

ESB Lough Ree Power Hydrogeological Assessment

IEL P0610-02

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Prepared for: Electricity Supply Board.

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1. INTRODUCTION

AECOM Infrastructure and Environment Ireland Limited (AECOM) is pleased to present this report to Electricity Supply Board (ESB) which details a risk screening and technical assessment of groundwater quality at the Lough Ree Power (LRP) generating station in Lanesborough, Co Longford and the associated Ash Disposal Facility (ADF) site at Derraghan, Co Longford.

The site location plan, indicating both the LRP site and the ADF site, is presented in Figure 1. The LRP site layout is presented in Figures 2 and 3; the ADF site layout is presented in Figure 4.

1.1 OBJECTIVE & BACKGROUND INFORMATION

ESB operates both the LRP and the ADF sites under an Industrial Emissions Licence (IEL) Licence (Reg. No. P0610-02) issued by the Environmental Protection Agency (EPA). The most recent version of this licence was issued on 06 January 2014.

Under Condition 6.13.3 of the Licence the site is required to complete risk screening and a technical assessment of groundwater quality beneath the site as follows:

Within eighteen months of the date of grant of this licence, the licensee shall carry out a risk screening and where necessary a technical assessment in accordance with the Guidance on the Authorisation of Discharges to Groundwater, published by the Environmental Protection Agency. A report on the outcome of the screening and where relevant the recommendations of the technical assessment in relation to the setting of groundwater compliance points and values, shall be included in the next AER. Any actions required to demonstrate compliance with the European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended, shall be agreed by the Agency and implemented before 22 December 2015. Groundwater monitoring results shall be submitted annually or as required in the Schedules to this licence.

The objective of the works reported herein is to complete an assessment of groundwater beneath the site in accordance with the Guidance on the Authorisation of Discharges to Groundwater¹ to comply with Condition 6.13.3 of the site's IEL Licence.

2. SCOPE OF WORKS

AECOM completed the following scope of works to meet the objectives of this report:

- Risk Screening to include:
 - Review of publicly available historical and environmental data on the site and surrounding area, as shown on the available historical maps, aerial photographs and regulatory information;
 - Summarising the environmental site setting
 - Development of preliminary conceptual site model
- Tier 1 – Preliminary Site Assessment to include
 - Assessment of the environmental setting of the site and surrounds by reviewing relevant geological, hydrogeological and topographical maps;
 - Review of previous environmental reports;
 - Completion of a site visit and interview with key knowledgeable staff to identify current environmental conditions at the site which may represent a potential environmental risk;
 - A review of relevant site documentation provided by ESB, including annual environmental reports, IPPC licence application and site material safety data sheets;
 - Interviews with key knowledgeable personnel during the site visit; and

¹ Environmental Protection Agency (2011), Guidance on the Authorisation of Discharges to Groundwater.

- Development of Conceptual Site Model.
- Tier 2 – Generic Quantitative Risk Assessment to include
 - Assessment of available data against generic assessment criteria (GAC);
 - Assess potential groundwater impacts and compliance with groundwater regulations; and
 - Identify any potential data gaps and recommended additional works to demonstrate compliance with the Groundwater Regulations.
- Production of one consolidated report to include the findings of the Tier 1 and Tier 2 assessments.

3. EXISTING REPORTS

AECOM completed a review of existing site-specific and regional hydrogeological information from the following sources. The data from these reports was used to inform the following sections.

- URS Ireland Limited (2013), Assessment of Dust Deposition Monitoring Locations, Lough Ree Power (IPPC Register No. P0-610-02), Dated 17 December 2013, 47092647, DURP0002.
- URS Ireland Limited (2013), Assessment of Dust Deposition Monitoring Locations, Lough Ree Power ADF (IPPC Register No. P0-610-02), Dated 17 December 2013, 47092647, DURP0002.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-02, Annual Environmental Report, 2013.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2012 to 31st December 2012.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-01, Annual Environmental Report for the period 1st January 2011 to 31st December 2011.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2010 to 31st December 2010.
- URS Ireland Limited (2009), Environmental Exit Audit- Summary Report, Former ESB Power Generating Station, Lanesborough, Co. Longford, dated 25 November 2009, Final, Issue No1, 49341529.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2009 to 31st December 2009.
- Electricity Supply Board, Lough Ree Power Generating Station, IPPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2008 to 31st December 2008.
- Electricity Supply Board, Lough Ree Power Generating Station, IPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2007 to 31st December 2007.
- Electricity Supply Board, Lough Ree Power Generating Station, IPC Licence Reg. No. 610-01, Annual Environmental Report, for the period 1st January 2006 to 31st December 2006.
- Electricity Supply Board, Lough Ree Power Generating Station, IPC Licence Reg. No. 610, Annual Environmental Report, for the period 1st January 2005 to 31st December 2005.

4. SITE SETTING

For ease of description the following section is separated into two subsections. Subsection 4.1 details the LRP generating site and subsection 4.2 details the Ash Disposal Facility (ADF).

4.1 Lough Ree Power (LRP) Station Site

4.1.1 Description of the Facility

The LRP site is located 300 m north of Lanesborough on the eastern bank of the River Shannon. Construction of the LRP station commenced in July 2002 as a replacement for the former 85 megawatt (MW) Lanesborough Power Station; a milled peat-fired power-generating station. Generating activities ceased at the former Lanesborough Power Station in 2004 and demolition of the station building was completed in 2010.

Construction of the LRP station was completed in August 2004 and the station became commercially operational in December 2004. The LRP site occupies an area of 33 hectares (Ha) adjacent to the former Lanesborough Power Station site.

Along with West Offaly Power Station, the LRP station is one of Ireland's first power stations to be built in conformance with the Large Combustion Plant Directive. The station consists of a single boiler/turbine unit and auxiliary plant, with an electrical output of 100 MW. The boiler operates through the combustion of milled peat, with the utilisation of gas oil as a start-up fuel. Approximately 800,000 tonnes of peat, supplied locally from Bord na Móna works, is burned at this installation annually.

