Appendix 14.1

Preliminary Site Assessment

Irish Water

Arklow Waste Water Treatment Plant

Preliminary Site Assessment

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Contents

Executive summary

Arup was commissioned by Irish Water to prepare a preliminary assessment of the potential for land contamination on the site of the Waste Water Treatment Plant (WwTP) of the proposed Arklow WwTP Project.

The proposed WwTP which is on a site at Ferrybank, Arklow is accessed from Mill Road which runs generally north-north-east, south-south-west along the west of the north. To the south of the site is the North Quay of the Avoca River, to the east of the site is a rock revetment and the Irish Sea. To west of the centre of the proposed WwTP is an abandoned tank farm operated by Irish Fertilizer Industry (IFI) (referred to as the Foudi site), and to the west of the northern parts of the site and on the opposite side of Mill Rd are Arklow Marine Services and an abandoned industrial site locally referred to as the Eirgas site.

The site is underlain by a substantial thickness of made ground which was placed to reclaim the land and the surrounding area from the Avoca River and the Irish Sea between 1845 and 1885, during the re-routing of the outfall of the Avoca River. The site was then used as a chemicals factory, munitions factory and finally a gypsum plasterboard factory.

Data from previous site investigations suggest that the made ground and groundwater are contaminated with heavy metals and hydrocarbons and asbestos, are present in the made ground. The nature of the interaction with the Irish Sea and the extent of the tidal effects on the groundwater are uncertain. The impact on the Avoca River and Irish Sea have not been assessed previously.

The desk study has highlighted that the site of the proposed WwTP was used to manufacture cordite, (an explosive) and handled phosphogypsum a material naturally enriched radioactive elements. The extent of the contamination by cordite and phosphogypsum has not been assessed previously.

The area of reclamation around the site also has a history of industrial use and part of the area was used as a landfill.

It is recommended that to fill in data gaps and to gain a better understanding of the ground conditions of the site that a ground investigation is carried out followed by a Detailed Site Assessment. The ground investigation should include:

- A non-intrusive investigation of the site to confirm the presence of elevated levels of radiation;
- Targeted geo-environmental site investigation to assess impacts of the previous site use on the soils at the site
- Assessment of the thickness of the made ground under the site and confirmation of the nature of the soils used to infill the previous course of the Avoca River;

- Installation of monitoring boreholes along the north and west perimeter of the site to determine if any contamination from neighbouring sites is migrating onto the proposed WwTP.

1 Introduction

1.1 Project contractual basis

Arup was commissioned by Irish Water to prepare a preliminary assessment of the potential for land contamination on the site of the Wastewater Treatment Plant (WwTP) of the proposed Arklow WwTP Project.

This assessment comprises an appendix to the Environmental Impact Assessment Report that supports the planning application for the Arklow WwTP Project.

The site for the WwTP is at Ferrybank, Arklow, Co. Wicklow and is the location of the currently derelict Wallboard Factory. The proposed WwTP, subject of this assessment (the site), is delimited by the yellow line presented on Figure 1 together with the planning boundary for the Arklow WwTP Project (red line).

1.2 Project objectives

This report presents the Preliminary Site Assessment (PSA) of the current land contamination risks and the potential land contamination risks associated with the use of the site following the proposed development. This report presents the findings of a detailed source audit and desk-based assessment

This PSA aims to identify areas of contamination within the WwTP development site which may pose a risk to land users and groundwater quality. In undertaking this assessment, the project will consider past activities and land uses and undertake a site walk over to identify areas of potential contamination.

Potential contamination risks associated with the demolition of the existing buildings are not covered by this PSA. These are covered by the construction strategy and Construction Environmental Management Plan (CEMP) which are appended to the Environmental Impact Assessment Report.

1.3 Scope of work

The scope of works includes:

- A review of the published information showing former activities and site history;
- A review of the previous site investigations;
- A site walkover carried out on the 18th October 2017;
- Interviews with people who have knowledge of the site;
- Consultation with Wicklow County Council on groundwater abstractions, contaminated land sites and legacy landfills in the area;
- Development of a preliminary conceptual site model; and
- Preparation of a PSA report in general accordance with the 2013 EPA guidance template.

1.4 Personnel involved

The Arup personnel working on the project are summarised in Table 1.

Table 1: Arup personnel

Personnel	Experience
Jenny Lightfoot, BSc, MSc, CGeol, FGS, SiLC	Ms J Lightfoot has over 20 years' experience in hydrogeology and contaminated land. She is the leader of Arup (UK) North West and Yorkshire Geo-Environmental Team and is an experienced project manager on both groundwater and contamination-related projects. She is a Chartered Geologist, a Specialist in Land Condition (SiLC) and is on the IGI Register of Professional Qualified Geoscientists / Competent (in respect of environmental risk assessment for regulated and unregulated waste disposal and contaminated land).
Christopher Newton MSci, CGeol, FGS	Mr C Newton, project manager and lead project hydrogeologist, has eleven years' experience working on Geo-Environmental projects and hydrogeological issues associated with contaminated land. He is a Chartered Geologist and is on the IGI Register of Professional Qualified Geoscientists / Competent (in respect of environmental risk assessment for regulated and unregulated waste disposal and contaminated land).
Jenny Flink, BSc, MSc	Miss. J Flink, graduate hydrogeologist for the project, has one year experience working on hydrogeology, water quality and contaminated land projects.

2 Sources of information

2.1 Environmental baseline information

As part of the desk study that was undertaken to establish the baseline conditions (i.e. soils, geological and hydrogeological environment), the following sources of information were reviewed:

- Bing Maps, Aerial photography;
- Environmental Protection Agency (EPA). EPA Maps online dataset of environmental information on the area including:
  - Water, Water Framework Directive; and
  - Environment and Wellbeing, Clean Water and Health;
- Google Maps, Aerial photography;
- Geological Survey of Ireland (GSI). Geological maps of the site area produced by the Geological Survey of Ireland including;
  - Quaternary Maps (GSI);
  - Bedrock Mapping;
  - National Landslide Database (GSI);
  - Karst Database (GSI); and
  - Historic Mine Sites - Inventory and Risk Classification;
- GSI, Wicklow GWB: Summary of Initial Characterisation. Groundwater Bodies;
- National Parks and Wildlife Service (NPWS), Proposed / Designated National Heritage Area (NHA), Special Protection Area (SPA), Special Area of Conservation (SAC) Sites;
- Ordnance Survey of Ireland (OSI), Current and historical Ordnance Survey (OS) maps including:
  - Historical maps (1837-1842 and 1888-1913) available for the study area at 1:2,500 and 1: 10,560 scales; and
  - Recent aerial photography (1995, 2000, 2005);
- Water Framework Directive (WFD) Ireland. Water Maps;

2.2 Previous ground investigations

Ground investigation data from previous projects relevant to the study area including:

- RPS Environmental (2005). Soil and Groundwater Investigation Report, Ferrybank, Arklow;
- RPS (2006). Geotechnical Interpretative Report, Ferrybank, Arklow.
- Tobin's Engineering (2005). SI Report, IFI Tank Farm Site, Arklow;
- A single GI report held by the Geological Survey of Ireland (GSI).

2.3 Guidance

At present, there is no statutory or regulatory guidance on the assessment of land contamination in Ireland, except where the site is operated under an EPA regulated licence (Environmental Protection Agency, 2013) e.g. Industrial Emission Licence (IEL) or Integrated Pollution Control (IPC) permit. The 2013 EPA (Environmental Protection Agency, 2013) guidance document presents a summary of the processes to be followed and clearly sets out the documents to be prepared at each stage. The 2013 EPA guidance follows a similar international guidance on the assessment of land contamination (CLR11). In the absence of a directly relevant guidance the 2013 EPA guidance has been followed in this report.

This report has been prepared in accordance with the EPA Preliminary Site Assessment template within the 2013 EPA's guidance document on management of contaminated land (Environmental Protection Agency, 2013).

3 Site description

3.1 Site location and extent

The proposed WwTP is located on a site at Ferrybank, Arklow and is accessed from Mill Road which runs generally north-north-east, south-south-west along the west of the north (Figure 2). To the south of the site is the North Quay of the Avoca River, to the east of the site is a rock revetment and the Irish Sea. To west of the centre of the proposed WwTP is an abandoned tank farm operated by Irish Fertilizer Industry (IFI) (referred to as the Foudi site), and to the west of the northern parts of the site and on the opposite side of Mill Rd are Arklow Marine Services and an abandoned industrial site locally referred to as the Eirgas site.

A marina and residential development are located on North Wall Quay approximately 50m and 110m west of the site respectively. The site is bounded to the north by a patch of waste land and then a sports field. Approximately 400m north-west of the northern most corner of the site is the Bridgewater Shopping Centre (Figure 1).

The site is predominately flat and largely covered with asphalt /concrete or buildings. The ground level generally varies between approximately +1.5mOD to +2.5mOD apart from the area in the northern part of the site where the ground level is up to +3.7mOD.

3.2 Current site use

The site is not currently in use. Buildings on site derelict and in a poor state. The site is currently fenced and kept secure although it has recently been occupied by unauthorised caravans.

3.3 Proposed development

The proposed Arklow WwTP Project comprises the following:

- A new WwTP of 36,000 population equivalent (PE) and associated infrastructure including an inlet pumping station, a storm water storage tank, preliminary and secondary treatment facilities, sludge thickening and dewatering facilities, a pump sump and tank to discharge excess storm water flows as well as site administration facilities and associated landscaping (all located at the site of the Old Wallboard factory at Ferrybank);
- Interceptor sewers along North Quay, South Quay and under the Avoca River (including associated manholes and vent stacks) that would tie in with the existing wastewater network and bring the untreated wastewater to the WwTP;
- A combined sewer overflow (CSO) and storm water storage tank to the west of River Walk on a vacant site locally referred to as ‘the Alps’;
- A short sea outfall pipeline (that terminates at the shoreline) to discharge excess storm water flows to the Irish Sea;

- A long sea outfall pipe (approximately 900m in length) to discharge the treated wastewater effluent to the Irish Sea; and
- An upgrade to the existing revetment on the coastal side of the Wallboard Factory.
- A landscaped area with additional native planting will be provided to the north-west of the WwTP site. Upon commissioning, this landscaped area will be handed over to the Wicklow County Council as a continuation and contribution to the public realm of the area.

This site the subject of this assessment includes the Arklow WwTP and the area of the revetment. The area of the Arklow WwTP project and the Arklow WwTP are shown on Figure 1.

3.4 Site walkover

Arup carried out a site walkover on the 18 October 2017 assisted by Kevin Scanlon of Arklow Town Council and briefly by a member of Arklow Town Council who is on the drainage team and had some useful site knowledge. The aim of the site visit was to:

- Identify potential sources of contamination; and
- Inform the design of a geo-environmental site investigation.

During the site walk over Arup visually inspected the site and collected notes and made a detailed photographic record of the site.

The site visit identified a number of features on the site which are summarised in Table 2 and in Figure 2. Photographs taken during the site visit are presented in Appendix G which show some of the features highlighted.

Before entering the site, the member of the drainage team indicated that the area under the running track 300m north of the site is underlain by a landfill. He had personal experience of laying pipes in the area. He also recollected that prior to the construction of the Wallboard Factory it was possible to find guncotton on the surface of the site.

The site is dominated by the large factory building located in the middle of the site (Photograph G.1). The building comprises a large steel framework shed covered (roof and sides) by sheets. Arklow Town Council confirmed that the building had been surveyed and the sheets on the roof and sides comprise asbestos cement. In the north of the site is a high (>15m chimney indicating that the processes on site used heat and produced gaseous emissions. The building is derelict, some of the sheets are loose and it partly covered by graffiti. The site was recently occupied illegally people living in caravans and was heavily littered with domestic refuse (Photograph G.2). It is also possible that some material was fly tipped.

Table 2 Features identified during site walk over, 18 October 2017

Area number	Feature	Comments
1	Area where ground level has been raised	Very overgrown area with small trees approximately 3m to 4m high. Area is likely to have been used for stockpiles and/or illegal tipping. This corresponds with the area highlighted during one of the interviews as potentially containing phosphogypsum.
2	Pits and trenches	Pits approximately 3m x 4m and 1m to 2m deep are noted on the ground inside the factory building (Photograph G.3). There are also trenches, possible drains, connecting the pits (Photograph G.4). The pits are filled with rubbish and the walls of the pits consists of red brick. These could have been used to convey pipes. No evidence of contamination was seen in the pits.
3	Circular structures on floor and ceiling	There are approximately 5m wide circular structures on the ground and ceiling inside the factory (Photographs G.5 and G.6). These appear to have held a large heavy structure or piece of plant.
4	Pit smelling of oil	A small pit smelling of oil was noted in the north-western corner of the factory.
5	Below ground concrete trench	Below ground concrete trench covered by blocks of concrete were noted on the ground outside the factory building (Photograph G.7 and G.8).
6	Pipe	A heavily corroded above ground pipe was noted on the north-western side of the factory building coming on to site from the Foudi site and traversing the site in the concrete lined trench.
7	Above ground tank	A tank is located on the western side of the factory building (Photograph G.9). A pipe located on the outside of the tank is heavily corroded from a certain height.
8	Office building	Office building which Kevin Scanlon informed us was constructed using comprises asbestos containing material.
9	Area where guncotton was previously found on ground	Area covered by gorse and briers where the member of the Arklow Town Council informed us that guncotton reportedly has been observed on the ground.
10	Boat fuelling station	A boat fuelling station is located along the river southwest of the site.
11	Masterglaze	Building rented out to the windows manufacturer Masterglaze (Photograph G.10).
12	Ramp and hopper	A ramp and broken hopper is located on the southern end of the factory building.
13	Electrical substation	An electrical substation is located in the south-eastern part of the site.
14	Bunded concrete pad	The pad appeared to have held a large above ground tank. Pipes where seen coming out of ground to the north west of the pad. No oils staining was seen. The tank could have stored fuel.
15	Concrete tank supports	Tanks supports suggested that a large (>5m^3) above ground tank had been present. The tank could have stored fuel.

3.5 Surrounding land use

3.5.1 Unregulated landfills and contaminated land

According to information from Wicklow Country Council there was a former town landfill present approximately 300m north of the site under the running track. This landfill closed before 1977 and was unlicensed. The landfill extended from a Shopping Centre (Bridgewater Centre) to the running track that is present to the north of Mill Road. Much of the landfill was removed during the construction of the Bridgewater Centre. However, the area closest to the site, the running track is understood to be still underlain by landfill (Section 2.2.9).

3.5.2 Licensed sites

Based on the EPA web viewer there are no sites which hold an Industrial Emission Licence (IEL) or Integrated Pollution Control (IPC) licence shown within one kilometre of the site (EPA, n.d.).

3.5.3 Wastewater discharges

There are approximately 16 wastewater secondary discharge points along the length of the River Avoca within 2km upstream of the site (EPA Catchments, 2018). These are points are where urban wastewater (sewage) is released into the River Avoca having undergone secondary treatment. The three closest discharge points are identified by the code TPEFF3400D0006SW017. Two of these points are located approx. 0.1km south-west and one point is located 0.1km west of the WwTP site.

The industries listed in Table 3 hold a Section 4 Wastewater Discharge to Waters license (EPA Catchments, 2018). This discharge license is given by local authorities under the Local Government (Water Pollution) acts 1977 to 1990 (EPA, 2011).

Table 3 Industries holding a wastewater discharge license within 2km of the WwTP site.

Industry	Location	Distance to site
Quality Ceramics Arklow	Arklow Harbour, South Quay	80m south.
Gaelcholoiste na Mara	Pearse Park, Arklow	Approx. 1.5km north-west
Roadstone Arklow Quarry	Arklow Rock	Approx. 1.6km south

4 Site history

The site history has been established based on a review of the publicly available data and previous site investigations.

4.1 Historical maps and photographs

The Site history has been prepared based on a review of publicly available historical maps from the Ordnance Survey internet page, the Glucksman Library in Dublin and photographs showing the historical layout of the site. The historical maps are shown in Appendix A and the photographs are presented in Appendix B. A summary of the site history is outlined in Table 4.

These maps have been produced by geo-referencing historical features on the historical maps which are still in the same location today, such as landmark buildings or crossroads. All effort has been made to make the location of these maps as accurate as possible but the position of historical features should be considered indicative.

Table 4: A summary of the relevant information presented on historical maps from 1838-2005.

Date	Land use at the site	Land use in the vicinity of the site	Source
1838	Estuary of the Avoca River and sand. The Avoca River passes through the centre of the site. The south-eastern most part of the site is shown to be in the Irish Sea.	North, West and East: Estuary of the Avoca River. The Avoca River open to the Irish Sea approximately 50m west of the sea. South: Undeveloped land shown as 'sand hills'	Map from OSI Web Viewer (Appendix A)
Unknown	The Avoca River is not shown in the centre of the site and it is shown as undeveloped	North: Undeveloped land. Two probable pond features as shown. One extends onto the north of the site. East: Beach and Irish Sea South: North Quay and South Quay terminating in two piers on either side of Avoca River. West: Undeveloped land, an inlet from the Avoca River which extends onto the west of the site and a ditch which is connected to the inlet under the site and runs due north from the site.	Map from OSI Web Viewer (Appendix A)
1885	Arklow Chemical Works shown in the southern half of the site (including three chimneys, a gasometer and several tanks)	The map extent is limited so does not show all the areas beyond the site. Based on the map the following is noted North: No significant change East: No significant change South: No significant change West: No significant change	Map from Ordnance Survey (From Glucksman Map Library) (Appendix A)
1887	No significant change	North: No significant change East: No significant change South: No significant change West: No significant change	Map from Ordnance Survey (From Glucksman Map Library) (Appendix A)
Around 1880-1890	Building labelled as "Arklow Manure Works" (Arklow Chemical Works). Buildings are shown in the south of the site. A tall tank and high chimney are show in the picture in the south of the site.	Not shown	Arklow Old photos (Public Facebook group) (Appendix B, Plate 1)
Around 1900	The Kynoch Factory. An extensive development is shown comprising numerous buildings on the site and beyond the site boundary. The buildings include numerous small buildings on the site, to the west and to the north of the site which are surrounded by berms/bunds. Two large tanks are shown on a structure which appears to be two storeys high in the located in or to the north of the site.	See 'land use at the site'	Drawing from Imperial Metal Industries (1962) (Appendix B, Plate 2)

1910	Chemical Works comprising numerous buildings located in the south and centre of the site. Several tanks are shown in the south and east of the site. Two chimneys are shown, one south of the centre and one in the south west of the site. A hydraulic press and hydraulic ram are shown in the west of the central part of the site. Several railway tracks are shown across the site including two running north off the site. One track has a siding which ends close to a pond in the north of the site and passes by three buildings labelled as 'magazines' to the east of the north of the site).	North: Magazines in the open ground behind the beach East: Part of the Chemicals works extends beyond the site boundary to the east of the centre of the site. South: The rail track is shown extending from the site across the quay to a pier West: No significant change	Map from OSI Web Viewer (Appendix A)
Around 1890-1920	A significant industrial development is shown probably the Kynoch Factory. The photograph shows the southern side of the site viewed from the south east and shows several high buildings, three chimneys and a structure on a high frame on the quay, possibly a tank. The quay is covered by numerous objects that look like tanks and stockpiles of soil.	Not shown	Arklow Old photos (Public Facebook group) (Appendix B, Plate 3)
Unknown date estimated to between 1910-1951	The site is covered in low lying derelict structures comprising the remains of the old Kynoch Factory. Coastal erosion is noticeable along the east of the site and the sand from the beach appears to extend in the centre of the site. Plate 5 shows small collection of buildings in the south of the site it is unclear if they are part of the former Kynoch Factory or new structures	North: Some structures remain but the areas appears to be derelict and overgrown. East: Coastal erosion defence comprising steaks are visible along the beach South: Wharf on the South Quay West: No change	Arklow Old photos (Public Facebook group) (Appendix B, Plates 4 and 5)
1951	Some small buildings and structures around the site (possibly derelict buildings from the Kynoch Factory) The pond, ditch and inlet are not shown under the site.	North: Scattered buildings, open land East: Beach and Irish Sea South: No significant change West: No significant change	Map from Ordnance Survey (From Glucksman Map Library) (Appendix A)
1995	Several long buildings are shown which fit within the foot print of the site probably belonging to the Plasterboard Factory	North: Sports field (running track) East: The revetment is shown along the eastern edge of the site. South: Several residential houses and industrial buildings on South Quay West: Tank farm is shown in the site adjacent to the south of the site (Foudi site). A large building (Arklow Marine Services) to the west of the centre of the site. Ferrybank road has been built and a second industrial site is shown to the west of the north of the site (Eirgas).	Map from OSI Web Viewer (Appendix A)

2000	No significant change	No significant change	Map from OSI Web Viewer (Appendix A)
2005	No significant change	No significant change	Map from OSI Web Viewer (Appendix A)

4.2 Other sources of published information

Considering its industrial history there are several sources of information on the development of the site and its use as a chemical works. A summary of the relevant is presented below based on a review of this information.

The development and use of the of the area is driven by the Avoca Mines located approximately 10.5km north west and upstream of the site. The Avoca mines have been mined for copper, lead and sulphur for centuries (Hargaden, 2015).

4.2.1 Land reclamation

The Hibernian Mine Company realigned the Avoca River to its current course to facilitate the passage of ships carrying ore (Hargaden, 2015) and built a quay wall along the banks of the river sometime between 1845 and 1885. It is likely that the material used to fill in the course of the old river was taken from the dredging of the new alignment and but potentially could have been sourced from the mine spoil. The ore mined in the Avoca Mines contained (Hargaden 2015i):

- Copper;
- Lead;
- Sulphur
- Pyrite; and
- Iron.

It is possible that the spoil contained small amounts of the above minerals where the rock may not have had sufficient quantities of the above minerals to be used as ore.

4.2.2 Chemical works

Once the land had been reclaimed a chemical factory established on the site (Appendix B, Photograph 1). The chemical factory was set up 1848 by the Wicklow Mining Company as Arklow Chemical Works. Hargaden (2015i) reports that the chemical works developed products which could be derived from pyrites from local mines such as:

- sulphuric acid;
- bleaching powder (a solid combination of chlorine and slaked lime) (Britannica); and
- chemical fertiliser or chemical manure (a precursor to modern nitrate and phosphate based fertilizers) (Britannica).

Arklow Chemical Works comprised coke ovens for making gas, limekilns, pyrite burners, cast iron chambers to make sulphuric acid and equipment to make bleach and manures (Hargaden, 2015).

4.2.3 Kynoch factory

It is understood that an ammunition manufacturer, Kynoch became established on the site in 1895 and purchased the chemical factory which was then not in operation (Cannon, 2006). The Kynoch factory is reported by Imperial Metal Industries, (1962) to have produced:

- dynamite; and
- cordite.

The chemical works was kept in operation to produce the nitric and sulphuric acid (Cannon, 2006), as these were used to produce cordite. The Kynoch Factory extended one and half miles (2.4km) north from the mouth of the Avoca River and included several workshops, explosive drying sheds and magazine sheds (Hargaden, 2015ii). Some of the many buildings belonging to the Kynoch Factory are shown on Drawing 3 in Appendix B.

The Kynoch Explosives Factory operated in the area and supplied ammunition to British forces until shortly after World War I (Cannon, 2006). While in operation several major accidents occurred on the site including explosions, fires and toxic fumes from nitric and sulphuric acid (Cannon, 2006).

After a period of winding down construction during 1918 The sale of the factory was announced in 1919 (Cannon 2006). The reasons appear to be financial or political (Cannon 2005 and Hargaden, 2015ii).

4.2.4 Wallboard factory

The site appeared not to have been bought and was left derelict until the Arklow Gypsum Ltd. Plant established on the site which operated from 1971 to 2002 (Hargaden 2015i). Arklow Gypsum was a subsidiary of NET (Nitrigin Éireann Teoranta), later known as Irish Fertilizer Industry (IFI) (Hargaden 2015i). IFI produced fertilisers, sulphuric acid, bleaching powder in a factory located 2km upstream from Arklow town initially using pyrite from the Avoca Mines (Hargaden 2015i).

One of the by-products of phosphoric acid production in NET was the production of gypsum (phosphogypsum) and Arklow Gypsum was set up to draw use of the gypsum to make plasterboard (Hargaden, 2015). The firm is known locally as the ‘Wallboard Factory’.

4.3 Anecdotal information

Arup met with Michael Fitzgerald, a local resident with considerable amount of local knowledge of the history of the area, on 1 December 2017. Michael stated that gypsum that was used on the site originated from the IFI plant, 2.8km north

west of the site (see Figure 1). While it was operating gypsum was pumped to the Wallboard Factory in pipes. Michael indicated that an area to the north of the factory comprised solid phosphogypsum that had been generated on site. Before the wallboard factory was built, gypsum was deposited in a pond just east of the IFI plant. According to Michael, site investigations carried out at IFI showed that radioactive material was present.

Michael stated that guncotton is present in the ground on the site. He presented some guncotton he had found on the site which he kept in a plastic bag. He explained that the material is highly flammable and sensitive to impact.

A low-lying area in the north-western part of the site seen on historical maps is shown in Figure 10. Michael claimed that this area was used as a 'dump' for various types of materials from the Kynoch factory. A diversion from the train tracks accessing this area can be seen on the historical map from 1910 (Appendix A).

Arup met with a local resident and employee of Arklow Marine Services on 27 November 2017. Similar to Michael Fitzgerald, the local resident stated that guncotton is present everywhere on the site. He also reported that an incident in one of the tanks on the adjacent Foudi site, that allegedly led to a hydrocarbon spillage into the ground. Additionally, whilst operating an explosion took place on the Foudi site in the tank farm which led to the release of airborne contaminants.

5 Site environmental setting

5.1 Site hydrology

The proposed WwTP is located on a site at Ferrybank, Arklow. The site is located on reclaimed land north of North Quay on the Avoca River. The location of the site is shown on the site location plan in Figure 1.

There are no surface water features on the site. The nearest feature is the Avoca River which flows from west to east approx. 15m to the south of the site. The Avoca River is tidal in the vicinity of the site and flows into the Irish Sea approx. 250m to the south-east of the site. The Irish Sea is approx. 20m to the east of the site and separated by a rock covered revetment present along the eastern boundary of the site.

5.2 Regional geology

5.2.1 Regional soils and superficial deposits

Based on the GSI maps base the dominant soil type in the vicinity of the site is shown to be made ground. The soils in the vicinity of the site are presented on Figure 3.

Immediately outside of the made ground areas under Arklow Town the predominant soils types are poorly drained mainly acidic soils derived from Irish Sea Till and alluvium in the vicinity of the Avoca River. Beach sands and gravels are shown along the coast within 1km north of the site (Figure 3) (GSI Groundwater Data Viewer, 2017).

Similar to the soil, the Quaternary deposits information from the GSI Geotechnical Data Viewer for Arklow Dock shows the area of the site to be underlain by made ground. The Quaternary deposits in the vicinity of the site are shown on Figure 4

The predominant Quaternary deposits outside of the area of made ground is Irish Sea Till derived from Lower Palaeozoic sandstones and shales and Alluvium. It is likely that these underlie the made ground.

5.2.2 Regional bedrock

Based on the published maps the site is underlain predominately by the Ordovician Kilmacrea Formation with the exception of the south-east corner which is under lain by the Ordovician Maulin Formation. The regional geology is presented on Figure 5.

The Kilmacrea Formation is described by the GSI as a buff-weathering, grey and black slates and shale with occasional sandstones. The Maulin Foundation is described as dark blue-grey slates and phyllites.

The Kilmacrea Formation dips reported in the vicinity of the site vary from 44º east-north-east to 80º south east. In general, the area is shown to comprise the south-eastern limb of a large anticline with and north east to south west trending axis approximately 3km to the north west of the site.

A fault is shown trending generally SSW-NNE running beneath the south-east section of the site, separating the two formations.

According to the GSI Groundwater Data Viewer (2017), there are no karst features present in close proximity to the site or the surrounding area.

5.3 Regional hydrogeology

5.3.1 Hydrogeological units

The Kilmacrea and Maulin Formations have been designated by the GSI as a Locally Important Aquifer - Bedrock which is moderately productive only in Local Zones (LI). Locally Important aquifers are dominated by poor yielding boreholes with yields less than $40m^3/d$. The aquifer designations in the vicinity of the site are shown on Figure 6

A gravel aquifer which partly under lies the west of site and extends west-north-west away from the site is designated by the GSI as a Local sand and gravel (Lg) aquifer (see Figure 6). This is described by the GSI as an aquifer with a surface area between $1km^2$ and $10km^2$ which may supply excellent yields but due its smaller size the amount of recharge available to meet abstractions can be limited GSI, 2017).

The Kilmacrea and Maulin formations are part of the Ordovician Metasediments within the Wicklow Groundwater Body (GSI, 2003). The GSI describe the Ordovician Metasediments as one of the better aquifers within the groundwater body.

The majority of groundwater flow in the Kilmacrea and Maulin formations will take place mainly in the weathered zone in the upper three meters of the bedrock (GSI, 2003). The GSI state that deeper groundwater flow can take place in isolated fractures. Pumping tests are reported by the GSI for the Maulin Formation and the Kilmacrea Formation which provided transmissivity values of $30m^2/d$ to $32m^2/d$ in these formations.

5.3.2 Recharge

The average rainfall between 1984 and 2016 in the area is approximately 877mm/yr. The average monthly rainfall values for Arklow (Ballyrichard House) for 1984 to 2016 are summarised in Table 5.

Table 5 Average Monthly Rainfall (mm) measured at Arklow (Ballyrichard House), Co. Wicklow (1984 – 2016)

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1984 - 2016	98	72	62	69	63	68	60	80	68	105	104	101

Recharge is the amount of rainfall that replenishes the aquifer. It is a function of the effective rainfall, the permeability and thickness of the subsoil and the aquifer characteristics. The recharge in the area is approximately between 201mm/annum to 250mm/annum (GSI Groundwater Data Viewer). The recharge in the vicinity of the site is presented on Figure 7.

5.3.3 Aquifer vulnerability

Aquifer or groundwater vulnerability is a relative measure of the ease with which the groundwater could be contaminated by human activity and depends on the aquifer's intrinsic geological and hydrogeological characteristics.

The vulnerability is determined by the permeability of any overlying deposits. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability, gravelly overburden.

The groundwater vulnerability under site has been classified is as low. The groundwater vulnerability in the vicinity of the site is shown on Figure 8.

The groundwater vulnerability is relevant to the bedrock LI aquifer. The vulnerability of the Lg (sand and gravel) aquifer is likely to be far higher dependent on the thickness of the soil above the Lg aquifer and the depth to groundwater.

5.3.4 Groundwater hydrochemistry

Groundwater in the Ordovician bedrock of the Wicklow Groundwater Body is generally soft to moderately soft (20–80 mg/l CaCO3) and has low electrical conductivity, ranging from 130 to 220 µS/cm (GSI. 2003).

Within the proximity of the site, the quality of the groundwater in the LI bedrock aquifer and the Lg aquifer are considered to be heavily influenced by the Irish Sea, creating a brackish environment which will not be potable.

According to the Environmental Protection Agency (EPA, 2017), the Wicklow Groundwater Body was classified as having "Good" status in conjunction with the Water Framework Directive (WFD) between 2010 – 2015. The current status is under review but the groundwater body is "at risk of not achieving good status" (WFD Ireland, 2017).

5.3.5 Sensitive features - groundwater abstractions

Based on the records of the GSI nine domestic, agricultural and industrial use groundwater wells are located within 2km of the site. The abstractions identified within 2km of the site are summarised in Table 6 and include 14 boreholes drilled to depths between 5.9mBGL and 53.3mBGL and have yields varying from ($0m^3$/d to $160m^3$/d). The closest to the site is used for domestic use only, however the

location accuracy of this borehole is 1km so the exact location of this borehole is unknown. The closest borehole with a high level of location accuracy is located approx. 850m south-west of the site and is used for industrial use.

The source that the groundwater is abstracted from is not stated but it is likely that it abstracts from the sands and gravels and/or bedrock beneath.

Consultation with Wicklow County Council (WCC) has confirmed that they do not have records of any private groundwater abstractions within the 2km from the site.

Table 6 Summary of groundwater abstractions within 2km of the site.

Abstraction ID	Depth of well (mBGL)	Depth to Bedrock (mBGL)	Location Accuracy (m)	Townland	Use	Yield m^3/d
3217SWW061	23.8	15.2	20	Ticknock	Unknown	22
3217SWW062	9	7.5	20	Abbeylands	Industrial use	60
3217SWW063	7.4	7.4	20	Abbeylands	Other	10
3217SWW064	5.9	3.5	20	Tinahask Upper	Other	12
3217SWW079	17.9	14.8	20	Seabank	Unknown	0
3217SWW098	36.6	27.4	20	Coolboy	Agri & domestic use	43.6
3217SWW043	61	0	100	Kilbride	Domestic use only	22
3217SWW070	6.1	0	100	Rock Big	Unknown	0
3217SWW006	31.7	9.1	1000	Killiniskyduff	Domestic use only	21.8
3217SWW007	27.4	3.1	1000	Tinahask Lower	Domestic use only	22
3217SWW011	25.9	0	1000	Seabank	Domestic use only	33
3217SWW048	48.7	21.3	1000	Arklow	Industrial use	55
3217SWW052	53.3	12	1000	Arklow	Domestic use only	160
3217SWW053	45.7	3.6	1000	Arklow	Domestic use only	55

The GSI and EPA have delineated certain areas nationwide as Source Protection Areas (SPAs) in order to provide protection for groundwater abstractions, and public water supplies. There are no SPAs located beneath the site or within 2 km south of the site boundary (Figure 8**)**.

In addition, there are no National Federation Group Water Schemes Zones of Influence within 2km of the site.

5.3.6 Sensitive features - groundwater dependent terrestrial ecosystems

The National Parks and Wildlife Service online database was consulted to establish whether areas with national or international important ecological sites

are located within the vicinity of the study area. The locations of the features highlighted are presented in Figure 8.

There are no Special Areas of Conservation, Special Protection Areas or National Heritage Areas with 2km of the site. There are two proposed National Heritage Sites within 2km of the site. These are the Arklow Sand Dunes (Ref: 001746) located 1.9km to the north of the site and the Arklow Town Marsh (Ref: 001931) located 0.9km to the north west of the site.

The Arklow Town Marsh is a wetland area located north of the Avoca estuary (NPWS, 2009a), approximately 0.9km north-west of the site. The wetland comprises a groundwater dependent terrestrial ecosystem.

The Arklow Sand Dunes are a dune system connected to wet woodland (NPWS, 2009b) located along the coast. Whilst the sand dunes are not water dependant, the wet woodland are likely to be groundwater dependent terrestrial ecosystem.

