

GROUNDWATER DATA REVIEW

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FAO Mr. Pat Murphy,
CHI Environmental,
Grannagh,
Kilmacow
County Kilkenny.



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1 SUMMARY

This report reviews groundwater quality monitoring results and sampling practice in respect of a former rock quarry at Grannagh, Co Kilkenny. The results are compared with the EPA Threshold Values. Hydraulic gradient, data reliability, sampling methodology and a number of potentially-influencing factors are discussed.

2 DESCRIPTION OF SAMPLING POINTS & METHODOLOGY

2.1 Groundwater Sampling Points

The groundwater data under review has been collected and analysed from the three sampling boreholes listed in Table 2 / §2.2.

Table 1 / §2.1
Groundwater Monitoring Boreholes

ID	Location	Grid Reference
PT-1	Northern Site Boundary (Midpoint)	S57736 15008
PT-2	Southern Site Boundary (Adj. Car Park)	S57682 14713
PT-3	Southern Site Boundary (Adj. Residence)	S57992 14798

It has been reported that PT-1 and PT-2 are 30m and 40m in depth respectively. The depth of PT-3 has not been ascertained but is estimated as being commensurate with that of a PT-1. No static water levels are currently available.

PT-1 and PT-2 are purpose-installed groundwater monitoring boreholes bored into limestone rock. PT-3 is a drilled domestic well likely to be of similar construction. Well diameters are expected to be ca. 150mm and capable of accommodating a standard submersible pump.

2.2 Sampling Methodology

Pre-sampling preparation of PT-1 and PT-2 has been reported to consist of hypochlorite sterilisation followed by purging using a submersible pump. The water sample is collected directly from the discharge after a prescribed period of time.

PT-3 is in constant use as a domestic supply. Treatment is absent and water samples are collected from a direct water feed from the well.

It is noted from the certificate of analysis that, in any particular round of sampling, the wells are have not necessarily been sampled on the same day.

3 HYDROGEOLOGY

Although hydrometric data is not available from the groundwater monitoring points, the regional hydraulic gradient for any site can often be ascertained from topographic features and surface water features. However a number of features at this site complicate the prediction of a groundwater flow direction. The area of Granny is hydraulically bounded to the SE by the River Suir and to the NE by the River Blackwater. Land surface elevations are ca. 20m OD and the base of the original quarry is expected to be below the adjacent water level in the River Suir which is estimated at ca. 2m OD and tidally influenced.

Whilst there is no doubt that, generally speaking, regional groundwater is moving from north to south and towards the Suir, tidal influences, floods and low flows could reverse such a gradient at certain times in the immediate vicinity of the river which may extend beneath the site.

Nonetheless, in an overall sense, if there were any leachate presence in groundwater either from the old dump adjacent to the east or from the quarry infill programme, one would expect to see a higher level of associated chemical indicators in PT2 when compared with PT1.

4 GROUNDWATER MONITORING REQUIREMENTS

Whilst groundwater analyses for a comprehensive range of analytical parameters are available from three recent sequential rounds of groundwater sampling, before a detailed analysis is undertaken it is appropriate to identify the EPA's Groundwater Pollution Indicators with respect to this type of site and the applicable Threshold Values.

4.1 EPA Groundwater Pollution Indicators

In respect of point source indicators arising from landfill and similar sites such as the quarry reinstatement at Grannagh, specific groundwater pollution identifiers have been defined by the Environmental Protection Agency (Daly, D. & Craig, M., 2010, P5. *Methodology for Establishing Groundwater Threshold Values & the Assessment of Chemical & Quantitative Status of Groundwater, including an Assessment of Pollution Trends and Trend Reversal.* Johnstown:EPA. Such identifiers are listed below in Table 2 / §4.

