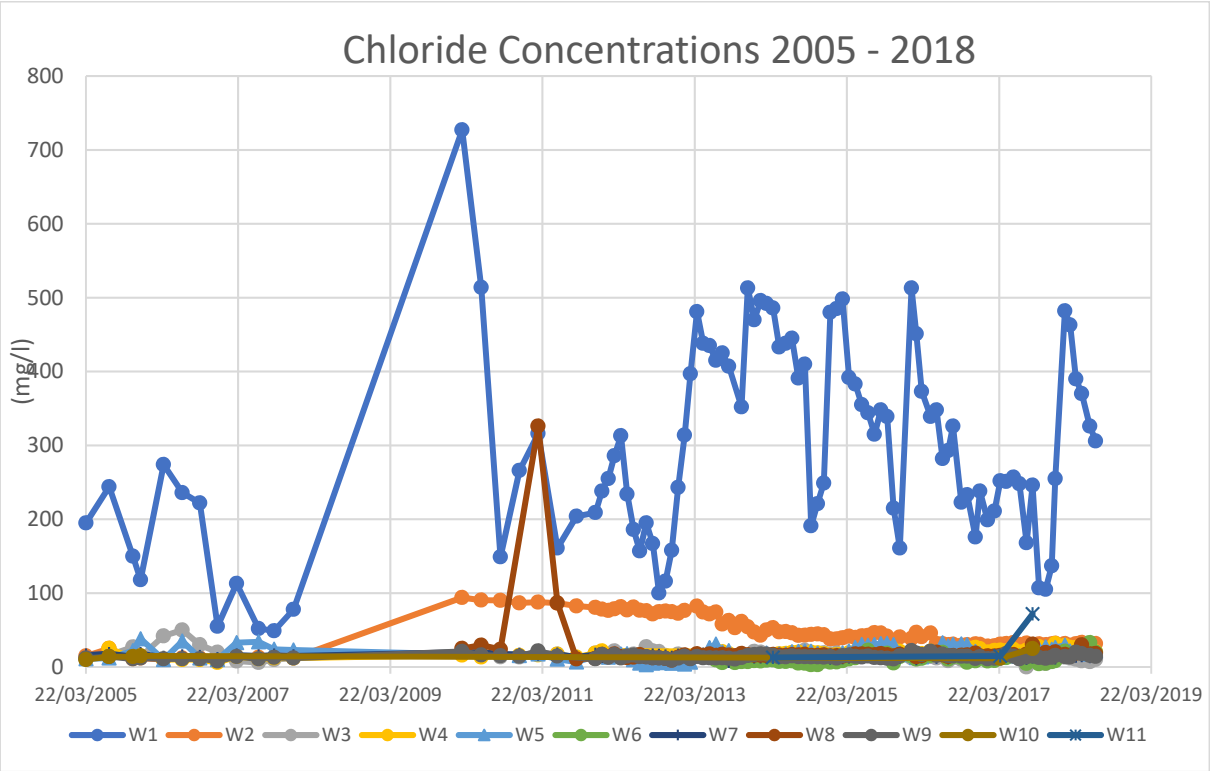


Figure 1. Chloride concentrations at all groundwater monitoring locations at Bryn Posteg Landfill Site.

The chloride concentrations at W1 were reviewed in relation to sodium and ammoniacal nitrogen concentrations at this location. Sodium is part of the annual suite, therefore the chloride and ammoniacal nitrogen concentrations for the corresponding monitoring occasions were collated. These are presented graphically, on Figure 2.

Ammoniacal nitrogen is found in very high concentrations in the leachate for the site (up to 2660 mg/l in 2016), and as such is commonly used as an indicator of impact from landfill leachate on surrounding water receptors. It can be seen on Figures 2 and 3, that throughout the available data period (since 2009), ammoniacal nitrogen concentrations remained very low at W1, often being below the detection limit (highest ammoniacal concentration at W1 was 1.78 mg/l recorded in March 2011). There is no discernible correlation between the concentration of chloride and that of ammoniacal nitrogen at this location (see Figure 3). The discrepancy between the concentrations of chloride and ammoniacal nitrogen suggest that the source of high chloride concentrations at this location is not related to leachate from the site but reflects a non-landfill offsite source.