5.4 Site geology and hydrogeology

A ground investigation was undertaken on the site in 2006. This has been used to prepare the following review the site geology and hydrogeology. A summary of the geo-environmental results of the assessment are presented in the proceeding section (Section 0).

5.4.1 Site geology

According to the RPS (2006) report, the ground conditions are made ground underlain by sand and gravel. The RPS report included both the WwTP and the Eirgas site. The made ground across the two sites was described as "clay, sand, gravel, plastic, glass, brick and wood".

Results of site investigation reported by RPS (2005 and 2006) are summarised in Table 7 below.

Table 7 Summary of site investigation results (RPS 2006)

Geology	Depth (mBGL)	Thickness (m)
Made ground (clay, sand, gravel, plastic, glass, brick, wood)	0.9 – 4.2	0 – 4.2
Sand (medium dense to dense silty, gravelly sand)	0 – 20	0 – 20
Gravel (medium dense silty, sandy gravel)	2.5 - 26	
Clay/ Silt (stiff to very stiff grey, sandy, gravelly, clay/silt)	9.7 - 30	
Bedrock (slightly to moderately weathered, strong grey fine grained Meta-Greywacke)	21 – Unknown (base unproven)	Unknown

5.4.2 Site hydrogeology

It is stated in the RPS report that "*12 boreholes were drilled across the site (GW1 to 6 and MW1 to 6).*" and … "*groundwater monitoring wells were installed in the made ground material and sands and gravels*"

Groundwater levels for the made ground or sand/gravel beneath the WwTP site were reported by RPS (2005) to vary between 1.6mBGL (0.18mOD) and 2.6mBGL (-0.07). Based on the RPS report the groundwater beneath the site is considered to be tidal and a variation of 0.3m was recorded between monitoring visits. RPS report that groundwater under the site flows generally to the south east and discharges to the Irish Sea.

Based on the results of the ground investigation carried out for RPS the groundwater in the made ground and sand and gravel is likely to be in continuity with the Avoca River and the Irish Sea.

6 Previous geoenvironmental sampling and monitoring

Four study reports relevant to the site have been reviewed to inform this assessment:

- RPS Geotechnical Interpretative Report (2006) and RPS Environmental Impact Statement (2005)
- Tobin Environmental (2005)
- Radiological Protection Institute of Ireland (RPII) (1992)

A summary of the investigations and the key findings of the reports is presented below.

6.1 RPS (2005 and 2006)

6.1.1 Scope of investigation

A site investigation was carried out between May 2005 and August 2005 by IGSL for RPS, on behalf of Mountford Pigott Partnership at the site and on the adjacent Eirgas site. The site work included a geo-environmental and geotechnical investigation for a proposed residential development. The site work included:

- 21 trial pits ranging from 0.9mbgl to 4.0mbgl;
- Eight cable percussive boreholes drilled to depths ranging between 19mbgl to 20.36mbgl and terminated in estuarine deposits;
- Four rotary core boreholes drilled to depths ranging between 23mbgl to 30mbgl. Bedrock was proven in two boreholes;
- 49 dynamic probes refused between depths ranging between 1.0mbgl to 8.3mbgl;
- Two slit trenches;
- Groundwater monitoring;
- Ground gas monitoring
- In-situ soil testing;
- 64 soil sample for environmental analysis. These were collected at approx. 0.5mbgl and approx. 1.5mbgl and at any areas of visible contamination.

Samples were submitted to a UKAS accredited laboratory (Alcontrol Geochem, Dublin) for:

  - Heavy metals
  - Hydrocarbons
  - Asbestos
  - pH analysis

The copies of the logs from the trial pits excavated on site are presented in Appendix C, together with a borehole location plan. No other logs were available for review.

6.1.2 Soil chemical tests

The strategy for locating the ground investigation boreholes and trial pits is not clear in the RPS report. The RPS (2005) report determined the following soil results:

- Benzo(a)pyrene ranged in concentration from 2.7mg/kg to 4.7mg/kg across the site and at depths ranging from 0.6mbgl to 2.7mbgl;
- Total PAH's ranged in concentration from 46.0mg/kg to 55.3mg/kg at 1.6mbgl in two locations in the south of the WwTP;
- Asbestos sheets are reported to have been observed in the north of the WwTP site; and
- Elevated levels of heavy metals including arsenic (63mg/kg to 463mg/kg), and lead (534mg/kg to 15030mg/kg) were present in the made ground across the WwTP site.

RPS show that the western half of the Eirgrid site is underlain by domestic waste. In two areas, located in the north and south of the Eirgrid site hydrocarbon odours or oily contamination is reported. Heavy metals including arsenic, lead and nickel are also reported to be elevated in the made ground in the Eirgrid site. A copy of the summary plan showing the contamination noted by RPS is presented in Appendix C.

6.1.3 Groundwater monitoring

Groundwater samples were taken from a number of boreholes across the proposed WwTP site and the Eirgas site. Within the proposed WwTP site two boreholes were sampled one in the southern section of the site and a second borehole within the centre of the site. In the RPS report the results were compared to the EPA Interim Guideline Value (IGV's) which have now been superseded.

In summary the exceedances of the IGV's for sulphate, boron, cadmium, copper, lead, nickel and zinc were noted on the site of the proposed WwTP. Exceedances of the IGV's were noted for copper, boron, arsenic, ammoniacal nitrogen and sulphate beneath the Eirgas site. The Eirgas site is shown in the RPS report to be up hydraulic gradient of the proposed WwTP.

6.1.4 Ground gas monitoring

Results of the ground gas monitoring for both the Eirgas and proposed WwTP site are reported by RPS (2005). The results show low borehole gas flow levels (<0.2L/hour), methane concentrations below 0.1% and carbon dioxide, less than 6.3%. This suggests that significant quantities of gas are not being generated below either site.

The concentrations recorded are low for gas recorded from an area of landfill. It is possible that either the waste contained very low levels of putrescible matter or that the borehole response zones were below the ground water level.

6.2 Tobin (Nov 2005)

BRG Ltd were contracted by Tobin Consulting Engineers to undertake site investigation on the Foudi site immediately west of the WwTP. Tobin were commissioned by a property developer (Foudi Limited) to gather geological and soil chemistry information to investigate the extent of ground contamination on the site. Tobin assessed the suitability of the site to be developed for a residential use.

This site was reported to be previously owned by the Irish Fertilizer Industries (IFI) a tank farm storing sodium hydroxide, nitric acid, heavy fuel and solid fuel. A re-fuelling sock and fuelling point were also present on this site. At the time of the preparing Tobin report (2005), the nitric acid tank had not been used for approximately 12 years and remaining tanks were out of operation for approximately 22 years. All tanks were empty but had not been cleaned out. Additionally, several pumping stations with above and below ground pipelines are present in this site. In the Tobin report it is stated that it is possible asbestos may have been used in the insulation material surrounding these pipes. The report states that asbestos was found in building roofs and floors on this site.

Tobin reported no visual evidence that the integrity of the tanks had been compromised such as leakage of material to ground.

Site investigation took place on the 14th and 15th October 2005 and included 10 window sample holes drilled to depths ranging from 2.0mbgl to 3.0mbgl. Made ground varied in thickness from 0.2m to 1.8m and generally consisted brown to orange brown sandy to gravelly material with “red bricks, glass and coal slag”. This material is considered by Tobin to be the infill material used to reclaim the land during construction of Arklow Harbour.

Natural fluvial subsoil was present underneath infill material and comprised of fluvial or marine, loose to medium dense, sand and gravel with occasional lenses of sandy clay.

Several soil samples were collected between 0.5mbgl and 1.5mbgl and tested for the following parameters:

- Diesel range organics, mineral oil, petrol range organics and BTEX compounds;
- pH, alkalinity and sodium;
- Polychlorinated biphenyls;
- Polycyclic aromatic hydrocarbons (PAH);
- Heavy metals

It is stated in the report that the results of this analysis determined that the site is not contaminated from the storage of acid and fuel on this site. However, the made ground (infill material) contains elevated concentrations of heavy metals i.e. copper, zinc, lead and arsenic and PAHs. There is limited potential for mobility of these compounds and may move toward the Irish Sea (Tobin, 2005).

6.3 Phosphogypsum ponds investigation (1992)

In 1992 the Radiological Protection Institute of Ireland (RPII) carried out a radiological investigation on behalf of IFI focusing on two phosphogypsum disposal sites located approximately 2.5km north west of the site. The report was reviewed as it is likely that the phosphogypsum comprises the same type of material that was handled on site and was indicated to be present in the north of the site. A copy of the site investigation is presented in Appendix E.

An investigation was carried out in July 1992 during which 5 boreholes were drilled to 4mbgl. The soils proven are recorded as gypsum, carbon black, shale or sediment. The radiation dose measured at the surface was 0.15µSv/h which is reported to be typical for that area.

A total of 23 samples were collected from various depths and analysed for radium-226 (^{226}Ra), lead-214 (^{214}U), bismuth-214 (^{214}Bi) and lead-210 (^{210}Pb) using high resolution gamma spectrometers. The results of the analysis show that the radioactive concentration in the samples ranges between less than 1000 Bq/kg. The highest radioactive concentration is approximately 20 times higher than in surrounding local soils.

The report concluded that the risks at the surface were no greater than the background readings, however if the soils are disturbed there could be a potential hazard and recommended not disturbing the soil.

7 Preliminary conceptual site model

A preliminary geo-environmental conceptual site model (CSM) has been derived based on the information reviewed. The preliminary CSM consists of three key parts sources, pathways and receptors. These are described in detail below. Where a potential for all three exists together then a source-pathway-receptor (SPR) linkage is highlighted in Table 9 below.

7.1 Potential sources

Based on the review of the available information, a number of processes have taken place on site which could be potential source for contamination. A summary of the potential contaminants present presented below.

7.1.1 Made ground and fill material

The materials used to infill the Avoca River to reclaim the site from the sea are likely to comprise local soils that were available. It is likely that a large volume of this fill material was derived from the excavation of the new route of the Avoca River and will comprise natural soils. However, it is very probable that there was a shortfall in soils as the area of fill was greater that the area of cut.

Considering that the works were funded by the mine company it is very likely that the waste soil and rock from the mine was used. Based on the mineral mined and the results of the previous ground investigation. The principal contaminants are likely to be metals including copper, lead and sulphur.

Following the operation of the Kynoch factory two ponds partly on the site were infilled. Dependant on the fill materials and the organic content of sediments in the pond before they were filled, they could present a source of ground gas.

7.1.2 Cordite

Cordite comprises a mixture of nitro-glycerine (NG) and nitrocellulose (NC) (also referred to as guncotton) (Edkins 2006). The raw materials in producing cordite (Edkins, 2006) include:

- cotton;
- sulphuric acid;
- nitric acid;
- glycerine;
- sodium carbonate,
- acetone,
- petroleum jelly; and
- graphite.

Once the cordite is produced it is dried in storing houses equipped with extraction system to remove acetone and then in drying houses to remove remaining moisture before it is moved for storage in magazines (Edkins, 2006).

Based on the DoE Industry Profile wastes were usually disposed of on-site. NC is also stored under water as it is safer (DoE, 1995), hence it is likely that waste was dumped in the open ponds.

It is also reported that, at munition factories waste was also burned in open areas (DoE, 1995) by ignition with liquid paraffin. Considering the position of the Kynoch buildings relative to the site boundary this is unlikely to have occurred with the site boundary. Testing of the finished product was also likely to have been carried out on site. This is likely to have occurred at a safe distance from the buildings and away from the site.

In addition to NC and NG waste acids would have been disposed of (DoE, 1995). These could have been discharged in the Avoca River and/or spilt and allowed to drain to ground.

NC is reported to be especially persistent and resistant to degradation. NG is reported to be slightly soluble and is toxic in the aquatic environment (DoE, 1995).

Cordite would have been stored onsite in magazines prior to shipment offsite (DoE, 1995). One of these is shown in the north of the WwTP.

Cordite or its constituents are likely to be present though out the site in the superficial layers of made ground which comprised the ground level prior to the demolition of the Kynoch factory buildings. Also it is likely to be present in deeper areas fill such where previous water features have been infilled.

7.1.3 Phosphogypsum

Gypsum can be generated as a by-product of phosphate production process (IAEA, 2013), such as occurred at the IFI plant (RPII (1992) Appendix E). This by-product is referred to as phosphogypsum. The source rock (calcium phosphate) can contain naturally occurring radioactive material (NORM) associated with ^{238}U and ^{232}Th and their daughter products which can become concentrated in the phosphogypsum (IAEA, 2013). In addition, phosphogypsum can contain fluorides and heavy metals (arsenic, cadmium, lead and mercury) (IAEA, 2013).

The production of phosphogypsum worldwide is relatively common and as of 2013 the annual production rate was 160 million tonnes/annum (IAEA, 2013). While it presents a potential risk to human health and the environment, it is stated by the IEAE that "*Best practices established for the management of non-radiological risks to humans and to the environment have generally proven to be effective in minimizing any risks arising from the residual radioactivity content*."

Phosphogypsum is reported to have been transported to the site in pipes in liquid form. It is likely that is was then dried on site to produce a solid. The chimney could be the flue from the drying process and exhaust fumes from the plant.

Liquid phosphogypsum was probably handled in the north of the site around the chimney and where the pipes where seen. They may have been handled in the pits which were observed inside the north of the factory. The solid phosphogypsum could have potentially been handled or stored anywhere on the site.

Based on the review of the historical maps there are no areas of void for filling. The solid phosphogypsum is only likely to be present on the surface. Liquid phosphogypsum could have escaped from the pipes in the north of the site.

7.1.4 Others

During the site visit serval above ground oil storage tanks and an electrical substation were noted. It is possible that these stored hydrocarbons were used as a fuel source by the Wallboard factory. These could have escaped to ground and be a potential source of contamination

The Wallboard building was confirmed by Arklow Town Council to have been constructed using asbestos. There is a possibility that reject asbestos containing materials have been deposited on the site during the construction. This was observed by RPS in the north of the site.

Landfill waste is present in an adjacent site and could be a source of ground gas on the WwTP site.

Based on the review of the historical maps there is a potential for a gas works to be located in the south of the site, operated as part of Arklow Chemical Works. This could be a source of various contaminants.

7.1.5 Summary

Based on the information reviewed above and the other potential sources of contamination which could be present, a table has been prepared listing the likely contaminants which may be present. This information is supplemented with information from the Contaminated Land Research Report 8 (CLR8) (Department for Environment, Food and rural Affairs and The Environment Agency, 2002). Additional information was taken from the Industry profile, "Chemical Works - explosives, propellants and pyrotechnics manufacturing works" published by the DOE (Department of the Environment Industry Profile, 1995).

The chemicals listed in Table 8 are all recognised as chemicals which would pose a risk to human health and/or the environment.

Table 8 Chemicals/contaminants of potential concern

Activity/feature	Industry category as specified in CLR8	Potential chemicals of concern
Uncontrolled fill of Avoca River and reclamation of the site and adjacent area	-	Metals including copper and lead and sulphur
Landfill (300m to the north of the site and in areas of uncontrolled fill on the site)	*"Waste recycling, treatment and disposal sites: landfills and other*	Organics (e.g. PAHs, phenols) Inorganics (e.g. cyanides, sulphates) Metals (e.g. lead, cadmium, zinc)

	waste treatment or waste disposal sites"	Ground gas (methane and carbon dioxide)
Chemical works (production including nitric and sulphuric acid, acetone, bleaching powder and fertilisers)	*"Chemical works: fertiliser manufacturing works"*	Nitric and sulphuric acids Alkalis (ammonium hydroxide) Metals and their compounds (e.g. potassium chloride, potassium sulphate) Ammonium salts Phosphates Organic chemicals (amine absorbents with trace heavy metal contamination, PAHs from coal tar residues)
Gasworks (part of Arklow Chemical Works)	*"Gas works, coke works and other coal carbonisation plants"*	Organics (constituents of coal tar, oil/fuel hydrocarbons) Inorganics (e.g. sulphuric acid, sulphates, cyanides) Metals and metal compounds Asbestos
Explosives factory (including storage magazines, tanks and other parts of the explosives factory)	*"Chemical works: Explosives, propellant and pyrotechnics manufacturing works"*	Nitric and sulphuric acids Organic solvents (e.g. acetone) Organic compounds (e.g. hexamine, toluene or glycerine) Fuels (liquid hydrocarbons) Inorganic compounds (e.g. ammonium nitrate, sodium nitrate) Explosives (nitro-glycerine and nitrocellulose) Metals (lead, copper)
Plaster board factory handling phosphogypsum	-	^{238}U, ^{232}Th and their daughter products Heavy metals (arsenic, cadmium, lead and mercury) Asbestos containing material
Electrical substation	-	Polychlorinated biphenyls (PCBs)

7.2 Potential pathways

The principal pathways are:

- direct exposure of contamination in the made ground (ingestion, inhalation and dermal contact);
- percolation of recharge through the unsaturated made ground to the groundwater;
- percolation of liquid contaminants through the made ground;
- movement of groundwater in the made ground (below the water table) into the sand and gravel;
- groundwater movement though the made ground and sand and gravel; and

- movement of ground gas though the unsaturated made ground and sand and gravel.

7.3 Potential receptors

The principal receptors are:

- demolition and construction workers;
- site users (current and future Irish Water site operators);
- proposed buildings associated with the WwTP;
- groundwater in the sand and gravel;
- groundwater in the locally important bedrock aquifer;
- Avoca River; and
- Irish Sea.

7.4 Source-pathway-receptor linkages

Considering the CSM outlined above and presented in Figure 11, the following plausible SPR linkages are highlighted for the current and proposed development of the site.

Table 9: Identified source-pathway-receptor linkages

Source	Pathway	Receptor
Made ground contamination - historic channel infill of Avoca River and land reclaimed from the sea, above ground storage tanks and infilled ponds.	Direct contact (ingestion, inhalation and dermal contact)	Demolition and construction workers, Irish Water site operators and current site users
	Migration of ground gas though the permeable unsaturated zone	Current buildings, demolition and construction workers and the proposed WwTP
	Percolation of dissolved phase or liquid contaminants	Groundwater in the sand and gravel
	Groundwater in the sand and gravel	Avoca River and Irish Sea
Phosphogypsum (solid stored above ground and escaped from buried pipes)	Direct contact (ingestion, inhalation and dermal contact)	Demolition and construction workers, Irish Water site operators and current site users
	Percolation of dissolved phase or liquid contaminants	Groundwater in the sand and gravel
	Groundwater in the sand and gravel	Avoca River and Irish Sea
Electrical substation and above ground oil storage tanks	Percolation of dissolved phase or liquid contaminants	Groundwater in the sand and gravel
	Groundwater in the sand and gravel	Avoca River and Irish Sea

Shallow surface contamination of made ground with cordite	Direct contact (ingestion, inhalation and dermal contact)	Demolition and construction workers, Irish Water site operators and current site users
Adjacent landfill (ground gases)	Diffusion through the subsurface permeable made ground to the surface	Site buildings and demolition and construction workers

Based on the results of this PSA there is not considered to be a risk to the locally important bedrock aquifer as the clay above it is likely to act as an aquitard.

8 Summary, conclusions and recommendations

8.1 Summary and conclusions

A desk based study and site visit were undertaken to investigate potential contamination at the site of the proposed WwTP in Arklow. Initial desk based investigations and site walkover highlighted potentially contaminated areas shown in Figure 10.

The site is underlain by a substantial thickness of made ground which was placed to reclaim the land from the Avoca River and the Irish Sea between 1845 and 1885, during the re-routing of the outfall of the Avoca River. The site was then used as a chemicals factory, munitions factory and finally a gypsum plasterboard factory.

Data from previous site investigations suggest that the made ground is contaminated with heavy metals, hydrocarbons and asbestos and contaminants have migrated into groundwater. The nature of the groundwater interaction with the Irish Sea and the extent of the tidal effects on the groundwater are uncertain. Also, the contaminant impact on the Avoca River and Irish Sea have not been assessed previously.

The desk study has highlighted that the site of the proposed WwTP was used to manufacture Cordite, (an explosive) and handled phosphogypsum a material naturally enriched radioactive elements. The extent of the contamination by these two has not been assessed previously.

The surrounding area also has a history of industrial use and part of the area was used as a landfill. The potential contaminant source areas are all up hydraulic gradient of the proposed WwTP. Consequently, there is the potential for the groundwater quality under the site to be affected by contamination from up hydraulic gradient of the site. In addition, the area of landfill could be a potential source of ground gas. Based on limited monitoring data, the ground gas flows and concentrations are low. However, the response zones of the boreholes are unknown hence the validity of the monitoring is uncertain.

The conceptual site model developed based on the data review and walkover has identified potential pollutant linkages that require further assessment.

8.2 Recommended way forward

The actions described below are recommended to address data gaps, to improve site characterisation and to inform further risk assessment.

Site investigation:

- A non-intrusive investigation of the site to assess radiological contamination that may be present at surface associated with

phosphogypsum, followed by radiological monitoring where intrusive investigation penetrates phosphogypsum material;

- Targeted geo-environmental site investigation to assess impacts of the previous site use on the soils at the site and to confirm the results of the previous site investigation. This should be carried out using trial pits for shallow made ground and boreholes where the made ground is deeper;
- Install monitoring wells in boreholes along the north and west perimeter of the site to determine if any contamination from neighbouring sites is migrating under the site of the WwTP.

Sampling and laboratory testing and monitoring:

- Gather soil samples at various depths from trial pits and boreholes. Test for contamination including heavy metals, hydrocarbons, asbestos, explosives (nitrocellulose & nitroglycerine) and radioactivity (phosphogypsum soils only);
- Carry out groundwater and surface water quality monitoring across the site over a several months to account for seasonal variation and test for comparable determinands to the soil samples;
- Monitor groundwater, and sea levels using dataloggers to determine the effect of tidal variation on the groundwater levels and impact on surface water around the proposed WwTP;
- Monitor ground gas in selected monitoring wells to assess potential sources areas (landfill, thick made ground, ponds) and in proposed building footprints; and
- Once all information from site investigation is available complete a detailed site assessment and compare the results with the design of the WwTP to assess the impact on the proposed development and where necessary develop a remediation strategy.

Table 10 Summary of proposed site investigation

Investigation method	**Purpose**	**Historic Contamination**
Non-intrusive survey of the site for radioactivity	• To confirm the presence and location of any stockpiles of phosphogypsum or areas effected by radioactivity.	Phosphogypsum
Trial pits (TP)	• To assess the impact of the previous site uses on the soils at the site; • To sample any soils highlighted to have elevated radioactivity; • To confirm the presence and location of explosive materials in the subsurface; and • to confirm the results of the previous site investigation. The trial pit locations should be targeted based on the previous site uses and the features highlighted during the site walkover. These	Heavy metals, hydrocarbons, asbestos, radionuclides, explosives and sulphate, chloride

Investigation method	Purpose	Historic Contamination
	features include infilled ponds, the potential stockpile of phosphogypsum, the locations of tanks on the wall board site and the historic location of tanks on the Kynoch Factory. Trial pits will be logged to record the presence of made ground and samples shall be collected to confirm the nature of any contamination observed. Monitoring of radioactivity shall be carried out during the excavation of the trial pits in any phosphogypsum.	
Ground gas monitoring wells (LFG)	• To determine if any ground gas from neighbouring sites or the infilled pond is migrating under the site of the WwTP	Ground gas (methane and carbon dioxide)
Groundwater monitoring wells (GW)	• To confirm the depth and composition of the deeper area of made ground; • To assess impacts of the previous site use on the soils and groundwater at the site; • To assess the impact of up-hydraulic gradient contamination; • To ascertain the quality of the water migrating offsite; • To determine the tidal effect on groundwater level and flow under the site. • To confirm the results of the previous site investigation. The groundwater monitoring borehole locations should be targeted based on the previous site use and the likely direction of groundwater flow. Boreholes should be installed up-hydraulic gradient and down-hydraulic gradient to assess the impact of the up-hydraulic gradient contamination and the impact of the site on groundwater quality migrating beyond the site boundary.	Heavy metals, hydrocarbons, asbestos, radionuclides, explosives and sulphate, chloride
Surface water samples (SW)	• To determine the impact of the site on surface water around the proposed WwTP. The surface water samples shall be collected at high and low tide to determine if there is a difference in the impact during the tidal cycle. The samples shall be evenly spaced round the site so that samples are collected from the Avoca River and the Irish Sea.	Heavy metals, hydrocarbons, asbestos, radionuclides, explosives and sulphate, chloride

A plan showing the proposed site investigation locations is presented in Figure 12.

9 References

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A3

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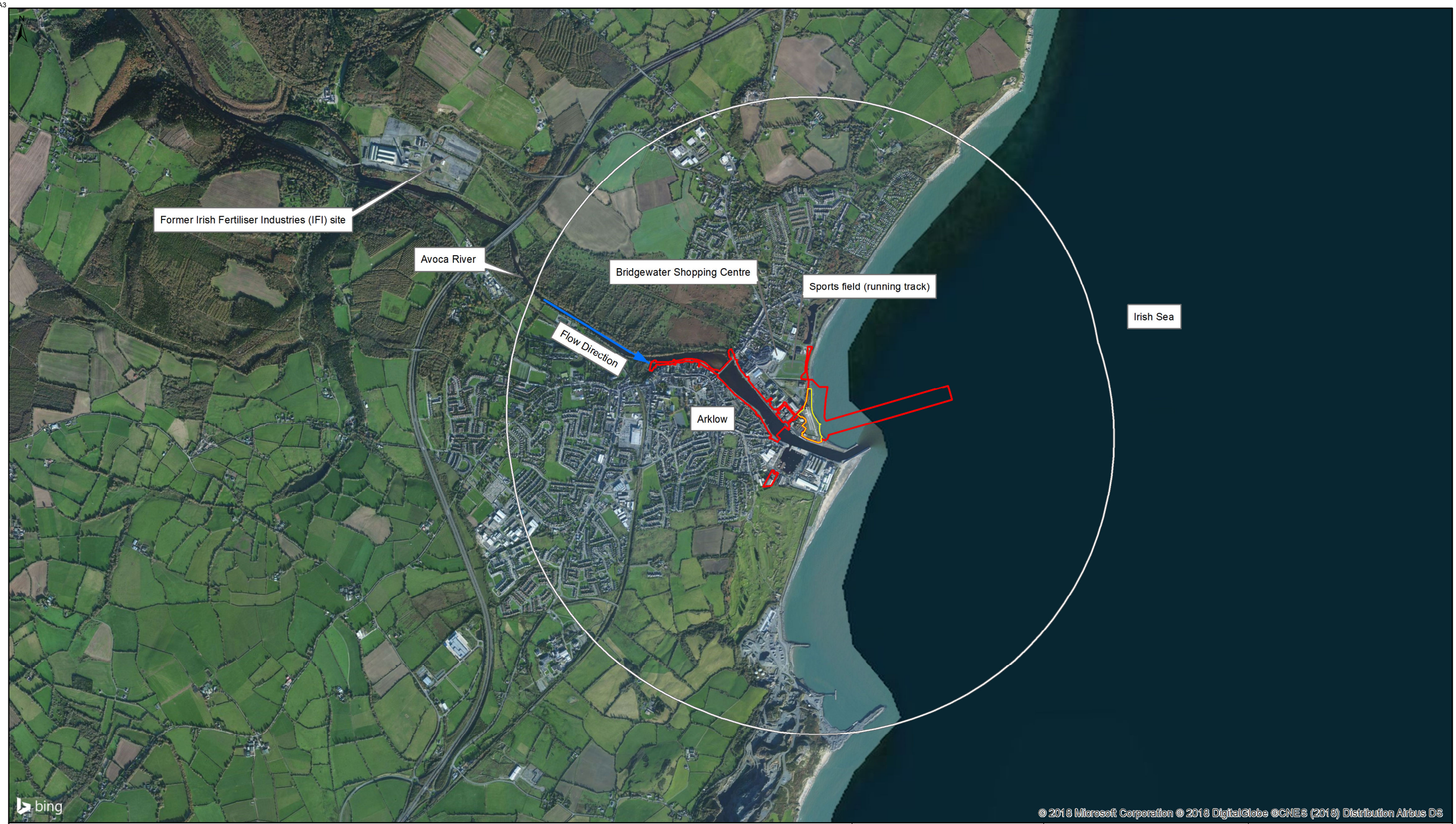

Legend

- Generalised Groundwater Flow Direction
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer

Kilometers
0 0.25 0.5 1

Issue	Date	By	Chkd	Appd
D1	2017-12-19	LM	CN	EW

ARUP
50 Ringsend Road
Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Client
Irish Water

Job Title
Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project

Site location

Scale at A3
1:25,000

Job No
247825-00

Drawing Status
Draft

Drawing No
001

Issue
D1

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 1 Site location.mxd

A3

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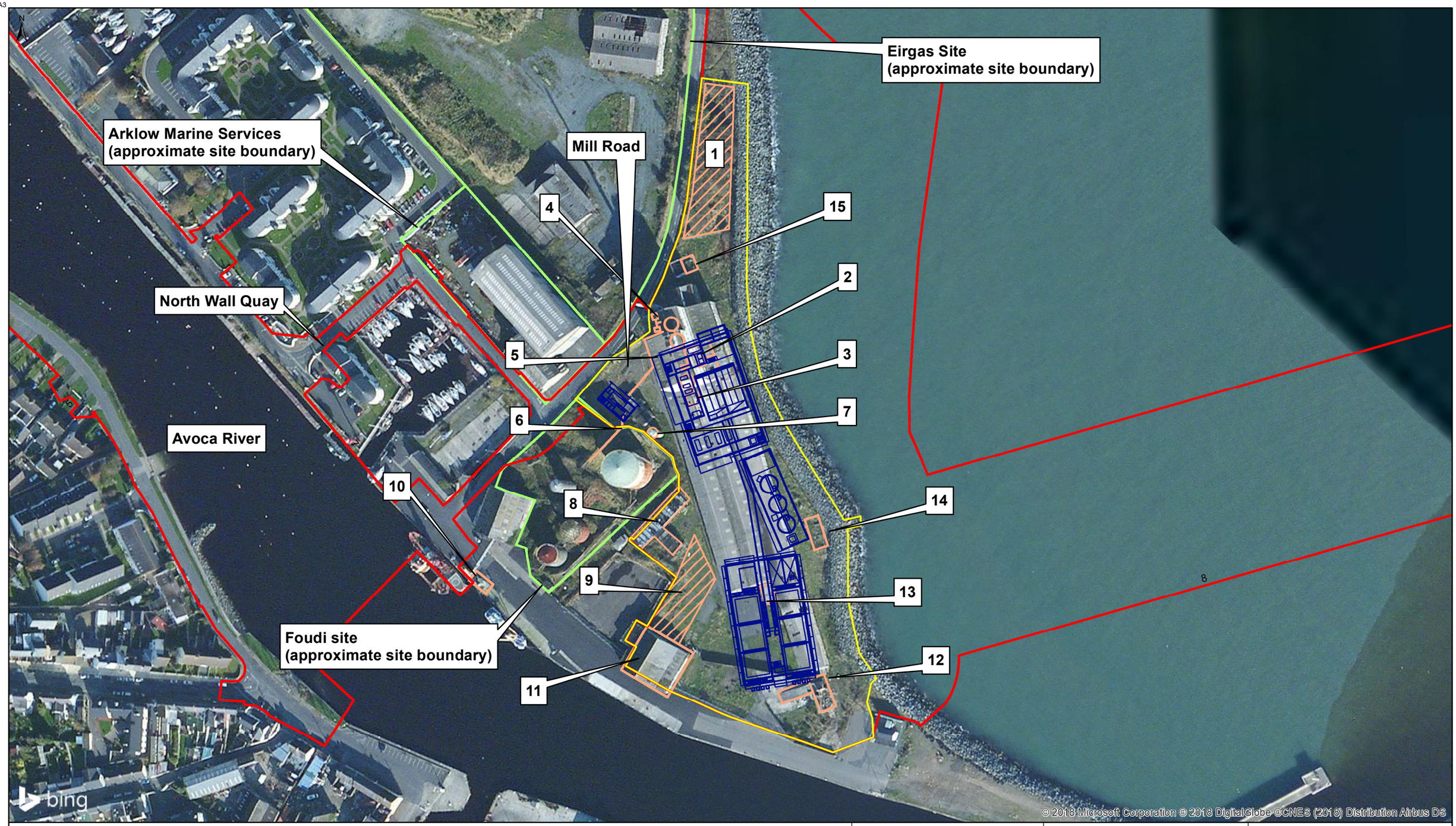

Legend

Arklow WwTP Site Plan

Proposed Buildings

Layer

WwTP Site Boundary

Arklow Scheme boundary_20-07-2018.dwg Polyline

Layer

Proposed Development Planning Boundary *Proposed Development Planning Boundary*

External Sites of Interest

1. Area where ground level has been raised
2. Pits and trenches connecting pits
3. Circular structures seen on floor and ceiling
4. Pit smelling of oil
5. Concrete trench below ground
6. Pipe above ground
7. Above ground tank
8. Office reported to have been constructed using asbestos containing material
9. Area where gun cotton was found on ground
10. Boat fuelling station
11. Masterglaze
12. Ramp and broken hopper
13. Electrical substation
14. Concrete pad and bund used for an above ground tank
15. Above ground tank supports

Meters

0 25 50 100

Issue	Date	By	Chkd	Appd
D1	2018-06-08	JF	CN	EW

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50 Ringsend Road
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Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Features identified during site visit on the 18th of October 2017