The plant uses circulating fluidised bed (CFB) combustion. With this technology, the fuel is injected into a hot turbulent bed of sand, with air being blown through the bed from the bottom. The fluidised bed has a large thermal mass, leading to more even and controlled combustion. CFB combustion technology is particularly suitable for fuels with a high ash content or low or varying heating values. Fluidised bed combustors also produce lower NO_x emissions compared to alternative combustion systems and allow for simple desulphurisation through the use of sorbent materials in the bed to retain sulphur. With the CFB technology, the air blown through the bed cause particles to become entrained in the hot gases. These particles are removed in a cyclone and a portion of the gases are recirculated through the boiler.

Ash is transported from the main generator building via pipework to the Ash Silo. At the ash silo, the ash moisture content is increased to between 15% and 18% before being dispensed to the ash wagon for transport to the ADF, a non-hazardous, lined dedicated ash landfill.

The LRP station can be subdivided as follows;

- The power station site which is operated by ESB; and
- The peat handling site which is operated by Bord na Móna.

The main features of the facility (see Figure 2) are as follows:

- Peat Screening building;
- Intermediate peat house;
- Tippler;
- Conveyor;
- Combustion Turbine;
- Boiler house;
- Auxiliary Transformers;
- 110kV Compound;
- Transformers;
- One diesel above ground storage tank (AST);
- Chemical Tanks;
- Water Treatment Building;

- Electrical Supply Building;
- Offices and administration building;
- Stores;
- Workshop;
- Laboratory;
- Water Pump house;
- Demineralisation Water Tank; and
- Waste Storage Area.

4.1.2 **Adjacent Land Use**

Site Boundary	Land Use
North	Ash ponds from the former Lanesborough Power Station are located immediately to the north, northeast and northwest of the site. (It is understood that these have been capped with a peat layer and re-vegetated) Agricultural fields lie beyond the ash ponds.
South	Commercial buildings are located on the south eastern site boundary. Residential buildings are located 150 m south of the site boundary with Lanesborough village beyond.
East	Agricultural fields.
West	Former Lanesborough Power Station site and the River Shannon beyond.

4.2 **Ash Disposal Facility Site**

4.2.1 **Description of the Facility**

The ADF site is located at Derraghan, 3 km south east of the LRP site. It occupies an area of 33 Ha located within commercial Bord na Móna peat harvesting land. The site layout is presented in Figure 4.

The ADF is an engineered landfill complete with a geo-synthetic clay liner (GCL) at the base. The GCL consists of sodium bentonite clay, supported by geotextiles, which forms another hydraulic barrier to the leachate. The landfill is subdivided into cells which are filled sequentially. The GCL is overlain with a composite drainage layer (CDL), which collects any leachate generated. The CDL falls to a leachate collection drain at one end of each cell, which transfers leachate to a leachate monitoring manhole. Collected leachate is either pumped over the ash as a means of dust suppression and compaction or pumped to the lined lagoon using an electrical submersible pump.

Since landfilling operations commenced at the site all leachate generated has been recycled over the ash. The site does not have a licence to discharge leachate to a local surface waterbody.

As each cell reaches capacity, the cell is capped with a low permeability GCL and, as a result, leachate production at the ADF will eventually cease.

4.2.2 **Adjacent Land Use**

Site Boundary	Land Use
North	Peat bog
South	Peat bog
East	Peat bog and agricultural fields
West	Peat bog

5. ENVIRONMENTAL SITE SETTING

Information presented within this section has been collated from publicly available sources, including the Environmental Protection Agency (EPA) (www.epa.ie), Ordnance Survey of Ireland (OSI) (www.osi.ie), Geological Survey of Ireland (GSI) (www.gsi.ie), National Parks and Wildlife Service (NPWS) (www.npws.ie), and Water Framework Directive Ireland (www.wfdireland.ie) and reports listed in Section 3.

5.1 LRP Site

<i>Physical Feature</i>	<i>Details</i>
Topography	The site is generally flat. According to OSI Discovery Series map No.40 the site is located at approximately 40m above Ordnance Datum (OD).
Geology	<p>Information from GSI indicates the underlying bedrock is Dinantian Pure Bedded Limestone.</p> <p>Teagasc have identified the subsoil beneath the south of the site as being Till derived chiefly from limestone. The northern portion of the site is underlain by Cutover peat.</p> <p>From intrusive investigation works at the site, the typical subsoil profile at the site can be summarised as follows:</p> <ul style="list-style-type: none"> • 0.0 – 2.0 m bgl – Made ground, comprising loose clayey gravel • 2.0 – 10.0 m bgl – Natural ground, comprising gravelly clay • Limestone bedrock was encountered at depths varying from 6 – 16 m bgl <p>A borehole log for onsite monitoring well PS-GW1 is attached in Appendix A, no borehole log was available for PS-GW2</p>
Hydrogeology	<p>The bedrock aquifer beneath the site is classified as a Regionally Important Aquifer – Karstified Aquifer characterised by conduit flow (Rkc).</p> <p>The GSI indicates that the site is located in a zone of 'high' groundwater vulnerability.</p> <p>There are no Source Protection Zones within 1 km of the site.</p> <p>Given the proximity of the River Shannon, the groundwater flow direction is expected to be towards the west of the site.</p>
Nearby Groundwater Abstraction wells	<p>According to GSI, the nearest groundwater abstraction well is located approximately 500 m to the north east of the site. This abstraction well is installed in the limestone bedrock and is reported to be "moderate" yielding with a yield of 76.4 m³/d. The well was installed in 1965 and is reported to be used for agricultural and domestic use.</p> <p>There are two onsite abstraction wells. According to GSI, both abstraction wells are installed in the limestone bedrock. One well is reported to have a yield of approximately 2,000 m³/d; no such information is available for the other well. Water from both wells is used in the power generation process. Abstracted groundwater is not used for potable water.</p>
Water Framework Directive	<p>Groundwater beneath the site is designated as a WFD protected area for drinking water.</p> <p>The WFD Groundwater beneath the site is identified as the Lanesborough_2 groundwater body IE_SH_G_137. The EPA has classified the water body as having a 'good status' and being 'At risk of not achieving good status'.</p>
Surface Water	<p>The closest surface water body is the River Shannon which flows from north to south 180 m from the site's western boundary.</p> <p>According to the EPA, based on the most recent monitoring event at Ballyleague Bridge, 500 m south of the site, the River Shannon has a 'Moderate' Status before it enters Lough Ree.</p>
Protected Areas	<p>One protected area was identified within a 5 km radius of the site:</p> <ul style="list-style-type: none"> • Lough Ree (004064), a Special Protected Area (SPA), located approximately 500 m south of the site.

