

Memo

Project	Island Road	Ref	L13-2107/L15-5034
From	Nova CGI Ltd	Date	21/10/2015

This memo is intended as a background to the proposed development at the Island Road Site in Reading and to be the basis of agreement to address Planning Condition 34 (see below). The site is a disused landfill site, as described below. It is proposed to redevelop the site for commercial / industrial use.

The following points are considered pertinent to the development scenario –

- The site will be surfaced with impermeable surfacing (80-90% est) with the remainder being planted areas;
- Positive pressure gas systems are to be installed on all buildings;
- The ground is to be dynamically compacted to remove placement voids in the waste and the building frame and slab will have piled foundations; and
- Water will be stored on site in attenuation structures and discharged to the river, no water will be discharged to ground.

Planning Condition 34 states - *No development should take place until a long term monitoring and maintenance plan in respect of contamination, including a timetable of monitoring and submission of reports to the local planning authority, shall be submitted to and approved in writing by the local planning authority.*

Introduction

This document has been produced in reference to the redevelopment of Island Road, Reading. Nova CGI Ltd. (Nova), on behalf of Evander Properties conducted two ground investigations to determine ground conditions, the first investigation was primarily an environmental assessment of the site and the second was primarily a geotechnical assessment of the site.

Background

The Site is irregular in shape and measures approximately 7.5 hectares in size. There are no buildings or structures present on the Site, which is comprised of rough ground with some areas of hard standing. During the 2013 ground investigation the Site was covered in a large amount of fly tipping, the majority of which had been removed prior to the second ground investigation in 2015. The Site is accessed from Island Road. The Site is bounded to the north by large mature trees with the Kennet and Avon Canal, to the east by the A33 road, to the south by Island Road and to the west by further disused land.

Site Development

The proposed development comprises of three industrial/warehouse units with office spaces and loading bays. The largest building will be in the western half of the site and two smaller ones to the east.

Site Use

The Site was vacant during the Site investigations. Prior to the investigations, the Site was used as a go-kart racing track. The land is known to have been used as a landfill historically. Historic maps show landfilling occurring between 1973 and 1979. The Environment Agency states inert waste was buried at the Site from 1977 to 1985.

Site Investigations

Two ground investigations were carried out, the first in 2013 and the second in 2015.

Details of the underlying geology underlying the Site has been obtained from BGS Sheet 268. The bedrock is indicated as the Lambeth Group which is described as clay, silt and sand which was deposited in the Palaeogene Period. This is overlain by superficial deposits; Alluvium described as clay, silt, sand and gravel.

2013

A ground investigation was carried out between 18th December 2013 and 10th January 2014. The purpose of this investigation was to determine ground conditions at the site. The site investigation included:

Exploratory Hole Type	Quantity	Hole Reference	Depths
Cable percussive boreholes	6	BHN1 to BHN6	9.5-19.95m
Window sample boreholes	10	WSN1 to WSN9 & WSN12	2.5-5.5m
Trial pits – machine excavated	19	TPN1 to TPN19	2.2-4.0m
Stockpile sampling – machine excavated	4	SH1 to SH4	2.1-4.0m
Slotted standpipe installations	16	BHN1 to BHN6, WSN1 to WSN9 & WSN12	2.5-17.0m

Geology findings from the site investigation are reported in the table below:

Strata	Start Depth (m)	Finish Depth (m)	Thickness (m)
Made Ground	0.00	0.50-4.50	0.50-4.50
Landfill	0.50-4.50	5.50-8.00	3.30-5.90
Alluvium	5.50-8.00	6.10-9.30	0.60-2.30
River Terrace Deposits	6.10-9.30	10.00-11.10	1.10-3.90
Lambeth Group	10.00-11.10	To base of hole	

Groundwater was encountered during the drilling works in the majority of locations at depths between 0.30mbgl and 6.90mbgl on the first strike. Second strikes were noted between 6.1mbgl and 9.3mbgl. A third strike was noted in BHN1 at 14.1mbgl.