Client
Irish Water

Job Title
Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project

Scale at A3
1:2,000

Job No
247825-11

Drawing Status
Draft

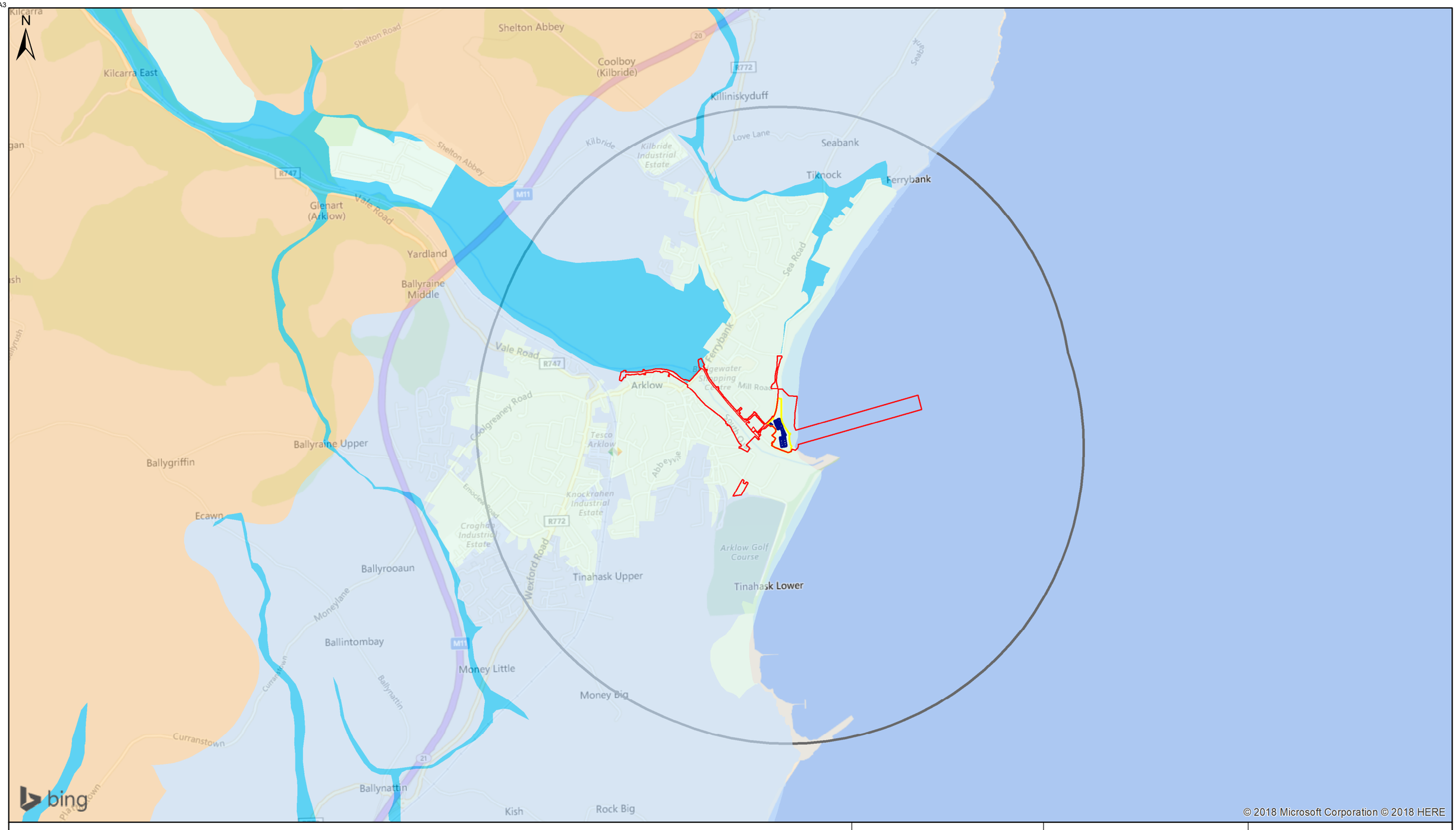
Drawing No
002

Issue
D1

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 2 Site walkover.mxd

A3

30/08/2018 16:53:04



Legend

- Proposed Buildings
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
I1	2018-06-08	JF	CN	EW

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www.arup.com

Client: **Irish Water**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Soils in the vicinity of the site

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **003**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 3 Soils.mxd

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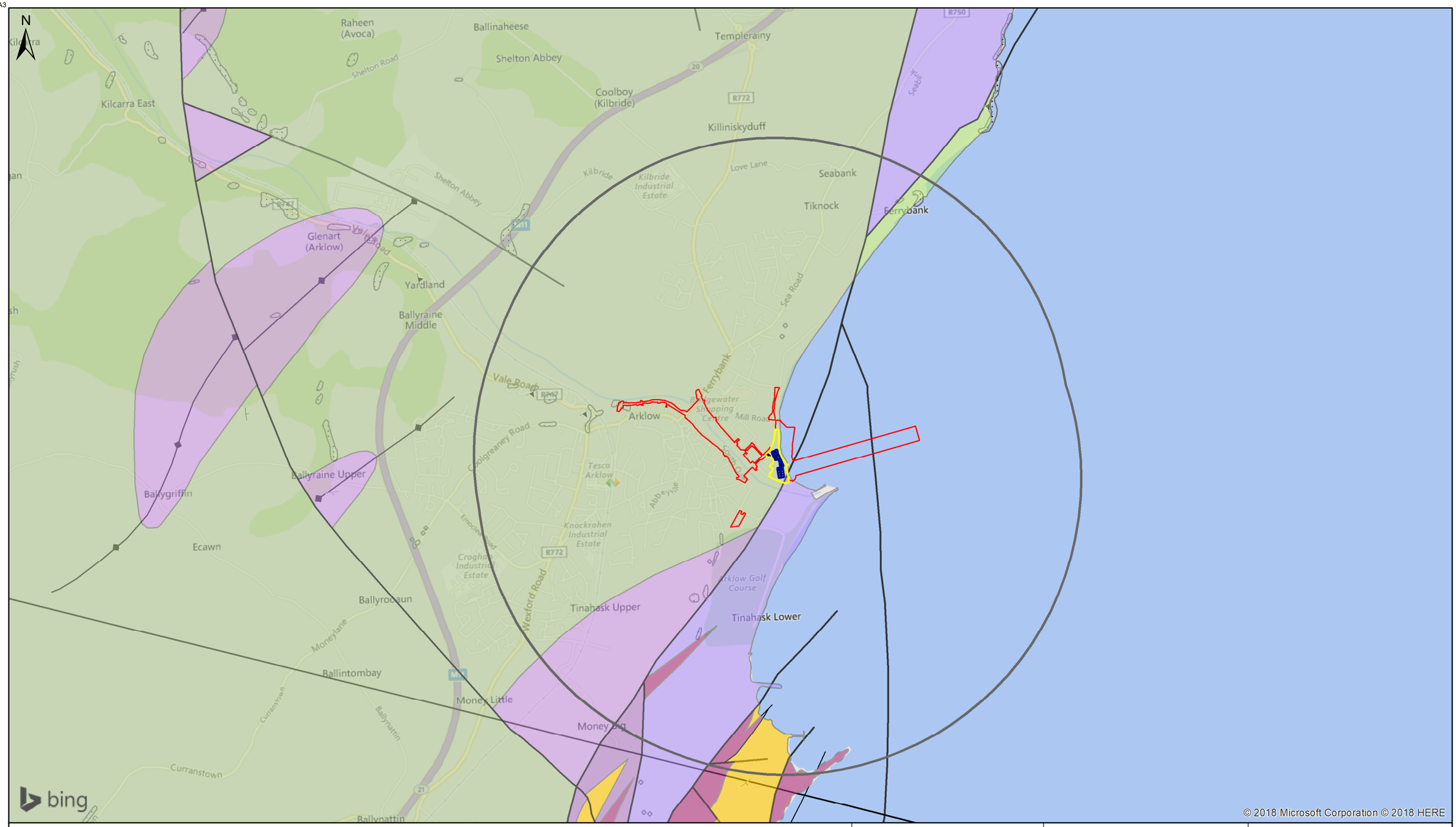

Legend

- Proposed Development Planning Boundary
- Proposed Buildings
- WwTP Site Boundary
- Arklow WwTP Site 2km Buffer
- Dolerite (Slieve Gullion Complex)
- Ballylane Shale Formation
- Oaklands Formation
- Arklow Head Formation
- Felsic volcanics (Arklow Head Formation)
- Kilmacrea Formation
- Maulin Formation
- Bedrock_Outcrop_2016
- First foliation parallel to bedding
- Strike and dip of bedding, way up unknown
- Strike and dip of first foliation
- Strike and dip of overturned bedding
- Anticlinal Axis
- Fault
- Lithological boundary offshore
- X-Section

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
D1	2018-06-08	JF	CN	EW

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50 Ringsend Road
Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
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Regional geology in the vicinity of the site

Client: **Irish Water**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **005**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 4 Geology.mxd

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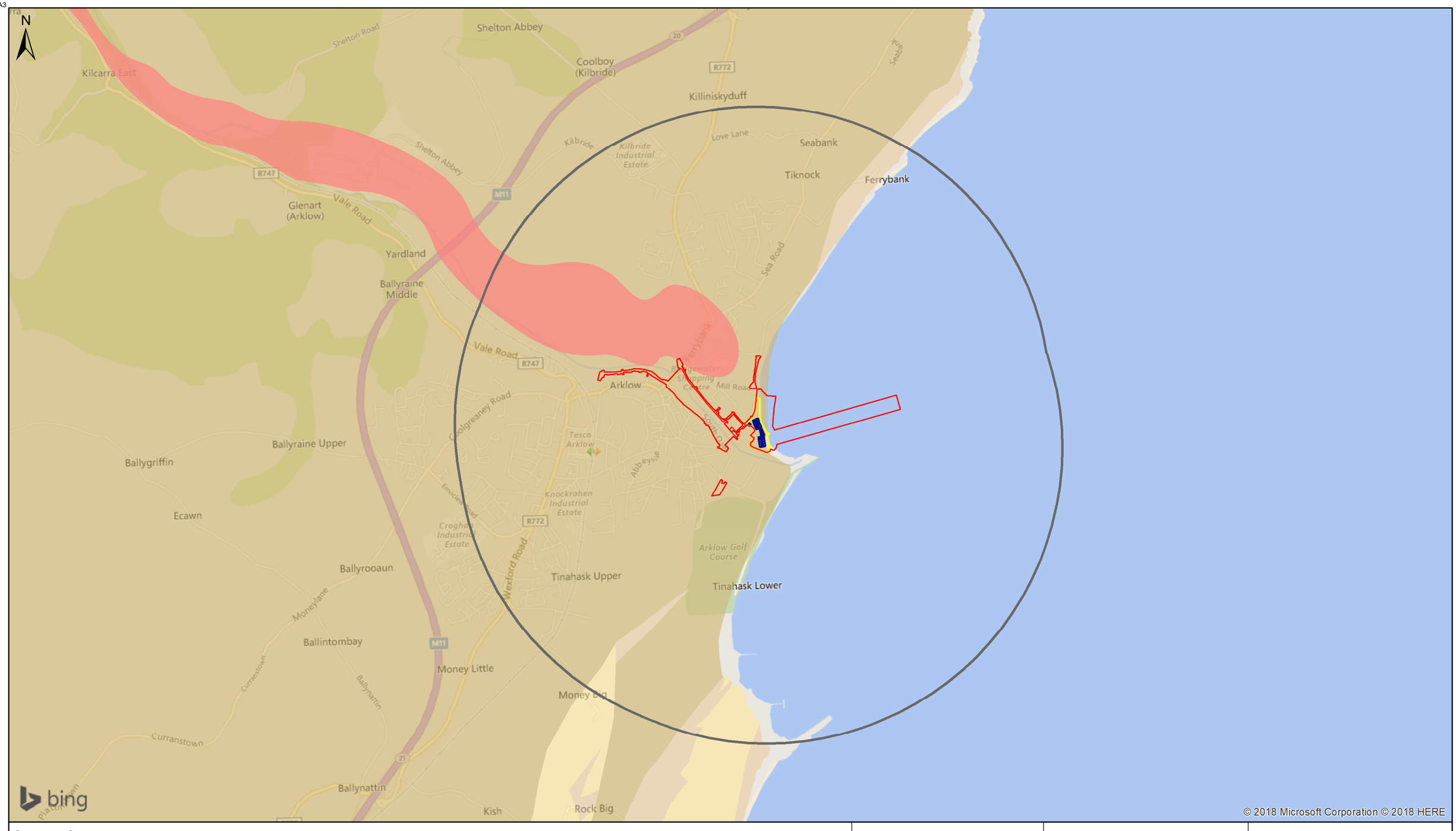

Legend

- Proposed Buildings
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer

Aquifer classification

- LI (Locally Important Aquifer - Bedrock which is modertately productive only in local zones))
- Pl (poor Aquifer - Bedrock which is generally unproductive except for local zones)
- Pu (Poor aquifer - Bedrock which is generally unproductive)
- Lg - Locally Important Gravel Aquifer

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
I1	2018-06-08	JF	CN	EW

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Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
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Aquifer designation in the vicinity of the site

Client: **Irish Water**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **006**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 5 Bedrock aquifers.mxd

A3

30/08/2018 16:26:38

Legend

- Proposed Buildings
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer

Groundwater recharge (mm/year)

- 1-50
- 51-100
- 101-150
- 151-200
- 201-250

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
I1	2017-12-19	JF	CN	EW

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Groundwater recharge

Client: **Irish Water**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **007**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 6 Recharge.mxd

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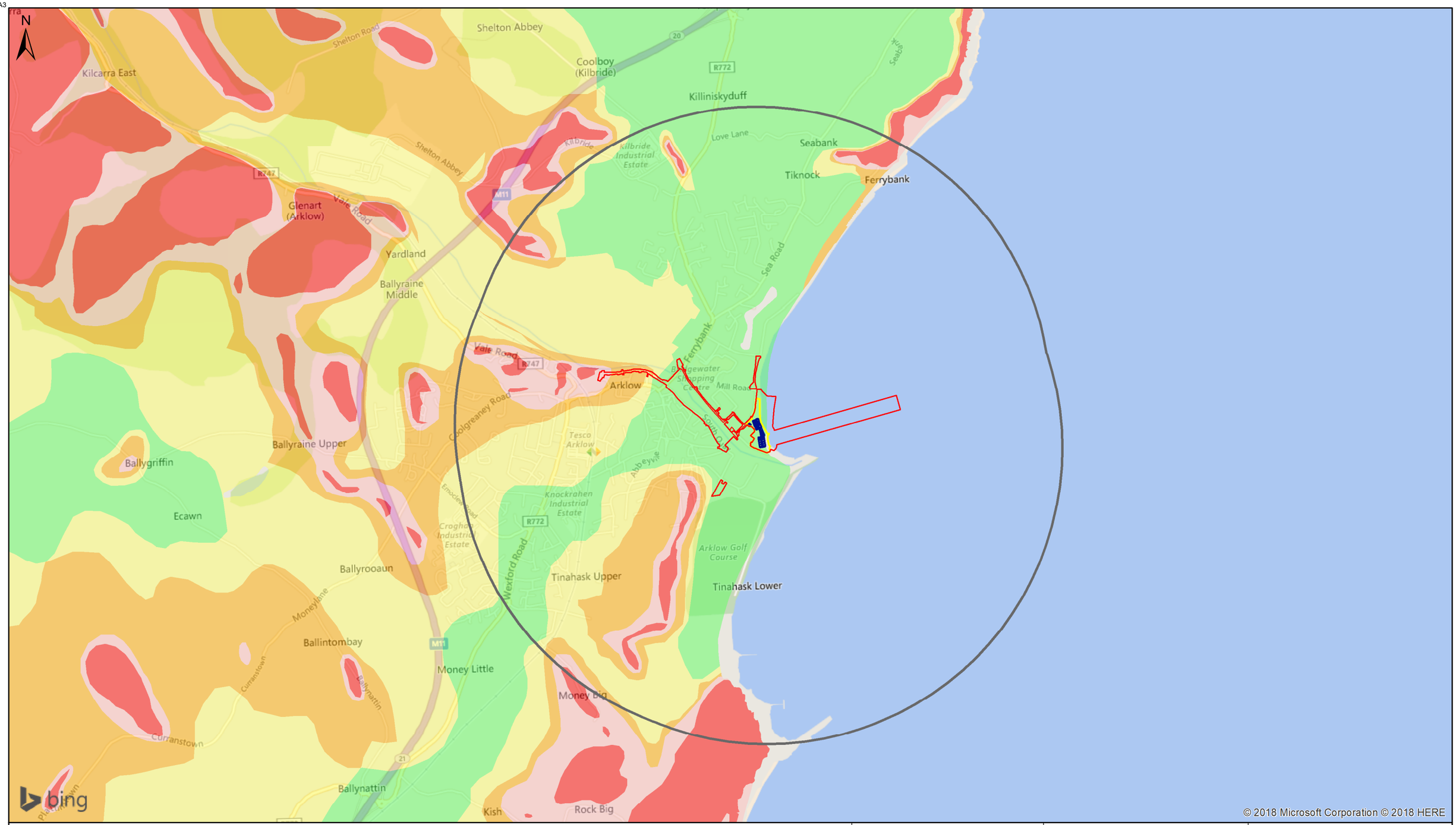

Legend

- Proposed Buildings
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer

Groundwater vulnerability

- X - Rock at or near surface or Karst
- E - Extreme
- H - High
- M - Moderate
- L - Low

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
I1	2017-12-19	JF	CN	EW

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Groundwater vulnerability

Client: **Irish Water**

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Drawing No: **008**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 7 Groundwater vulnerability.mxd

A3

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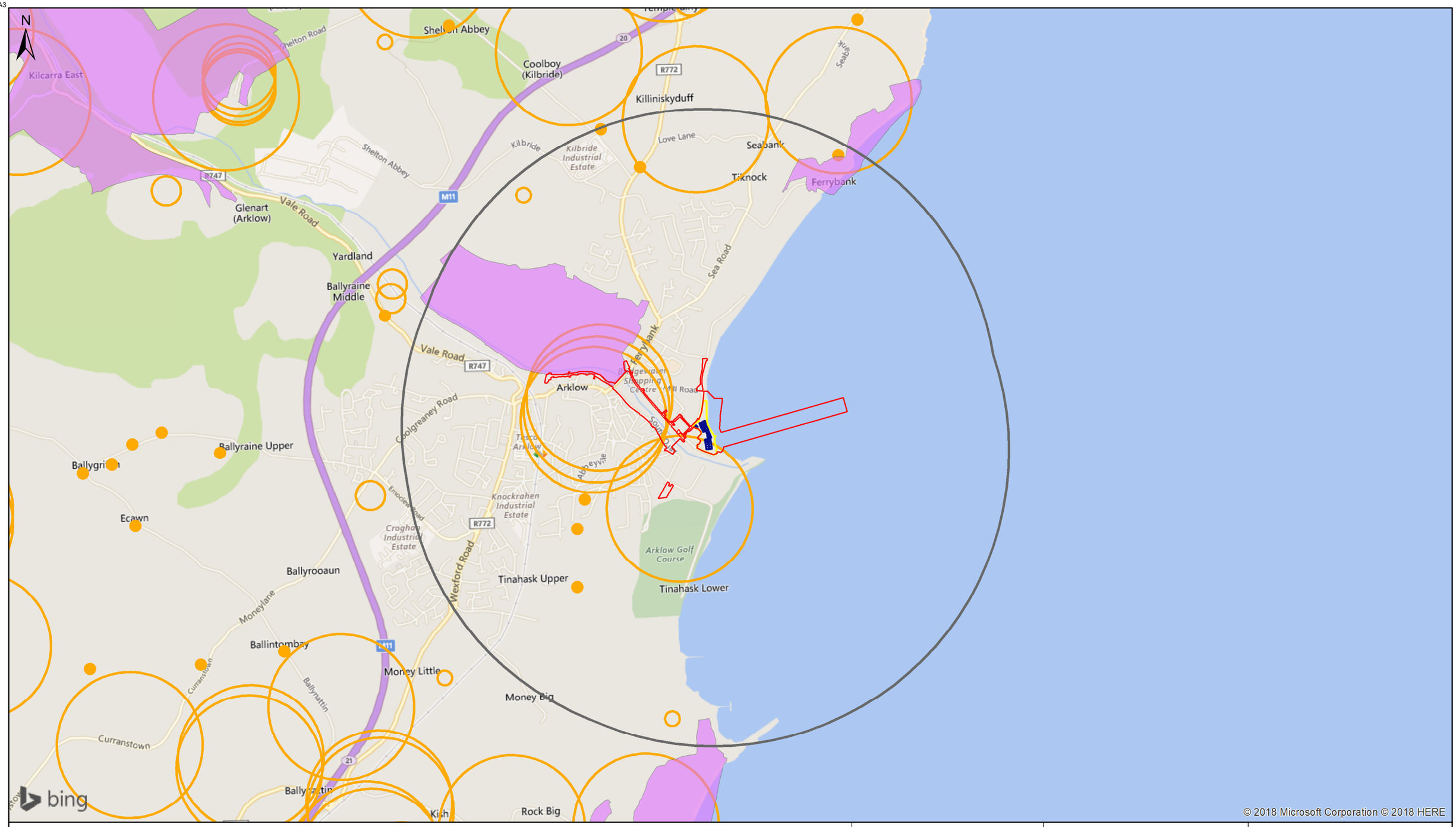

Legend

- Proposed Buildings
- WwTP Site Boundary
- Proposed Development Planning Boundary
- Arklow WwTP Site 2km Buffer
- Proposed National Heritage Area (pNHA)
- Location of a well or spring based on the GSI database (the size of the circle denotes the uncertainty of the location)

There are no records of any Source Protection Areas or National Federation group water scheme, or drinking water protection areas within the study area.

There are no Special Areas of Conservation (SAC), Special Protection Areas (SPA) or National Heritage Areas (NHA) within the study area.

Meters
0 250 500 1,000

Issue	Date	By	Chkd	Appd
I1	2017-12-19	JF	CN	EW

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Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
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Hydrogeological receptors in the vicinity of the site

Client: **Irish Water**

Job Title: **Wastewater Treatment Plant for the Arklow Wastewater Treatment Plant Project**

Scale at A3: **1:25,000**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **009**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 8 Sensitive features.mxd

A3

30/08/2018 17:04:09

Legend

- Proposed Development Planning Boundary
- Proposed Buildings
- WwTP Site Boundary
- Site boundary
- RPS 2006 Site investigation location
- RPS 2006 Groundwater monitoring locations
- Tobins 2005 Site investigation

Meters
0 20 40 80

Issue	Date	By	Chkd	Appd
I1	2017-12-19	JF	CN	EW

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Client: **Irish Water**

Job Title: **Arklow Wastewater Treatment Plant**

Previous site investigation locations

Scale at A3: **1:2,200**

Job No: **247825-00**

Drawing Status: **For Issue**

Drawing No: **009**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 9 Previous SI.mxd

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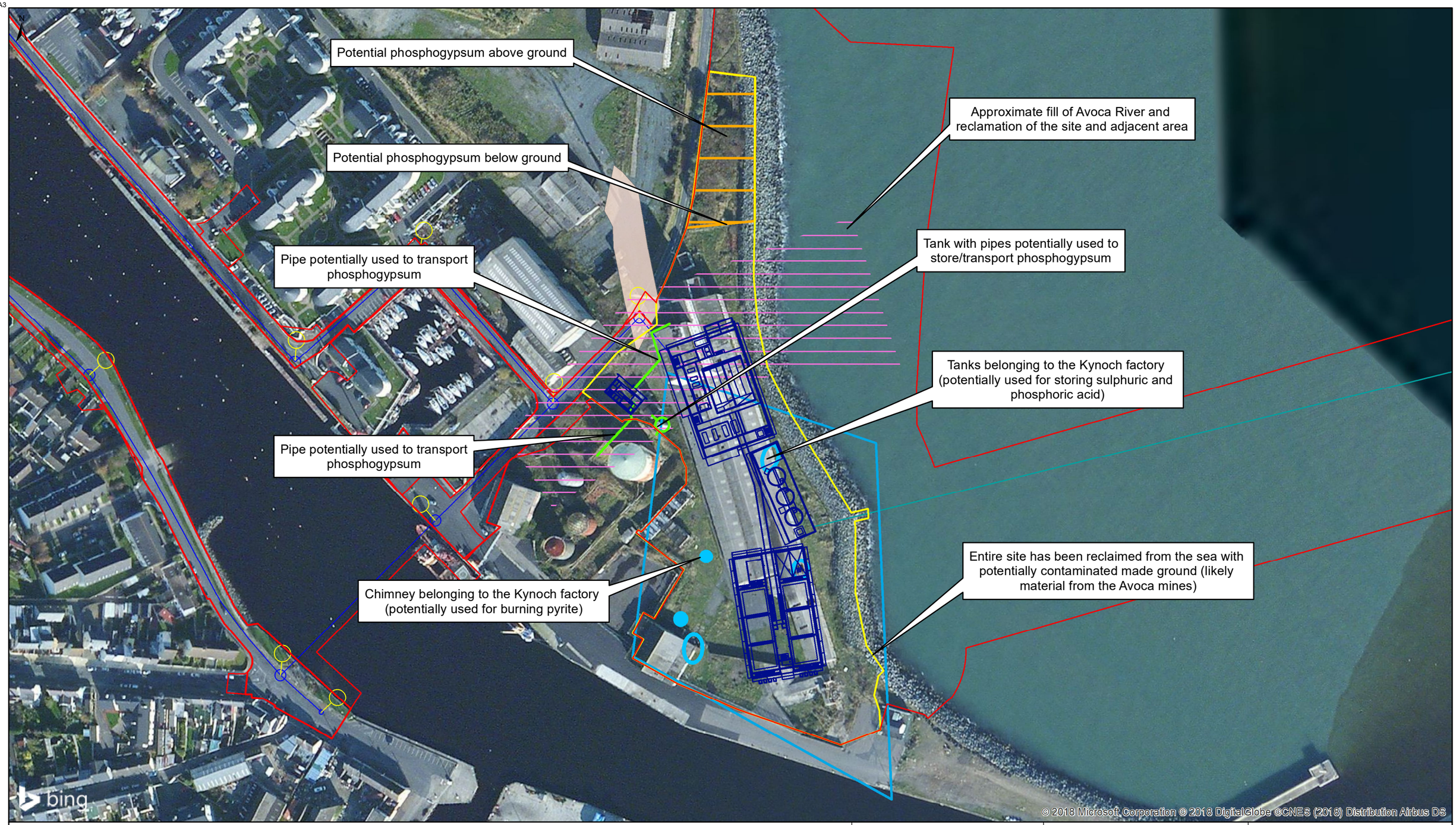
20/12/2017 16:40:20



Legend

- Proposed Development Planning Boundary
- Proposed Buildings
- WwTP Site Boundary
- Site boundary
- Historic river channel (likely infilled with material from the Avoca mines)
- Footprint of main Kynoch factory buildings including the Chemical works
- Area where phosphogypsum potentially was dumped (Detailed radiological survey to investigate the potential presence of radiological contamination)
- Low lying area reportedly used to dump various material from the Kynoch factory
- Approximate fill of Avoca River and reclamation of the site and adjacent area

Meters
0 20 40 80

Issue	Date	By	Chkd	Appd
I1	2017-12-20	JF	CN	EW

ARUP
50 Ringsend Road
Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Client: **Irish Water**

Job Title: **Arklow Wastewater Treatment Plant**

Areas of contamination highlighted during the PSA

Scale at A3: **1:2,000**

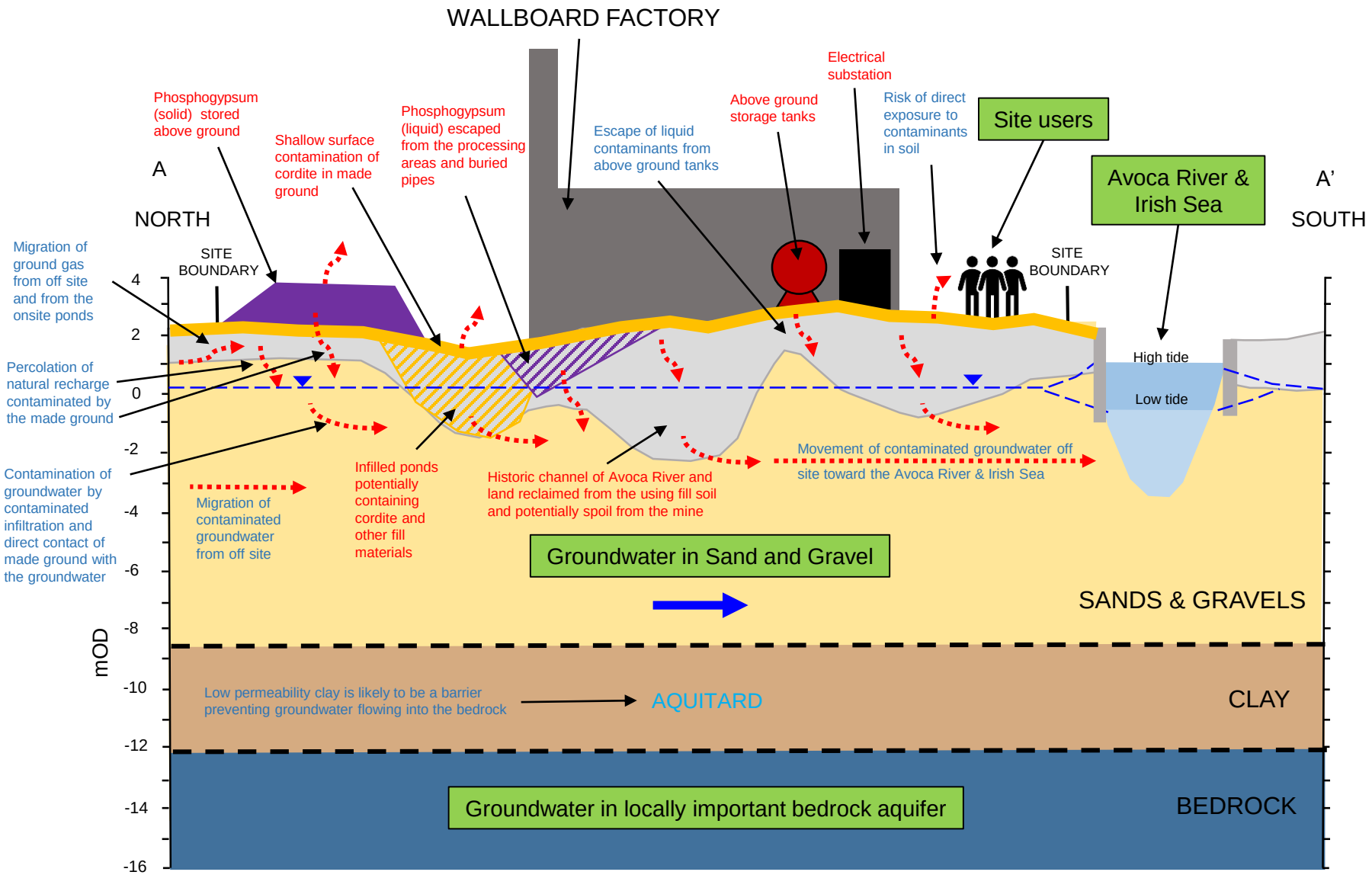
Job No: **247825-11**

Drawing Status: **Issue**

Drawing No: **010**

Issue: **I1**

MXD Location: \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Figure 10 Areas of concern V3.mxd



Legend

Red text Source
Blue text Pathway
Green box Receptor

Groundwater table in the sand and gravel
Groundwater flow direction
Elevation in metres above Ordnance Datum (Malin)

Issue	Date	By	Chkd	Appd
P1	2018-10-08	JF	CN	JL

ARUP

Client
Irish Water

Job Title
Arklow WwTP
Preliminary Site Assessment

Preliminary Conceptual Site Model

Scale at A3
NTS

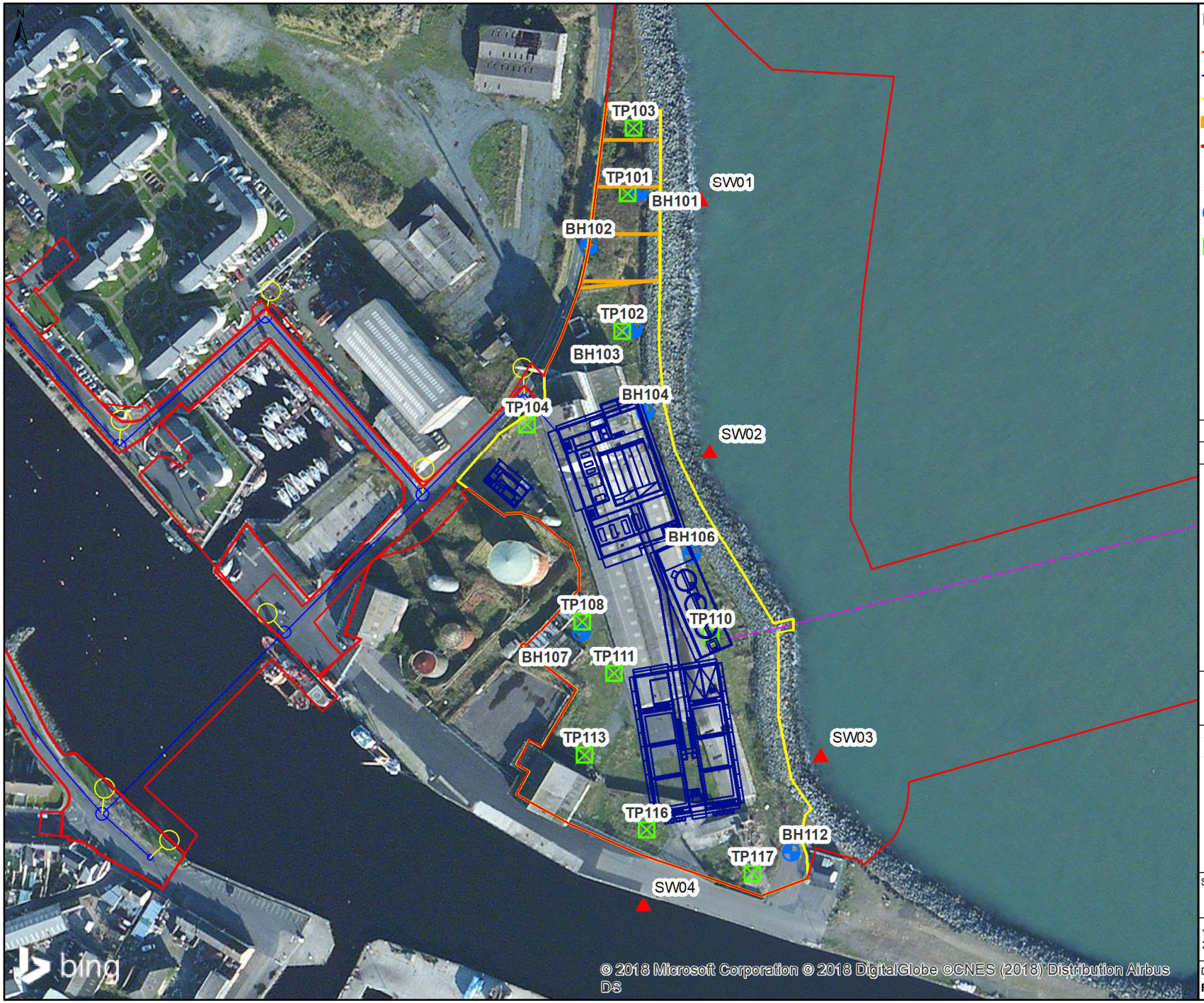
Job No
247859-00

Drawing Status
Draft

Drawing No
Figure 9

Issue
F1

A4



Legend

- Proposed Development Planning Boundary
- Proposed Buildings
- WwTP Site Boundary
- Proposed non-intrusive radiological survey
- Site boundary
- Arup Proposed surface water sampling locations
- Arup Proposed GW borehole
- Arup Proposed trial pit