It has been suggested previously, that the high chloride concentrations result from impact from rock salt, for example due to the proximity of this location to a road, which may be treated with salt during the winter months. To explore this possibility, the chloride concentrations were compared to the sodium concentrations at W1 (see Figure 2 below for the time-series graph, and Figure 4 for a correlation between chloride and sodium at W1). It can be seen that chloride and sodium concentrations fluctuate similarly over time and are well correlated (with a regression coefficient (R^2) of 0.93). This indicates that chloride and sodium at this location are controlled by the same factor.

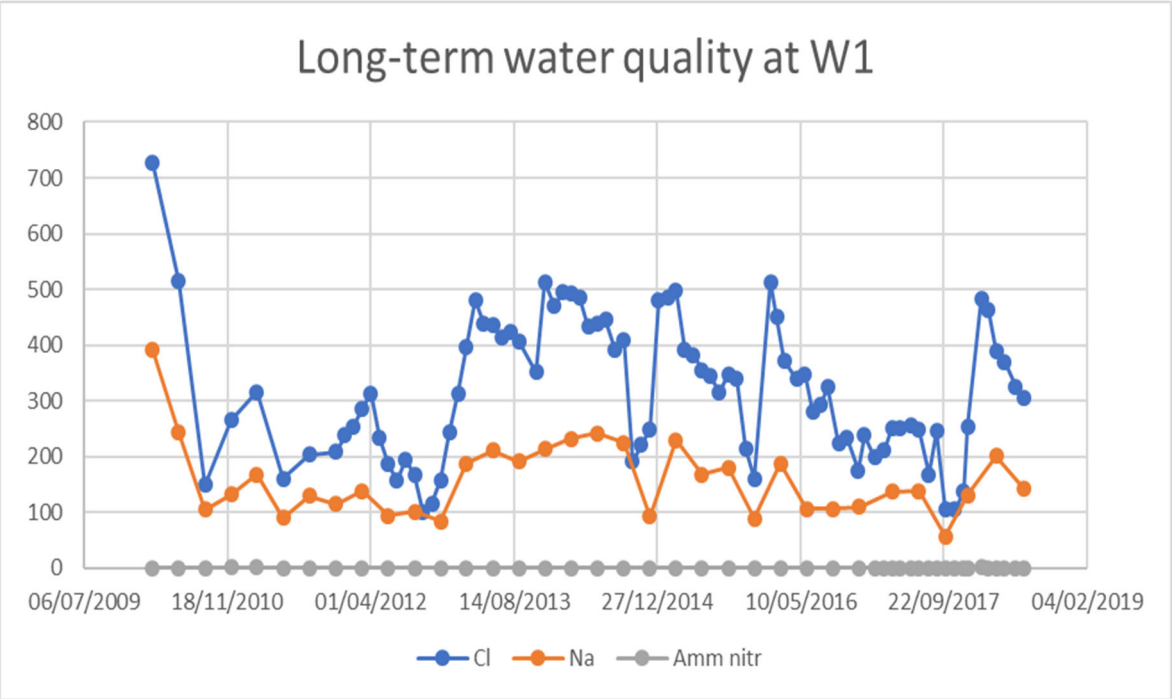


Figure 2. Chloride, sodium and ammoniacal nitrogen concentrations at W1.