5.2 ADF Site

Physical Feature Details

Topography	The site is generally flat. According to OSI Discovery Series map No.40 the site is located at approximately 50m above Ordnance Datum (OD).
Geology	The GSI indicates that the bedrock underlying the site comprises Dinantian (early) sandstones, limestones and shales. Teagasc have identified subsoil beneath the site as Cutover peat bog. No Borehole logs for the onsite monitoring wells were available to AECOM. GSI records indicate that bedrock was encountered at 0.6 m and 3.1 m bgl at boreholes located 2.4 km to the east of the site and 3.1 km to the north of the site, respectively. Overburden was reported as peat.
Hydrogeology	The underlying bedrock aquifer may generally be regarded as a locally important aquifer (bedrock which is moderately productive only in local zones) with 'low' groundwater vulnerability. There are no Source Protection Zones within 3 km radius of the site. The local groundwater flow direction is unknown, However it is expected that the general regional groundwater flow direction is towards Lough Ree, located approximately 6 km west of the site.
Nearby Groundwater Abstraction wells	According to GSI records, the nearest groundwater abstraction well is located approximately 2.5 km north east of the site. This abstraction well is installed in the limestone bedrock and is reported to be "moderate" yielding, with a yield of 65.5 m ³ /d.
Water Framework Directive	Groundwater beneath the site is designated as a WFD protected area for drinking water. The WFD Groundwater beneath the site is identified as the Inny groundwater body IE_SH_G_110. The EPA has classified the water body as having a 'good status' and being 'Strongly expected to achieve good status'.
Surface Water	The closest surface water bodies are an unnamed stream 0.75 km to the southwest of the site and the Bilberry Stream located 1 km to the northeast of the site. The unnamed stream is shown to flow in a general south westerly direction and discharges to Lough Ree 5.5 km south of the site. The Bilberry Stream joins the Bilberry River 6 km south east of the site. The Bilberry River also discharges to Lough Ree. According to the EPA, the Billberry River has a 'Moderate' Status.
Protected Areas	The following protected areas were identified in proximity of the site: <ul style="list-style-type: none"> Fortwilliam Turlough, (000448), a Special Area of Conservation (SAC), is located 5.5 km to the west of the site. Forthill Bog (001448), a Natural Heritage area (NHA), is located 4 km south of the site.

6. CHEMICALS OF CONCERN

6.1 LRP Site

Historic Contamination

The LRP site was developed on green field land adjacent to the former Lanesborough Power Station site. There are no records of historic contamination at the site.

Chemical Storage

The following is list of the major chemicals stored onsite.

Chemical	Container Volume
Caustic Soda (NaOH)	30 m ³ (start-up fuel for auxiliary diesel generator)
Sulphuric Acid (H ₂ SO ₄)	30 m ³
Ammonia (NH ₃)	1 m ³
Diesel (gas oil)	150 m ³ (start-up fuel for auxiliary diesel generator) 1 m ³ (diesel tank for fire water pump) 1.3 m ³ (emergency diesel generator tank) 25 m ³ (back-up fuel source for locomotives) 2 No. 2.3 m ³
Turbine Lubricating Oil	8 m ³
Gear Oil	2.3 m ³
Anti-freeze	1 m ³
Waste Oil	1 m ³

The material safety data sheets for all bulk chemicals stored on-site listed in the table above are presented in Appendix B.

During the AECOM site visit, it was noted that all chemicals listed above are banded and/or stored in double skinned containers. All bands were reported to be in good condition. Under Condition 6.9 of the IEL Licence, the site is required to complete bund integrity testing once every three years. The most recent bund integrity testing was completed during 2014, the result of which is reported in the 2014 AER. It was reported to AECOM that all bunds passed the 2014 integrity testing.

The site achieved ISO14001 certification in 2014. There is an appointed environmental committee for the site which sits biannually. The committee is responsible for the implementation of the following good environmental practices aimed at reducing risks from potential spills and leaks;

- In-house environmental audits are completed monthly;
- Tanks and interceptors are alarmed;
- Bunds are inspected monthly and alarms tested biannually; and
- Oil and chemical tanks are filled to maximum of 75% of their total capacity.

Appendix C contains a complete inventory of all other chemicals stored onsite in minor volumes.

Other Potential Contaminants

A number of other contaminant sources were identified from the LRP site:

- Cooling water;
- Blowdown water;
- Water treatment effluent; and
- Surface water drainage infrastructure, including settlement ponds.

Spills and Leaks

No spills or leaks have been reported since the development of the site.

6.2 ADF Site

The single contaminant of concern identified at the ADF site is the leachate generated at the landfill.

7. CONCEPTUAL SITE MODEL

7.1 LRP Site

A conceptual site model (CSM) identifying current understanding of source-pathway-receptor linkages based on the most recent reports is tabulated below and presented graphically in Figure 5.

<i>Potential Sources</i>	<i>Viable Pathways</i>	<i>Potential Receptors</i>
Above Ground Storage Tanks	Human Health (inhalation of vapours)	Human Health
Site drainage infrastructure	Controlled waters	<ul style="list-style-type: none"> On-site employees Workers onsite undertaking subsurface works
Process water effluent infrastructure	Lateral migration of contaminated groundwater through the permeable fill, made ground and overburden	Controlled Waters
Potential Historic Contaminated soil to the south of the site	Preferential pathways through onsite drainage	<ul style="list-style-type: none"> Groundwater beneath the site The River Shannon

7.2 ADF Site

A conceptual site model (CSM) identifying current understanding of source-pathway-receptor linkages based on the most recent reports is tabulated below and presented graphically in Figure 6.