Issue	Date	By	Chkd	Appd
I1	2017-12-18	JF	CN	EW

Meters

0 25 50 100

ARUP

50 Ringsend Road
Dublin 4, D04 T6X0
Tel +353 (0)1 233 4455 Fax +353 (0)1 668 3169
www.arup.com

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Proposed surface water monitoring locations

Scale at A4
1:2,500

Job No	Drawing Status
247825-11	**For Issue**

Drawing No	Issue
Figure TN02	**I1**

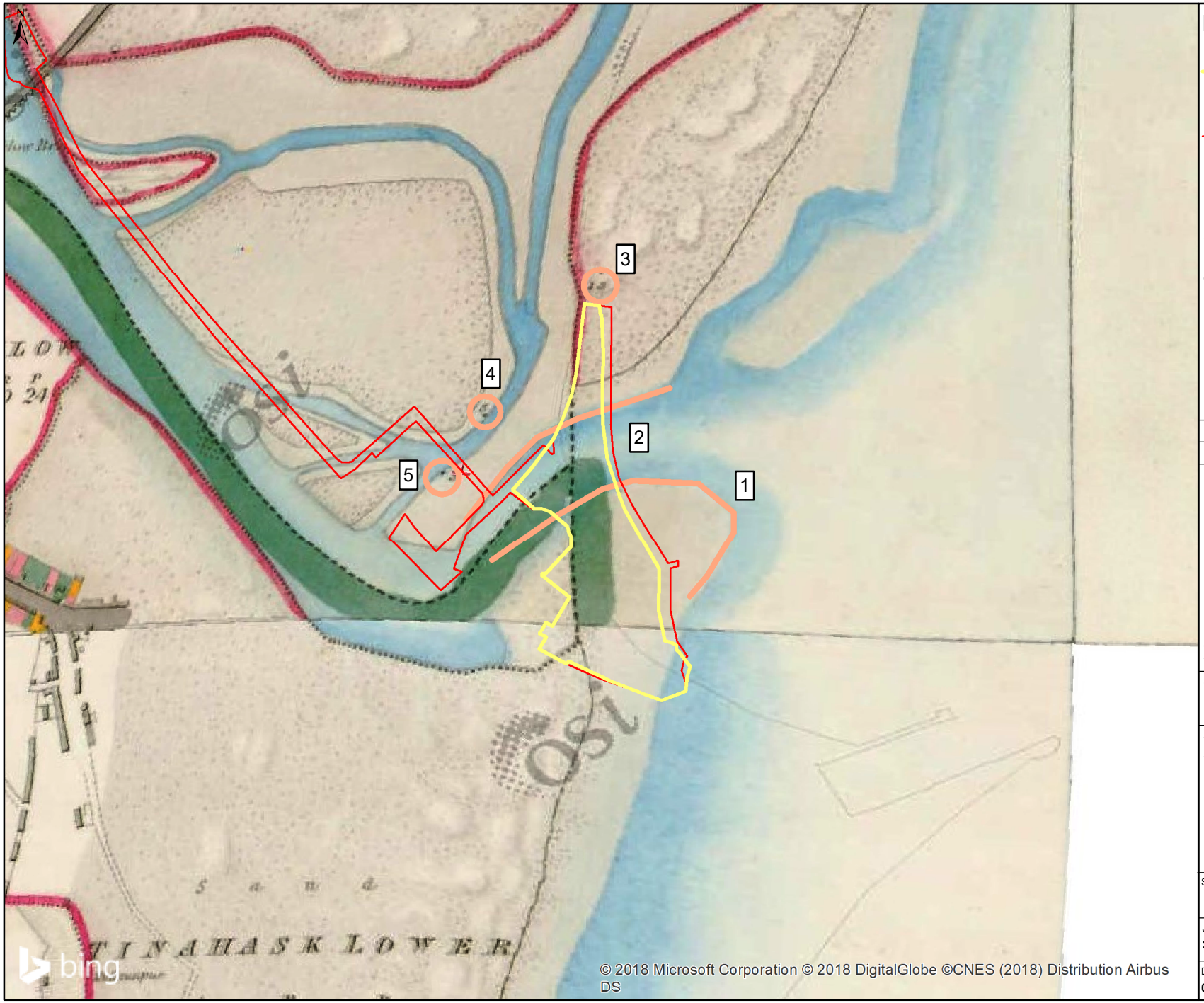
30/08/2018 17:30:18

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\PSA\Proposed SI.mxd

Appendix A

Historical Maps

A4



Legend

WwTP Site boundary

Proposed Development Planning Boundary

1. Headland feature
2. Historic channel
3. Level 15ft
4. Level 5ft
5. Level 5ft

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, 1838

Scale at A4
1:5,000

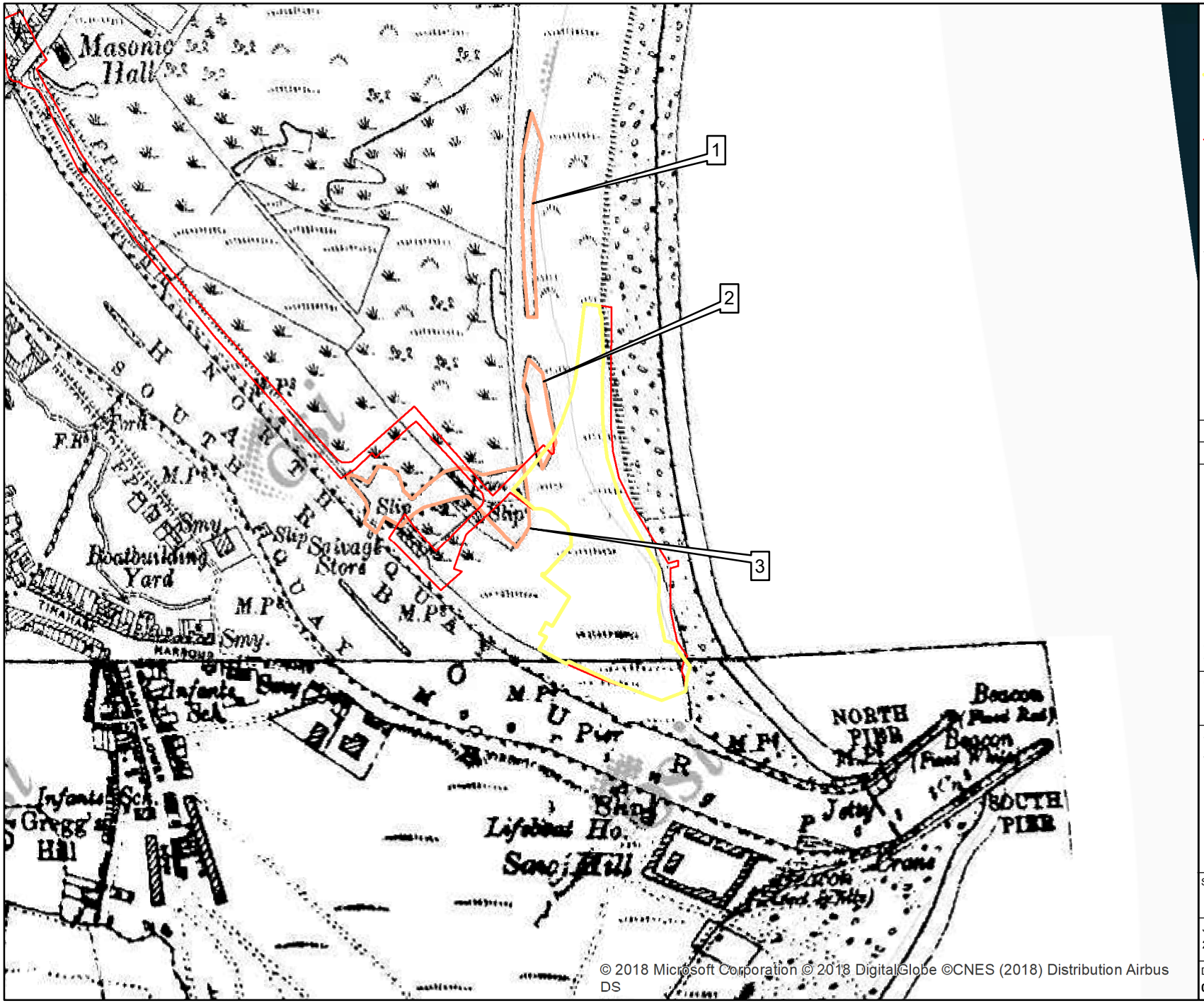
Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
001	**D1**

31/10/2017 11:00:33

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 1 1838.mxd

A4



Legend

WwTP Site boundary

Proposed Development Planning Boundary

1 & 2. Probable pond features
3. Dammed pond feature with slips

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, Unknown date

Scale at A4
1:5,000

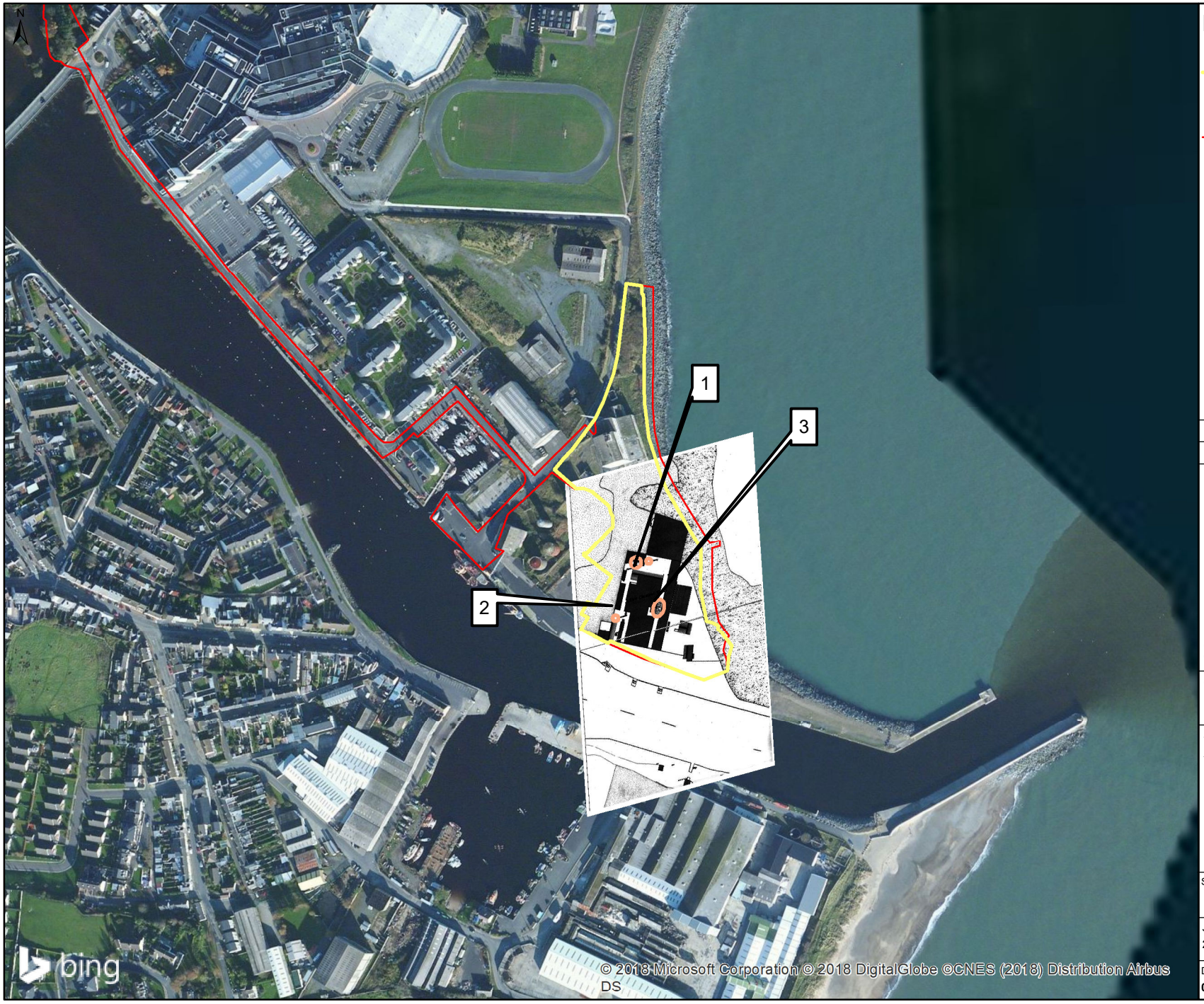
Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
002	**D1**

31/10/2017 11:04:28

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 2 no date.mxd

A4



Legend

WwTP Site boundary

Proposed Development Planning Boundary

1. Chimneys
2. Gasometer
3. Tanks

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 40 80 160

ARUP

Glucksman Map Library, trinity College, Dublin.
Ordance Survey 1885 map.

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, 1885

Scale at A4
1:5,000

Job No
247825-00

Drawing Status
Draft

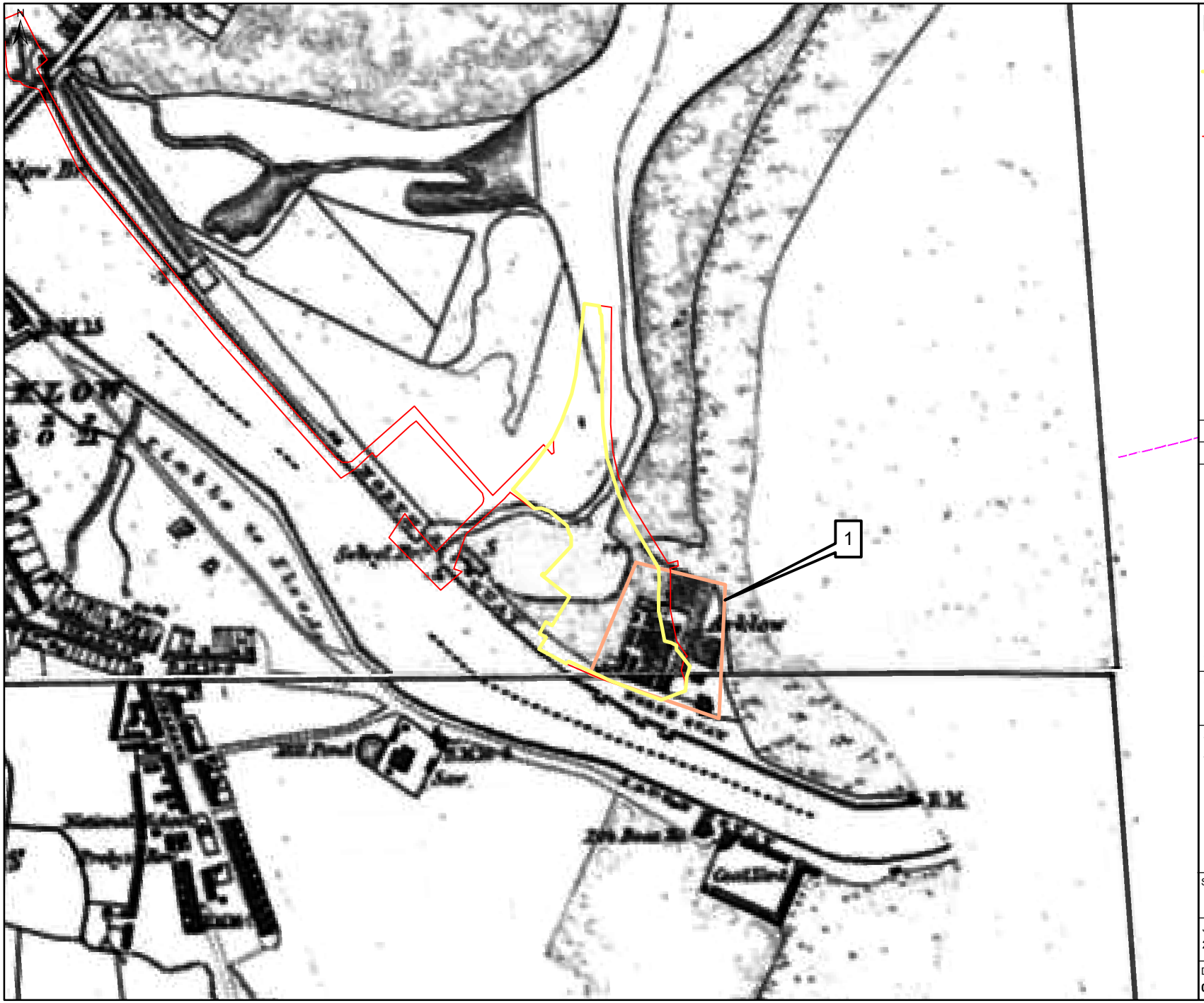
Drawing No
003

Issue
D1

31/10/2017 11:04:28

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 3 1885.mxd

A4



Legend

WwTP Site boundary

Proposed Development Planning Boundary

1. Footprint of Arklow Chemical Works buildings

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

Glucksman Map Library, Trinity College, Dublin.
Ordance Survey 1887 map.

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, 1887

Scale at A4
1:5,000

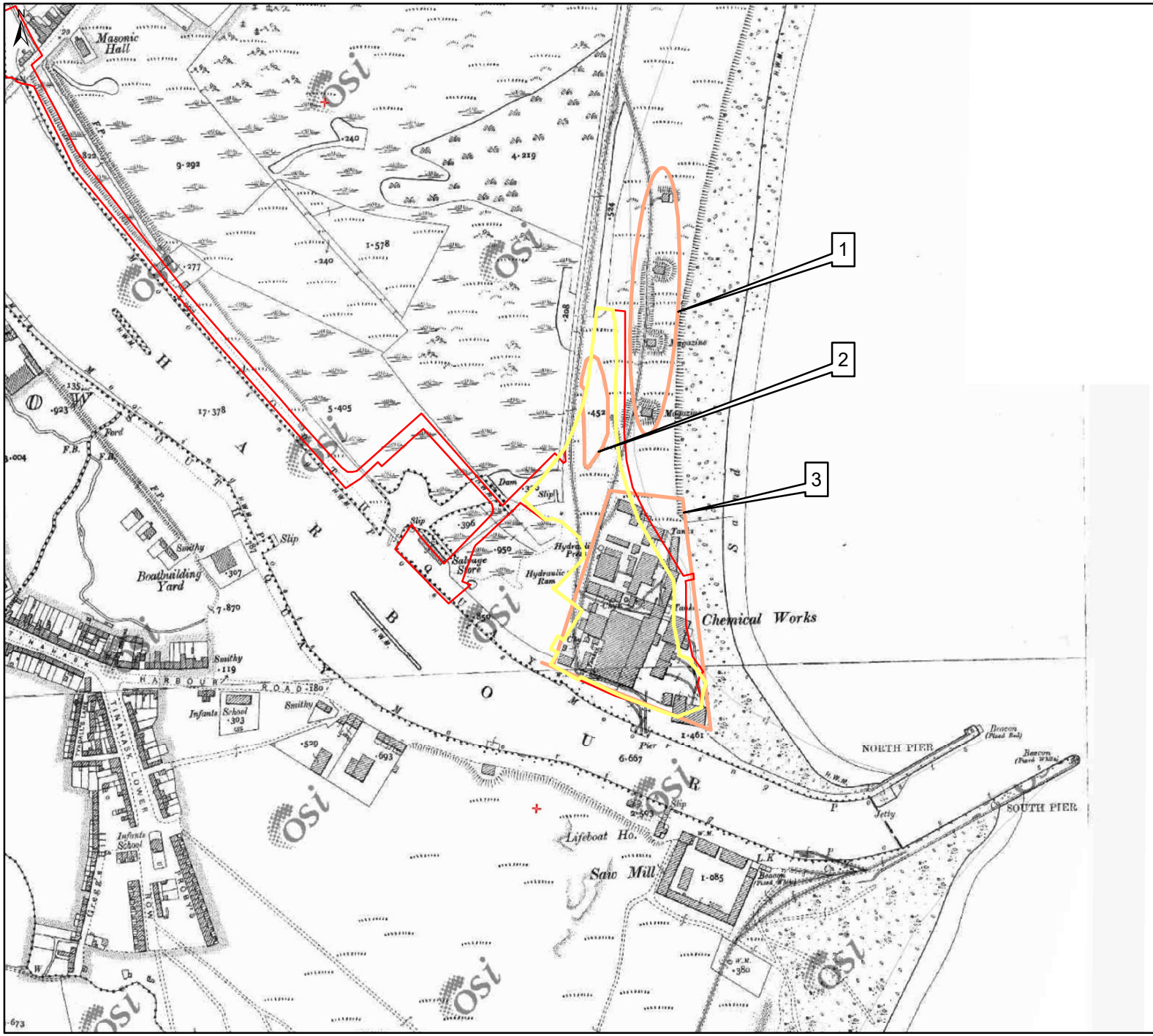
Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
004	**D1**

31/10/2017 11:04:28

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 4 1887.mxd

A4



Legend

- WwTP Site boundary
- Proposed Development Planning Boundary

1. Storage magazines
2. Probable pond feature
3. Arklow Chemical Works/ Kynoch Factory buildings

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, 1910

Scale at A4
1:5,000

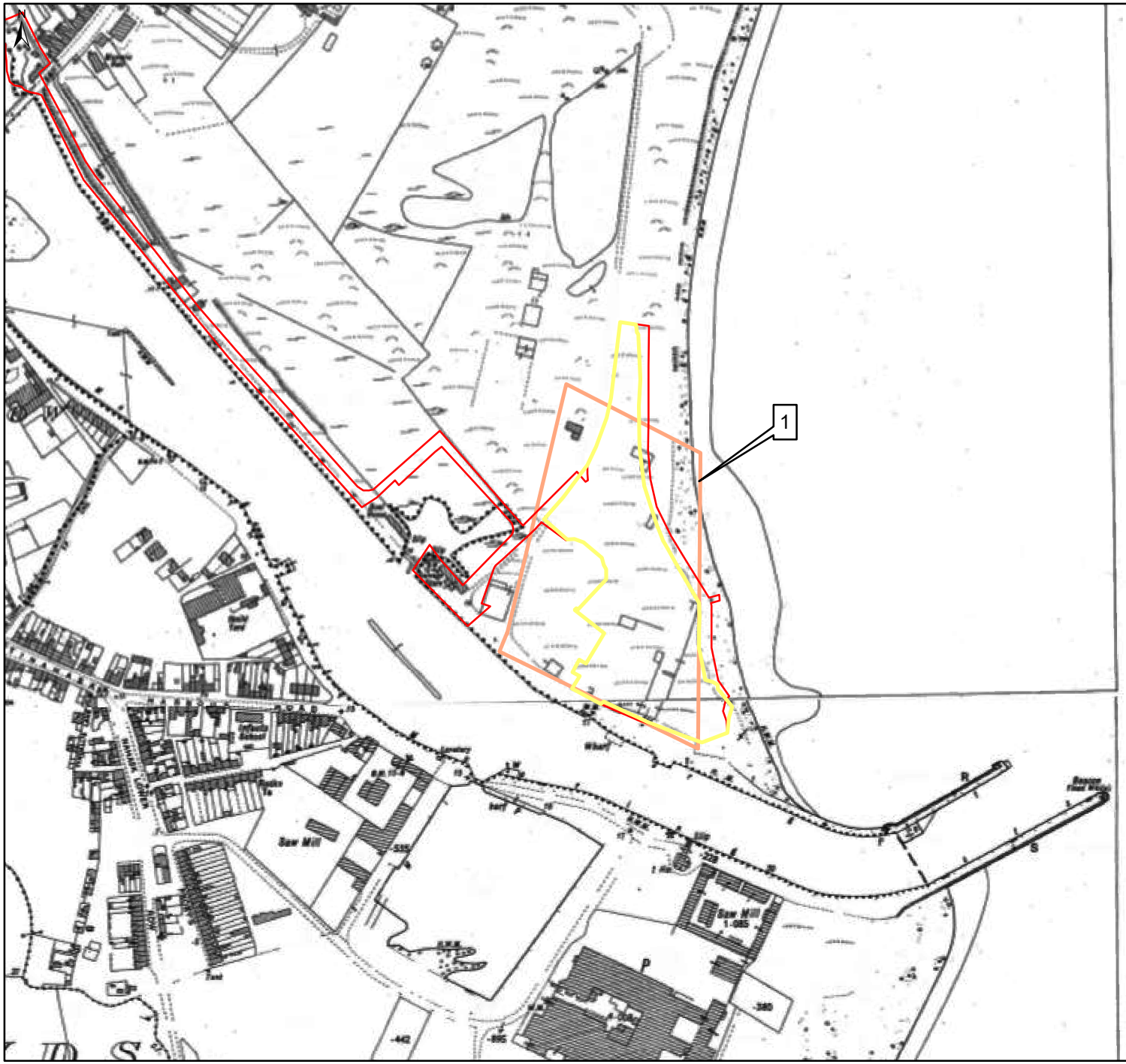
Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
005	**D1**

31/10/2017 11:04:28

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 5 1910.mxd

A4



Legend

WwTP Site boundary

Proposed Development Planning Boundary

1. Possible derelict Kynoch Factory buildings

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 40 80 160

ARUP

Glucksman Map Library, Trinity College, Dublin.
Ordance Survey 1951 map.

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Historic Ordnance Survey Ireland map, 1951

Scale at A4
1:5,000

Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
006	**D1**

31/10/2017 11:04:28

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 6 1951.mxd

A4

Legend

WwTP Site boundary

Proposed Development Planning Boundary

1. Wallboard factory
2. Tank

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Ordnance Survey Ortho 1995

Scale at A4
1:5,000

Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
007	**D1**

31/10/2017 11:28:59

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 7 1995.mxd

A4

Legend

- WwTP Site boundary
- Proposed Development Planning Boundary

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Ordnance Survey Ortho 2000

Scale at A4
1:5,000

Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
008	**D1**

31/10/2017 11:28:05

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 8 2000.mxd

A4

Legend

WwTP Site boundary

Proposed Development Planning Boundary

Issue	Date	By	Chkd	Appd
P0	2018-01-24	JF	CN	EW

Meters

0 50 100 200

ARUP

OSI, 2017. Public Viewer. Accessed 31st July 2017. Available at: http://maps.osi.ie/publicviewer/#V2,584232,796724,1,3

Client
Irish Water

Job Title
Arklow Wastewater Treatment Plant

Ordnance Survey Ortho 2005

Scale at A4
1:5,000

Job No	Drawing Status
247825-00	**Draft**

Drawing No	Issue
009	**D1**

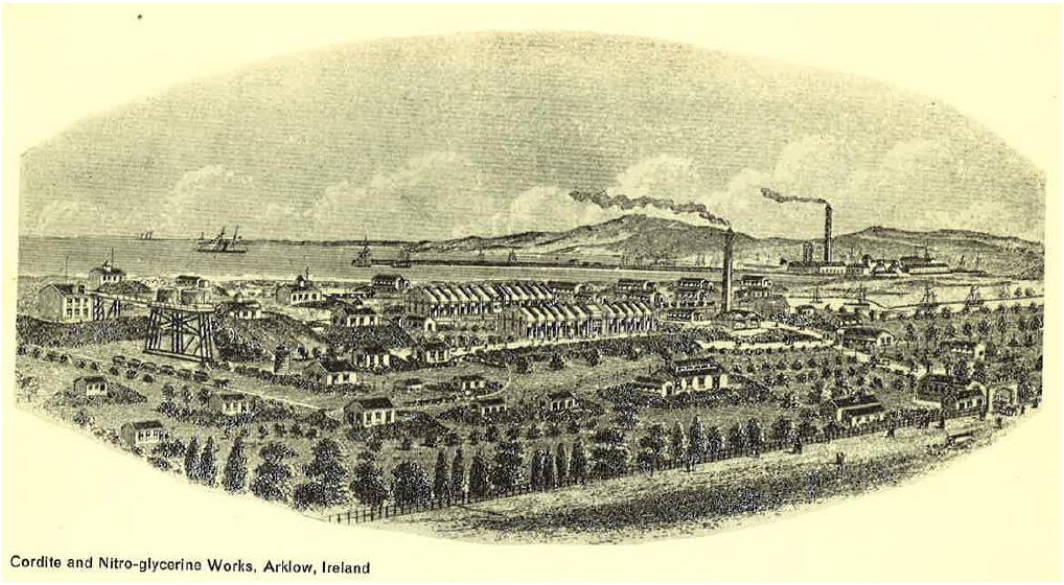
31/10/2017 11:27:09

MXD Location \\global\europe\Dublin\Jobs\247000\247825-00\4. Internal\4-03 Design\4-03-03 Infrastructure\GIS\1. Project Viewers\Historical maps\Figure 9 2005.mxd

Appendix B

Historical Photographs and Drawings

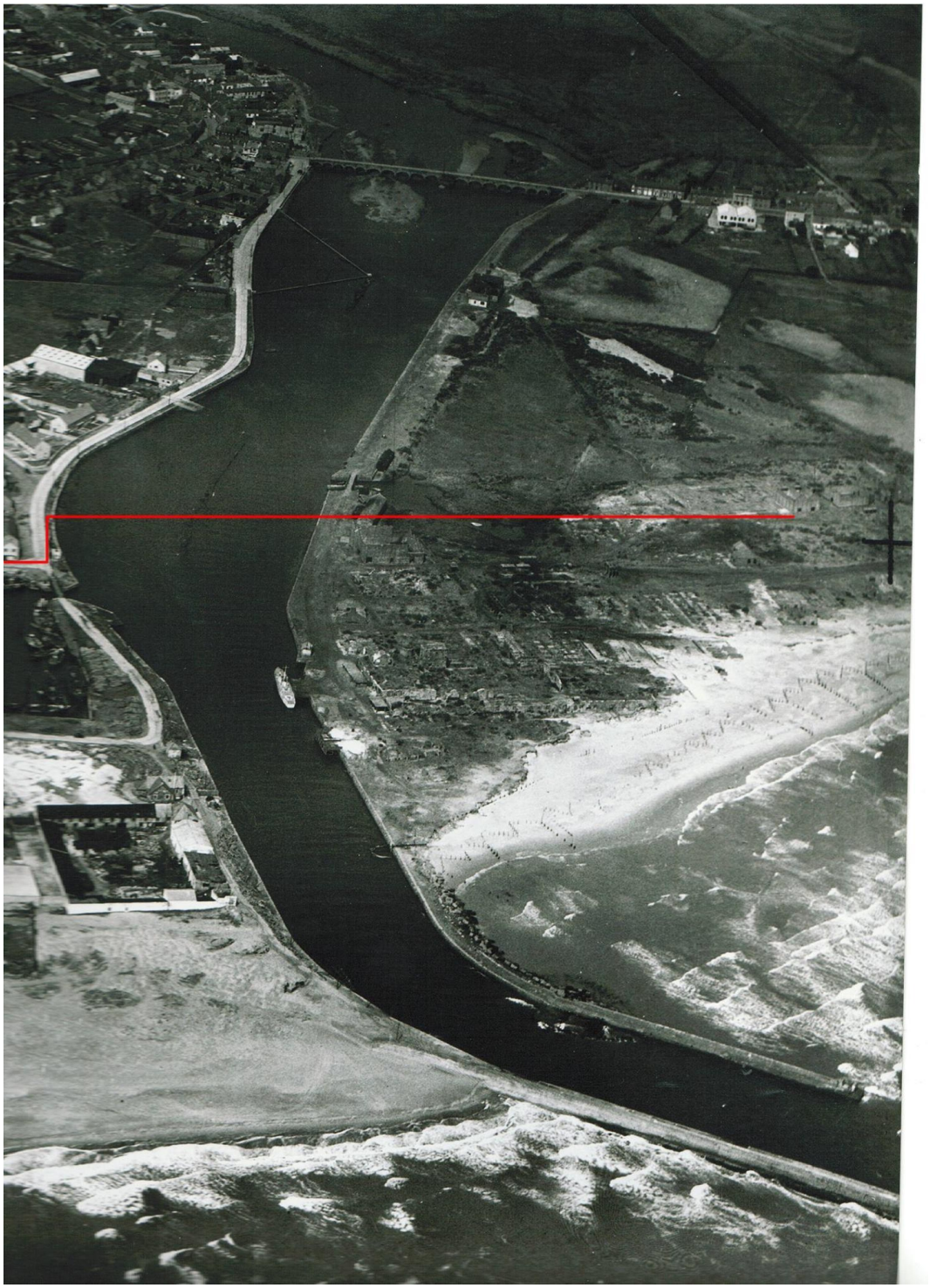
Drawing 1: Kynoch factory approximately 1900 (Imperial Metal Industries, 1962).



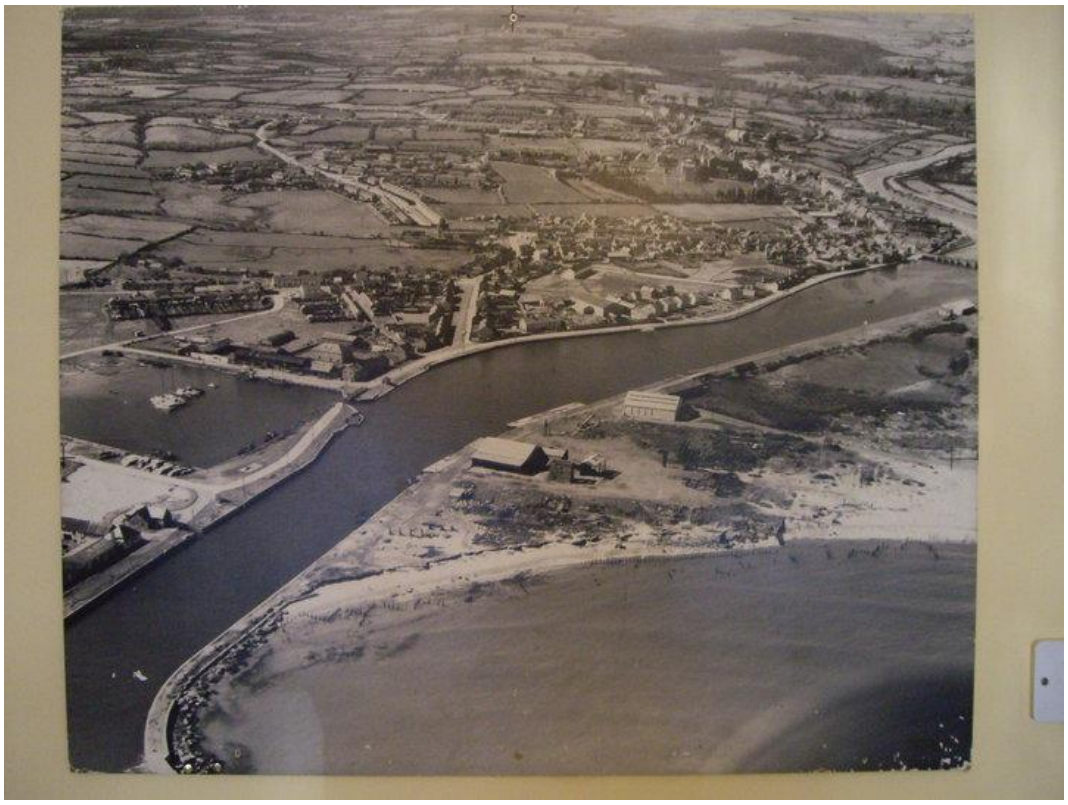
Photograph 1: Arklow Manure Works (Arklow Chemical Works), unknown date. View from Avoca River facing north.