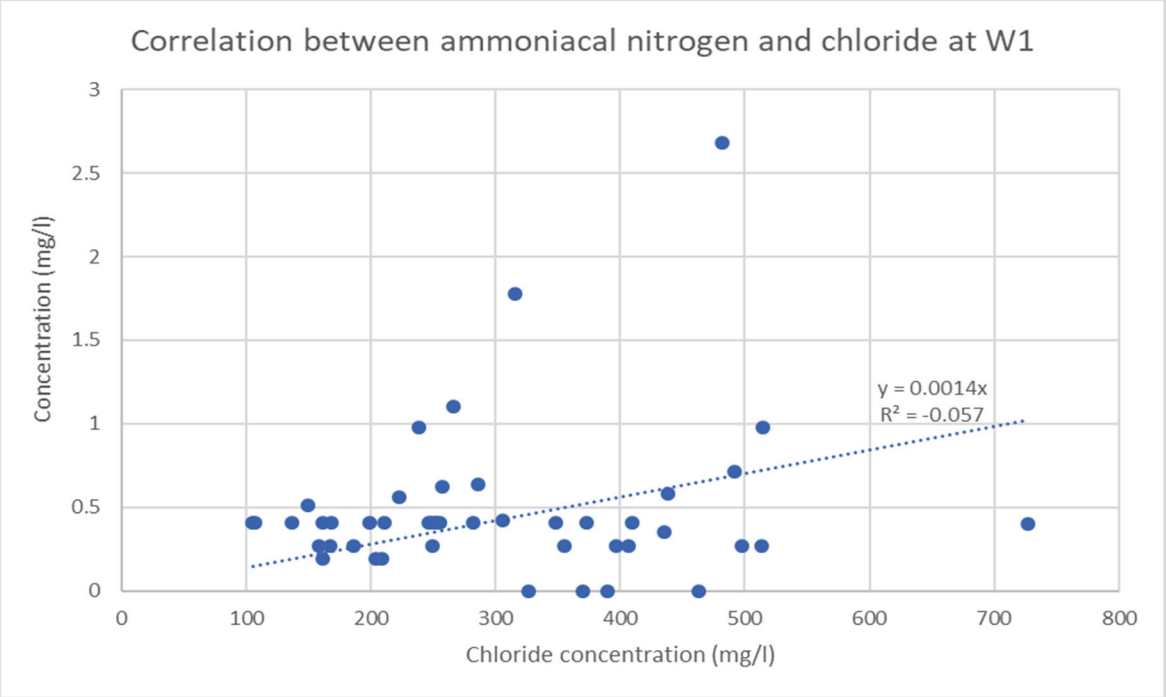


Figure 3. Correlation between chloride and ammoniacal nitrogen concentrations at W1