<i>Potential Sources</i>	<i>Viable Pathways</i>	<i>Potential Receptors</i>
Leachate	Controlled waters	Controlled Waters
<ul style="list-style-type: none"> Collected at the base landfill Collected in the lagoon 	<ul style="list-style-type: none"> Lateral migration of contaminated groundwater through the peat. 	<ul style="list-style-type: none"> Groundwater beneath the site Streams to the 1 km north and 0.75 km south of the site

8. ASSESSMENT OF CURRENT GROUNDWATER STATUS

As required by the site's IE Licence, ESB completes the following groundwater monitoring at the site;

<i>Monitoring Point</i>	<i>Parameter</i>	<i>Monitoring Frequency</i>
PS-GW1 and PS-GW2	Ammoniacal Nitrogen, Diesel Range Organics (DRO) and Total Petroleum Hydrocarbons (TPH)	Annually
ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW6	pH, Electrical Conductivity (EC)	Monthly
	Ammoniacal Nitrogen, TPH ² and chloride,	Quarterly
	Heavy metals	Annually

Annual Environmental Reports (AERs) containing results of groundwater monitoring from 2005 to 2013 were provided to AECOM for review. AERs (2005 – 2013) are attached in Appendix D. Groundwater monitoring results for 2014 were also provided to AECOM.

There are two monitoring wells on the LRP site, one up-gradient well and one down-gradient well; providing the minimum coverage for an environmental assessment. Locations of groundwater monitoring wells are indicated on Figure 2.

² TPH was changed to Total EPH, EPH (C6-10) and EPH (C10-40) in 2014

Monitoring well PS-GW01, the up-gradient well is located at the eastern site boundary.

Monitoring well PS-GW02 is the down-gradient well and is located on the western site boundary.

There are four groundwater monitoring wells on the ADF site, locations of which are indicated on Figure 4.

Appropriate generic assessment criteria (GAC) protective of controlled water receptors were selected based on the LRP site setting and the conceptual site model for the site, which is summarised below:

- The closest surface water body to the site is the River Shannon (a designated SAC).
- The bedrock aquifer is classified (GSI) as a 'locally important aquifer which is moderately productive only in local zones'.
- The groundwater beneath the site is protected as a drinking water resource under the Water Framework Directive.
- There are no groundwater abstraction wells for drinking water located down-gradient of the site.

Based on the above, the most sensitive receptors identified are the protected groundwater beneath the site and the River Shannon 180 m from the eastern boundary of the LRP site.

Given the above site setting, groundwater water quality was assessed by comparing analytical results to appropriate assessment criteria according to the following hierarchy:

- European Communities Environmental Objectives (Groundwater) Regulations, 2011 (Statutory Instrument No. 389 of 2011); and
- Environmental Protection Agency's Draft Interim Guidelines Values (IGVs) for the Protection of Groundwater, 2003³.

8.1 Generic Risk Assessment and Groundwater Chemical Status

Tabulated laboratory data compared to GAC from the most recent monitoring rounds completed between March 2014 and May 2015 are presented in Table 1. The following table presents a summary of the results which were reported above the adopted GAC indicating a potential risk to controlled waters.

Parameter	GAC	Reported Concentration Range of Exceedences	Exceeding wells
Iron	200 ug/L	12,400 - >25,000 ug/L	ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW6
EPH (C10-40)	10 µg/L (IGV)*	91.7 µg/L	PS-GW2
Ammoniacal Nitrogen as NH ₄	0.175 mg/L (GTV)**	0.585 mg/L – 13.8 mg/L	ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW6

* EPH(C10-40) is compared against the IGV for Total Hydrocarbons

** Ammoniacal Nitrogen as NH₄ is compared against the GTV for Ammonium

Elevated concentrations of the above parameters may indicate that the groundwater beneath the site is of 'Poor Status'.

Total EPH and EPH (C6-10) were not detected at concentrations exceeding the MDL (100 µg/L). However, it should be noted that the MDL is greater than the GAC of 10 µg/L. It is recommended

³ Environmental Protection Agency, Towards setting guideline values for the protection of groundwater in Ireland (Interim Report).

that in future sampling a laboratory/laboratory method is used which can provide a MDL of 10 µg/L or lower.

8.1.1 **Temporal Trends and Potential Extent of Contamination**

Temporal trends for the parameters identified as exceeding the GAC in Section 8.2 along with arsenic (elevated concentrations noted in historic data) are presented in Graphs 1 to 3⁴. The following is a summary of the apparent trends.

Arsenic (Graph 1)

An elevated arsenic concentration was detected at ADF-GW4 (17.5 µg/L) in 2015. Historically, arsenic concentrations have fluctuated at this location between less than the MDL in 2005 and 17.5 µg/L in 2015. No significant overall trend is obvious between 2005 and 2015.

Arsenic was not detected at concentrations exceeding the GAC at ADF-GW3, ADF-GW5 or ADF-GW6 during the March or May 2015 monitoring rounds. No discernible overall trend is obvious at these locations since 2005.

The source of the reported elevated arsenic concentration is unclear but may be associated with natural processes or the ash landfilled at the site. Arsenic is commonly present as arsenopyrite in limestones. Under reducing conditions, which would be typical of poorly drained peaty areas containing a large portion of decaying organic matter, the arsenopyrite may become soluble leading to elevated arsenic concentrations in groundwater.

Continued monitoring would be required to assess this potential upward trend. Additionally, groundwater elevation data, total depth of monitoring well and, if possible, the geological unit (peat or bedrock) in which the well is screened should be, if possible, ascertained during future monitoring rounds. This may help identify the processes leading to increased arsenic concentrations.

Iron (Graph 2)

Elevated concentrations of iron were detected at ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW6 in 2015. Iron concentrations exceeding the IGW (200 µg/L) have not been reported at these location prior to 2014.

The source of the elevated concentrations of iron in these wells may be associated with elevated background concentrations associated with the regional geology (impure limestones)⁵. In areas with such a geological make-up, iron can frequently fluctuate between zero and concentrations exceeding the IGW. Additionally, peat is typically poorly drained and contains a large portion of decaying organic matter. Such conditions can give rise to oxygen-deficient/reducing environments which increases the solubility of iron, giving rise to elevated iron concentrations in the groundwater.. The source of the elevated iron concentrations may be associated with the landfilling of ash.