Table 2 / §4.1
EPA Groundwater Pollution Identifiers (EPA 2010)

Aluminium	Cyanide
Ammonium	Lead
Arsenic	Mercury
Boron	Nitrate
Cadmium	Nitrite
Chloride	Organics (selected)
Chromium	Sodium
Conductivity, Electrical	Sulphate
Copper	

Whilst in the author's experience additional landfill-associated identifiers in water include iron, manganese, potassium, BOD, COD, TOC and selected bacteria, for the purpose of this overview it will be sufficient to focus on those listed in Table 2.

4.2 Threshold Values

This is an unlined site and natural recharge percolation is the mechanism by which infiltration reaches the water table. The underlying bedrock beneath the immediate area is Dinantian Lower Impure Limestone (DLIL), a limestone/shale overlying the Kiltorcan Old Red Sandstone which lies to the south. The aquifer classification is as stated in the EIS: LI, a Locally Important Aquifer – moderately productive only in Local zones. Since the water body recharged by infiltration is the aquifer and its most sensitive use is for drinking water supply, the TVs (Threshold Values) to be applied to the receiving body for the pollutant identifiers are, if effect, the drinking water quality standards as listed in Schedule 5 of the Groundwater Regulations.

5 GROUNDWATER QUALITY REVIEW

In the following section the results for those EPA Groundwater Pollutant Identifiers (GPIs) that have been included in the laboratory analyses undertaken for the three rounds of sampling

documented to date are compared with the Threshold Values taken from the EPA's Drinking Water Guidelines.

5.1 GPs including Metals & Standard Chemicals

With the exception of aluminium and nitrite, analysis of all the Groundwater Pollution Indicators associated with landfills and the site under consideration were undertaken in 2012, 2014 and 2015. The results have been transcribed into summary form in Table 3 / §5.

Table 3 / §5
Comparison GPs & Threshold Values

Groundwater Pollutant Identifier	Units	Groundwater Sampling Points							TVs
		PT-1			PT-2			PT-3	
		9.10.12	12.3.14	3.2.15	12.10.12	12.3.14	23.1.15	26.1.15	
Aluminium	µg/l	-	-	-	-	-	-	-	200
Ammonia	mg/l	<0.2	<0.2	<0.2	<u>0.344</u>	<0.2	0.203	<0.2	0.23
Arsenic	µg/l	0.322	0.308	0.399	0.466	0.686	535	0.218	10
Boron	µg/l	68.1	37.3	32.3	98.7	105	107	28.5	1,000
Cadmium	µg/l	<0.1	<0.1	<0.1	0.551	0.432	0.485	<0.1	5.0
Chloride	mg/l	47.9	41.8	26.7	69.6	102	82.9	19.2	250
Chromium	µg/l	2.15	10.6	2.02	2.22	<3	2.58	0.961	50
Conductivity	µS/cm@20°	646	629	674	1,004	1,320	1,050	353	1,500
Copper	µg/l	<0.85	0.99	35.4	1.69	2.71	0.971	7.05	2,000
Cyanide	µg/l	<50	<50	<50	<50	<50	<50	<50	50
Lead	µg/l	<0.02	0.102	1.09	0.063	0.198	0.118	0.092	10
Mercury	µg/l	0.0404	0.0526	<0.01	<0.01	0.0131	<0.01	<0.01	1.0
Nitrate (as N)	mg/l	3.58	2.96	11.2	5.68	2.69	4.13	3.9	11.3
Nitrite (NO ₂)	mg/l	-	-	-	-	-	-	-	0.15
Sodium	mg/l	26.6	19.4	13.6	41.4	62.7	49.7	98.6	150
Sulphate	mg/l	81.6	19.3	16.1	144	<u>287</u>	139	60.3	250

A **bold underlined result** indicates exceedance of the Threshold Value.

Apart from exceptions by ammonia (as N) in 2012 and sulphate in 2014, none of the Threshold Values have been exceeded. Both exceptions appear to be anomalies from normal compliance within the Threshold Values.