Photograph 2: Arklow Chemical Works and probably Kynoch factory, unknown date. View from Avoca River facing north west.

Photograph 3: Aerial view of the Kynoch factory and harbour area, unknown date.



Photograph 4: Aerial view of the Kynoch factory and harbour area, unknown date.



Photograph 5: Coastal erosion protection on beach down from the site, unknown date. View facing south.

Photograph 6: View of harbour area facing north west showing restoration of the north pier in the foreground and construction of the Arklow Gypsum Ltd. Wallboard Factory and the adjacent IFI tank farm in the background.

Photograph 7: Arklow Gypsum Ltd. Wallboard Factory, unknown date.

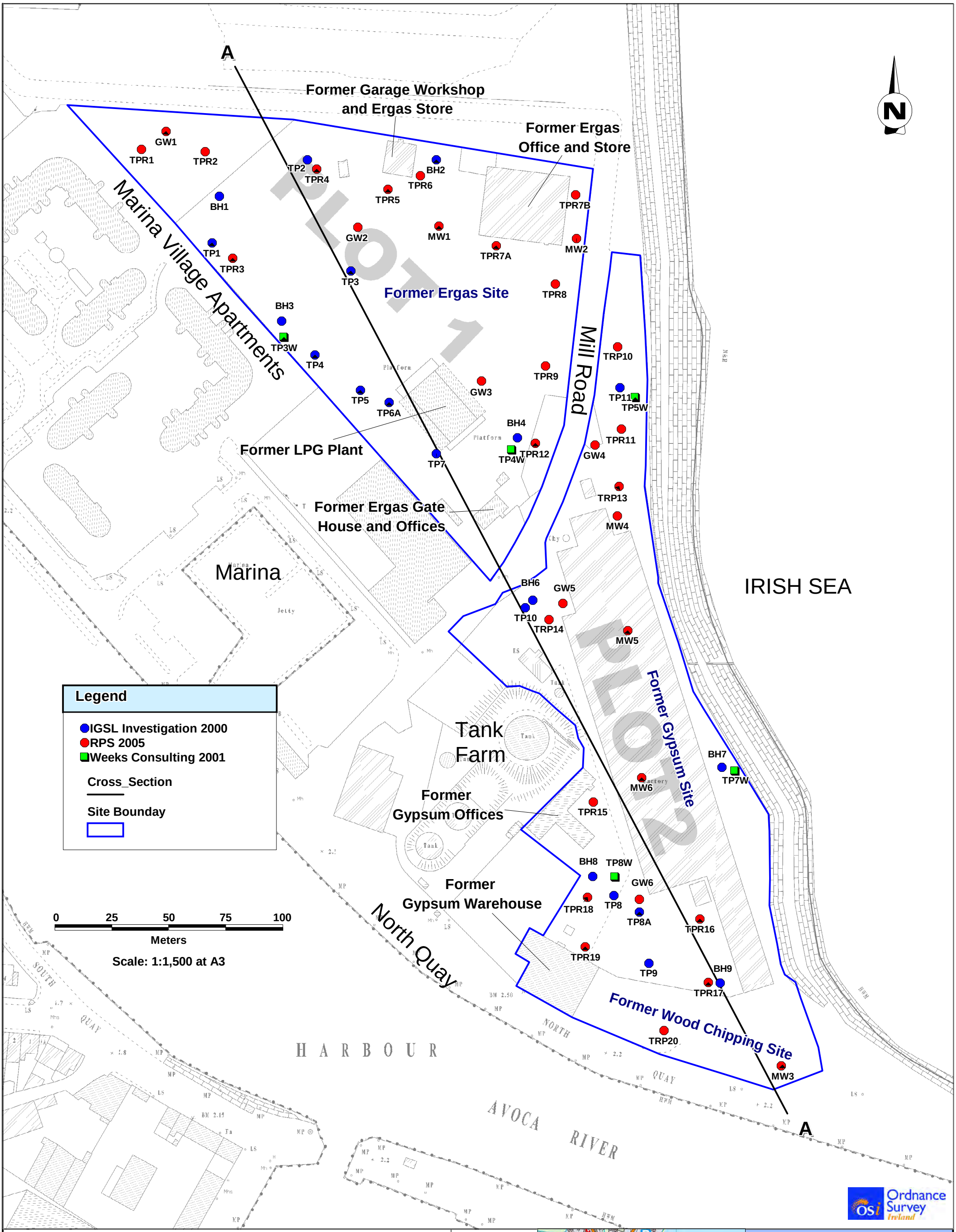
Photograph 8: Arklow Gypsum Ltd. Wallboard Factory, unknown date. View from Mill road facing south.

Photograph 9: View facing east showing Avoca River, Wallboard Factory, IFI tank farm and harbour area, unknown date.

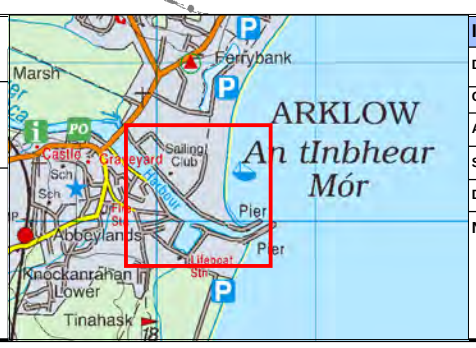
Photograph 10: View facing south showing coastal erosion protection on beach with the Wallboard Factory in the background, unknown date.

Appendix C

RPS Draft Environmental Impact Statement (August 2005) and Geotechnical Interpretative Report (September 2006)



Project	*Ferrybank Residential Development*	**Figure**	2
Title	**Site Layout & Investigation Locations**		



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Issue Details

Drawn:	Caitriona Reillly/ Hauke Steinberg	**Project No.**	MDC0186
Checked:	Niall Mitchell	**File Ref.**	MDC0186Mi2009D04
Approved:	Jean Clarke		
Scale:	1:1,500 @ A3	**Drawing No.**	**Rev.**
Date:	02/09/05	Mi2009	D04

Notes
1. This drawing is the property of RPS-MCOS Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
3. Ordnance Survey Ireland Licence No. EN 0005005 Copyright Government of Ireland.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP1
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	18/05/2005
CO-ORDINATES:	E 325085.52 N 173439.94	Date Completed:	18/05/2005
		Ground Level (mOD):	2.11

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10	2.01						
	MADE GROUND consisting of grey sand with much pottery, wood pulp and some plastic with one battery.						D	0.50		
	MADE GROUND consisting of black landfill material, metal, glass, clay and ash.		0.70	1.41						
1.0	MADE GROUND consisting of pottery		1.20	0.91						
	Loose black stained SAND		1.40	0.71		tp1 1.4-	D	1.40		
	Loose light brown fine slightly gravelly SAND		1.70	0.41						
2.0						Q 5515	B	2.00		
	Very loose grey SAND		2.20	-0.09	▽					
	End of Trial Pit at 2.80 m		2.80	-0.69		Q 5516	B	2.80		
3.0										
4.0										

Groundwater Conditions: Water fast @ 2.4m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.8m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP2
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	18/05/2005
CO-ORDINATES:	E 325139.45 N 173429.32	Date Completed:	18/05/2005
		Ground Level (mOD):	2.04

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10	1.94						
	MADE GROUND consisting of grey clay					tp2 0.5m	D	0.50		
	MADE GROUND consisting of brown clay with red brick		0.55	1.49						
			0.70	1.34						
1.0	MADE GROUND consisting of black landfill material, metal, glass, clay and ash.					tp2 1-1.	D	1.00		
	Loose grey black SAND		1.40	0.64						
						Q 5513	B	1.80		
2.0	Very loose brown very gravelly fine to coarse SAND		1.90	0.14	▽					
	Very loose light brown fine to medium SAND		2.50	-0.46						
	End of Trial Pit at 2.60 m		2.60	-0.56		Q 5514	B	2.60		
3.0										
4.0										

Groundwater Conditions: Water fast @ 2m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.6m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP3
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	18/05/2005
CO-ORDINATES:	E 325148.42 N 173368.94	Date Completed:	18/05/2005
		Ground Level (mOD):	1.92

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10	1.82						
	MADE GROUND consisting of graded gravel		0.40	1.52						
	MADE GROUND consisting of black landfill material, metal, glass, clay and ash.					tp3 0.9-	D	0.90		
1.0					▽					
	Very soft black PEAT		1.60	0.32		tp3 1.6-	D	1.60		
	Very soft grey silty PEAT		1.90	0.02						
2.0										
	Very loose fine SAND		2.50	-0.59		Q 5511	B	2.60		
3.0	Very loose slightly clayey/silty gravelly SAND		3.00	-1.09		Q 5512	B	3.10		
	End of Trial Pit at 3.20 m		3.20	-1.29						
4.0										

Groundwater Conditions: Fast at 1.4m with a slight sheen on the water.

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.2m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP4
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	18/05/2005
CO-ORDINATES:	E 325182.41 N 173417.83	Date Completed:	18/05/2005
		Ground Level (mOD):	2.25

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of gravelly slightly clayey sand					tp4 0.6m	D	0.60		
	MADE GROUND consisting of grey clay with metal and plastic		0.80	1.45						
1.0										
	MADE GROUND consisting of black landfill material, metal, glass, clay and ash.		1.40	0.85						
2.0						tp4 2.4-	D	2.40		
	Very loose grey fine to coarse SAND		2.60	-0.35	▽	Q 5509	B	2.70		
3.0										
4.0	End of Trial Pit at 4.00 m		4.00	-1.75		Q 5510	B	4.00		

Groundwater Conditions: Water fast @ 2.6m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 4m. Very strong hydrogen sulphide odour from the trial pit.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP5
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
CO-ORDINATES:	E 325214.48 N 173402.66	Date Completed:	17/05/2005
		Ground Level (mOD):	2.30

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of graded gravel		0.10	2.20						
	MADE GROUND consisting of hardcore		0.40	1.90						
	MADE GROUND consisting of black brown sandy clay with much glass, plastic and pottery.					tp5 0.7m	D	0.70		
1.0										
	Very loose light brown slightly clayey/silty slightly gravelly SAND with red stained sand in one corner to a depth of 1.6m.		1.30	1.00		tp5 1.3- Q 5508	D B	1.30 1.50		
2.0										
	End of Trial Pit at 2.50 m		2.50	-0.20	▽					
3.0										
4.0										

Groundwater Conditions: Water fast @ 2.5m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.5m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP6
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
CO-ORDINATES:	E 325228.01 N 173420.05	Date Completed:	17/05/2005
		Ground Level (mOD):	2.44

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.05	2.39						
	MADE GROUND consisting of hardcore									
	MADE GROUND consisting of black clay with much glass, plastic and red brick. Hydrocarbon odour in this strata.		0.60	1.84		tp6 0.8m	D	0.80		
1.0										
	Very loose light brown SAND		1.30	1.14						
2.0										
						Q 5506	B	2.60		
3.0					▽					
	End of Trial Pit at 3.20 m		3.20	-0.76		Q 5507	B	3.20		
4.0										

Groundwater Conditions: Water fast @ 3.2m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP7A
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
CO-ORDINATES:	E 325258.81 N 173382.39	Date Completed:	17/05/2005
		Ground Level (mOD):	2.04

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND conisisting of tarmacadam		0.05	1.99						
	MADE GROUND consisting of hardcore		0.15	1.89						
	MADE GROUND consisting of brown sandy clay with plastic and red brick									
	MADE GROUND consisting of brown sand		0.70	1.34						
	MADE GROUND consisting of black gravelly clay		0.80	1.24						
1.0						tp7a 1m	D	1.00		
	Loose brown SAND		1.10	0.94						
						Q 5504	B	1.50		
2.0	Loose grey silty SAND		1.90	0.14	▽					
	Very loose light brown SAND		2.70	-0.66		Q 5505	B	2.80		
3.0										
	End of Trial Pit at 3.50 m		3.50	-1.46						
4.0										

Groundwater Conditions: Water fast @ 2.5m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.7m-3.5m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP7B
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
CO-ORDINATES:	E 325295.13 N 173400.83	Date Completed:	17/05/2005
		Ground Level (mOD):	2.46

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.20	2.26						
	MADE GROUND consisting of brown clay and hardcore		0.50	1.96						
	MADE GROUND consisting of brown white sandy clay with some plastic and glass.					tp7b 0.6	D	0.60		
1.0										
	MADE GROUND consisting of black clay		1.20	1.26		tp7b 1.2	D	1.20		
	Loose grey red brown SAND		1.70	0.76	▽					
2.0						Q 5503	B	2.20		
	End of Trial Pit at 2.30 m		2.30	0.16						
3.0										
4.0										

Groundwater Conditions: Water fast @ 2m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP8
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
CO-ORDINATES:	E 325290.50 N 173367.63	Date Completed:	17/05/2005
		Ground Level (mOD):	1.97

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.									
	MADE GROUND consisting of hardcore		0.20	1.77						
	MADE GROUND consisting of white clay with much pottery		0.50	1.47		tp8 0.5-	D	0.50		
	MADE GROUND consisting of black very gravelly very sandy clay with many angular cobbles and brick, with one crushed 15 litre oil can.		0.70	1.27		tp8 0.7-	D	0.70		
1.0					▽					
	Very soft black PEAT		1.90	0.07		tp8 1.9-	D	1.90		
2.0	Very loose grey fine to coarse SAND		2.10	-0.13		Q 5502	B	2.20		
	End of Trial Pit at 2.30 m		2.30	-0.33						
3.0										
4.0										

Groundwater Conditions: Fast at 1.5m with a slight sheen on the water.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.1m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP9
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	17/05/2005
		Date Completed:	17/05/2005
CO-ORDINATES:	E 325286.39 N 173326.63	Ground Level (mOD):	1.59

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of black clay with building rubble					tp9 0.5m	D	0.50		
1.0					▽					
	MADE GROUND consisting of sandy clay bands of different colours yellow, red and black.		1.50	0.09		tp9 1.5-	D	1.50		
2.0	MADE GROUND consisting of black sandy clay with brick		2.00	-0.41						
	Very loose grey fine to coarse SAND		2.70	-1.11		Q 5501	B	2.80		
3.0	End of Trial Pit at 2.80 m									
4.0										

Groundwater Conditions: Fast at 1.3m with a slight sheen on the water.

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.8m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP10
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
CO-ORDINATES:	E 325319.63 N 173316.02	Date Completed:	19/05/2005
		Ground Level (mOD):	2.07

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10	1.97						
	MADE GROUND consisting of grey clay		0.60	1.47						
	MADE GROUND consisting of white laminated gypsum		0.80	1.27		tp10 0.8	D	0.80		
1.0	MADE GROUND consisting of grey and purple clay, glass, red brick, wood and sheets of broken corrigated asbestos		1.10	0.97						
	MADE GROUND consisting of sand, clay, cobbles, waven pipes and plastic					tp10 1.9	D	1.90		
2.0	Soft black fibrous PEAT		2.10	-0.03						
	Medium dense yellow and orange very gravelly SAND		2.20	-0.13	▽	P5905	B	2.30		
3.0	End of Trial Pit at 3.30 m		3.30	-1.23						
4.0										

Groundwater Conditions: Water fast @ 2.5m

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP11
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
		Date Completed:	19/05/2005
CO-ORDINATES:	E - N -	Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.									
	MADE GROUND consisting of white gypsum, brown clay, brick, concrete blocks and broken sheets of asbestos		0.30							
	MADE GROUND concrete slab		0.89							
1.0	End of Trial Pit at 0.90 m		0.90							
2.0										
3.0										
4.0										

Groundwater Conditions:

Stability: Pit unstable

Remarks: Pit stopped on concrete slab

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP11A
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
CO-ORDINATES:	E 325321.93 N 173289.65	Date Completed:	19/05/2005
		Ground Level (mOD):	2.06

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples Ref. No.	Samples Type	Samples Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0	MADE GROUND consisting of topsoil, black sandy clay.									
	MADE GROUND consisting of white laminated gypsum		0.30	1.76						
						tp11 0.8	D	0.80		
1.0	MADE GROUND consisting of clay, sand, gravel, cobbles, boulders, brick, wood and ceramic material		0.90	1.16						
					▽	tp11 1.9	D	1.90		
2.0	Medium dense grey and buff SAND and GRAVEL		1.95	0.11		P5910	B	2.10		
	End of Trial Pit at 2.40 m		2.40	-0.34						
3.0										
4.0										

Groundwater Conditions: Water fast @ 1.95m

Stability: Pit unstable

Remarks: Pit continually colapsing at 2.4m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP12
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	18/05/2005
CO-ORDINATES:	E 325278.05 N 173285.57	Date Completed:	18/05/2005
		Ground Level (mOD):	1.85

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples: Ref. No.	Samples: Type	Samples: Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0	MADE GROUND conisisting of tarmacadam		0.05	1.80						
	MADE GROUND consisting of hardcore									
	MADE GROUND consisting of hard purple sandy clay		0.40	1.45		tp12 0.8	D	0.80		
1.0	MADE GROUND consisting of concrete blocks and building rubble		1.00	0.85						
	Loose grey slightly clayey/silty gravelly SAND		1.60	0.25	▽	Q 5517	B	2.00		
2.0										
3.0	End of Trial Pit at 3.00 m		3.00	-1.15						
4.0										

Groundwater Conditions: Water fast @ 2m.

Stability: Pit unstable

Remarks: Pit continually colapsing at 3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP13
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
CO-ORDINATES:	E 325319.11 N 173274.12	Date Completed:	19/05/2005
		Ground Level (mOD):	2.16

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples: Ref. No.	Samples: Type	Samples: Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.20	1.96						
	MADE GROUND consisting of black and grey sand with wood, metal, plastic and white gypsum					tp13 0.8	D	0.80		
1.0										
	MADE GROUND concrete slab		1.60	0.56						
	MADE GROUND consisting of red clay sand and gravel		1.90	0.26						
2.0						tp13 2.3	D	2.30		
	Medium dense grey SAND		2.90	-0.74	▽	P5913	B	3.00		
3.0										
	End of Trial Pit at 3.20 m		3.20	-1.04						
4.0										

Groundwater Conditions: Water fast @ 2.9m. Water was red in colour

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.2m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP14
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
CO-ORDINATES:	E - N -	Date Completed:	19/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10							
	MADE GROUND consisting of brown very sandy gravelly clay with red brick, glass and concrete					tp14 0.5	D	0.50		
1.0	MADE GROUND concrete slab		0.90							
	End of Trial Pit at 1.20 m		1.20							
2.0										
3.0										
4.0										

Groundwater Conditions:

Stability: Pit unstable

Remarks: Attempted to break out concrete with breaker for 45 minutes.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP14A
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
		Date Completed:	19/05/2005
CO-ORDINATES:	E 325270.08 N 173222.28	Ground Level (mOD):	2.27

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.05	2.22						
	MADE GROUND consisting of brown and purple sand, gravel, clay and bitumen					tp14A 0.	D	0.50		
	MADE GROUND consisting of yellow, orange and purple sand with wood, glass and red brick		0.60	1.67						
1.0										
2.0					▽					
						tp14A 2.	D	2.70		
3.0	Medium dense yellow and orange SAND and GRAVEL		3.00	-0.73						
	End of Trial Pit at 3.10 m		3.10	-0.83						
4.0										

Groundwater Conditions: Water fast @ 2.5m with a slight sheen on the water

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.1m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP15
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	19/05/2005
CO-ORDINATES:	E 325292.15 N 173167.98	Date Completed:	19/05/2005
		Ground Level (mOD):	2.93

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples Ref. No.	Samples Type	Samples Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0	MADE GROUND consisting of grey clay									
	MADE GROUND consisting of black clay sand and gravel with red brick		0.40	2.53						
1.0						tp15 0.8	D	0.80		
	Medium dense yellow and orange SAND with half lithified gravel lenses (possible made ground)		1.50	1.43		tp15 1.5	D	1.50		
2.0										
	Medium dense yellow and orange laminated slightly clayey/silty very gravelly SAND		2.50	0.43	▽					
3.0										
	End of Trial Pit at 3.50 m		3.50	-0.57		P5916	B	3.50		
4.0										

Groundwater Conditions: Water fast @ 3.0m. Water was yellow in colour

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.5m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP17
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	20/05/2005
CO-ORDINATES:	E 325350.03 N 173067.25	Date Completed:	20/05/2005
		Ground Level (mOD):	2.82

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of hardcore		0.10	2.72						
	MADE GROUND consisting of clay, sand, gravel, red brick (foundations), plastic and metal					tp17 0.6	D	0.60		
1.0										
	Medium dense yellow slightly clayey/silty gravelly SAND		1.60	1.22		tp17 1.6	D	1.60		
2.0										
3.0					▽	P5923	B	3.00		
	End of Trial Pit at 3.30 m		3.30	-0.48						
4.0										

Groundwater Conditions: Water fast @ 3.1m

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP18
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	20/05/2005
CO-ORDINATES:	E 325302.68 N 173134.40	Date Completed:	20/05/2005
		Ground Level (mOD):	2.90

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of hardcore		0.10	2.80						
	MADE GROUND consisting of grey clay, sand, gravel and concrete									
	MADE GROUND consisting of black and red clay, ash, brick and gravel		0.70	2.20		tp18 0.8	D	0.80		
1.0	MADE GROUND consisting of yellow and orange sand with wood, metal and red brick		1.00	1.90						
						tp18 1.5	D	1.50		
2.0										
3.0	Medium dense yellow and orange SAND and GRAVEL		3.00	-0.10	▽	P5919	B	3.00		
	End of Trial Pit at 3.30 m		3.30	-0.40						
4.0										

Groundwater Conditions: Water fast @ 3.0m

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.3m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP19
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	20/05/2005
CO-ORDINATES:	E 325303.45 N 173094.53	Date Completed:	20/05/2005
		Ground Level (mOD):	2.69

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND concrete slab		0.20	2.49						
	MADE GROUND consisting of red brick (foundations), clay, sad gravel and asbestos					tp19 0.6	D	0.60		
1.0			1.30	1.39						
	MADE GROUND consisting of yellow and orange sand with wood, metal and red brick									
2.0						tp19 2.5	D	2.50		
3.0										
	Medium dense yellow and orange SAND and GRAVEL with shells		3.60	-0.91	▽					
4.0	End of Trial Pit at 4.00 m		4.00	-1.31		P5922	B	4.00		

Groundwater Conditions: Water fast @ 3.6m

Stability: Pit unstable

Remarks: Pit continually colapsing at 4.0m.

REPORT NO. 10755	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Ferrybank Development Arklow	Trial Pit No.:	TP20
		Sheet:	Sheet 1 of 1
CLIENT:	Cardinal Europe Limited	Excavation Method:	10 tonne machine
ENGINEER:	RPS-MCOS	Date Started:	20/05/2005
CO-ORDINATES:	E 325336.64 N 173046.06	Date Completed:	20/05/2005
		Ground Level (mOD):	2.73

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	MADE GROUND consisting of topsoil, black sandy clay.		0.10	2.63						
	MADE GROUND consisting of brown sand, gravel, clay, cobbles, concrete blocks, red brick (foundations), glass and ash					tp20 0.6	D	0.60		
1.0										
2.0						tp20 2.0	D	2.00		
	Medium dense yellow and orange SAND and GRAVEL with shells		2.30	0.43	▽					
3.0	End of Trial Pit at 3.00 m		3.00	-0.27		P5928	B	3.00		
4.0										

Groundwater Conditions: Water fast @ 2.7m

Stability: Pit unstable

Remarks: Pit continually colapsing at 3.0m.

Appendix D

Tobin Environmental Soil and Groundwater Investigation Report (November 2005)

Site Investigation Programme
for
Foudi Limited, c/o ID Partnership Ireland Ltd.
at
IFI Tank Farm Site, Arklow, County Wicklow.

November 2005

FI

TOBIN
Patrick J. Tobin & Co. Ltd.

Table of Contents

1 INTRODUCTION

Tobin Consulting Engineers have been requested by Foudi Limited, c/o ID Partnership Ireland Ltd. to undertake a site investigation programme within a proposed development site on the North Quay of Arklow Harbour.

The site investigation programme was required to address information sought in Item 5 of a Planning Application-Further Information Request, issued by Arklow Town Council on the 22nd September 2005 (Arklow Town Council Planning Application Reference P72/2005).

The exact wording of Item 5 of the Further Information Request is as follows:

Land Contamination:
Having regard to the previous industrial use of the site you are required to carry out an assessment of the contamination of the site arising from that use and to identify any remedial measures required in that regard.

The purpose of the site investigation programme is to gather geological and soil chemistry information from the site, to facilitate an assessment of the presence and significance of contamination of the ground. The overall objective of the investigation is to characterise the contaminants present and also to identify pathways and receptors for the purpose of any eventual risk assessment.

The British Standard on Investigation of Potentially Contaminated Sites – Code of Practice (BS10175:2001) was used for the purpose of carry out the site assessment within the Foudi Ltd. development site,).

This site investigation report is considered to represent the Phase 1 aspect of the Site Assessment. The report includes the following detail:

- Information on the past uses of the site;
- The current setting and use of the site and surrounding area;
- Identification of physical constraints and existing potential hazards within the site boundary;
- Provide information on the sub-terrain materials encountered during the investigation;
- Provide information on the presence and risk of asbestos within the site;
- Description of the site investigation programme;
- Provide information on the chemistry of the sub-terrain material; and
- Provide conclusions of the findings of the site investigation programme and propose recommendations for the future development of the site.

Owing to the presence of storage tanks, bunded walled areas and pipelines across the site, it is not possible to undertake a full site investigation programme at this stage of the planning application process. This investigation can only be undertaken when it is possible to dismantle the existing infrastructure within the site, i.e. tanks, bunded areas, overground and underground service pipework and buildings.

It is suggested, for logistic and technical reasons, that the further site investigations on ground currently occupied by the storage tanks can only be undertaken in the interval following the mantling of the existing infrastructure and prior to construction of the proposed residential development.

The dismantling of infrastructure within the site can only be undertaken when a decision on the Planning Application has been reached. To undertake such dismantling, demolition, and earthworks would constitute unauthorised development and may result in future planning appeals with respect to this application.

This site investigation programme has been designed to undertake intrusive investigations within assessable areas of the site and to acquire as detailed a level of information as possible at this stage of the application. The extent of the investigation has focused on the main areas of potential risk.

It is highlighted that the request in the Further Information that the assessment of the site should be specifically related to the previous industrial use of the site and potential contamination arising from that use.

The intrusive investigation has been concentrated around the existing storage tanks within the site and around the electricity and administration buildings within the site. Some site investigation points have been specifically located in areas of no infrastructure is evident, in order to determine the likely presence of contamination in potentially less sensitive areas of the site.

Based on the findings of the site investigation, the report provides conclusions and recommendations, which may be used by the Local Authority to assess the risk of the site on the environment and by the developer for future works undertaken within the site.

2 PHYSCIAL SITE SETTING

The Foudi site is located to the extreme easterly margin of the North Quay of Arklow Harbour, as shown on Figure 1. The proposed development site is offset from the harbour wall by approximately 30 metres.

The proposed residential development will be constructed within the boundary of the former IFI Tank Farm. The IFI Tank Farm is occupied by 4 No. redundant tanks, which were used as part of the IFI main plant further to the west of Arklow.

The tanks within the farm were used to store heavy fuel oil (2 No. tanks), nitric acid (1 No. tank) and sodium hydroxide (1 No. tank). The position of these tanks in relation to the overall site is shown on Figure 2.

Based on information supplied by IFI to the Environmental Protection Agency (information sourced from IFI IPC Licence data), the nitric acid tank has not been in use for approximately 12 years and the remaining tanks have been redundant for approximately 22 years. IFI representatives indicated to the EPA during previous assessments that the tanks were all empty, however these tanks had not been cleaned out.

Existing documentation for the site suggests that site investigations have previously been undertaken within the site. However, apart from a descriptive summary of the results, which suggests that the site has been contaminated, no detailed information was available with respect to the techniques or extent of investigations undertaken within the site or the information of laboratory analysis of samples. This information would have been desirable to review prior to embarking on this phase of investigation, however it did not result in any significant constraint to the present study, which is a stand-alone investigation.

During investigations within the site, large and thick concrete slabs were encountered at a number of locations across the site, most notably to the extreme north of the site.

During reconnaissance surveys of the site for the purposes of this study, there was no visual evidence that the integrity of the tanks has been compromised. The pump locations of the tanks were visually assessed, with no evidence of significant leakage of material to ground. There are also several redundant loading and discharge pumping stations in this compound, with above and below ground pipelines.

The lagging material around the pipework was of unknown composition and may have contained asbestos. An assessment of this aspect was deemed necessary at this juncture, as special dismantling procedures, handling and deposition measures would be required during site clearance.

All buildings within the site were assessed during the reconnaissance survey. The largest building is to the extreme west of the site. This structure is a large warehouse structure, which is currently used and as a coal/briquette distribution enterprise. A more recent lean-to extension has been constructed to the northern wall of the warehouse structure. This lean-to appears to have been utilised as an administration building during the operation of the IFI Tank Farm. Two electrical supply buildings (Main Electrical Room and Electrical Switch Room) were noted to the south and east of the tanks.

Access to the immediate environs of the storage tanks is significantly hampered due to the existence of earthen berms and blockwork bund walls around the tanks. Significant alignments of pipework are still in-situ adjacent to the tanks. Underground electrical ducts were also apparent from open manhole access chambers.

3 HISTORICAL ACTIVITIES ON ARKLOW HARBOUR

A literature review was undertaken to determine the nature and extent of historical industrial activities undertaken in Arklow. This review was considered pertinent, owing to the historical importance of Arklow, with respect to industrial activities, as Arklow has a long history of industrialisation.

Copper mining in the Avoca Mines has been undertaken for centuries. It is highly probable that the material used to infill the River Avoca estuary and build up a harbour wall was sourced from mine waste/stripped overburden generated from the Avoca Mines. This hypothesis is proposed as a large volume of material would be required for infilling and there was a ready supply of mine waste/surplus overburden available from the Avoca mines. Also, there is no other land scar in the Arklow area to indicate such quarrying/mining. The creation of a harbour at Arklow would have greatly facilitated and significantly decreased costs for export of ore from Ireland to Britain.

In the 1860's a chemical factory was established on the north Arklow Harbour area. This chemical factory was established to utilise the sulphur-containing by-products of the slag from the mines (i.e. pyrites). Sulphuric acid, nitric acid, acetone and fertilisers were produced at the factory. In 1894 Kynoch's, an English explosives and munitions company took over the chemical works and also constructed a factory, in order to produce high grade explosives. This plant produced nitroglycerine, guncotton, cordite and picric acid. The chemical works were required by Kynoch to provide acid and acetone for the explosive manufacture. Production at the Kynoch plant continued until 1918, however a gradual rationalisation of the explosive manufacture lead to the eventual formation and expansion of the production of fertilisers at Arklow, due to the availability of the proximal chemical works.

Although relocated from the Harbour to the IFI Main Production Site, the last Sulphuric Acid plant ceased production in 1982, when the supply of pyrites from Avoca mines stopped.

Over the centuries, the power used in the industries around Arklow would have been generated by steam, which would have involved large coal burning plants. This activity would have resulted in large scale import and storage of coals in the harbour area. Also following burning, the cinders and other by-products of the chemical industries would have been discarded to land, most likely proximal to the plant. These industrial activities would have lead to large scale historical contamination of lands along the harbour and in large parts of Arklow.

4 GEOLOGICAL AND HYDROGEOLOGICAL SETTING

Relevant information from the Geological Survey of Ireland (GSI) was sourced to determine the geological and hydrogeological setting of this site. A Groundwater Protection Scheme for the County Wicklow has been prepared by the GSI, on behalf of Wicklow County Council.

The 1:100,000 scale map for the Arklow area (Geology of Carlow-Wexford, Sheet 19, 1994) indicates that the proposed site is underlain by Kilmacrea Formation and/or the Maulin Formation. The Kilmacrea Formation is composed of dark grey slate and minor beds of pale sandstone. The Maulin Formation is composed of dark grey slate, which is mica rich. The Kilmacrea Formation and the Maulin Formation were deposited from fine grained material deposited in a deep marine environment during the Ordovician Period (i.e. 510 to 438 million years ago).

Unconsolidated subsoil material overlies bedrock, with no outcrops recorded in the vicinity of the site. The origin of the subsoil material is associated with the movement and deposition of glaciers during the last Ice Age. The ice sheet would have ground down the underlying bedrock, breaking the rock and grinding it to small sizes, ranging from clays to boulders. The powerful erosive forces of the ice sheets are considered to have moulded/sculpted the existing landscape of this area.

Detailed Quaternary information suggests that the Ice Sea Ice Sheet, which would have moved from Scotland down the Irish Sea to the south would have been the dominant glacial feature. Irish Sea Till deposits are dominated by clay material. Owing to the location of the site within the estuary of the River Avoca, deposition of fluvial alluvium deposits would have continued after the last glaciation, leading to accumulation of varied material and debris.

The Groundwater Protection Scheme for County Wicklow indicates that the thickness of natural unconsolidated material in this area ranges from 3m to 5m. It is considered likely that the unconsolidated materials immediately adjacent to the River Avoca are considerably thicker, due to powerful meltwater erosion of the river channel at the end of the last glaciation.

Reference to 19th Century field sheets for the site (1:10,560 scale) indicates that the natural setting of this area is one of low-lying waterlogged conditions. This is not unexpected owing to the location of the site to the River Avoca estuary and the marine environment.

While the bedrock environment of the site has not been altered due to human activities, the site has been altered through infilling on top of natural subsoil materials. Significant infilling of materials has occurred along both the north and south banks of the River Avoca during the 19th century, to form a north and south harbour quay. This infilling has resulted in reclamation of lands and the creation of a north and south harbour wall.

The aquifer potential of the Killmacrea Formation and the Maulin Formation is classified by the GSI as comprising a Locally Important Aquifer, which is moderately productive only in localised zones (GSI Aquifer Code Ll).

Notwithstanding the aquifer potential of the bedrock, the quality of the groundwater beneath the site is considered poor owing to the proximity of the site to the marine environment (i.e. brackish water) and also the industrial uses within the site over approximately 150 years.

The groundwater beneath the site is considered to be significantly impacted by a tidal water level fluctuations. During periods of low tide, groundwater from the site discharges to the marine environment. However, during high tide, the marine environment is considered to backflow into the site and infilled material, i.e. seawater intrudes beneath the site. The effect of this tidal water level fluctuation is that material infilled within the site has been effectively washed periodically (i.e. approximately twice daily) since it was deposited within the site.