Further monitoring would be required to assess any trends in iron concentrations in these wells.

EPH (C10-40)

An elevated concentration of EPH (C10-40) above the IGW of 10 µg/L was detected in 2015 at monitoring well PW-GW2 (91.7 ug/L). EPH (C10-40) analysis was not completed prior to 2015. Further monitoring would be required to assess any trends in EPH concentration.

The source of the elevated concentrations of EPH is not known. It may be associated with on-site sources or potentially from the natural peat deposits in the locality. It is recommended that future analysis include for laboratory interpretation of the type of hydrocarbons detected in order to distinguish between peat and other hydrocarbon sources.

Total EPH and EPH (C6-10) were not detected at concentrations above the MDL (100 µg/L) at any location on the LRP or ADF sites. However, it should be noted that the MDL is greater than the GAC of 100 µg/L. It is recommended that in future sampling a laboratory/laboratory method is used which can provide a MDL of 10 µg/L or lower.

⁴ No trend analysis is presented for EPH (C10-40), because this has not been analysed for prior to 2015.

⁵ Inny Groundwater Body: Summary of Initial Characterisation, Draft 1 – Inny GWB -17th October 2003

Ammoniacal Nitrogen⁶ (Graph 3)

Elevated ammoniacal nitrogen concentrations exceeding the GTV (0.175 mg/L) were detected at all monitoring locations at the ADF in 2015 (ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW5) and marginally at the LRP site in 2014 (PS-GW1 (0.2 mg/L) and PS-GW2(0.2 mg/L)).

Generally, ammoniacal nitrogen concentrations recorded in the ADF wells have fluctuated between 1 mg/L in 2006 and 13.8 µg/L in 2015. Graph 3 shows a general downward trend for ADF-GW5 and potential upward trends for ADF-GW3, ADF-GW4 and ADF-GW6. Further monitoring would be required to assess any potential upward trends.

The source of the elevated ammoniacal nitrogen concentrations is unclear. Teagasc have identified the subsoil beneath the ADF site as consisting of cutover peat bog. These areas tend to be nitrogen saturated and would typically have significant leaching of dissolved inorganic nitrogen, particularly ammonium to groundwater. This can result in elevated ammoniacal nitrogen concentrations in the groundwater. Elevated ammoniacal nitrogen concentrations may also be reflective of reducing conditions created as result of ash landfilling activities at the site. Further monitoring would be required to assess potential upward trends.

8.2 Impact on Receptors

8.2.1 Risks to Controlled Waters

Iron

The presence of iron at ADF-GW3, ADF-GW4 ADF-GW5 and ADF-GW6 in May 2015, at concentrations exceeding the IGV indicates a potential risk to controlled waters receptors. The source of the elevated iron concentrations in these wells may be associated with elevated background concentrations associated with the regional geology (impure limestones). However the elevated iron concentrations detected at ADF-GW6 may be associated with ash landfilling activities at the site. Further monitoring would be required to confirm the assumptions and to assess any significant upward trends.

Ammoniacal Nitrogen)

The presence of ammoniacal nitrogen at concentrations exceeding the GTV (0.175 mg/L) were detected at all monitoring location in 2015 (ADF-GW3, ADF-GW4, ADF-GW5 and ADF-GW5) indicates a potential risk to controlled waters receptors.

Ammoniacal nitrogen concentrations detected in ADF-GW3 (6.42 mg/L), ADF-GW4 (13.8 mg/L) and ADF-GW6 (4.08 mg/L) indicate a potential upward trend when compared to the previous monitoring event.

The source of the elevated concentrations of ammoniacal nitrogen in these wells is unclear, but may be associated with the regional geology and more specifically, the cut over peat over burden in the area. Alternatively, it may be a result of landfilling activities at the site. Further monitoring would be required to assess this potential upward trend.

EPH (C10-40)

Elevated concentrations of EPH (C10-40) was detected in PS-GW2 indicating a potential risk to controlled waters. EPH (C10-40) has not been analysed prior to 2014. The temporal trends in EPH (C10-40) at this location should be assessed over future rounds to confirm this risk and to assess if there is a significant upward trend.

⁶ The 2005 to 2012 AERs reported ammonia (N). The 2013 AER reported NH₄. 2014 analytical results for PW-GW1 and PW-GW2 report ammoniacal nitrogen. Laboratory reports available for 2015 provide analytical results in ammoniacal nitrogen as N, ammoniacal nitrogen as NH₃ and ammoniacal nitrogen as NH₄. For simplicity, historical trends have combined the 2005 – 2012 ammonia (N) results with the NH₄ reported in 2013 and the ammoniacal nitrogen as NH₄, most recently reported in 2015.

8.3 Chemical Status of Groundwater Body

The Lanesborough_2 groundwater body IE_SH_G_137 beneath the LRP site is identified as being 'At risk of not achieving good status' under the Water Framework Directive (WFD). The status of the groundwater body was identified as 'Good'.

The Inny groundwater body IE_SH_G_110, beneath the ADF site is identified as being 'Strongly expected to achieve good status' under the Water Framework Directive (WFD). The status of the groundwater body was identified as 'Good'.

Elevated concentrations of arsenic, iron, EPH (C10-40) and ammoniacal nitrogen were detected at groundwater monitoring locations across the ADF site. However given that the elevated concentrations were <100 GAC the risk to the overall status of the groundwater body is considered to be low.