A number volatile organic compounds (VOCs) were detected by ALcontrol's in their analysis for SVOCS and VOCs in the sampling rounds. The manifestation of these compounds appears to have resulted solely from the use of sodium hypochlorite as a sterilising agent prior to purging and sampling. The compounds consist of the following trihalomethanes: chloroform, bromoform, dibromochloromethane, and bromodichloromethane. Cis-1,2-dichloroethene was also detected in PT-2 in both the 2012 and 2014 analyses. This is a common cleaning solvent and may be present in the sterilisation agent that was added to the wells. Discontinuation of the sterilisation practice has been advised.

No other potential pollutants have been detected in the analyses reviewed.

6 OBSERVATIONS & RECOMMENDATIONS

6.1 Microfiltration

Daly & Craig point out that Threshold Values were derived for Dissolved Metals and not for Total Metals. Although they state that groundwater supplies are usually unfiltered, where monitoring wells are used that are not being pumped on a daily basis, sediment accumulation often occurs. Furthermore, occasionally laboratory sample bottles for metals analyses have nitric acid pre-added which can have the effect of leaching solid fraction metals into solution. Microfiltration is appropriate but this should take place immediately upon collection and before the sample is decanted into the laboratory-provided bottle. An alternative procedure is to effect swift delivery to the laboratory and undertake microfiltration at that stage.

6.2 Hydrometric Data

It is good practice and useful data to collect static water levels from each monitoring point prior to purging. A record of purge volumes should be kept and the depth of pump placement.

6.3 Sterilisation

The pre-addition to the boreholes of sterilisation fluids such as 11% Sodium Hypochlorite is inappropriate since it is likely to interfere with the parameters being measured and, as can be observed by its presence in the AI control analytical reports, gives rise to the presence of THMs (trihalomethanes) such as chloroform, bromoform, dibromochloromethane, and bromodichloromethane. It is recommended that this practice be discontinued.

6.4 Electrical Conductivity

Although the Threshold Value has not been exceeded, it has been noted that Electrical Conductivity values are elevated. This may be due to a number of factors. Not least are the possibilities of high sediment content in the sample water and/or saline intrusion. It is recommended that settlement and filtration be allowed to take place before a field or laboratory value of EC is collected.

6.5 Sampling Span

In some cases sampling for single rounds appears to have taken place over a span of days. This is poor practice. It is normal that all sample collection take place at least within a few hours. It is recommended that this be undertaken in future sampling rounds.

6.6 Sample-Analysis Time Lag

There appears to be a significant lag time between the date of sample collection and the date of analysis in several of the samples. On one occasion this lag was in excess of one week. Furthermore this lag is not the same for every sample collected during the particular round of sampling. This is poor practice and leads to elevated results and inconsistencies. In the interests of consistency and sample validation it is recommended that no such lag should take place in future sampling rounds.

6.7 Ammonia & Sulphate

Due to limits for ammonia and sulphate being exceeded in 2012 and 2014 respectively, concentrations should be subjected to scrutiny future analyses of groundwater from PT-2.

6.8 Nitrate

Although marginally below the Threshold Value, nitrate was elevated in PT-1 in 2015. In future rounds it should be carefully monitored in PT-1.

6.9 Nitrite & Aluminium

As specified EPA Groundwater Pollution Identifiers, nitrite and dissolved aluminium should be included in future laboratory analysis of groundwater.