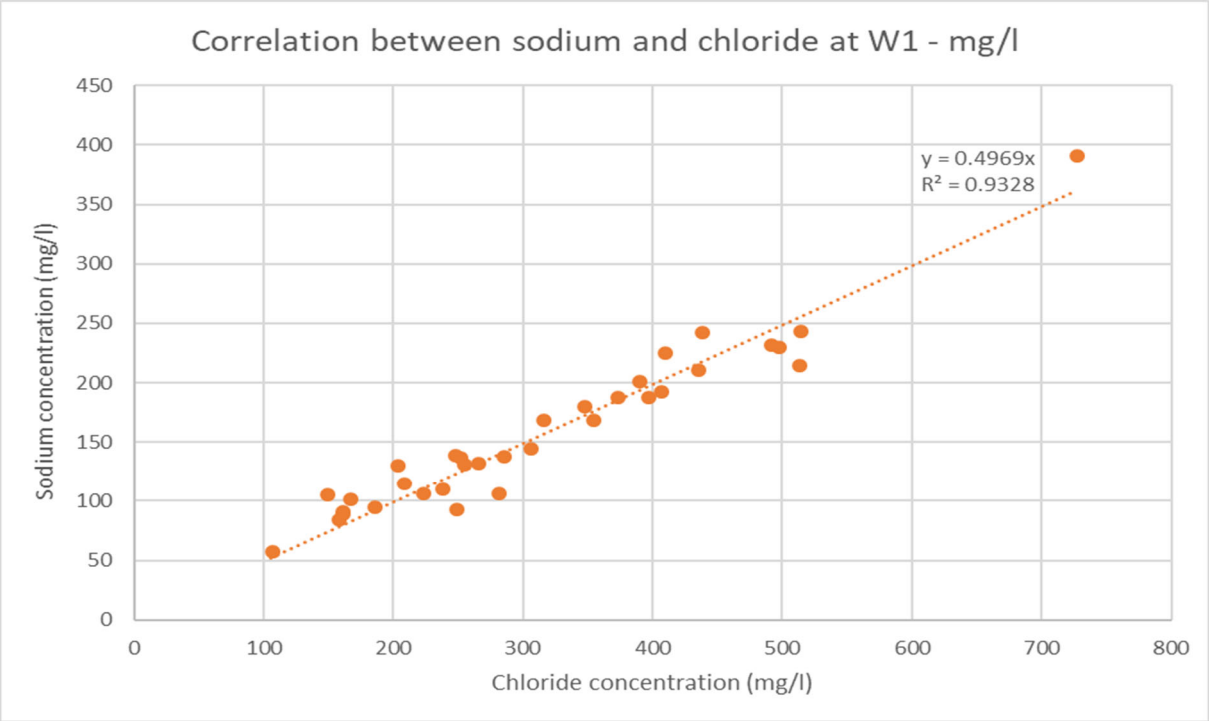


Figure 4. Correlation between chloride and sodium concentrations at W1

The results are consistent with the influencing factor being salt. The molar ratio of chloride to sodium in salt (NaCl) is 1:1. When converted to mmol/l, the chloride and sodium concentrations at W1 have an average ratio of 1.3, with slightly higher molar concentrations of chloride compared to sodium. This likely reflects the geochemical behaviour of the two ionic species, with Na^+ potentially adsorbing to available sorption sites, while Cl^- represents a conservative tracer, unlikely to sorb or precipitate in the environment.

It has been commented previously that if chloride levels are high at W1 due to periodic application of grit along the road, then high levels should also be recorded at W2 located approximately 500 m south east of W1, also along the B4518. Drawing 3376-CAU-XX-XX-DR-V-1803.A0-C5 shows the locations of these sample points. It is likely that this difference is due to the different horizons intercepted by these boreholes. The 2018 HRA (3400-CAU-XX-XX-RP-O-3001) highlights that the groundwater levels within the superficial deposits are heavily dependent on the presence or absence of sand and gravel lenses, and therefore there does not appear to be a uniform water body or gradient across the site. Within the Llandovery series, groundwater level interpretation is complicated by the juxtaposition of screened sections and intersected fractures. The groundwater levels reported at different locations were reviewed in the 2018 HRA in detail and indicated that W1 and W2 monitor different horizons based on this information. W1 has significantly lower groundwater levels, consistent with the response zone coinciding with the deeper aquifer, the Llandovery shale. W2 consistently has higher groundwater levels than W1, indicating that groundwater in this well it is in continuity with the perched groundwater within the superficial boulder clay deposits. The discussed observations support the interpretation that a localised pathway could be causing an impact at W1, but not W2.

To explore the seasonality of the observed chloride concentrations, the concentration of chloride in each month was averaged for the years 2005 to present. The results are included in Figure 5 below. Concentrations of chloride typically peak in the first quarter of the year, and then decrease gradually

through the rest of the year. The error bars represent the standard error of the datasets. The error bars for data in the first quarter of the year do not overlap with those for data in the last quarter of the year, indicating that the average concentrations in the first and last quarter are significantly different from each other. This supports the interpretation of seasonal variation within this data. This seasonality is consistent with a periodic impact during the winter months.