9. CONCLUSIONS AND RECOMMENDATIONS

Based on the hydrogeological assessment completed herein AECOM conclude the following with respect to the site:

- The following potential on-site sources have been identified:
 - Chemical and heavy fuel oil storage;
 - Site drainage infrastructure;
 - Process water effluent infrastructure; and
 - Surface water drainage infrastructure (including Sedimentation tank).
- No spills or leaks have been reported since development of the site.
- Bunds were observed to be in a good condition. Bund integrity testing was completed in 2014 and it was reported to AECOM that all bunds passed the respective integrity tests. Good environmental management practices are in place to reduce the risk of spills to the environment.
- Given that the elevated concentrations of iron, EPH (C10-40) and ammoniacal nitrogen were <100 x GAC the risk to the overall status of the Inny groundwater body is considered to be low.
- Potential risks to groundwater were identified from elevated concentrations arsenic, iron, EPH (C10-40) and ammoniacal nitrogen at the ADF facility. Further monitoring is recommended to identify any significant upward trends and to confirm or otherwise the potential risks and to demonstrate compliance with the Groundwater Regulations.
- Considering the bulk chemicals stored on the LRP site, it is recommended that, in addition to the current license requirements, pH and electrical conductivity analysis be completed at PS-GW1 and PS-GW2 on a quarterly basis to detect potential releases of acids, bases and/or salts.
- With respect to the ADF, sampling should include representative samples of the ash for leachate analysis to include contaminants of concern. It is understood that ESB have proposed fly ash monitoring for future rounds.
- During future monitoring rounds additional groundwater data (including, but not limited to groundwater elevation data, total depth of monitoring wells and the geological unit in which wells are screened) should be collected. This may help identify the process leading to increased arsenic, iron and ammoniacal nitrogen concentrations in the groundwater samples.
- It is recommended that alternative analysis for hydrocarbons is used with an LOD <10ug/L to screen for potential hydrocarbons.

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FIGURES

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TABLES

Table 1 - 2014/2015 Groundwater Monitoring Results
Lough Ree Power
Risk Screening and Technical Assessment

Sample Identity			PS-GW1	PS-GW2	ADF-GW3	ADF-GW4	ADF-GW5	ADF-GW6
Date of Sample			Mar/April15	Mar/April15	Mar/May 15	Mar/May 15	Mar/May 15	Mar/May 15
Analyte	Unit	GAC						
Aluminium	ug/l	150 ⁺	-	-	<2.9	<2.9	<2.9	11.5
Arsenic	ug/l	7.5 ⁺	-	-	1.17	5.11	1.77	2.4
Cadmium	ug/l	3.75 ⁺	-	-	<0.1	<0.1	<0.1	<0.1
Copper	ug/l	1500 ⁺	-	-	<0.85	1.25	<0.85	0.952
Molybdenum	ug/l	nc	-	-	8.35	2.27	2.07	1.93
Nickel	ug/l	15 ⁺	-	-	1.56	2.17	3.44	7.73
Selenium	ug/l	nc	-	-	0.495	0.909	0.46	0.887
Zinc	ug/l	100 [#]	-	-	<0.41	7.8	15.9	6.19
Sulphate	mg/l	187.5 ⁺	-	-	0.187	1.64	6.13	9.03
Calcium	mg/l	200 [#]	-	-	112	189	119	149
Magnesium	mg/l	50 [#]	-	-	8.1	7.43	11.8	14.7
Iron	ug/L	200	-	-	>25000	18400	12800	12400
Chloride	mg/l	187.5 ⁺	-	-	15.9	18	17.3	25
GRO >C5 - C10	ug/l	nc	-	-	<10	<10	<10	<10
EPH (C6-10)	ug/l	10 [#]	<100	<100	<100	<100	<100	<100
EPH (C10-40)	ug/l	10 [#]	<46	91.7	<46	<46	<46	<46
Total EPH (C6-40)	ug/l	10 [#]	<100	<100	<100	<100	<100	<100
MTBE	ug/l	30 [#]	<3	<3	<3	<3	<3	<3
Benzene	ug/l	0.75 ⁺	<7	<7	<7	<7	<7	<7
Toluene	ug/l	10 [#]	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	10 [#]	<5	<5	<5	<5	<5	<5
m,p-Xylene	ug/l	10 [#]	<8	<8	<8	<8	<8	<8
O-Xylene	ug/l	10 [#]	<3	<3	<3	<3	<3	<3
Sum of detected BTEX	ug/l	10 [#]	<28	<28	<28	<28	<28	<28
pH	pH units	nc	-	-	7.46	7.29	7.62	7.35
Ammonical Nitrogen as N	mg/l	nc	<0.2	<0.2	4.99	10.7	0.455	3.17
Ammonical Nitrogen as NH ₃	mg/l	nc	<0.2	<0.2	6.23	12.9	0.459	3.77
Ammonical Nitrogen as NH ₄	mg/l	0.175 ⁺	0.0161	0.0751	6.42	13.8	0.585	4.08

Notes:

- X exceeds GAC
- nc - no criteria available
- MDL - Method Detection Limit
- + Irish Groundwater Threshold values (GTVs) 2010
- # Irish Interim Guideline values (IGVs) 2003
- not analysed

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Table 2 - Historical Trend Analysis for Selected Samples
 Lough Ree Power
 Risk Screening and Technical Assessment

Sample Identity	Date of Sample	ADF-GW4											ADF-GW5										ADF-GW6																
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2015 (Mar)	2015 (May)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015 (Mar)	2015 (May)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015 (Mar)	2015 (May)					
Analyte	Unit	GAC																																					
Arsenic	ug/l	7.5*	<2	7.9	11	2	4.11	16.9	2	11	13.12	17.5	5.11	<2	1.9	7	<1	1.75	5.74	0.83	7.7	3.93	2.68	1.77	<2	<1	<1	<1	0.953	6.18	0.748	8.9	4.315	6	2.4				
Iron	ug/l	200*	0.61	11	1011	35	0.108	2.1	0.019	7.3	0.96	27.4	18400	5	6	1730	31	0.7	0.442	0.032	0.5	1.22	23.2	12800	4	4.6	<2	62	1.67	1.38	0.195	0.02	2.08	2520	12400				
Ammonical Nitrogen **	mg/l	0.175*	8.5	10	8	4.5	10	10.18	8.608	9.203	11.45	13.8	-	3	1	3	8.5	12	2.275	2.086	1.408	2.63	0.585	-	3	3	3	3	3	2.11	1.868	1.8	1.67	4.08	-				