6.10 Cyanide

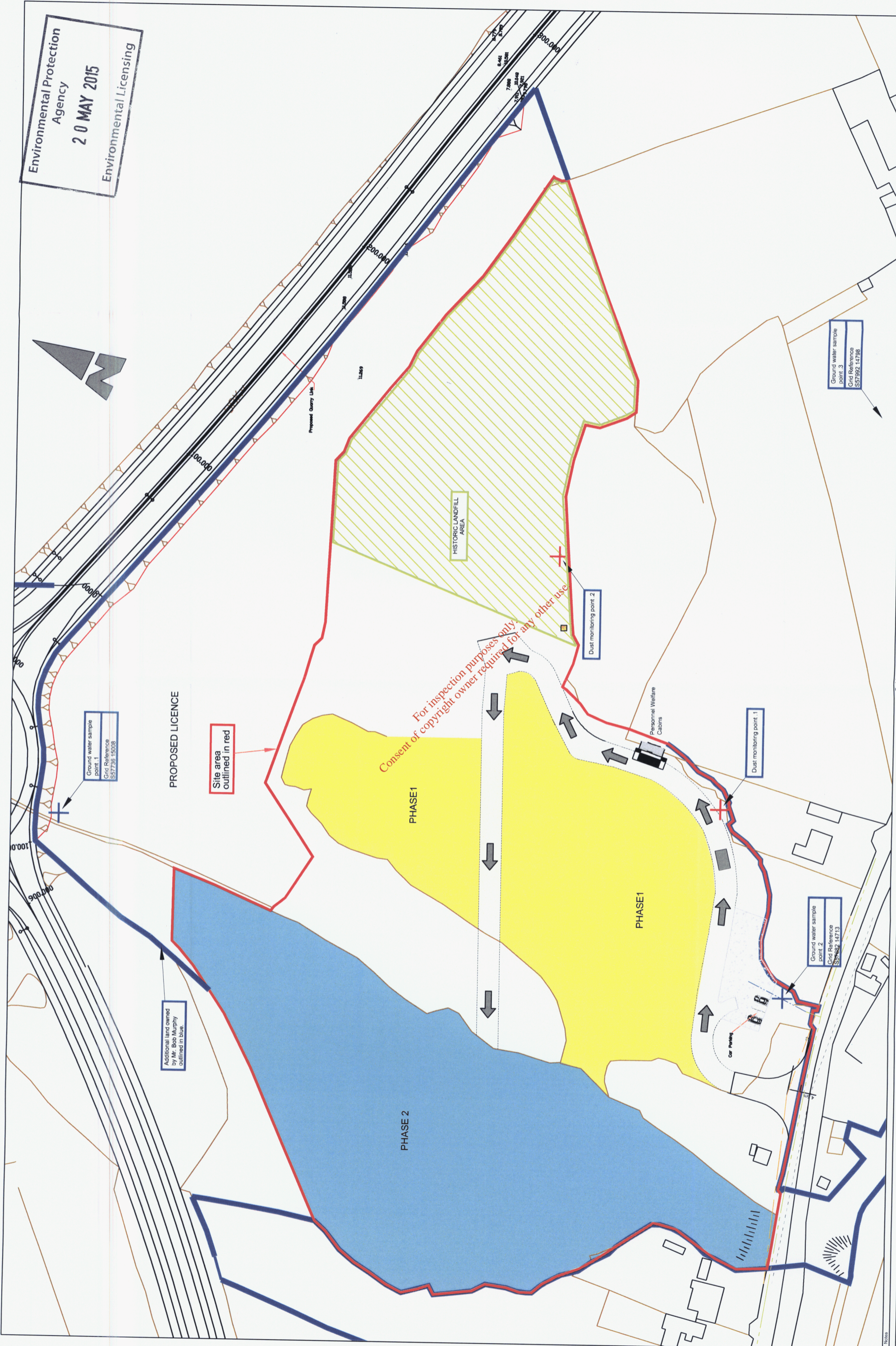
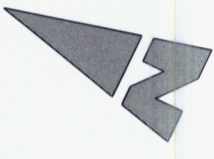
The detection limit for cyanide should be reduced by ALcontrol to below the current limit of 0.05 mg/l, which is itself the Threshold Value.

7 CONCLUSIONS

Notwithstanding the inadvertent THM content introduced through sterilisation, groundwater quality evidenced in the three boreholes through the groundwater monitoring programme does not indicate any negative impact from either the former quarry restoration programme or the adjoining historic landfill. In the light of this, the annual sampling frequency remains appropriate and supplemental recommendations are made in §6.

This concludes this report. □□

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