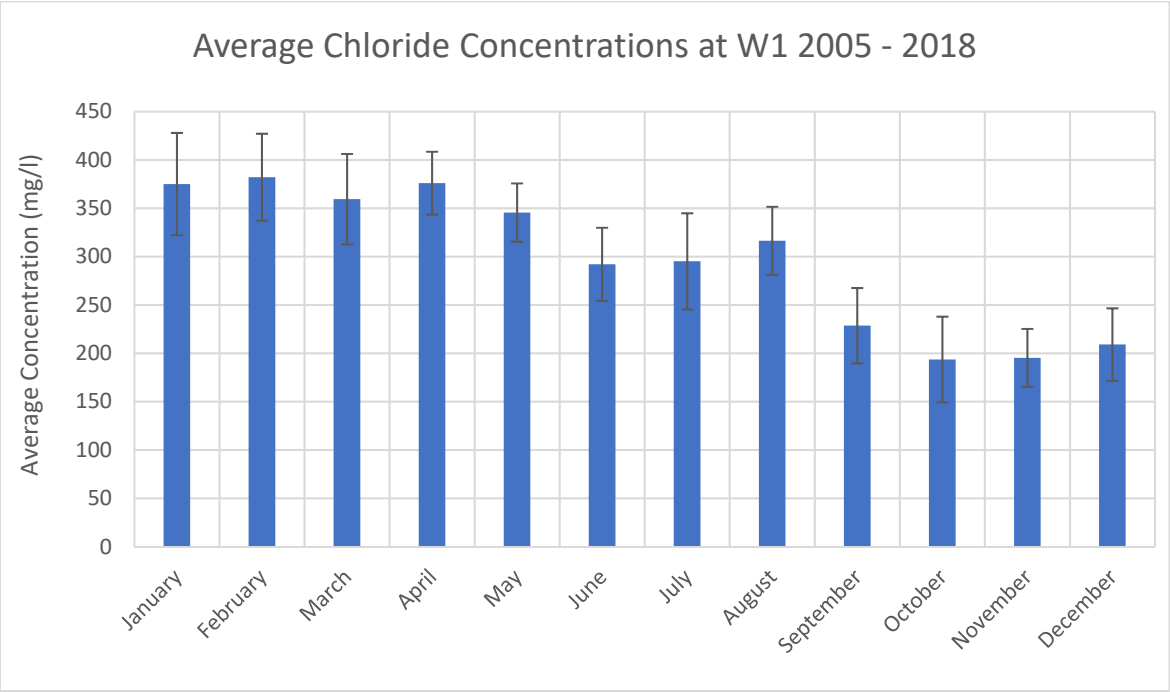


Figure 4. Correlation between chloride and sodium concentrations at W1

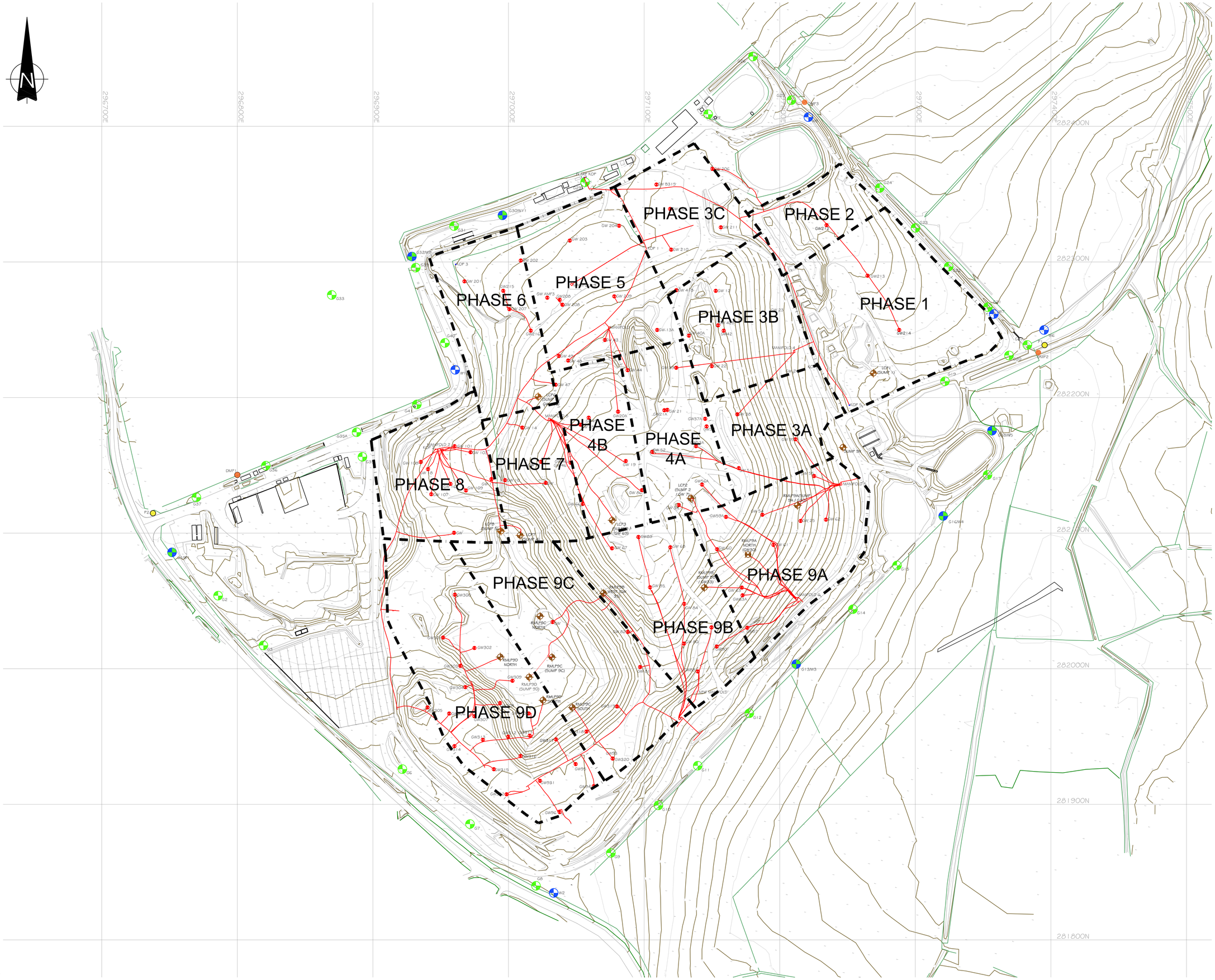
The evidence reviewed above indicates that W1 is impacted by a source of salt, possibly by a localised pathway, which is causing chloride concentrations to exceed the current compliance limit for this parameter at this location. It is further noted, that chloride concentrations at this location can vary over a range more than 200 mg/l within a year. This hinders the identification of an impact from the landfill using chloride as an indicator species over this localised chloride concentration. We therefore propose that the chloride compliance limit requirement for W1 is removed, as exceedances in other parameters at this location (such as ammoniacal nitrogen) are more diagnostic of potential impact from the site.