Chemical and geotechnical testing was carried out on a number of samples. Testing carried out included:

Chemical testing carried out included:

- 53 No. Metal Suite (Arsenic, Boron, Cadmium, Chromium, Chromium Hex, Copper, Lead, Mercury, Nickel, Selenium, Vanadium and Zinc)
- 1 No. Loss on ignition
- 29 No. pH
- 34 No. Organic Matter
- 53 No. TPH CWG
- 27 No. PAH
- 28 No. VOC
- 28 No. SVOC

A summary of the results can be found below:

Test	Unit	Minimum	Maximum
Arsenic	mg/kg	1.5	29
Boron	mg/kg	0.7	11
Cadmium	mg/kg	<0.1	22
Chromium	mg/kg	16	950
Chromium Hex	mg/kg	<0.1	<0.1
Copper	mg/kg	9.3	2,600
Lead	mg/kg	8.7	620
Mercury	mg/kg	<0.05	0.81
Nickel	mg/kg	14	710
Selenium	mg/kg	<0.05	2.5
Vanadium	mg/kg	3.5	81
Zinc	mg/kg	28	13,000
pH		7.5	10.1
Organic Matter	%	0.5	19
Aliphatic C5-C35	mg/kg	<10	1,700
Aromatic C5-C35	mg/kg	<10	1,900
PAH	mg/kg	<1.6	310

Leachate testing on samples included:

- 17 No. Metal Suite (Arsenic, Boron, Cadmium, Chromium, Chromium Hex, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc)
- 17 No. Ammoniacal Nitrogen as N

A summary of the results can be found below:

Test	Unit	Minimum	Maximum
Arsenic	ug/l	<0.16	6.7 (BHN4)
Boron	ug/l	<100	750 (BHN6)
Cadmium	ug/l	<0.03	0.06 (BHN1)
Chromium	ug/l	<0.25	1.6 (BHN1)
Chromium Hex	ug/l	<10	<10
Copper	ug/l	<0.4	4.0 (BHN1)
Lead	ug/l	<0.09	1.4 (BHN1)
Mercury	ug/l	<0.01	<0.01
Nickel	ug/l	<0.50	13 (BHN4)
Selenium	ug/l	<0.25	0.28 (TPN07)
Vanadium	ug/l	<0.6	1.2 (BHN6)
Zinc	ug/l	<1.25	16.8 (BHN4)
Ammoniacal Nitrogen as N	mg/l	0.076	36 (BHN4)

Chemical testing on water samples included:

- 5 No. Metal Suite (Arsenic, Cadmium, Chromium, Copper, Lead, mercury, Nickel, Selenium, Vanadium, Zinc)
- 5 No. pH
- 5 No. Ammoniacal Nitrogen as N
- 5 No. TPH CWG
- 5 No. PAH
- 5 No. VOCs
- 5 No. SVOCs

A summary of the results can be found below:

Test	Unit	Minimum	Maximum
Arsenic	ug/l	1.2	12 (BHN03)
Cadmium	ug/l	<0.03	0.4 (BHN03)
Chromium	ug/l	0.38	4.7 (BHN02)
Copper	ug/l	0.6	1.4 (BHN03)
Lead	ug/l	0.40	3.5 (BHN03)
Mercury	ug/l	<0.01	0.03 (BHN05)
Nickel	ug/l	4.0	16 (BHN03)
Selenium	ug/l	<0.25	1.3 (BHN03)
Vanadium	ug/l	<0.6	3.3 (BHN03)
Zinc	ug/l	17.2	54.2 (BHN05)
pH		6.9	7.6
Ammoniacal Nitrogen as N	mg/l	5.2	270 (BHN03)
Aliphatic C5-C35	ug/l	<10	430 (BHN02)
Aromatic C5-C35	ug/l	<10	50 (BHN02)
PAH	ug/l	<0.20	5.8 (BHN02)

Six rounds of ground gas monitoring were undertaken as part of this ground investigation. One was undertaken during the site investigation, one immediately after the works and an additional four after the ground investigation. Ground water sampling was carried out and water samples were collected and sent off for chemical testing.

A summary of the gas monitoring data is found below. The following trends were identified:

- Carbon Dioxide (CO₂) concentrations were identified to range between 0.1% by volume and 36.0% by volume (maximum identified in BHN3).
- Methane (CH₄) concentrations were identified to range between 0.0% by volume and 79.4% by volume (maximum identified in WSN4).
- Groundwater levels were recorded between 1.88mbgl and 7.70mbgl. Locations BHN3(19mm), BHN4(19mm), BHN5(19mm), WSN1 to WSN4 and WSN7 to WSN9 were all recorded dry on at least one occasion.