5 ASBESTOS SURVEY WITHIN THE SITE

Owing to the uncertain nature of lagging around the tanks and pipework within the site, Tobin Consulting Engineers engaged Asbestos Consultancy Services Ltd. (ACS) to undertake an inspection of the site. This assessment was undertaken on the 14th October 2004.

The asbestos survey was conducted in accordance with the UK Health and Safety Executives Guidelines "MDHS 100" Type 3 (demolition).

During the course of the assessment ACS acknowledged that the site was relatively open and most features was accessible.

The item of preliminary concern relates to the insulation lagging around the pipework and tanks. ACS determined that this insulation comprised rockwool insulation and no asbestos was found.

The buildings within the site are predominantly roofed with single skin asbestos cement sheeting. Asbestos cement gutters and down-pipes were also noted. Removal of this material can be undertaken by an experienced contractor and does not need specialist involvement.

ACS investigation the electrical supply rooms and other potential areas of the site for the presence of asbestos containing substances. Asbestos vinyl floor tiles were recorded within the administration building to the west of the site. This material can be removed by an experienced contractor and does not require specialist involvement. A single asbestos insulation spark board was found in the main electrical shed, which ACS removed for sampling. This has since been disposed of by ACS in an approved manner.

A copy of the full asbestos survey undertaken by ACS is included in Appendix A of this report.

6 SITE INVESTIGATION PROGRAMME

The purpose of this site investigation programme was to address the Further Information request by Arklow Town Council (Item 5).

The exact wording of Item 5 of the Further Information Request is as follows:

Land Contamination:
Having regard to the previous industrial use of the site you are required to carry out an assessment of the contamination of the site arising from that use and to identify any remedial measures required in that regard.

In order to determine the nature and extent (both lateral and vertical) of below ground materials existing within the site boundary, Tobin Consulting Engineers designed a site investigation programme.

In the design of the intrusive site investigation, certain constraints existed within the site. These constraints entailed restrictions at which investigation could not be conducted due to the presence of built structures, storage tanks, block and earthen embankments, very thick concrete slabs and overground and underground pipework.

BRG Ltd. were contracted to carry out the site investigation programme, which entailed the intrusive drilling using window sampling techniques. The work was conducted using Pionjar jackhammer percussion drills. A continuous profile of the overburden stratigraphy was retrieved in the samplers and the material was logged to British Standard BS5930:1999 specification.

In total 10 No. window sample holes were drilled across the site. The position of the drill holes were agreed between Tobin Consulting Engineers and BRG Ltd. prior to the commencement of investigations, based on site logistics. The location of the drill sites are shown on Figure 2, with the window sample logs included in Appendix B. All intrusive investigations were undertaken between the 14th and 15th October 2005.

Prior to commencement of drilling a rockbreaker was used to clear surface concrete. All proposed sites were swept with CAT scanner to ensure no buried pipework or electrical ducts were encountered, to maintain a safe working environment.

Each window sample hole continued to depths ranging from 2.0m to 3.0m below ground level. Made Ground was encountered in each hole and varied in thickness significantly across the site, from 0.2m to 1.8m thick. The made ground generally consisted of brown to orange brown sandy to gravelly material, with inclusions of red

bricks, glass and coal slag. Modern waste, comprising plastic bag and tyre rubber was encountered within one window sample hole (WS9) to the southwest of the site, towards the property boundary with the harbour road. Window sample hole WS9 is located immediately adjacent to an electricity switch room, which appears to be a relatively modern construction structure. It is likely that the modern waste was deposited in this area during excavation for this structure.

The Made Ground encountered in each window sample is considered to have been in-situ for a considerable duration, and most likely is the infill material used to reclaim the low lying marine environment during the construction of Arklow Harbour. The coal slag encountered intermixed with the sandy/gravely material suggests that at some time in the past either coal was stored on this part of the harbour or fuel ash/cinders from furnaces were deposited in this area. Such scenarios are considered reasonable, owing to the known historical industrial activities in Arklow. The IFI activities within the site would have been constructed on top of this made ground material. The site investigation programme has undertaken analysis to determine the potential contamination from historical sources as well as those posed purely by the IFI activities within the site.

It should be noted that it is highly probable that the Made Ground encountered within the IFI Tank Farm site exists over a significant adjacent area of Arklow Harbour. The ground was raised and reclaimed along the entire length of the north and south bank of the River Avoca estuary to form Arklow Harbour. Therefore, the analysis of the potential contaminants within the Made Ground within the IFI site could be inferred to the entire harbour area.

All window samples continued to a sufficient depth to encounter natural subsoil material. The natural fluvial subsoil comprised fluvial/marine, loose to medium dense, Sand and Gravel, with occasional lenses of Sandy Clay.

A sample of the material encountered in each hole from the depth interval between 0.5m to 1.5m, was retrieved for chemical analysis. The material retrieved from window sample holes WS2, WS4, WS5, WS6, WS8 and WS9 was from the made ground. The material retrieved from window sample holes WS3, WS7 and WS10 was from the natural subsoil material existing beneath the site. The material retrieved from window samples hole WS1 straddled the made ground/natural subsoil. Each sample was collected in laboratory designated sample containers. The samples were submitted to Alcontrol Laboratories Ltd. on 17th October 2005.

The suite of parameters requested are considered sufficiently extensive to assess the contaminant potential of the site. The list of parameters tested was based on the materials known to be stored in the tanks within the site, but also based on the nature of the Made Ground encountered at each investigation point.

The parameters analysed to determine the potential impact of the IFI activities included the following:

- Diesel Range Organics, Mineral Oil, Petrol Range Organics and BTEX Compounds (to specifically determine if leakage to ground occurred from the Heavy Fuel Storage Tanks);
- pH, Alkalinity and Sodium (to specifically determine if leakage to ground occurred from the Nitric Acid or Sodium Hydroxide Storage Tanks); and
- Select samples for analysis of Polychlorinated Biphenyls (PCB) (to specifically determine if any materials were discharge from electricity transformers in the past).

The parameters analysed to determine the potential impact as a result of the materials used to infill and reclaim the lands in this area included the following:

- Polycyclic Aromatic Hydrocarbons (PAH) (to determine the impact of such material within the Made Ground);
- Heavy Metals (to determine the impact of the Made Ground, which appeared to originate from surplus and unusable mining waste).

Sufficient sample was retrieved from each window sample hole to allow analysis of all required parameters. The analysis of the soil samples and interpretation of the results are provided in Section 7 below.

7 INTERPRETATION OF SOIL/GROUNDATER SAMPLES

The results of the soil analysis are presented in Table 1 below. The sample locations, relative to the site infrastructure are shown on Figure 2. The full analytical report from Alcontrol Laboratories Ltd. is included in Appendix C.

As discussed in Section 6 above, the suite of parameters analysed were chosen to specifically assess the following:

- The potential impact on the subterrain environment as a result of the activities associated with the IFI storage tanks within the site; and
- The potential impact on the subterrain environment as a result of the infilling of material during the construction of the North Quay of Arklow Harbour.

Contaminant Potential due to IFI Storage Tanks

The concentration of Mineral Oil, Petrol Range Organic Compounds and BTEX Compounds are below the detection limit of the laboratory. The limits of detection are of a sufficiently low range to indicates that there is no contaminant potential posed by free hydrocarbon fuel product in the soil environment.

The analysis detected elevated concentrations of Diesel Range Organic Compounds in all samples. However the independent interpretation of the DRO results by the laboratory suggests that the elevated DRO concentration are false positives as a result of the presence of Polycyclic Aromatic Hydrocarbon (PAH) Compounds. This interpretation is further supported by the fact that the Mineral Oil Concentration is below detection limit for all samples. The presence of PAH compounds in the ground is considered to be a historical legacy rather than as a result of activities associated with the IFI activities. This is discussed further below.

It is therefore submitted that the sampling programme indicates that the ground environment has not been contaminated due to the storage of heavy fuel within the storage tanks within this site.

The pH was analysed for each sample to assess if leakage of acids or caustic material has occurred. The pH of the samples varies from 5.26 (WS9) to 10.66 (WS 6), i.e. from slightly acidic soils to basic soils.

The pH from WS6 is significantly higher than the other results, however WS6 is positioned to the west of the Sodium Hydroxide Storage Tank. While a pH of 10.66 is considered slightly elevated, the value does not indicate a leakage of sodium hydroxide to ground. The concentration of Sodium Hydroxide had occurred, the pH

and Sodium concentrations would be elevated, which is not the case.

The minimum pH levels of the samples is 5.26. It would be expected that the pH levels would be significantly lower if leakage of nitric acid had occurred within the site.

The Alkalinity of the samples varies from 50mg/kg to 300mg/kg. As with the pH values, there is no apparent pattern to the values and nothing to suggest any elevated alkalinity values in the environs of the Sodium Hydroxide storage tank or the Nitric Acid storage tank.

It is submitted that range of pH values determined in the analysis does not suggest there is evidence of leakage of acids or hydroxide from the storage tanks.

As part of the analysis, 3 No. samples (WS5, WS6 and WS8) were chosen for analysis of Polychlorinated Biphenyls (PCB) compounds. PCB compounds were used by the ESB in electricity transfer stations in the past, due to their excellent electrical transfer properties. However, their use was discontinued due to concerns about their toxicity to humans and their persistence in the environment. This investigation considered it prudent to determine if any PCB was present around any of the buildings within the site, which may have been previously used as electricity transfer stations.

The results of the analysis indicates that no PCB was found in the three soil samples and it may reasonably be inferred that no discharges of PCB Compounds has occurred within the site.

With respect to the previous activities associated with the IFI Tank Farm, the results of the analysis does not suggest that the storage of heavy fuel oil, nitric acid and sodium hydroxide has resulted in contamination has resulted in contamination of the soil environment. It is acknowledged that storage of materials within this site was discontinued approximately 12 years ago, however it ground contamination had occurred some evidence of such would have been determined in the analysis.

Contaminant Potential due to Made Ground

Based on the nature of the material encountered at each sampling location, it was considered appropriate to include for analysis for the Made Ground. It is considered that this material has been in-situ for a considerable period and was most likely deposited during the construction of the North Quay. Owing to the landform along the North Quay, similar Made Ground occurs along the entire length of the North Quay.

The Made Ground encountered at each sampling point comprised brown to orange brown sandy to gravely material, with inclusions of red bricks, glass and coal slag. The Made Ground was quite distinctive from the natural mineral subsoil materials.

Analysis of the made ground was requested to determine its potential contaminant loading. A range of heavy metals were analysed, as well as the range of Polycyclic Aromatic Hydrocarbons (PAH) Compounds. PAHs are found in heavy fractions of petroleum distillation, asphalt, coal and from the incomplete combustion of fossil fuel (furnace ash, gas works clinker, etc.).

All samples retrieved from the site display elevated concentrations of PAH, with significant elevation noted from window sample point WS1, WS2, WS7 and WS9. The source of the PAH is considered to be the material described as Coal Slag, which was encountered in most sampling points. While it is not possible to definitively define the source of this material, it is intermixed with the Made Ground and is most likely of similar age. The material may have been generated due to the storage of coal reserves on the harbour wall or from deposition of furnace ash/clinker following combustion in furnaces.

The concentration of heavy metals varies, depending on the element analysed. The concentration of Cadmium, Mercury and Selenium for all samples is below the detection limit of the laboratory. The concentration of Chromium is slightly elevated, but at the range detected (6-31mg/kg) it is most likely representative of background concentrations. It is noted that the concentration of Chromium is well below the Target Level indicated in the Dutch Guidelines.

The concentration of Copper, Zinc, Lead and Arsenic are significantly elevated, and in most cases the results are above the Dutch Limits. The chemical results support the view that the Made Ground along the Harbour Wall was sourced from mining waste. The Avoca Mines were principally mined for Lead, Zinc and Copper, with the presence of Arsenic most likely a natural occurrence.

The soil sampling results suggest that the Made Ground material used to form the Harbour Wall is contaminated with elevated concentrations of heavy metals and PAH. This contamination is most likely occurring along the entire length of the harbour wall and is not isolated to the IFI Tank Farm Site.

Risk Assessment

Risk assessment represent a tool that can be used to identify, on a site specific basis, the extent of risk to human health or the environment. A risk assessment is an objective and scientific effort, using a systematic approach, to assess the potential impact on the overall environment. The conventional Hazard Pathway Target model for environmental management is considered the most appropriate method for assessing the risk at this site.

The chemical analysis of the samples retrieved during the site investigation programme suggests that the IFI storage tanks have not resulted in any significant contamination of the soil environment. However, the Made Ground deposited along the North Quay, to facilitate land reclamation and construction of the Harbour Wall, has been shown to contain potential contaminants, namely high concentrations of heavy metals and PAH compounds. The metals and PAHs represent the hazard in the risk assessment.

The pathway for contaminant transport is the absorption of contaminants to infiltrating waters. However, most metals have a fairly limited mobility in soils and groundwater. The coal slag described in the site investigation points is bound within the Made Ground and this may also limit the PAH mobility.

The marine environment represents the only potential target in this risk assessment. There are no beneficial users of groundwater between the site and the marine discharge point. The River Avoca water quality has been significantly impacted by past industrial activities within the catchment. It is widely acknowledged that the quality of the River Avoca has been significantly adversely impacted by discharges from the currently disused Copper and Sulphur Mines. The risk significance of the Made Ground should be assessed with regard to the overall catchment system. When this is assessed, the proposed site does not pose a significant risk to the marine environment.

Owing to the setting of the site, the Made Ground occurs from the interval above the low tide mark to approximately 1.5 to 2m above the high tide mark (i.e. the natural setting of the site is a estuarine mud bank). Therefore, the Made Ground has been repeatedly (approximately twice daily) inundated with seawater. The persistence of the metals and PAHs in the Made Ground serves to highlight the limited mobility of the contaminants.

Owing to the nature of the historical contamination, i.e. metals and PAHs, remediation options are significantly limited. The distribution of the historical

contamination within the site is not such that discrete pockets of material could be excavated and removed. The contaminated material occupies the entire site and most likely the entire length of the North Quay. It is not considered feasible or appropriate to excavate all of the Made Ground from the site, as it is probable that the integrity of the Harbour Wall in the environs of the development site would be undermined by such works.

The contaminants within the Made Ground have been present in this area of Arklow for a significant period (centuries). Owing to the limited aquifer potential beneath the site and the proximity of the marine environment, the risk significance is considered low.

The potential end-use of this site is for the construction of residential accommodation structures. The presence of elevated metals and PAHs does not pose any occupancy risk, as there is no risk of gas generation.

It is suggested that the most appropriate option of further development of this site is to allow the Made Ground to remain in-situ. During construction within the site, if any surplus materials are generated, this should be subjected to analysis and disposed of appropriately, i.e. deposited in appropriately licence landfill (KTK Landfill) or transferred to an appropriately licensed contaminated soil transfer station (SITA Greenogue Site). These disposal options can only be finalised when the soil analysis of the surplus materials is available.

The remainder of the site should be levelled and prepared for construction. The construction of serviced hardstanding and structures within the site will significantly decrease the infiltration of rainwater to ground.

Parameter	Unit	Dutch Limits		WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS8	WS9	WS10
		TV	IV										
Natural Moisture Content	%			10.3	18.6	15.6	5.4	20.4	16.7	13.2	12.4	11.6	10.6
PH				7.69	6.57	5.39	8.14	5.71	10.66	5.44	6.87	5.26	5.97
Diesel Range Organics (Note 1)	mg/kg			862	937	701	27	67	61	131	185	58	158
Mineral Oil	mg/kg	50	5000	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Petrol Range Organics (C5-C9)	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Petrol Range Organics (C10-C12)	mg/kg			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	mg/kg	0.05	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	mg/kg	0.05	130	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	mg/kg	0.05	50	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Xylene	mg/kg	0.05	25	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PCB	mg/kg							0.001	0.001		0.001		
Total PAH	mg/kg	1	40	1,180.58	183.55	19.48	5.09	18.91	12.77	57.24	20.40	221.38	3.72
Total Alkalinity	mg/kg			100	50	100	300	50	300	50	250	100	150
Sodium	mg/kg			305	331	1213	485	2177	603	1367	939	902	479
Arsenic	mg/kg	29	55	<0.5	341	3554	<0.5	441	108	585	489	846	144
Cadmium	mg/kg	0.8	12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	mg/kg	100	380	15	12	6	17	14	19	16	13	14	31
Copper	mg/kg	36	190	139	1153	970	187	1063	812	3578	3563	1705	1047
Lead	mg/kg	85	530	419	1918	2225	369	7762	1275	2751	3445	2941	2423
Mercury	mg/kg	0.3	10	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	mg/kg			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/kg	140	720	233	725	1086	329	1467	574	1966	3634	2793	512
Note 1: Analysis of the Gas Chromatographs for the DRO indicates that the elevated concentration are attributed to the presence of PAHs													

Table 1: Analytical Results of Soil Samples from IFI Tank Farm Site

8 CONCLUSIONS AND RECOMMENDATIONS OF SITE INVESTIGATION PROGRAMME

- This site investigation programme was undertaken to address a specific request from Arklow Town Council in correspondence requesting Further Information on a Planning Application lodged by Foudi Ltd. (Planning Ref.: P72/2005).

- Foudi Ltd. propose to redevelop this site for residential end-use.

- The proposed development site is located to the extreme easterly margin of the North Quay of Arklow Harbour. The site is offset from the Harbour Wall by approximately 30 metres.

- The purpose of the site investigation was to gather geological information and chemical data to facilitate an assessment of the presence and significance of contaminants in the ground.

- The site investigation undertaken within the site and detailed in this report was as detailed as possible at this stage of the project. The existence of infrastructure within the site, associated with its previous industrial use, created certain physical constraints.

- This site was previously in the ownership of IFI and was used as a storage depot for Heavy Fuel Oil, Sodium Hydroxide and Nitric Acid. These materials were stored in the tanks still existing within the site. Existing information suggests that the storage tanks have not been used for periods ranging from 12 to 22 years.

- A reconnaissance walk –over survey of the site was undertaken, to assess the site and to allow adequate scoping of the site investigation programme. This walk-over survey of the site suggested that the storage tanks were still of high integrity and no visual evidence of leakages to ground was apparent.

- An asbestos survey of the site revealed that the tank insulation lagging. The only asbestos containing materials were the cement roof sheeting and vinyl floor tiles.

- During any development works within the site, the developer shall engage a suitably trained and experienced contractor to remove this material. The contractor shall have a plan of work available for inspection by any interested party. The materials shall be appropriately handled and exported to an approved and licensed disposal site. All documentation shall be retained and issued to the developer.

- The natural geological and topographic setting of this site has been impacted by human intervention. The land along Arklow Harbour (both North and South Quay) has been infilled with material, with the objective to raise the elevation of the lands and create a harbour to facilitate marine activity. The creation of Arklow Harbour is centuries old.

- The natural subsoil, beneath the Made Ground, is likely to comprise a sequence of estuarine sands and gravels, with interbedded clay bands. Available geological information indicates that the bedrock beneath the site comprises either the Kilmacrea Formation or the Maulin Formation, both of which are classified by the Geological Survey of Ireland as being Locally Important Aquifers.

- The site is very proximal to the marine environment and would be naturally below the high tide mark, but for human intervention. The quality of the groundwater is considered such that it would have no beneficial end-use for human purposes.

- A literature review of available information indicates that the North Quay of Arklow Harbour has a long industrial history. Industries associated with acid manufacture and explosives and munitions manufacture have operated in the general vicinity of the subject site in the past 150 hundred years. Also this are of Wicklow has an even longer association with mining, which have resulted in significant degradation of the environment to the present day.

- Owing to the existence of the storage tanks, built structures, earthen embankments, block-work bund walls and above ground pipework, access to certain areas of the site were restricted.

- As part of this site investigation programme, 10 No. window sample holes were drilled within the site, to depths ranging from 2.0m to 3.0m below ground level.

- Made ground, comprising brown to orange sandy to gravelly material, with inclusions of red bricks, glass and coal slag was encountered from depth ranges 0.2m to 1.8m bgl. All sampling points continued to a sufficient depth to intercept natural subsoil material, which comprised a sequence to sands and gravels.

- The chemical analysis of the samples, from the depth range 0.5m to 1.5m was conducted to determine the contaminant potential presented by past IFI activities and the contaminant potential presented by the infilling of materials during the construction of the Harbour Wall.

- The chemical analysis does not suggest that the soil environment has been impacted by the storage of materials within the site, namely the storage of heavy fuel oil, sodium hydroxide and nitric acid.

- The chemical analysis does suggest that the composition of the Made Ground presents a contaminant potential, due to elevated concentration of heavy metals (Copper, Zinc, Lead and Arsenic) and Polycyclic Aromatic Hydrocarbon (PAH) Compounds.

- The qualitative risk assessment of the site indicates that there is limited potential for mobility of the heavy metals and PAH compounds from the Made Ground. The only potential target is the marine environment and there is not further potential for exploitation of the underlying aquifer, due to its proximity to the marine environment.

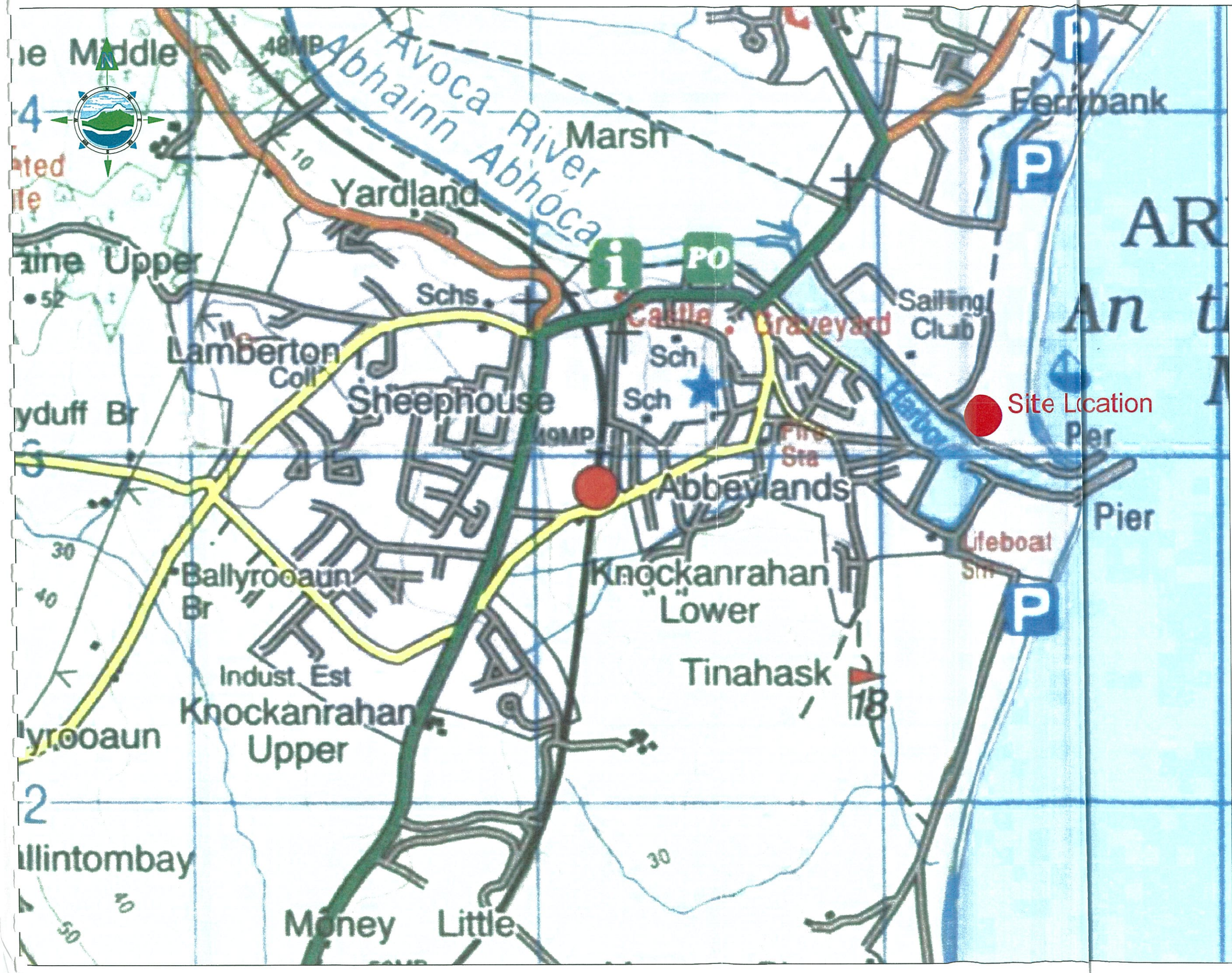
- There is limited remedial measure for in-situ remediation of heavy metals and PAH compounds associated with coal slag/furnace ash. The extent of the Made Ground is considered to be extensive along the entire North Quay area and is not limited to the IFI Tank Farm site.

- It is suggested that owing to the age of the infill material, its probable lateral extent along the North Quay and the low risk significance, the most appropriate manner for dealing with the site is to allow the made ground remain in-situ. The development proposal envisages constructing at the approximate current day ground level, and there will be no basement excavations. Any excess material generated during site preparation will be tested prior to export from the site and disposed of in an approved and licensed facility.

- Subject to Planning Approval being granted by Arklow Town Council for this development, it is recommended that the storage tanks are carefully dismantled and cleaned to ensure any residues within the tanks do not result in emissions of potential contaminated materials. The dismantling of the pipework should also follow similar procedures.

- Owing to the nature of the materials previously stored within the tanks, the appointed contractor should prepare detailed Method Statements for the dismantling and disposal of all excess material, including soils, metals, lagging, etc. This Method Statement should be issued for agreement to the Planning Authority prior to commencement of works.

- Following the dismantling of the structures within the site and based on structural assessment of the concrete tank foundations, it may be necessary to undertake additional drilling and sampling in the immediate environs of the tanks. It is suggested that this work would only be necessary if cracks or other defects are visual from the tank foundations.



NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
3. ENGINEER TO BE CONFIRMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Issue	Date	Description	By	C
B	JUNE 05	Revision of Site Layout	J.S.	N

Client: Foudi Ltd c/o ID Partnership Ireland Ltd.

Project: Residential Development, Arklow

Title: Regional Site Location

Scale @ A1: 1:10,000 @ A3

Prepared by:	Checked:	Date:
MC	CP	NOV 200

Project Director: JPK

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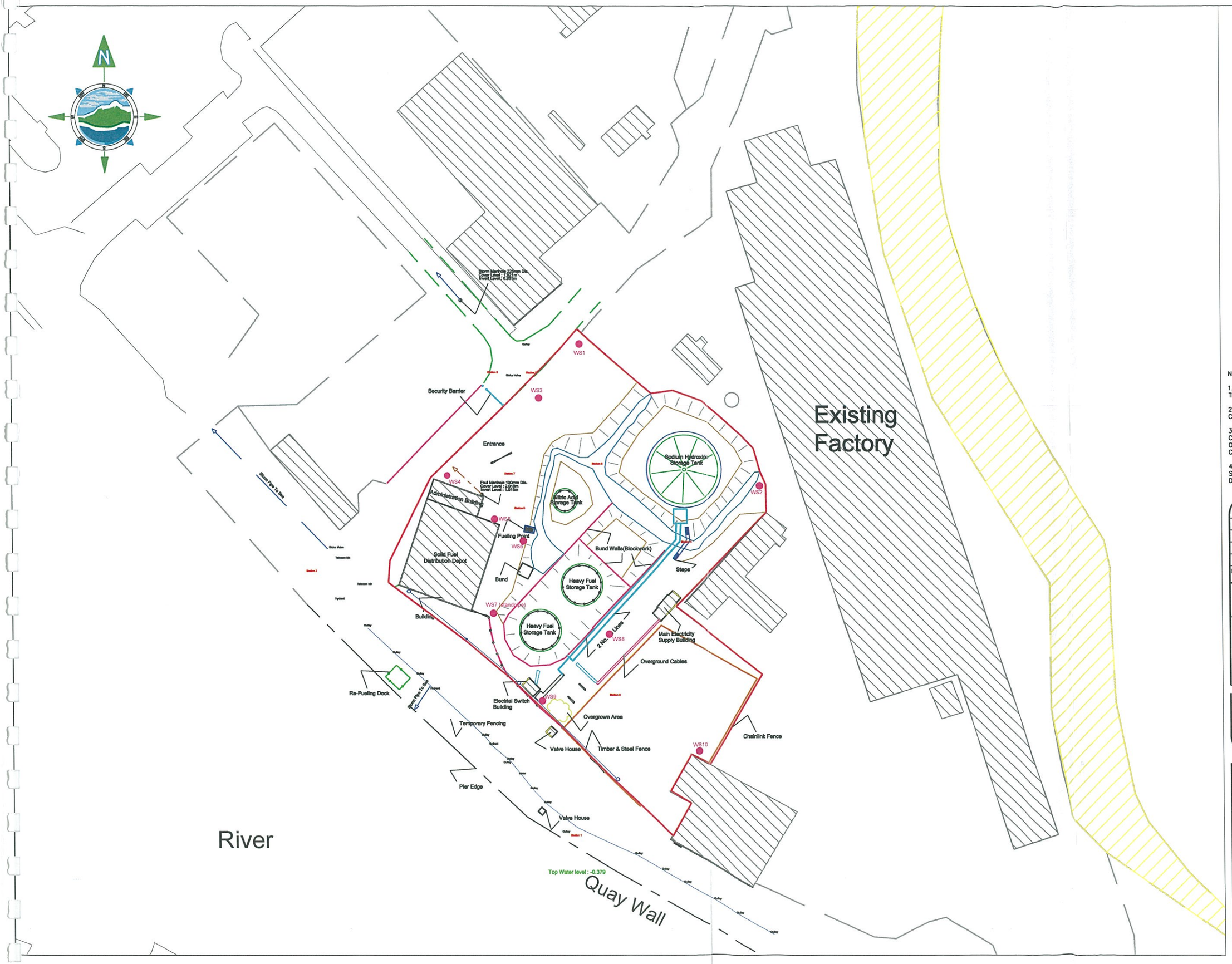
Drawing No.: Figure 1 | Issue B



N O T E S

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING

2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE

3. ENGINEER TO BE CONFIRMED BY THE CONTRACTOR
OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES

4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY
DATUM AT MALIN HEAD

Issue	Date	Description	By	C

Client:
Foudi Ltd. c/o ID Partnership Ireland Ltd.

Project:
Residential Development, Arklow

Title:
Site Layout and Site Investigation Locations

Scale @ A1: 1:1000 @ A3

Prepared by:	Checked:	Date:
MC	CP	NOV 200

Project Director: JPK

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Drawing No.: Figure 2

Issue: A

APPENDIX A

ACS Ltd. Asbestos Survey Report

Asbestos Consultancy Services Limited

A C S Limited

Project Supervision
Air Monitoring
Surveys
Sample Identification

CONFIDENTIAL REPORT

Client:
TES Consulting Engineers,
Unit 10/3,
Blanchardstown Corporate Park,
Dublin 15.

Attention: Mr. Mark Conroy

Title:
Asbestos Survey of Former IFI
At Arklow, County Wicklow

Report ref. ACS 5-495 **Order no: e mail**

Date recd: 10th October 2005 **Report by: P. G. Byrne**

Copies to: **Date:** 18th October 2005

CONDITIONS

CLIENT WORK – TERMS AND CONDITIONS OF ACCEPTANCE

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2. This report shall only be reproduced in full.
3. The client is responsible for delivery to Asbestos Consultancy Services Limited of test item(s) free of any duty, VAT, freight charges etc., unless otherwise agreed in writing by Asbestos Consultancy Services Limited.
4. The client shall be responsible for collecting non-perishable samples received for inspection, testing or laboratory work upon completion of the work. If the client fails to collect such samples within 30 days following completion of the work, Asbestos Consultancy Services Limited shall be entitled without further notice to dispose of the samples.
5. Payment for work carried out shall be in accordance with the terms stated on Asbestos Consultancy Services Limited Invoices.
6. The laws of Ireland shall apply.

Introduction.

As part of corporate due diligence and in advance of any future building work Asbestos Consultancy Services Ltd was requested to inspect the former IFI Tank Farm (the new Foudi site), Arklow. This was undertaken on the 14th October in the presence of the client and his assistance is acknowledged. The survey was carried out in accordance with the UK Health and Safety Executives Guideline "MDHS 100" Type 3 (demolition). Six samples were removed for laboratory analysis and the results are included at the back of this report.

Asbestos Sources and their Locations.

The approximate locations of the photographs are noted on the appended site plan.

1. Asbestos Sprayed Coatings.

None were found during the survey.

2. Asbestos Thermal Insulations (laggings).

None were found during the survey. Plates 1, 2 and 3 show rockwool insulation on the pipes near the entrance, beside the insulated tank and on the tank itself respectively. This was the only thermal insulation noted during the survey.

3. Asbestos Fibre Board.

This is a soft, plaster-like board, which can contain up to 40% brown asbestos. It was used as a fire stop in ceiling voids, partitions, lift-shafts, firedoors and in ceiling boards and tiles. It came in the form of eight by four foot sheets, cut to suit the application and four by two and two by two foot ceiling tiles. It was replaced around 1980 by an asbestos free substitute called "Supalux".

Plate 4 shows an asbestos insulation board spark guard in the main electrical shed. It was removed as part of the sampling exercise and has since been disposed of in an approved manner. No other boards were noted during the survey.

4. Asbestos Cement Products.

These typically contain 10 to 15% white asbestos, whose fibres are firmly bound into the cement matrix. Thus, unless cut, drilled, wire brushed or otherwise severely abraded, will not give rise to detectable levels of fibrous dust. Asbestos cement products include corrugated sheets, guttering, ridge tiles, down pipes, sewer and flue pipes, flat panels, water tanks and roof tiles.

Plate 5 shows the single skin asbestos cement roof on the fuel shed which measured approx 25m long and 24m wide with the apex rising approx 5m above the eaves. This would give the roof an area of approx 650m^2 and Plate 6 shows asbestos cement gutters and down pipes. Plate 7 shows a small (approx 10) amount of asbestos cement sheets on the main electrical shed. Plates 8 and 9 show asbestos cement wall and roof panels on a shed and prefab building outside but adjacent to the site. Asbestos cement products can be removed by any trained, experienced contractor. Notification to the Health and Safety Authority is not required but a plan of work must be kept available for inspection on site. However given the sensitive location of the site it is recommended that, as a courtesy, the Health and Safety Authority be informed and for the same reason it is also recommended that at least one set of reassurance air tests be taken during the removal. Once removed the sheets must be double wrapped in heavy duty polythene before disposal in an approved landfill such as KTK in Kilcullen, Co. Kildare.