I trust the data presented here provides the required evidence to support the proposed amendment to the compliance limit for chloride at W1. Please do not hesitate to contact me to discuss any aspect of this correspondence in greater detail.

Yours sincerely,

Diana R. Brookshaw
Principal Environmental Scientist
For Caulmert Ltd

3376-CAU-XX-XX-DR-V-1803.A0-C5: Infrastructure Plan and Phase Layout



NOTE

1. DO NOT SCALE FROM THIS DRAWING, WORK FROM FIGURED DIMENSIONS ONLY. ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.

2. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING WILL BE ALLOWED WITHOUT THE PRIOR PERMISSION IN WRITING.

3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALIST DRAWINGS AND SPECIFICATIONS.

4. MAXIMUM SURCHARGE LOAD ON 50.0m FLOOR 20KN/m2 UNLESS OTHERWISE STATED.

LEGEND

- IN WASTE GAS WELL
- LEACHATE COLLECTION / MONITORING POINT
- PERIMETER GAS MONITORING BOREHOLE
- PERIMETER GROUNDWATER MONITORING BOREHOLE
- PERIMETER GAS & GROUNDWATER MONITORING BOREHOLE
- SURFACE WATER MONITORING LOCATION
- DUST MONITORING POINT

APPROVED AND ISSUED

C5	BOREHOLE NAME CHANGE	DA	HC	HC	16.10.18
C4	PHASE 1 AMENDMENTS	EJD	DB	DB	13.07.18
C3	APPROVED AND ISSUED	DA	DB	DB	02.07.18
C2	APPROVED AND ISSUED	DA	DB	DB	14.06.18
C1	APPROVED AND ISSUED	DA	SO	SO	08.06.18
P2	MINOR AMENDMENTS	DA	SO	SO	31.05.18
P1	ISSUED FOR COMMENT	DA	SO	SO	29.05.18
REV	MODIFICATIONS	BY	RE	AP	DATE

POTTERS WASTE MANAGEMENT

PROJECT:

BRYN POSTEG LANDFILL SITE

TITLE:

INFRASTRUCTURE PLAN AND PHASE LAYOUT

DRAWN BY	DATE	
DA	29.05.2018	
REVIEWED BY	SCALE @ A1	JOB REF:
SO	1:1250	3376
AUTHORISED BY	ISSUE	REVISION
SO	A0	C5

DRAWING NUMBER

3376-CAU-XX-XX-DR-V-1803

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