Monitoring Summary 2013-2014

Borehole	Response Zone	No. of monitoring occasions	Methane (% peak)	Carbon Dioxide (% peak)	Oxygen (%)	CO (ppm)	H ₂ S (ppm)	PID Reading (ppm peak)	Flow (l/hr peak)	Water (mbgl)	Atmospheric Pressure (mb)
BHN1a	3.0-5.0 LF	6	37.2-58.4	24.9-29.2	0.0-2.7	0-6	0-3	0.0-2.2	0.0-2.4	DRY – 4.86	998-1021
BHN1b	8.8-10.0 RTD	6	0.3-32.0	0.1-18.6	7.3-20.8	0-3	0-1	0.1-5.1	0.0-1.7	4.90 – 6.59	998-1021
BHN2a	3.9-5.0 LF	6	0.3-65.6	2.7-30.6	0.0-50.4	0-1	0-4	0.0-1.6	0.0-2.9	4.89 – 5.14	998-1021
BHN2b	8.5-11.0 RTD	6	1.3-10.5	0.5-16.6	15.4-20.1	0-2	0-2	0.0-2.6	0.0-0.3	4.68 – 5.75	998-1021
BHN3a	2.5-4.5 LF	6	31.0-70.9	0.2-36.0	0.0-62.9	0-1	0-2	0.0-1.1	0.0-1.4	DRY – 4.53	998-1021
BHN3b	7.0-9.3 AL	6	0.2-10.9	0.1-8.2	12.9-20.8	0	0-2	0.0-2.9	0.0-0.2	5.07 – 5.72	998-1021
BHN4a	3.0-5.0 LF	6	0.6-64.8	0.4-31.7	0.0-19.8	0	0-6	0.0-6.2	-0.1-1.2	DRY – 4.51	998-1021
BHN4b	9.0-10.5 RTD	6	0.1-2.6	0.1-2.2	18.7-21.1	0-5	0-1	0.0-2.7	0.0-0.3	5.79 – 7.53	998-1021
BHN5a	2.0-4.0 LF	6	5.4-35.6	17.1-25.1	0.0-29.2	0-1	0-3	0.0-2.8	0.0	DRY – 3.99	998-1021
BHN5b	7.0-10.0 RTD	6	0.0-8.6	0.3-6.4	12.6-20.8	0-1	0-3	0.0-4.3	0.0-0.2	4.41 – 5.53	998-1021
BHN6a	2.0-5.0 LF	6	27.7-61.8	24.7-29.2	0.0-4.0	0-2	0-7	0.0-3.3	0.0-0.6	DRY – 4.86	998-1021
BHN6b	9.0-12.0 RTD	6	1.1-8.6	2.0-7.0	11.5-19.4	0-1	0-3	0.0-2.4	0.0-0.1	5.13 – 7.70	998-1021
WSN1	1.0-4.0 LF	6	24.7-53.2	12.1-17.7	0.0-5.8	0-3	0-3	0.0-1.5	0.0-0.3	DRY – 3.94	998-1021
WSN2	1.5-5.45 LF	6	4.4-73.8	0.5-26.9	0.0-13.5	0-1	0-3	0.0-2.9	0.0-1.2	DRY – 5.48	998-1021
WSN3	1.5-3.45 LF	6	27.4-35.3	4.0-17.1	0.3-4.7	0	0-2	0.0-1.8	0.0-6.2	DRY – 2.78	998-1021
WSN4	1.5-5.45 LF	6	1.4-79.4	0.6-32.5	0.2-7.2	0-2	0-5	0.0-1.4	0.0-4.1	DRY – 2.80	998-1021
WSN5	1.2-5.0 LF	6	32.5-43.6	1.6-25.5	0.4-25.3	0-2	0-3	0.0-2.4	0.0	4.57 – 4.99	998-1021
WSN6	0.5-3.0 LF	2	61.8-68.9	7.4-25.9	0.2	0-6	0	0.0	0.0-0.3	4.39 – 4.55	998-1021
WSN7	1.0-5.0 LF	6	0.5-73.7	0.3-31.9	0.1-19.7	0-1	0-1	0.0-1.4	0.0-1.2	DRY – 4.72	998-1021
WSN8	1.0-2.5 LF	6	0.0-13.2	0.3-18.2	0.3-20.5	0-1	0-1	0.0-8.3	0.0-0.1	DRY – 1.88	998-1021
WSN9	1.5-5.0 LF	6	36.2-56.5	26.1-28.8	0.2-1.7	0-2	0-2	0.0-4.2	0.0-2.9	DRY – 4.60	998-1021
WSN12	2.5-5.45 LF	6	0.0-35.4	0.1-25.5	0.1-20.0	0-2	0-2	0.7-8.4	0.0-0.3	4.38 – 4.89	998-1021