Notes:
 X exceeds GAC

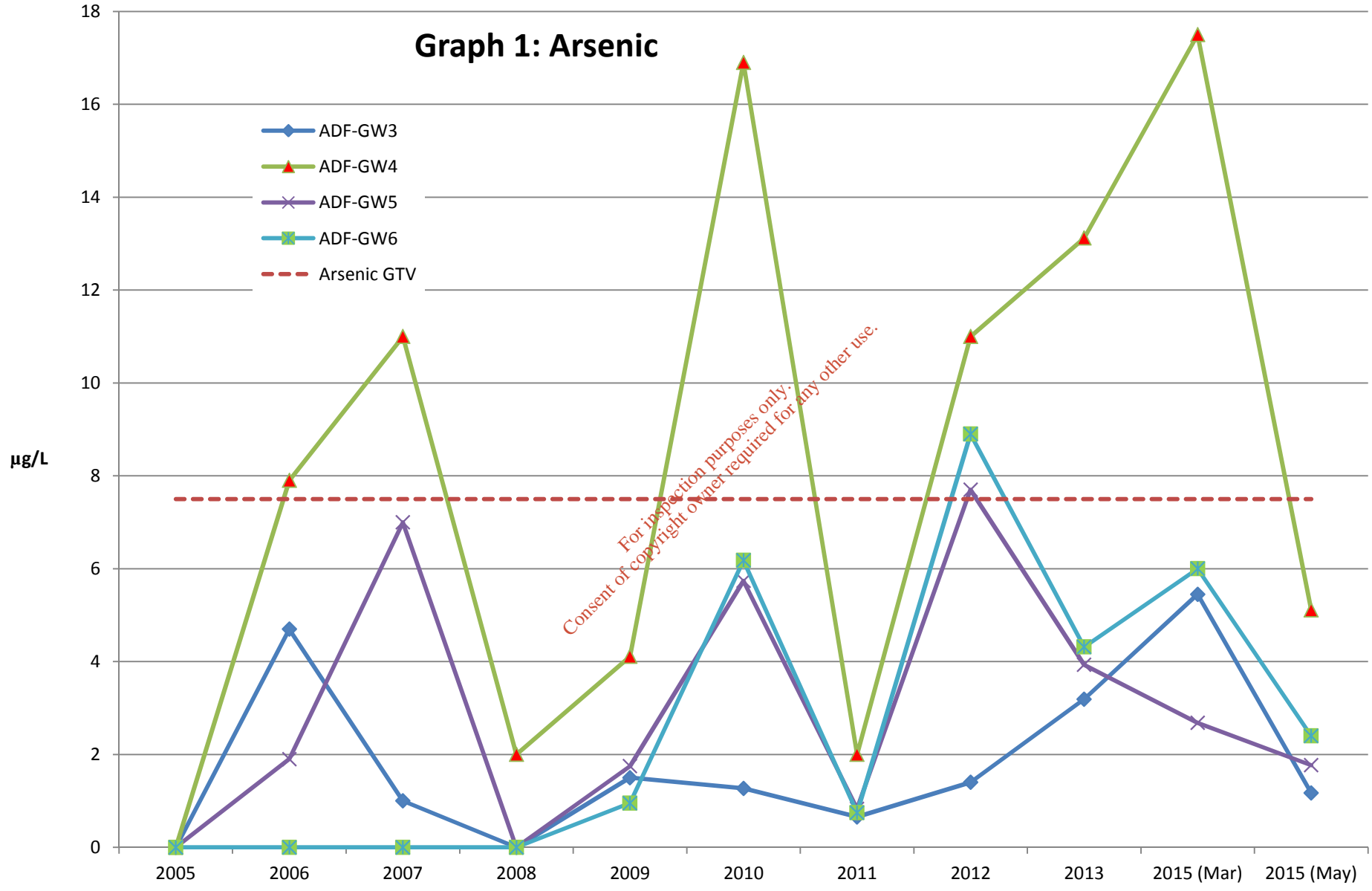
** - Including the ammonia reported between 2005 and 2011;
 nc - no criteria available
 MDL - Method Detection Limit
 + Irish Groundwater Threshold values (GTVs) 2010
 # Irish Interim Guideline values (IGVs) 2003
 - not analysed

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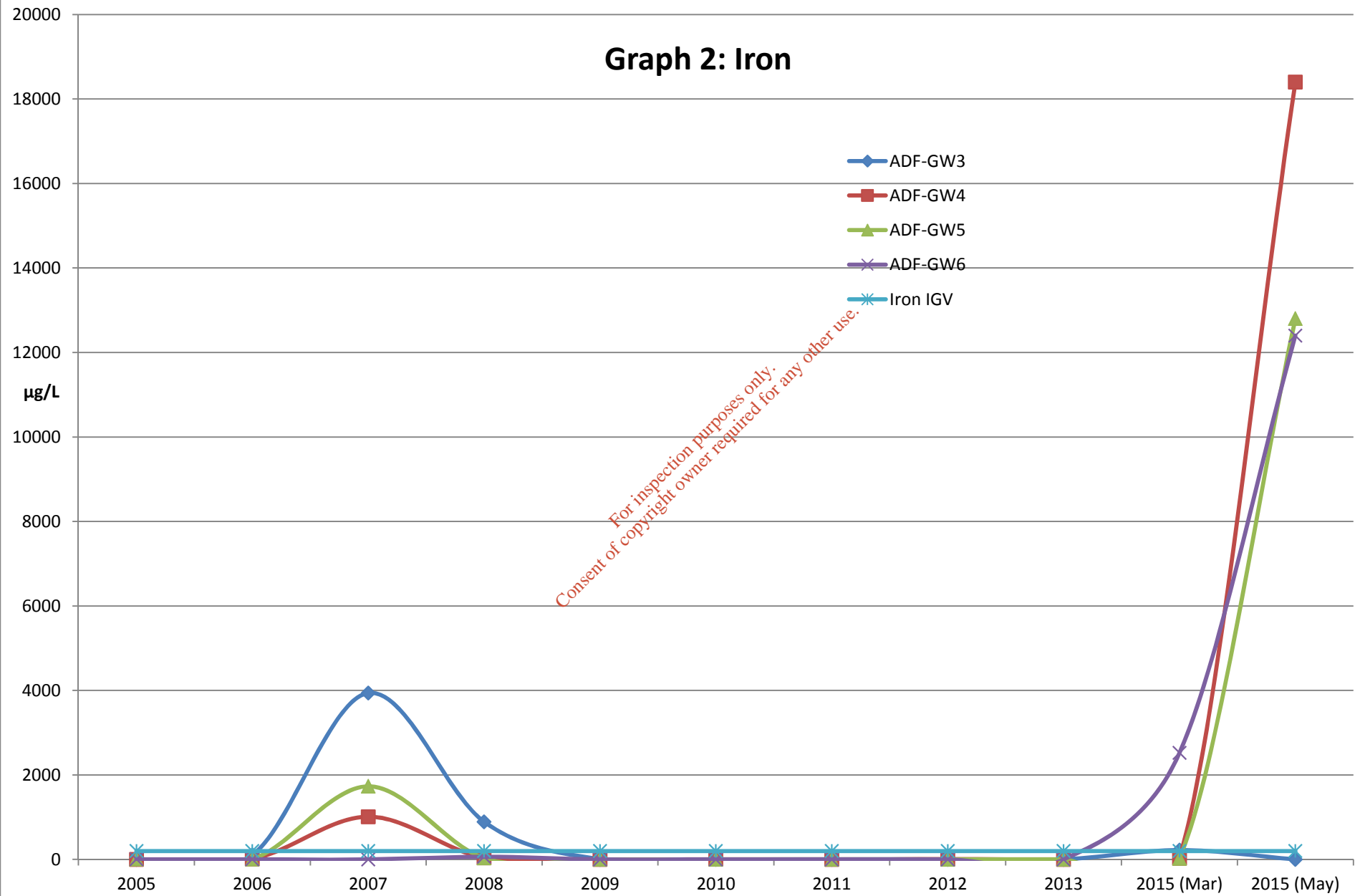
GRAPHS