5. Asbestos Rope, Gasket and Other Sealants.

Plate 10 shows an asbestos gasket lying on a catwalk beside the insulated tank and this would indicate that others may be entombed between the pipe flanges. The usual method of removal is to cut either side of the flange leaving the gasket intact. When the metal is recycled the gasket will be reduced to harmless ash.

6. Asbestos Textured Coatings.

Artex and other textured coatings contain a small quantity (less than 5%) of white asbestos but none were found during the survey.

7. Asbestos Vinyl Floor Tiles.

Some older vinyl floor tiles are known to contain a small quantity of white asbestos, as does the more commonly encountered bitumen adhesive. Thus, any tile in contact with the adhesive, whilst perfectly safe in use, must be disposed of as asbestos waste.
Plate 11 shows floor tiles with a bitumen adhesive in an end room (less than 20m^2) of the administration block. The removal and disposal is carried out as per asbestos cement products.

8. Asbestos Millboard and other Paper Products.

Asbestos millboard is a form of compressed paper product, often associated with electrical switch gear, fuse boards and appliances. None were found during the survey.

9. Other Asbestos Sources.

Plate 12 shows a Shires "Lynx" cistern in an external toilet adjacent to the administration block. These are known to contain brown asbestos but their removal and disposal are an easily managed detail.

10. Non Asbestos Sources.

Plate 13 shows the felt patch on the sink in the administration block. Older patches contained white asbestos but analysis of the sample taken showed it to be asbestos free. The same result was obtained for the webbing on the valves beside the insulated tank (Plate 14) and no asbestos was noted in the electrical switch room (Plate 15) beside the entrance.

11. Exclusions.

The site was relatively open and most features were accessible. However experience has shown that asbestos sources can be found entombed in the most unpredictable of places, thus if during any future building work a suspect material is uncovered it must be regarded as potentially hazardous and left undisturbed until its identity can be confirmed by laboratory analysis and the result added as an addendum to this report.

Plate 1 – Rockwool on Pipes at Entrance to Tank Farm

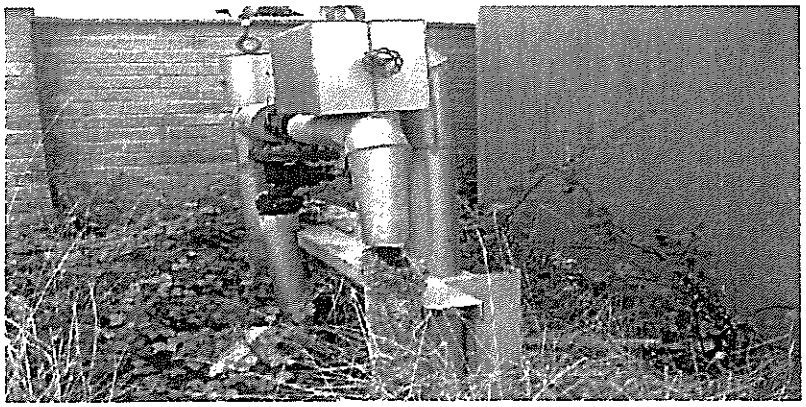

Plate 2 – Rockwool on Pipes beside Storage Tank

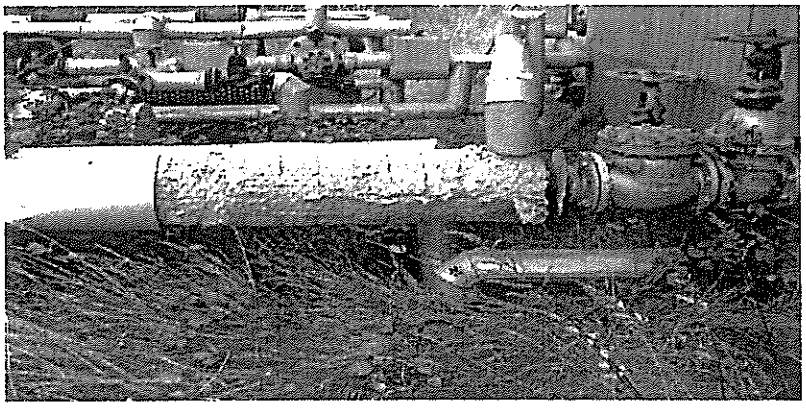

Plate 3 – Rockwool Insulation on the Storage Tank

Directors: Peter G Byrne - Claire Byrne
Registered Office: "Hampdale", Cedarwood Road, Glasnevin, Dublin 11.
Phone: 01 834 0152, Fax 01 8068475 - Mobile 086 8261784 Email byrnepg@indigo.ie
Company Registration Number: 327994

Plate 4 – Asbestos Spark Guard in the Main Electrical Shed

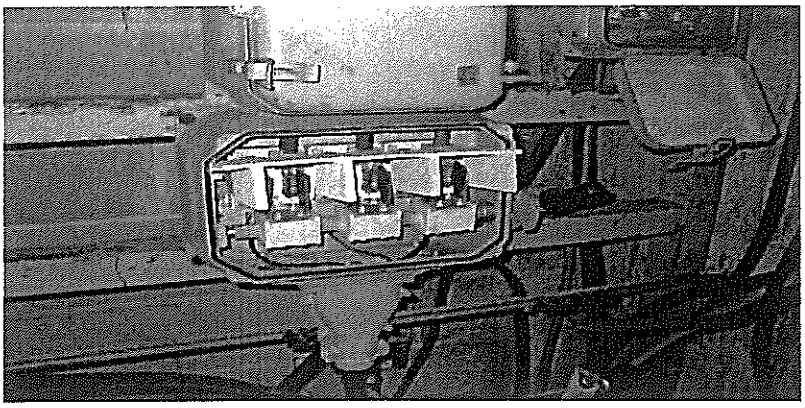

Plate 5 – Asbestos Roof on the Fuel Shed

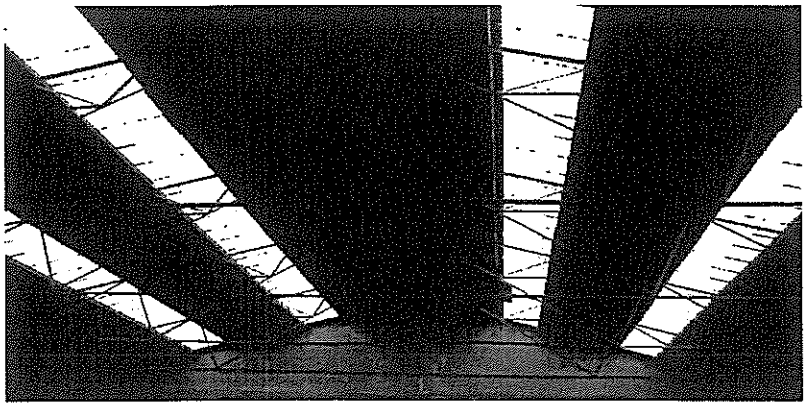

Plate 6 – Asbestos Down Pipe and Gutter on the Fuel Shed

Plate 7 – Asbestos Roof on the Main Electrical Shed

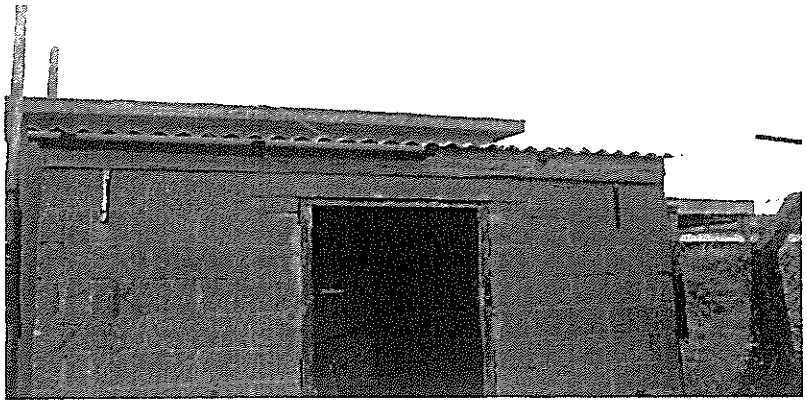

Plate 8 – Asbestos Roof on Building beside the Car Park

Plate 9 – Asbestos Panels on Prefab near the Main Electrical Shed

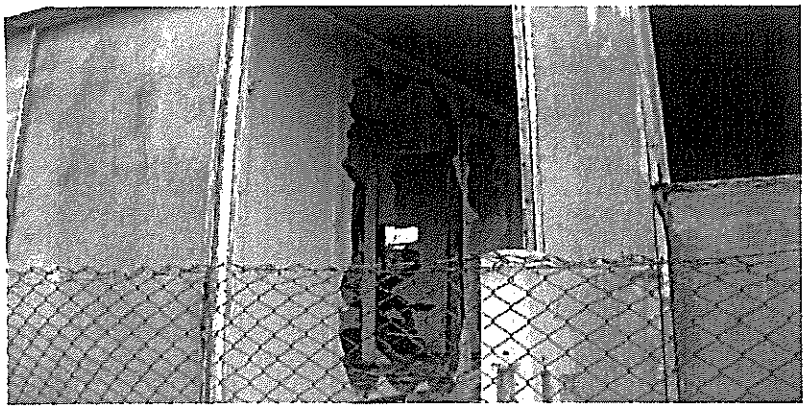

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Plate 10 – Asbestos Gasket near the Insulated Tank

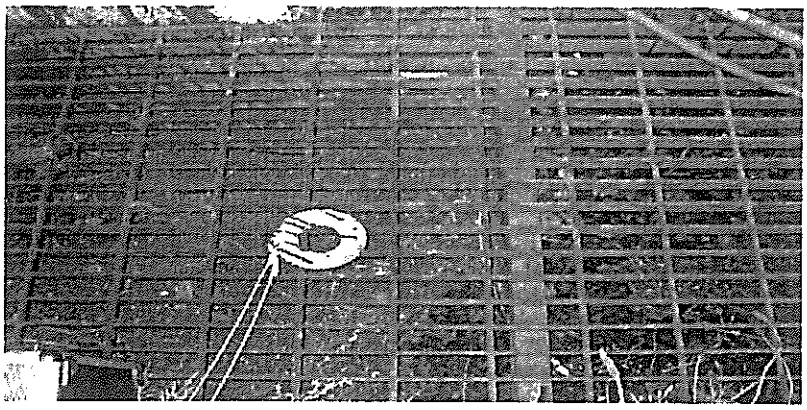

Plate 11 – Floor Tiles with Bitumen Adhesive in the Administration Block

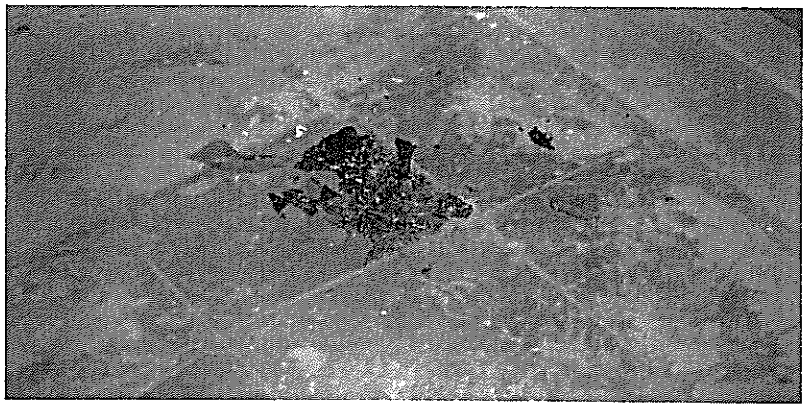

Plate 12 – Shires "Lynx" Toilet Cistern outside the Administration Block

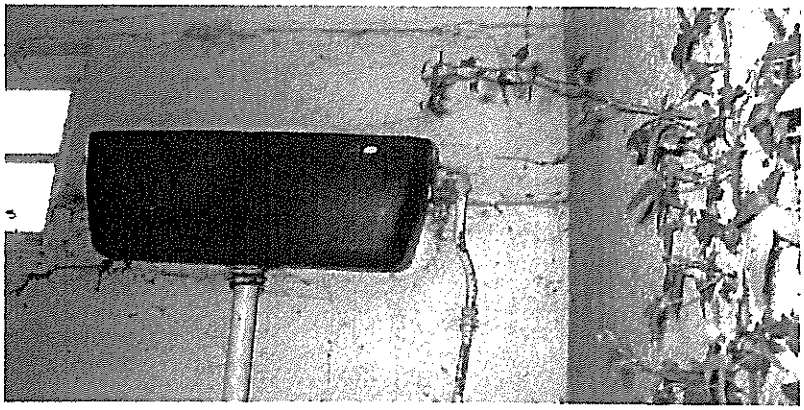

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Plate 13 – Felt Patch on the Sink in the Administration Block

Plate 14 – Webbing on Valve beside the Insulated Tank

Plate 15 – The Electrical Switch Room near the Entrance

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INTRODUCTION

Six samples of possible asbestos containing materials (marked as in the table below) were taken during a survey of the premises listed below on the 14th October for determination of the presence and type of asbestos.

TESTS

The samples were analysed on the 15th October according to an in house laboratory procedure based on MDHS/77 "Identification of Asbestos by Optical Microscopy".

RESULTS

Site :- Former IFI Tank Farm, Arklow, County Wicklow

Sample Identification	Laboratory No.	Result
Spark guard in Small mains electrical shed	05/1093	Brown asbestos detected
Fibrous insulation on pipes	05/1094	No asbestos detected
Webbing on pipe valve	05/1095	No asbestos detected
Gasket on catwalk	05/1096	White asbestos detected
Felt patch on kitchen sink	05/1097	No asbestos detected
Floor tiles with bitumen adhesive	05/1098	White asbestos detected in the adhesive

Note: This report refers exclusively to the samples submitted to the laboratory for analysis.

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ACS 5-495

Appendix 1

Site Plan of Former IFI Tank Farm, Arklow

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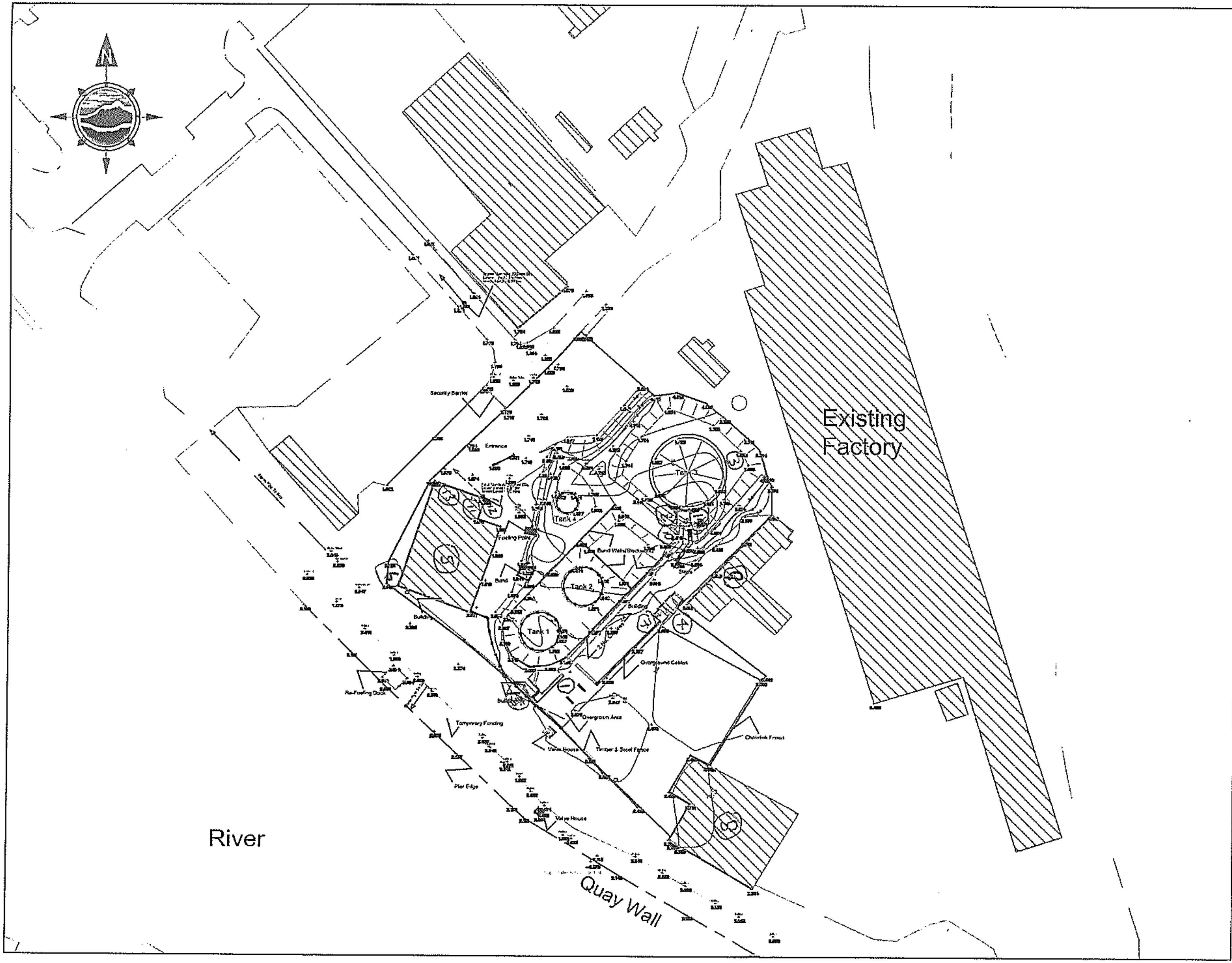

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING

2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE

3. ENGINEER TO BE CONFIRMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES

4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Issue	Date	Description	By	Chkd

Client: Delaney Properties Ltd

Project: Residential Development, Arklow

Title: Site Survey

Scale @ A1: 1:500

Prepared by: JS | Checked: JN | Date: MAY 2005

Project Director: JPK

TOBIN
Patrick J. Tobin & Co. Ltd.
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Fairgreen House, Fairgreen Road,
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e-mail: info@tobin.ie
www.tobin.ie

Drawing No. 2320 - 2000 | Issue: A

APPENDIX B

Window Sample Logs

BRG Ltd.
35 Cleevaun,
Naas, Co Kildare
Tel: 045 874386

Borehole No
WS1
Sheet 1 of 1

Project Name: Arklow - IFI Site	Project No.: R16/05	Co-ords: 325244E - 173208N	Hole Type: WS
Engineer: TES	Drill Type: Pionjar	Level: - / Azimuth: - 90	Scale: 1:25
Client: IFI	Driller: C Bolger	Dates: 14/10/2005	Logged By: G Reid

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
								MADE GROUND Dark brown sandy, gravelly clay, fragments of red brick
					0.70			Loose, Green/grey, Sandy GRAVEL
					0.80			loose, orange, gravelly SAND
		0.50-1.50	J		0.90			Medium dense, light brown, Sandy GRAVEL
					1.65			Dark brown, fibrous PEAT, woody fragments
		1.50-2.80	D		1.85			Medium dense, grey/orange, fine grained, Sandy GRAVEL, minor shell fragments
					2.80			End of Borehole at 2.80 m

1
2
3
4

Type | Results

Remarks: Piezometer Installed

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Borehole No
WS2
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325290E - 173147N		WS
Engineer:	**Drill Type**	**Level:**	**Azimuth**	**Scale**
TES	Pionjar	-	- 90	1:25
Client:	**Driller**	**Dates:**		**Logged By**
IFI	C Bolger	14/10/2005		G Reid

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			TOPSOIL
		0.50-1.50	J					MADE GROUND, sandy gravels with fragments of red brick and slag
		1.50-2.00	D		1.70			Medium dense to dense, orange/grey, fine grained SAND
					2.00			End of Borehole at 2.00 m
			Type	Results				

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2
3
4

Remarks:

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Borehole No
WS3
Sheet 1 of 1

Project Name: Arklow - IFI Site	Project No.: R16/05	Co-ords: 325233E - 173192N	Hole Type: WS
Engineer: TES	Drill Type: Pionjar	Level: - / Azimuth: - 90	Scale: 1:25
Client: IFI	Driller: C Bolger	Dates: 14/10/2005	Logged By: G Reid

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.30			TOPSOIL
					0.75			Loose, dark brown/red Sandy GRAVEL
		0.50-1.50	J					Medium dense, orange to red/brown, locally oxidised, Gravelly SAND
					1.65			Black, pseudofibrous, PEAT
					1.85			Medium dense, grey/black banded SAND
					2.00			Medium dense, orange/brown Sandy GRAVEL, occasional shell fragments
		1.50-3.00	D					
					3.00			End of Borehole at 3.00 m

Type	Results

Remarks:

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Tel: 045 874386

Borehole No
WS4
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325208E - 173164N		WS
Engineer:	**Drill Type**	**Level:**	**Azimuth**	**Scale**
TES	Pionjar	-	- 90	1:25
Client:	**Driller**	**Dates:**		**Logged By**
IFI	C Bolger	14/10/2005		G Reid

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			TOPSOIL
								MADE GROUND, consisting of sub rounded limestone and sandstone gravels with red brick fragments in a light brown sandy clay
		0.50-1.50	J					
					1.80			Soft/firm, reddish brown, Sandy CLAY, with occassional rounded gravel.
					2.00			Dark brown, fibrous PEAT, woody matter
					2.05			Soft/firm, reddish/brown, Sandy CLAY, with occassional gravel
		1.50-3.00	D					
					2.40			Medium dense, yellowish brown, fine grained SAND.
					2.50			Loose/medium dense, orange/grey, subrounded GRAVEL
					3.00			End of Borehole at 3.00 m
			Type	Results				

1 2 3 4

Remarks:

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Tel: 045 874386

Borehole No
WS5
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325217E - 173157N		WS
Engineer: TES	Drill Type Pionjar	Level: -	Azimuth - 90	Scale 1:25
Client: IFI	Driller C Bolger	Dates: 14/10/2005		Logged By G Reid

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
								TOPSOIL
					0.50			MADE GROUND, gravelly clays with fragments of red brick
		0.50-1.50	J					
					1.55			Medium dense, orange brown fine grained SAND
					1.60			Medium dense, yellow fine grained SAND and medium grained GRAVEL
		1.50-3.00	D					
					2.35			Soft/firm, black, organic CLAY, with wood fragments, strong organic smell.
					2.40			Mediun dense, grey, fine grained SAND
					2.65			Medium dense, orange, fine grained GRAVEL
					3.00			End of Borehole at 3.00 m
			Type	Results				

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4

Remarks:

BRG

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Borehole No
WS6
Sheet 1 of 1

Project Name: Arklow - IFI Site	Project No.: R16/05	Co-ords: 325226E - 173140N	Hole Type: WS
Engineer: TES	Drill Type: Pionjar	Level: - / Azimuth: - 90	Scale: 1:25
Client: IFI	Driller: C Bolger	Dates: 14/10/2005	Logged By: G Reid

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.50-1.50	J					MADE GROUND, Sandy clays with gravels, fragments of red brick and glass
					1.50			Medium dense, dark red/brown Sandy GRAVEL
		1.50-3.00	D		2.35			Black fibrous PEAT, woody fragments
					2.37			Medium dense, banded grey and black, SAND
					3.00			End of Borehole at 3.00 m

1
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4

Type | Results

Remarks:

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Borehole No
WS7
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325221E - 173221N		WS
Engineer:	**Drill Type**	**Level:**	**Azimuth**	**Scale**
TES	Pionjar	-	- 90	1:25
Client:	**Driller**	**Dates:**		**Logged By**
IFI	C Bolger	15/10/2005		G Reid

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
								TOPSOIL
					0.30			Loose, light brown to orange brown SAND & GRAVEL
					0.70			Medium dense, brown/reddish brown Sandy GRAVEL
		0.50-1.50	J					
		1.50-2.80	D					
					2.80			End of Borehole at 2.80 m
			Type	Results				

Remarks: Piezometer Installed

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Tel: 045 874386

Borehole No
WS8
Sheet 1 of 1

Project Name: Arklow - IFI Site	Project No.: R16/05	Co-ords: 325246E - 173115N	Hole Type: WS
Engineer: TES	Drill Type: Pionjar	Level: - / Azimuth: - 90	Scale: 1:25
Client: IFI	Driller: C Bolger	Dates: 15/10/2005	Logged By: G Reid

Well	Water Strikes	Samples & In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
								TOPSOIL
					0.55			MADE GROUND, Bands of sand and gravel inter-digitating with zones of gravelly rubble containing red brick and slag fragments
		0.50-1.50	J					
		1.50-2.80	D					
					2.55			Medium dense, orange, fine grained, SAND
					2.80			End of Borehole at 2.80 m

Type	Results

Remarks:

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Borehole No
WS9
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325236E - 173109N		WS
Engineer:	**Drill Type**	**Level:**	**Azimuth**	**Scale**
TES	Pionjar	-	- 90	1:25
Client:	**Driller**	**Dates:**		**Logged By**
IFI	C Bolger	15/10/2005		G Reid

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			TOPSOIL
		0.50-1.50	J					MADE GROUND, sandy, clayey gravels, with fragments of red brick, coal slag, plastic bag, and tyre rubber.
		1.50-2.80	D		2.20			Loose, brown, sub-angular GRAVEL
					2.80			End of Borehole at 2.80 m
			Type	Results				

Remarks: Piezometer Installed

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Tel: 045 874386

Borehole No
WS10
Sheet 1 of 1

Project Name	Project No.	Co-ords:		Hole Type
Arklow - IFI Site	R16/05	325276E - 173091N		WS
Engineer:	**Drill Type**	**Level:**	**Azimuth**	**Scale**
TES	Pionjar	-	- 90	1:25
Client:	**Driller**	**Dates:**		**Logged By**
IFI	C Bolger	15/10/2005		G Reid

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			Tarmac underlain by loose fill
		0.50-1.50	J					Loose, grey to red/brown Sandy GRAVEL
					1.50			Loose, red/brown Gravelly SAND
		1.50-2.00	D		1.70			Loose, orange/brown Gravelly SAND
					2.00			End of Borehole at 2.00 m
			Type	Results				

1
2
3
4

Remarks:

BRG

APPENDIX C

Alcontrol Laboratories Ltd. Analytical Report

☑ Interim
☐ Validated

ALcontrol Laboratories Ireland

Table Of Results

Ref Number: 05-B05488/01
Client: TES (Dublin)
Date of Receipt: 17/10/2005
(of first sample)

Sample Type: SOIL
Location: Arklow IFI
Client Contact: Mark Conroy
Client Ref: 1307

	Detection Method		FLAME PHOTO	GC	GC	GC	GC	GC	GC	GC	GC	GC	GCMS	GCMS	GCMS	GCMS	GCMS
	Method Detection Limit		<4mg/kg	<1mg/kg	<1mg/kg	n/a	<10ug/kg	<10ug/kg	<10ug/kg	<10ug/kg	<10ug/kg	<10ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg
	UKAS Accredited		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
ALcontrol Reference	Sample Identity	Other ID	Sodium	Diesel Range Organics	Mineral Oil by GC	DRO Interpretation	Petrol Range Organics C5-C9	Petrol Range Organics C10-12	Benzene	Toluene	Ethylbenzene	Total Xylene	Total PCB	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene
			mg/kg	mg/kg	mg/kg		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
05-B05488-S0004	WS1	0.50-1.50	305	862	<1	See attached	<10	<10	<10	<10	<10	<10	-	127104	18956	24910	51907
05-B05488-S0005	WS2	0.50-1.50	331	937	<1	See attached	<10	<10	<10	<10	<10	<10	-	1882	3231	1708	4145
05-B05488-S0006	WS3	0.50-1.50	1213	701	<1	See attached	<10	<10	<10	<10	<10	<10	-	257	134	248	298
05-B05488-S0007	WS4	0.50-1.50	485	27	<1	See attached	<10	<10	<10	<10	<10	<10	-	153	56	43	74
05-B05488-S0008	WS5	0.50-1.50	2177	67	<1	See attached	<10	<10	<10	<10	<10	<10	1	168	200	86	130
05-B05488-S0009	WS6	0.50-1.50	603	61	<1	See attached	<10	<10	<10	<10	<10	<10	<1	205	120	95	110
05-B05488-S0010	WS7	0.50-1.50	1367	131	<1	See attached	<10	<10	<10	<10	<10	<10	-	499	378	707	908
05-B05488-S0011	WS8	0.50-1.50	939	185	<1	See attached	<10	<10	<10	<10	<10	<10	<1	379	213	151	236
05-B05488-S0012	WS9	0.50-1.50	902	58	<1	See attached	<10	<10	<10	<10	<10	<10	-	188	246	142	175
05-B05488-S0013	WS10	0.50-1.50	479	158	<1	See attached	<10	<10	<10	<10	<10	<10	-	114	43	50	36

Notes : METHOD DETECTION LIMITS ARE NOT ALWAYS ACHIEVABLE DUE TO VARIOUS CIRCUMSTANCES BEYOND OUR CONTROL.
THE DATA ON THIS PRELIMINARY REPORT IS NOT VALIDATED AND MAY BE SUBJECT TO CHANGE.

NDP = NO DETERMINATION POSSIBLE

Checked By : Dylan Halpin

* SUBCONTRACTED TO OTHER LABORATORY / ** SAMPLES ANALYSED AT THE CHESTER LABORATORY

☑ Interim
☐ Validated

ALcontrol Laboratories Ireland

Table Of Results

Ref Number: 05-B05488/01
Client: TES (Dublin)
Date of Receipt: 17/10/2005
(of first sample)

Sample Type: SOIL
Location: Arklow IFI
Client Contact: Mark Conroy
Client Ref: 1307

	Detection Method		GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GCMS	GRAVIMETRIC	ICP	ICP
	Method Detection Limit		<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<1ug/kg	<0.1%	<0.5mg/kg	<0.5mg/kg
	UKAS Accredited		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
ALcontrol Reference	Sample Identity	Other ID	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)+Benzo(k) fluoranthene	Benzo(a)pyrene	Indeno(123cd)pyrene	Dibenzo(ah)anthracene	Benzo(ghi)perylene	Total 16 EPA PAHs	Natural Moisture Content	Arsenic Low Level	Cadmium Low Level
			ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	%	mg/kg	mg/kg
05-B05488-S0004	WS1	0.50-1.50	241256	96412	189050	160795	70325	71691	39527	38509	19847	10271	20015	1180575	10.3	<0.5	<0.5
05-B05488-S0005	WS2	0.50-1.50	36632	11350	39549	31102	14587	14851	1182	10390	5285	1856	5799	183548	18.6	341.0	<0.5
05-B05488-S0006	WS3	0.50-1.50	3843	1054	4086	2823	1957	2140	132	950	543	405	604	19476	15.6	3554.0	<0.5
05-B05488-S0007	WS4	0.50-1.50	742	372	955	727	447	524	319	260	158	72	193	5093	5.4	<0.5	<0.5
05-B05488-S0008	WS5	0.50-1.50	3078	753	4182	2780	2245	2307	145	958	731	465	683	18912	20.4	441.0	<0.5
05-B05488-S0009	WS6	0.50-1.50	1778	460	2438	1933	1375	1484	118	868	670	403	713	12771	16.7	108.0	<0.5
05-B05488-S0010	WS7	0.50-1.50	10673	4161	12260	9496	5657	4808	367	3288	1797	241	1995	57236	13.2	585.0	<0.5
05-B05488-S0011	WS8	0.50-1.50	3044	865	3907	2993	1816	2245	1391	1156	704	499	805	20402	12.4	489.0	<0.5
05-B05488-S0012	WS9	0.50-1.50	2373	972	4251	3532	2778	2556	242	1457	881	603	982	21380	11.6	846.0	<0.5
05-B05488-S0013	WS10	0.50-1.50	480	177	620	455	316	449	226	190	146	233	185	3721	10.6	144.0	<0.5

Notes : METHOD DETECTION LIMITS ARE NOT ALWAYS ACHIEVABLE DUE TO VARIOUS CIRCUMSTANCES BEYOND OUR CONTROL.
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NDP = NO DETERMINATION POSSIBLE

Checked By : Dylan Halpin

* SUBCONTRACTED TO OTHER LABORATORY / ** SAMPLES ANALYSED AT THE CHESTER LABORATORY

☑ Interim
☐ Validated

ALcontrol Laboratories Ireland

Table Of Results

Ref Number: 05-B05488/01
Client: TES (Dublin)
Date of Receipt: 17/10/2005
(of first sample)

Sample Type: SOIL
Location: Arklow IFI
Client Contact: Mark Conroy
Client Ref: 1307

	Detection Method		ICP	ICP	ICP	ICP	ICP	ICP	METER	TITRATION							
	Method Detection Limit		<1mg/kg	<1mg/kg	<1mg/kg	<0.3mg/kg	<0.5mg/kg	<1mg/kg	napH Units	<5mg/kg							
	UKAS Accredited		✓	✓	✓	✓	✓	✓	✓								
ALcontrol Reference	Sample Identity	Other ID	Chromium	Copper	Lead	Mercury Low Level	Selenium Low Level	Zinc	pH	Total Alkalinity as CaCO3							
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pH Units	mg/kg							
05-B05488-S0004	WS1	0.50-1.50	15	139	419	<0.3	<0.5	233	7.69	100							
05-B05488-S0005	WS2	0.50-1.50	12	1153	1918	<0.3	<0.5	725	6.57	50							
05-B05488-S0006	WS3	0.50-1.50	6	970	2225	<0.3	<0.5	1086	5.39	100							
05-B05488-S0007	WS4	0.50-1.50	17	187	369	<0.3	<0.5	329	8.14	300							
05-B05488-S0008	WS5	0.50-1.50	14	1063	7762	<0.3	<0.5	1467	5.71	50							
05-B05488-S0009	WS6	0.50-1.50	19	812	1275	<0.3	<0.5	574	10.66	300							
05-B05488-S0010	WS7	0.50-1.50	16	3578	2751	<0.3	<0.5	1966	5.44	50							
05-B05488-S0011	WS8	0.50-1.50	13	3563	3445	<0.3	<0.5	3634	6.87	250							
05-B05488-S0012	WS9	0.50-1.50	14	1705	2941	<0.3	<0.5	2793	5.26	100							
05-B05488-S0013	WS10	0.50-1.50	31	1047	2423	<0.3	<0.5	512	5.97	150							

Notes : METHOD DETECTION LIMITS ARE NOT ALWAYS ACHIEVABLE DUE TO VARIOUS CIRCUMSTANCES BEYOND OUR CONTROL.
THE DATA ON THIS PRELIMINARY REPORT IS NOT VALIDATED AND MAY BE SUBJECT TO CHANGE.