2015

A ground investigation was carried out between 1st and 9th September 2015. The purpose of this investigation was to determine ground conditions for pile foundation design and to install pipework to monitor the chalk groundwater during construction. The site investigation included:

Exploratory Hole Type	Quantity	Hole Reference	Depths
CPT hole	15	CPTS1 to CPTS15	2.02m to 22.08m
CPT hole	6	CPTL1 to CPTL6	2.73m to 13.15m
Trial Pits – machine excavated	6	TP1 to TP6	1.80m to 2.70m
Cable percussive boreholes	3	CP1 to CP3	35.00m
Slotted standpipe installations	3	CP1 to CP3	35.00m

Geology findings from the site investigation are reported in the table below:

Strata	Start Depth (m)	Finish Depth (m)	Thickness (m)
Made Ground	0.00	1.00 - 6.30	1.00-6.30
Landfill	1.00-6.30	6.90-7.30	3.30-5.50
Alluvium	6.90-7.30	8.10-8.70	1.00-1.20
River Terrace Deposits	6.90-8.70	8.00-11.00	1.10-2.10
Lambeth Group	8.00-11.00	15.20-17.40	5.00-9.60
Chalk Group	15.20-17.40	>35.00	>14.70-17.60

Groundwater was encountered during the drilling works in the majority of locations at depths of between 4.0mbgl and 8.1mbgl. Seepage was encountered between 5.0mbgl and 6.9mbgl.

Drilling into the chalk was undertaken using aquifer protection methods with dual casing and bentonite seals.

Chemical testing for water samples is detailed below:

- 6 No. Metals Suite (Arsenic, Boron, Cadmium, Chromium, Chromium Hex, Copper, Mercury, Nickel, Lead, Selenium, Zinc)
- 6 No. Biological Oxygen Demand
- 6 No. Chemical Oxygen Demand
- 6 No. Ammoniacal Nitrogen
- 6 No. Dissolved Oxygen
- 6 No. pH
- 6 No. Total Organic Carbon
- 6 No. PAH
- 6 No. TPH CWG inc. BTEX

Test	Unit	Minimum	Maximum
Arsenic	ug/l	<0.16	3.6 (BHN4)
Boron	ug/l	170	3600 (BHN2)
Cadmium	ug/l	<0.03	<0.03
Chromium	ug/l	<0.25	3.4 (BHN2)
Chromium Hex	ug/l	<3.0	<3.0
Copper	ug/l	<0.4	<0.4
Lead	ug/l	<0.09	<0.09
Mercury	ug/l	<0.01	<0.01
Nickel	ug/l	1.0	4.6 (BHN5)
Selenium	ug/l	<0.25	3.7 (BHN5)
Zinc	ug/l	<1.25	3.54 (BHN4)
pH		7.0	7.5

Total BOD	mg/l	<1.0	1600 (BHN5)
Total COD	mg/l	<10	3300 (BHN5)
Dissolved Oxygen	mg/l	6.8	7.3 (BHN5)
Ammoniacal Nitrogen as N	mg/l	0.26	250 (BHN2)
TOC	mg/l	3.7	290 (BHN5)
Aliphatic C5-C35	ug/l	<10	6800 (BHN2)
Aromatic C5-C35	ug/l	<10	3100 (BHN2)
PAH	ug/l	<0.20	3.2 (BHN2)

Three of the wells sampled (BHN2A, BHN4A, BHN5A) were screened in the landfill material, as expected these all showed the presence of some elevated metals concentrations, plus some elevated hydrocarbon concentrations, elevated Ammoniacal Nitrogen and two of the boreholes also showed elevated COD and BOD.

