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From Maxwell Lundie
To Miss Sarah Green, Environment Agency
Copies Aydin Zorlutuna, Hyder
Subject NW Bicester Eco-Town – Exemplar Site and Masterplan Site
Your Ref: WA/2011/109125/02-L01

Following receipt of your letter dated 26 May 2011 (REF WA/2011/109125/02-L01), we enclose our response to your request for information on groundwater and gas monitoring, groundwater analysis and contaminated land analysis undertaken at the Bicester Eco-Town Exemplar Site.

Monitoring of the groundwater and ground gas regimes were undertaken on four occasions between August and November 2010 and are included as an addendum to the Hyder Consulting factual report. The results of the groundwater and gas monitoring results are summarised below together with an interpretation of the soil and water contamination testing.

1 Ground Gas Risk Assessment

The number and frequency of ground gas monitoring rounds is dependent on the sensitivity of the development and the generation potential of any ground gas source. In this case, the ground gas monitoring programme has been devised in order to establish a preliminary indication of the ground gas regime at the site.

The results of monitoring have been assessed using the current guidance document:

- CIRIA C665 “Assessing Risks Posed by Hazardous Ground Gases to Buildings” and
- BS8485:2007 “Code of Practice for the Characterization and Remediation from Ground Gas in Affected Developments”.

1.1 Ground Gas Monitoring Results

Gas Screening Values (GSV) hazardous gas flow rates for methane and carbon dioxide have been recorded and are summarised in Table 1.1 for the Exemplar Site and, for completeness, Table 1.2 for the Masterplan Site. The corresponding Characteristic Gas Situation (CGS) is presented in these tables. It is widely understood that the proposed development is to comprise mainly residential houses and therefore the CGS for ‘Situation A’, defined in the guidance as ‘all development types except those in Situation B’, has been considered (Situation B is defined as ‘low rise housing with a ventilated underfloor void’).

Table 1.1 Gas Screening Values for the Exemplar Site

Borehole No.	Max. CH ₄ (v/v %)	Max. CO ₂ (v/v %)	Max. Flow Rate (l/h)	Max. CH ₄ GSV (l/h)	Max. CO ₂ GSV (l/h)	Characteristic Gas Situation A
BH1	0	2.5	0.2	0	0.005	1

BH5	0	3.7	0.3	0	0.011	1
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Table 1.2 Gas Screening Values for the Masterplan Site

Borehole No.	Max. CH ₄ (v/v %)	Max. CO ₂ (v/v %)	Max. Flow Rate (l/h)	Max. CH ₄ GSV (l/h)	Max. CO ₂ GSV (l/h)	Characteristic Gas Situation A
BH3	0	1.0	0.0	0	0.00	1
BH10	0	0.9	0.1	0	0.001	1
BH11	0	1.1	0.4	0	0.004	1

1.1.1 Radon Gas

The above gas situation does not account for radon. As such, a detailed BR 211 Radon Report was obtained from the British Geological Survey (BGS), which states that basic radon protection measures are required for the site area. The rationale for such measures is due to the estimated probability of 3 – 5% for a property being above the Action Level for Radon. Details on the technical specifications for basic radon protection measures are given in document BRE report BR211.

1.2 Ground Gas Risk Assessment Conclusions

The results of the gas monitoring to date indicate a very low risk classification for the proposed development from methane and carbon dioxide. However, basic radon protection measures will be necessary in the construction of all new dwellings or extensions on site.

2 Groundwater Assessment

The groundwater monitoring was undertaken over the same period as the ground gas monitoring between August and November 2010. The results of the groundwater monitoring are presented below in Table 2.1 for the Exemplar Site and, also for completeness, results for the Masterplan site are presented in Table 2.2.