NDP = NO DETERMINATION POSSIBLE

Checked By : Dylan Halpin

* SUBCONTRACTED TO OTHER LABORATORY / ** SAMPLES ANALYSED AT THE CHESTER LABORATORY

Geochem Analytical Services

Diesel Range Organics/Mineral Oil
by
G.C.

Client Name TES (Dublin)
Client Ref 1307
Sample Matrix Soil

Job Number B05488
Date Extracted/Prepared 19/10/2005
Date Analysed 24/10/2005

Separatory Funnel Ext Yes
Soxtec Extraction No
Column Extraction No

Sample number	Sample Identity	Depth	Diesel Range Hydrocarbons (mg/kg)	Mineral Oil (mg/kg)	Interpretation
004	WS1	0.50-1.50m	862	< 1	Possible PAH's
005	WS2	0.50-1.50m	937	< 1	Possible PAH's
006	WS3	0.50-1.50m	701	< 1	Possible PAH's
007	WS4	0.50-1.50m	27	< 1	No Identification Possible
008	WS5	0.50-1.50m	67	< 1	Possible PAH's
009	WS6	0.50-1.50m	61	< 1	Possible PAH's
010	WS7	0.50-1.50m	131	< 1	Possible PAH's
011	WS8	0.50-1.50m	185	< 1	Possible PAH's
012	WS9	0.50-1.50m	58	< 1	Possible PAH's
013	WS10	0.50-1.50m	158	< 1	Possible PAH's

Checked by Maria Mendez

Appendix E

Report to Irish Fertilizer Industries (IFI) on Sampling and Analysis of Material from the Phosphogypsum ponds (1992)

010397

Report to

Irish Fertiliser Industries (IFI)

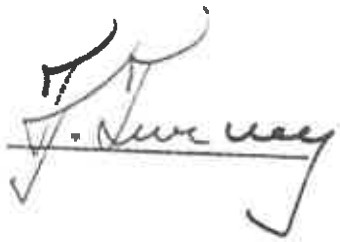
on

Sampling and Analysis of Material

from the Phosphogypsum Ponds

Radiological Protection
Institute of Ireland
3 Clonskeagh Square
Clonskeagh Road
Dublin 14

Report prepared by



Mr FJ Turvey
Assistant Chief Executive
Radiological Protection
Institute of Ireland

REPORT ON THE SAMPLING AND ANALYSIS OF MATERIAL FROM THE PHOSPHOGYPSUM PONDS AT IFI

Background

Following the discovery of scrap metal in County Cork which was significantly contaminated by naturally occurring radioactive material an investigation into its origin was initiated in 1991 by the Nuclear Energy Board - now superseded by the Radiological Protection Institute of Ireland (RPII).

The source of the material was found to be a fertiliser manufacturing plant which had been scrapped some years previously. It was decided to investigate the fertiliser industry in Ireland as a whole to see whether there might be, or might have been, a radiation hazard to workers or members of the public: this work has been completed and the Institute concludes that none existed nor does one exist today. However, it did note the presence of two shallow land disposals sites at IFI Arklow where a by-product of the manufacture of phosphate fertiliser known as "phosphogypsum" had been buried when the factory was engaged in producing phosphate fertiliser in the 1970s. The phosphogypsum is known to concentrate a high percentage of the naturally occurring radioactive material radium which is normally present in the raw phosphate rock used to feed the manufacturing process.

The burial sites, often referred to as ponds because of their shallowness and the high moisture content of the material in them, appeared to be well maintained and contained, having being capped with approximately one metre of shale. Shortly after completing this investigative study the Institute was informed that the proposed route for the Arklow by-pass road runs across the ends of the two ponds and that this might lead to the excavation of the ponds to provide foundations for the road. This prompted questions concerning radiological safety such as, where would the material excavated be disposed of, who would be responsible for resealing the ponds and guaranteeing their tightness in the future and how hazardous would it be to excavate the phosphogypsum? IFI requested the Institute

to sample and analyse the material from the two ponds with a view to clarifying the questions posed by the proposal to route the road over the ponds.

Proposal

The proposal was to bore to a depth of approximately 2 metres at six places, three in each pond along axial centre lines. Each core would provide two samples, one from the lower half of the core (hopefully in phosphogypsum) and the other from the upper half.. Samples of grass and drainage water from the ponds were also proposed. Subsequently, some slight alteration to the sampling procedure was agreed on site with IFI and other interested parties.

Each sample was to be analysed principally for radium-226 but also for lead-214, bismuth-214 and lead-210 using high resolution gamma spectrometers.

Sampling and Dose Rate Measurements

Sampling commenced on Monday 20 July and was scheduled to be completed on the same day. A Cobra drill - see photographs in appendix B - was used to obtain samples. Difficulty was experienced penetrating the cover layer of shale which was firmly compacted - this was unexpected and as a result only one bore hole was drilled. A second visit on the 27 July was made with more suitable attachments for the drill. Sampling of material in the ponds, the grass growing on them and drainage water from the large pond was successfully completed. Appendix A gives details of samples taken and their location. Gamma dose rate readings were taken at ground and minus 0.3m levels at each sampling location using a 900 Series Mini Monitor.

Results

The results of samples analysed are given in table 1. Figure 1 gives the positions from which material from the ponds was taken and figure 2 gives positions of water samples. Other information on the samples is given in Appendix A.

In general the concentration of radioactive material in the samples is lower than expected ie below 1000 Bq/kg. However, the sampled material is still considerably more radioactive (some 20 times) than soils in the locality and this warrants continued care and maintenance of the ponds. It should also be remembered that the radioactive materials are chemically toxic and that other non-radioactive heavy metals, such as cadmium are likely to be present.

No enhancement of normal background gamma radiation dose rate was detected either at the surface of the ponds or just below it. The readings varied between 0.1 and 0.15 μSv/h which are typical for the area.

Contamination of grasses by radium, bismuth and lead was not detected. This result is in accordance with expectations since radium and its non-gaseous daughters usually remain fixed in soils.

The drainage water from the large pond is not heavily contaminated but a larger sample of water will need to be taken for more detailed analysis in order to determine how close contamination levels are to World Health Organisation (WHO) limits for potable water. The water was taken from only one of the two sumps in the large pond since the other sump was dry.

Radioactive polonium, which together with lead is the next most toxic daughter of radium was not measured directly because of the difficulty and expense involved. However, it can be confidently assumed that it is present to the same extent as bismuth and lead.

Conclusions & Recommendations

The two ponds contain naturally occurring radioactive materials, mainly radium, polonium, lead and bismuth. Except for location "X", ie northern extremity of small pond, the samples were mixtures of gypsum, carbon black, shale or sediment. In location "X" samples taken at 1m and 1.5m were white and assumed to be reasonably pure gypsum.

The concentrations of radium, lead and bismuth were measured and that of polonium was inferred from these measurements. The highest concentrations were approximately 20 times higher than in local soils. However, the background gamma dose rate, ie radiation from the ground, is no higher than elsewhere in the locality. There is therefore no external radiation hazard to those who might walk across the ponds. Grass growing on the ponds shows no sign of significant contamination. Although water samples taken from a sump in the large pond indicate an absence of gross contamination there is a need to take a further large quantity sample to enable more precise measurements, which would allow comparison to be made with WHO limits for drinking water.

There would be a potential hazard if the present containment were to be breached. For example, if the phosphogypsum were to be excavated in order to prepare foundations for the proposed road. The potential hazard would be one of internal contamination (by ingestion, inhalation or possibly via an open cut or wound).

If it were necessary to disturb the containment the risk of internal contamination could be minimised and probably rendered acceptably low, however, the Institute would in the first instance recommend the avoidance of breaking into the containment of the ponds. If this cannot be achieved then special provisions for the safety of those working on the site should be made as also should alternative safe disposal for any extracted material.

TABLE 1

Samples from Phosphogypsum Ponds at IFI Arklow - Preliminary Results

Sample Code	Ref. No.	Description	Radioactivity Concentration (Bq/kg)					
			Ra-226	Bi-214	Pb-214	Pb-210	U-238	U-235
92JUL092CR	R-018	Loc A - 0.5m	748 ± 87	467 ± 24	419 ± 20	487 ± 31	43 ± 8	< 7
92JUL093C	R-026	Loc A - 0.65m	740 ± 81	477 ± 23	432 ± 18	596 ± 37	42 ± 7	< 7
92JUL094C	R-024	Loc A - 1.0m	743 ± 117	443 ± 26	398 ± 20	584 ± 44	26 ± 11	< 9
92JUL095CR	R-023	Loc A - 1.5m	622 ± 91	477 ± 25	430 ± 21	476 ± 32	41 ± 8	< 7
92JUL096C	R-016	Loc A - 4m	200 ± 55	131 ± 11	120 ± 8	148 ± 17	51 ± 9	< 6
92JUL097C	R-009	Loc B - 0.5m	482 ± 69	281 ± 16	264 ± 13	393 ± 27	20 ± 8	< 6
92JUL098CR	R-019	Loc B - 1.5m	622 ± 69	423 ± 21	370 ± 17	445 ± 28	33 ± 6	< 6
92JUL099CR	R-020	Loc B - 2.5m	497 ± 66	318 ± 18	280 ± 14	380 ± 27	23 ± 8	< 6
92JUL100C	R-028	Loc C - 0.4m	268 ± 49	176 ± 11	160 ± 8	167 ± 16	69 ± 8	< 5
92JUL101CR	R-029	Loc C - 1.5m	477 ± 109	320 ± 24	286 ± 17	394 ± 39	22 ± 11	<10
92JUL102C	R-032	Loc C - 2.5m	562 ± 95	407 ± 23	354 ± 19	393 ± 32	19 ± 9	< 8
92JUL103CR	R-017	Loc Y - 0.3m	54 ± 60	43 ± 7	44 ± 5	56 ± 15	36 ± 11	< 7
92JUL104C	R-022	Loc Y - 1.5m	759 ± 98	460 ± 23	405 ± 18	459 ± 31	22 ± 8	< 7
92JUL105CR	R-021	Loc Y - 2.5m	408 ± 123	336 ± 30	311 ± 21	284 ± 45	34 ± 19	<14
92JUL106C	R-030	Loc X - 0.3m	<20	20 ± 5	17 ± 3	31 ± 7	49 ± 9	< 3
92JUL111C		Loc A - Grass	<20	<17	<12	<60	<38	<16
92JUL114C		Loc Y - Grass	<20	<13	< 8	<60	<20	<12
92JUL067C	R-013	Loc X - 1.5m	708 ± 35	469 ± 12	429 ± 6	462 ± 19	25 ± 8	< 8
92JUL070C	R-031	Loc X - 1.0m	561 ± 34	344 ± 9	311 ± 5	372 ± 12	22 ± 7	< 7
92JUL068C	R-014	Deep Water	<11	2.4 ± 1.7	< 2	< 4	1.5 ± 2.7	< 2
92JUL069C	R-015	Surface Water	2 ± 2	< 4	< 3	< 3	<10	< 4

Note: All errors quoted on activities are at the 95% confidence level

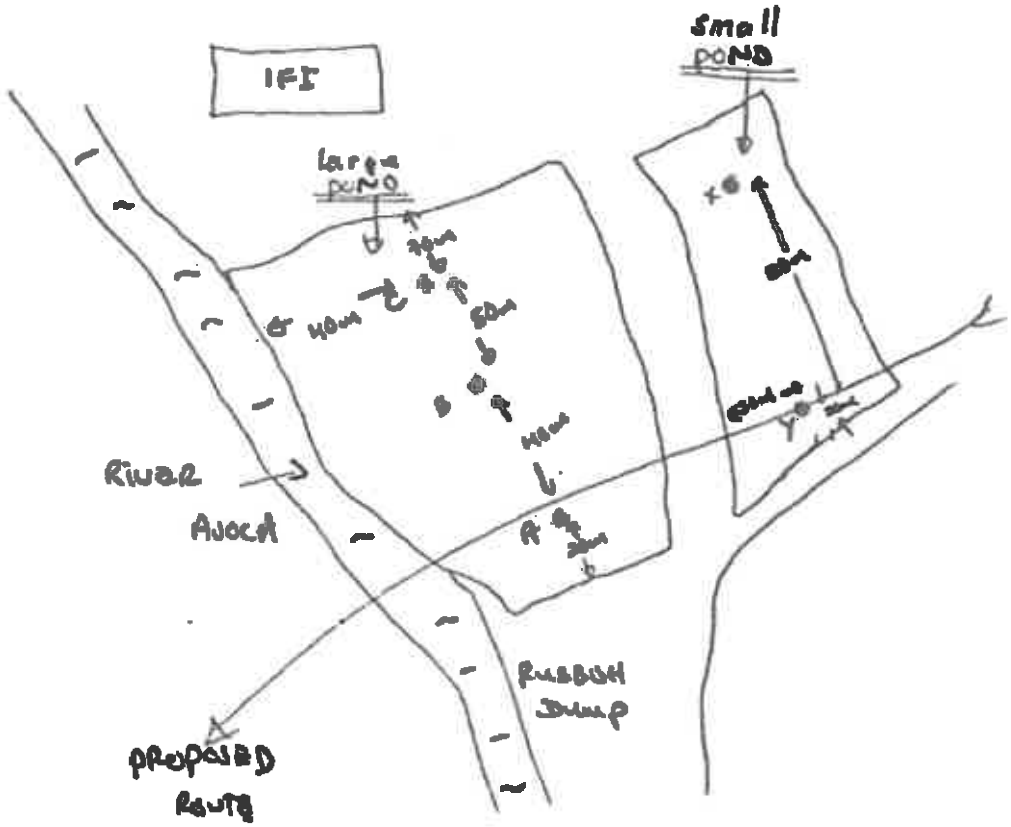


FIGURE 1. **Schematic Diagram of Sampling Locations**

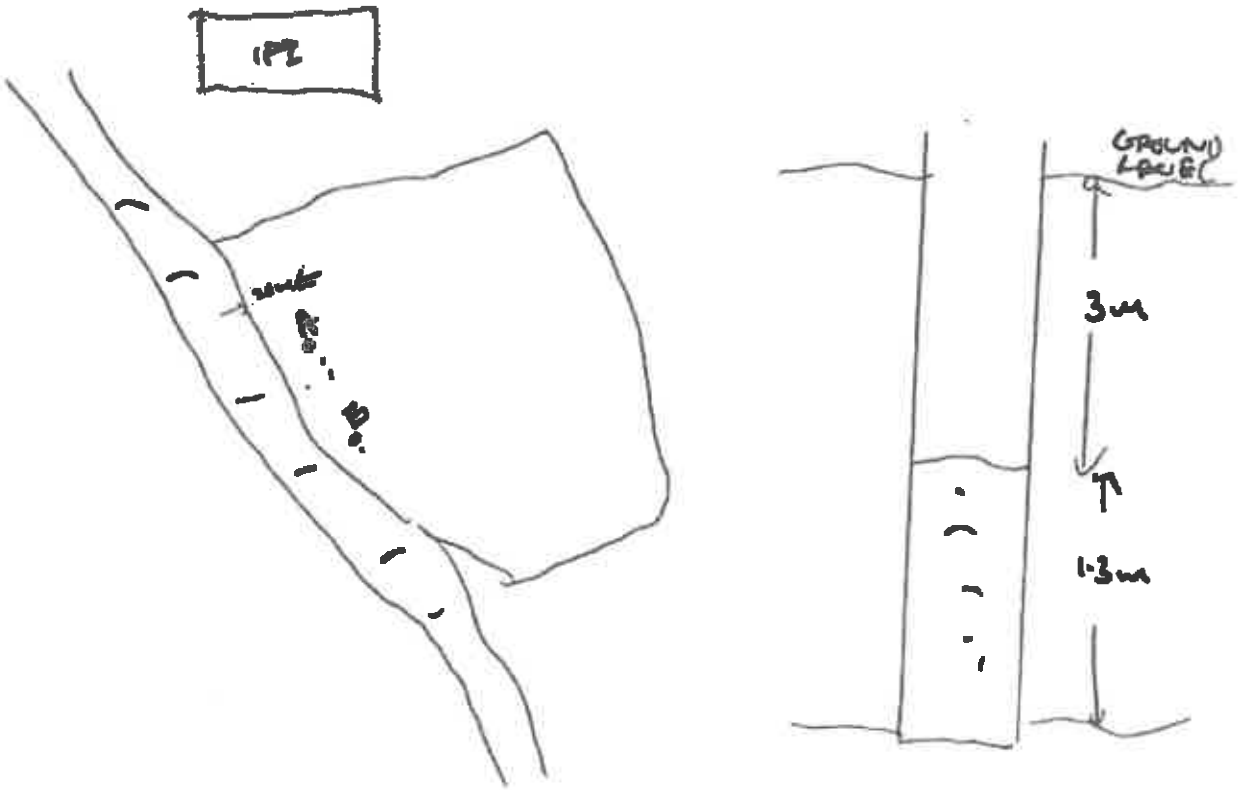


FIGURE 2. **Schematic Diagram of Shaft B and Location for Water Sampling**

APPENDIX A

Samples Collected from IFI Arklow

20/7/92 and 27/7/92

Large Pond

Location A

1. **R-018**
   Sampled at 0.5m
   Mixture of shale and gypsum

2. **R-026**
   Sampled at 0.65m
   Mixture of gypsum and carbon black

3. **R-024**
   Sampled at 1.0m
   Mixture of gypsum and carbon black

4. **R-023**
   Sampled at 1.5m
   Mixture of gypsum and carbon black

5. **R-016**
   Sampled at 4m
   Mixture of gypsum, carbon black and sediment/sand

6. **Grass sample - large pond #1**

7. **R-014**
   Water sample from bed level of well shaft B about 4.3m below ground level

8. **R-015**
   Water sample from surface of water in shaft B about 3m below ground level

Location B

1. **R-009**
   Sampled at 0.5m
   Mixture of gypsum and carbon black

2. R-019
Sampled at 1.5m
Mixture of gypsum and carbon black

3. R-020
Sampled 2.5m
Mixture of gypsum and carbon black

4. Grass sample - large pond #2

Location C

1. R-028
Sampled at 0.4m
Mixture of shale, gypsum and carbon black

2. R-029
Sampled at 1.5m
Mixture of gypsum and carbon black

3. R-032
Sampled at 2.5m
Mixture of carbon black (moist) and gypsum

4. Grass sample - large pond #3

Large Pond

Location Y

1. R-017
Sampled at 0.3m
Mixture of shale and gypsum

2. R-022
Sampled at 1.5m
Mixture of gypsum and carbon black

3. R-021
Sampled at 2.5m
Mixture of gypsum and carbon black

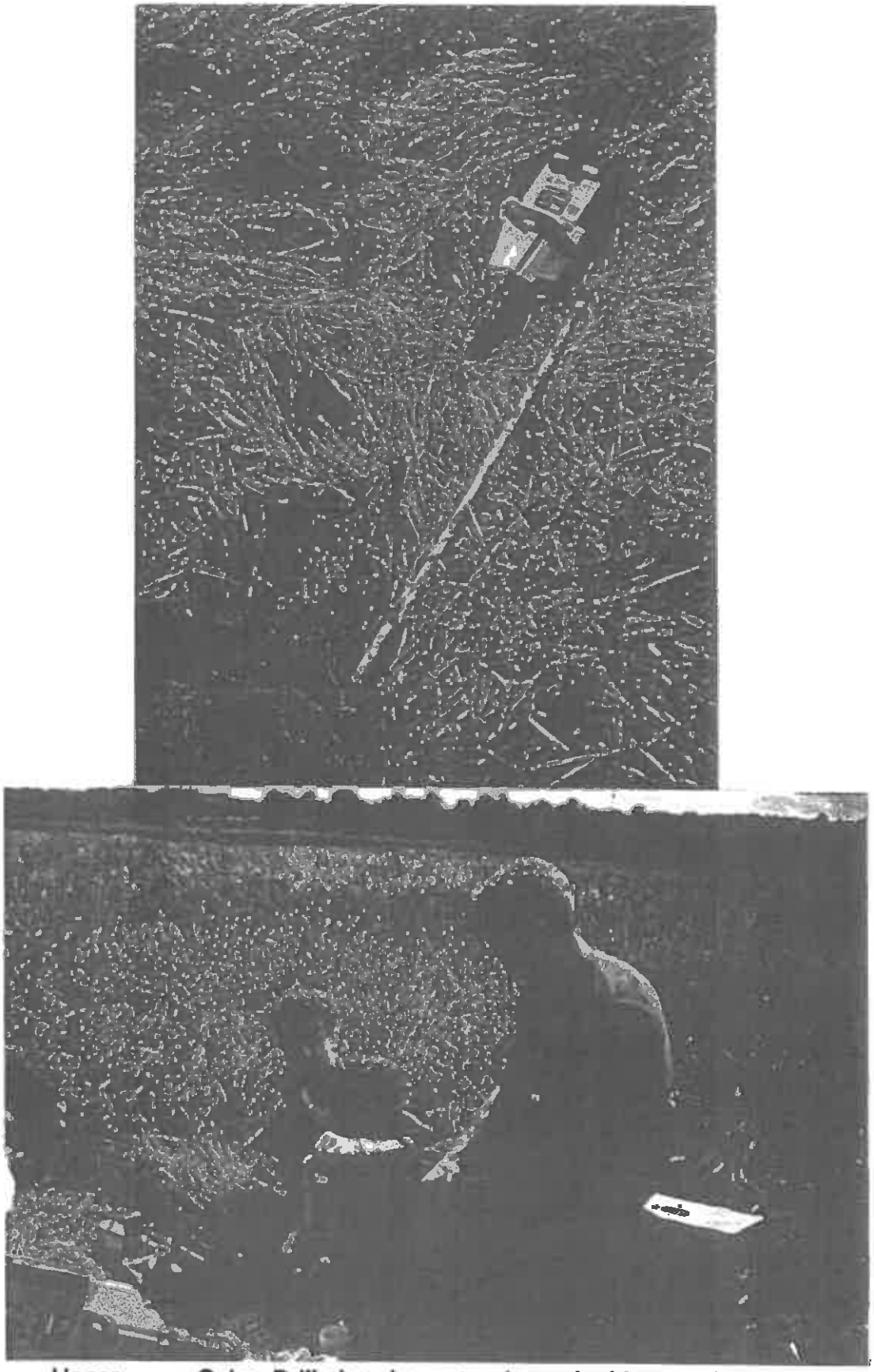
4. Grass Sample - small pond #1

Location X (sampled 20/7/92)

1. R-030
   Sampled at 0.3m
   Mixture of shale/soil

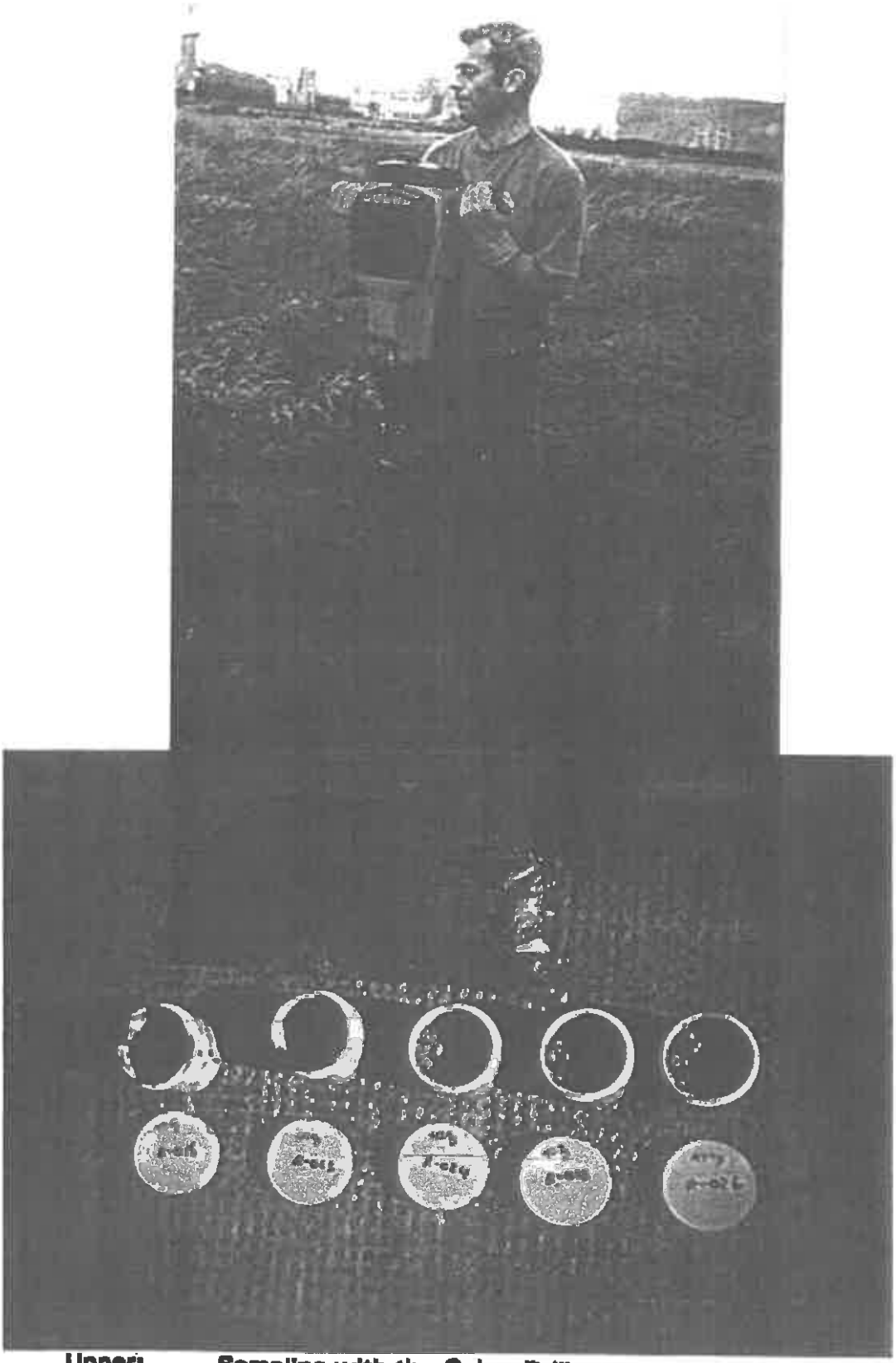
2. R-031
   Sampled at 1.0m
   Gypsum

3. R-013
   Sampled at 1.5m
   Gypsum



Upper: Cobra Drill showing extension rod with sampling bit attached.

Lower: Sampling bit loaded with gypsum.



Upper: Sampling with the Cobra Drill

Lower: Grass and material samples taken from Large Pond.

Appendix F

Report to Ove Arup & Partners on Analysis of samples for the Arklow By-pass Project taken on the 27th of April 1994

10/7/215

Report

to

Ove Arup & Partners Ireland

on

Analysis of Samples for the Arklow By-pass Project
Taken on the 27th of April 1994

15th June 1994

Radiological Protection Institute of Ireland

Introduction

5 soil samples and 1 water sample were analyzed by the Radiological Protection Institute of Ireland (RPII) to determine if they contained enhanced levels of natural radionuclides which could be attributed to phosphate production at the former IFI phosphate fertilizer plant at Arklow. In particular, the samples were analyzed with reference to the isotopes of the ^{238}U and ^{232}Th decay series.

Background

While isotopes of the ^{238}U and ^{232}Th decay series occur naturally in all soils, enhanced levels of these isotopes are sometimes associated with the phosphogypsum by-product of the phosphate fertilizer industry. The most comprehensive source of data on concentrations of these isotopes in Irish soils is the 1991 Soil Survey which was carried out by scientists from Trinity College. This survey found soil concentrations of ^{226}Ra, which is the most radio-toxic of the ^{238}U progeny and which is responsible for a major fraction of the internal dose resulting from naturally occurring radio-isotopes, in the range of 1 to 292 $Bq.kg^{-1}$ with an mean concentration of 46 $Bq.kg^{-1}$. For the ^{238}U progeny ^{234}Th, the survey found a range and mean concentration of 1 to 543 $Bq.kg^{-1}$ and 39 $Bq.kg^{-1}$. Corresponding values for the ^{232}Th progeny ^{228}Ac were 1 to 71 $Bq.kg^{-1}$ and 25 $Bq.kg^{-1}$.

Under equilibrium conditions, the members of each series are present in roughly equal concentrations. However, a number of processes occur naturally in soils to disturb this equilibrium. These include differences in mobility between members of the decay chain due to chemical factors and emanation of radon gas.

Sampling

The samples were taken and delivered to the RPII by Ove Arup & Partners. The sampling date and details of the individual samples were supplied to the RPII by Ove Arup & Partners. The sample date for all samples is the 27th of April 1994. The depths at which each sample was taken is indicated in Table 1.

Laboratory Analysis and Results

The radionuclide concentrations in the soil and water samples were determined using high resolution gamma spectroscopy. The results are given in Table 1 and are corrected to the sampling date, i.e. 27th April 1994. The uncertainty quoted in this table includes only the counting errors which are calculated at 2 sigma. An additional 5% systematic uncertainty applies to all results. These values have been corrected for background and known interferences.

For the water sample the gross beta concentration was also determined. This concentration, correcting for potassium and excluding tritium was found to be less than 1 $Bq.l^{-1}$. Note that 1 $Bq.l^{-1}$ is the action level set by the World Health Organisation for further investigation for drinking water. Note also that gross beta is essentially used as a screening technique and so this data should not be compared directly with the gamma spectroscopy data.

Table 1
Gamma Spectroscopy Data for Arklow ByePass

Sample Type	Sample Depth (meters)	Activity Concentration (Bq/Kg-wet)					
		^{235}U	^{226}Ra	^{214}Pb	^{214}Bi	^{228}Ac	^{212}Pb
Soil	6.0 M	32.66 ± 5.8	41.46 ± 8.9	35.12 ± 0.9	34.83 ± 1.0	24.26 ± 1.1	22.8 ± 0.7
Soil	4.0 M	25.85 ± 5.6	15.3 ± 7.5	16.46 ± 0.8	16.21 ± 0.8	12.77 ± 1.1	12.43 ± 0.7
Soil	3.5 M	28.82 ± 4.5	34.88 ± 9.4	26.66 ± 1.2	25.37 ± 1.2	17.42 ± 1.5	17.93 ± 1.0
Soil	7.5 M	< 7.4	9.26 ± 6.0	< 1.6	< 1.6	< 3.2	< 1.2
Soil	1.0 M	14.60 ± 5.5	25.15 ± 10.0	15.04 ± 1.1	13.48 ± 1.1	< 3.3	16.7 ± 1.1
Water	3.9 M	< 2.3	< 5.7	1.36 ± 0.3	< 0.45	< 0.7	0.65 ± 0.24

Conclusions

1) All soil measurements are within those considered typical of natural radioactivity levels in Irish soils.

2) The measurements made on the 6 samples (5 soil and 1 water) indicate that at the sampling location and depths the levels of naturally occurring radionuclides have not been enhanced by the activities of the phosphate industry.

David Pollard
(Laboratory Manager)

Introduction

5 soil samples and 1 water sample were analyzed by the Radiological Protection Institute of Ireland (RPII) to determine if they contained enhanced levels of natural radionuclides which could be attributed to phosphate production at the former IFI phosphate fertilizer plant at Arklow. In particular, the samples were analyzed with reference to the isotopes of the ^{238}U and ^{232}Th decay series.

Background

While isotopes of the ^{238}U and ^{232}Th decay series occur naturally in all soils, enhanced levels of these isotopes are sometimes associated with the phosphogypsum by-product of the phosphate fertilizer industry. The most comprehensive source of data on concentrations of these isotopes in Irish soils is the 1991 Soil Survey which was carried out by scientists from Trinity College. This survey found soil concentrations of ^{226}Ra, which is the most radio-toxic of the ^{238}U progeny and which is responsible for a major fraction of the internal dose resulting from naturally occurring radio-isotopes, in the range of 1 to 292 $Bq.kg^{-1}$ with an mean concentration of 46 $Bq.kg^{-1}$. For the ^{238}U progeny ^{234}Th, the survey found a range and mean concentration of 1 to 543 $Bq.kg^{-1}$ and 39 $Bq.kg^{-1}$. Corresponding values for the ^{232}Th progeny ^{228}Ac were 1 to 71 $Bq.kg^{-1}$ and 25 $Bq.kg^{-1}$.

Under equilibrium conditions, the members of each series are present in roughly equal concentrations. However, a number of processes occur naturally in soils to disturb this equilibrium. These include differences in mobility between members of the decay chain due to chemical factors and emanation of radon gas.

Sampling

The samples were taken and delivered to the RPII by Ove Arup & Partners. The sampling date and details of the individual samples were supplied to the RPII by Ove Arup & Partners. The sample date for all samples is the 27th of April 1994. The depths at which each sample was taken is indicated in Table 1.

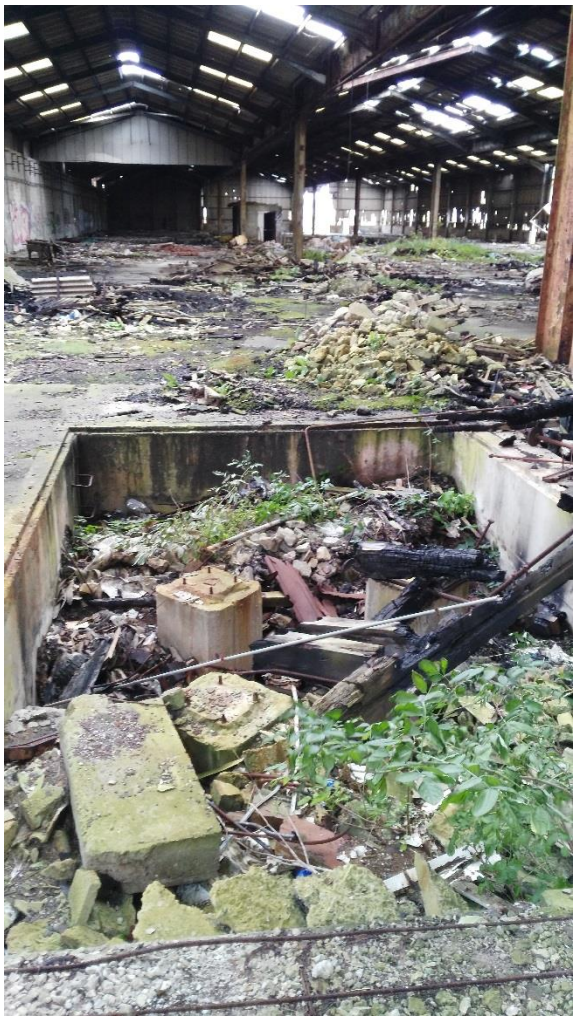
Appendix G

Photographs Taken During Site Visit on 18 October 2017

Photograph 11: Factory building, facing south.

Photograph 12: Inside factory building, facing north.

Photograph 13: Pit inside factory building, facing south.



Photograph 14: Trenches inside factory building.