The boreholes installed in the chalk (CP1, CP2, CP3) indicated the presence of some similar determinants but at lower concentrations, for instance CP3 (north eastern area) showed traces of PAH's and CP2 (eastern section) showed elevated BOD and COD levels.

Given the nature of the area and the presence of multiple landfills it is not possible to tell where any contamination may originate.

Three rounds of ground gas monitoring were undertaken as part of the ground investigation. Each were carried out fortnightly once the works has finished. Ground water samples were collected on the second visit. Water samples were collected and sent for chemical testing.

A summary of the gas monitoring data to date is found below. The following trends were identified:

- Carbon Dioxide (CO₂) concentrations were identified to range between 0.5% by volume and 33.4% by volume (maximum identified in WSN7).
- Methane (CH₄) concentrations were identified to range between 0.7% by volume and 70.8% by volume (maximum identified in WSN2).
- Groundwater levels were recorded between 2.84mbgl and 7.05mbgl. Locations BHN1(19mm), BHN4(19mm), BHN6(19mm), WSN1 to WSN4 and WSN8 to WSN9 were all recorded dry on at least one occasion.

Monitoring Summary 2015

Borehole	Response Zone	No. of monitoring occasions	Methane (% peak)	Carbon Dioxide (% peak)	Oxygen (%)	H ₂ S (ppm)	CO (ppm)	Flow (l/hr peak)	Water (mbgl)	Atmospheric Pressure (mb)
BHN1a	3.0-5.0 LF	3	30.9-35.0	16.4-20.2	8.4-10.2	0	0	0.0-0.1	6.51-6.54	999-1020
BHN1b	8.8-10.0 RTD	3	50.0-54.8	20.4-29.3	0.9-6.9	0-3	0-2	0.0	DRY-4.84	999-1020
BHN2a	3.9-5.0 LF	3	1.4-5.4	1.8-14.5	14.9-18.7	0-1	0-1	0.0-3.5	5.42-5.53	998-1020
BHN2b	8.5-11.0 RTD	3	37.2-39.4	4.9-29.8	0.3-4.5	0-3	0-1	0.0-0.2	4.98-4.99	998-1020
BHN3a	2.5-4.5 LF	3	0.0-21.5	0.6-11.5	13.2-20.2	0-1	0-1	0.0	5.65-5.71	999-1020
BHN3b	7.0-9.3 AL	3	50.4-63.6	26.5-33.0	0.4-4.2	0-4	0-4	0.0	4.51-4.58	998-1020
BHN4a	3.0-5.0 LF	3	0.1-1.7	0.4-1.2	19.8-20.7	0	0-4	0.0	6.24-7.05	998-1020
BHN4b	9.0-10.5 RTD	3	49.3-61.9	25.6-31.5	0.4-4.2	0-12	0-3	0.0	DRY	999-1020
BHN5a	2.0-4.0 LF	3	1.3-7.5	1.2-5.9	15.2-19.2	0	0-6	0.0	4.87-4.89	999-1020
BHN5b	7.0-10.0 RTD	3	19.7-28.0	15.7-23.2	0.5-6.3	0-4	0-7	0.0	-	999-1020
BHN6a	2.0-5.0 LF	3	0.8-1.3	2.1-6.0	14.4-18.5	0	0-8	0.0	6.38-6.44	998-1020
BHN6b	9.0-12.0 RTD	3	33.6-50.3	19.0-31.0	0.4-8.3	0-4	0-10	0.0	DRY-4.85	997-1020
WSN1	1.0-4.0 LF	3	34.0-47.2	14.0-19.8	0.8-6.6	0-1	0-2	-0.1-0.1	DRY	998-1020
WSN2	1.5-5.45 LF	3	50.3-70.8	21.1-27.6	0.5-5.7	0-1	0-1	0.0	DRY	999-1020
WSN3	1.5-3.45 LF	3	29.2-36.6	13.8-18.1	0.2-6.3	0-1	0-3	0.0	DRY-2.84	998-1020
WSN4	1.5-5.45 LF	3	1.2-63.8	0.6-33.0	0.2-20.6	0-4	0-7	0.0-0.2	DRY	998-1020
WSN5	1.2-5.0 LF	3	39.3-43.5	21.4-26.9	0.4-4.9	0-3	0-4	0.0	4.92-4.94	1000-1020
WSN7	1.0-5.0 LF	3	6.4-52.0	17.2-33.4	0.5-9.4	0-9	0-4	-0.1	4.70-4.75	998-1020
WSN8	1.0-2.5 LF	3	0.0-10.3	0.5-11.0	10.2-20.0	0-1	0-2	0.0	DRY-2.50	998-1020
WSN9	1.5-5.0 LF	3	27.3-34.6	18.9-31.2	0.4-7.4	0-1	0-7	-0.1	DRY-4.60	998-1020
WSN12	2.5-5.45 LF	3	24.7-31.1	18.1-24.5	0.5-5.6	0-1	0-25	0.0	4.54-4.57	1000-1020
CP1	22.0-35.0m CG	3	17.4-29.0	7.3-14.3	6.0-12.3	0-1	0-9	-0.1-0.0	5.55-6.17	999-1020
CP2	25.0-35.0m CG	3	2.4-6.5	1.9-5.0	16.5-19.1	0	0-2	0.0	5.40-5.69	999-1020
CP3	20.0-35.0m CG	3	24.3-36.7	12.5-20.5	5.0-9.6	0	0-4	0.0-4.0	6.00-6.55	999-1020