Table 2.1 Groundwater Monitoring Results for the Exemplar Site

Borehole No	Installation Depth	Minimum Groundwater Depth (mbgl)	Maximum Groundwater Depth (mbgl)
BH1	7.00	3.10	3.22
BH5	7.10	2.72	6.10

Table 2.2 Groundwater Monitoring Results for the Masterplan Site

Borehole No	Installation Depth	Minimum Groundwater Depth (mbgl)	Maximum Groundwater Depth (mbgl)
BH3	7.00	2.72	3.05
BH10	7.00	2.17	2.68

BH11	7.00	1.10	1.42
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Within the excavated trial pits located in the Exemplar Site, groundwater was encountered solely in TP1 at the base of the pit at 2.90m bgl. As such, a water sample was not taken as it was not possible to obtain an appropriate sample. For completeness the details of groundwater encountered in trial pits excavated in the Masterplan Site are presented in Table 2.3.

Table 2.3 Groundwater Strikes in Trial Pits in the Masterplan Site

Trial Pit No	Groundwater Influx Depth (m bgl)
TP7	2.60
TP8	0.60
TP9	2.60
TP10	1.70
TP13	0.75
TP18	2.40

Trial pits TP7 to TP10 and TP13 were carried out after a period of heavy rain which may have had an influence on the ingress of water into the excavations.

The results suggest that excavations for shallow foundations may encounter some groundwater flow in some areas, particularly after heavy rain so that provision for pumping should be allowed for. The groundwater strikes within the trial pits generally coincide with the top of the limestone.

3 Groundwater Contaminant Testing

3.1 Exemplar Site Groundwater Contaminant Testing

Groundwater samples obtained from boreholes BH1 and BH5 and a water abstraction point on Mr. Malin's land located in the Exemplar site were tested for inorganic determinands. Table 3.1 details the results of the analysis and comparison with UK Drinking Water Standards (DWS).

Table 3.1 Summary of Water Analytical Testing Results at the Exemplar Site

Contaminant	BH1 Concentration (mg/l)	BH5 Concentration (mg/l)	DWS (mg/l)	No. of Exceedances
Nickel	0.018	0.002	0.05* ¹	0
Chromium	0.006	0.001	0.05* ¹	0
Cadmium	0.0002	<0.001	0.005* ¹	0
Copper	0.013	0.002	2* ¹	0
Lead	0.013	<0.001	10* ¹	0
Zinc	0.029	0.005	5* ¹	0
Arsenic	0.007	<0.001	0.01* ¹	0
Mercury	<0.0001	<0.0001	0.001* ¹	0
Selenium	<0.001	<0.001	0.01* ¹	0

*1 UK Drinking Water Standards (DWS)

3.2 Exemplar Site Groundwater Contaminant Testing Conclusions

For PAH compounds, the most stringent value for benzo(a)pyrene has been used, which has a DWS of 0.01µg/l. All PAHs recorded values below the laboratory detection limit of 0.01µg/l. Likewise, for TPHs, the DWS of 10µg/l for hydrocarbons has been applied to all fractions, with none recorded above this limit.

In summary, there are no exceedances of the UK Drinking Water Standards in the three water samples tested.

3.3 Masterplan Site Groundwater Contaminant Testing

Table 3.2 summarises the analytical testing undertaken on water samples obtained during monitoring of exploratory holes located in the Masterplan site with comparison to UK Drinking Water Standards (DWS).

Table 3.2 Summary of Water Analytical Testing Results at the Masterplan Site

Determinand	Number of Samples Tested	Minimum Concentration (mg/l)	Maximum Concentration (mg/l)	DWS (mg/l)	No. of Exceedances
Arsenic	4	<0.001	0.007	0.01 ⁽¹⁾	0
Barium	4	0.01	0.15	0.7 ⁽¹⁾	0
Beryllium	4	<0.01	<0.01	N/A	N/A
Cadmium	4	<0.0001	0.0002	0.005 ⁽¹⁾	0
Chromium	4	<0.001	0.006	0.05 ⁽¹⁾	0
Copper	4	<0.001	0.013	2 ⁽¹⁾	0
Lead	4	<0.001	0.013	0.025 ⁽¹⁾	0
Mercury	4	<0.0001	<0.0001	0.001 ⁽¹⁾	0
Nickel	4	<0.001	0.018	0.02 ⁽¹⁾	0
Selenium	4	<0.001	<0.001	0.01 ⁽¹⁾	0
Zinc	4	0.029	0.005	3 ⁽¹⁾	0
Cyanide (free)	4	<0.02	<0.02	0.05 ⁽¹⁾	0
Cyanide (total)	4	<0.02	<0.02	0.05 ⁽¹⁾	0
Sodium	4	7	56	200 ⁽¹⁾	0
Magnesium	4	3	10	50 ⁽¹⁾	0
Strontium	4	0.2	2.18	N/A	N/A
Potassium	4	<1	5	12 ⁽¹⁾	0
Lithium	4	<0.01	0.05	N/A	N/A
Phosphorous	4	<0.1	0.5	2.2 ⁽¹⁾	0
Phenol	4	<0.05	<0.05	0.05 ⁽¹⁾	0
PAH	4				