Graph 1: Arsenic



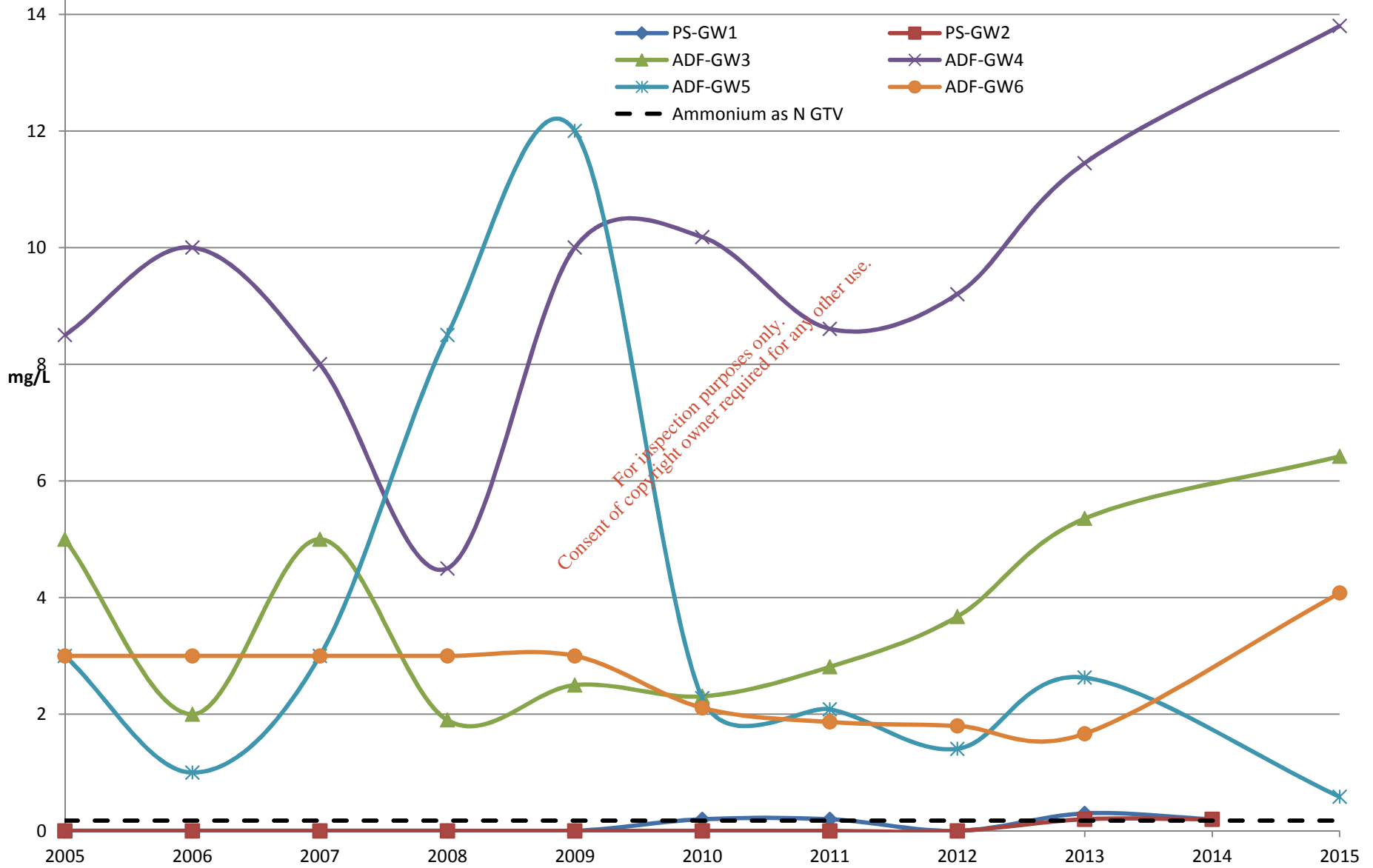
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Graph 2: Iron



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Graph 3: Ammoniacal Nitrogen



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APPENDIX A – BOREHOLE LOGS

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APPENDIX B – MATERIAL SAFETY DATA SHEETS

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APPENDIX C – INVENTORY OF CHEMICALS STORED ON-SITE

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APPENDIX D – AER REPORTS (2005 – 2013)

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