Development Groundworks

At present it is proposed that the site will be developed as a single project, i.e. the groundworks will occur across the whole development site in one go.

The ground works will be undertaken in the following order and will include –

- Levelling the site – this will just involve the removal of the built up bunded areas;
- Ground improvement – dynamic compaction will be used across the site, this is intended to remove any placement voids from within the waste materials – this may not be required beneath the building foot prints.
- Piled foundations – these will be needed to support the building frames and the building slabs. A separate piling risk assessment will be submitted for the piling works.

It is expected that the works will take around 12 weeks to complete.

Ultimately we envisage that around 80-90% of the site will be capped with buildings / concrete / low permeability surfacing. The remainder will be maintained planting areas. No surface water will be discharged to the ground beneath the site.

The site development will significantly reduce the generation of leachate at the site.

Proposed Monitoring

There are three elements that we consider could be monitored during the construction works, these are –

- Ground gas;
- Deep Groundwater; and
- Shallow groundwater / the adjacent river.

Ground gas

The site is a former land-rise landfill (i.e. the waste was not placed in a hole and does not extend to below ground levels) and as such it is an actively gassing site. We are proposing the use of a positive pressure gas system. This is designed and used at sites that have an active gassing regime that exhibits both gas presence and driving pressures.

We envisage that the ground compaction will drive out some trapped gas from voids in the fill during the works. However, overall the ground treatment and site capping will reduce the gas generation at the site.

As the positive pressure system is suitable for a worst-case scenario, we do not believe that continued gas monitoring is needed during the works.

Deep Groundwater

Three groundwater monitoring boreholes have been installed into the chalk strata, these are located in areas that will be planted and should be able to remain intact throughout the construction process. The data indicates that there are currently potential minor impact from leachate in the strata, though more monitoring data will allow this to be confirmed. It is unclear whether this originates from this site or from one of the neighbouring landfill sites.

The boreholes have been installed in areas where they can be retained throughout the construction and post-construction phases. We propose to monitor these boreholes during and after the works. It is proposed that monitoring would be conducted at monthly intervals, before, during and after the groundworks phase of the project. We have already undertaken one round of monitoring and propose that around a further four are undertaken.

Shallow Groundwater

The shallow groundwater wells monitor the conditions in the landfill, these will be affected by the construction phase of the development and will not be available for monitoring. We do not believe that the shallow wells would provide much beneficial monitoring data if they could be retained, they will just indicate that leachate is present within the landfill.

We would consider that the primary receptor for shallow groundwater impact during the construction phase is the adjacent watercourse. We propose to undertake a watching brief during the works and if necessary, we could undertake upstream and downstream sampling of the watercourse during the works, subject to health and safety assessment. However, sampling of the watercourse may not be informative given the dilution rate within the watercourse.