1 UK Human Health / Drinking Water Standards

2 N/A – Not available.

3.4 Masterplan Site Groundwater Contaminant Testing Conclusions

The results show that there are no exceedances of the metals tested for UK drinking water quality, however, further tests are required to assess the extent of any micro-organisms, chemical and taste to confirm the full UK drinking water requirements.

4 Contaminated Land – Exemplar Site

In order to focus on contaminants of potential concern (COPC), the laboratory testing results for the Exemplar site have been compared with the respective SGVs/GAC. The results and respective screening criteria are presented in Tables 4.1 to 4.4.

Any contaminants that exceed the SGVs/GAC are considered to be COPC. Those that do not exceed the respective SGVs/GAC are not considered to be COPC and do not require further assessment in relation to the proposed development of the site.

The assessment has therefore been undertaken in a phased approach, focussing initially on the Tier 1 Assessment. The Tier 1 assessment includes the following stages, which were completed where applicable:

- Zoning of data/site averaging areas;
- Maximum Concentration Assessment - comparison of maximum detected concentrations against relevant Generic Assessment Criteria (GAC);
- Mean and Maximum Value Statistical Analysis – consideration of statistical outliers and 95% Upper Confidence Levels (UCLs) against relevant GAC;
- Risk Evaluation/Assessment of Significant Results; and
- Identification of the need for Tier 2 Assessment and derivation of Site Specific Assessment Criteria (SSAC).

For the Tier 1 Assessment, Environment Agency published generic Soil Guideline Values (SGVs) derived using the Agency’s CLEA model, was used. Where these are not available, GAC published by LQM/CIEH were utilised (Ref 11).

The assessment criteria relevant to the standard sensitive receptor setting within the CLEA model has been used i.e. a female receptor aged 1 to 6 years, a residential building (small terraced house) and a sandy loam soil with a pH7 and SOM 1%. Given the proposed site end use, the stringent “residential with plant uptake” land use scenario has been adopted.

Table 4.1 Summary of Inorganic Testing Results

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	SGV/GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Arsenic	7	10.5	21	32 ⁽¹⁾	0
Barium	7	21	221	1300 ^{(2)*}	0
Beryllium	7	0.4	3.7	51 ⁽²⁾	0
Cadmium	7	<0.2	0.4	10 ⁽¹⁾	0
Chromium	7	11.3	31	3000 ⁽²⁾	0
Copper	7	7.1	17.1	2330 ⁽²⁾	0
Lead	7	7	68.8	450 ⁽³⁾	0

Mercury	7	<0.5	<0.5	1 ⁽¹⁾	0
Nickel	7	16.4	28.9	130 ⁽¹⁾	0
Selenium	7	<0.5	0.6	350 ⁽¹⁾	0
Zinc	7	18.5	65	3750 ⁽²⁾	0
Cyanide (free)	7	<0.5	<0.6	53 ⁽²⁾	0
Cyanide (complex)	7	<0.5	<0.6	266 ⁽²⁾	0
Asbestos	1	Not detected	N/A	N/A	N/A

1 EA published SGV

2 LQM/CIEH published GAC (2nd Edition)

3 Previous EA published SGV (currently withdrawn)

*Residential without plant uptake scenario

Table 4.2 Summary of PAH Testing Results

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Naphthalene	6	<0.1	<0.1	1.5 ⁽¹⁾	0
Acenaphthylene	6	<0.1	<0.1	170 ⁽¹⁾	0
Phenanthrene	6	<0.1	1.6	92 ⁽¹⁾	0
Benzo(a)anthracene	6	<0.1	2.3	3.1 ⁽¹⁾	0
Benzo(b)fluoranthene	6	<0.1	1.9	5.6 ⁽¹⁾	0
Benzo(k)fluoranthene	6	<0.1	1.1	8.5 ⁽¹⁾	0
Benzo(ghi)perylene	6	<0.1	2.0	44 ⁽¹⁾	0
Pyrene	6	<0.1	4.5	560 ⁽¹⁾	0
Benzo(a)pyrene	6	<0.1	<0.1	0.83 ⁽¹⁾	0
Fluorene	6	<0.1	0.2	160 ⁽¹⁾	0
Fluoranthene	6	<0.1	4.9	260 ⁽¹⁾	0
Acenaphthene	6	<0.1	<0.1	210 ⁽¹⁾	0
Anthracene	6	<0.1	0.6	2300 ⁽¹⁾	0
Chrysene	6	<0.1	2.4	6 ⁽¹⁾	0
Dibenzo(ah)anthracene	6	<0.1	0.3	0.76 ⁽¹⁾	0
Indeno(123cd)pyrene	6	<0.1	1.6	3.2 ⁽¹⁾	0
Total PAH (USEPA 16)	6	<1.40	<1.53	No value	N/A

Table 4.3 Summary of TPH Testing Results

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
Gasoline Range Organics (GRO)					
C5-6	6	<0.2	<0.2	30 ⁽¹⁾	0
C6-7	6	<0.2	<0.2	73 ⁽¹⁾	0
C7-8	6	<0.2	<0.2	73 ⁽¹⁾	0
C8-10	6	<0.2	<0.2	19 ⁽¹⁾	0
Aliphatic Fractions					
C8-10	6	<4	<5.25	19 ⁽¹⁾	0
C10-12	6	<4	<5.25	93 (48) ⁽¹⁾	0
C12-16	6	<4	5.03	740 (24) ⁽¹⁾	0
C16-21	6	<4	<5	45000 (8.48) ⁽¹⁾	0
C21-35	6	<9.61	<10.43	45000 (8.48) ⁽¹⁾	0
Aromatic Fractions					
C8-10	6	<4	<5	27 ⁽¹⁾	0
C10-12	6	<4	<5	69 ⁽¹⁾	0
C12-16	6	<4	<5	140 ⁽¹⁾	0
C16-21	6	<4	<5	250 ⁽¹⁾	0
C21-35	6	<9.61	<10.43	890 ⁽¹⁾	0

Table 4.4 Summary of BTEX Testing Results for Soils (BTEX)

Determinand	Number of Samples Tested	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	GAC (mg/kg) Res. with Plant Uptake	No. of Exceedances
BTEX					
Benzene	6	<0.01	<0.01	0.33 ⁽¹⁾	0
Toluene	6	<0.01	<0.01	610 ⁽¹⁾	0
Ethyl Benzene	6	<0.01	<0.01	350 ⁽¹⁾	0
m/p-Xylene	6	<0.01	<0.01	230 ⁽¹⁾	0
o-Xylene	6	<0.01	<0.01	250 ⁽¹⁾	0

4.1 Contaminants of Potential Concern

There are no contaminants that exceed the respective SGVs/GAC.

4.2 Human Health Risk Assessment Conclusions

None of the contaminants tested returned values greater than the respective SGVs/GAC, therefore the soil that has been tested is deemed suitable for use in gardens (including growing edible plants) without the need for treatment or other remedial action.

During site construction works, site workers should remain vigilant to the possible risk of encountering isolated areas of contaminated material. Should potentially contaminated material be encountered, further testing will be required to assess the risks to the health and safety of site workers and the environment. All persons engaged in site construction works should be made aware of the findings of the intrusive investigation and the hazards associated with handling potentially contaminated materials. It is recommended that all works are conducted in accordance with the Health and Safety Executive publication entitled "Protection of Workers and the General Public during the Development of Contaminated Land".